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Urban Soil Lead Abatement Demonstration Project

Volume II: Boston Report

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Urban Soil Lead Abatament Demonstration Project

Volume II: Boston Report

Environmental Criteria and Assessment Office
Office of Health and Environmental Assessment
Office of Research and Development
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

BOSTON LEAD-IN-SOIL/LEAD FREE KIDS DEMONSTRATION PROJECT

Final Report

Submitted July 1992

to

The Environmental Protection Agency

by

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1. EXECUTIVE SUMMARY

Perceptions of the child lead poisoning problem have steadily changed as evidence has accumulated demonstrating subtle but serious consequences of lead exposure levels previously believed to be innocuous. Whereas concern 25 years ago was directed at symptomatic children with blood lead levels of 60 μg/dL and above, the Centers for Disease Control recently redefined lead poisoning as a blood lead level greater than 10 μg/dL. It is estimated that in 1984 17% of all children in the United States aged six months to five years had blood lead levels of 15 μg/dL or greater and that in many cities as many as 35-50% have blood lead levels in excess of 10 μg/dL. There is currently no lead level believed to be safe for children.

Children have multiple potential sources of lead exposure. The most important recognized sources include lead contaminated paint, dust, and water. Paint used on both interior and exterior surfaces of houses through the 1950's and continuing, to some extent through much of the 1970's, often contained high concentrations of lead. Dust is now recognized as a major vector by which children are exposed to lead via normal hand-to-mouth activities. Lead in house dust derives, in part, from deteriorating lead based paint within the house, and in part from lead contaminated soil and dust from areas outside the home. Children may also ingest lead from pottery, canned foods, and numerous other sources, although these are generally viewed as minor sources of exposure for most children.

Concern has been raised recently that lead contaminated soil in older urban areas is another important vector for children's exposure to lead. The sources of soil contamination include deteriorated exterior paint, past deposition of airborne lead from gasoline, and point sources such as smelters, incinerators, and other industrial activities. At present lead contaminated soil is neither regularly removed as part of a comprehensive strategy to prevent childhood lead poisoning, nor removed as part of environmental interventions on behalf of children who have already suffered excessive exposure. In part, this is due to the lack of data demonstrating the effectiveness of lead contaminated soil abatement.

There is general agreement that children's exposure to lead should be reduced as much as possible and that there is an urgent need to develop practical means for the prevention and

treatment of low level lead exposure. In 1986 the reauthorization of the Superfund toxic waste cleanup program (SARA) included a provision providing funds for projects to evaluate the impact of residential lead contaminated soil abatement on children's blood lead levels. Boston was chosen to implement one of these projects, Baltimore and Cincinnati are the sites of the other two projects.

This report describes the randomized environmental intervention study conducted in Boston to determine the effect of removing lead contaminated soil on children's blood lead levels. The study was designed to test the following hypothesis:

> A reduction of 1,000 PPM or more of lead in soil accessible to children will result in a mean decrease of at least 3 μg/dL in the blood lead levels of urban preschool children living in areas with high soil lead levels, multiple potential sources of lead exposure, and a high incidence of lead poisoning.

The report also describes the range of costs associated with lead contaminated soil, dust, and paint abatement and practical issues that arose during these abatement activities.

The study was conducted by investigators from the Boston University Schools of Medicine and Public Health, the Harvard School of Medicine, and the Boston Department of Health and Hospitals with full approval of the Human Studies Committee of the Trustees of Health and Hospitals of the City of Boston and in conjunction with the United States EPA (Region I, and Research Triangle Park which is coordinating the Three-City Study).

1.1 LEAD POISONING AND LEAD CONTAMINATED SOIL IN BOSTON

As in many cities in the United States, childhood lead poisoning is a common problem in Boston. It has been estimated that approximately 24% of Boston children 6 months to 5 years of age have blood lead levels greater than 15 μg/dL and 69% have blood lead levels greater than 10 μg/dL. While occurring throughout most of the City, most of the lead poisoning cases are concentrated within very limited geographic areas. Thirty percent of all cases in the City between October 1979 and February 1985 occurred among the 4% of preschool children who resided in 28 areas encompassing two-three city blocks. In these areas more than one of every four children was poisoned during this period. Whereas the

average surface soil lead concentration in Boston is approximately 600 PPM, the surface soil lead level in these areas averaged more than 3,000 PPM in tests done before the start of our study.

1.2 IDENTIFICATION AND ENROLLMENT OF STUDY POPULATION

The study population was drawn from children living in and around the areas described above who were under four years of age on August 1, 1989 and had finger stick blood lead levels of 10-20 μg/dL determined as part of the screening efforts of the Boston Childhood Lead Poisoning Prevention Program between January and June 1989. Additional children up to four years of age who lived on the same premises as these children were also identified for enrollment. Homes of potential participants were visited by study staff to determine if they met the following additional eligibility criteria: the cumulative amount of chipping or peeling paint did not exceed 30% of the total surface area on the exterior walls of the child's home or exceed 40% on the walls of abutting premises (these percentages were determined by visual inspection); premises had a yard of at least ten square feet composed of dirt and/or grass that was accessible to the child; the mean or median surface soil lead level was 1,500 PPM or greater; the child resided in a dwelling with eight or fewer residential units, was mobile, and had never been lead poisoned; and the family resided on premises for at least three months and had no plans to move within the three months of enrollment.

All children meeting these criteria had venous blood lead determinations beginning in August, 1989 and those with lead levels between 7 and 24 μg/dL were enrolled. The baseline venous lead levels were obtained prior to any environmental abatement activities. Children with blood lead levels above 24 μg/dL were excluded because they met the former definition of lead poisoning and were likely to undergo medical and environmental interventions that could obscure any changes associated with the study interventions. All these children were referred to the Boston Childhood Lead Poisoning Prevention Program and followed according to Massachusetts state law and lead program case management protocols.

Informed consent for participation was obtained both from the parents and landlord. One hundred and fifty two children were enrolled in the study. Participants were randomly assigned to one of three groups: 54 in the Study Group, 51 in Control Group A, and 47 in Control Group B. The Study Group received loose interior paint removal, interior dust abatement, and soil abatement. Control Group A received loose interior paint removal and interior dust abatement. Control Group B received only loose interior paint removal. Several study groups were employed to enable separation of the effects of soil and interior dust abatement. Children who moved during the study were traced and whenever possible, interviews and blood, handwipe, and environmental samples were obtained at both the new and original residence according to the study schedule.

1.3 ENVIRONMENTAL MEASUREMENTS

1.3.1 Soil

Soil sampling was conducted to determine eligibility of properties, characterize the potential exposure of participants to lead from the soil, document lead levels after abatement and monitor the rate of recontamination after abatement. A detailed protocol for soil sampling and analysis was developed in conjunction with the EPA. After enrollment, approximately eight composite surface and eight core samples at a depth of 15 cm were taken at each property Post abatement and recontamination assessment samples were taken at every other previously sampled location. Soil samples were analyzed by x-ray fluorescence by the EPA Region I Laboratory.

1.3.2 Dust

Household dust sampling was conducted to characterize the potential exposure of children to lead from dust, to document the reduction in dust lead levels following abatement, and to monitor rates of recontamination after abatement. Dust on upfacing surfaces believed most accessible to the child was sampled. Six-seven samples in each household were obtained from the following locations: entry floor, and the window wells and floors from the kitchen, living room, and child's bedroom Both the lead concentration in the dust and the amount of dust per unit area (loading) were determined. A detailed

protocol for dust sampling and quality assurance plan for the sampling and analysis of soil and dust was developed by Region I of the EPA.

1.3.3 Water

Two water samples were taken during the course of the study. Each was a first flush sample taken by the parent from the cold water faucet in the kitchen. Water samples were analyzed by a private laboratory. Water lead sampling and analysis was conducted according to the standard EPA protocol.

1.3.4 Paint

In the second year of the study (1990) portable x-ray fluorescence analyzers (PGT XK-3) were used to identify lead in paint. Measurements were taken in the child's bedroom, kitchen, and living room. One measurement was taken on the lower part of the wall and one was taken on the window sill in each room according to a detailed protocol for lead paint inspection.

1.4 CHILD AND FAMILY MEASURES

1.4.1 Social and Behavioral Questionnaire

Questionnaires were administered to parents to ascertain family demographic characteristics and possible sources of lead exposure, to obtain information about renovations, and to characterize children's exposure to lead in soil. Follow-up interviews were conducted toward the end of the study to assess changes in child behavior, house cleaning and new renovations.

1.5 OUTCOME MEASURES

1.5.1 Blood Samples

Venous samples were obtained to determine blood lead levels on three occasions: the first was taken prior to any abatement activities, the second an average of six months after

abatement activities, and the third an average of 11 months post-abatement. Serum ferritin levels were obtained at baseline. Blood lead levels were determined using graphite furnace atomic absorption and FEP levels were determined using a zinc protoporphyrin hematofluorometer. The detection limit was 1 μg/dL for blood lead, and a total method coefficient of variation was 13.8% at the 10 μg/dL blood lead level. The laboratory maintained a strict internal quality control system for the blood lead analyses. In addition, the laboratory participated in the external quality control system developed and overseen by the Centers for Disease Control.

1.5.2 Hand Lead Determinations

Handwipe samples were obtained each time blood samples were drawn. Parents were asked not to wash the child's hands for the two hours immediately preceding sampling. Wearing disposable gloves, a study staff member wiped all surfaces of each hand, front and back up to the wrist, with three commercial wetwipes. To assess the extent of any contamination during sampling, field blanks consisting of six additional wipes were handled so as to simulate wiping the child's hands, and set aside to determine the background wetwipe lead levels. Field blanks were taken for every tenth child. Each set of six wetwipes was composited for chemical analysis and extraction of the lead utilized 1N hot HNO_3. The total quantity of lead was reported in μg per pair of hands.

1.5.3 Environmental Interventions

The purpose of the soil abatement was to remove lead contaminated soil accessible to the children living on the premises. A six inch layer of topsoil was removed and replaced with 6 inches of clean topsoil. A water permeable geotextile fabric barrier was laid directly on top of the exposed subsurface immediately following removal of topsoil and prior to placement of clean topsoil, so as to protect against recontamination by the subsurface soil. The lead content of the surface soil was tested and then covered with sod, grass seed, bark, or mulch. The abated lots ranged from 12 to 702 square meters, and 3-182 cubic yards of soil were removed per lot. Soil disposal was accomplished in accordance with guidelines developed in conjunction with the Massachusetts Department of Environmental Protection.

Lead contaminated soil was removed to a location with limited access - a quarry abutting a cemetery in Boston.

The purpose of loose paint abatement was to minimize lead based paint as a potential source of children's exposure during the study period by removing loose chipping paint from the inside of the home. Loose paint abatement consisted of vacuuming the loose paint areas with HEPA (High Efficiency Particulate Aerosol Filter) vacuums, washing loose paint areas with a trisodium phosphate and water solution, and painting the window wells with primer.

The purpose of the interior dust abatement was to significantly reduce the amount of lead bearing dust in the treated homes. It consisted of HEPA vacuuming and wiping surfaces with a wet cloth, or for furniture, with an oil treated rag. Floors, including carpeted areas, woodwork, walls, and furniture surfaces were cleaned.

1.6 ANALYSIS

First, crude analyses were conducted of the change from baseline blood lead levels to the first and second post-abatement blood lead levels. Analysis of variance was used to compare mean blood lead changes among the intervention groups and paired t-tests were used to determine whether the mean changes in blood lead levels within an intervention group were significantly different from zero.

Analysis of covariance was used to compare the intervention groups with respect to post-abatement blood lead levels adjusted for pre-abatement levels. The post-abatement blood lead levels were reasonably normally distributed and did not require any transformations. The base model that was used to obtain estimates of adjusted post-abatement blood lead means in the intervention groups was:

$$Y_i = b_0 + b_1 Z_{1i} + b_2 Z_{2i} + b_3 X_i + e_i$$

where for the ith child,

Y_i	=	post-abatement blood lead level
Z_{1i}	=	1 if in Control Group A, otherwise 0
Z_{2i}	=	1 if in Control Group B, otherwise 0
X_i	=	pre-abatement blood lead
e_i	=	error term

The coefficients, b_0, b_1, b_2, and b_3 were estimated using least squares methods, and t-tests were used to test the null hypothesis that b_1 and b_2 were equal to zero.

Potential confounders of the relationship between group assignment and post-abatement blood lead were added to the base model one at a time to obtain adjusted estimates of the group effect adjusted for baseline blood lead level and the potential confounder. More complex models that controlled for several variables simultaneously were also developed. Potential confounders included age, sex, race, socioeconomic status as measured by the Hollingshead Index, mouthing behaviors, and environmental sources of lead (e.g., paint and water). In most instances, the variables were categorized; cutoffs were based on the frequency distribution of the particular variable or on external considerations.

1.7 RESULTS

Only three of the 152 (2%) children enrolled dropped out before completion of the study. Another 22 (14.5%) moved from their original premises but were followed. Baseline characteristics of children in the three groups were similar in most respects. The average age of children was similar across groups, as was the proportion of subjects in the lowest socioeconomic level according to the Hollingshead Index (Classes 4-5). However, the mean pre-abatement blood lead level was higher among children assigned to the Study Group. The proportion of Hispanics was higher in the Study Group than the Control Groups and the proportion of Blacks was lower. There was also a larger proportion of males in the Study Group. Median surface soil lead levels were, on average about 800 PPM higher than those taken at a depth of 15 centimeters.

Median interior floor dust lead levels were similar to the median surface soil levels and median window well dust lead levels were five to seven times higher. The soil and floor dust lead levels were similar across the intervention groups. Window well dust lead levels were more variable across the groups but the differences were not statistically stable. Median first flush tap water lead levels were all above 14 μg/dL and were similar across groups. Lead-based paint was detected in almost all participants' homes and XRF readings on the walls and woodwork were similar among the groups.

1.7.1 Blood Lead Levels

1.7.1.1 Crude Analyses

Mean blood lead levels in all the three groups declined at the first post-abatement sampling round (POST1) and rose at the second post-abatement sampling round (POST2) although for no group did the mean return to the baseline. At POST1 the average blood lead decline was 2.87 μg/dL in the Study Group, 3.52 μg/dL in Control Group A, and 2.04 μg/dL in Control Group B. All declines were significantly different from zero. Between POST1 and POST2 the average blood lead level increased 1.39 μg/dL in the Study Group, 2.69 μg/dL in Control Group A and 1.52 μg/dL in Control Group B. The increases in the two Control Groups were significantly different from zero but the increase in the Study Group was not ($p=.08$).

Two siblings in the Study Group became lead poisoned sometime between the POST1 and POST2 sampling rounds. Their blood lead levels were 19 μg/dL and 12 μg/dL at baseline (PRE) (September 1989), 10 μg/dL and 17 μg/dL, respectively, at POST1 (March 1990) and 35 μg/dL and 43 μg/dL, respectively, at POST2 (July 1990). No other children experienced a blood lead rise of this magnitude during the study. In fact, these two children's POST2 blood lead levels were more than three standard deviations higher than the overall mean POST2 level. The increases were believed to be unrelated to the study interventions since the elevated levels were detected many months after the abatement activities and the siblings were exposed to leaded paint at another site that was being renovated. Therefore, these two children were excluded from subsequent analyses. Without these children, the mean blood lead level in the Study Group increased by only 0.46 μg/dL between POST1 and POST2.

Because the PRE and POST2 sampling rounds are most closely matched on season, subsequent analyses focused on this comparison. The mean decline in blood lead was 2.44 μg/dL in the Study Group ($p=0.001$), 0.91 μg/dL in Control Group A ($p=0.04$) and 0.52 μg/dL in Control Group B ($p=0.31$). The mean blood lead level of the Study Group declined 1.53 μg/dL more than that of Control Group A (95% Confidence Interval: - 2.87, - 0.19) and 1.92 μg/dL more than that of Control Group B (95% Confidence Interval: - 3.28, - 0.56). The magnitude of the decline in blood lead associated with soil abatement was independent of a child's baseline blood lead level.

1.7.2 Adjusted Analyses

Potential confounding variables were added to the base model one at a time to obtain adjusted estimates of the group effect. The POST2 blood lead levels adjusted for baseline level were generally similar to crude levels. The adjusted mean difference between the Study and Control Groups were slightly diminished but remained statistically significant. The differences between the Study Group and Control Groups A and B were - 1.28 (p=.02) and - 1.49 (p=.01), respectively. Group assignment was a significant predictor of POST2 blood lead levels (p=0.02).

The results were also similar when the analysis included only children who lived on the study premises for at least 300 days after the pre-abatement blood lead test thereby eliminating children who moved during the follow-up period. Here, the differences between the Study Group and Control Groups A and B were - 1.42 (p=.02) and - 1.49 (p=.02), respectively.

The results were also quite similar when age, sex, socioeconomic status, ferritin levels, mouthing and handwashing behaviors, spending time away from home, spending time outside the study area, playing in the yard, eating food outdoors, sitting on the floor inside the home, eating canned foods including those imported from foreign countries, lead related jobs and hobbies and cigarette smoking among household residents, living in owner occupied premises, the presence of chipping paint, the presence of pets that go outdoors, and tap water lead levels were added to the base model one at a time. When the paint lead variables were added, differences between the Study and Control Groups were somewhat diminished (-1.19 and - 1.34 μg/dL for Control Groups A and B, respectively) and the group effect was borderline significant (p=0.06). When race was added to the base model, differences were also diminished (- 0.92 and - 1.26 μg/dL) and the group effect was not statistically significant (p=0.09). However, no statistically significant differences in crude or adjusted POST2 blood lead levels were seen among Study Group children of different races.

No "dose-response" relationship was observed between the mean change in blood lead level and the starting soil lead level or the size of the excavated area. POST2 abatement blood lead levels were quite similar for children in the lowest and highest pre-abatement soil lead categories and the smallest and largest excavated yard areas. The lack of a trend should be evaluated in light of the study eligibility criteria that restricted the soil and blood lead

ranges. Only six children in the Study Group had median pre-abatement soil lead levels that were less than 1,000 PPM, and pre-abatement blood lead levels were restricted to 7 through 24 μg/dL.

Exploratory multivariate analyses were also conducted to control simultaneously for several potential confounding variables. Two variable selection methods were used. First, a backward elimination procedure identified variables that were statistically significant predictors of POST2 blood lead levels. When Pre-Pb, age, race, and lead jobs were controlled simultaneously the adjusted POST2 blood lead levels were 10.36, 11.26, and 11.66 μg/dL for Groups S, A, and B, respectively, and the adjusted differences between the Study Group and Control Groups A and B were 0.90 and 1.31 μg/dL, respectively. The overall group effect was not statistically significant ($p=.08$).

Second, a potential confounding variable was selected for the multivariate model if its inclusion in the base model altered the magnitude of difference between the Study Group and either Control Group by more than 10%. The variables identified by this criterion were race, socioeconomic status, and playing or sitting on the floor. In a model controlling these variables and Pre-Pb, the adjusted differences between the Study Group and Control Groups A and B were 0.80 and 1.21 μg/dL, respectively. The overall group effect was not statistically significant ($p=.16$).

1.7.3 Handwipe Lead Levels

Because the handwipe field blank lead levels varied considerably and were not individually matched to the participants, background levels were taken into account by subtracting the maximum or median field blank level for each sampling round. When the maximum level was subtracted, the mean hand lead level in all groups declined from the pre-abatement to the first post-abatement sampling round. The mean hand lead level in the Study Group changed little at the second post-abatement sampling round while it increased in the Control Groups. When the median level was subtracted, the mean hand lead level in the Study Group declined at the first and second post-abatement sampling rounds. The mean hand lead levels in the two Control Groups first declined and then rose to a level higher than baseline.

Because the PRE and POST2 sampling rounds are most closely matched on season, we focused subsequent analyses on this comparison. When the maximum blank level was subtracted, the mean hand lead level decreased by 3.61 μg in the Study Group ($p=.02$), 0.99 μg in Control Group A ($p=.69$), and 0.36 μg in Control Group B ($p=.85$). When the median blank lead level was subtracted the mean hand lead levels declined by 2.75 μg in the Study Group ($p=.08$), and 0.68 in Control Group A ($p=.79$) and increased by 0.76 in Control Group B ($p=.72$).

When the POST2 hand lead levels were adjusted for baseline level the mean differences between the Study Group and the two Control Groups were diminished; the magnitude of the reduction was greater for the Control Group A comparison. Group assignment was not, however, a significant predictor of POST2 hand lead levels (p values were .48 and .43, respectively).

1.8 CONCLUSION

One of the most difficult aspects of the childhood lead problem is identifying the sources of lead and determining their relative contribution to children's lead burden. Lead based paint and household dust have received most of the attention to date. Far less attention has been paid to urban outdoor sources of lead, especially soil, except in cases of stationary sources such as smelters. Our findings suggest that lead contaminated soil does contribute to the blood lead levels of urban children.

Numerous previous studies have shown that soil and dust lead levels are correlated with children's blood lead levels These studies have relied largely on cross-sectional data, often from communities with point sources of lead such as smelters, where soil lead concentrations are far greater than those typically found in urban settings. The current study found that soil abatement alone (Study vs. Control Group A) was associated with a 0.8 to 1.4 $\mu g/dL$ decline in blood lead levels and that soil and interior dust abatement combined (Study Group vs. Control Group B) was associated with a 1.2 to 1.6 $\mu g/dL$ decline. These blood lead changes were observed approximately one year following soil abatement in which surface soil lead levels were dropped an average of 1,856 PPM.

Although designed and conducted to produce rigorous results, the study has several limitations. Participants were chosen to be representative of the population of urban preschool children who are at risk of lead exposure by using the Boston Childhood Lead Poisoning Prevention Program to identify potential participants from neighborhoods with the highest rates of lead poisoning and by using as wide a range of blood lead levels as was practical. Since no study subjects had blood lead levels below 7 μg/dL or in excess of 24 μg/dL at baseline, the study provides no information about the effect of lead contaminated soil abatement for children with these lead levels. Similarly, a different effect might have been found for children who had a greater blood lead contribution from soil, such as in communities with smelters or other stationary sources where soil lead levels are substantially higher than those seen in this study, or where differences in particle size result in differences in bioavailability.

There are little data available about rates of change in children's blood lead levels following a change in exposure to a potential source of lead. It is possible that the intervention would have been associated with a greater reduction in children's blood lead levels had they been followed for a longer period of time. In addition, all children in the study were exposed to lead contaminated soil prior to enrollment and so we are unable to investigate whether exposure to lead contaminated soil in the first year of life is associated with higher blood lead levels. Lastly, the unit of abatement was the single premises rather than clusters of premises. It is possible that the effect of lead contaminated soil abatement on children's blood lead levels would have been greater had we also removed lead contaminated soil from properties that surrounded Study Group children's premises.

In conclusion, this intervention study suggests that an average 1,856 PPM reduction in soil lead levels results in a 0.8-1.6 μg/dL reduction in the blood lead levels of urban children with multiple potential sources of exposure to lead.

This study provides information about soil abatement as a secondary prevention strategy, that is the benefit to children already exposed to lead derived, in part, from contaminated soil. It can not be used to estimate the primary prevention effect of soil abatement. Since children's post-abatement blood lead levels reflect both recent exposure and body burdens from past exposure, the benefit observed is probably less than the primary

prevention benefit, that is the benefit of abating lead contaminated soil before children are exposed to it so as to prevent increases in blood levels and body stores.

Soil lead tends to be concentrated at the surface and it is not rapidly removed by natural processes. Once soil is contaminated with lead, it is likely to remain contaminated indefinitely. In the future, soil is likely to become one of children's most intense sources of lead as the current housing stock, 52% of which is estimated to have dangerous concentrations of lead paint, ages and is replaced. Lead contaminated soil abatement may well result in long-term reductions in environmental lead so that multiple future generations of children benefit as they move onto abated properties. This thesis is currently untested, however, and must be validated by monitoring abated properties for rates of reaccumulation of lead.

1.9 IMPLICATIONS

Soil abatement in this study was associated with an approximately 0.8-1.6 μg/dL reduction in children's blood lead levels, slightly less than what was originally hypothesized. The clinical and public health implications of a reduction of this magnitude are not readily apparent. The magnitude of reduction in blood lead observed suggests that lead contaminated soil abatement may not be a particularly useful clinical intervention for children with low level lead exposure. It might be extremely useful, however, in specific situations, such as if soil lead were extremely high or the particular child had pica for soil. It is also a relatively inexpensive and low technology intervention. Although there are no data regarding the relative safety of soil and lead based paint abatement, it seems unlikely that soil abatement is as dangerous to children, families, and workers as lead based paint abatement can be.

Although the average benefit associated with abatement of lead-contaminated soil is modest in this study, the societal impact may be substantial. Consider, for example, the impact on the blood lead distribution of an average decline of 1 or 2 μg/dL in the mean blood lead level of a population of children assuming a starting mean blood lead level of 12 μg/dL, a standard deviation of 4, and a normal distribution. We also assume that the amount of change (as opposed to the percentage of change) is constant for all starting values, as we observed in our own sample in which the distribution of starting values was truncated.

Specifically, this assumption may not apply to children with starting blood lead values greater than 25 μg/dL. A decline of 2 μg/dL in the mean blood lead level results in 72% as many children with levels exceeding 10 μg/dL, 47% as many children with levels exceeding 15 μg/dL, and 26% as many children with levels exceeding 20 μg/dL (values of 10, 15, and 20 μg/dL were chosen because they correspond to the new CDC definition of lead poisoning and the new action levels for environmental and medical intervention, respectively). Even a 1 μg/dL decline in mean blood lead level results in 87%, 70%, and 52% as many children with levels of 10, 15, and 20 μg/dL, respectively. The percentage shifts may differ somewhat in a more representative sample in which the distribution of starting values is likely to be log normal.

Policy decisions regarding urban lead contaminated soil abatement as a lead control strategy will require numerous considerations. For example, are other types of remediation (e.g. planting grass cover and shrubs) equally effective but less expensive and intrusive? How does the cost effectiveness of soil abatement compare to other lead exposure reduction activities, such as paint abatement? Will it be practical to perform large scale abatements without encountering problems regarding the disposal of lead contaminated soil? Will future research help specify whether changes in children's blood lead levels of the magnitude seen in this study are clinically relevant or prudent from a public health or societal perspective? And will we develop and sustain the resolve and commit the resources needed to prevent what remains the most important environmental health problem of children in the United States?

2. BACKGROUND

Perceptions of the child lead poisoning problem have steadily changed as evidence has accrued demonstrating subtle but serious metabolic and developmental consequences of lead exposure levels previously believed to be innocuous.[1,2] Childhood lead poisoning was initially perceived as a disease (often presenting as encephalopathy and sometimes resulting in seizures, coma, or death) associated with the ingestion of peeling lead paint. Over the past two decades, as scientific evidence has consistently revealed deleterious effects at lower and lower lead levels, regulatory agencies have reduced the acknowledged level of children's lead burden requiring environmental and medical intervention and clinical guidelines have been revised accordingly. Whereas concern was initially directed at symptomatic children with blood lead levels of 60 μg/dL and above, lead poisoning is currently defined by the Centers for Disease Control (CDC) as a blood lead level of 10 μg/dL or greater.[3] The Agency for Toxic Substances and Disease Registry estimates that approximately 17% of all children in the United States aged six months to five years have blood lead levels of 15 μg/dL or greater.[4] There is currently no lead level believed to be safe for children.

Children are exposed to lead from multiple sources.[4-10] The most important sources include lead contaminated paint, dust, soil, and water. Paint used on both the interior and exterior of houses through the 1950's and continuing, to some extent through the 1970's, often contained high concentrations of lead.[11] It is estimated that 42 million homes in the United States, or approximately 52% of all housing units, contain paint with more than 0.7 mg/cm sq. of lead.[4] This enormous reservoir of lead, estimated to represent more than three million tons, is easily accessible to young children.

More recently, concern has been raised that lead contaminated soil in older urban areas is another important vector for children's exposure to lead.[4,12,13] The sources of soil contamination include lead paint chips from deteriorated exterior paint, past deposition of airborne lead from gasoline, and point sources such as smelters and other industrial activities.

House dust is, in part, composed of soil[10,14] and can therefore be contaminated by exterior lead sources. Other sources of house dust lead may be deteriorating lead based paint

from furnishings or interior walls.[6,8,15] Drinking water may contain high concentrations of lead from old pipes or leaded solder. Children may also ingest lead from pottery and canned foods although this is generally viewed as a minor contributor to exposure for most children.[4]

There is a general consensus that children's exposure to lead should be reduced as much as possible.[4,16] With clear and growing evidence of long-term adverse cognitive and behavioral deficits associated with levels of lead as low as 10 μg/dL,[1,4] increasing numbers of authorities have argued that there is an urgent need to develop practical and cost effective approaches for the prevention and treatment of low level lead exposure.[4,11,17] It was in response to this mandate that the Boston Lead-In-Soil/Lead Free Kids Demonstration Project was conducted. The study was designed to provide scientifically rigorous data about the effectiveness of lead contaminated soil abatement in lowering children's blood lead levels, the cost of removing lead contaminated soil, and a number of related questions relevant to policymakers, public health officials, child advocates, and clinicians.

2.1 LEAD POISONING IN BOSTON

As in many U.S. cities, childhood lead poisoning is a widespread problem in Boston. Children between the ages of nine months to six years are at greatest risk because they have a high degree of hand-to-mouth activity, they absorb ingested lead more efficiently, and because of the heightened vulnerability of their developing nervous systems to lead toxicity. In recent years in Boston, the rate of identified lead poisoned children in this age group ranged from 1.5% and 2.0%, on the basis of pre-1991 CDC guidelines (i.e., blood lead level greater than 25 μg/dL).

In order to identify the areas in Boston with the highest rates of childhood lead poisoning, the Boston Department of Health and Hospitals' Office of Environmental Affairs mapped all children in Boston identified as lead poisoned between October 1979 and February 1985. These efforts demonstrated that lead poisoning in Boston, while occurring throughout most of the City was, to a surprising degree, concentrated within very limited geographic areas.[18] It showed that four high prevalence neighborhoods accounted for 87% of the city's lead poisoned children but only 56% of the at-risk (nine months to six year olds

population. It also showed that children living in 28 2-3 city block areas produced nearly 30% of Boston's child lead poisoning cases despite accounting for only 4% of the child population aged nine months to six years. In each of these small areas, designated Emergency Lead Poisoning Areas (ELPAs), an average of more than 30 children were lead poisoned. This represents more than one of every four children.

2.2 CONTAMINATED SOIL IN BOSTON

The soil in Boston is contaminated by lead-based paint which has weathered or been scraped off the exterior of buildings and by the deposition of lead in gasoline exhaust.

Scientific studies that correlate increases in blood lead levels with exposure levels have not shown a significant contribution by exposure to soil with less than 500 parts per million (PPM) lead. These studies have suggested that soil lead levels of 500-1,000 PPM can significantly contribute to children's lead burdens, although other factors such as particle size, distribution and lead species are important.[4,10,13,19-21] At present, however, lead contaminated soil is regularly not removed either as part of a comprehensive strategy to prevent childhood lead poisoning, or an environmental intervention on behalf of children who already have suffered excessive exposure. In part, this may be due to the lack of data demonstrating the effectiveness of lead contaminated soil abatement. In the ELPA's described above the surface soil lead level averaged more than 3,000 PPM, or 3-6 times the "acceptable level" established by the CDC.[3,18] Testing at numerous sites throughout Boston has revealed much lower average lead levels of 600-700 PPM.

In October, 1986 the reauthorization of the Superfund toxic waste cleanup program (SARA) was signed into law. Included in the bill was a provision, Section 111 (a) (6), providing funds for "a pilot program for removal, decontamination, or other action with respect to lead-contaminated soil in one to three different metropolitan areas." Boston was chosen to implement the first of the projects.

The EPA convened two workshops of lead experts to provide consultation on the design of the study. The first workshop was held in April, 1987 in Raleigh, North Carolina. It brought together individuals with expertise in the health effects of lead exposure, epidemiology of lead toxicity, the biogeochemistry of lead, and the abatement of

environmental sources of lead. A general design and evaluation for the study was drafted at this workshop. A second workshop was held in Lexington, Massachusetts in June, 1987. It was devoted to a continuing exploration of (1) possible study designs that could provide scientifically rigorous data on the relationship between preschool children's exposure to lead contaminated soil and blood lead levels, and the effectiveness of the removal of lead contaminated soil in reducing low level lead exposure; (2) the ethical, legal, and logistical constraints on the design of any such study conducted in Boston, Massachusetts; and (3) the process by which broad-based scientific, pediatric, and public health acceptance of a scientifically sound and implementable design could be achieved.

2.3 IMPLEMENTATION

The first phase of the study ran for ten months from May 28, 1987 to March 31, 1988. It involved: (1) location and establishment of study facilities; (2) procurement of equipment and supplies; (3) recruitment of some staff; (4) examination of scientific, legal and ethical problems and issues; and (5) efforts directed at developing a study design in conjunction with EPA staff. During this phase the significant implications of the Massachusetts Lead Poisoning Prevention Law for the design and conduct of the study were explored.

In response to these issues, and in an effort to resolve related scientific and ethical issues, a small group of medical, scientific, and public health experts assumed responsibility for designing and implementing a lead contaminated soil abatement study in Boston, Massachusetts early in 1988. They were: Michael Weitzman, M.D. (Principal Investigator), Ann Aschengrau, Sc.D. (Coinvestigator), David Bellinger, Ph.D. (Coinvestigator) and Mr. Ronald Jones B.A. (Coinvestigator).

An initial draft of a proposed study design was submitted to the Environmental Protection Agency on January 22, 1988. In May of 1988 the investigators hosted a meeting attended by Evan Charney, M.D., representatives of the Massachusetts Department of Public Health, the Conservation Law Foundation, the Centers for Disease Control, and the Environmental Protection Agency. At this meeting the investigators presented their proposed study design and two alternative designs, one by Dr. Renate Kimbrough of the Environmental Protection Agency and another by Dr. Michael Rabinowitz, then of Harvard

Medical School. The attendees unanimously endorsed and suggested ways to strengthen the study design proposed by the investigators from the Boston Lead-In-Soil Demonstration Project.

In August of 1988 a revised study design that incorporated suggestions from the May, 1988 meeting was submitted to the Environmental Protection Agency along with letters of support from participants in the May meeting. The study was given the Environmental Protection Agency's full support, contingent on the approval of the Human Studies Committee of the Trustees of Health and Hospitals of the City of Boston. In the fall of 1988 the proposal was submitted to the Human Studies Committee of the Trustees of Health and Hospitals of the City of Boston, and recruitment of staff began. In December of 1988 the full approval of the Human Studies Committee was obtained. Enrollment of study participants began in January 1989.

This document represents the final report to the Environmental Protection Agency, and as such describes in detail the study's design, implementation, problems encountered, data collection and analysis, and findings.

3. STUDY ADMINISTRATION

The study was managed by a team consisting of a Principal Investigator (Michael Weitzman, M.D.) and three Coinvestigators (Ann Aschengrau, Sc.D., David Bellinger, Ph.D., and Ronald Jones, B.A.). The day-to-day management was the responsibility of a full time study Administrator (Natalie Zaremba) and Assistant Epidemiologist (Julie Shea, MPH). An organizational chart can be found on page 23.

The study was designed to evaluate the impact of a large scale environmental intervention on the blood lead levels of a specific target population. It required a concerted effort by the U.S. Environmental Protection Agency, the Trustees of Health and Hospitals of the City of Boston, Inc., the City of Boston, and the study's investigators and staff. Responsibilities for the various aspects of the study are listed below.

THE U.S. ENVIRONMENTAL PROTECTION AGENCY:

1. Provided funding to conduct the study.
2. Designated a Project Manager from EPA Region I.
3. Assisted in the development of Protocols.
4. Provided analyses of soil and dust environmental samples.
5. Provided representatives for community meetings and other activities conducted as part of the Community Relations Plan.
6. Provided for or assisted with training and guidance in the collection of soil and dust samples.
7. Assisted the study staff in the calibration of equipment.

THE TRUSTEES OF HEALTH AND HOSPITALS:

1. Provided bookkeeping, accounting, and other fiscal services.
2. Provided personnel management services for the study.
3. Provided internal fiscal audits for the study.
4. Provided for the long-term maintenance and storage of client records and data.

THE CITY OF BOSTON:

1. Provided assurance of appropriate removal and disposal of lead contaminated soil.
2. Ensured access through rights-of-way and easement necessary to the study.
3. Provided logistical support during the soil removal phase of the study.
4. Assisted in the resolution of the soil disposal controversy.

THE STUDY'S INVESTIGATORS AND STAFF:

1. Developed study Protocols and provided for their review.
2. Developed a Community Relations Plan and provided for its implementation.
3. Provided a Management Staff to supervise all study activities except those specifically provided by the Trustees EPA, or the City. Project Management Staff coordinated all phases of field work.
4. Acquired and maintained suitable space for an operations center and for training of study staff.
5. Acquired and maintained computerized data systems suitable for recording, storing, and analyzing data generated in the course of the study.
6. Provided for recruitment of households in areas selected for the study.
7. Prepared and printed instructions, maps, questionnaires, consent forms, and other materials to be used in the study.
8. Collected environmental samples for quality control purposes.
9. Furnished equipment and containers for soil and dust environmental samples and provided appropriate sample preparation.
10. Contracted for the laboratory analysis of blood samples and provided appropriate sample preparation.
11. Contracted for the laboratory analysis of water samples.
12. Provided personnel to conduct interviews, draw blood, collect handwipes and environmental samples, and use the XRF machine for paint lead analysis.
13. Validated all environmental data and maintained the following:
    a. Area maps used in the study;
    b. Questionnaires;
    c. Tabulation of blood lead and free erythrocyte protoporphyrin results by name, age, and address; and
    d. Forms recording lead readings by the XRF device.
14. Implemented quality assurance measures throughout the study, except for laboratory work performed by the EPA
15. Followed standard chain-of-custody measures for all samples.
16. Provided follow-up for all study children found to be lead poisoned according to CDC guidelines.
17. Notified all parents of the results of blood and environmental tests and provided an interpretation of the results
18. Developed and implemented a data analysis plan in conjunction with EPA and other appropriate organizations

19. Developed and implemented a plan to secure the cooperation of community residents and property owners who were directly affected by the study but were not the parents of children participating in the study.
20. Advertised for, negotiated, and managed contracts for interior dust and loose paint abatements, soil abatement, moving, storage, and deleading.
21. Prepared draft and final study reports in conjunction with the EPA.
22. Provided necessary, authorized equipment.
23. Provided lead poisoning education, supportive services or referrals to parents of children in the study.

4. HUMAN STUDIES REVIEW

During the fall of 1988 the Boston Department of Health and Hospitals Human Studies Review Committee reviewed the proposal submitted to Region I of the Environmental Protection Agency in August, 1988 as well as all study protocols. The complex ethical, legal, and scientific concerns raised about the study in 1987 and early 1988 by the Massachusetts Department of Public Health, the legal counsels of the City of Boston and Region I of the Environmental Protection Agency were also submitted to the Human Studies Review Committee for the Committee's review. Full approval of the Human Studies Review Committee was granted in December, 1988 and Annual Reports were submitted to the Committee in December 1989 and 1990.

5. STUDY DESIGN

5.1 PURPOSE

The purpose of the Boston Lead-In-Soil Demonstration Project was to determine the effect of removing lead contaminated soil on children's blood lead levels. The hypothesis tested was:

> A significant reduction (equal to or greater than 1,000 PPM) of lead in soil accessible to children will result in a mean decrease of at least 3 μg/dL in the blood lead levels of children living in areas with multiple possible sources of lead exposure and a high incidence of lead poisoning.

We were also interested in a series of related questions relevant to explicating whether lead contaminated soil is an important vector for lead exposure for children living in highly lead contaminated environments and whether soil abatement is a feasible intervention: Is the soil abatement more or less effective for certain subsets of children? Is interior dust abatement effective in reducing children's blood lead levels and how quickly and to what extent do soil and house dust become recontaminated after abatement? What is the cost of soil and dust abatement? What problems can be anticipated if lead contaminated soil abatement were widely adopted as a strategy for the primary and secondary prevention of childhood lead poisoning?

The final study design, described in detail in the following sections, is illustrated on the next page in Figure 5-1.

5.2 IDENTIFICATION OF STUDY POPULATION

The study used the ongoing city-wide screening efforts of the Boston Childhood Lead Poisoning Prevention Program (BCLPPP) to identify potential participants. The BCLPPP receives the results of capillary blood screening tests (blood lead levels and free erythrocyte protoporphyrin levels) for many of the preschool children living in Boston. The source

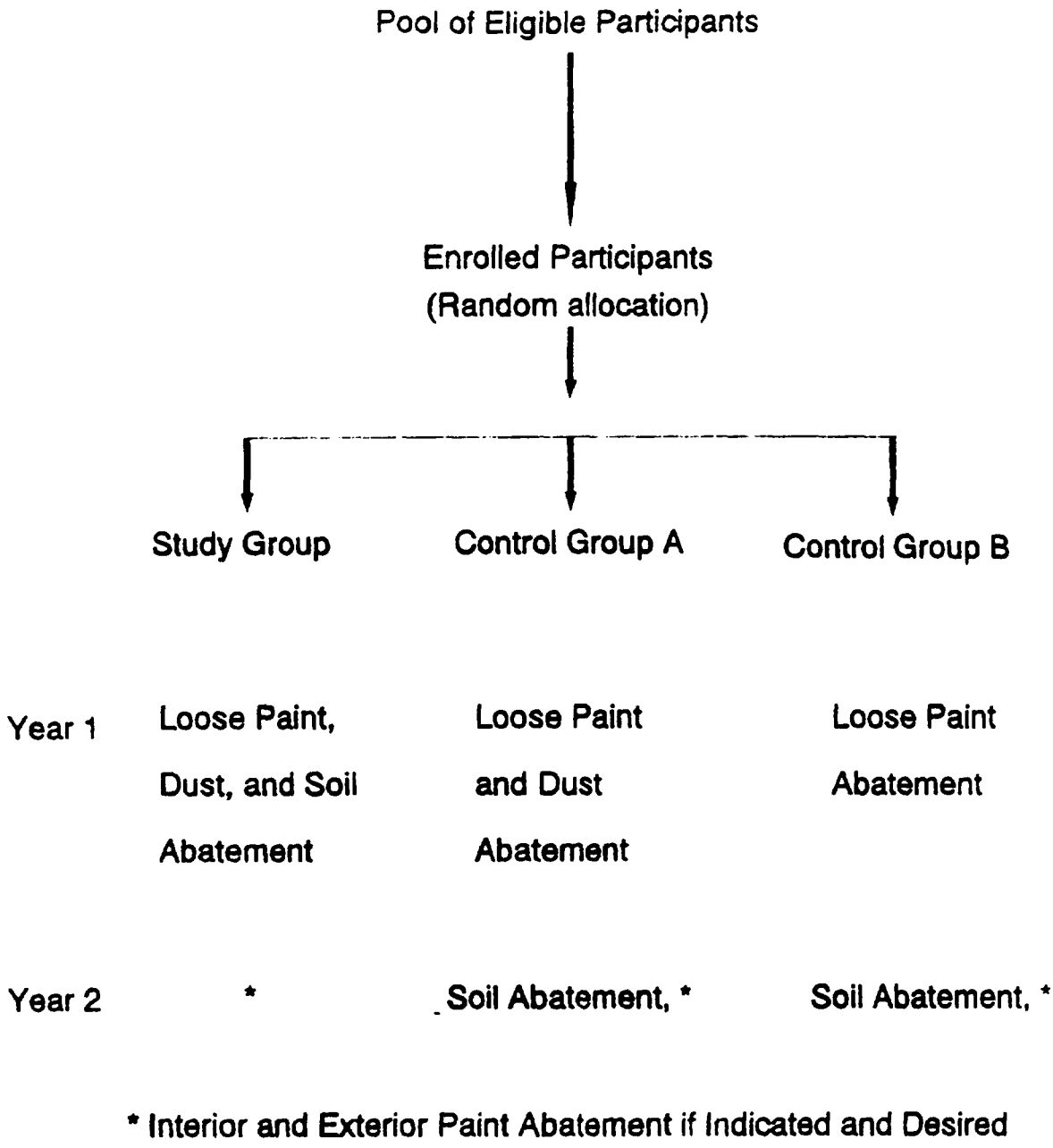


Figure 5-1. Study Designs.

neighborhoods of Boston who were under four years of age on August 1, 1989 who had finger stick blood lead screening tests done as part of their routine health care between January and June 1989 and whose screening levels were between 10 and 20 μg/dL. Additional children under four years of age who lived on the same premises as the BCLPPP participant during the recruitment period were also identified for possible enrollment. The map (Figure 5-2) on the following page shows the area of Boston involved in the Study.

5.3 ELIGIBILITY CRITERIA

Homes of potential study participants were visited by trained study field staff, and families and landlords were contacted to determine if potential participants met the following additional eligibility criteria:

1. The participant's parent(s) or caretaker(s) and, if applicable, landlord agreed to participate;

2. Exterior walls of premises had little or no chipping paint. On a drive-by inspection, study staff judged by visual inspection that (1) the cumulative amount of chipping paint on the exterior walls (excluding trim, but including porches) did not exceed 30% of the total surface area; and (b) the cumulative amount of exterior chipping paint on the adjacent wall of an abutting premises (including trim) did not exceed 40%.

3. Premises had a yard of at least ten square feet composed of dirt, grass or a combination thereof and was accessible to the child.

4. The child resided in a dwelling with eight or fewer residential units.

5. Average or median surface soil lead level was 1,500 PPM or greater.

6. Child was mobile

7. Child had never been lead poisoned.

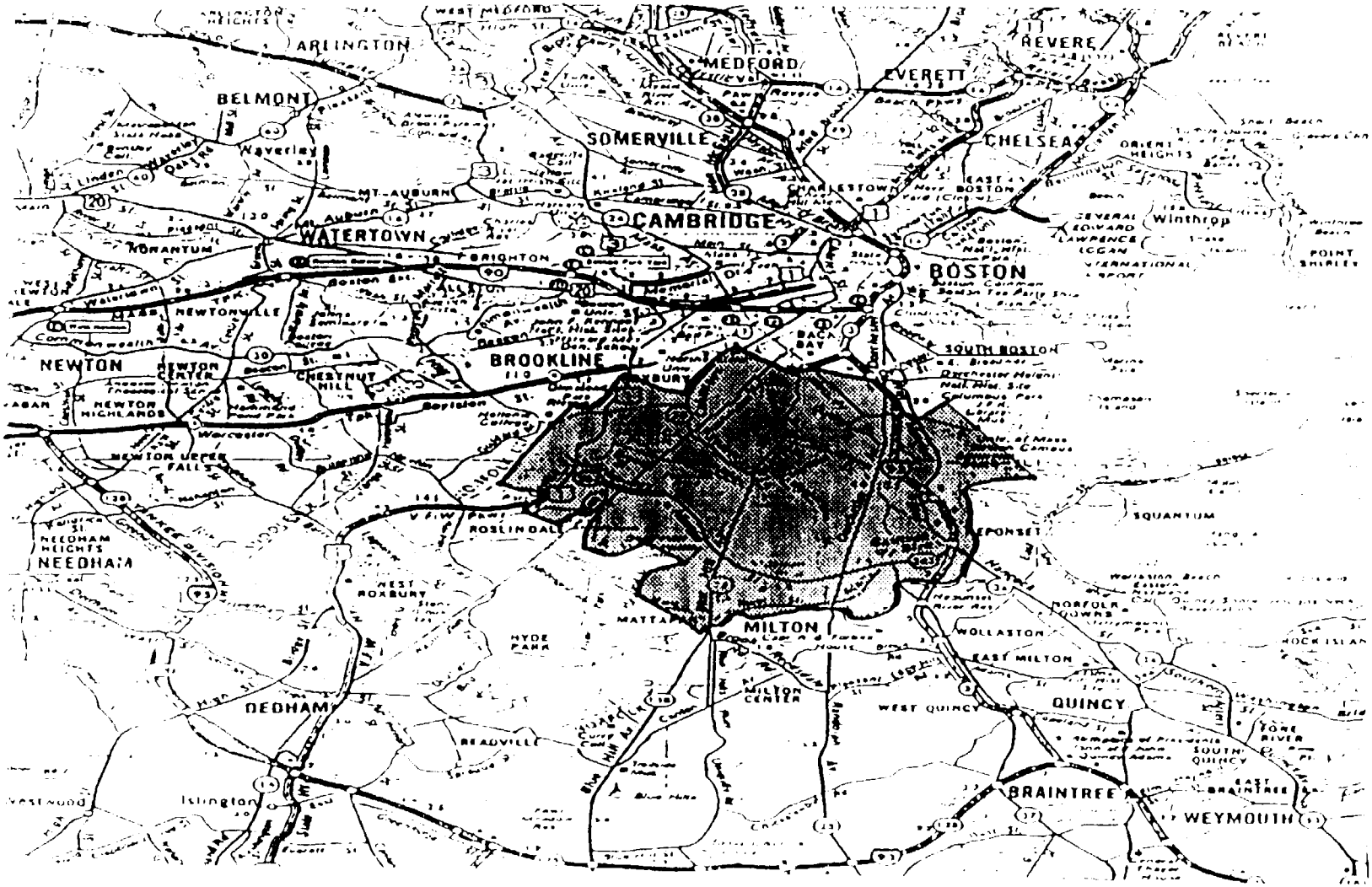


Figure 5-2. Map of study area.

8. Family resided on premises for at least three months (as of the baseline venous blood lead test).

9. Family had no definite plans to move within the next three months after enrollment.

5.4 RATIONALE FOR ELIGIBILITY CRITERIA

The choice of eligibility criteria was motivated by both scientific and practical considerations. The paramount concern from a scientific standpoint was to maximize the ability of the study to detect a decrease in blood and hand lead levels following soil abatement.

Children residing in Dorchester, Roxbury, Mattapan, and Jamaica Plain were targeted because these areas were known to have a high incidence of childhood lead poisoning as well as elevated soil lead levels. Only children up to four years of age at baseline were included because these children still have a high degree of hand-to-mouth activity.

Participant children were required to be mobile, live in small to medium sized residences, have accessible yards composed, at least in part, of contaminated soil because these children would have the opportunity to come into both direct and indirect contact with contaminated soil. The exact yard and premises size requirements were arbitrarily chosen. The minimum soil contamination level was set at 1,500 PPM in order to make possible the 1,000 PPM decline in soil lead specified in the study hypothesis.

Based on the precision of the analytic method used to determine blood lead level, the hypothesized drop in blood lead levels following abatement, and the sample size requirements, we established 7 μg/dL as the minimum baseline blood lead level required for eligibility. Children whose baseline blood lead levels were above 24 μg/dL were excluded. They met the current definition of lead poisoning and so were likely to undergo medical and environmental interventions during the follow-up period (i.e. chelation and paint deleading) that could overwhelm the changes expected from the study interventions. Previously lead poisoned children were excluded because of the possibility that their response to the study interventions might differ from that of non-poisoned children due to their elevated body lead burden.

Homes and abutting properties were required to have little or no exterior chipping paint in order to minimize the likelihood that any impact of the abatement would be attenuated by the rapid recontamination of study premises' soil (please see Eligibility Protocol for a description of how the extent of chipping was ascertained).

Three months residency at the current premises was required to ensure that a child's baseline blood and hand lead levels reflect the lead levels in various environmental media around the premises. Lastly, families were included only if they had no definite plans to move within the three months following enrollment to minimize attrition during the course of the study

These eligibility criteria were applied both to children identified through the BCLPPP and other children living on the premises Children were not excluded if they attended a day care center or day camp in the summer.

Eligibility criteria were generally evaluated in the following sequence: routine blood screening, drive-by assessment to determine exterior condition of the home, sample soil, interview family, search for other children residing on the premises, recruit landlord. All children meeting the criteria received a venous blood lead determination beginning in August, 1989. If the blood lead level was between 7 and 24 μg/dL and the child's parents and the landlord of the premises agreed to participate, the child was enrolled in the study. This was considered the child's baseline blood lead level for the purposes of this study. All baseline venous blood lead levels were obtained prior to any environmental abatement activities.

At enrollment, informed consent for the subsequent environmental sampling, interview, blood tests, hand lead determinations, etc. was obtained from the parent or caretaker. Consent for the soil abatement was also obtained from the landlord.

The families of children with lead levels outside the eligible range were informed of the results and of the reasons for excluding their children from the study. All children with blood lead levels above 24 μg/dL were referred to the Boston Childhood Lead Poisoning Prevention Program and followed according to Massachusetts state law and lead program case management protocols.

Figure 5-3 Eligibility Assessment and Recruitment Flow Sheet depicts the eligibility assessment and recruitment sequence, the number of children assessed and eligible at each step of the process, and the final number of children enrolled. The numbers and percentage

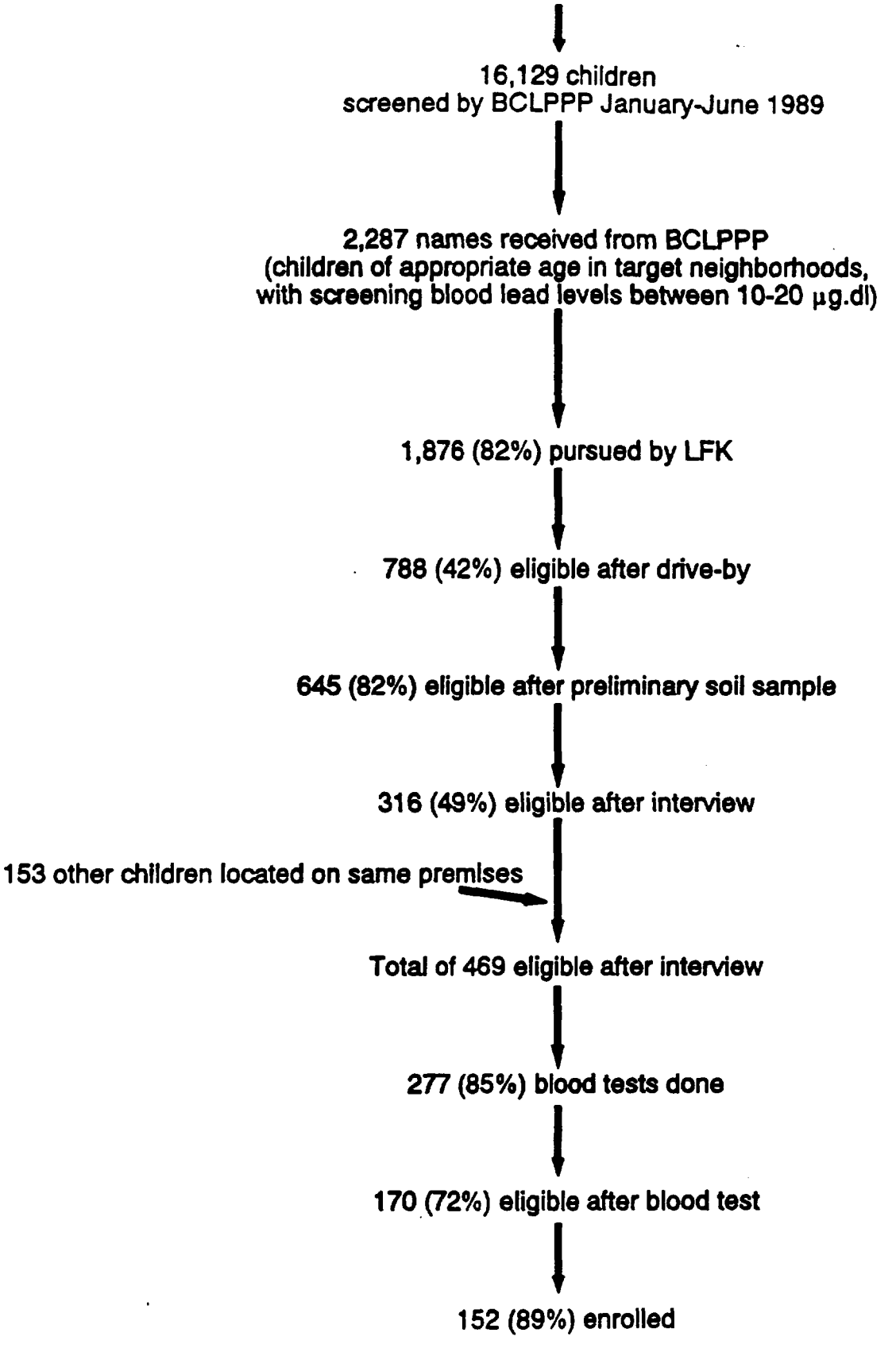


Figure 5-3. Eligibility Assessment And Recruitment Flow Chart.

of children judged ineligible by reason ineligible are given in Table 5-1. One hundred and fifty two children were ultimately enrolled in the study.

5.5 INTERVENTION

As eligible participants were enrolled, they were randomly assigned to one of three groups using a computer generated random number table: the Study Group, Control Group A, or Control Group B (the randomization unit was the child's premises). Randomization was used to enhance the probability that the three groups would be comparable with respect to measured and unmeasured characteristics

The study design is illustrated in Figure 5-1. The Study Group received loose interior paint removal, interior dust abatement, and soil abatement in the first year. The unit of abatement activity was the single premises on which the subject(s) lived. Control Group A received loose paint removal and interior dust abatement in the first year of the study and soil abatement in the second year. Control Group B received only loose interior paint removal in the first year and soil abatement in the second year The unit of abatement activity for Control Groups A and B was also single premises.

The purpose of including several intervention groups was to enable separation of the effects of soil and interior dust abatement Removal of lead paint hazards was not included as a study intervention but was suggested and facilitated, when indicated, after the second follow-up study blood lead level was determined.

5.6 STUDY SIZE

We enrolled 152 children in the study: 54 children in the Study Group, 51 in Control Group A, and 47 in Control Group B Using data from other studies conducted with comparable populations, we estimated that there would be at most, a 15-20% attrition rate during the course of the study and based our original statistical power calculations on a final study size of 122 children. (See section on attrition and follow-up.) The statistical power of the study to detect a 3 μg/dL difference in blood lead levels between the Study Group and

TABLE 5-1. PERCENT OF CHILDREN JUDGED INELIGIBLE ACCORDING TO REASON FOR INELIGIBILITY

Reason Ineligible*	Percent
More than eight residential units on premises	19.3
Yard less than ten square feet	1.6
Yard inaccessible to child	0.4
Cumulative exterior chipping paint on premises (excluding trim, including porches and walls) exceeded 30% of total surface area	5.2
Cumulative exterior chipping paint on adjacent side of an abutting premises (including trim) exceeded 40%	2.3
At least 50% of the preliminary soil samples were not in excess of 1,500 PPM lead, or the average of the soil sample results did not exceed 1,500 PPM lead	6.2
Case manager unable to contact parent/guardian after five attempts	0.6
Paint deleading scheduled to be performed	0.9
Family intended to move in next three months	2.3
Parent/guardian was not interested in participating	4.1
Child's sibling had been lead poisoned while living at this residence and an environmental intervention was to be performed	0.0***
Case manager unable to contact landlord after five attempts	0.8
Landlord not interested in participating	6.8
Data error unable to be resolved from screening form*	0.1
Child did not have a permanent address	0.7
Case manager determined that landlord was not interested in participating prior to landlord recruitment attempt	4.3
Child moved during eligibility phase	9.5
Child lived in public housing	2.5
Duplicate name/listing (e.g. child was screened twice during eligibility phase)*	0.6
Premises located in unsafe area	0.7
Foster child	0.3
Child did not reside in Mattapan, Dorchester, Jamaica Plain, or Roxbury*	0.0***
Landlord and/or parent claimed that premises were scheduled to be deleaded	0.5
Residents claimed no children live on premises	0.3
Family was not located at the address. (This code was used when a case manager was not sure if the family had moved, but could not find the family at the premises)	1.0

TABLE 5-1 (cont'd). PERCENT OF CHILDREN JUDGED INELIGIBLE ACCORDING TO REASON FOR INELIGIBILITY

Reason Ineligible*	Percent
Language barrier	0.5
Case manager unable to contact a resident on the premises (e.g., landlord) for permission to sample soil	0.7
Child's venous baseline blood level was below 7μg/dL*	2.2
Child's venous baseline blood level was 25μg dL or greater*	0.5
Child was not in the eligible age range	0.0***
Phlebotomist unable to draw blood for baseline sample	0.0***
Disposition of premises unable to be determined before enrollment deadline (12/8/89)	2.7
Subject moved after receiving baseline blood draw but before abatement was done	0.1
Parent claimed that child had been lead poisoned	0.2
Soil results not reported from EPA	0.1
Subject not interested in participating after baseline blood draw but before abatement was done	0.1
Child lived in a dwelling in which there were insufficient number of other children less than four years old**	0.1
Interior chipping paint exceeded 16 square feet**	0.2
No Date of Birth in BCLPPP+ data	3.6
No Pb Level in BCLPPP data	9.4
Pb in error in BCLPPP data	3.3
No address in BCLPPP data	1.6
Total	100.0

*Ineligibility codes issued in-house by the Assistant Epidemiologist.
**Code became inapplicable during the course of the study
***Only one child in each of these categories.
+BCLPPP = Boston Childhood Lead Poisoning Prevention Program.

Note that ineligibility codes were issued for all children whose names were received from BCLPPP as well as for "other" children who were recruited on the premises by case managers

each Control Group was excellent (.89-.91). The assumptions underlying these power calculations were:

1. Mean blood lead level of 12.6.

2. Standard deviation of the blood lead level of 4.1.

3. Alpha level of 0.05 (two-tailed).

The estimates of mean and standard deviation were derived from the baseline study data.

5.7 CHANGES IN STUDY DESIGN AND SAMPLE SIZE

Two major changes in the proposed study design were made after the study design was submitted to the EPA in August 1988: elimination of one arm of the soil abatement group and a reduction in sample size from 330 to 152. Both changes were made with the approval of the Centers for Disease Control and the Environmental Protection Agency.

We originally intended to divide the Study Group into two subgroups. For one subgroup, the unit of abatement activity would be the study subject's premises, and, for the other, the unit would be an approximate six to seven house cluster of homes including and adjacent to the study subject's home. The goal was to determine whether one abatement strategy produced a greater decline in children's blood lead levels than the other. Difficulties in recruiting landlords and budgetary constraints required us to abandon the cluster subgroup and limit the Study Group to single residence abatement units. This reduction limited somewhat the scope of the inferences that could be drawn about the impact of soil abatement but in no way compromised the scientific integrity of the study.

In addition, we originally planned to include 330 children in the study: 130 in the Study Group (65 each in the cluster and single premises subgroups) and 100 in each Control Group. The power of this sample size to detect both 3 and 2 μg/dL drops in blood lead levels was excellent. Several reductions in the sample size were made during the course of participant recruitment and 152 children were ultimately enrolled (approximately 50 in each group). The final sample size met the minimum required by the Centers for Disease Control

(i.e., 150 participants) and still had excellent power (.89 to .91) to detect a 3 μg/dL decrease in blood lead levels (even with 20% attrition).

The sample size was reduced because of difficulties recruiting landlords, budgetary constraints, elimination of the cluster concept, and a larger than expected percentage of baseline blood lead levels below the eligibility criteria of 7 μg/dL. The initial screening blood lead determinations were based on finger stick samples, while the confirmatory baseline levels were based on venous samples. We anticipated that almost all of the baseline lead levels would fall within the eligible range (7 to 24 μg/dL) but only about 70% did. We suspect that the initial finger stick samples were prone to contamination during sampling.

5.8 ATTRITION AND FOLLOW-UP OF STUDY POPULATION

This study utilized randomization to achieve comparable Study and Control Groups. Attrition because of population mobility and loss of interest can threaten comparability of groups, terminate the assigned intervention, and/or result in a sample size so small as to increase the likelihood of finding no effect when one does in fact exist. We recognized that not all attrition could be avoided during the approximately 18 months that participant families were involved in the study, and we anticipated 15-20% attrition. Table 5-2 lists by Study Group the number of children initially enrolled, the number who moved during the study but were followed so that blood and environmental samples could be obtained, the number dropped from the study, and the number who remained at their original premises.

TABLE 5-2. FOLLOW-UP STATISTICS BY PARTICIPANT GROUP

	Starting Population of Children	Moved But Were Followed	Dropped Out Before 2nd Follow-Up Blood Test	Still at Original Premises at 2nd Follow-Up Blood Test
Study Group	54	11 (20.4%)	0 (0.0%)	43 (79.6%)
Control Group A	51	8 (15.7%)	2 (3.9%)	41 (80.4%)
Control Group B	47	3 (6.4%)	1 (2.1%)	43 (91.5%)
Total	152	22 (14.5%)	3 (2.0%)	127 (83.6%)

Valuable information on the effects of the intervention was gathered even from children who moved during the course of the study. In effect these children received a partial intervention. To obtain the necessary information on these children, the study staff made a concerted effort to trace these families and obtain blood, handwipe, and environmental samples according to the study schedule. Tracing methods included contacting friends, neighbors, relatives, and landlords as well as the U.S. postal service. Information that would facilitate tracing was collected at enrollment.

All families successfully traced were interviewed to obtain information on the date and reason for moving. An attempt was made to obtain all environmental exposure data at both the new and original residence as well as to obtain blood and handwipe samples. The amount of time that a child resided at an abated residence was taken into account in certain analyses.

In order to minimize the number of participants who dropped out due to lack of sustained interest or commitment, parents and property owners were offered carefully considered incentives to remain in the study until its completion. Incentives were also available to families who moved away from their original address but remained involved in the study. The incentives for participating families included a $25 per month gift certificate at a local supermarket or general purpose store and at the end of the study a $150 gift certificate at one of a variety of stores.

Property owners' cooperation also was vital to the study. In addition to having lead contaminated soil removed, property improvement assistance in the form of assistance in deleading proved to be a very effective incentive. The study offered to pay (1) the full cost of interior and exterior paint deleading of owner-occupied homes; and (2) up to $2,000 towards the cost of interior and exterior paint deleading for non-owner occupied premises. Table 5-3 lists the numbers of owner and non-owner occupied premises in the study, households offered assistance with deleading, and the numbers agreeing to and receiving assistance with interior lead paint abatement.

The money spent for participant incentives was a relatively inexpensive way to promote good will and encourage continued participation in the study. Study participants performed an invaluable service to children in these communities and ultimately throughout the United States. Even though every effort was made to minimize the disruption to families,

TABLE 5-3. INTERIOR AND EXTERIOR PAINT DELEADING ACTIVITIES *

	Units in Owner-Occupied Premises	Units in Non-Owner Occupied Premises	Total
Total	90	33	123
Offered Deleading Assistance	90	33	123**
Agreed to and Received Both Interior and Exterior Deleading Assistance	41***	5	46****
Received Only Exterior Deleading	7	2	9

*Deleading activities occurred from August to February, 1991 after all study samples were collect
**Six units already had deleading certificates (4 nonowner-occupied, 2 owner-occupied)
***One owner did not receive a compliance letter.
****Several units were in the same premises.

Note that a single family home was counted as one unit; all single family homes were owner-occupied.

the study design required repeated visits to the homes of study participants for environmental and biologic samplings and environmental interventions. These activities were intrusive and, for many families, the purpose unclear. Thus it was anticipated that some participants might tire of the inconveniences related to the study and drop out. If this had happened in sufficient numbers, the success of the study would have been seriously jeopardized and the investments of time and money wasted. Participant incentives were critical in mitigating these problems. Similarly, the study would not have been conducted without landlord participation, necessitating our offer of assistance with lead paint abatement.

6. PARENT EDUCATION AND COMMUNITY RELATIONS STRATEGIES

Educational materials were developed and provided to all participating parents and the public. They included information on the sources of lead in the environment, known effects of lead on a child's well-being, and methods for reducing children's lead exposure (such as wet mopping, washing hands). In addition, all parents were told the soil lead levels on their premises and their children's blood lead levels.

The success of this study was dependent upon participant and community support and cooperation. As a result, efforts to inform, educate, and involve potential participants and community leaders were integral to conducting the study. The receptivity of parents and property owners to enrolling and remaining in the study was related to a variety of factors. For example, the degree to which participants and landlords perceived that participation was in their best interest was a vital aspect of whether the individuals approached were willing to enroll and remain involved despite substantial inconvenience. It was also reasoned that whether participation resulted in positive recognition and improved standing in the community or was a source of stigmatization would also impact upon enrollment and retention. Thus, in addition to one-to-one educational activities and incentives for participating families and landlords, a detailed community relations program was developed. Community relations activities were designed to enhance the likelihood of positive responses to the above mentioned concerns through activities that increased community acceptance of the study.

An underlying objective of the community relations strategy was to ensure that the study resulted in the least possible amount of intrusion for the community, and that, to the extent possible, participants were recognized for their contribution to the success of the study. A major priority was to ensure that communication with the community, especially potential participants, was timely, forthright, and well presented. Thus, materials were translated into the appropriate languages and study staff remained in close contact with participating families and landlords and helped them plan and prepare for each of the study's activities.

It was also extremely important that respected and trusted members of the community be apprised of the study's objectives, methods, progress, and difficulties. Thus, a Community Advisory Committee was convened and met with the study's investigators during the course of the study, both to keep them informed and to obtain their input into various aspects of the study.

The effectiveness of the incentives employed and the community relations activities are evidenced by the fact that the requisite number of families were enrolled and that only 3 of the 152 (2%) children enrolled dropped out before completion of the study, despite numerous intrusive and disruptive study related activities.

7. ENVIRONMENTAL MEASUREMENTS AND ANALYSIS

7.1 SOIL

Soil sampling was conducted to determine eligibility of properties, characterize the potential exposure of participant children to lead from the soil, document the reduction in soil lead levels, and monitor the rate of recontamination after abatement. Preliminary soil sampling to determine eligibility was conducted from approximately April to November, 1989. The start date was chosen to allow for melting of snow and frost prior to sampling. After eligible properties were identified and preabatement blood samples taken from the children, detailed soil sampling of the properties was undertaken. Playgrounds frequented by the children were also sampled. Follow-up sampling was conducted right after the soil abatement to document the drop in soil lead levels and at approximately nine months after abatement to assess the rate of recontamination. A detailed protocol for soil sampling and analysis was developed in conjunction with the EPA and the other Lead-In-Soil Demonstration Project teams from Baltimore and Cincinnati. Boston also participated in an exercise to evaluate the merits of the wet digest method versus XRF and based on this, a decision was reached to use XRF for soil analysis. The soil sampling process is summarized below.

7.2 PRELIMINARY SOIL SAMPLING TO DETERMINE ELIGIBILITY

Following the drive-by survey of exterior paint conditions, a potential study participant was approached by a study staff member who described the study and asked for permission to sample the soil. If the potential participant was not available, other occupants of the property were briefly told about the study and asked for permission to sample the soil. In some cases preliminary soil sampling occurred before speaking with any residents, in which case flyers about the study were left for all residents. In most cases, four composited surface samples were taken within two meters of the house, one from each side of the house where soil was present. Samples were analyzed by X-Ray Fluorescence (XRF) at the EPA

Region I Laboratory. The property was eligible if the median or the mean soil lead level was equal to or greater than 1,500 PPM.

7.3 DETAILED SOIL SAMPLING

After a child was enrolled, composited soil samples were taken throughout the property both at the surface and at a depth of 15cm using one of three pattern sampling methods described in the Appendix: line source, targeted, or small area patterns. The line source soil sampling pattern used for most of the premises involved drawing lines parallel to the premises about 0.5 meters away from the foundation and about 0.5 meters from the property boundary. Depending on the size of the property, more parallel lines were added in between the foundation and property boundary lines. Each parallel line was then divided into segments seven meters in length. Composite soil samples were taken from a 2 by 2 foot square at a random point along each line segment. The composite sample consisted of five samples taken from the center and each corner of the square. The number of composited surface and core samples taken varied according to the size of the yard. On average eight of each were taken. Pattern selection was made according to the layout of the property. Samplers made sketches showing property and sample locations. All soil samples were transported to the EPA Region I laboratory and analyzed by XRF. Soil abatement was documented immediately after landscaping by taking composite surface soil samples at every other previously sampled location marked in copies of property sketches. On average, four composite surface samples were taken at this stage.

7.4 RECONTAMINATION ASSESSMENT SOIL SAMPLING

Approximately nine months after the initial soil abatement was conducted, composite surface soil samples were taken to determine the extent of soil recontamination. These samples were taken at every other previously sampled location marked on the property sketches. On average about five composited samples were taken from each premises.

The schedule for soil sampling was as follows:

	Study Group	Control Group A	Control Group B
Summer-Fall 1989	Test Abate* Test**	Test	Test
Summer-Fall 1990	Test	Test Abate* Test**	Test Abate* Test**

* This refers only to soil abatement.

** These tests were conducted to document reductions in soil lead levels immediately following the soil abatement.

7.5 DUST

Household dust sampling was conducted to characterize the potential exposure of children to lead from dust, to document the reduction in dust lead levels following abatement, and to monitor rates of recontamination after abatement. Our intent was to sample dust on upfacing surfaces most accessible to the child (i.e., bare floors, window sills, and wells). The Sirchee-Spittler modified dust buster was used to obtain the samples. This instrument is a hand-held dust vacuum unit whose sampling head was modified to catch the dust sample in a fine mesh (325) stainless steel screen. This modification enabled better sample recovery than would be possible with the woven fiber cloth that is usually supplied with commercially available dust busters. We generally took six samples in each household from the following locations: the participant child's bedroom window well and floor, the kitchen window well and floor, and the living room window well and floor. The three floor dust samples were later composited into a single sample because the individual samples were often lighter (less than 10 μg) than considered optimal for accurate XRF analysis. We determined the lead concentration in the dust (PPM), the amount of dust per unit area (mg/m^2), and the lead loading (mg/m^2).

A detailed protocol for the dust sampling was developed by Dr. Thomas Spittler of Region I of the Environmental Protection Agency and is included in the Appendix.

The schedule for dust sampling was as follows:

	Study Group	Control Group A	Control Group B
Summer-Fall 1989	Test Abate* Test**	Test Abate* Test**	Test
Winter 1990	Test	Test	Test
Summer-Fall 1990	Test	Test	Test

* This refers only to interior dust abatement.

** These tests were conducted to document reductions in dust lead levels immediately after the dust abatement with HEPA vacuuming.

7.6 WATER

Two water samples were taken during the course of the study. Each was a first flush sample taken by the parent from the cold water faucet in the kitchen. Water samples were analyzed by the Hall-Kimbrell Laboratory in Lawrence, Kansas. The water lead sampling and analysis protocol can be found in the Appendix. Elevated water lead levels (i.e., above 50 μg/L) were reported to the participants. These participants were also informed of ways to reduce the lead content of their drinking water.

The schedule for water sampling was as follows:

	Study Group	Control Group A	Control Group B
Winter-Spring 1990	Test	Test	Test
Summer-Fall 1990	Test	Test	Test

7.7 PAINT

In the last year of the study portable x-ray fluorescence analyzers (PGT XK-3) were used to identify lead in paint. Measurements were taken in the child's bedroom, kitchen, and living room. One measurement was taken on the lower part of the wall and one was taken

on the window sill in each room. A detailed protocol for lead paint inspection is included in the Appendix.

The schedule for interior paint sampling was as follows:

	Study Group	Control Group A	Control Group
Summer-Fall 1990	Test	Test	Test

7.8 QUALITY ASSURANCE FOR SOIL AND DUST SAMPLING AND ANALYSIS

A quality assurance plan for the sampling and analysis of soil and dust was developed by the EPA Region I and is included in the Appendix. It includes a description of the proper procedures for soil sampling, sample custody, equipment calibration and analysis, internal quality control checks and corrective actions.

8. SOCIAL AND BEHAVIORAL QUESTIONNAIRE

After the baseline soil sampling, the case managers administered two questionnaires to the child's parent or caretaker. The goals were to (1) gather information necessary to characterize the study population and (2) assess factors that bear on a child's contact with various sources of lead. Dr. Edmund Maes of the Centers for Disease Control initiated the development of the questionnaire which was modified by Dr. Ann Aschengrau and consultants from the Center for Survey Research at the University of Massachusetts, Boston. Copies of the questionnaires are included in the Appendix.

One questionnaire, designated the "family questionnaire", was concerned with family demographics (e.g., family size, parent's occupation and education, house cleaning), possible sources of lead exposure (e.g., hobbies), and data on recent renovations and deleading activities.

Another questionnaire, designated the "child questionnaire", collected information intended to characterize each child's exposure to lead in soil. The respondent was asked to identify the child's outside play areas (both in the immediate area of the dwelling and in the neighborhood), to estimate the amount of time the child usually spends in each location, the amount of time spent away from home (e.g., day care), handwashing, hand-to-mouth activities, vitamin use, and nutritional data.

Because (1) the lead content of different foods may vary and (2) diet and nutritional status may affect lead kinetics, specifically absorption, we also administered a food frequency questionnaire.

After the interview, a study staff member measured the height and weight of the child and obtained systolic and diastolic blood pressure readings. Parents' height and weight were also obtained by interview.

Follow-up "family" and "child" interviews were done toward the end of the study to assess changes in child behavior, house cleaning, new renovations, and increases in lead related knowledge.

The study staff were trained in proper interviewing techniques by a staff member of the Center for Survey Research of the University of Massachusetts. Each interviewer was

required to tape her first few interviews and feedback was given. Interviews were translated into Spanish, Portuguese, Creole, and Haitian Creole, and administered as needed, in these languages. These foreign languages were used in a total of 17.6% of the interviews.

9. BIOLOGICAL SAMPLING AND MEASURES

9.1 BLOOD SAMPLING

On three occasions during the study, blood samples of 2-3 ml each were drawn from the antecubital vein for determination of blood lead, FEP (free erythrocyte protoporphyrin) levels, and ferritin levels. The first sample was taken beginning in September 1989 prior to any abatement activities, the second taken an average of six months (beginning in March 1990) after initial abatement activities, and the third taken an average of 11 months after initial abatement activities (beginning July, 1990). Serum ferritin levels were obtained only at baseline.

All laboratory analysis results were reviewed within one day of receipt from the contract laboratory and health care providers were notified of the results. Any children with blood lead levels of 25 μg/dL or above were referred to the Boston Childhood Lead Poisoning Prevention Program and followed according to Massachusetts state law and accepted pediatric health practices.

An optional fourth blood sample was proposed in the original study design to be obtained during 1991 if sufficient funds were available and if the effect of the soil abatement was unclear.

The schedule for blood sampling was follows:

	Study Group	Control Group A	Control Group B
Fall 1989	Test	Test	Test
Winter 1990	Test	Test	Test
Fall 1990	Test	Test	Test
1991 Optional *	Test	Test	Test

* For children still residing on the original enrollment premises.

9.2 BLOOD SAMPLE ANALYTIC PROCEDURES

We selected Environmental Sciences Associates (ESA) Laboratories in Bedford, Massachusetts to perform the blood lead and free erythrocyte protoporphyrin (FEP) analyses since they met all of our stringent performance criteria including experience in performing biologic analyses for health studies, participation in proficiency testing programs, continuous OSHA certification and a detection limit of 1 μg/dL for blood lead. In quality assurance testing administered by the CDC, ESA's coefficients of variation were 20.9, 13.8, and 7.1% at the 4, 10 and 46 μg/dL blood lead levels. Bioran Laboratories in Cambridge, Massachusetts performed ferritin analyses.

ESA Laboratories determined blood lead levels using graphite furnace atomic absorption and EP levels using an ESA model zinc protoporphyrin hematofluorometer. Protocols describing both methods are included in the Appendix.

9.3 HAND LEAD DETERMINATIONS

Handwipe samples were obtained each time blood samples were drawn. Parents were asked not to wash the child's hands for the two hours immediately preceding sampling. Wearing disposable gloves, a study staff member wiped all surfaces of each hand, front and back up to the wrist, with three commercial wetwipes (Walgreen's Wetwipes). Sampling took place inside the child's home. To assess the extent of any contamination during sampling, field blanks consisting of six additional wipes were handled so as to simulate wiping the child's hands, and set aside to determine the background wetwipe lead levels. Field blanks were taken for every tenth child. Each set of six wetwipes was placed in a sealed container, labelled and transported to Dennison Laboratories, Woburn, Massachusetts where they were composited for chemical analysis. Extraction of the lead utilized 1N hot HNO_3 The total quantity of lead was reported in μg per pair of hands. Sampling and Analysis protocols are in the Appendix.

The schedule for hand lead determinations was as follows:

	Study Group	Control Group A	Control Group B
Fall 1989	Test	Test	Test
Winter 1990	Test	Test	Test
Fall 1990	Test	Test	Test
1991 Optional *	Test	Test	Test

* For children still residing on the original enrollment premises.

9.4 QUALITY ASSURANCE AND CONTROL FOR BLOOD LEAD MEASUREMENTS

ESA Laboratories maintained strict internal quality control systems for their blood lead analyses including composition of calibration curves with at least one reagent blank and three standards, running standards both at the beginning and end of large runs, running known control and QC material with every set of standards and every ten samples, and running duplicates and spiked samples every ten samples.

In addition, ESA participated in the external quality control system developed and overseen by Dr. Daniel Paschal of the Centers for Disease Control. CDC developed quality assurance standards for specimen collection, preservation and shipping, analytic method performance, bench and blind quality control materials, accuracy and blanks, and data integrity that are described in detail in a protocol in the Appendix.

The protocol also includes the results of four whole bovine blood pool analyses comparing ESA to the CDC, Cincinnati and Baltimore Lead-In-Soil Demonstration Project laboratories. The conclusions drawn from these analyses were that: (1) ESA and the other laboratory blood lead results were comparable; (2) each laboratory's blood lead data were produced from analytical systems in statistical control (as defined by Shewhart); and (3) no statistically significant time trends were observed.

9.5 REPORTING AND EVALUATION OF CLINICAL DATA

The results of a child's blood lead, FEP, and ferritin analyses were provided to the family and, with the family's permission, to the primary health care provider. Our staff's relationship with primary health care providers, such as neighborhood health centers, was vitally important to the success of the study. Study staff took every opportunity to encourage study participants to maintain ongoing relationships with their primary health care provider.

10. DETAILED DESCRIPTION OF THE INTERVENTIONS

10.1 LOOSE PAINT ABATEMENT

The purpose of loose paint abatement was to remove safely any very loose chipping paint from the inside of the home without generating dust or leaving behind small paint chips. No children were allowed to be on-site during this process. Loose paint abatement consisted of vacuuming the loose paint areas with HEPA (High Efficiency Particulate Aerosol Filter) vacuums, washing loose paint areas with a trisodium phosphate and water solution, and painting the window wells with primer.

Loose paint abatement was conducted to minimize lead based paint as a potential vector for children's exposure during the study period. Loose paint abatement should be distinguished from deleading, which was conducted after the collection of all environmental and child-based samples was completed. Interior and exterior deleading is described in a subsequent section of this report.

10.2 INTERIOR DUST ABATEMENT

The purpose of the interior dust abatement was to significantly reduce the amount of lead bearing dust in the treated homes. It always followed the loose paint abatement.

Dust abatement was accomplished by HEPA vacuuming and wiping surfaces with a wet cloth and furniture with an oil treated rag. Floors, woodwork on walls, window wells, and furniture surfaces were cleaned. Only the living areas were abated. The common entries, stairways, etc. were not cleaned. In the Study Group and Control Group A, interior dust abatement took place at the beginning of the first year. Dust abatement was not done in Control Group B.

Loose paint and dust abatements were performed from October 1989 through January 1990. It became readily apparent that the loose paint and dust abatements were time consuming and logistically complicated to accomplish, largely because of the inconvenience they caused to participating families. Cancellations and postponements by participating

families were frequent. All scheduled work was confirmed twice and attempts were made to have "backups" that could be used to fill openings in schedules made by cancellations.

Families were required to be out of their homes during these abatement activities. Many families considered cancelling just prior to the actual abatements because they had nowhere to go during the several hours it took to perform the abatement. Therefore it was frequently necessary to arrange activities for them during the period in which the loose paint and dust abatements were being conducted. Families were offered lunch at McDonald's Restaurant and free access to the Children's Museum, the New England Aquarium, The Tropical Rain Forest exhibit at the Franklin Park Zoo, or the Museum of Science. Study staff provided transportation to these various sites.

Two case managers from the study staff supervised these abatement activities and used documentation forms to record progress. ACP Cleaning Inc. of Malden, Massachusetts, performed all interior loose paint and dust abatement activities.

10.3 SOIL ABATEMENT

Soil lead was abated on 35 premises in the Study Group during the Fall of 1989. Soil abatement was undertaken on 58 premises in the Control Groups during the Fall of 1990. Eight premises were not abated in the Control Groups. The methods used differed somewhat during the two phases and are described in detail later in this section.

The purpose of the soil abatement was to remove and provide a barrier between lead contaminated soil and the children living on the study premises. The abatement was to be as permanent as feasible given the practical limitations of the study. The strategy for soil abatement involved removing a six inch layer of topsoil and placing a fabric or synthetic barrier topped with 8" of clean topsoil.

The initial plan was to remove 6" of soil, test the soil at the 6" depth, and continue to remove soil until a level was reached where lead was present at less than 500 PPM. This approach called for on-site soil testing, to be carried out with all of the workers and equipment standing by for the results of the analysis After pilot testing this method during the fall of 1987, it was decided that it was far too time consuming to be practical given the

large number of properties to be abated. A decision was made to remove soil to a set depth of 6" and replace it with 8" of clean topsoil.

In those situations where the driveway consisted of soil and the ground was frozen the area was capped with a minimum 3" layer of asphalt. This approach was employed in four instances. Soil removal was not undertaken in areas where asphalt was used as a barrier.

After excavation to 6" and replacement with 8" of clean topsoil, surface soil or cover was tested to insure that it was not contaminated with lead. Surface soil or cover was retested on average seven months later to ascertain whether it had been recontaminated by subsurface or above surface sources.

Testing and removal protocols emphasized:

- Thorough sampling of the yard.
- Adherence to removal safety procedures for insuring that the removal operation did not spread contamination via dust or mishandled soil to other areas at the study residence or neighboring premises.
- Insuring that replacement soil met requirements for low lead content.

The preparation of a site for soil abatement started well before the actual excavation. The study's abatement coordinator attempted to meet with the property owner. Many yards were found to have abandoned cars, trash, and other debris which had to be removed before abatement. This work was done in large part by ACP Cleaning, Inc., the same contractor who conducted the interior loose paint and dust abatements.

Several different methods were used to verify that the appropriate amount of soil had been removed. One method involved running a string between two reference points on objects such as the edge of a sidewalk or a fencepost. By measuring down from the string to the soil surface before and after excavation a determination could be made as to how much soil was removed. This method proved adequate for level yards, but it was not practical for uneven terrain.

In most cases, permanent features of the property were used as reference points. Before excavation, orange paint was sprayed onto fenceposts, building foundations, and tree trunks at ground level, and notes were made on existing slopes and hills. In most yards this worked well, but it was difficult to accurately measure 6" on very uneven yards. Contractors were urged to err on the side of taking out too much, rather than too little soil.

In situations where soil abatement involved frozen ground it was often impossible to remove less than 12" of soil because the soil was excavated as large, thick, frozen slabs.

10.3.1 Subsurface Fabric/Synthetic Barrier

In most situations, the soil at the 6" level still contained significant amounts of lead. A geotextile fabric barrier made of nonwoven polyethylene and polypropylene material which is water permeable, very durable, and has the appearance of a thick grey felt was laid directly on top of the exposed subsurface immediately following removal of topsoil and prior to placement of clean topsoil. The placement of this barrier served two purposes:

1. It indicated the border between old subsurface and newly applied surface barrier to determine how well the surface barrier would persist over time.

2. It protected against recontamination of the surface soil by the remaining contaminated subsurface soil.

10.3.2 Surface Covers

One of the following surface covers were employed:

- 8" of clean topsoil topped with:

  - sod
  - hardy grass seeding
    bark or mulch where grass would not grow
  - gravel, crushed stone or crushed bank in driveways and parking areas, walkways, and areas susceptible to erosion

- 3" Asphalt (No soil removal or fabric barrier required).

Selection of surface cover for a particular area was based on:

Appropriateness for site
- Least cost option that was acceptable to property owner
- Ease of maintenance.

Replacement soil was obtained by the contractor Franklin Environmental Services and was tested by Alpha Analytical Laboratories for lead, 23 other metals, and a number of other contaminants such as volatile organic components Laboratory confirmation was given to the study staff indicating that the replacement soil lead level was undetectable.

Where there was sufficient sunlight to support grass, the soil was covered with sod. There were many yards where sod would not grow well. There were also many unpaved driveways and paths where the soil had to be abated, but something other than replacement soil was needed to cover the geotextile fabric. For parts of yards where grass would not grow, bark mulch was used. In these cases 6" of clean soil was put down, followed by 4" of bark mulch. Gravel was used for driveways and heavily travelled walkways. In these cases 2" of clean soil was put down, covered by 6" of gravel.

10.3.3 Soil Abatement Procedures

Lot sizes varied from about 2,000 to 7,500 square feet (including the area occupied by house and sidewalks, etc.). The lots that were abated in 1989 averaged 199 square meters (2,141 sq. ft.) and ranged from 12 square meters to 702 square meters. An average of 41 cubic yards of soil was removed in 1989 (range of 3-168 cubic yards). The lots that were abated in 1990 averaged 178 square meters (1,918 sq. ft.) and ranged from 26 square meters to 656 square meters. An average of 44 cubic yards of soil was removed in 1990 (range of 6-182 cubic yards).

Several different soil abatement methods were used on the 36 Study Group properties abated in 1989. Initially, the soil was loosened with rototillers, then vacuumed into a truck using an industrial vacuum similar to that used to pick up leaves. The second method was to use a Bobcat (brand-name) tractor to dig up large areas and shovels for areas with narrow access. A third method was adopted for digging up properties after the ground had frozen. This called for jackhammers to loosen the soil and backhoes to remove it. Paving parts of the property was another option used after the ground froze.

The first method, using the truck-mounted (Supersucker) vacuum was abandoned relatively quickly for a number of reasons. The soil had to be gathered into piles, then fed into the vacuum. At best, this meant handling each shovelful of soil twice. After heavy rains the soil was wet, requiring extra labor to feed the soil into the vacuum. The machine was so big that it could not move around the property, so all the soil from the backyard had to be taken to the front to be fed into the machine. Rental of the vacuum itself also was extremely expensive. Six properties, including two double sized properties, were abated using this method before it was abandoned.

The majority of properties were abated using the Bobcat tractor combined with hand labor. The Bobcat was able to lift the soil into a dump truck that had a ten cubic yard capacity. In areas of the yard which were done by hand, soil was dug out with shovels, then taken by wheelbarrow to a point where the Bobcat could scoop it up and place it in the truck. This is an especially useful strategy because it can be adapted to almost any property. Eighteen properties, including one double sized property, were excavated using Bobcat and hand-labor. We were forced to abandon this approach when the ground froze in December of 1989.

The last 12 properties in the Study Group were abated during an unusually severe cold spell that began in late November and continued through December of 1989. The ground quickly froze to a depth of over 14", making the use of Bobcats or hand tools impossible. Jackhammer crews and backhoes were added to the work force. The work was very slow, and it became difficult to remove exactly six inches of soil. The backhoe would often remove a slab of frozen soil 12" thick and ten square feet in area. The workday was shortened due to the impact of windchill temperatures of -40 degrees Fahrenheit on workers and equipment.

During this period we offered some property owners the option of having part or all of their property paved with asphalt. One entire property and parts of three others were ultimately paved. Since sod could not be planted during this period, grass seed was spread on the new soil and repeated the following spring.

The general techniques used for soil abatement of properties in Control Groups A and B in 1990 were similar to those used on the properties in the Study Group. The contractor used a Bobcat tractor to excavate large areas. Smaller areas were excavated by hand, and soil was wheelbarrowed to a place where the Bobcat could scoop it up and lift it into a truck. On some occasions a rototiller was used to loosen the soil in preparation for hand digging.

There were, however, two important changes in the soil abatement procedures in 1990. First, in place of gravel for driveways and walks, a material called "crushed bank" was used. This mixture of ground stone (or stone dust) and gravel forms a packed surface which, unlike gravel, is not subject to scattering. It creates an attractive and durable gray gravel-like surface. A layer 8" deep was spread over the geotextile fabric and packed down with a compacting machine. This was used extensively to resurface dirt paths and driveways.

The second important change was that a single contractor did all of the work. During the previous year, two contractors were used. One did the excavation and the other did the landscaping. In the second year, several types of contractors submitted bids, including landscapers, hazardous waste firms, and deleading firms. The contract was awarded to Franklin Environmental Inc., of Wrentham, Massachusetts. This company regularly performs underground storage tank removals, hazardous waste removal and hauling, and asbestos work. Using one contractor made it much easier to coordinate landscaping and excavation activities.

The soil abatement schedule required that every property be prepared well in advance of the commencement of excavation activities. It was clear, from our experience in 1989, that additional staff would be needed to do advance work and to monitor abatement so three "site monitors" were hired in August 1990. They visited properties to be abated and met with landlords to address the following issues in preparation for soil abatement:

Note presence of:

- Debris blocking access to yards
- Locked gates
- 6 foot access for bobcat bulldozer
- Dogs
- Abandoned cars
- Cars blocking access to yard
- Bad traffic or busy intersections
- Narrow streets
- Access to outdoor water spigot

Also:

- Ascertain owner preferences for sod, crushed bank, or bark mulch
- Plan for access to water if not available outside
- Drop off letter explaining process to owner
- Obtain signed cancellation form if owner did not want soil removal

During the fall of 1990 lead contaminated soil was removed from 58 properties on which children in the Control Groups resided. The original schedule called for the soil removal to be done soon after the second follow-up blood sample was obtained and after the exterior deleading was complete in the Control Groups. This required that two properties be

scheduled each week. Abatements did in fact proceed very close to original plans, despite difficulties and unanticipated delays.

Soil removal for Control Groups A and B began in September 1990. Crew size ranged from 6 to 12 people, with an average of 9. Crews typically included a foreman, who coordinated movement of materials and people, a truck driver, a Bobcat operator, and five or six laborers. The contractor worked on as many as four sites at once. Often four sites were excavated in two to three days, and all landscaped simultaneously in the following two days. Most sites were completed in one day. The largest sites took two to three days to complete.

The sites varied in size and difficulty. Some sites had to be abated entirely by hand because there was no access for the Bobcat. This meant using a wheelbarrow to take all of the contaminated soil out and bring all of the clean soil in. Most sites, however, consisted of a combination of areas that could be excavated by Bobcat and smaller areas that had to be excavated by hand.

There were only a few minor delays and the last property was abated on December 11, 1990.

10.3.4 Soil Abatement Safety

A soil abatement health and safety plan was developed to prevent the accidental dispersal of lead-contaminated soil and to protect workers from lead exposure and accidents while work was being done.

The same soil abatement health and safety plan was followed in both the 1989 and 1990 soil abatement phases.

Respirators were used by individuals conducting lead contaminated soil abatements only for the pilot abatements conducted in 1989. During these abatements air monitoring was conducted by Applied Occupational Health Systems (AOHS), an industrial hygiene consultant firm from New Hampshire. Air monitors were put on the perimeter of the site and on the dumpster into which the lead contaminated soil was placed. They were also clipped to the shoulders of some of the workers. These monitors collected data on the amount of lead dust escaping from the work area and the level of lead in air at the site. Area and personal breathing zone air samples were collected by drawing air through 0.8 micron pore size, 37 millimeter diameter mixed cellulose ester filters mounted in closed face cassettes. Air

was drawn through the filters using MSA or Gillian personal air sampling pumps with a flow rate of at least 2.0 liters per minute as established by prior and post calibration using the primary bubble tube method. At the end of the sampling period, the cassettes were capped, sealed, labeled and hand-delivered to the AOHS, American Industrial Hygiene Association (AIHA) accredited laboratory (#342), for analysis utilizing atomic absorption spectroscopy (NIOSH Method 7082).

Monitoring results were compared to the OSHA Permissible Exposure Limits (PEL) and Action Level. The OSHA PEL for lead is 50 mg/m^3. The highest time weighted average exposure found during the pilot abatements was 0.82 mg/m^3. Based on these findings, respiratory precautions were abandoned.

Soil was prevented from becoming airborne by frequent watering using a garden hose during excavation. This worked well as evidenced by air monitoring results during the first abatements in 1989. When the ground was very dry, as it was during the first days of the 1990 abatements, the ground needed to be watered for several hours the day before abatement was scheduled.

Safety measures for preventing soil from being tracked or spilled off site consisted of establishing work areas, and surrounding the areas with plastic dropcloths. Weather permitting, decontamination areas were set up on the plastic, where workers would wash off, then remove their boots and tyvek suits. The decontamination area consisted of wading pools filled with water, scrub-brushes for the boots, and trash bags for the disposal of tyvek suits worn by the workers.

The waste water from the decontamination pools was poured back into the area that was just abated, before the geotextile fabric was in place. Equipment such as shovels, rototillers, and Bobcat bulldozer blades and tires were hosed off in a place where the wash water would drain back into the work area.

The Health and Safety Plan is included in the Appendix.

10.3.5 Soil Disposal

Disposal of the lead contaminated soil in a safe and cost effective manner was critical to the success of the study. This proved to be a difficult task throughout the study.

Soil disposal was accomplished in accordance with guidelines developed in conjunction with the Massachusetts Department of Environmental Protection. Lead contaminated soil was removed to a location to which access was controlled, specifically a granite quarry in the Hyde Park section of Boston (Barry's Quarry) that abuts and will become an extension of an existing cemetery. This site was extremely useful because it was very close to the study properties and was unlikely to result in exposure to the disposed soil.

We began using this site in October 1989. At that time, quarry owners had bulldozers operating every day and arrangements were made to place soil from the study in a designated area of the quarry. Each load of lead contaminated soil from the study was covered with uncontaminated soil from other parts of the quarry to minimize the possibility that children and other individuals would be exposed to the lead in the abated soil. This site also provided minimal risk of contaminating water tables as underground wells are not used and all drinking water in the Boston area comes from a reservoir far west of the City.

On November 3, 1989, during the soil abatement phase of the Study Group, the City Councilor from the Hyde Park section of Boston raised concerns about the safety of disposing of lead contaminated soil in that section of the City. These included questions about whether the lead contaminated soil would harm children or adults in the area, contaminate the community water supply, and reduce property values of homes in this neighborhood. Moreover, the justice and wisdom of taking soil that was believed dangerous to children from one neighborhood and disposing of it in another neighborhood was also questioned. This resulted in the project temporarily suspending use of the quarry in that neighborhood for the disposal of soil.

To stay on schedule, it was crucial that we not halt abatements and so it was essential to use a temporary site for soil storage until the disposal site controversy was resolved. Although soil was not considered hazardous waste by the Environmental Protection Agency or by the Massachusetts Department of Environmental Protection, it was extremely difficult to find an alternate permanent disposal site. Most landfills in the area were closed. The landfills that were open were unwilling to accept lead contaminated soil because the operators of these facilities feared that by accepting the soil they would incur penalties under future regulations. A common concern voiced by the disposal industry is that material legally

accepted today may be declared hazardous in the future and result in additional costs to landfill owners.

We resorted to a temporary storage facility until access to the quarry was restored. The temporary disposal site for soil from 14 properties was a parking lot at the Mattapan Chronic Care Hospital. Permission to use the site was granted by Boston's Commissioner of Health and Hospitals. A trench was cut in the pavement and a silt fence installed to prevent run-off. Plastic drop-cloths were used to cover the soil and prevent dust from being blown off the site. The parking lot was surrounded by woods on two sides and an abandoned building on another. It was well within the grounds of the hospital and close to a rarely used road. The combination of precautions taken to keep the soil in place and the remote location made this a suitable temporary storage site for the lead contaminated soil.

The controversy was eventually resolved in a series of meetings involving city councillors, representatives of the neighborhood in which the quarry is located, the study's principal investigator, the EPA Region I Project Manager, and a representative of the Mayor's Office. Input was also elicited from the Massachusetts Department of Public Health, the Massachusetts Department of Environmental Protection, scientists and others working with the study, and various lead experts not associated with the study. The unanimous consensus of public officials and lead experts was that there was no danger to local residents. The concerns of residents and the City councillor were allayed and permission was granted to resume using the quarry as a disposal site on December 2, 1989. Soil which had been temporarily stored at the Mattapan Hospital site was moved to the quarry on December 7 and 8, 1989. Although successfully resolved, this episode occurred despite substantial efforts at public awareness and community relations that preceded disposal activities and jeopardized the study for a period of time. These issues may have significant implications for future lead contaminated soil abatement and disposal efforts in other communities.

10.3.6 Obstacles to Soil Abatement

Disposal of contaminated soil was clearly the greatest obstacle encountered in the study. It was not, however, the only difficulty confronted. Listed below are some of the other

problems that had to be addressed and that may have implications for future lead contaminated soil abatement efforts:

- Narrow streets that were difficult to negotiate with trucks
- Narrow access for Bobcats (less than six feet wide)
- Bulky trash items in yards
- Non functioning cars in yards
- Fences that had to be taken down and replaced to gain access to yards
- Availability of tested "clean soil"

11. INTERIOR AND EXTERIOR PAINT DELEADING

Paint deleading was not included as a study intervention but we strongly recommended it to homeowners and landlords after all study interventions, environmental sampling and the second follow-up blood and handwipe sampling were completed. Deleading performed in conjunction with the study met or exceeded minimum requirements of the Massachusetts Lead Law. It included the removal of lead paint from chewable surfaces below five feet and making intact all surfaces above five feet. Specifications written by the study's deleading coordinator required that, whenever possible, dust generating methods be avoided. The preferred deleading methods were off-site treatment of surfaces covered with leaded paint and replacement with new materials. Exterior and common interior areas of multi-unit housing were deleaded, as well as the inside of participant's living units.

All contractors were monitored by the study's inspection staff to ensure that proper safety and health considerations were addressed during the deleading and participant families vacated the premises during deleading. Dust wipe samples were taken upon completion of the deleading to confirm that the premises were safe for families to re-occupy.

11.1 PRE-DELEADING PLANNING

Planning the deleading activities began in January, 1990 when the loose paint and dust abatement interventions were completed. At that time we anticipated deleading as many as 100 units. Because of the logistical complexities that this presented, advice was sought from numerous sources.

All deleading contractors licensed to work in Massachusetts were invited to attend a pre-request for bids "brainstorming" meeting on February 14, 1990. Mark Farfel and Susan Guyeaux who have been involved in research and development of deleading procedures in Baltimore, Maryland also were asked to attend and offer suggestions. The scope of work was described, preliminary specifications explored, and feedback obtained from local contractors. It quickly became apparent that several contractors would be required to perform the work.

The most prominent problem was scheduling deleading around soil abatement activities in Groups A and B so that soil abatement could be completed before the cold weather months when the ground freezes. It was also necessary to delead the exteriors of buildings before soil removal in Groups A and B to prevent recontamination. (Group S received soil abatement the previous year.) These problems led to the decision to develop separate contracts for interior and exterior deleading activities so that these activities could be performed independently, thereby preventing delays that could interfere with soil abatement. It was decided that eight contracts would be needed (four for interior work and four for exterior). This approach allowed for the soil abatement needs to be satisfactorily addressed and allowed medium sized as well as larger deleading companies to bid on the activities.

Requests for bids were put out in three phases due to the time involved in preparing lead paint inspection and bid documents. Each phase ended in competitive negotiations to bring down the initial bids.

Exterior work included the removal of lead contaminated paint from chewable surfaces below five feet on siding, porches, rails, stairs, windows and doorways of common areas as well as the building's exterior surface. Loose paint above five feet was also made intact. If these areas of the home were deteriorated, or if it was too difficult or hazardous to remove the lead paint from a surface, items were removed and replaced with new materials of similar workmanship as other items in the house or neighborhood. Columns with chewable surfaces were covered or scraped to a height of five feet.

Interior deleading consisted of removing lead contaminated paint from chewable surfaces below five feet and making intact all loose paint above five feet on walls within the apartment or housing unit. To minimize deleading hazards, dust generating methods were avoided whenever possible. Replacement and off site dipping were used whenever possible although some use of dry scraping was unavoidable.

The following contractors performed the interior and exterior deleading. All were licensed by the State of Massachusetts to engage in deleading activities:

Action Deleading
Point West Plaza
21 Torrey Street
Brockton, MA 02401

Paint by Numbers
P. O. Box 128
N. Easton, MA 02356

A. Escalada Painting Co.
633 Ferry Street
Marshfiled, MA 02050

Tri-State Restoration
16 Hazel Drive
Hampstead, NH 03841

Contractor hired by the one owner who chose to hire his own contractor:

Tolan and Sons Deleading
44 Coburn Street
Framingham, MA 01701

Subcontractor to Action Deleading:

Webster Environmental
161 Granite Avenue
Dorchester, MA 02124

11.2 DEVELOPMENT OF INSPECTION PROCEDURES

It was originally planned that an inspector from the Office of Environmental Affairs of Boston's Department of Health and Hospitals would perform limited inspections of participants' homes and provide information on the lead paint content in the premises. It was essential for scientific considerations that we have a measure of children's exposure to lead in paint and take this lead source into account when we determined the effectiveness of lead contaminated soil abatement. Because this plan called for inspections to be performed by a "code enforcement inspector," under Massachusetts law it would require that any unit found to have lead paint be deleaded. Such an approach, however, was likely to discourage many families and landlords from participating.

After meetings with representatives of the Massachusetts Department of Public Health, it was decided that the study would hire private inspectors who were not bound by code enforcement inspection requirements. The inspection reports generated by these individuals would be filed with the State's Lead Paint Poisoning Prevention Program, but since the participating children's blood lead levels were below 25 μg/dL, the reports would not be reviewed by state officials and so would not result in mandatory deleading. This allowed the study to obtain the necessary scientific information without putting participating families or owners in legal jeopardy.

In April 1990 private inspectors were hired. Inspection procedures were developed that were consistent with study needs and legal requirements. It was initially expected that these inspectors would only perform a one-time inspection in each unit prior to any deleading activities. It was planned that study case managers would be trained by an industrial hygiene consulting firm to monitor deleading operations. Final deleading compliance letters were to be issued by an inspector from the Office of Environmental Affairs after work was completed. The Massachusetts Department of Labor and Industries, however, refused to grant a waiver of their deleading regulations to allow on-site monitoring by study case managers (even though there is no provision in the regulation for monitoring, i.e. the regulation addresses inspections only). Thus, the only way to provide on-site safety monitoring was to have the private inspectors do both on-site monitoring and inspections. The final compliance letters were issued by the inspector who had performed the initial inspection.

Initial inspections were performed between June and August 1990. Monitoring of deleading activities took place between August and the end of December 1990.

11.3 DELEADING ACTIVITIES

The 152 children participating in the study lived in 123 housing units on 101 premises. Deleading or assistance with deleading was offered to all 123 households. Thirty of these households either moved or refused to have an inspection for lead based paint. Study staff did not pursue deleading in these cases. In all cases, however, irrespective of whether an extensive inspection was performed, at least six measurements of the lead content of interior paint were obtained per unit. Using a PGT (Princeton Gamma Tech) x-ray fluorescence instrument, the inspector obtained measurements of the lead in the paint on the woodwork and on one wall in the kitchen, living room, and child's bedroom. If more than one child lived in the unit, samples were obtained from each child's bedroom. Inspections were refused generally over concern about the legal obligation to delead the unit if an inspection revealed the presence of lead based paint. Study assistance with deleading was first offered at the time families and landlords were recruited to participate in the study. Refusals to have premises inspected or deleaded, however, occurred throughout the study.

Ninety-five units were given full inspections for lead-based paint. Six of these units had previously been deleaded and 32 families refused deleading after the inspection. In an additional seven cases, deleading was refused after the deleading bids went out. Thus, deleading was refused for 39 of the 95 inspected units. Reasons for refusal included unwillingness to prepare for the move and disruptions to lifestyle that the move would entail (e.g., children's transportation to school and adults' transportation to work).

A total of 92 deleading operations were conducted at 46 premises. Each deleading operation refers to either the interior deleading of a unit or the exterior deleading activities associated with that unit. Deleading related work started on August 20, 1990 and all work that could be considered deleading was completed by December 31, 1990. There were tasks that the contractor initially believed to be completed but were found to be incomplete when post-deleading inspections were performed. These and other loose ends brought the completion date for all deleading related activities to February 14, 1991.

Most deleading involved single units within buildings that had two or more living units. Four of the addresses involved deleading two units within the same building and four participating families lived in single family houses. Three non-owner occupied residences participated in study assisted deleading. There were four units on these three properties. The study offered to pay up to $ 2,000 towards deleading units in non-owner occupied households. One owner who had two units at the same address chose to hire his own deleading contractor to perform the work. The study paid $4,000 directly to the contractor and monitored the deleading activities in the same manner as the other households in the study. The remaining two non-owner occupied addresses were deleaded by contractors hired by the study, as was the case for all owner occupied properties.

Forty-five deleading compliance letters were issued at the end of deleading activities. Deleading compliance letters are official documents stating that a property is in compliance with the Massachusetts Lead Law and that previously identified violations have been rectified. One non-owner occupied address was not issued a deleading compliance letter because only the building's exterior was deleaded under the study's guidance. Although the interior of this unit had been previously deleaded, it was done under an older version of the law. The law does not permit issuance of a certificate for exterior deleading alone and does not contain a grandfather clause covering work performed under the old law. In three

additional premises, only exterior deleading was done although we initially had planned to do interior and exterior deleading at these sites. No deleading compliance letters were issued for these premises.

In one dwelling, no compliance certificate was issued although both interior and exterior deleading was completed. On initial inspection of this dwelling access to the basement was prevented by a locked door. During the final inspection after deleading activities were completed, this door was found open and was being used as an entrance to office space created recently by the owners. The inspectors would not issue a compliance letter because this allowed children access to an area that previously had not been inspected. The owners must now have this area inspected and, if necessary, deleaded in order to obtain a certificate of compliance. This is the responsibility of the owners since the study will not be involved in any further inspection or deleading activities.

Weekly progress meetings were held to arrange and monitor deleading activities. Contractors, inspectors, and the study's deleading coordinator attended all meetings and whenever necessary, other members of the study staff attended to discuss issues or problems that required their attention. This forum was used to provide updated information on all changes in field activities, schedules, moving issues, etc., and keep inspectors, contractors, and the project administrator informed of other changes that were required to accomplish tasks in the necessary order.

11.3.1 Exterior Deleading

Exterior deleading work was performed on 46 properties covered under four separate deleading contracts This work included all common interior areas; other buildings on the properties such as garages; and exterior window sills (except for window sills in participating families' units which were addressed as part of interior deleading). Deleading certificates of compliance were issued for 42 of the 46 exterior deleading operations.

Exterior deleading required from 1 to 41 days per property. A total of 1,156 days were required for the 46 exterior deleading operations. The average duration of exterior deleading was 25 days per site. These figures include all of the work activities, including non-hazardous finish work All four of the exterior contracts were completed within the scheduled time frame.

Exterior deleading did not require occupants to relocate. All work was performed without disruption to any of the building's occupants except for requiring alternate access during the periods that work was being done on stairways. It was the responsibility of the contractor to check the soil abatement schedule to make sure exterior deleading work did not interrupt the soil work. No exterior deleading took place when properties were undergoing soil removal or landscaping.

Lead painted exterior surfaces were freed of loose or peeling lead paint by chipping and scraping and were then given a primer coat of paint. Application of finish coats of paint were the owner's responsibility.

Common hallways in multi-unit buildings were addressed as part of the exterior deleading contracts. The contractor was responsible for informing other building occupants of the work activities occurring in these areas and to assure that alternate access rules were observed. HEPA vacuum units were installed on the first floor at the entrance to buildings. Containment barriers were set up to make sure that the work area was isolated and that no contamination spread outside of the work area. A warning sign, as required by the Massachusetts Lead Law, was affixed to the outside of the containment area entrance. Work in the common hallways/staircases began on the top floor and proceeded down to the first floor level. Deleading was performed according to the methods developed and explained in the study's specifications and were monitored by the study's inspection team to insure compliance.

11.3.2 Interior Deleading

Interior deleading involved only the inside of the living units of families participating in the study. Exterior window sills of these units were included in the interior deleading contract activities. The unit's occupants and all of their belongings were relocated for the duration of the interior deleading work. A moving contractor was hired by the study to remove the occupant's belongings and furniture prior to the deleading contractor's arrival. All belongings were fumigated to exterminate insects and placed into storage for the duration of the deleading. Damages caused by the movers were addressed prior to the final release of a 15% retainer.

The moving contractor billed additional charges for items that remained in storage for over seven days at a rate of $6.00 per household per day. Additional storage per household ranged from 1 to 43 days and averaged 9.5 days. There were a total of 391 extra storage days, charged at a cost of $2,346. Forty-one households were moved under the moving/storage contract; five households did not require moving assistance.

Case managers and contractors occasionally helped families with last minute packing. In five instances extra charges were incurred when it was necessary to cancel moves since occupants were unprepared. The cost of these cancellations was $1,800. There was only one last minute cancellation that was never rescheduled because the occupants would not or could not pack for moving. In the other four instances of cancellations, moves and deleading were rescheduled. No compensation was made to the deleading contractor in cases where sites were eliminated prior to the scheduled start date. The moving contractor, however, did receive compensation for costs incurred when a move was cancelled or postponed. The total cost of moving and storage (including additional storage costs and cancellation fees) was $33,666.

The duration of interior deleading activities ranged from 3 to 58 days per unit, averaging 15.6 days. A total of 716 days were needed to delead the 46 interior sites. This included only the time during which occupants were required to be out of their homes.

Interior deleading work included 46 households that were addressed under four separate contracts. Most work was started on schedule, but in several instances work was not completed according to schedule. Some of these time overruns were unavoidable. No penalties were assessed against contractors if the explanations for schedule delays were reasonable. There were six cases, however, where these delays were avoidable and penalties in the form of liquidated damages of $1,000 per day were assessed for a total cost of $6,000. All of the penalties were assessed against the same contractor and only after other attempts by study staff to rectify problems were exhausted. These penalties were used as a last resort and only when it was absolutely necessary to maintain the study's best interests. Alterations of time schedules were rarely permitted, and only with approval of the deleading coordinator.

Interior deleading involved the removal of lead paint from chewable surfaces below five feet, and doors and windows and other chewable surfaces within the living unit. This was accomplished by replacement, off-site dipping in paint removing chemical mixtures, and

scraping. Owners had the option to have items that had ornamental detail taken off site to have the lead paint removed by dipping. Loose paint above five feet was made intact. The dipping process did cause some of the older deteriorated materials to separate or dissolve, but this kind of damage was minimal.

Items that had little or no ornamental detail were replaced with #2 pine. When doors were dipped, the door jamb was scraped free of lead paint to a height of five feet on site. In general, this was the only instance where dry scraping was allowed during interior deleading. Dry scraping or the use of chemical solvents was allowed only when there was an architectural or structural reason for not removing the material from the site or when it was required to satisfy the requirements of the Massachusetts Lead Law. When new doors were installed the pre-hung/hollow-core type was used. This eliminated the need for scraping jambs. Since the study investigators and staff believe that dry scraping is an extremely hazardous process, this type of deleading was kept to an absolute minimum.

All items deleaded off site and replaced, and all items that were deleaded on site were given a coat of primer paint by the deleading contractor. This was done to make sure that any fine dust film or residue left on the surface was sealed in. New materials were not painted by the contractor as this was the responsibility of the property owner. Similarly, making the surfaces above five feet intact involved priming only the repaired surfaces. The entire wall surface was left for painting by the owner after deleading was completed.

Prior to removal of the critical barriers, the contractor was required to HEPA vacuum and wet wash all surfaces within the containment area. This cleaning process followed a set sequence beginning with surfaces that were deleaded, then walls and vertical surfaces, then horizontal surfaces, and finally floors. Critical barriers were then removed and the unit HEPA vacuumed again. Wood floors were coated with polyurethane

11.3.3 Temporary Housing

The ability of participants to find short-term housing during interior deleading presented a major obstacle. If the study were to provide temporary housing, these sites would have had to be deleaded or the study would have had to delead them prior to housing families there. Deleaded units were very difficult to locate and unavailable for short-term rental. The study staff investigated the possibility of deleading several units in exchange for

temporary housing. This option was ruled out because of insurance, liability, and other legal reasons Participants were urged to find their own alternate housing with friends or family. The study paid for lodging only after families had demonstrated a sincere effort and were unable to find temporary housing. Study staff provided participants with a list of hotels/guest houses that would provide lodging. Families made their own lodging arrangements and the study staff set up purchase orders to handle payment.

Seven families were assisted in finding temporary lodging while deleading was being performed Their stays ranged from 1 to 19 nights, and the average length of temporary lodging paid for by the study was 11 nights. A total of 78 nights of lodging were provided by the study at a total cost of $11,612. An additional 39 families found alternative housing without assistance from the study staff.

11.3.4 Damage Control

Pre-existing damage was recorded prior to the commencement of deleading. The contractor was responsible for giving a written report on the pre-existing damage to the study site monitor before beginning work. Pre-existing damage that was uncovered after the work had started was brought to the attention of the study site monitor and recorded in the monitor's daily log

Study site monitors were on each site daily when deleading activities were being conducted to assure that deleading activities were done safely with minimum damage. Due to the nature of the work, however, some damage was inevitable. This was understood by participating families and owners beforehand, and it was understood that certain corrections would be the responsibility of the property owner.

In order to avoid damage and excess ripping of wallpaper the contractor was required to cut a seam between door and window casings and wallpapered surfaces before removing doors or windows There was only one case where wallpaper was torn during the removal of a window casing. There was no conflict since the owner was aware of possible damage.

Owners were requested to remove telephone and electrical cords that came into contact with lead painted surfaces addressed as part of the deleading, before the scheduled start date. If lines were left in place the contractor took appropriate action to work safely around these area. However, there were several cases where telephone lines left in place were cut or

broken. The contractors were not held responsible for repairs except when there was obvious lack of consideration when they were removed.

Any damage to walls was corrected by the contractor by filling with joint compound and priming. All finish painting was the property owner's responsibility. Any damage that occurred through neglect or carelessness of work crews was corrected by the responsible party. In cases where there was a dispute as to where responsibility lay, the study site monitors and deleading coordinator determined what course of action was appropriate.

All work sites were strictly monitored by on-site study representatives who interrupted or redirected work for reasons of safety or requested corrections according to the specifications.

11.3.5 Clearance Sampling

Massachusetts requires clearance sampling for dust lead levels after interior deleading in situations where dust is visible. The State standard for acceptable dust lead levels after deleading is 200 μg/square foot on the floor, 500 μg/square foot on window sills, and 800 μg/square foot in window wells. When no dust is visible to the inspector, clearance sampling is not required.

The study specifications required that visible dust be removed completely before the work area was considered ready for clearance sampling. Clearance sampling was required for every unit deleaded in conjunction with the study. The study did clearance sampling in two rooms on each floor of each deleaded interior unit and in the common hallway areas. Moreover, the study insisted that all clearance samples meet the lead levels indicated in the Massachusetts Lead Law before the deleading operation was considered complete.

Samples were taken by lead inspectors from the floor, window sill, and window well from each room sampled after contractors informed the inspectors that deleading was complete. Inspectors did not inform contractors where the samples were going to be obtained. The samples were obtained by wiping surfaces with commercially available "Wash and Dries". Inspectors wore disposable gloves, which they changed between samples, and they wiped one square foot on the floor and wiped measured window sills and wells. Blanks were included with each set for quality control purposes. In order to improve the efficiency of sample preparation, study staff added hydrochloric acid to the samples to start

the 15 hour digestion period. Analysis was performed by the Lead Lab at Boston City Hospital using atomic absorption spectrophotometry (spectroscopy). By having the study staff start the digestion process the turn around time involved in preparation and analysis was reduced by at least one day per unit.

Due to cost constraints, the original plan was to do clearance sampling only after deleading was believed to be completed However, pre-deleading clearance sampling was performed in the interiors of 17 units to provide data for pre and post-deleading comparisons.

Post-deleading clearance sampling of the 46 household interiors revealed that 32 (70%) of the households had acceptable dust lead levels without additional clean-up. Fourteen (30%) of the households were found to have unacceptable dust lead levels and required a second cleaning and an additional set of samples. Two of these 14 required a third cleaning before acceptable lead levels were obtained.

The failure rate of final wipe samples was very high despite the fact that the sites appeared clean by visual inspection. All deleading contractors working for the study were monitored during deleading activities and wipe samples were not taken unless areas appeared clean of dust and dirt. This, along with limiting dry scraping to areas where it was absolutely necessary, should have provided a work area that was as free of lead contaminated dust as possible. This highlights some of the dangers associated with interior deleading activities and raises questions about the adequacy of visual inspections for dust post interior deleading.

Clearance sampling was performed in conjunction with the final inspection activities that occurred at the completion of interior deleading activities. It took approximately one hour per site to obtain the samples and begin the digestion process.

12. SCHEDULE OF ACTIVITIES

The schedule of activities is shown on Tables 12-1 and 12-2. Table 12-1 gives the timetable of activities by month. The actual dates on which activities began and ended are shown on Table 12-2.

TABLE 12-1. TIMETABLE OF ACTIVITIES

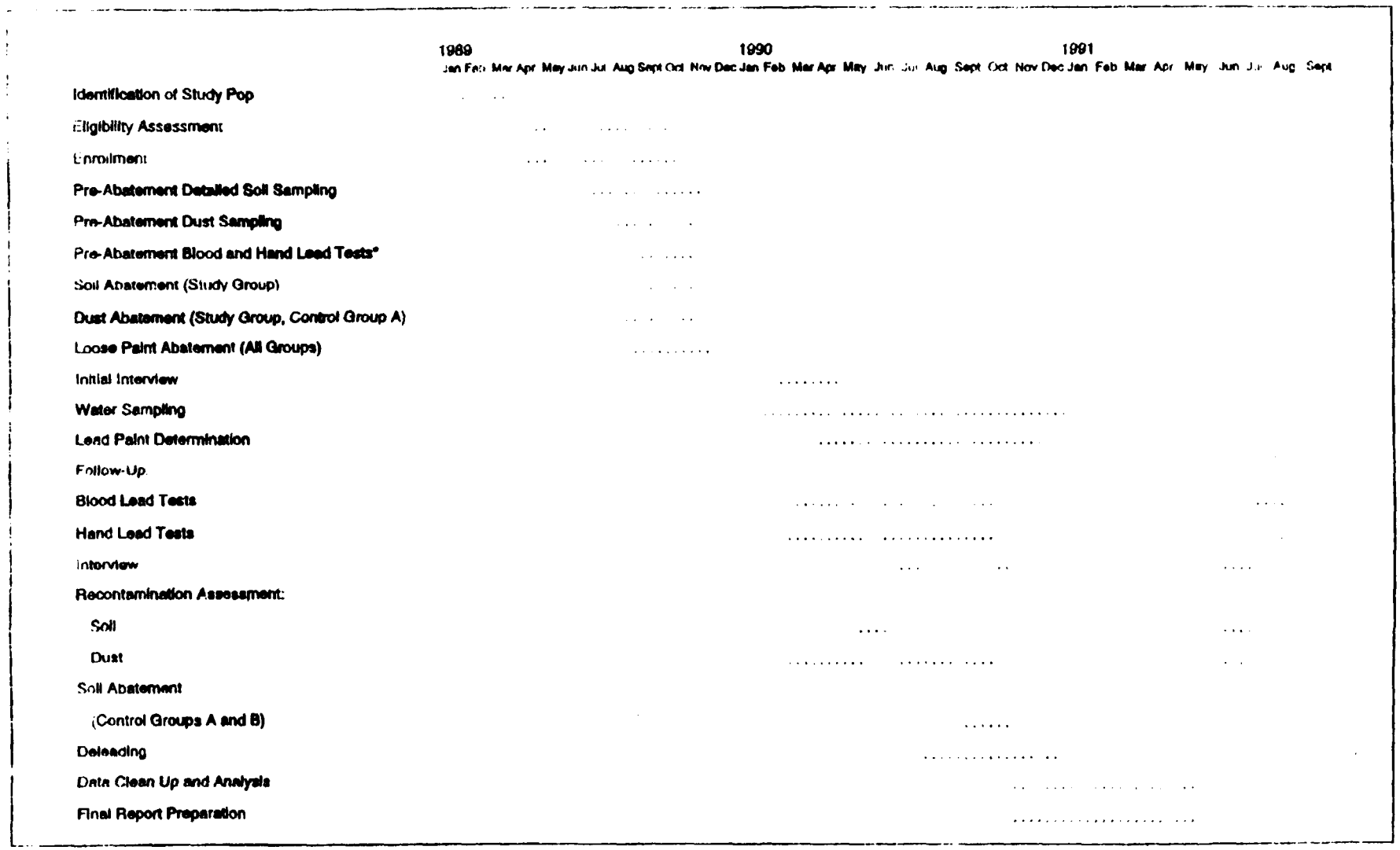


TABLE 12-1. TIMETABLE OF ACTIVITIES

	1989											1990												1991				
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Identification of Study Pop	.....																												
Eligibility Assessment		.....																											
Enrollment			.....																										
Pre-Abatement Detailed Soil Sampling						.....																							
Pre-Abatement Dust Sampling							.....																						
Pre-Abatement Blood and Hand Lead Tests*							.....																						
Soil Abatement (Study Group)							.....																						
Dust Abatement (Study Group, Control Group A)							.....																						
Loose Paint Abatement (All Groups)							.....																						
Initial Interview													.....																
Water Sampling													.....																
Lead Paint Determination															.....														
Follow-Up:																													
Blood Lead Tests														.....				.....											
Hand Lead Tests														.....				.....											
Interview																			.....										
Recontamination Assessment:																													
Soil																	...												
Dust														.....				.....											
Soil Abatement																													
(Control Groups A and B)																				.....									
Deleading																			.....										
Data Clean Up and Analysis																						.....							
Final Report Preparation																						.....							

TABLE 12-2. STARING AND ENDING DATES FOR INTERVENTIONS AND SAMPLING

	Started On	Ended On
Baseline Blood Sampling	9/14/89	1/8/90
POST1 Blood Sampling	3/19/90	6/13/90
POST2 Blood Sampling	7/19/90	11/17/90
Baseline Handwipe Sampling	9/13/90	12/20/89
POST1 Handwipe Sampling	3/20/90	7/3/90
POST2 Handwipe Sampling	7/18/90	1/3/91
Preliminary Soil Sampling	4/4/89	11/18/89
Pre-Abatement Detailed Soil Sampling	8/4/89	6/20/90*
Soil Abatement (Study Group)	9/18/89	12/26/89
Soil Abatement (Control Groups A and B)	9/11/90	12/11/90
Soil Recontamination Sampling, Round #1	6/11/90	7/13/90
Pre-Abatement Interior Dust Sampling	8/17/89	1/16/90
Post-Abatement Interior Dust Sampling	10/6/89	3/9/90
Dust Recontamination Sampling, Round #1	3/27/90	6/14/90
Dust Recontamination Sampling, Round #2	7/2/90	12/15/90
Interior Dust Abatement	10/2/89	1/30/90
Interior Loose Paint Abatement	10/2/89	1/30/90
Water Sampling Round #1	2/8/90	7/23/90
Water Sampling Round #2	7/18/90	2/11/91
XRF Lead Paint Determinations	4/10/90	1/7/91
Initial Questionnaire Administration	2/2/90	5/2/90
First Follow-up Questionnaire Administration	7/19/90	3/21/91
Paint Deleading	8/28/90	1/4/91

*Approximately 80% of the detailed soil sampling was completed by 1/24/90. 23 soil samples were taken between 1/24/90 and 6/20/90. Approximately 90% of the detailed soil sampling was completed by 5/25/90. 12 soil samples were taken between 5/25/90 and 6/20/90.

13. DATA COLLECTION AND MANAGEMENT

The study generated and maintained data from the soil, dust, water, paint, blood lead, and hand lead analyses. In addition, information collected from two sets of questionnaires was collected and analyzed. Data collection instruments were developed to gather and code all information.

Quality control and assurance measures were performed at each step of data collection. These included the following measures:

1. All original paper forms were stored by premises identification number or in chronological order in file cabinets enabling easy access and retrieval.

2. Original report sheets from ESA, EPA, Dennison, Bioran, and Hall- Kimbrell laboratories were stored separately.

3. All completed forms and questionnaires were reviewed manually for accuracy and completeness and any questions and problems were resolved in an ongoing manner.

4. The standard data entry validation tools (range checks, picture formats etc.) were used for all data sets created through data entry.

5. The quality of identifiers was assured through table-lookup at data entry. The principal identifiers were validated against a table of valid values and invalid values were rejected. Valid values called up additional identifying information (name, address, etc.) to verify a correct match.

6. Up-to-date source coding listings and coding manuals of all database files structures, programs and documentation was maintained and available for easy access.

7. 100% verification of all data entered by the study's data entry clerk was conducted visually.

8. There were daily and weekly backups of all important files as well as biweekly archiving of all important files in the database format.

9. There was periodic inventory of all collected data.

The study data base consisted of many data files which were either created by data entry using the Paradox database management system, received from the EPA Region I Laboratory as Lotus files, or received from the Boston Childhood Lead Prevention Program (BCLPPP) as Dbase3+ files. All received files were imported into Paradox for data correction. All Paradox files were converted into Statistical Analysis System (SAS) data sets for data management and analysis.

The study had two distinct data collection phases, the "eligibility" phase and the "study" phase, and each phase required its own set of data files. During the eligibility phase, information pertaining to criteria for study enrollment was collected in order to identify subjects who were willing and eligible to participate in the study. Computer files generated during the subject recruitment period were used for study management and for descriptive analyses of the non-participants. When the study phase began, data pertaining to participants were transferred from the eligibility data files to the study files. The eligibility data files were archived.

Data were collected about four separate units of observation: child, family, unit (premises and apartment concatenated) and premises. Some data files contained repeat measures type data, i.e. the same set of data items for the same unit of observation collected at different times. For instance, blood lead test results were collected three times for each child The goal of the organization of the data base was to make it possible to (1) easily match a child to the data that apply to his premises or apartment, and to (2) easily match information pertaining to a stage of a study (e.g., pre-abatement, post-abatement, etc) across all files with repeated measures data.

The central file was the KID file which provided the means by which data from different files could be combined to form composite case records. The unit of observation for the KID file was a child and each observation contained all the identifiers for that child (child id, family id, premises id, unit id). Any files that did not have identifiers in common were merged through the KID file.

Repeated measure data contained a variable called PHASE that designated the phase of the study in which the test was done. By selecting test results based on values of PHASE, data from different stages of the study can be compared.

A more detailed description of the data management plan including a database configuration and file descriptions was also developed and is included in the Appendix.

14. DATA ANALYSIS

The main purpose of the data analysis was to test the hypothesis that a reduction of at least 1,000 PPM in the concentration of lead in soil with starting concentrations greater than 1,500 PPM results in at least a 3 μg/dL reduction in children's blood lead levels over the following year. First, we conducted crude analyses of the change from baseline blood lead levels (i.e., before any abatement activities) to the first and second post-abatement blood lead levels obtained an average of six and eleven months, respectively, after the abatement activities. We used analysis of variance to compare mean blood lead changes among the intervention groups and paired t-tests to determine whether mean changes in blood lead levels within the intervention groups were significantly different from zero.

Following the crude analyses, we used analysis of covariance to compare the intervention groups with respect to post-abatement blood lead levels adjusted for pre-abatement blood levels. This was necessary because of slight differences in the baseline blood lead levels of children in the three groups. The post-abatement blood lead levels were reasonably normally distributed and did not require any transformations. The base model that we used to obtain estimates of adjusted post-abatement blood lead means in the intervention groups was:

$$Y_i = b_0 + b_1 Z_{1i} + b_2 Z_{2i} + b_3 X_i + e_i$$

where for the ith child,

Y_i = post-abatement blood lead level

Z_{1i} = 1 if in Control Group A, otherwise 0

Z_{2i} = 1 if in Control Group B, otherwise 0

X_i = pre-abatement blood lead

e_i = error term

The coefficients, b_0, b_1, b_2, and b_3 were estimated using least squares methods, and t-tests were used to test the null hypothesis that b_1 and b_{2c} were equal to zero (i.e., Was the mean adjusted post-abatement blood lead level in each Control Group different from that of the Study Group?).

Potential confounders of the relationship between group assignment and post-abatement blood lead were added to the base model one at a time to obtain estimates of the group effect adjusted for baseline blood lead level and the potential confounder. More complex models that controlled for several variables simultaneously were also developed. Potential confounders included age, sex, race, socioeconomic status as measured by the Hollingshead Index, mouthing and handwashing behaviors, and environmental sources of lead (e.g., paint and water). In most instances, the variables were categorized; cutoffs were based on the frequency distribution of the particular variable or on external considerations (e.g., regulatory standards for environmental sources of lead). In some instances, variables were combined before being added to the base model. For example, the following set of variables were developed to describe mouthing behaviors: pacifier use (yes/no), thumb sucking (often/sometimes/rarely/never) and a count of the number of times any other mouthing behaviors were reported at interview (zero/one/two/three-five).

There were several reasons why we decided to use analysis of covariance (ANCOVA) with baseline Pb as a covariate to estimate the differences between groups instead of analysis of variance (ANOVA) with the absolute change in Pb as the dependent variable. Consider the following models:

ANCOVA Model $Y = \alpha_i + \beta X + E$

ANOVA Model $W = \gamma_i + E$

where Y = post treatment Pb,

X = baseline Pb.

and $W = Y - X$.

The relationship between the ANOVA and ANCOVA models depends on whether you assume a fixed effect model or a mixed model for the ANOVA. The ANCOVA model may be rewritten as a fixed effect ANOVA model if $\beta = 1$.

$$Y = \alpha i + \beta X + E$$

$$Y - X = \alpha i + (\beta - 1) X + E$$

$$W = \alpha i + (\beta - 1) X + E$$

The ANCOVA model does not force the slope of the regression to be equal to one; rather, it allows the slope to be estimated from the data. If the slope is, in fact, equal to one, the two models are equivalent. Samuels[22] shows that the ANOVA mixed model is a special case of the ANCOVA model, with $\beta = \rho$, the correlation between Y and X.

In either case, the ANOVA model provides a less powerful test of treatment differences than does the ANCOVA model. It is recommended only if there is a large imbalance in baseline means, in which case the ANCOVA model may not be valid.[22,23] In our study the mean pre-abatement blood lead level was higher among children assigned to the Study Group; however, this difference was not statistically significant.

An important assumption of the ANCOVA model is that the slopes of the regression lines are equal in the treatment groups. We found this to be the case here, with the interaction term not significantly different from zero ($p > 0.10$).

The data analysis was conducted using SAS statistical software. The statistical methods used (t-test, analysis of variance and analysis of covariance) are described in the SAS manuals and standard statistics text books.

15. RESULTS

15.1 BLOOD LEAD LEVELS

15.1.1 Crude Analysis

Table 15-1 describes the results of crude analyses that examined the change in blood lead levels among all participants following the abatement activities. Mean blood lead levels in all the intervention groups declined at the first post-abatement sampling round (POST1) and rose at the second post-abatement sampling round (POST2) although for no group did the mean return to the baseline. At POST1 the average blood lead decline was 2.87 μg/dL in the Study Group, 3.52 μg/dL in Control Group A, and 2.04 μg/dL in Control Group B. All declines were significantly different from zero. At POST2 the average blood lead level increased 1.39 μg/dL in the Study Group, 2.69 μg/dL in Control Group A and 1.52 μg/dL in Control Group B. The increases in the two Control Groups were significantly different from zero but the increase in the Study Group was not ($p=0.08$).

Two siblings in the Study Group became lead poisoned sometime between the POST1 and POST2 sampling rounds. Their blood lead levels were 19 μg/dL and 12 μg/dL at baseline (September 1989), 10 μg/dL and 17 μg/dL, respectively, at POST1 (March 1990) and 35 μg/dL and 43 μg/dL, respectively, at POST2 (July 1990). No other children in any group experienced a blood lead rise of this magnitude during the course of the study. In fact, these two children's POST2 blood lead levels were more than three standard deviations higher than the overall mean POST2 level. Figure 15-1 depicts the relationship between PRE and POST2 blood lead levels for all children and visually demonstrates that these two children were outliers. Since the elevated levels were detected many months after the abatement activities, we do not believe that the increases were related to the study interventions. We hypothesize that the siblings were exposed to another source of lead, probably leaded paint at another site, and have information from parent reports about their exposure to renovations of an apartment containing lead contaminated paint to support this hypothesis.

Therefore, with the approval of the EPA project officer and a consultant statistician, we excluded these two children from subsequent analyses. Table 15-2 describes the blood lead

TABLE 15-1. CRUDE CHANGES* IN BLOOD LEAD LEVELS AMONG ALL PARTICIPANTS

STUDY PHASE	STUDY GROUP		CONTROL GROUP A		CONTROL GROUP B	
Pre-Abatement (Sept. '89-Jan '90)	13.18 (N=54)		12.37 (N=51)		12.02 (N=47)	
		-2.87 p=0.0001		-3.52 p=0.0001		-2.04 P=0.0001
Post-Abatement POST1 (Mar. '90 - June '90)	10.31 (N=54)		8.86 (N=48)		9.83 (n=46)	
		+1.39 p=0.08		+2.69 p=0.0001		+1.52 P=0.0001
POST2 (July '90 - Nov. '90)	11.70 (N=54)		11.49 (N=49)		11.35 (n=46)	

distributions over time and Table 15-3 describes the average change in blood lead levels with the two lead poisoned siblings excluded. Without these children, the mean blood lead level in the Study Group increased by only 0.46 μg/dL at POST2. This increase was not significantly different from zero (p=0.31). Figures 15-2 and 15-3 depict the blood lead changes graphically.

Because the PRE and POST2 sampling rounds are most closely matched on season, we focused subsequent analyses on this comparison. The mean decline in blood lead was 2.44 μg/dL in the Study Group (p=0.001), 0.91 μg/dL in Control Group A (p=0.04) and 0.52 μg/dL in Control Group B (p=0.31) The mean blood lead level of the Study Group declined 1.53 μg/dL more than that of Control Group A (95% Confidence Interval: -2.87, -0.19) and 1.92 μg/dL more than that of Control Group B (95% Confidence Interval: -3.28, -0.56) Over the course of the study, behavioral changes including more frequent housecleaning and handwashing were similar among the groups and so do not explain these

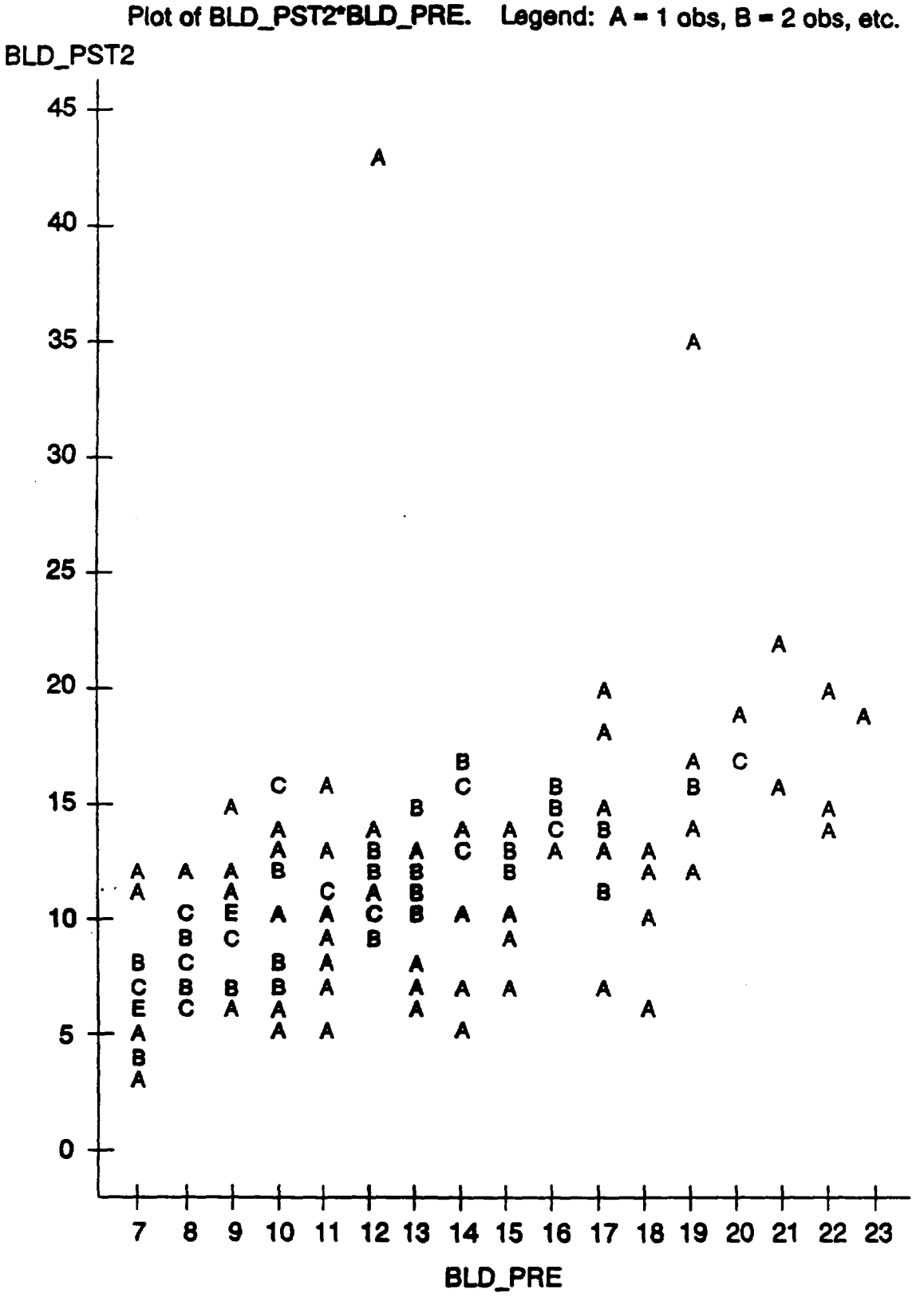


Figure 15-1. Relationship Between Pre And Post2 Blood Lead Levels.

TABLE 15-2. BLOOD LEAD (μg/dL) DISTRIBUTION OVER TIME AND ACCORDING TO GROUP EXCLUDING CHILDREN WHO BECAME LEAD POISONED

	S (N=52)	A (N=51)	B (N-47)	Total (N=150)
PRE				
Minimum	7	7	7	7
25%	9.5	9	9	9
50%	13	12	12	12
75%	16	15	14	15
Maximum	22	23	22	23
Mean	13.10	12.37	12.02	12.51
Standard Deviation	4.36	4.26	3.71	4.13
POST1	(N=52)	(N=48)	(N=46)	(N=146)
Minimum	2	3	4	2
25%	6	6	8	6
50%	10	8	9	9
75%	13	12	12	12
Maximum	22	17	18	22
Mean	10.19	8.85	9.83	9.64
Standard Deviation	4.63	3.79	3.49	4.04
POST2	(N=52)	(N=49)	(N=46)	(N=147)
Minimum	4	3	5	3
25%	7	9	8	8
50%	10	11	11.5	11
75%	14	14	14	14
Maximum	22	20	20	22
Mean	10.65	11.49	11.35	11.15
Standard Deviation	4.04	3.94	3.65	3.88

TABLE 15-3. CRUDE CHANGES* IN BLOOD LEAD LEVELS EXCLUDING CHILDREN** WHO BECAME LEAD POISONED

STUDY PHASE	STUDY GROUP		CONTROL GROUP A		CONTROL GROUP B	
Pre-Abatement (Sept. '89-Jan. '90)	13.10 (N=52)		12.37 (N=51)		12.02 (N=47)	
		2.90 p =0.001		-3.62 p=0.0001		-2.04 P=0.0001
Post-Abatement POST1 (Mar. '90 - June '90)	10.19 (N=52)		8.85 (N=48)		9.83 (n=46)	
		+0.46 p=0.31		+2.69 p=0.0001		+1.52 P=0.0009
POST2 (July '90 - Nov. '90)	10.65 (N=52)		11.49 (N=49)		11.35 (n=46)	

*The crude differences in blood lead levels were calculated by taking the average of each child's blood lead change. Only children with blood lead levels for each relevant phase (e.g., PRE and POST1) contributed to the average change for that period and so simply subtracting the average level for one phase from another will sometimes give a slightly different value.

**Two children in the Study Group became poisoned between the POST1 and POST2 sampling rounds.

differences. The impact of soil abatement was independent of the starting blood lead level (Table 15-4).

15.2 CHARACTERISTICS OF FINAL STUDY POPULATION

The final study population excluding the two poisoned siblings consisted of 150 children in 125 families living in 122 units on 100 premises (Table 15-5). The characteristics of the final study population are presented in Table 15-6. The mean pre-abatement blood lead level was higher among children assigned to the Study Group. With two exceptions, the proportions of children in most racial groups were similar among the intervention groups. The proportion of Hispanics was higher in the Study Group than the Control Groups and the proportion of Blacks was lower. There was also a larger proportion of males in the Study

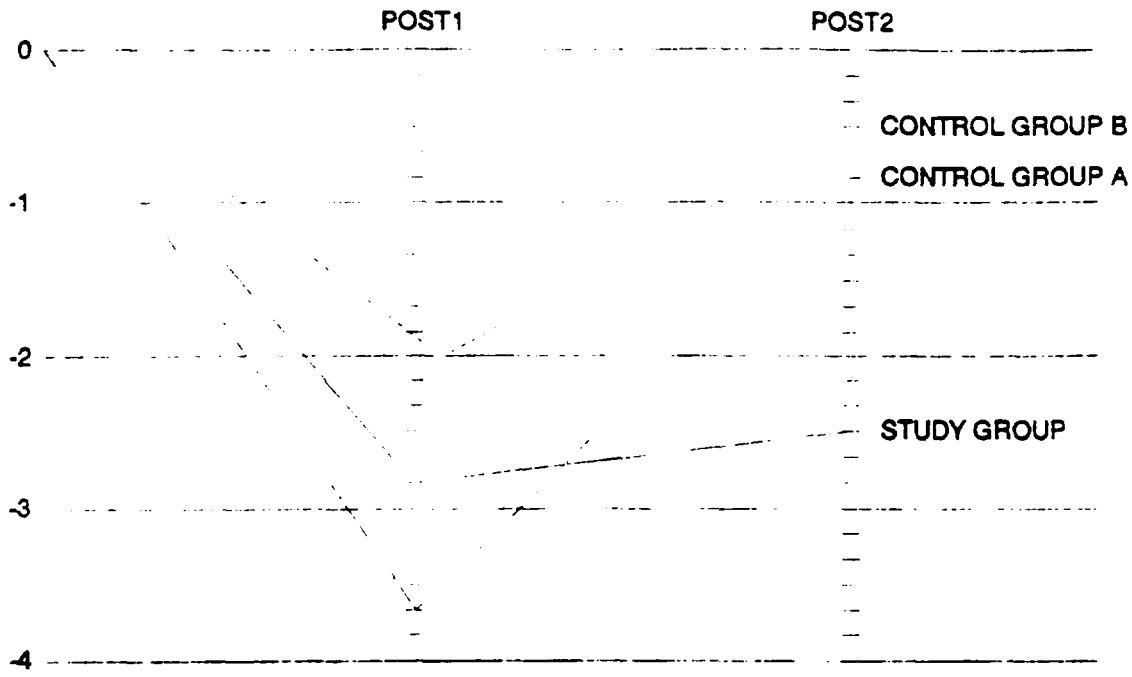
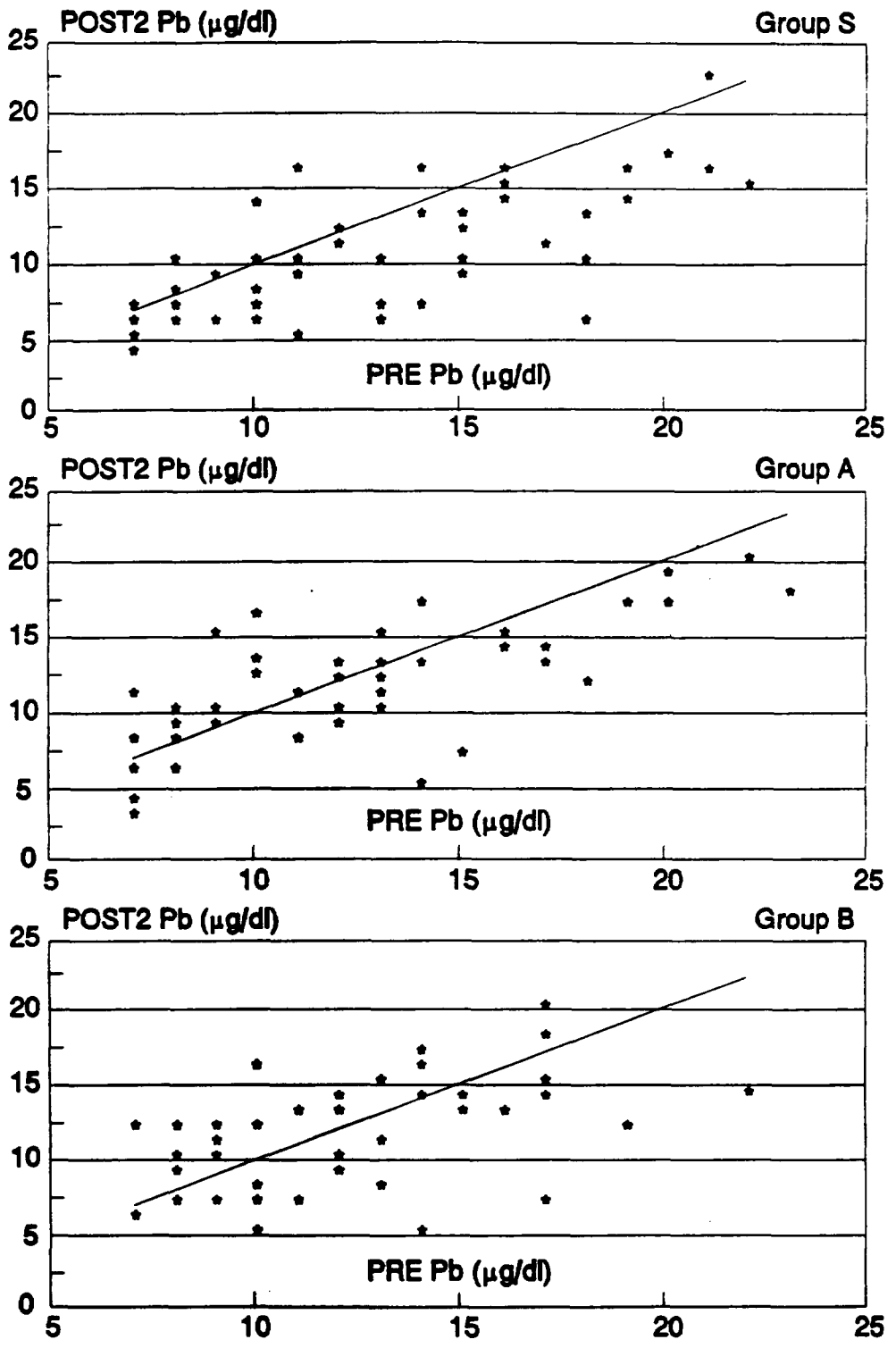


Figure 15-2. Crude Change in Blood Lead Levels Excluding Children Who became Lead Poisoned.

Group. The age distribution varied across groups, however, the average age of the children was quite similar. The proportions of subjects classified in the lowest socioeconomic level according to the Hollingshead Index (Classes 4 and 5) were higher in the Study Group and Control Group B than Control Group A. However, the proportions of owner occupied premises and participant owned units were similar across groups.

Overall, median lead levels in preliminary surface soil samples were approximately 700 PPM higher than median levels in detailed surface samples taken throughout the yard. We believe that this is because the preliminary samples were taken closer to the house. Median surface soil lead levels were also about 800 PPM higher than those taken at a depth of 15 centimeters. Median interior floor dust lead levels were generally similar to the median surface soil levels while median window well dust lead levels were five to seven



Note: Diagonal indicates no change from PRE to POST2

Figure 15-3. Plots of PRE and POST2 Blood Lead Levels According to Group Excluding Children Who Became Lead Poisoned.

TABLE 15-4. ADJUSTED* DIFFERENCES IN BLOOD LEAD LEVELS STRATIFIED BY PRE-ABATEMENT BLOOD LEVELS**

Pre-Abatement Blood Lead Levels	S-A	S-B
<15 (N = 105)	-1.35	-1.69
≥15 (N = 45)	-0.98	-0.72
<12 (N = 69)	-1.43	-1.47
≥12 (N = 81)	-1.17	-1.46
<10 (N = 44)	-0.99	-1.39
≥10 (N =106)	-1.35	-1.31
<10 (N = 44)	-1.00	-1.39
10-14 (N = 61)	-1.57	-1.70
≤15 (N = 45)	-0.98	-0.72

*Adjusted for pre-abatement blood lead level.
**Excludes two children who became lead poisoned.

TABLE 15-5. DISTRIBUTION OF CHILDREN, FAMILIES, UNITS, AND PREMISES ACCORDING TO GROUP IN THE FINAL STUDY POPULATION

	GROUP			
	S	A	B	TOTAL
NUMBER OF.				
Children	52	51	47	150
Families	43	43	39	125
Units*	42	42	38	122
Premises	34	36	30	100

*Units consists mainly of apartments in multi-unit dwellings.

times higher. Soil and floor dust lead levels were similar across the intervention groups. Window well dust lead levels were more variable across the groups but the differences were not statistically stable.

TABLE 15-6. CHARACTERISTICS OF FINAL STUDY POPULATION

	Study Group Soil, Dust, Loose Paint Abatement (N=52)	Control Group A Dust, Loose Paint Abatement (N=51)	Control Group B Loose Paint Abatement (N=47)	Total (N=150)
Pre-Abatement Blood Lead Level (Mean)	13.1	12.4	12.0	12.5
Pre-Abatement Ferritin Level (Mean)	25.7	24.6	26.6	25.6
Age in Months at Baseline				
% 9-24	34.6	21.6	25.5	27.3
% 25-36	26.9	45.1	29.8	34.0
% 37-51	38.5	33.3	44.7	38.7
Age (Mean)	30.5	31.4	33.1	31.6
% Male	59.6	49.0	51.1	53.3
% Black	42.3	50.0	63.0	51.4
% White	7.7	8.3	4.4	6.9
% Hispanic	26.9	10.4	6.5	15.1
% Cape Verdean	19.2	16.7	15.2	17.1
% Other	3.9	14.6	10.9	9.6
% Class 1-3 SES*	30.0	54.2	26.1	36.8
% Class 4, SES	26.0	14.6	34.8	25.0
% Class 5, SES	44.0	31.3	39.1	38.2
% Owner Occupied Premises**	73.5	86.1	70.0	77.0
% Participant Owned Units***	25.6	29.3	29.0	27.9
Soil Lead Level (Median PPM, Preliminary Sampling)**	2,722	3,163	3,111	2,904
Soil Lead Level (Median PPM, Detailed Sampling)**				
At Surface	2,074	2,230	2,100	2,152
15 cm Depth	1,374	1,244	1,348	1,348
Dust Lead Levels (Median PPM)***				
Floor	2,651	2,513	2,542	2,547
Window Wells	11,815	15,907	13,429	13,832
Water Lead Levels (Median µg/L)***	14.8	14.7	22.0	17.0
Paint Lead Levels (% Undetectable)***				
Wall	30.6	47.4	20.0	33.7
Woodwork	5.1	0.0	11.1	5.2

*According to Hollingshead Index.
**Unit of analysis is the premises.
***Unit of analysis is the housing unit or apartment.

Median first flush tap water lead levels were all above 14 μg/L and were similar across the groups. Lead-based paint was detected in almost all homes and was more likely to be detected on woodwork than walls. XRF readings were similar among the groups.

We also examined the final study population with respect to the calendar months and time interval between children's PRE, POST1 and POST2 blood samples (Table 15-7). The pre-abatement blood sampling round lasted 97 days from September through December 1989. A greater proportion of subjects in Control Group B had their pre-abatement blood drawn towards the end of the round (November and December 1989) than did the Study Group and Control Group A (42.5 vs. 23.1 and 25.5%). The POST1 abatement sampling round lasted 86 days from March through June 1990. A larger proportion of Control Group A was sampled in April compared to the other two groups. The POST2 sampling lasted 121 days and began and ended earlier in the year than the pre-abatement sampling (July through November 1990). However, the mean number of days between PRE and POST1, POST1 and POST2, and PRE and POST2 samples were similar across the groups.

Finally, we examined mean PRE, POST1, and POST2 blood lead levels according to the calendar month of blood sampling (Table 15-8). Mean PRE blood lead levels varied little by month of sampling (12.3 to 12.6 μg/dL). Mean POST1 blood lead levels did vary by sampling month (8.6 to 11.3 μg/dL); the lowest mean level was seen in April (8.6 μg/dL). Mean POST2 blood lead levels increased slightly from August through October (11.0 to 11.9 μg/dL), the months when most of the sampling occurred.

15.2.1 Adjusted Analyses

In the analysis of covariance the intervention groups were compared with respect to post-abatement blood lead levels adjusting for pre-abatement blood levels using a "base model" that included only group variables. Potential confounding variables, described in Table 15-9, were then added to the base model one at a time to obtain adjusted estimates of the group effect.

The POST2 blood lead levels adjusted for baseline level were generally similar to crude levels (Base Model, Table 15-10). The adjusted mean difference between the Study and Control Groups were slightly diminished (columns S-A and S-B) but remained statistically significant. 95% confidence intervals for S-A and S-B were -0.17 to -2.39 and -0.35 to

TABLE 15-7. DISTRIBUTION (%) OF CALENDAR MONTHS AND MEAN INTERVAL BETWEEN BLOOD SAMPLES

	Groups		
	S	A	B
Pre Abatement*			
September 1989	42.6	47.1	36.2
October 1989	30.8	27.5	21.3
November 1989	13.5	5.9	25.5
December 1989	9.6	19.6	17.0
Post-Abatement			
Post 1			
March 1990	42.3	31.3	50.0
April 1990	44.2	56.3	39.1
May 1990	11.5	12.5	4.3
June 1990	1.9	0.0	6.5
Post 2			
July 1990	0.0	2.0	2.2
August 1990	34.6	44.9	39.1
September 1990	36.5	22.4	23.9
October 1990	26.9	26.5	32.6
November 1990	1.9	4.1	2.2
Mean Number (SD**) of Days Between:			
PRE and POST1	175 (30)	177 (38)	167 (33)
POST1 and POST2	158 (24)	151 (33)	158 (29)
PRE and POST2	333 (28)	329 (24)	325 (21)

*All pre-abatement blood samples were taken before soil abatement occurred on the premises.
**SD = Standard Deviation.

TABLE 15-8. MEAN BLOOD LEAD LEVEL ACCORDING TO CALENDAR MONTH OF SAMPLING

	Number in Category	Mean Blood Lead Level ($\mu g/dL$)
Pre Abatement*		
September 1989	65	12.6
October 1989	40	12.4
November 1989	22	12.5
December 1989	23	12.3
Post-Abatement		
Post1		
March 1990	60	10.4
April 1990	68	8.6
May 1990	14	10.9
June 1990	4	11.3
Post2		
July 1990	2	10.1
August 1990	58	11.1
September 1990	41	11.0
October 1990	42	11.9
November 1990	4	6.5

-2.62 respectively Group assignment was a significant predictor of POST2 blood lead levels (p=0.02). In other words, which group a child was in (S, A, or B) was a significant determinant of their POST2 blood lead level The results were quire similar when the blood lead levels were log transformed.

The results were similar when only one child randomly chosen from each family was included in the analysis (18.4% of families had more than one child). The differences between the Study Group and Control Groups A and B were -1.31 (p=.04) and -1.73 (p=.01), respectively. When the analysis was limited to the first child initially identified on

TABLE 15-9. ADJUSTED ANALYSIS: DESCRIPTION OF VARIABLES ADDED TO THE BASE MODEL

Variable	Categories
Age (In Months at Baseline)	<=30 Months / > 30 Months
Gender	Male/Female
Socioeconomic Status (According to the Hollingshead Index)	Continuous Variable
Race	Black/White/Hispanic/Cape Verdean/Other
Mouthing Behaviors	Yes/No
Pacifier Use	Often/Sometimes/Rarely/Never
Thumb Sucking	Zero/One/Two/Three-Five
Number of All Other Mouthing Behaviors Reported at the First Follow-Up Interview	
Spends Time Away From Home	Yes/No
Spends Time Outside of Study Area	Yes/No
Plays in Home Yard	Yes/No
Eats Food Outdoors	Yes/No
Plays or Sits on Floor Inside Home (# Hours Per Day)	<=One / Two-Four / > Four
Handwashing	
Before Meals and Snacks	Almost Always/Sometimes or Almost Never
After Playing Outdoors	Almost Always/Sometimes or Almost Never
Pets in Household that go Outdoors	Yes/No
Canned Food Intake	
Number of Canned Food Items Eaten in Last Six Months	Zero-Seven
Imported Canned Food Eaten	Yes/No
	<=15 ng/ml / > 15 ng/ml
Ferritin Level	Yes/No
Lead Jobs Among Household Members in Last Year	
Cigarette Smoking Among Household Members	
Lead Hobbies Among Household Members in Last Year	
Paint Lead Variables	
Maximum XRF Reading on Wall	Not Detectable/0.5-9.9/10.0
Maximum XRF Reading on Woodwork	Not Detectable/0.5-9.9/10.0
Number of Places Lead Paint Detected	Zero-Six
Amount of Interior Chipping Paint at Baseline	0-50/51-200/>200 square inches
Water Lead Level (Maximum Lead Ingested from Water, Derived from Water Lead Concentration and Daily Intake)	Not Detectable-6.0/6.1-24.9 />=25.0
Owner Occupied Premises	Yes/No

TABLE 15-10. CRUDE AND ADJUSTED CHANGES IN BLOOD LEAD LEVELS*

	S	A	B	S-A[1]	S-B[2]	Overall[3] Group Effect
	POST2 Blood Lead Levels					
Crude	10.65	11.49	11.35	-1.53	-1.92	
Base Model**	10.26	11.54	11.74	-1.28	-1.49	.02
Base Model Plus Age	10.21	11.57	11.83	1.35 -p=.02	1.61 -p=.01	.01
Base Model Plus Gender	10.21	11.55	11.74	-1.34 p=.02	-1.53 p=.01	.02
Base Model Plus Socioeconomic Status	10.30	11.42	11.80	-1.12 p=.06	-1.50 p=.01	.03
Base Model Plus Race	10.52	11.44	11.78	-0.92	-1.27	.09
Base Model Plus Mouthing Variables	10.80	12.04	12.31	-1.23 p=.04	-1.51 p=.02	.04
Base Model Plus Paint Lead Variables	10.54	11.72	11.88	-1.19	-1.34	.05
Base Model Plus Chipping Paint Variable[4]	10.23	11.55	11.77	-1.31 p=.02	-1.53 p=.01	.02
Base Model Plus Water Lead Level	10.15	11.34	11.59	-1.20 p=.04	-1.44 p=.02	.03
Base Model Plus Time Away From Home	10.23	11.47	11.70	-1.25 p=.03	-1.47 p=.01	.03
Base Model Plus Time Away From Study Area	9.77	10.94	11.25	-1.17 p=.04	-1.48 p=.01	.03
Base Model Plus Yard Play	10.33	11.60	11.85	-1.27 p=.03	-1.51 p=.01	.02
Base Model Plus Outdoor Eating	10.25	11.52	11.79	-1.27 p=.03	-1.54 p=.01	.02
Base Model Plus Play or Sit on Floor Inside	10.45	11.59	11.90	-1.14 p=.06	-1.45 p=.02	.04
Base Model Plus Hand Washing Before Meals	10.15	11.50	11.78	-1.35 p=.02	-1.63 p=.01	.02
After Outdoors	9.96	11.35	11.49	-1.39 p=.02	-1.53 p=.01	.01
Base Model Plus Pets That go Outdoors	10.15	11.45	11.75	-1.30 p=.03	-1.60 p=.01	.02

TABLE 15-10 (cont'd). CRUDE AND ADJUSTED CHANGES IN BLOOD LEAD LEVELS*

	S	A	B	S-A[1]	S-B[2]	Overall[3] Group Effect
	POST2 Blood Lead Levels					
Imported Canned Food	10.21	11.40	11.72	-1.19 p=.04	-1.51 p=.01	.03
Base Model Plus Ferritin Level	10.14	11.42	11.59	-1.28 p=.02	-1.45 p=.01	.02
Base Model Plus Lead Jobs	10.47	11.72	12.01	-1.25 p=.03	-1.54 p=.01	.02
Base Model Plus Lead Hobbies	10.28	11.49	11.85	-1.21 p=.04	-1.57 p=.01	.02
Base Model Plus Smoking	10.26	11.52	11.82	-1.25 p=.03	-1.55 p=.01	.02
Base Model Plus Owner Occupied Premises	10.07	11.24	11.60	-1.17 p=.04	-1.53 p=.01	.02

[1]Crude and adjusted blood lead difference between Group S and A. P values are given if the overall group effect is statistically significant.
[2]Crude and adjusted blood lead difference between Group S and B. P values are given if the overall group effect is statistically significant.
[3]P values associated with group assignment. Describes the statistical stability of the relationship between group assignment and POST2 blood lead levels.
[4]The chipping paint variable included an indicator term for missing.
*Excludes two children who became lead poisoned.
**Base Model: POST2_Pb = Group + Pre_Pb.

a premises (N=85), the differences between the Study Group and Control Groups A and B were -0.92 (p=.17) and -1.46 (p=.04), respectively.

The results were also similar when the analysis included only children who lived on the study premises for at least 300 days after the pre-abatement blood lead test, thereby eliminating children who moved during the follow-up period. Here, the differences between the Study Group and Control Groups A and B were -1.42 (p=.02) and -1.49 (p=.02), respectively.

The results were also similar when we took into account the timing of the blood samples using two different methods. First, we limited the analysis to subjects whose PRE

and POST2 blood samples were most closely matched on calendar time (within sixty days of one year or 305-420 days apart, N=134). Here, we found that the differences between the Study and each Control Group were identical (1.41 μg/dL, p=.02) Second, we included all 150 study subjects and controlled for timing by including indicator terms for calendar month of the PRE blood sample and the number of days between the PRE and POST2 samples. Again, we found similar differences between the Study Group and Control Groups A and B (1.22, p=.03 and 1.30, p=.03, respectively). The latter results were also similar when the model included an interaction term between calendar months and number of days. The interaction was not significant.

The results were also quite similar when age, sex, socioeconomic status, ferritin levels, mouthing and handwashing behaviors, spending time away from home spending time outside of the study area, playing in the yard, eating food outdoors, sitting on the floor inside the home, eating canned foods including those imported from foreign countries, lead related job and hobbies and cigarette smoking among household residents, living in owner occupied premises, the presence of chipping paint, the presence of pets that go outdoors, and tap water lead levels were added to the base model one at a time (Table 15-10). The results were virtually identical when the continuous variables were treated as such. However, when the paint lead variables were added, differences between the Study and Control Groups were somewhat diminished (-1.19 and -1.34 μg/dL for Control Groups A and B, respectively) and the group effect was borderline significant (p=0.05). When race was added to the base model, differences were also diminished (-0.92 and 1.27 μg/dL) and the group effect was also not statistically significant (p=0.09). However, no statistically significant differences in crude or adjusted POST2 blood lead levels were seen among Study Group children of different races (Table 15-11).

No "dose-response" relationship was observed between the mean change in blood lead level and the starting soil lead level or the size of the excavated yard area (Tables 15-12 and 15-13) POST2 abatement blood lead levels were similar for children with the lowest and highest pre-abatement soil lead levels and the smallest and largest excavated yard areas. The lack of a trend should be evaluated in light of the study eligibility criteria that restricted the soil and blood lead ranges. Only six children in the Study Group had median pre-abatement

TABLE 15-11. CRUDE AND ADJUSTED* POST2 BLOOD LEAD LEVELS AMONG CHILDREN IN THE STUDY GROUP ACCORDING TO RACE

Race	Crude POST2 Blood Lead Level **	Adjusted POST2 Blood Lead Level **
Black (N=22)	11.51	11.27
White (N=4)	11.00	11.54
Hispanic (N=14)	10.05	9.78
Cape Verdean (N=10)	10.76	11.32
Other (N=2)	11.64	11.99

*Adjusted for pre-abatement blood lead level.
**Differences between racial groups were not statistically significant.

TABLE 15-12. CRUDE AND ADJUSTED* POST2 BLOOD LEAD LEVELS AMONG STUDY GROUP PARTICIPANTS ACCORDING TO INITIAL SOIL LEAD LEVEL

Median Pre-Abatement Soil Lead Level (PPM)***	Number In Category	Crude POST2 Blood Lead Level **	Adjusted POST2 Blood Lead Level **
< 1,000	6	9.00	9.17
1,001 - 2,000	18	12.00	11.47
2,001 - 3,000	16	9.81	10.75
> 3,000	12	10.58	10.04

*Adjusted for pre-abatement blood lead level.
**Differences were not statistically significant.
***Adjusted using the weighing factors derived from the intercalibration study.

soil lead levels that were less than 1,000 PPM, and pre-abatement blood lead levels were restricted to 7 through 24 μg/dL.

We also conducted exploratory multivariate analyses to control simultaneously for several potential confounding variables. Two variable selection methods were used. First, a backward elimination procedure identified variables from the list in Table 15-9 that were statistically significant predictors of POST2 blood lead levels. When Pre-Pb, age, race, and

TABLE 15-13. CRUDE AND ADJUSTED* POST2 BLOOD LEAD LEVELS AMONG STUDY GROUP PARTICIPANTS ACCORDING TO THE SIZE OF THE EXCAVATED YARD AREA

Excavated Yard Area (Sq. Feet)	Number In Category	Crude POST2 Blood Lead Level**	Adjusted POST2 Blood Lead Level**
≤ 1,000	11	9.82	10.80
1,001 - 2,000	18	10.67	11.66
> 2,000	23	11.04	10.58

*Adjusted for pre-abatement blood lead level.
**Differences were not statistically significant.

lead jobs were controlled simultaneously the adjusted POST2 blood lead levels were 10.36, 11.26, and 11.66 μg/dL for Groups S, A, and B, respectively, and the adjusted differences between the Study Group and Control Groups A and B were 0.90 (95% CI +0.23 to -2.04) and 1.31 μg/dL (95% CI -0.14 to -2.47), respectively. The overall group effect was not statistically significant (p=.08). These results were quite similar when the blood lead levels were log transformed.

Second, a potential confounding variable was selected for the multivariate model if its inclusion in the base model altered the magnitude of difference between the Study Group and either Control Group by more than 10%. The variables identified by this criterion were race, socioeconomic status, and playing or sitting on the floor. In a model controlling these variables and Pre-Pb, the adjusted POST2 blood lead levels were 10.71, 11.51, and 11.92 μg/dL for Groups S, A, and B, respectively, and the adjusted differences between the Study Group and Control Groups A and B were 0.80 (95% CI +0.45 to -2.05) and 1.21 μg/dL (95% CI +0.06 to -2.48), respectively. The overall group effect was not statistically significant (p=.16). The results were quite similar when the blood lead levels were log transformed.

We also examined the data for the presence of effect modification, that is, differences in soil abatement effectiveness according to the child's characteristics. No statistically significant interactions were seen for age, sex, socioeconomic status, length of residence (since birth or not), residence in an owner occupied home, and behavioral characteristics

such as amount of time spent playing in the yard, eating food outside, handwashing after outside play, thumb sucking, and other mouthing behaviors. However, the data suggested that the effect of the soil abatement was enhanced among children who played in their yards more than 15 hours per week (S-A -2.17 and S-B -3.56) and among children who lived in non-owner occupied housing (S-A -3.08 and S-B -2.44).

15.3 HAND LEAD LEVELS

Tables 15-14 and 15-15 describe the handwipe lead distributions over time and Tables 15-16 and 15-17 describe the results of crude analyses that examined the average change in hand lead levels among the participants following abatement activities. The handwipe field blank lead levels varied considerably within and across phases. The means and standard deviations were 6.0 and 1.9 for PRE, 8.4 and 3.5 for POST1, and 12.3 and 5.4 for POST2. Because the blanks were so variable and were not individually matched to the participants, background levels were taken into account by subtracting the maximum and median field blank level for each sampling round. (Any negative value was treated as zero.) When the maximum level was subtracted, the mean hand lead level in all groups declined from the pre abatement to the first post-abatement sampling round. The mean hand lead level in the Study Group changed little at the second post-abatement sampling round while it increased in the Control Groups (Table 15-16). When the median level was subtracted, the mean hand lead level in the Study Group declined at the first and second post-abatement sampling rounds. The mean hand lead levels in the two Control Groups first declined and then rose to a level higher than baseline (Table 15-17).

Because the PRE and POST2 sampling rounds are most closely matched on season, we focused subsequent analyses on this comparison. When the maximum blank level was subtracted, the mean hand lead level decreased by 3.61 μg in the Study Group ($p=.02$), 0.99 μg in Control Group A ($p=.69$), and 0.36 μg in Control Group B ($p=.85$). When the median blank lead level was subtracted the mean hand lead levels declined by 2.75 μg in the Study Group ($p=.08$), and 0.68 in Control Group A ($p=.79$) and increased by 0.76 in Control Group B ($p=.72$).

TABLE 15-14. HANDWIPE LEAD (μg/pair of hands) DISTRIBUTIONS OVER TIME ADJUSTING FOR MAXIMUM FIELD BLANK LEAD LEVEL* AND EXCLUDING CHILDREN WHO BECAME LEAD POISONED

	S	A	B	Total
Pre	(N=52)	(N=49)	(N=47)	(N=148)
Minimum	0	0	0	0
25%	2.5	2.5	1.5	2.5
50%	4.5	3.5	3.5	4.5
75%	8.0	6.5	8.5	7.5
Maximum	52.5	42.5	35.5	52.5
Mean	6.67	5.67	6.60	6.31
Standard Deviation	8.21	7.08	7.41	7.56
POST1	(N=51)	(N=48)	(N=46)	(N=145)
Minimum	0	0	0	0
25%	0	0	0	0
50%	0	0	0	0
75%	3.0	3.0	4.0	3.0
Maximum	25.0	17.0	59.0	59.0
Mean	2.90	2.10	4.57	3.17
Standard Deviation	5.40	3.42	11.65	7.58
POST2	(N=52)	(N=49)	(N=46)	(N=147)
Minimum	0	0	0	0
25%	0	0	0	0
50%	0	0	0	0
75%	2.5	1.0	7.0	4.0
Maximum	53.0	91.0	58.0	91.0
Mean	3.06	4.14	6.15	4.39
Standard Deviation	8.11	15.85	13.07	12.64

*Negative levels were assigned the value zero.

When the POST2 hand lead levels were adjusted for baseline level the mean differences between the Study Group and the two Control Groups were diminished; the magnitude of the reduction was greater for the Control Group A comparison (Table 15-18). Group assignment was not, however, a significant predictor of POST2 hand lead levels (p values were .48 and .43 respectively).

TABLE 15-15. HANDWIPE LEAD (μg/pair of hands) DISTRIBUTIONS OVER TIME ADJUSTING FOR MEDIAN FIELD BLANK LEAD LEVEL* AND EXCLUDING CHILDREN WHO BECAME LEAD POISONED

	S	A	B	Total
PRE	(N=52)	(N=49)	(N=47)	(N=148)
Minimum	0	0	0	0
25%	4.75	4.75	3.75	4.75
50%	6.75	5.75	5.75	6.75
75%	10.25	8.75	10.75	9.75
Maximum	54.7	44.75	37.75	54.75
Mean	8.79	7.79	8.75	8.45
Standard Deviation	8.33	7.20	7.51	7.67
POST1	(N=51)	(N=48)	(N=46)	(N=145)
Minimum	0	0	0	0
25%	1.5	2.5	1.3	1.5
50%	3.5	5.5	3.5	4.5
75%	8.5	8.5	9.5	8.5
Maximum	30.5	22.5	64.5	64.5
Mean	6.30	5.96	7.89	6.69
Standard Deviation	6.80	4.86	12.68	8.64
POST2	(N=52)	(N=49)	(N=46)	(N=147)
Minimum	0	0	0	0
25%	0	0	0.5	0
50%	3.5	2.5	4.5	3.5
75%	8.0	6.5	12.5	9.5
Maximum	58.5	96.5	63.5	96.5
Mean	6.04	6.58	9.42	7.28
Standard Deviation	9.34	16.82	14.31	13.74

*Negative levels were assigned the value zero.

15.4 ENVIRONMENTAL LEAD LEVELS

Tables 15-19 through 15-25 describe the distributions of soil, dust, water, and paint lead levels among the Study and Control Groups. Table 15-26 describes the QA/QC results for the soil and dust analyses. Median soil and dust lead levels, maximum first flush water lead levels and maximum wall and woodwork paint lead levels were used to characterize

TABLE 15-16. CRUDE CHANGES* IN HAND LEAD LEVELS (μg/pair of hands)* EXCLUDING CHILDREN WHO BECAME LEAD POISONED**

STUDY PHASE	STUDY GROUP	CONTROL GROUP A	CONTROL GROUP B
Pre-Abatement (Sept. '89-Dec. '89)	5.67 (N=52)	5.67 (N=49)	6.60 (N=47)
	-3.81 p=0.002	-2.96 p=0.01	-1.95 P=0.35
Post-Abatement POST1 (Mar. '90 - July '90)	2.90 (N=52)	2.10 (N=48)	4.57 (n=46)
	+0.22 p=0.86	+2.13 p=0.30	+1.59 P=0.45
POST2 (July '90 - Jan. '91)	3.06 (N=52)	4.14 (N=49)	6.15 (n=46)

each child's unit or premises. Detection limits for soil and dust were each 100 PPM, for water it was 1 μg/L, and for paint it was 0.5 mg/cm^2. The soil and dust concentrations were adjusted using weighing factors designed to make the Boston project's soil and dust lead levels comparable to those of the Cincinnati and Baltimore Lead-In-Soil Demonstration projects. These weighing factors (1.0370 for soil and 1.1527 for dust) were derived from the results of the intercalibration study conducted under the supervision of Dr. Robert Elias. Dr. Elias is with the U.S. EPA Environmental Criteria Assessment Office and has the responsibility to facilitate the successful completion of the Lead-In-Soil Demonstration Projects.

15.4.1 Soil

At baseline the median surface soil lead levels were slightly higher in Control Group A (2,230 PPM) than the Study Group and Control Group B (2,074 and 2,100 PPM). Sampling

TABLE 15-17. CRUDE CHANGES IN HAND LEVELS (μg/pair of hands)* EXCLUDING CHILDREN WHO BECAME LEAD POISONED**

STUDY PHASE	STUDY GROUP		CONTROL GROUP A		CONTROL GROUP B	
Pre-Abatement (Sept. '89-Dec. '89)	8.79 (N=52)		6.74 (N=49)		8.14 (N=47)	
		2.53 p =0.05		-1.29 p=0.31		-0.77 P=0.73
Post-Abatement POST1 (Mar. '90 - July '90)	6.30 (N=52)		5.96 (N=46)		7.89 (n=46)	
		0.25 p=0.86		+0.69 p=0.75		+1.53 P=0.52
POST2 (July '90 - Jan. '91)	6.04 (N=52)		6.98 (N=49)		9.80 (n=46)	

conducted within a few weeks of the soil abatement documented the reduction in lead levels in the Study Group. The drop in median soil lead levels ranged from 166 to 5,558 PPM, the average drop was 1,856 PPM. However, many samples still had detectable lead levels at post-abatement sampling (Median Post Abatement Level: 109 PPM).

About nine months after soil abatement, median surface soil lead levels in the Study Group had not increased but several properties had evidence of recontamination. Eight properties (23%) had median soil lead levels ranging from 156 to 1,867 PPM. The concentration of lead in soil for these eight properties in PPM, were 156, 171, 202, 228, 249, 259, 389, and 1,867. The surface soil lead levels in Control Groups A and B did not change substantially over this period.

TABLE 15-18. CRUDE AND ADJUSTED CHANGES IN HAND LEAD LEVELS (μg/pair of hands) EXCLUDING CHILDREN WHO BECAME LEAD POISONED*

	S POST2	A Blood Lead	B Levels	S-A	S-B	Overall[3] Group Effect
Crude**	3.06	4.14	6.15	-2.62	-3.25	
Adjusting for Pre Abatement Hand Lead Level**	2.90	4.47	6.04	-1.56	-3.14	p=.48
Crude***	6.04	6.58	9.42	-2.07	-3.51	
Adjusting for Pre-Abatement Hand Lead Level***	5.86	6.95	9.29	1.08	-3.43	p=.43

*Two children in the Study Group became poisoned between POST1 and POST2 sampling rounds.
**Adjusts for maximum field handwipe blank lead level.
***Adjusts for median field handwipe blank lead level.

15.4.2 Dust

Tables 15-20 through 15-22 describe the distribution of interior floor dust lead concentration (PPM), dust loading (mg/m^2), and dust lead loading (μg/m^2) over time in the Study and Control Groups. At baseline median dust lead concentrations were similar across the three groups (2,513-2,651 PPM). Median floor dust lead concentrations in the Study Group and Control Group A were reduced by 53% and 49%, respectively, an average of 4-5 weeks after the interior dust abatement (Post Abatement). Floor dust lead levels remained substantially below baseline levels an average of 33 weeks after interior dust abatement for both the Study Group (67%) and Control Group A (54%) (Recontamination 2). During this period Control Group B experienced a comparable decline (42%) in floor dust lead levels. (Control Group B received loose paint abatement but not interior dust abatement.)

At baseline the median floor dust loading was higher in Control Group B than in the other two groups (40 vs. 24 and 25 mg/m^2). In the Study Group median floor dust loading increased by 50% an average of 4-5 weeks after the interior dust abatement. (Mean floor dust loading was essentially unchanged.) Median dust loading in the Study Group then

TABLE 15-19. DISTRIBUTION OF SURFACE SOIL LEAD CONCENTRATIONS* OVER TIME AND ACCORDING TO GROUP

	S	A	B	Total
Pre Abatement (Aug.'89 - June '90)	(N=34)	(N=36)	(N=30)	(N=100)
Minimum	415	747	985	415
25%	1,556	1,374	1,452	1,452
50%	2,074	2,230	2,100	2,152
75%	2,644	3,215	3,422	3,163
Maximum	5,704	6,948	4,563	6,948
Mean	2,255	2,524	2,401	2,395
Standard Deviation	1,165	1,381	1,195	1,248
Post (Oct.'89 - Dec.'89) Abatement	(N=25)	N/A	N/A	(N=25)
Minimum	52			52
25%	83			83
50%	109			109
75%	166			166
Maximum	249			249
Mean	123			123
Standard Deviation	56			56
Recontamination (June '90 - July '90) Assessment	(N=34)	(N=34)	(N=30)	(N=98)
Minimum	52	622	954	52
25%	52	1,556	1,556	52
50%	52	2,23	1,970	1,556
75%	109	3,007	3,059	2,385
Maximum	1,867	5,755	5,081	5,755
Mean	145	2,437	2,315	1,605
Standard Deviation	315	1,226	1,144	1,443

*Adjusted using the weighing factor derived from the intercalibration study. The median soil concentration was used to characterize the premises. Detection limit was 100 PPM. Undetectable levels were assigned the value 50 PPM. N/A = Not Applicable.

TABLE 15-20. DISTRIBUTION OF INTERIOR FLOOR DUST LEAD CONCENTRATIONS* OVER TIME AND ACCORDING TO GROUP

	S	A	B	Total
Pre Abatement (Aug '89 Jan.'90)	(N=41)	(N=40)	(N=36)	(N=117)
Minimum	150	646	496	150
25%	1,164	1,406	1,354	1,303
50%	2,651	2,513	2,542	2,547
75%	4,288	4,369	5,314	4,380
Maximum	107,201	22,823	46,108	107,201
Mean	6,623	4,202	5,178	5,350
Standard Deviation	16,786	5,075	8,272	11,291
Post (Oct.89 - March '90) Abatement	(N=31)	(N=34)	N/A	(N=65)
Minimum	450	519		450
25%	807	865		865
50%	1,233	1,274		1,268
75%	2,190	2,121		2,132
Maximum	12,680	5,141		12,680
Mean	2,420	1,822		2,107
Standard Deviation	3,058	1,352		2,327
Recontamination 1 (March '90 - June '90)				
	(N=40)	(N=35)	(N=37)	(N=112)
Minimum	334	426	184	184
25%	657	807	807	795
50%	939	1,279	1,095	1,095
75%	1,712	1,568	1,499	1,562
Maximum	49,566	6,052	4,253	49,566
Mean	3,108	1,458	1,493	2,059
Standard Deviation	8,257	1,108	1,084	5,033
Recontamination 2 (July '90 - Dec.'90)				
	(N=33)	(N=35)	(N=34)	(N=102)
Minimum	346	311	288	288
25%	692	749	968	784
50%	876	1,153	1,475	1,193
75%	1,349	1,568	2,017	1,694
Maximum	4,841	3,804	10,374	10,374
Mean	1,294	1,300	1,886	1,494
Standard Deviation	1,094	774	1,777	1,300

*Adjusted using the weighing factor derived from the intercalibration study. A single composited floor dust sample was used to characterize a child's living unit. N/A = Not Applicable

TABLE 15-21. DISTRIBUTION OF INTERIOR FLOOR DUST LOADING* (mg/m^2) OVER TIME AND ACCORDING TO GROUP

	S	A	B	Total
Pre-Abatement (Aug.'89 - Jan.'90)	(N=41)	(N=40)	(N=35)	(N=116)
Minimum	4	7	5	4
25%	13	11	15	12
50%	24	25	40	29
75%	69	51	71	67
Maximum	363	246	141	363
Mean	51	41	47	46
Standard Deviation	67	46	36	52
Post (Oct.89 - March '90) Abatement	(N=31)	(N=34)	N/A	(N=65)
Minimum	9	3		3
25%	15	9	31	12
50%	36	19	31	29
75%	59	37	31	45
Maximum	254	117	31	254
Mean	52	30	31	41
Standard Deviation	58	31	31	47
Recontamination 1 (March '90 - June '90)	(N=40)	(N=35)	(N=37)	(N=112)
Minimum	2	3	2	2
25%	14	15	12	13
50%	24	28	32	27
75%	62	48	56	55
Maximum	366	195	278	366
Mean	57	41	47	49
Standard Deviation	74	43	53	59
Recontamination 2 (July '90 - Dec.'90)	(N=32)	(N=33)	(N=33)	(N=98)
Minimum	2	2	2	2
25%	9	10	11	9
50%	16	17	19	17
75%	32	41	32	35
Maximum	136	153	115	153
Mean	27	31	29	29
Standard Deviation	31	36	29	32

*A single composited floor dust sample was used to characterize a child's living unit. N/A = Not Applicable.

TABLE 15-22. DISTRIBUTION OF INTERIOR FLOOR DUST LEAD LOADING* ($\mu g/m^2$) OVER TIME AND ACCORDING TO GROUP

	S	A	B	Total
Pre-Abatement (Aug '89 - Jan. '90)	(N=41)	(N=40)	(N=35)	(N=116)
Minimum	9	9	3	3
25%	35	36	38	36
50%	61	68	87	75
75%	126	203	208	153
Maximum	7,976	437	3,354	7,976
Mean	344	117	291	250
Standard Deviation	1,280	113	623	836
Post (Oct.89 - March '90) Abatement	(N=31)	(N=34)	N/A	(N=65)
Minimum	10	3		3
25%	22	12		17
50%	47	27		41
75%	74	71		71
Maximum	2,547	191		2,547
Mean	145	49		94
Standard Deviation	452	50		315
Recontamination 1 (March '90 - June '90)	(N=40)	(N=35)	(N=37)	(N=112)
Minimum	1	6	1	1
25%	13	14	11	13
50%	28	32	31	31
75%	80	67	82	77
Maximum	3,087	259	929	3,087
Mean	236	53	83	128
Standard Deviation	658	58	156	410
Recontamination 2 (July '90 - Dec. '90)	(N=32)	(N=33)	(N=33)	(N=98)
Minimum	2	1	2	1
25%	7	9	14	9
50%	18	21	25	21
75%	28	46	62	46
Maximum	224	226	527	527
Mean	38	39	65	47
Standard Deviation	60	50	107	77

*Adjusted using the weighing factor derived from the intercalibration study. A single composited floor dust sample was used to characterize a child's living unit. N/A = Not Applicable

TABLE 15-23. DISTRIBUTION OF INTERIOR WINDOW WELL DUST LEAD CONCENTRATIONS* OVER TIME AND ACCORDING TO GROUP

	S	A	B	Total
Pre-Abatement (Aug.'89 - Jan.'90)1	(N=40)	(N=41)	(N=34)	(N=115)
Minimum	231	1,153	58	58
25%	3,458	3,170	2,594	3,170
50%	11,815	15,907	13,429	13,832
75%	28,818	38,039	28,818	33,428
Maximum	121,034	74,926	147,546	147,546
Mean	19,481	22,429	27,285	22,839
Standard Deviation	23,039	20,722	37,314	27,299
Post (Oct.89 - March '90) Abatement	(N=32)	(N=32)	N/A	(N=64)
Minimum	58	58		58
25%	2,795	778	11,166	1,037
50%	7,550	2,190	11,166	3,400
75%	16,138	3,689	11,166	10,778
Maximum	46,108	63,399	11,166	63,399
Mean	10,789	4,766	11,166	7,777
Standard Deviation	10,492	11,166	11,166	11,168
Recontamination 1 (March '90 - June '90)	(N=41)	(N=35)	(N=36)	(N=112)
Minimum	1,153	1,383	692	692
25%	4,323	5,418	3,977	4,409
50%	12,103	10,086	11,527	11,181
75%	18,443	25,359	32,276	23,486
Maximum	44,955	55,330	98,844	98,844
Mean	12,493	15,671	21,464	16,370
Standard Deviation	10,559	14,156	22,998	16,806
Recontamination 2 (July '90 - Dec.'90)	(N=34)	(N=32)	(N=30)	(N=96)
Minimum	807	865	548	548
25%	3,573	5,418	2,900	3,631
50%	8,213	13,832	9,942	10,807
75%	27,665	29,207	42,650	34,581
Maximum	109,507	96,827	103,743	109,507
Mean	19,815	20,674	24,761	21,647
Standard Deviation	23,830	23,123	27,604	24,676

*Adjusted using the weighing factor derived from the intercalibration study. The median window well dust concentration was used to characterize a living unit. N/A = Not Applicable.

TABLE 15-24. DISTRIBUTION OF INTERIOR WINDOW WELL LOADING* (mg/m^2) OVER TIME AND ACCORDING TO GROUP

	S	A	B	Total
Pre Abatement (Aug. '89 - Jan. '90)	(N=40)	(N=41)	(N=34)	(N=115)
Minimum	20	23	0	0
25%	52	68	89	63
50%	155	280	216	219
75%	525	578	401	547
Maximum	2,722	6,542	5,701	6,542
Mean	339	564	443	450
Standard Deviation	472	1,100	968	884
Post (Oct.89 - March '90) Abatement	(N=32)	(N=32)	N/A	(N=64)
Minimum	0	0		0
25%	27	16	244	18
50%	79	29	244	39
75%	162	122	244	160
Maximum	2,018	1,293	244	2,018
Mean	185	115	244	150
Standard Deviation	372	244	244	314
Recontamination 1 (March '90 - June '90)	(N=41)	(N=35)	(N=36)	N=(112)
Minimum	32	22	9	9
25%	123	176	85	118
50%	387	284	213	278
75%	646	542	558	615
Maximum	3,431	3,207	8,905	8,905
Mean	513	489	634	545
Standard Deviation	615	601	1,509	984
Recontamination 2 (July '90 - Dec. '90)	(N=34)	(N=32)	(N=30)	(N=96)
Minimum	30	38	15	15
25%	125	216	158	153
50%	295	438	418	341
75%	546	760	744	700
Maximum	3,310	2,867	3,457	3,457
Mean	559	562	641	585
Standard Deviation	726	559	837	707

*The median window well loading was used to characterize a child's living unit. N/A = Not Applicable.

TABLE 15-25. DISTRIBUTION OF INTERIOR WINDOW WELL LEAD LOADING* ($\mu g/m^2$) OVER TIME AND ACCORDING TO GROUP

	S	A	B	Total
Pre-Abatement (Aug.'89 - Jan.'90)	(N=40)	(N=41)	(N=34)	(N=115)
Minimum	5	32	0	0
25%	213	351	279	282
50%	2,262	3,825	2,236	3,145
75%	9,298	17,122	11,465	12,829
Maximum	56,614	451,193	657,170	657,170
Mean	7,861	25,545	26,976	19,817
Standard Deviation	12,606	73,487	111,910	75,178
Post (Oct.89 - March '90) Abatement	(N=32)	(N=32)	N/A	(N=64)
Minimum	0	0		0
25%		13		27
50%	114	68		249
75%	687	381		1,398
Maximum	3,280	11,561		46,529
Mean	46,529	674		1,942
Standard Deviation	3,211	2,073		6,114
	8,267			
Recontamination 1 (March '90 - June '90)	(N=41)	(N=35)	(N=36)	(N=112)
Minimum	98	83	9	9
25%	1,066	644	672	803
50%	3,547	3,810	3,503	3,531
75%	7,817	13,293	8,683	8,711
Maximum	19,869	38,116	173,592	173,592
Mean	5,007	8,544	11,955	8,346
Standard Deviation	4,961	10,416	29,861	18,210
Recontamination 2 (July '90 - Dec.'90)	(N=34)	(N=32)	(N=30)	(N=96)
Minimum	41	44	6	6
25%	1,754	1,540	1,340	1,549
50%	5,102	5,104	5,318	5,186
75%	11,234	12,797	18,690	13,434
Maximum	169,584	80,981	52,078	169,584
Mean	12,443	10,750	11,406	11,555
Standard Deviation	28,946	16,129	14,160	20,920

*Adjusted using the weighing factor derived from the intercalibration study. The median window well dust concentration, and loading were used to characterize a child's living unit. N/A = Not Applicable.

TABLE 15-26. QA/QC RESULTS FOR SOIL AND DUST ANALYSES

	EMSL RESULTS*			BOSTON RESULTS*		
	Consensus Mean	Biweight Mean	95% Biweight Distribution Bounds	Mean	Range	% of Results Within EMSL 95% Bounds
SOIL**						
CINL	290	315	204-426	399	207-570	61.3
BALH	934	1,017	847-1,187	1,044	747-1,244	73.3
BOSM	5,759	6,219	4,742-7,696	6,786	6,015-7,549	100.0
CINH	12,376	12,729	11,361-14,096	14,074	11,407-16,592	50.0
DUST**						
CIN02	242	233	93-372	331	115-461	64.7
BAL03	1,334	1,438	1,091-1,786	1,232	980-1,441	92.0
CIN01	2,933	2,617	1,422-3,812	2,671	2,075-3,228	100.0
BOS01	***	***	***	11,783	10,374-15,561	***

*Adjusted using the weights derived from the intercalibration study.
**Acronyms stand for the source of the sample.
***BOS01 was not included in the intercalibration study because of lack of material.

decreased to a level 33% below baseline by the end of the recontamination assessment period In Control Group A median floor dust loading decreased by 24% after dust abatement and remained substantially below baseline levels during subsequent sampling. Median levels in Control Group B decreased by 53% from baseline levels over this time period.

At baseline floor dust lead loading was higher in Control Group B than the other groups (87 vs. 61 and 68 $\mu g/m^2$). An average of 4-5weeks after the interior dust abatement, lead loading had decreased by 23% in the Study Group and by 60% in Control Group A. By the end of the recontamination assessment period, floor lead loading had declined by 70% in the Study Group and 69% in Control Group A. Control Group B declined by 71% over this time period.

Tables 15-23 through 15-25 describe the distribution of interior window well dust lead concentration, dust loading, and dust lead loading over time in the Study and Control Groups. At baseline median dust lead concentrations were higher in Control Group A than the Study Group and Control Group B (15,907 vs. 11,815 and 13,429 PPM). Median window well dust lead concentrations in the Study Group and Control Group A were reduced by 36% and 86%, respectively, an average of 4-5 weeks after the interior dust abatement (Post Abatement). Window well dust lead levels increased in these groups over the recontamination assessment period but were still below baseline levels (13-30%) an average of 33 weeks after interior dust abatement (Recontamination 2). During this period the window well dust lead concentrations in Control Group B declined by 26%.

At baseline the median window well dust loading (mg/m^2) was higher in Control Group A than in the other groups (280 vs. 155 and 116 mg/m^2). An average of 4-5 weeks after the interior dust abatement, the median window well dust loading levels decreased by 49% in the Study Group and 90% in Control Group A. Over the recontamination assessment period, median window well dust loading substantially rose in both groups and were 56-90% above baseline by the end of this period. Median levels in Control Group B also rose by 94% by the end of this period.

At baseline the median window well dust lead loading was higher in Control Group A than the other groups (3,825 vs. 2,262 and 2,236 $\mu g/m^2$). An average of 4-5 weeks after the interior dust abatement, lead loading had decreased by 70% in the Study Group and by 98% in Control Group A. Over the recontamination assessment period window well lead loading rose (from baseline levels) by 126% in the Study Group and 33% in Control Group A. Control Group B increased by 138% over this time period.

Lastly, no dose-response relationship was seen when we modeled the second recontamination assessment floor and window well dust measures as a function of the change in soil lead concentration.

The results of the external audit sample analyses conducted by EMSL, the external QA/QC contract laboratory in Las Vegas, indicate that our soil and dust lead data were generally of good quality (Table 15-26). While our mean soil concentrations were consistently higher than the consensus and biweight means, the majority of our results fell within the 95% biweight distribution bounds provided by EMSL. The best agreement was

seen for lead levels that encompassed most of our soil samples (BALH and BOSM). Our dust lead results were also in good agreement with those of the EMSL laboratory; the majority of our results also fell within the 95% biweight bounds and the best agreement was seen for lead levels that encompassed most of our floor dust samples (BAL03 and CIN01). Because of the lack of material, no EMSL data are available for the highest dust lead category (BOS01) where a large portion of our window well dust samples fell.

15.4.3 Water

Table 15-27 describes the distribution of water lead levels in the Study and Control Groups. The maximum levels in two first flush tap water samples was used to characterize each living unit. Water lead levels ranged from undetectable to 560 μg/L The median concentration in Control Group B was higher than the other two groups (36 vs. 20 and 18 μg/L).

TABLE 15-27. DISTRIBUTION OF WATER LEAD CONCENTRATIONS* (μg/L) ACCORDING TO GROUP

	S (N=34)	A (N=34)	B (N=29)	Total (N=97)
Minimum	1	UD	2	UD
25%	11	8	11	9
50%	20	18	36	20
75%	43	58	61	57
Maximum	350	387	560	560
Mean	43	54	76	56
Standard Deviation	68	84	115	90

*The maximum of two first flush samples was used to characterize the living unit of the child. UD means undetectable. The detection limit was 1.0 μg/L. To calculate the mean and standard deviation, 0.5 μg/L was used to characterize undetectable levels.

15.4.4 Paint

Table 15-28 describes the distribution of wall and woodwork paint lead concentrations among the Study and Control Groups. The maximum XRF readings for the wall and woodwork were used to characterize each living unit. A smaller proportion of units in Control Group B had detectable lead paint on walls (20.0%) than the Study Group and Control Group A (30.6% and 47.4%, respectively). Almost all units had detectable lead paint on woodwork.

Table 15-29 describes the amount of chipping paint that was present at baseline inside subjects' living units Case managers conducted the chipping paint assessments by visual inspection in all but 20 units. A larger proportion of units in the Study Group had significant amounts (>200 square inches) of chipping and peeling paint compared to Control Groups A and B. All groups received loose paint abatement as part of the intervention.

TABLE 15-28. DISTRIBUTION (%) OF WALL AND WOODWORK PAINT LEAD CONCENTRATIONS* (mg/cm^2) ACCORDING TO GROUP

	S (N=39)	A (N=40)	B (N=36)	Total (N=115)
Wall				
Undetectable	30.6	47.4	20.0	33.7
0.5-1.0	25.0	18.4	33.3	25.0
1.1-9.9	25.0	10.5	16.7	17.3
10.0	19.4	23.7	30.0	24.0
Woodwork				
Undetectable	5.1	0.0	11.1	5.2
0.5-1.0	10.3	15.0	27.8	17.4
1.1-9.9	25.6	30.0	22.2	26.1
10.0	59.0	55.0	38.9	51.3

*The maximum XRF level for the wall and woodwork were used to characterize the living unit of the child. Detection limit was 0.5 mg/cm^2.

TABLE 15-29. DISTRIBUTION (%) OF AMOUNT INTERIOR CHIPPING PAINT* AT BASELINE ACCORDING TO GROUP

	S (N=34)	A (N=36)	B (N=32)	Total (N=102)**
Amount of Chipping Paint at Baseline (Square Inches)				
0 - 50	55.9	58.3	46.9	53.9
51-200	14.7	22.2	34.4	23.5
> 200	29.4	19.4	18.8	22.5

*The presence of interior chipping paint at baseline was assessed by visual inspection of all rooms in the living unit.

**The chipping paint assessment was not performed on 20 units (8 in S, and 6 each in A and B). Percentages exclude units with missing data

15.5 COST OF ABATEMENT ACTIVITIES

15.5.1 Soil Abatement

In this section the actual cost of soil abatement is presented, along with the cost breakdown for the various components of the abatement including soil sampling, excavation, disposal and replacement. Costs are described separately for abatements conducted in 1989 and 1990 because of differences in contractors and abatement requirements. Average cost per property, per square meter, and per cubic yard of soil excavated and replaced are presented. These figures must be interpreted with caution given the many unique conditions under which the abatements were conducted for this study. Alternative cost estimates are also provided that perhaps better reflect future costs of lead contaminated soil abatement.

Lead contaminated soil was abated from thirty-six properties in 1989. The abated areas of these properties averaged 2,141 square feet, or 199 square meters and ranged from 12 to 702 square meters. It is estimated that an average of 41 cubic yards of soil were excavated and replaced at each site. This estimate is crude since 12 of the 36 abatements were conducted after the ground had frozen and consequently large slabs of earth were often removed that were difficult to measure. In some cases, measurements were not possible Since the yard sizes were somewhat smaller, on average, for the premises abated in 1990

(178 versus 199 square meters), and since the measurement of cubic feet excavated in 1990 was easier and more accurate and resulted in an estimate of 44 cubic yards per property, we have assumed that the cubic feet abated per property were similar in 1989 and 1990, Thus, the estimated cost per cubic meter in 1989 is probably greater than the actual cost incurred.

The costs of soil abatements are shown in Tables 15-30 and 15-31.

Many of the soil abatement related costs incurred in both 1989 and 1990 may not be applicable to future soil abatement activities in this and other communities. In 1989, for example, $69,668 was spent for contract development and supervision by Applied Occupational Health Systems. This cost was incurred because of lack of experience with lead contaminated soil abatement. Probably only the $19,401 spent for abatement supervision is applicable for other settings. Other portions of the Contract Development/Supervision expenses might be applicable as one time costs for future soil abatement activities. Similarly, of the $52,307 spent for miscellaneous extra costs ($1,453/property), only the $2,425 ($67/property) spent for pre-abatement yard cleaning may be applicable for future soil abatement activities, although it might be argued that the cost for hoses, sprinklers, and tarps may also be needed for future soil abatements. If these costs are included miscellaneous costs totalled $7,627, or $220/property.

While $26,190 was spent on soil disposal in 1989 ($725/property), soil disposal is likely to be the most variable and unpredictable expense associated with future abatements and it may be more useful to estimate abatement costs without including the cost of soil disposal.

For the 36 properties abated in 1989, the total cost for soil sampling and analysis ($10,933), pre-abatement yard cleaning ($2,425), soil excavation and replacement ($186,420), and supervision of abatement activities was $219,179 or approximately $6,100 per property. The cost per square meter of soil abated and replaced was $31, and the cost per cubic yard of soil replaced was $140. In 1990, the total cost of soil sampling and analysis ($17,535), pre- abatement yard cleaning ($1,550), soil excavation and replacement ($307,995), and supervision of abatements ($39,247) was $366,327, or $6,315 per property. The cost per square meter of soil abated and replaced was $35, and the cost per cubic yard of soil replaced was $143. Thus, the average costs were quite similar in 1989 and 1990.

TABLE 15-30. 1989 SOIL ABATEMENT COSTS

1. Soil Sampling and Analysis	$ 3,780
Labor, Sampling 36 Properties @ $105 Each	36
2 Core Sampling Tubes @ $17.95 Each	74
2 Core Sampling Tubes @ $36.80 Each	25
1,000 Plastic Bags @ $25 Per 1,000	200
Miscellaneous Supplies	6,818
Analyses of Approximately 20 Samples/Site @ $9.47 Each x 36	$ 10,933
Total for Soil Sampling and Analysis	
2. Contract Development/Supervision by Applied Occupational Health Systems (AOHS)	
Development	$ 20,503
Pilot Abatement	9,450
Abatement Supervision	19,401
Dosimeters	365
Final Report	2,449
LFK Field Operations Coordinator 6 Months	17,500
Total Contract Development/Supervision	$ 69,668
3. Abatement Contract	157,740
33 Properties @ $4,780 Each	28,680
3 Properties @ 2 x $4,780 Each	$ 186,420
Total Abatement Contract	
4. Soil Disposal	
Use of Barry's Quarry	
Mattapan Costs, Prep, Clean-up	
Total Soil Disposal	
5. Miscellaneous Extra Costs	$ 2,425
Yard Cleaning Pre-abatement	1,402
Hoses and Sprinklers	3,800
Extra Poly Tarps, 19 Sites	30,795
Cold Weather Abatement	13,885
Asphalt, 4 Properties	
Total Miscellaneous Extra Costs	
Total Cost for 36 Soil Abatements in 1989	$345,518
Average Cost Per Property, including all factors listed above	$ 9,598
Cost Per Square Meter of Soil Abated	$ 48
Cost Per Cubic Yard of Soil Replaced	$ 218

TABLE 15-31. 1990 SOIL ABATEMENT COSTS

1. Soil Sampling and Analysis	
Labor, 58 Sites Sampled @ 105 Per Site	$ 6,090
2 Core Sampling Tubes @ 17.95 Each	36
2 Core Sampling Tubes @ 36.80 Each	74
2,000 Plastic Bags @ $25 Per 1,000	50
Miscellaneous Supplies	30
Analyses of approximately Samples/Site	0
@ $9.47 Each x 58	10,985
Total for Soil Sampling and Analysis	$ 17,535
2. Supervision of Abatements	
3 Site Monitors 3 Months Each	$ 25,550
Travel for Site Monitors	1,697
LFK Field Operations Coordinator 4 Months	12,000
Total for Supervision	$ 39,247
3. Abatement Contract	
51 Properties @ $4,738.38 Each	$241,657
7 Properties @ 2 x $4,738.38 Each	66,337
Total Abatement Contract	$307,995
4. Soil Disposal	
Use of Barry's Quarry	$ 2,500
Materials for Temporary Storage	1,724
Taking Stored Soil to Quarry	1,400
Site Monitor at Quarry	1,528
Gravel for Quarry Driveway	485
Bulldozer Rental for Covering Soil - 3 Months	9,350
Total Soil Disposal	$ 16,987
5. Miscellaneous Extra Costs	$ 1,550
Yard Cleaning/Change Orders	655
Hoses and Sprinklers	795
Transit Level Rental	$ 3,000
Total Miscellaneous Extra Costs	
Total Cost of 58 Soil Abatements in 1990	$384,764
Average Cost Per Property, Including all Factors Listed Above	$ 6,634
Cost Per Square Meter of Soil Abated	$ 37
Cost Per Cubic Yard of Soil Replaced	$ 150

15.5.2 Interior Loose Paint and Dust Abatement

Actual cost for units that received interior paint abatement alone, and for units that received both interior paint and dust abatement are presented. Actual cost of dust abatement alone cannot be provided as no units in the study received dust abatement in the absence of interior loose paint abatement Possible cost for dust abatement alone is estimated using two different approaches Costs are provided for the abatement activities, and for the costs associated with pre-abatement preparation, abatement monitoring, and the costs associated with cancellations The contractor who performed the interior loose paint and dust abatements charged different unit rates depending on unit size. Actual costs for loose paint abatement and loose paint and dust abatement. and estimates of costs for dust abatement alone are therefore provided by the cost category charged by the contractor. Average costs are also provided.

A total of 129 units had interior abatements: 40 units had only loose paint abatement. and 89 units had loose paint and dust abatement.

While participants were asked to prepare their units for abatement activities it quickly became apparent that most could not accomplish this. Thus, the contractor hired to do the interior abatements was paid to prepare the units at a rate of $20/hour. This included moving all furniture items to the middle of the room. A total of 407.25 hours at $20/hour ($8,145) was spent on preparation activities for the 129 units that received interior abatements In calculating cost estimates we have used the average unit preparation cost as $63/unit ($8,145/129 units) This assumes that these costs did not vary by size of unit.

All interior abatement activities were monitored by study staff. It is estimated that the total cost of monitoring was $15,832. Although the monitoring cost may have varied by unit size and abatement category (loose paint abatement alone took approximately 1/2 day per unit whereas loose paint and dust abatement took approximately one day per unit to complete) the average cost of monitoring was used ($15,832/129 or $123/unit).

Interior Loose Paint Abatement Costs

Abatement Work	- 32 units @ 499/unit	$15,968
	8 units @ $988/unit	7,904
	Total for 40 units	$23,872
Preparation	- 40 units @ $63/unit	$ 2,520
Monitoring	- 40 units @ $123/unit	$ 4,920
Cancellations	- 4 units @ $499/unit	$ 1,996

Thirty-two units were abated at a cost of $499 per unit. Eight units were considered oversized and were abated at a cost of $988 per unit. Thus, for 75% the cost of loose paint abatement was $499 and for 25% the cost was $988. The average cost for all 40 units was $597/unit. These figures do not include the costs of preparation work, monitoring, or the cancellations.

If the costs of preparation work ($63/unit) and monitoring ($123/unit) are included, the cost for interior loose paint abatement was $685/unit for 75% of the units, $1,174/unit for 25%, and the average cost was $783/unit.

If the costs of cancellations are added, then each figure would be increased by $50 ($1,996/40).

Interior Loose Paint and Dust Abatement Costs

Abatement Work	- 84 units @ $873/unit	$73,332	
	4 units @ $1,748/unit	6,992	
	1 unit @ $1,310	1,310	
	Total for 89 units	$81,634	
Cancellations	- 9 units @ 873/unit		$ 7,857

For 84 units the cost of loose paint and dust abatement combined was $873, for four units the cost was $1,748/unit, and for one unit the cost was $1,310. The average cost for all 89 units was $917/unit. These figures do not include the costs of preparation work, monitoring, or cancellations.

If the costs of preparation work and monitoring are included the respective costs are $1,059, $1,934, and $1,496 with an average cost of $1,103. If the costs of cancellations are added, and cancellations were common, occurring in 10% of cases, then each figure above should be increased by $50.

15.5.3 Interior Dust Abatement Costs

No units in the study underwent dust abatements without associated loose paint abatement. The figures presented therefore represent hypothetical cost estimates of interior dust abatements. Estimates are provided of costs estimated in two different ways.

First, the cost per unit for loose paint and dust abatement was divided in half as it took approximately 1/2 day to do loose paint abatements alone and approximately one day to do loose paint and dust abatement. Among the 89 units that had both loose paint and dust abatements, the estimated cost of dust abatements alone were: $437 each for 84 units, $674 each for four units, and $650 for one unit. The estimated average cost was $458 overall not including the costs of preparation and monitoring. If preparation and monitoring costs are included the respective costs were $525, $867, and $748 with an average cost of $552 overall.

Secondly, the average cost for dust abatement was estimated by subtracting the average cost of loose paint abatement alone, with and without the costs of preparation and monitoring ($783 and $597, respectively), from the average cost of loose paint and dust abatement combined, again with and without the cost of preparation and monitoring included ($1,103 and $917, respectively). By this method, the average cost of dust abatement was $134 without including preparation and monitoring costs and $320 if they were included.

All estimates provided for the cost of interior loose paint, loose paint and dust, and dust abatement do not include costs associated with identifying units in need of abatement, recruiting landlords, making arrangements for families to be off the premises during abatement activities, and pre or post-environmental sampling.

15.5.4 Deleading Costs

Interior and exterior deleading activities are described in detail in another section of the report. The study offered to pay in full the cost of exterior and interior deleading for owner occupied units, and $2,000 towards the cost of these activities for non-owner occupied units. Non-owner occupied properties were viewed as businesses and therefore were believed to be responsible for bringing their properties into compliance with the Massachusetts Lead Law and so were not offered full coverage of the deleading costs. A total of 46 exterior and 46 interior deleading operations were facilitated and paid for in total or in part. These

92 operations were performed by four licensed deleading contractors under eight separate contracts. One contractor subcontracted some of the work to a fifth licensed deleader.

The study incurred a variety of costs that may or may not be relevant to or included in cost estimates of deleading activities, such as those associated with lead based paint inspections, including the purchase of a portable XRF machine, respirator use by inspectors while monitoring deleading (monitoring is not currently required in Massachusetts), clearance sampling to assure that the units were free of lead contaminated dust (this is also not required in Massachusetts but it is conducted if dust is discernible on visual inspection), moving and furniture storage charges, and alternate housing for families during deleading. Many of these costs may not be applicable to deleading activities undertaken as part of the environmental management of children with elevated lead levels, and they may in large part reflect idiosyncrasies associated with this study. Many of these costs may, however, be quite relevant to future endeavors where deleading is undertaken on a large scale or as part of a comprehensive approach to the primary prevention of low level lead toxicity among children. All actual cost estimates are presented.

Costs Associated with Lead Paint Inspections

Development of the inspection process	
$1,800/wk × 10 weeks	$18,000
Conducting Inspections of units	
$2,000/wk × 12 weeks	24,000
Monitoring Deleading Activities	
$2,000/wk × 24 weeks	48,000
Cost of One Portable XRF Machine	4,147
Total Cost of Inspecting and Monitoring	$94,147

As described earlier, for the purposes of this study it was necessary to hire private lead paint inspectors. In other situations, code enforcement inspectors may work for public regulatory agencies, such as health departments, or families who do not have children with elevated lead levels but want inspections may hire licensed private inspectors. Three lead paint inspectors and one assistant accomplished the inspection related activities. They had the additional assistance of an intern inspector who worked on the project.

The total cost of inspector related activities for this study was $94,147, or approximately $1,000 per deleading operation This figure is probably substantially higher than usual because of factors unique to this study. For example, the $18,000 spent to develop the inspection process is most likely best viewed as a cost idiosyncratic to this study, or as a one time cost that might be incurred by other cities or projects that were starting up large scale deleading activities. Similarly, private lead inspectors do not typically monitor deleading activities, but rather perform lead inspections to determine the need for deleading and to issue certificates of compliance after deleading has been completed. The cost of the portable XRF could also be viewed either as a one time cost, or not included as a cost since any lead related regulatory agency must have this type of equipment. Therefore, it is probably most realistic to include only the costs of actually conducting inspections of units in arriving at the total cost of deleading.

Ninety-two deleading operations were performed, and the cost of lead paint inspections associated with these operations was $24,000, or approximately $260 per operation. Since certificates of compliance are issued only after both interior and exterior deleadings in Massachusetts, a more accurate estimate of this inspection/compliance cost might be $520 per unit deleaded.

Costs Associated With Actual Deleadings

46 Exterior Deleading Operations	$262,278
46 Interior Deleading Operations	343,242
Total Cost of Exterior and Interior Deleading	$605,520

The average cost of an exterior deleading operation was $5,702 and the average cost of an interior deleading operation was $7,462. Thus the average total cost per unit of both interior and exterior deleading operations was $13,164.

Cost of Respirators

4 PAPT Respirators @ 546/each	$ 2,186

Respirators were purchased for use by inspectors during deleading monitoring. While it would be accurate to factor their cost into the study related deleading costs, this is a one-time cost and is not regularly required for lead paint inspectors. Deleaders are required to wear respirators while performing deleading operations.

Cost Associated With Moving and Storage

41 Moves @ 720/each	$29,520
5 Cancellations @ 360/each	1,800
Extra Storage	2,346
Total Cost	$33,666

$33,666 was spent on moving and storing the property of 41 families. Five other families were able to find alternative housing without any financial assistance from the project. Thus, to accomplish 46 interior and 46 exterior deleading operations, 41 required financial assistance with temporary moves and the average cost for those requiring moving assistance was $820 per family.

Cost Associated With Alternative Housing

Seven families could not locate suitable alternative housing and the study identified and paid for temporary housing for those individuals. A total of 78 nights of alternative housing was provided for these seven families at a total cost of $11,612, or approximately $1,650/family.

Cost Associated With Clearance Samples

Materials (centrifuge tubes and wash and drys)	$ 1,476
Acid dispenser and centrifuge shaker	997
Analyses of 619 samples at $14.50/each	8,975
Total Cost	$11,448

A total of $11,448 was spent obtaining and analyzing clearance samples. No estimate is available of the cost associated with the inspectors' time involved in obtaining clearance samples. The average cost of performing clearance sampling for the 46 interior units is therefore approximately $250/unit deleaded. Since it is not currently standard public health

practice to conduct clearance sampling with all interior deleading operations, it may be best to exclude the cost of clearance sampling in estimating total costs of deleading operations.

15.5.4.1 Total Deleading Costs

$741,712 was spent for the 46 interior and 46 exterior deleading operations. This includes the cost associated with inspecting and monitoring deleading activities, the actual deleading activities, financial assistance with moving and storage, alternative housing for selected families and clearance samples for all interior deleading operations. Thus, the average cost per combined interior and exterior deleading operation was $741,712/46, or approximately $16,124 per combined operation. If the cost of moving, storage, and alternative housing are removed, the total cost was $696,434/46, or approximately $15,000 per combined operation. If the cost of moving, storage, alternative housing, and inspections and clearance samples are removed, the total cost was $594,072/46, or approximately $13,000 per combined operation. This cost may be likened to the cost of deleading a single family home, or one interior operation and an exterior deleading operation in a multiunit home. Deleading of subsequent units in multiunit homes would have costs closer to that of interior unit deleading alone.

Separate costs associated with exterior deleading operations may be about $5,700/exterior operation, although there is no data to suggest how comparable costs would be in other cities with different sizes or types of homes. The average cost per interior deleading activity, not including the costs associated with the unique situations of this study (e.g., moving, storage, alternative housing, inspections, monitoring, and clearance samples) was $7,500/interior deleading operation. If one assumes that many of the unique costs are applicable to future large scale deleading activities in other communities, the actual cost may be closer to $10,000-$10,500 per unit.

16. DISCUSSION

One of the most difficult aspects of the childhood lead problem is identifying the sources of lead and determining their relative contribution to children's lead burden. Lead based paint and household dust have received most of the attention to date. Far less attention has been paid to urban outdoor sources of lead, especially soil, except in cases of stationary sources such as smelters. Our findings suggest that lead contaminated soil does contribute to the blood lead levels of urban children. We found that soil abatement alone (Study vs. Control Group A) was associated with a 0.8 to 1.4 μg/dL decline in blood lead levels and that soil and interior dust abatement combined (Study Group vs. Control Group B) was associated with a 1.2 to 1.6 μg/dL decline. (These numbers are the range of adjusted point estimates.) These blood lead changes were observed approximately one year following soil abatement in which surface soil lead levels were dropped an average of 1,856 PPM.

Numerous previous studies have shown that soil and dust lead levels are correlated with children's blood lead levels.[4,6-10,12-14,19-21] These studies have relied largely on cross-sectional data, often from communities with point sources of lead such as smelters, where soil lead concentrations were far greater than those typically found in urban settings. Many of the smelter area studies were conducted in response to crises and were not designed as research studies so that important design features such as study size and timing of intervention could not be planned. These studies have produced widely differing results with slope estimates of the soil lead - blood lead relationship that vary over nearly an order of magnitude.[25]

Removal of lead contaminated soil in this study was associated with a 0.8-1.6 μg/dL reduction in children's blood lead levels, suggesting that urban soil lead is biologically available and contributes to low level lead absorption in children. The clinical and public health implications of a reduction of this magnitude are not readily apparent. The magnitude of reduction in blood lead observed suggests that lead contaminated soil abatement may not be a particularly useful clinical intervention for children with low level lead exposure. It might be extremely useful, however, in specific situations, such as if soil lead were extremely high or the particular child had pica for soil. It is also a relatively inexpensive

and low technology intervention. Although there are no data regarding the relative safety of soil and lead based paint abatement, it seems unlikely that soil abatement is as dangerous to children, families, and workers as lead based paint abatement can be.[26-31]

16.1 STUDY PROBLEMS AND THEIR RESOLUTION

16.1.1 Recruitment and Retention of Study Participants

A potential problem was the recruitment and retention of study participants. The success of the study depended, in part, on recruiting and retaining sufficient numbers of participants who were representative of the general population of urban preschool children who are at risk for low level lead exposure. These concerns were important so as to provide a large enough sample so that we had sufficient power to test the study hypothesis and be generalizable to other children. The issue of generalizability was addressed by using the Boston Childhood Lead Poisoning Prevention Program (BCLPPP) for identification of children. This program has data on the majority of children screened in the neighborhoods of Boston of interest (i.e., those neighborhoods with the highest rates of lead poisoning). We also attempted to improve generalizability by choosing as wide a range of blood lead levels as was practical. That is, we could not choose children with blood lead levels greater than 24 μg/dL because of concern that they would receive medical and possibly environmental interventions that might confound study results. We chose as a lower limit blood lead values of 7 μg/dL because of concern that it would be difficult to ascertain the effect that soil abatement would have on lower blood lead levels. Our range for blood lead levels at entry was therefore 7-24 μg/dL. A related concern was that the BCLPPP screening data were derived from fingerstick lead tests. We addressed this by confirming all potential subjects' blood lead levels with venous blood samples before final enrollment.

Recruitment of participants was further supported by six approaches:

1. An active and visible community relations program and subject education effort was mounted. This ensured that residents of the target communities were aware of the lead poisoning problem in their communities, the risks that lead poisoning posed for their children, and of the program at the time that study staff attempted to recruit them. In addition, study staff were educated in the epidemiology, long-term effects, prevention, and treatment of childhood lead poisoning so that they could discuss these issues with potential subjects and convince them of the importance of the study and its potential benefits to their children and community.

2. Each month families were given $25 gift certificates for local supermarkets and general purpose stores as long as they participated in the study. Even if they moved they were eligible for these incentives as long as they stayed in touch with the study staff and agreed to provide access for environmental and biologic sampling and study interviews. All families completing the study were given a $150 gift certificate.

3. Study staff were enthusiastic, well trained, well supported by the study's management, often experienced in home visitation, and frequently came from the target communities. This led to a close and effective rapport with participating families.

4. Families were not enrolled if during intake they stated that they had plans to move during the next three months.

5. Study activities were very intrusive and disruptive to families and we made every effort to minimize family disruption by scheduling study activities at their convenience, taking children to museums and restaurants during interior abatement work, and offering alternative housing if necessary during interior lead paint abatement.

6. There was great concern about landlord consent to participate and the early stages of recruitment supported this concern. That is, landlords were initially reluctant to participate because of concern that if lead paint were found on the interior surfaces of their houses, they would be forced to pay for deleading. This problem was addressed by offering landlords of non-owner occupied premises $2,000 towards the cost of interior lead paint deleading and landlords of owner occupied premises the full cost of interior lead paint deleading. Moreover, we pointed out that (1) these properties were not in compliance with Massachusetts law and that at some time in the future they would have to be deleaded; (2) the study would facilitate and pay for part or all of the cost; and (3) if the landlords did not delead at the end of the study and a child became lead poisoned, they might be found liable if the family chose to sue them. We also pointed out that the soil contained high levels of lead and that we would remove this soil at no cost to them.

16.1.2 Lead Contaminated Soil Disposal

A great deal of energy went into identifying a location to dispose of lead contaminated soil. After exploring multiple options, some of which were not used because of distance from the excavation site or political concerns, a quarry was identified that abutted a cemetery in a Boston neighborhood not involved in the study. This worked well until the City councillor from that neighborhood raised concerns about the potential hazard of this soil to this neighborhood. This problem was resolved by temporarily storing the abated soil on a city-owned property while the EPA Project Manager, the principal investigator and other

members of the Lead Free Kids Staff, and representatives from the Mayor's Office met with the City councillor and concerned citizens and convinced them that dumping the soil in the quarry and covering it with unleaded soil posed no risk to residents of this community.

16.1.3 Limited Funding

Early in the study the Boston Lead-In-Soil Project was subjected to a cut in funds available from the EPA due to the other projects having budgetary needs that had to be addressed. This was dealt with by calculating the minimum number of families who needed to be recruited and retained to have sufficient power to test the study hypothesis. The CDC was helpful in supporting these estimates. This budget cut, plus the need to offer landlords substantial incentives to participate, led us to abandon the cluster arm of the Study Group and focus only on the effects of abating individual properties.

16.1.4 Concerns About Ethical, Legal, and Logistical Constraints

A series of very complicated ethical, legal and logistical constraints, documented in detail in documents produced by Region I of the EPA, submissions to and correspondence with the Institutional Review Board of the Trustees of Health and Hospitals, and correspondence with the Massachusetts Department of Public Health, led to great concern about the feasibility of carrying out a scientifically rigorous study in Boston. This problem, or series of problems, was dealt with by assembling a credible and capable leadership team with an established and respected record of scientific and public health accomplishment. The team assumed leadership for all aspects of the study, met regularly, provided daily oversight of all study activities, and worked closely and effectively with local and national EPA and public health officials, lead advocates, and nationally renowned leaders in the field of childhood lead poisoning research and treatment. This is a very truncated discussion of a substantial number of very complicated legal and ethical issues.

16.1.5 Frozen Ground During Soil Abatement of the Study Group

The ground froze during lead contaminated soil abatement of the Study Group in the Winter of 1989-1990. The study had a very narrow window of time in 1989 in which to accomplish soil abatement for the Study Group. Before these abatements were completed the

soil froze, as Boston experienced the coldest December in recorded history. This problem was addressed by using jack hammers to loosen soil so that abatements could proceed.

16.2 LIMITATIONS

Although designed and conducted to produce rigorous results, the study has a number of limitations that deserve mention:

16.2.1 Relatively Small Sample Size

Despite a sample size with adequate power to detect the hypothesized overall effect of the intervention, the relatively small sample size did result in a number of limitations:

1. Randomization was undertaken to maximize the probability that all three groups were comparable as regards measured and unmeasured characteristics. Because of the small sample size, randomization did not result in groups that were entirely comparable at baseline. In the analyses, we adjusted for the measured variables that were potential confounders.

2. Outliers had a greater influence on the study results. Two siblings in the Study Group had significant increases in blood lead levels between the first and second post-abatement sampling rounds. We hypothesized that they became poisoned because they were spending time at the father's home that had lead-based paint and was being renovated. The crude analysis was conducted both with and without these children and all results are reported. If the sample size were larger, however, the influence of the outliers would have been attenuated.

3. The relatively small sample size limited the stability of our stratified analyses on children with particular characteristics. For example, the small sample size resulted in a limited number of children with blood lead levels of 15 μg/dL and greater at baseline. Thus, our estimates are unstable regarding the effectiveness of soil abatement among children with lower versus higher starting blood lead levels.

16.2.2 Follow-up Limited To One Year

There are virtually no data available on the rate of change in children's blood lead levels following a change in lead exposure. It is possible that the intervention would have been associated with a greater reduction in children's blood lead levels had we followed them for a longer period of time. We have consequently applied to the EPA for a no cost

extension to obtain blood lead levels on participants who remained on the study premises during the summer of 1991. This will allow us to compare the blood lead levels of children who had soil abatement two years ago to those who had soil abatement during the fall of 1990.

16.2.3 Mobility Of Families

Twenty two families (14.5%) moved by the second post-abatement blood sampling round, and more families from the Study Group moved (20.4%) than families from Control Group A (15.7%) or Control Group B (6.4%). We followed all of these families for the duration of the study and obtained blood and environmental samples whenever possible. In addition it did not appear that the movement of the families reduced the magnitude of the treatment effect Children who lived on the study premises for at least 300 days had a similar reduction in blood lead levels as the entire group.

16.2.4 Limitations Resulting From Study Design

Several aspects of the design of the study may have limited the observed effectiveness of the intervention.

1. All children in the study, irrespective of group assignment, were exposed to lead contaminated soil prior to enrollment. An alternative study design which would have been logistically more difficult to execute would have involved conducting lead contaminated soil abatement prior to birth. Such a design would have enabled us to investigate whether exposure to lead contaminated soil abatement in the first year of life is associated with lower blood lead levels.

   This study provides information about soil abatement as a secondary prevention strategy, that is the benefit to children already exposed to lead derived, in part, from contaminated soil. It can not be used to estimate the primary prevention effect of soil abatement. Since children's post-abatement blood lead levels reflect both recent exposure and body burdens from past exposure, the benefit observed is probably less than the primary prevention benefit, that is the benefit of abating lead contaminated soil before children are exposed to it so as to prevent increases in blood levels and body stores.

2. Lack of Cluster Groups - Due to budgetary constraints and difficulties enrolling landlords, we abandoned our original plan to study clusters as the unit of abatement. We therefore evaluated only the effect of single premises abatements. It is possible that the effect of lead contaminated soil abatement on children's blood lead levels would be even greater had we abated lead contaminated soil from properties that surrounded Study Group children's premises.

3. Study staff regularly visited all participating families and provided education about lead poisoning, and while educational efforts were identical among the groups, this may have resulted in decreased group differences.

4. Children were already 31 months old, on average, at the outset of the study, well above the age at which mean blood leads are highest.[32,33]

These limitations all would tend to drive the results toward the null (Type II error), rather than produce false positive results (Type I error), making it likely that the study underestimates the full impact of urban soil abatement.

16.2.5 Limitations To Generalizability

There are limitations to the generalizability of the results stemming from the characteristics of the study population. For example, the abatement might have had a different effect among children with more or less exposure to soil lead. It might also have been different among children of higher socioeconomic status because of better diets, foundation shrubbery, more grass cover, or other reasons. The results therefore can be generalized to inner city children 1 to 4 years of age who have soil lead levels greater than 1,500 PPM, blood lead levels of 7 to 24 μg/dL, whose families' place of residence are reasonably stable (only 15% moved during the course of this study), and whose exterior lead paint is in fairly good condition. The study provides no information about the effect of lead contaminated soil abatement for children with lead levels outside of the eligible range (7 to 24 μg/dL). Similarly, the results may not be generalizable to children who live in communities with smelters or other stationary sources where soil lead levels are substantially higher than those seen in this study, or where differences in particle size result in differences in bioavailability.[5]

16.2.6 Misclassification

Errors in the sampling and measurement of lead in the environmental media and the blood and handwipes may have resulted in exposure and outcome misclassification. Because these errors were just as likely to occur in the Study Group as the Control Groups, they are more likely to result in bias toward the null than toward falsely positive results. We suspect that handwipe data was subject to non-differential misclassification because of sampling problems (e.g. the parent may have washed the child's hands shortly before sampling), and the highly variable background lead levels in the wipes (ranging from 2 to 18 μg).

Deficiencies in parental memory and report may have led to inaccuracies in the interview data. Most of the variables collected at interview were considered potential confounders of the relationship between soil abatement and blood and hand lead levels. Therefore any misclassification would have reduced our ability to control for confounding

16.3 IMPLICATIONS OF FINDINGS

Although the average benefit associated with abatement of lead-contaminated soil is modest, the societal impact may be substantial. Consider, for example, the impact on the blood lead distribution of an average decline of 1 or 2 μg/dL in the mean blood lead level of a population of children assuming a starting mean blood lead level of 12 μg/dL, a standard deviation of 4, and a normal distribution (Table 16-1) We also assume that the amount of change (as opposed to the percentage of change) is constant for all starting values, as we observed in our own sample in which the distribution of starting values was truncated. A decline of 2 μg/dL in the mean blood lead level results in 72% as many children with levels exceeding 10 μg/dL, 47% as many children with levels exceeding 15 μg/dL, and 26% as many children with levels exceeding 20 μg/dL (values of 10, 15, and 20 μg/dL were chosen because they correspond to the new CDC definition of lead poisoning, the new screening guideline, and the new action level for medical intervention). Even a 1 μg/dL decline in mean blood lead level results in 87% 70%, and 52% as many children with levels of 10, 15, and 20 μg/dL, respectively The percentage shifts may differ somewhat in a more representative sample in which the distribution of starting values is likely to be log normal

TABLE 16-1. PERCENTAGE OF CHILDREN EXPECTED TO HAVE BLOOD LEAD LEVELS EXCEEDING 10, 15, AND 20 μg/dL ASSUMING VARIOUS MEAN BLOOD LEAD LEVELS*

Mean	% > 10 μg/dL	% > 15 μg/dL	% > 20 μg/dL
12	69.1	22.7	2.3
11	59.9	15.9	1.2
10	50.0	10.6	0.6

*A constant standard deviation of 4 μg/dL is assumed for all mean blood lead levels.

The results of this study suggest that lead contaminated soil contributes to the lead burden of urban children and that abatement of lead contaminated soil around their homes results in a modest decline in blood lead levels. Thus it may be prudent to include soil inspection and abatement as part of primary prevention strategies in communities with high rates of childhood lead poisoning and as part of the environmental intervention on behalf of selected lead poisoned children.

Policy decisions regarding urban lead contaminated soil abatement as a lead control strategy will require numerous considerations. For example, are other types of remediation (e.g., planting grass cover and shrubs) equally effective but less expensive and intrusive? How does the cost effectiveness of soil abatement compare to other lead exposure reduction activities, such as paint abatement? Will it be practical to perform large scale abatements without encountering problems regarding the disposal of lead contaminated soil? Will future research help specify whether changes in children's blood lead levels of the magnitude seen in this study are clinically relevant or prudent from a public health or societal perspective? And will we develop and sustain the resolve and commit the resources needed to prevent what remains the most important environmental health problem of children in the United States?

16.4 ONE YEAR EXTENSION

In December, 1990 the investigators requested that unexpended funds that resulted from paint deleading refusals be used to support a no cost extension for one year. In May 1991

the extension was granted and signed. The extension will be used to accomplish a number of related objectives.

The first objective is to conduct detailed analyses of data already collected that are vital to our understanding of how lead contaminated soil abatement affects children's blood lead levels. A great deal of environmental and child based data were collected as part of this study. As anticipated from the outset of the project, only a selected number of analyses directed at answering the primary hypothesis posed by the project, that is, in the aggregate, did lead contaminated soil abatement result in significant reductions in children's blood lead levels, could be conducted by the end of May, 1991. The extension will enable the investigators to complete more detailed analyses regarding the impact of behavioral and environmental variables on the change in blood lead levels.

Second, analyses conducted to date suggest that soil abatement was associated with a 0.8-1.6 μg/dL reduction in children's blood lead levels, somewhat less than what was originally hypothesized. The clinical and public health implications of a reduction of this magnitude are not readily apparent. It is possible that larger differences in mean blood lead levels between the experimental and Control Groups may be found at two years post-abatement. If this is the case, then it might imply that this environmental intervention is prudent public policy. The one year extension enabled the investigators to obtain an additional blood and hand lead level measurement among children who still live at their original premises. This will also allow the investigators to examine the impact of paint deleading on blood lead levels. Additional soil and dust samples will also be obtained and analyzed for lead content so that recontamination can be further studied. The possibility of obtaining a fourth blood lead level if the results were inconclusive or if the financial resources were available was discussed in the original grant application submitted in August, 1988.

A one year extension also enables this project to be completed simultaneously with the other projects in Baltimore and Cincinnati and will facilitate our input in understanding how the data from each of the three projects complement each other. It also ensures that the investigators will be available to work with EPA officials in writing the final report to Congress combining the results of all three projects.

The Trustees of Health and Hospitals of the City of Boston has agreed to continue housing the grant. Michael Weitzman, M.D., although having moved to the University of Rochester School of Medicine and Dentistry, will continue to be the principal investigator, and in that capacity will continue to be responsible for the overall operation of the project during the extension period. Ann Aschengrau, Sc.D. at Boston University will continue to oversee the day-to-day data collection and analyses and she, along with Michael Weitzman, M.D., David Bellinger, Ph.D. of Harvard Medical School, and Alexa Beiser, Ph.D. at Boston University, will collaborate on the production of all reports.

Boston Lead Free Kids Study

Protocols and Other Documents

A. Protocols

1. Blood Sampling and Processing
2. Blood Lead Analysis
3. Erythrocyte Protoporphyrin Analysis
4. Handwipe Sampling
5. Handwipe Analysis
6. Child Height Measurement
7. Child Weight Measurement
8. Soil Sampling
9. Soil Lead Analysis
10. Interior Dust Sampling
11. Interior Dust Lead Analysis
12. Water Sampling
13. Water Lead Analysis
14. Lead Paint and Site Inspection
15. Interior Dust Abatement
16. Interior Loose Paint Abatement
17. Quality Assurance Plan: Soil and Dust Analyses
18. CDC External Quality Assurance Plan: Blood Lead Analyses
19. US EPA/EMSL External Quality Assurance Plan: Soil, Dust, and Handwipes

BOSTON LEAD FREE KIDS STUDY

PROTOCOL FOR SAMPLING BLOOD FOR LEAD ANALYSIS

Venipuncture Method

1. Make sure the consent form is signed.
2. Educate the patient according to their level of comprehension, with parent present.
3. Assure the patient of minimal discomfort.
4. Inspect the patient's arm and hands for best venipuncture site.
5. Determine the best method of venipuncture for the patient (butterfly 18 ga. or conventional needle 21 ga. assembly).
6. Clean venipuncture site using Becton Dickinson (B-D) alcohol prep until alcohol prep shows clean. Let air dry or dry with clean gauze.
7. Be sure the patient is properly restrained.
8. Apply tourniquet.
9. Don gloves.
10. Palpate for vein.
11. Clean site again and dry after palpating.
12. Insert needle assembly.
13. Draw 2 B-D pediatric 3 ml vacutainer evacuated tubes with EDTA preservative. Mix well; invert 3-5 times.
14. Loosen tourniquet before last tube is full or before withdrawing needle.
15. Withdraw needle.
16. Apply pressure to venipuncture site until bleeding is stopped, then apply band-aid.
17. Write in patient's name, other coded information, and sign labels. Attach labels to tubes.
18. Put tubes in cooler.

Processing Equipment:

1. Consent form
2. Butterfly 18 ga. or 21 ga. by 3/4", 12" tubing infusion set, vacutainer multiple sample Luer-Adapter, Becton Dickinson vacutainer with EDTA preservative, and vacutainer holder.
3. Becton Dickinson (B-D) alcohol swab.
4. Tourniquet
5. Cooler with "Blue Ice" packs to keep sample cool.
6. Trained and qualified person to obtain blood samples (i.e., medical technician, nurse, etc.).

All waste materials should be **red-tagged**. Upon failure to achieve venipuncture, the alternative fingerstick procedure as described by CDC may be used.

Revised 8/89

Boston Lead-In-Soil Demonstration (Lead Free Kids) Project

Whole Blood Collection and Processing Protocol

For Blood Lead and FEP determinations

Blood

↓

One 7 ml Lavender Top Vacutainer

↓

Invert Several Times To Ensure Proper Mixing

↓ ↓

Blood Lead | Blood FEP

↓

Initiate Chain Of Custody Document

↓

Refrigerate at 4°C Within 30 Minutes Of Collection
And Store At Same Temperature Until Shipment

↓

Pack Blood in Styrofoam Shipping Containers Provided By Laboratory

↓

Transport Blood Via Lead Free Kids Messenger
to Environmental Science Associates (E.S.A.) Laboratories
of Bedford, Massachusetts

LEAD FREE KIDS STUDY

BLOOD LEAD ANALYSIS

ANALYTE: Lead

MATRIX: Blood

LABORATORY: ESA Laboratories, Bedford, MA

PROCEDURE: Graphite Furnace Atomic Absorption (GFAAS)

METHOD: A 1:12 dilution with a Matrix Modifier, FGAAS

RANGE: 0-50 μg/dL

DATE:

1. PRINCIPLE OF THE METHOD

1.1 A 100 μL aliquot of well mixed blood is diluted to 1.2 mL with a matrix modifier.

1.2 The sample is then run by GFAAS using polarized Zeeman background correction.

2. RANGE AND SENSITIVITY

2.1 The sensitivity of this method is 1 μg/dL. The upper range is 50 μg/dL, samples above this range should be diluted and re-run.

3. INTERFERENCES

3.1 Normal constituents of blood and urine do not interfere. Zeeman background correction will adequately correct for all background interference at this dilution.

4. REAGENTS

4.1 Triton X-100

4.2 Dibasic ammonium phosphate (NHA) 2HP04

4.3 16 M nitric acid

4.4 Matrix Modifier - To approximately 1000 mL of DIW stir in 20 mL of Triton-X and 4 grams of dibasic ammonium phosphate. Then add 4mL of NHO3 and dilute to 2000 mL with DIW.

5. STANDARDS

5.1 Stock Standard - 1000 μg/mL Pb Fisher certified or equivalent.

5.2 Working Standard - 10 μg/mL Pb - Dilute 1 mL of the Stock Standard to 100 mL with DIW.

5.3 Curve Standard - 5, 10, 20 and 50 μg/dL - Dilute 0.5, 1.0, 2.0 and 5.0 mL of the Working Standard to 100 mL with the Matrix Modifier.

6. SAMPLE PREP

6.1 Using a micromedic pumping system, draw up 100 uL of well mixed blood, and dispense along with 500 μL of Matrix Modifier into a sample cup.

6.2 Draw up 100 μL of Matrix Modifier and dispense along with 500 μL of Matrix Modifier into the same sample cup from 6 1.

6.3 Controls - Follow Steps 6.1 - 6.2 using a known blood control.

6.4 Calibration Curve - Using a micromedic pumping system, draw up 100 μL of a <5 μg/dL blood sample, and dispense along with 500 μL of Matrix Modifier into a sample cup.

6.5 Draw up 100 μL of the lowest Curve Standard and dispense along with 500 μL of Matrix Modifier into the same sample cup from 6.4. Continue steps 6.4 -6.5 with remaining standards. Run the Matrix Modifier at the beginning of the run to ensure it is lead free.

7. INSTRUMENT PARAMETERS

HITACHI SIMULTANEOUS MULTIELEMENT ATOMIC ABSORPTION SPECTROPHOTOMETER

Element: Pb
Sample: Blood
Analyst: Lee

Date: '89.10.26

A/S PROGRAM

Signal Mode:	BKG Corrected
Measurement Mode:	Absorbance
Sample Blank:	No
STD Replicates:	1
Sample Replicates:	2
Statistics:	Mean, SD, RSD
Auto Sampling:	Yes
Sample Volume:	20 μL
Dilution:	Off (Sample)
Conc. Times:	1
Modif. Add.:	No
Stop Position:	16
Reslope -Standard:	No
-Interval:	1
Result on Record:	Yes (Conc. +Abs)
Chart Speed:	1

GROUP 1

Calculation Pb:	Peak Height
Slicing Height (Peak width only) Pb:	10%
Carrier Gas Int.:	Yes
Opt. Temp. Contr.:	On

GROUP 2

Calculation	
Slicing Height (Peak width only)	
Carrier Gas Int.:	Yes
Opt. Temp. Contr.:	On

STANDARD SAMPLE

S1	S2	S3	S4	S5	S6	S7	S8	S9	Pb

INSTRUMENTAL CONDITION

Unit:	ppb
Time Constant:	0.2 sec
Cuvette:	Pyro

Carrier Gas: 200 Ml/min
Interrupted Gas: 30 Ml/min

TEMPERATURE PROGRAM

Stage	No.	Temperature (C) Start	End	Time (Sec)	
Dry	1	50	120	60	Group 1:Pb
Ash	2	120	720	30	
Ash	3	720	720	30	
Atom	4	2400	2400	5	
Clean	5	3000	3000	5	

	W.L.	Lamp	Dimension
Pb	283.3 nm	7.5 mA	Linear

8. QUALITY CONTROL

8.1 A calibration curve composed of a minimum of reagent blank and three standards is prepared.

8.2 If a large number of samples are to be run, run a set of standards at the beginning and the end of the run. Average standards.

8.3 Run at least one known control, QC material, NBS or Quebec, etc. with every set of standards and every 10 samples.

8.4 At least one duplicate sample should be run every 10 samples.

8.5 At least one spiked sample should be run every 10 samples.

9. REFERENCE RANGES

BEI Lead in Blood - 50 μg/100 mL

10. NOTES

10.1 All plasticware used in this procedure must be soaked in 5% HNO3 and rinsed several times with DIW.

10.2 A well seasoned pyro-coated cuvette seems to work better for this method. It reduces the carbon buildup and minimizes the splattering of the sample

11. REFERENCE

Miller DT, Paschal DC, Gunter EW, Stroud PE, and D'Angelo J: Analyst 1982, 112, 1701.

ACCURACY AND PRECISION OF LABORATORIES

QC Sample TV	Boston ESA
"Low Bench" 1.6	0.2 (0.5)
"High Bench" 45.6	47.1 (1.6)
"Low Blind" 4.3	4.0 (0.6)
"High Blind" 10.3	10.6 (0.7)

LEAD FREE KIDS STUDY

ERYTHROCYTE PROTOPORPHYRIN PROCEDURE
(Hematofluorometer)

A. **Principle**

Erythrocyte Protoporphyrin (EP) is beneficial in identifying a biological response to lead (Pb) absorption (causing increased blood lead levels), as well as iron-deficiency anemia. A simple dedicated portable fluorometer, which is called a hematofluorometer, measures the zinc protoporphyrin level by using front surface illumination of a drop of blood on a glass microscope cover slip.

The instrument measures the ratio between zinc protoporphyrin (ZnP) and hemoglobin (oxyhemoglobin) in blood. Consequently, the raw data from the instrument is presented in ZnP/Hgb. The instrument has been calibrated to take the raw reading and convert it electronically to units or equivalent up EPP/100mL of whole blood at a fixed hematocrit (42) to conform to the CDC definition of the Modified Piomelli Technique (see manufacturer's manual for more detail).

B. **Apparatus**

1. ZnP Manual 4000 Hematofluorometer.
2. 25 - μL micropipet, Eppendorf.
3. Oxygenation apparatus.
4. Glass cover slips.
5. Wood applicator sticks.

C. **Basic Operation**

1. Introduction

   a. Gloves, safety glasses, and lab coats are to be worn in the blood lead laboratory at all times.

   b. Power to the unit is on at all times.

   c. Handle the calibration slides by the edge only.

2. Calibration Procedure

   a. Checker slides and internal calibration

1. Pull the slide assembly forward to the stop position. Place a low-level (green) calibration slide into the assembly. Push the slide assembly until it engages the first detent position. The "wait" indicator light will immediately light for a period of approximately one second and then go out. The "advance slide" indicator light will light. Push the slide assembly into the second position and wait until the "advance slide" indicator light again lights. Now push the slide assembly into the third position; take the digital reading when the "read" light illuminates.

2. Record three digital readings for the green checker slide in the Hematofluorometer Daily QC notebook. The average of these three readings should be within the range given by the manufacturer. If the average value is out of range, refer to Section C.2.c. of this procedure to calibrate the instrument.

3. Record the values for the medium level (yellow) and high level (red) checker slides following the above procedure.

4. Record the values for internal calibration: with no slide in the assembly, advance to the detent position. The digital display is the value for the internal low calibration. Advance to the second position and record the internal high calibration value. Advance to the third position and record the dark current. If the internal calibration values differ greatly from the previously recorded values and the checker slides are out of range, refer to Section C.2.b. of this procedure.

b. Cleaning the internal slides.

Periodically it may be necessary to remove dust that has accumulated on the internal slides. If you feel this process must be completed, notify the laboratory supervisor at once. If she/he sees fit, **PROCEED WITH GREAT CARE**. The internal slides are extremely fragile. They cannot be repaired or replaced so don't break them!

Remove the black cover on the right side panel of the hematofluorometer. Loosen the small screw within and pull out the slide assembly. You will notice that the top side of the assembly is very dusty. That is not our concern. On the underside, you will see portion of the internal slides that is exposed to the radiation. If there is dust on this portion, remove it in the following manner.

Moisten a cotton swab with methanol and **VERY CAREFULLY** attempt to remove the dust particles. Allow the slides to dry completely.

Replace the slide assembly and tighten the screw to the desired tension.

With no slide in the assembly, advance to the first, second, and third positions

and make note of the digital readings at each position. If the problem seems to have been rectified, analyze the checker slides and continue. Record in the QC notebook that this section was taken.

If the problem persists, notify the lab supervisor and if necessary, notify the ESA, Inc., Service Department.

c. Recalibration

If the internal calibration values are acceptable but one or more of the checker slides is out of range, complete the following. Record in the QC notebook that recalibration was done.

Zero Offset Calibration

If the low level check slide is out of range, place the slide in the assembly and advance to the third position. Depress the "Push to Cal" button on the front panel and hold while adjusting the "Zero Control" located on the rear panel until the desired reading is obtained. Check the low value calibration two or three times.

Slope Correction (High Value Calibration)

Place the high level (red) calibration slide into the assembly. Advance the slide to its third position. If calibration is necessary, depress the "Push to Cal" button and hold while adjusting the "Cal" control on the front panel.

Recheck the zero and high calibration points. Repeat calibration procedure if necessary. When the green and red slides are within range, the yellow slide must be within range since the calibration curve is linear. If it is not, notify the lab supervisor.

3. Sampling Procedure

a. Rock venous samples on an aliquot mixer for one hour to insure they are completely mixed and have reached room temperature.

NOTE: Protoporphyrin is light sensitive. Protect samples from excessive light exposure.

b. Turn on oxygen by turning the small black knob on the tank gauge. Turn until the water tap bubbles gently.

c. Place 25 μL of whole blood on a 25 X 25 mm coverslip. Spread blood to completely cover a 3/8 inch diameter spot on the center of the slide using the pipet tip or a wood applicator stick.

NOTE: Use a new pipet tip for each specimen.

d. Ensure that no clots, air bubbles, or other debris are located on the cover slip.

e. Place coverslip in oxygenation chamber for at least one minute.

f. Place the coverslip on the slide assembly and advance to the third position. The EP value expressed in μg EP/100mL will appear on the digital readout.

   Continue to take readings until the value has stabilized. (The blood may continue to oxygenate causing the value to drop. The value will stabilize when the blood is completely oxygenated.)

g. Record the last three readings taken on the green worksheet.

   The digital readout represents EP or FEP. To convert EP to ZPP, multiply the EP value by 1.1.

h. NOTE:

   1. Lysed blood will give questionable data.

   2. Elevated bilirubin concentration will give increased EP.

   3. Previously frozen samples will give questionable data due to lysed red blood cells. The same may happen with blood over two weeks old.

4. <u>Quality Control</u>

   a. Analyze a high, medium, and low control daily and record the values in the Hematofluorometer Daily QC notebook.

   b. These controls are taken from client samples, selected by the lab supervisor.

   c. If the QC values differ by more than 15 μg/100mL from the previous value, see the lab supervisor.

5. <u>Maintenance</u>

The hematofluorometer must be calibrated by the manufacturer (ESA, Inc.) once a year. At that time, values will be assigned to the checker slides.

Updated 2/90

LEAD FREE KIDS STUDY

PROTOCOL FOR HAND LEAD DETERMINATIONS (HAND WIPES)

Testing of hand lead will be conducted each time a blood sample is taken for lead analysis. There will be a total of three hand lead determinations: the first baseline test will be done before any abatement activities occur, and the second and third follow-up tests will occur 4-6 months and 9-12 after abatement activities are completed.

Since studies indicate that hand dust reaches equilibrium within two hours after washing, case managers will make every effort to conduct the hand lead testing more than two hours after the last hand washing reported by the parent or guardian.

Case managers will wear disposable gloves when obtaining a hand wipe. Lead in dust on children's hands will be sampled by wiping each hand of the child with three separate commercial wet-wipes. The Walgreen's brand wet-wipes will be used for the LFK study. All surfaces of the hands, front and back up to the wrists will be wiped thoroughly with each of the three wet-wipes. All six wet wipes will be placed inside the container provided by the analytic laboratory. The container will be labeled with the child's name and LFK number.

Each case manager team will also prepare hand wipe blanks at regular intervals during the sampling period (i.e. every tenth child). The hand wipe blank will be prepared by removing six wipes from the wet-wipe container and handling them in such a manner as to simulate wiping the child's hands. These wipes will be placed into a container labeled "BLANK", dated and submitted to the laboratory along with the regular samples. Blind external quality control samples prepared by the EPA with dummy (seemingly correct) identifiers will also be submitted to the lab.

Chain of custody forms will be initiated when hand wipe samples are taken. All samples will be transported to Dennison Laboratories of Woburn, Massachusetts by the Lead Free Kids Study driver.

The six wipes will be composited for chemical analysis. The method of extraction of the lead from the wet wipes is currently being determined. The total quantity of lead found will be reported as ug/pair of hands.

LABORATORY ANALYSIS OF HANDWIPES

Report of Analysis
Method

1 M Nitric Acid Extraction

1. Place each sample in a labeled, acid-washed 800 ml beaker.
2. To each sample, add 100 ml of 1 M nitric acid prepared with deionized water.
3. Swirl each sample for 10 seconds.
4. Cover each sample with a watchglass and allow it to extract at room temperature for 2 hours.
5. Decant the acid solution from the handwipes into a labeled, acid-washed 250 ml beaker.
6. Add 50 ml of 1 M nitric acid to the handwipes in the 800 ml beaker.
7. Swirl the sample for 10 seconds.
8. Decant the acid solution into the same 250 ml beaker to composite the acid rinse.
9. Repeat steps 6, 7, and 8 a second time for a total acid solution of about 200 ml.
10. Cover the samples with a watchglass which is elevated above the beaker rim with glass hooks. (The watchglass must be elevated to prevent "bumping" of the sample during evaporation).
11. Place the samples on the hotplate at about 250°C.
12. Evaporate the samples to dryness.
13. Add about 3-5 ml of 1 M nitric acid to each sample, rinsing the watchglass and the sides of the beaker.
14. Heat the samples gently on a hotplate at 120-150°C to redissolve lead.
15. a. Filter the samples using Whatman, rinsing the beaker/filter paper/funnel with IM HNO_3.
    b. Evaporate to about 5 mL on a hotplate.
16. Transfer to an acid-washed 10 mL graduated volumetric flask, rinsing and diluting with IM HNO_3.
17. Shake sample well and transfer to borosilicate test tube and cover.
18. Measure lead concentrations using a Varian 1475 Atomic Absorption Spectrometer. Report results in total μg/sample.

LEAD FREE KIDS STUDY

PROTOCOL FOR MEASURING THE LFK CHILD'S HEIGHT

The LFK child should be in his/her stocking feet when you measure his/her height. First, find an open wall in a room that has no carpeting or thin pile carpeting (the kitchen may be best). Place the yardstick up against the wall with the centimeter side facing you. Make sure that the bottom of the yardstick is resting squarely on the floor and that numbers on the yardstick are increasing as you look up from the floor. Have the child stand straight (no slouching!) up against the yardstick and measure his/her height to the nearest one-half centimeter (i.e. 40.0, 40.5, 41.0, 41.5). This means that you should round up to the nearest one-half centimeter if the height is in between half-centimeters. Thus, 40.25 should be rounded to 40.5 and 40.75 should be rounded to 41.0. The height measurement should be taken right at the top of his/her head (big hairdos should not be counted!!). A small ruler held across the top of the child's head may help you read the correct number on the yardstick. If the child is taller than the yardstick, mark his/her height on the wall with a light pencil and measure the distance from the floor to the mark with the yardstick. Record the height IN CENTIMETERS on the form provided.

LEAD FREE KIDS STUDY

PROTOCOL FOR MEASURING LFK CHILD'S WEIGHT USING THE SECA INTEGRA SCALE

SETTING UP THE SCALE

The scale is already assembled for use with the digital indicator head fitted at the back of the platform and the connecting cable stored in the compartment underneath the head.

INSTALLING THE BATTERY

The seca integra operates with a standard 9-V alkaline battery. Remove the digital display head from the bracket or base in order to open the battery compartment underneath. Connect the battery terminals, then insert the battery and close the cover. Replace the head on the bracket or base.

HOW TO WEIGHT CORRECTLY

Selected lbs. or kg measurement using the switch on the underside of the digital display.

- Switch on the scale by pressing the ON button.
- Weight yourself when display switches to 0.0
- Your weight is indicated after a short time (approximately 4 seconds).

The scale switches off automatically after 30 seconds.

How to use the seca integra when you wish to weight a small child for instance who cannot stand alone on the scale:

- First, weigh yourself as described above.
- Remain standing on the scale and press the ON button once again. 000.0 lb (or tArE kg) appears on the digital display.
- Wait until the display switches to 0.0 and then take the child in your arms.
- After a few seconds, the child's weight appears in the display.

StOP lbs (or SUP kg) signals that the scale has been overloaded.

WHAT TO DO IF....

...No weight display appears under load?
- Remove load from scale

... -appears?
- Press the ON button

.Err appears?
- Remove load from scale, press ON and wait for 0.0

. bAt appears?
- Change battery.

LEAD FREE KIDS STUDY

SUPERFUND SOIL LEAD ABATEMENT DEMONSTRATION PROJECT PROTOCOL FOR SOIL SAMPLING AND ANALYSIS

1. SOIL SAMPLING

1.1. SITE DESCRIPTION

1.1.1. General Site Description

For each location, a detailed drawing should be made that shows the boundary of the lot, the position of the main building and any other buildings such as storage sheds or garages, the position of the sidewalks, driveways, and other paved areas, the position of the play areas if obvious, and the position of the areas with exposed soil (grassy or bare) (See attachment A). Show down spouts and general drainage patterns. Identify each soil subarea by letter or number. If a large soil area needs to be divided into smaller patches for sampling convenience, show how this division was made.

In addition to the diagram, briefly describe the location, including the following information:

Type of building construction
Condition of main building
Condition of lot (debris, standing water, vegetation cover)
Nature of adjacent property
Presence and type of fence
Animals on property
Apparent use of yard (toys, sandbox, children present)
Underground utilities

1.1.2. Subarea Description

For each soil subarea identified on the general diagram, draw a full page diagram showing the approximate dimensions and position relative to the building foundation (see Attachment A). Indicate vegetation and bare soil areas, as well as obvious traffic patterns. Identify the category of landuse, such as roadside, property boundary, adjacent to foundation, play area. Select an appropriate sampling scheme and mark the sample locations on the diagram.

1.1.3. Sampling Schemes. The sample scheme selected for each subarea must adequately characterize the potential exposure of children to lead in the dust

from this soil. It must identify the areas of high lead concentrations, and the general distribution pattern of lead concentrations at the soil surface. For abatement purposes, the depth to which lead has penetrated the soil profile must be determined. Consequently, selected the most appropriate sampling scheme is the critical element in the site description. Several options are offered for the best judgement of the investigator.

Line Source Pattern. This pattern can be used whenever the source of the lead is thought to be linear, such as along a building foundation, a fencerow, a street, or beside a garage. Draw a line parallel to the source, such as the foundation of the main building, approximately 0.5 meters (20 inches) from the foundation. Repeat at the property boundary if the subplot is more than three meters wide (10 ft), and add a third parallel line between the first two if the subarea exceeds five meters (16 ft) in width. Divide each line into segments that do not exceed 7 meters (20ft) in length. Take one composite of 5-10 cores along each line segment. A subarea, for example, that is at the side of the main building and measures 12 X 7 meters would have three lines of two segments each. The lines would be parallel and approximately three meters apart. They would be 12 meters long and consist of two 6 meter segments each, making a total of six samples, each being a composite of at least five cores divided into a top 2 cm sample and a bottom 2 cm sample.

Targeted Pattern. This method is intended to be used in conjunction with the line source or grid patterns as a means of sampling obvious areas that would be missed by the regular patterns. In using the targeted pattern, the investigator should select those locations within the subarea that are likely to reflect potential exposure to lead in soil dust. These may be play areas, paths, drainage collection areas, or areas that are likely to contribute dust to other surfaces that children use. Determine the number of samples to be taken by identifying distinctive landuse characteristics (path, swingset, sandbox), and take a composite of 5-10 cores for each sample.

Small Area Pattern. When the subarea is less than two meters in each dimension, or when the accessible area of a larger plot is less than four square meters, a single composited sample may be taken if it appears that such a sample would adequately represent the subarea.

Grid Pattern. Establish a rectangular grid of intersecting lines 2-10 meters apart, and sample each rectangular area. For larger areas, randomly select the rectangles to be sampled. In each rectangular area, mark three lines parallel to the longest axis, and composite 5-10 cores along each line. Since the rectangle should not exceed four meters, there is no need to divide the line into segments. Therefore, each rectangle should have six samples of 5-10 composites each. Use this pattern when the subarea is generally uniform and there is no reason to suspect large variations in lead concentrations

When the sample sites have been located on the subarea diagram and the sample collection is ready to proceed, locate each sample with a flag and visually confirm an even and representative distribution of sample locations.

1.2. SAMPLE COLLECTION

The flags or other markers represent the center of the sample location for the targeted and small area patterns. For the line source and grid patterns, the flags indicate the sampling lines. Take at least five but not more than ten cores randomly selected from within the sampling area of the targeted and small area sampling patterns. For the line source sampling pattern, select a random location on each line and take subsamples within a 2' by 2' square area. Take these subsamples from the four corners and the middle of the square with the middle point being on the line. When the line exceeds 7 meters and is broken into segments, take a composited sample in the above manner on each segment. The cores make a composite identified as a single sample. A sample record sheet is used to record information about the composite.

The corer should be clean and free of lead contamination. Vegetation and debris can be removed at the point of insertion, but do not remove any soil or decayed litter. The corer should be driven into the ground to a depth of at least 10 cm, 15 cm if possible. If the 10 cm depth cannot reached, the corer should be extracted and cleaned, and another attempt made nearby. If the second attempt does not permit a 10 cm core, the sample should be taken as deep as possible, and the maximum depth of penetration noted on the sample record sheet. Every effort should be made to take all cores of a composited sample at the same depth.

The cores of each plot should be examined for debris, artifacts, and any other evidence of recent soil disturbance. These should be noted on the subarea description sheet, as should a brief description of the soil color and soil type.

For each sample location, the top 2 cm segment of each of the cores are composited into one sample, and the bottom 2 cm segment combined into a second. For the surface segment, debris and leafy vegetation should not be included with the sample. However, no soil or decomposed litter should be removed, as this is the most critical part of the soil sample and is likely to be the highest in lead concentration.

The soil core segments should be composited in sealable polyethylene containers suitable for prevention of contamination and loss of the sample. The sample identification number should be placed on the container and the sample record sheet. After each sample composite, the corer should be cleaned by reinsertion in the next sampling area. Store the composited soil sample at ambient temperature until returned to the lab.

A field blank should be taken for each sample crew day. This is normally done by taking a sample container with clean quartz sand into the field, opening it to expose the container for a period of time representing normal sample procedures, then returning the container to the lab in the same manner as other soil samples. The purpose of the field

blank is to detect accidental or incidental contamination during the sampling process.

1.3 SAMPLING HANDLING AND STORAGE

The sample containers should be sealed to prevent loss or contamination of the sample. Shipping containers should also be airtight. Storage should be in a cool, dry location.

1.4 RECORD-KEEPING AND SAMPLE CUSTODY

Soil sample records for each location consist of a location diagram and description, a plot diagram for each distinct soil plot, and sample record sheet for each sample in a plot. The sample record sheets should also contain space for chain-of-custody documentation (See Attachment B).

Samples should be sequentially numbered within each subarea. Each location diagram, subarea description, and sample record sheet should bear all sample numbers and the signature of the person responsible for verifying the quality of the information collected. This signature certifies that there has been no misuse of the sample protocol, no mistake in recording the information, and that the information is sufficient to clearly identify these samples for comparison with other types of samples taken at the same location, such as street dust, house dust, house paint, blood, and hand dust. These documents also establish the chain of custody required for the Quality Assurance Plan.

When the sample is delivered to the laboratory, custody is relinquished by the field investigator and received by the lab supervisor by signatures on the sample record form.

2. SAMPLE ANALYSIS

2.1 METHOD OF ANALYSIS

Three methods of analysis have been considered. They are Atomic Absorption Spectroscopy (AAS), Inductively Coupled Plasma Emission Spectroscopy (ICP), and X-Ray Fluorescence (XRF). The XRF method is the approved method for routine analyses, whereas the AAS method should be used for standardization.

2.1.1. Sample Definition. The representative urban soil sample is defined as the soil from 0-2 cm depth that passes a 250 µm stainless steel sieve. This fraction is comprised of small particles, and the concentration of lead believed to be closely related to that of particles on the hands of children. The fraction is also homogenous enough to allow reliable analysis by X-Ray fluorescence.

2.1.2 Sample Preparation. Sample preparation requires that the sample be air dried and separated by particle size before being digested by wet chemistry. Drying is done at room temperature overnight, or until the sample can be easily

disaggregated by hand or with a rolling pin. The full sample should be brought to complete disaggregation by passing through a 2 mm sieve, using the fingers or a stainless steel tool to crush the larger soil particles. Material larger than 2 mm should be discarded. Soil should not be milled to a fine powder with a mortar and pestle or any other grinding device.

The fraction that passes the 2 mm sieve is now called the total soil fraction. A portion of this sample is retained for possible reference analysis, but the larger fraction is passed through a #60 mesh sieve (250 µm), giving a fine soil fraction identified as the "Urban Soil Sample." The portion that does not pass the #60 mesh sieve should be discarded, as only the total soil fraction (<2 mm) and the fine soil fraction will be analyzed.

About 5-10% of the retained total soil samples should be analyzed. An aliquot is ground so that it all passes a #60 mesh (250 µm) sieve, mixed well and analyzed. Grinding is necessary to provide low/appropriate variance in XRF analysis.

During the processing of the sample, it should be remembered that small soil particles may individually be as high as 50,000 µg Pb/g, and paint fragments as high as 300,000 µg/g. Care should be taken to clean equipment between samples. The sieves may be cleaned by tapping on a hard surface to remove residual particles, or any other dry method. Wet washing is not recommended as this will interfere with the size calibration.

Care should also be taken to thoroughly homogenize the separated sample before removing the aliquot for analysis. Shaking will cause separation. Tumbling or stirring is recommended.

2.1.3. Atomic Absorption Spectroscopy (To be used for primary standards)

2.1.3.1. Wet Digestion. The extraction procedure used for solubilizing soil lead is critical to the interpretation of the results of the Superfund Soil Lead Abatement Demonstration Projects. Even in the absence of analytical errors, the data may not represent the same lead concentrations from sample to sample unless the correct extraction procedure is used. The method selected here does not represent the total extraction of lead, but the breakdown of the organic material and the leaching of lead from the inorganic soil fraction. The methods measure total non-matrix soil lead, because no other extractable fraction has been experimentally shown to measure bioavailable, or non-HF extractable, soil lead. Hot HNO_3 has been repeatedly shown to extract total non-matrix soil lead, or at least >95% of soil lead, compared to a total soil dissolution method (HF). The 1.0 N HNO_3 cold shake method has been shown to extract as much lead as the hot HNO_3 extract, except for unpolluted

soils where a higher fraction of the total soil lead is within the matrix of soil particles

The sample should be oven dried at 105°C for 24 hours or until a constant weight is achieved. The aliquot should be placed in a 150 ml beaker and covered with a watch glass. Class A borosilicate glassware and stainless steel tools should be used throughout the sample processing. Low density conventional polyethylene containers may be used to store the solution prior to analysis.

An aliquot of 1 g soil is normally considered representative of the whole sample if the soil is well mixed. Prior to removing the aliquot, the sample should be stirred with a spatula or rod. Shaking the container can cause the sample to separate by particle size.

2.1.3.1.1 Hot HNO_3 Extraction. Add 50 ml 7N HNO_3, cover and digest gently at 95°C for 2 hours, stirring occasionally. If excessive foaming occurs, remove from the heat periodically until foaming subsides. Maintain at least 25 ml in the beaker by adding 7N HNO_3 as necessary.

Cool and dilute with 10 ml 1N HNO_3. Filter through Whatman No. 42 filter paper into a volumetric flask. Rinse filter and labware with 1N HNO_3, and dilute to volume.

2.1.3.1.2 Cold HNO_3 Extraction. Weight the 1 g aliquot into a 4 oz. urinalysis cup. Add 50 mL 1.0 N HNO_3 to each cup. Screw the lid on tightly and place on a reciprocal shaker. Adjust the speed of the shaker to maintain a suspension of the soil particles. Shake for one hour, then filter through a Whatman 111-V filter. Rinse with 1.0 N HNO_3. Dilute to standard volume.

2.1.3.2 Analysis. Analysis by flame AAS should be at 283.3 nm, with background correction. Working standards should be prepared fresh daily, in the range of 2-50 µg/g, in a 1.0 N HNO_3 matrix.

2.1.4. XRF Analysis. Approximately 2 g of loose soil sample are poured into sample cups (Somar Labs, Inc., Cat No. 340), fitted with windows of 1/4 mil thick X-ray polypropylene film (Chemplex Industries, Inc., Cat No. 425). The sample cup should be at least half full. The sample cup is sealed with a sheet of microporous film (Spex Industries, Inc., Cat No. 352A) held in place by the snap-on sample cup cap. The exact weight of the sample is not important, but should be in the range of 2-6 g.

The instrument configuration for the Kevex Delta Analyst Energy Dispersive

X-ray Spectrometer is:

1. Kevex Analyst 770 Excitation/Detection Subsystem:

   a. X-ray tube: Kevex high output rhodium anode
   b. Power supply: Kevex 60 kV, 3.3 mA.
   c. Detector/cryostat: Kevex Quantum - UTW lithium, drifted silicon. 165 eV FWHM resolution at 5.9 KeV.

2. Kevex Delta Analyzer:

   a. Computer mainframe: Digital Equipment Corporation, PDP 11/73
   b. Computer software: Kevex XRF Toolbox II, Version 4.14
   c. Disk drives: Iomega Bernoullik box, dual drives, 10 MB
   d. Pulse processor: Kevex 4460
   e. Energy to digital converter: Kevex 5230

3. Operating Conditions:

   a. Excitation mode: Mo secondary target with 4 mil thick Mo filter.
   b. Excitation conditions: 30 kV, 1.60 mA
   c. Acquisition time: 300 livetime seconds
   d. Shaping time constant: 7.5 microseconds
   e. Sample chamber atmosphere: air
   f. Detector collimator: Ta

4. Analytical Conditions:

   a. Escape peaks, but not background be removed from all spectra.
   b. The intensity ratio, defined as the integral of counts in the Pb (LA) window divided by the integral of the counts in the Mo (KA) Comptom scatter window, should be determined for each spectrum
   c. The intensity ratios for the standards should be used to determine a linear least squares calibration curve.

   The acquisition time (3c) may be reduced at the discretion of the lab supervisor.

2.1.5. QA/QC. By blind insertion into the sample stream (where possible), the QA/QC officer will provide the following blanks at the indicated frequency. At the discretion of the project director, the field team will collect one blank per day by carrying a sample of clean quartz sand into the field in a normal sample container. The sample container will be opened and exposed during the collection of one sample, then closed and returned to the lab. The field blank can be split into two aliquots. One aliquot, the field blank, can be analyzed directly with no further treatment. The second aliquot (the sample blank) can

be analyzed after it has passed through the sample stream (except sieving). The field blank represents contamination added in the field, the sample blank represents contamination added in the field and during storage and sample preparation

A project standard soil sample will be prepared and distributed at the beginning of the study. This will be used as a lab control. For XRF analysis, there is no need for a reagent blank.

Field blank	1/field sampling day
Sample blank	1/field sampling day
Lab control	1/20 samples
Reagent blank	3/reagent batch

Additionally, split sample (duplicate) analyses and spiked samples will be determined as follows:

Split soil	1/20 samples
Spiked soil	1/20 samples

The spiked soil samples will be prepared by mixing dried and sieved soil of known concentration with the sample. Spiked soil samples may be used at the discretion of the project director. Additional split soil samples will be sent to a designated QA/QC laboratory for analysis using the hot HNO_3 method, one for each 40 samples.

An interlaboratory comparison, similar to the soil pilot study, will be conducted during each six month period, with 10-20 samples from each laboratory, including the QA/QC lab. These samples will be dried, but not sieved.

LEAD FREE KIDS STUDY

Additional Soil Sampling Methods

Protocol for Preliminary Soil Sampling

The goal of the preliminary sampling is to determine whether the soil surrounding the premise of a potential participant contains high levels of lead. For a premise to be eligible, two or more samples must contain at least 1500 parts per million, or the mean of all the samples must be 1500 parts per million or greater.

A total of up to five samples will be taken, which in most cases represents the four sides of the house and a separate play area if one exists. To start, draw a rough sketch of the house and surrounding property. Indicate areas that are paved and those with soil or grass. Label the sides of the house F, L, R, and B, for front, left, right, and back, respectively. Right and left are always from the perspective of standing on the sidewalk looking at the front of the house. Take one sample from each side of the house where there is soil. If there is an area of soil that is not directly adjacent to the house, but appears to be a potential play area, a sample should be taken there as well. Areas of soil that are on the same side of a house but are separated by a porch or stairs may be sampled separately, or combined as one sample.

Sampling Instructions:

Materials needed:

Trowel
paper towels
plastic bucket
zip-lock sandwich bags
marker
labels for bag
Chain-of-custody forms

To get a representative sample, you will use a technique called "composite sampling". This involves taking several sub-samples in an area and then mixing them together to make one composite sample.

For areas adjacent to the house, take five sub-samples along a line parallel to the house, at a distance of one meter from the foundation. The subsamples should be fairly evenly spaced along the foundation for the length of that side, or as much of that side as is not paved. Each subsample should consist of scoop of soil 5 cm in diameter and 2 cm deep. Mix the five sub-samples together in the bucket to make the composite sample from that side of the house. Put the composite sample in a zip-lock bag and place the identifying label on the bag. Fill out the label, giving premise address, premise ID, and sample letter. The sample identification number will consist of the premise number, followed by the letter corresponding to the side of the house. If more than one sample is taken on a side, then follow the letter with a number, for

example, F1, F2, etc. Indicate all sample locations on sketch.

For play areas that are not adjacent to the house, follow the composite sampling guidelines, treating the area as a rectangle or a square. Take sub-samples from the four corners and the middle of this area. Label samples from such play areas "P".

For each sample, initiate a chain-of-custody form. Between samples, wipe the trowel and bucket with paper towels to remove any residual soil.

LEAD FREE KIDS STUDY

Additional Sampling Methods

Protocol for Soil Recontamination Sampling

For each property that was in the project after the baseline blood sample, soil samples need to be taken to check for changes in soil lead. Some of the properties have been abated, and others have not. You will get a sampling pattern for each property. Recontamination samples will be taken at every other location where a detailed sample was taken before. In other words, you will take half the number of samples. The locations which need to be sampled will be highlighted on the map. Locations which are not highlighted can be ignored.

At each location on the map, there will be a number and a little box like this □ . Sometimes the box will be on a line, like this □ . The box is where the sample should be taken. It represents an area of about two square feet. At each location, get as close as you can to where the box appears on the map, and take five surface scoops of soil in an area of about two square feet. Mix these samples in the plastic container and put about a 1/2 cup of the mixed soil in the sample bag.

The sample bags can be written on using an indelible marker. Put the address, premid, and sample number on each bag. You can do these in advance to save time in the field. Please use a separate paper bag and chain-of-custody form for each property. If you are unable to take a sample or if there is some other problem with a property, please write a note separate from the chain-of-custody form and put it in the paper bag with the samples.

Samples should be numbered using the number on the sample plan, with the addition of the letters "RE". For example, RE2, RE4, RE6, etc.

Revised 2/90

LEAD FREE KIDS STUDY

HOUSEHOLD DUST SAMPLING PROTOCOL*

For this study, the household dust samples are defined as the samples that are most likely to come into contact with a child's hands during indoor activity. This would include dust on upfacing surfaces accessible to the child such as bare floors, carpets, window sills and wells, furniture, as well as dust on toys and other objects likely to be handled by children.

Dust sampling has two components that are important to interpreting lead exposure: the concentration of lead in the dust and the amount of dust or loading on the surface. The concentration of lead in dust appears to be closely related to the amount of lead on children's hands whereas the amount of dust on surfaces is an indicator of the importance of this route of human exposure.

Dust Collection and Sample Handling

There is no standard procedure for collecting dust samples. The following protocol was decided upon after reviewing other available methods (such as the personal air pump) and finding them inadequate. The dust sampling method chosen was the Sirchee-Spittler modified dust buster. We believe that it is the best method for collecting numerous household dust samples within a reasonable amount of sampling time. Other necessary equipment to conduct the sampling are a ruler to measure the sampling area, a 25" by 25" template for designating the floor sampling area, paper envelopes to which the dust samples will be transferred, tape to seal the envelopes, and a cylinder of compressed air for cleaning the sample collection screen.

Before collection, make certain that the Sirchee-Spittler modified dust buster is fully charged. You can tell this by running the dust buster for a few seconds and listening for a high pitched sound from the motor. Another way to monitor the charge in the dust buster is to keep track of the number of samples taken on a change. A maximum of 18 samples (roughly three households) should be taken on one charge. Also, when starting a sampling round in a household make sure that the sample collection screen is clean. Use the compressed air cylinder to blow the screen clean.

Seven dust samples should be taken in each LFK household from each of the following locations: entry floor (i.e. right inside the front door of the house or apartment), LFK child's bedroom window well and floor, kitchen window well and floor, and living room window well and floor. You may choose which window to sample in a room. The floor samples should be taken roughly from the center of the room. Sometimes it will not be possible to get all six samples in a household because of windows that are nailed shut, obstructed by air conditioners, etc. In these instances, obtain as many samples as possible from the designated locations.

Once the individual sampling locations are decided upon, the size of the sampling area must be measured. For the window wells, measure the sampling area with a ruler. For the floors, set down the 25" x 25" template. If the floor is very clean, it may be necessary to vacuum a surface area larger than 25" x 25". In these cases, vacuum an area whose size is double or triple the template area. Be sure to obtain an amount of dust that is adequate for analysis (at least 5 mg).

The sampling sequence should be as follows: Collect the bedroom, kitchen and living room floor samples first. Then, collect the floor sample from the entry way. Finally, collect the window well samples.

To collect a dust sample, switch on the dust buster and vacuum the designated area with back and forth strokes about 1-2 inches in width. The vacuum is most efficient if the head is held parallel to the ground and titled about 5 degrees in the direction of the motion. When the surface has been vacuumed, keep your finger on the switch while raising the vacuum to an upright position. The constant air flow will prevent loss of dust from the filter before it is in an upright position. Switch off the power and carefully remove the vacuum head without tilting it significantly. Reach in and remove the filter screen with a gentle clockwise motion.

Transfer the dust sample to the paper envelope in the following way. Empty the contents of the filter screen into the paper envelope. Tap the envelope to cause the sample to collect in one end. Next, tap the filter ring several times into the open envelope on a hard surface.

Tap the dust to the bottom of the envelope and then seal the envelope and fold over 1/2 inch of the top of the envelope and crease carefully. Tape the folded part of the envelope down with at least a 10 inch long piece of Scotch tape. Each envelope should be labelled with the following information: LFK child's name, LFK number, sample location (i.e. bedroom window well) and size of sample area. It would be best if these envelopes and labels were prepared beforehand. Remember to handle the dust containing envelopes carefully; keep them upright in an envelope box. We want to avoid any loss of dust from the envelopes.

Replace the filter screen with a counterclockwise motion, attach the vacuum head and collect the other samples in the household using the same method. When you are finished sampling a household, clean out the filter screen and the vacuum head with a blast of compressed air.

* Parts of this protocol were adapted from Dr. Tom Spittler's 12/88 protocol "Instructions for Operation and Maintenance of Sirchee-Spittler Hand-Held Dust Vacuum Units".

Updated 1/90

LEAD FREE KIDS STUDY

WATER SAMPLING PROTOCOL

We wish to obtain a tap water sample that will be predictive of the child's blood lead level. Since a standing water sample (i.e. water that has been standing in the pipes for at least 8 hours) is thought to be most predictive, it will be necessary for the parent or guardian to take the water sample. The case managers should give the following instructions to this individual:

> The tap water sample should be taken from the cold water faucet of the kitchen. It should be a first flush sample of water that has been standing in the pipes from 8 to 18 hours. We foresee two main options for the time a sample is taken: (1) it can be taken first thing in the morning, or (2) if all of the residents of the household have been out of the house for the entire day it can be taken at the end of the day (i.e. dinner time).
>
> We will provide a labelled plastic bottle for the sample. The bottle should be completely filled with the water. The bottle contains a small amount of acid preservative and so you should store it unopened in a safe place until you take the sample. We will return to pick up the sample at a convenient time.

Before dropping off a water collection bottle case managers will fill out and affix the label provided by the laboratory. The chain of custody form will be initiated when case managers pick up the water sample. The water samples will be shipped to the Hall-Kimbrell laboratory in Lawrence Kansas by U.S. Postal Service.

LEAD FREE KIDS STUDY

WATER ANALYSIS PROTOCOL

A. **Reference:** Method 239.2 (Atomic Absorption, furnace technique) EPA - 600/4-79-020

Optimum Concentration Range: 5-100 μg/L

Detection Limit: 1 μg/L

B. **Application:**

Tests for lead are carried out using the graphite furnace atomic absorption technique as described herein. Samples, blanks, quality control, replicate, and spike test solutions are prepared as described and placed in trays for automatic sampling. This instrument setup and analysis steps are performed using the parameters defined.

C. **Preparation of Standard Solution:**

1. Stock lead solution: Commercially available containing 1000 mg/L (1000 ppm) of lead.

2. Matrix modifier - ammonium monobasic phosphate + magnesium nitrate solution: Transfer 4 grams of $NH_4H_2PO_4$ monobasic Ultrex reagent and 0.2 grams of Mg $(NO^3)^2$, Suparapure, to a 100-mL volumetric flask and makeup to mark with deionized distilled water (DW) containing 0.5% (v.v) HNO_3.

3. Working lead solution: Dilute the stock solution to the ratios needed as calibration standards at the time of analysis. The calibration standards and reagent blank must be prepared with the same acid, i.e., 0.5% (v/v) HNO_3. The reagent blank used in all subsequent dilutions is prepared by diluting 5 mL conc. HNO^3 to 1 L with DW. A 1-ppm solution is prepared by dilution of the 1000-ppm stock solution with reagent blank. This 1-ppm solution is used to obtain calibration standards of 0, 5, 10, 25, 50, and 100 ppb lead. To obtain the calibration standards, withdraw appropriate aliquots of the 1 ppm solution and dilute to 100 mL with reagent blank.

D. **Sample Preparation**

All samples solutions for analysis are acidified in the field and contain 0.5% (v/v) conc. HNO_3.

E. Instrument Parameters for Lead Analysis

1.	Drying Time and Temp:	40 sec. - 120 degrees C
2.	Charring Time and Temp:	40 sec. - 1000 degrees C
3.	Atomizing Time and Temp:	5 sec. - 1800 degrees C
4.	Cleaning Time and Temp:	5 sec. - 2600 degrees C
5.	Cooling Time and Temp:	20 sec. - 25 degrees C
6.	Purge Gas Atmosphere:	Argon
7.	Wavelength:	283.3 nm
8.	Slit:	0.7 nm
9.	Tub/site:	Pyro coated tube with L'vov platform
10.	Matrix Modifier Setting:	5 μL
11.	Sample and Standard Quality Setting:	20 μL
12.	Max power:	30
13.	Background correction mode:	On
14.	Lamp:	Electrodeless discharge lamp (EDL)

Note: Parameters 1, 2, 4, and 5 use 1 second ramp time. Parameter 3 uses 0 second ramp time and gas stop flow.

F. INSTRUMENT USED

Perkin-Elmer Zeeman model 5100 atomic absorption spectrophotometer equipped with a model AS-60 autosampler and an HGA model 600 graphite analyzer

G. LABORATORY USED

Hall-Kimbrell Laboratory, Kansas City, Kansas

Drafted June 1990
Revised August 1990

LEAD FREE KIDS STUDY

LEAD PAINT AND SITE INSPECTION PROTOCOL

LFK participants' homes will be inspected to provide information on the extent of leaded paint to deleading contractors and the project epidemiologist. The contractors will be given this information so that they can make informed estimates on the cost of interior and exterior deleading. The project epidemiologist will use the measurements for scientific purposes to estimate the contribution of leaded paint to participant children's blood and hand lead levels.

The first part of this document describes how lead paint inspections will be conducted to gather information for the deleading contractors. The second part describes how this and additional information will be used for scientific purposes.

Lead Paint Inspection

Lead paint inspections will be performed according to current Massachusetts Department of Public Health requirements by registered inspectors. The following forms will be used to record the needed information on all properties:

1. Adapted Massachusetts lead paint inspection forms
2. LFK interior deleading information form
3. LFK exterior deleading information form

Instructions for filling out these forms are as follows:

Make sure the address of each property is recorded on each page of each form and that the participant child's room is designated on the appropriate form. Also record which machine (PGT or Microlead) was used to measure the amount of leaded paint. The sides of the house will be labelled as follows: A - front, B - left, C - rear, and D - right. Window and doors in each room will be numbered from left to right. Window measurements should be taken from the header to the sill and from casing to casing. A list of definitions and abbreviations that may be used on these forms is attached.

Lead Paint Measurements

Lead in paint will be measured using x-ray fluorescence (XRF). Two different brands of XRF machines will be used to measure lead in paint for the deleading contractors: Princeton Gamma-Tech (PGT) XK-3 and Microlead. The two different brands will be used because they are the only machines that are available to the study and both are needed to conduct the inspections in a timely fashion. Only PGT XK-3 measurements will be used for the scientific study data since the two machines are not sufficiently comparable for research purposes.

Differences between the machines are as follows: The possible measurements on the PGT range from 0 to 10 mg/cm^2 and those on the Microlead range from 0 to approximately 50 mg/cm^2. In general, the Microlead XRF reads leaded paint many more inches below the surface than the PGT does. When we tested the comparability of the two machines, we observed that repeated Microlead readings of the LFK conference room windowsill were 2.5, 2.2, 2.2 and 2.9 and repeated PGT readings of the same spot were 0.2, 0.7, 1.4, and 0.6. (Note: the first two readings were taken on one day and the second two readings were taken two days later).

XRF Machine Calibration

Both machines will be calibrated twice a day: once in the morning and again in the early afternoon. An XRF calibration form will be filled out each time a machine is calibrated (see attached). Calibration will involve making two sets of ten readings. The first set of ten readings will be done using a zero standard and the other set will be done using known lead standards of various levels (i.e. 1.45, 3.5 mg/cm^2).

XRK Machine Use in the Field

XRF readings of lead paint concentrations are read directly from the digital read-out on the machine. If the reading is 2.0 mg/cm^2 or less, three readings will be taken and the average will be recorded on the lead paint inspection form. If the inspector believes that there is lead present on a surface despite a negative or very low XRF reading, sodium sulfide will be used to test for leaded paint. The results of both the XRF measurement and the sodium sulfide test will be recorded on the inspection form.

XRF measurements will be taken on painted and on (non-vinyl) wallpapered surfaces. The determination of what constitutes an appropriate surface will be made by the inspector. Measurements will be taken on the interior and exterior of the participant's dwelling. The interior is defined as the apartment or living quarters of the LFK participant. The exterior is defined as the common hallways, stairs, entrances, porches, accessible basements as well as the exterior walls of the building. The exterior may also include any other buildings (i.e. garages) and fences on the property. Interior measurements will be taken on walls and woodwork including baseboards, windowsill, etc. in each room of the participant's unit. Ceiling measurements will be taken only if the paint on the ceiling is peeling.

Additional Deleading Information and Instructions

Besides taking the lead paint readings, the inspectors will record other pertinent information/instructions for the deleading contractors. Examples of such instructions are:

1. In general, baseboards will be made intact and capped with quarter round moldings. When lead painted decorative moldings are present, record the width that will be needed for replacement.

2. When porch rails or other items require replacement, specify materials and workmanship common to the area. Also note that this will require further negotiation with the landlord.

3. Indicate whether the door and window trim are decorative or flat. Flat boards will be replaced with #2 pine. Decorative moldings will be dipped off-site.

4. Ceilings will be tested for lead only if they are peeling. If peeling ceilings are not accessible, note that they should be made intact on the comment sheet.

5. Lead painted basement windows wherever possible will be covered with plexiglass.

6. Measure rails and count ballisters on exterior porches.

7. Exterior window sills and wells will be covered with aluminum and caulked.

Lead Paint Measurements for Scientific Purposes

Since the Microlead and PGT XRF machines are not sufficiently comparable, only the PGT measurements taken by the lead paint inspectors will be used for the project's scientific data. Thus, only about 50% of the properties initially inspected will have measurements useful to test the study hypothesis. Once the lead paint inspectors finish gathering all the data needed for deleading, they will return to the properties where the Microlead was used to take the measurements and will re-take six measurements using the PGT XK-3.

The six measurements will re-taken in each of the following rooms since it is likely that the participant child spends most of his/her time there: the child's bedroom, the kitchen, and the living room. One measurement will be taken on the lower part of the wall and one on the window sill (i.e. woodwork) in each of these rooms. The calibration and

measurement procedures described previously will also be followed during this round of measurements. Special study data collection forms will be developed for recording these data. These same data will be abstracted from the inspection forms for the properties that were originally tested using the PGT.

Abbreviations and Definitions for Lead Paint Inspections

n/a = not accessible
cov = covered
rep = replace
y = yes
n = no
dip = off-site removal of lead from surface by an approved method
R & R = remove and replace (unless otherwise noted, the replacement material will be #2 pine)
neg = negative
pos = positive
upper walls = walls above five feet
lower walls = walls below five feet
mit = make intact

porch = the area extending from the house, the wall the porch is attached to is the exterior of the house.

scrape = delead on-site

interior = the apartment or living quarters of only the LFK participant, excludes common areas within the building.

exterior = the common hallways, stairs, entrances and porches as well as the exterior walls of the building, and all other buildings and fences located on the property.

All other abbreviations are described on the individual forms.

LEAD FREE KIDS STUDY

INTERIOR DUST ABATEMENT

Description of abatement process

The purpose of the dust abatement is to significantly reduce the amount of lead-bearing dust in the treated homes. It follows the loose paint abatement in the Study Group and the Control Group A. The methods used are similar to those used during the loose paint abatement. The most important distinction is that no loose paint is removed during the dust abatement. This clean-up focuses on cleaning dust off surfaces where it accumulates.

The two primary activities involved in this process are vacuuming with a HEPA vacuum and wiping surfaces with either a wet cloth or an oil-treated rag(for furniture). The surfaces treated in this manner are floors, woodwork, walls, and furniture. For the dust abatement, the vacuuming on floors is timed. Carpets are vacuumed for 3 minutes per sqare yard. Wood and tiled floors are vacuumed for 2 minutes per square yard and washed with a TSP solution. Area rugs are vacuumed on each side, then rolled up so that the floor beneath can be vacuumed and washed.

Because the loose paint abatement and the dust abatement are so similar, checklists are used in both cases to document that all necessary steps are taken. In the dust abatement no tyvek suits and plastic dropcloths are required, but care is taken to do the rooms in such an order that no dust is tracked from an uncleaned area to a cleaned area.

Summary of dust abatement

1. Furniture is moved as needed to expose floor.

2. Top (horizontal) surfaces of woodwork(doorframes, windowsills, etc.) are HEPA vacuumed.

3. Walls and other vertical surfaces are HEPA vacuumed.

4. Vertical surfaces are wiped wiped with wet cloths(TSP solution). Cloths are used once and thrown away.

5. Horizontal surfaces are wiped with wet cloths.

6. Furniture is wiped with oil-treated cloths.

7. Area rugs are vacuumed on both sides and rolled up to expose floor.

8. Floors:

Wood, tile, or linoleum floors are vacuumed for 2 minutes per square yard, then washed with wet cloths.

Carpeted floors are vacuumed for 3 minutes per square yard.

9. Furniture is moved back to original positions. Tyvek foot coverings are used by anyone who needs to enter a cleaned area.

LEAD FREE KIDS STUDY

INTERIOR PAINT ABATEMENT

Description of abatement process

The purpose of the interior paint abatement is to safely remove any very loose, chipping paint from the inside of the home without generating dust, or leaving behind any small chips of paint. The techniques used for the interior paint abatement are simple in principle. Loose paint will be vacuumed using a HEPA vacuum. HEPA stands for "high efficiency particle accumulator". This vacuum is equipped with a special filter which catches dust that would pass through an ordinary vacuum. The peeling surfaces are then washed off using disposable cloths and a solution of Trisodium Phosphate (TSP) and water. TSP is a detergent which is good for picking up lead.

Obviously only very loose paint will come off during this process. This abatement is not "deleading". We are only trying to remove the paint most readily available to the children living in the house, and most likely to fall off and contribute to lead in the house dust.

Summary of loose paint abatement process

NOTE: This work is monitored by the case managers to ensure that no steps are skipped. All children are absent from the house during the abatement. All workers put on tyvek suits and overshoes before entering a work area and remove the tyvek overshoes before leaving the work area.

1. A case manager walks through premise with the contractor to identify areas to be washed. All window wells and trim are washed even if loose paint is not evident. In some cases, the window wells and trim are the only areas needing abatement. In others, walls and trim also need work. In general, we do not remove any ceiling paint, because ceiling paint rarely contains lead. A work plan for the premise is agreed upon, including the order in which the rooms will be worked on, what furniture will be moved, etc.. The entire floor of the apartment is HEPA vacuumed, and all toys are put in plastic trash bags.

2. Work proceeds room by room, starting from the far end of the unit and working back towards the entrance. In each room, furniture is moved away from windows, baseboards, or any other area of chipping paint. The floor around these areas is vacuumed to pick up paint that may already have fallen. Furniture and floors are then covered over with plastic sheets as needed to provide a work area within which paint can be contained. The plastic should be attached to walls or baseboards below any areas needing abatement, and should extend out into the room from the point of

attachment. In some cases the plastic may be put up under a window, run out to the middle of the room, and up over furniture or up a wall to form a basin.

3. Workers vacuum with a HEPA vacuum all areas of chipping paint. They do not use the vacuum to chip or scrape paint, simply to pick up whatever paint readily comes off. They then wash down chipping surfaces with disposable cloths soaked with a solution of water and sodium sulfide. The cloth may be folded over carefully for a second pass over one area, but the last time a surface is cleaned a new cloth should be used. Cloths will be thrown away after each use to prevent spreading dust and chips.

4. When all the surfaces to be cleaned in a room are finished, all plastic dropcloths are wiped off. The cleaned surfaces and the plastic are then cleaned with a HEPA vacuum. Window wells are painted with primer paint to "lock down" any remaining paint and dust.

5. All equipment is decontaminated by washing. The plastic is taken up. The workers start at the edges, and carefully roll the plastic inward towards them from all sides, until they stand in the center of a ring of rolled-up plastic. They step off the plastic, leaving behind the tyvek overshoes. The plastic can then be placed in a trash bag. The floor will be HEPA vacuumed to catch any residual dust. Any furniture that the contractors had to move will be moved back into place.

6. All rooms are treated in this manner. For Control Group B this concludes the abatement process for the fall of 1989. The Study Group and Control Group A have dust abatement immediately following the loose paint abatement.

LEAD FREE KIDS STUDY

Interior Paint and Dust Abatement
Site Documentation Form

Address_____-

Premise ID _____

Date_____

Monitor(s)_____

Please check appropriate circle to indicate that each step has been completed.

Part A:	Completed
1. Walkthrough with contractor to assess work to be done	[ ]
2. HEPA vacuum entire floor of residence	[ ]
3. All toys sealed in plastic bags	[ ]

Part B.

Note: In all activities of washing or wiping surfaces with cloths, the cloth should never be put into the wash water after use. All cloths are to be disposed of in a plastic bag immediately after use. A bag should be placed close to the work area to avoid unnecessarily tracking dust from immediate area.

Comments and Notes on Interior Paint abatement. Please note any unusual circumstances or conditions in this house:

On the next page, fill in one of the following room codes at the top of each column.
K = Kitchen P = Pantry LR = Living Room DR = Dining Room BR = Bedroom (BR2 = 2nd Bedroom, etc.) BT = Bathroom

O = Other (specify below)

O_____

O2_____

O3_____

Check steps when completed

Room Codes	___	___	___	___	___	___
1. Shades\curtains removed	[]	[]	[]	[]	[]	[]
2. Furniture moved away from loose paint paint abatement areas	[]	[]	[]	[]	[]	[]
3. Polyethylene in place for loose paint abatement	[]	[]	[]	[]	[]	[]
4. Workers wearing Tyvek suits, respirators and foot covering	[]	[]	[]	[]	[]	[]
5. Procedure observed for leaving or entering work area	[]	[]	[]	[]	[]	[]
6. Initial vacuuming of areas of loose paint	[]	[]	[]	[]	[]	[]
7. Washing of loose paint areas with TSP and water solution	[]	[]	[]	[]	[]	[]
8. Final HEPA vacuuming of loose paint areas	[]	[]	[]	[]	[]	[]
9. Wipedown of polyethylene sheets to collect any paint and dust	[]	[]	[]	[]	[]	[]
10. Workers removed foot coverings, and head covering, etc. when leaving work area	[]	[]	[]	[]	[]	[]
11. Floor coverings rolled up and removed in such a way that no paint could fall outside plastic	[]	[]	[]	[]	[]	[]
12. Floor area under poly vacuumed	[]	[]	[]	[]	[]	[]
13. Window wells painted with primer paint	[]	[]	[]	[]	[]	[]
14. Return furniture and other articles to original position	[]	[]	[]	[]	[]	[]

OR

15. Proceed to Dust Abatement(Part C.) [ ]

Part C. Interior Dust Abatement Checklist

Note: If it is not possible to move furniture to the next room before the dust abatement, the room may be cleaned one half at a time. The furniture can be moved to one half of the room while the other half is cleaned. If a piece of furniture can't be moved at all, every attempt should be made to vacuum and or wash as far under it as possible.

	Check steps when completed					
Room Codes	___	___	___	___	___	___
1. Move furniture as needed to clean floor	[]	[]	[]	[]	[]	[]
2. HEPA vacuum top surface of woodwork and other horizontal surfaces	[]	[]	[]	[]	[]	[]
3. HEPA vacuum walls and other vertical surfaces	[]	[]	[]	[]	[]	[]
4. Damp wipe horizontal surfaces (except floors)	[]	[]	[]	[]	[]	[]
5. Damp wipe vertical surfaces (trim, etc.)	[]	[]	[]	[]	[]	[]
6. Wipe furniture with oil-treated rags	[]	[]	[]	[]	[]	[]
7. HEPA vacuum area rugs on both sides (top and bottom)	[]	[]	[]	[]	[]	[]
8. Floors (see part D. also)						
A. Wall-to-wall carpets: HEPA vacuum (with beater bar) 3 minutes per square yard	[]	[]	[]	[]	[]	[]
B. Wood, tile, etc.						
1. Wash with clean rags using TSP solution	[]	[]	[]	[]	[]	[]
2. HEPA vacuum at a rate of 2 minutes per square yard (see schedule for each room part D)	[]	[]	[]	[]	[]	[]
C. Area Rugs HEPA vacuum on both sides, roll up rug, clean floor	[]	[]	[]	[]	[]	[]
9. Move articles back to original positions wearing foot covering	[]	[]	[]	[]	[]	[]

INTERIOR ABATEMENT DOCUMENTATION

PART D.

Room Code	Primary floor type Wood, carpet, linoleum, etc.	Area Rugs Check if Yes	HEPA vacuum time required Rugs sq. yds. X 3 Others sq. yd X 2	HEPA vacuum timed and completed

WESTON
MANAGERS DESIGNERS/CONSULTANTS
ESAT PROJECT
LANDMARK ONE
ONE VAN DE GRAAFF DRIVE
BURLINGTON, MA 01803
(617) 229-2050 • FAX: (617) 229-0046

May 29, 1991
K-1-05-11

Mr. Scott Clifford
ESAT Deputy Project Officer
Environmental Services Division
U.S. EPA Region I
60 Westview Street
Lexington, Massachusetts 02173

Re: TID No. 01-9104-50
Standard Operating Procedure
Columbia X-MET 820 XRF

Dear Mr. Clifford:

Environmental Services Assistance Team (ESAT) member Paul Killian has completed the Standard Operating Procedure (SOP) for the Columbia X-MET 820 x-ray fluorescence instrument. The task was requested by Beverly Fletcher and Scott Clifford, EPA Task Monitors, and authorized under Technical Instruction Document (TID) Number 01-9104-50.

Enclosed is the SOP. The ESAT demonstration on how to operate the instrument has been scheduled for June 7, 1991 at 10:00 am. Please contact Paul Killian at 617/229-2050 should you have any questions or comments.

Very truly yours,

ROY F. WESTON, INC.

Paul F. Killian

Paul F. Killian
Associate Project Scientist

John J. Hagopian

John J. Hagopian, P.G.
Team Manager
ESAT Region I

/pfk
Enclosures

cc: Beverly Fletcher

Environmental Services Assistance Team
EPA Region I

STANDARD OPERATIONS for the COLUMBIA X-MET 820 X-RAY FLUORESCENCE INSTRUMENT

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1.0 PURPOSE

To enable the operator to analyze soils samples for lead content using the Columbia X-MET 820 X-Ray Fluorescence Instrument.

2.0 SCOPE

This SOP will allow the operator to determine the concentration of lead in soil samples. This SOP covers the preparation of soil samples, operation of the Columbia X-MET 820 XRF instrument, and calculation of the results from the printed spectra. Modifications to this SOP can be made to determine lead content in other matrices as well as other elements in various matrices.

3.0 DEFINITIONS AND ACRONYMS

EPA	Environmental Protection Agency
ESAT	Environmental Services Assistance Team
LCS	Laboratory Control Sample
ppm	Parts Per Million
RTN	Hard Return on the Terminal
SOP	Standard Operating Procedures
SPL	Sample
X-MET	Columbia X-MET 820 X-Ray Fluorescence Instrument
XRF	Energy Dispersive X-ray Fluorescence

4.0 PRINCIPLES OF OPERATION

When an atom is bombarded with x-rays from a radioisotope x-ray source, it looses an electron from its inner shell. As a result, one of the atom's outer electrons is repositioned to the inner shell and emits energy. The energy emitted is at a specific Kiloelectron Volt (KeV) depending on which element and which outer electron was repositioned. The concentration of each element can be determined by examining the height of the peak at the specified KeV. This process is know as Energy Dispersive X-ray Fluorescence.

The advantage of the Energy Dispersive X-ray Fluorescence (XRF) technique is that the sample is not destroyed in the analysis. The sample remaining in a stable state, enables the analyst to reanalyze the sample at a later date, or digest and analyze the sample using other techniques such as inductively coupled plasma (ICP) or atomic absorption (AA) spectroscopy. Other advantages include the quick turnaround of sample results, and the ease of operating the instrument.

5.0 APPARATUS AND MATERIALS

5.1 SAMPLE PREPARATION

Sample cups, plastic, spectro-cup, Cat. No. 340, Somar Lab. Inc., New York or equivalent.

Mylar film, 6 micron

60 Mesh sieve

Sample weigh boats

Powder funnel

5.2 SAMPLE ANALYSIS

Columbia X-MET 820 X-Ray Fluorescence Instrument, with:
- Cm-244 source
- Texas Instrument 703 Data Terminal.

Printer paper - Thermal Fax Paper

6.0 PROCEDURES

6.1 SAMPLE PREPARATION

6.1.1 Sample Container Preparation

6.1.1.1 Invert cup and place a piece of 6 micron mylar film over the bottom aperture.

6.1.1.2 Snap a retaining o-ring over the film onto the base of the cup (o-ring teeth down).

6.1.1.3 Place cup upright and add enough soil to uniformly cover the mylar film bottom of the cup.

6.1.1.4 Snap cap into place on top of the cup.

6.1.1.5 Label the sample cup with the sequential laboratory Identification number and record that in the instrument logbook.

6.1.2 Sample Preparation

6.1.2.1 An aliquot of the soil, 2 to 3 table spoons (10 to 15 grams), is removed with a spoon or spatula and placed in a sample weigh boat.

6.1.2.2 The weigh boat is marked with the laboratory identification number and allowed to air dry under a hood overnight at ambient laboratory temperature.

6.1.2.3 The dried soil sample is manually shaken in a 60 mesh sieve until approximately 1 gram of fines have been collected. (Typically 10 to 15 seconds is adequate.)

6.1.2.4 The fines are then transferred to the analysis sample container using a glass powder funnel placed over the sample container. The cap is then placed on the sample container.

6.1.2.5 All excess soils from sample preparation are discarded in the waste barrel in the preparation hood.

6.1.2.6 The powder funnel, sieve, and spoon (or spatula) will be cleaned between samples to remove soil particles. The funnel and sieve will be blown free of dust with compressed air. The spoon will be wiped with disposal tissues.

6.2 SAMPLE ANALYSIS

6.2.1 Definition of Fields

6.2.1.1 >

This field details the type of sample analyzed. If the instrument is being recalibrated, STD (Standard) would be entered. Since the curves are prepared separately, no STD should be entered. The analyst should enter SPL, for sample. There is no default value for this field.

6.2.1.2 **LATEST?**

This field details which spectra to print. Since the spectra are not named, only the latest measurement may be recalled. Therefore, the field should be left blank and the hard return key pressed. The default for this field is the last sample.

6.2.1.3 **FIRST CHANNEL: 0 ?**

This field details which point the spectra is to start. The total spectra goes from Channel 0 to Channel 255. Since the Lead peak is located around Channel 166, the spectra should be viewed from Channel 140 to Channel 190. Therefore the proper input for this field is 140. The default for this field is 0.

6.2.1.4 **LAST CHANNEL: 255 ?**

This field details which point the spectra is to stop. The total spectra goes from Channel 0 to Channel 255. Since the Lead peak is located around Channel 166, the spectra should be viewed from Channel 140 to Channel 190. Therefore the proper input for this field is 190. The default for this field is 255.

NOTE: If you enter a Last Channel that is lower than the First Channel, the instrument will print out an error message and ask you to reenter the Last Channel value.

6.2.1.5 **WINDOW: 1 ?**

This field details how frequent the channels will be printed in the spectra. The choices are from 1 to 4. If 1 is chosen then every channel will be printed. If 4 is chosen then every fourth channel will be printed. The proper input for this field is 2. The default for this field is 1.

6.2.1.6 **RANGE,lower: 0 ?**

This field details the lower scale of the curve. Since the baseline of the peak is drawn from the two low points on either side of the peak, the graph does not need to extend below these two points. Therefore, the lower range is set at 250. The default for this field is 0.

NOTE: On occasions, one or both of the low points may fall below the 250 mark. When this occurs, the graph should be reprinted with the RANGE,lower set at 200. If the points still fall below 200, the sample is to be reported as non-detected.

6.2.1.7 **RANGE,upper: ### ?**

This field details the upper scale of the curve. Since the Lead peak is the highest point from Channel 140 to Channel 190, the curve does not have to extend any farther than just above the value of the peak. The value ### is the highest point on the graph from Channel 140 to Channel 190. Therefore, the upper range is set at the next higher multiple of 25. (i.e. if ### equals 459, then enter 475.) The default for this field is ###.

6.2.1.8 **40 CHARACTER PER LINE ?**

This field details the size of the print. When a larger Character Per Line is entered, the graph expands over more of the paper. Therefore, the Character Per Line is set at 80. The default for this field is 40.

6.2.2 <u>Instrument Operation</u>

6.2.2.1 Turn on the instrument by pressing the switch on the back left face of the instrument.

6.2.2.2 Turn on the printer by pressing the switch on the back right face of the printer.

6.2.2.3 Allow the instrument to warm up for 30 minutes.

6.2.2.4 Place the sample into the instrument by:
A. sliding the holder towards you;
B. opening the holder by lifting the top;
C. placing the sample into the open holder and closing the top;
D. sliding the holder back into place.

6.2.2.5 Type in sample identification (i.e. 300 STD)

6.2.2.6 Press the START 1 key on the instrument.

<u>Instrument will respond:</u>

DATE: dd,mm,yy TIME: hh-mm-ss
MEASURING:
MODEL 10 PROBE 1 50 SECONDS

After 50 seconds the analysis is complete, the instrument will signal by beeping. The instrument prints:

ASSAYS: PB ##.##
>

6.2.2.7 Type the following:

	Instrument response	Analyst Response	
a.	>	SPL	<RTN>
b.	LATEST?		<RTN>
c.	FIRST CHANNEL: 0 ?	140	<RTN>
d.	LAST CHANNEL: 255 ?	190	<RTN>
e.	WINDOW: 1 ?	2	<RTN>

f. RANGE,lower: 0 ? 250 <RTN>
g. RANGE,upper: ### ?. next higher multiple of 25 <RTN>
(i.e. if ### = 408 then enter 425)
h. 40 CHARACTERS PER LINE ? 80 <RTN>

The spectra for the sample is printed, and the instrument responds:

LATEST?

If all the points on the spectra fall above the baseline (250), proceed to step 6.2.2.8. Otherwise, reprint the spectra with the baseline (RANGE, lower) set at 200. This is done by repeating steps 6.2.2.7.b - 6.2.2.7.h, and entering 200 at step 6.2.2.7.f instead of 250. Regardless of whether or not the points still fall below the baseline (200), proceed to step 6.2.2.8.

6.2.2.8 Press the ESCAPE key twice.

6.2.2.9 Follow steps 6.2.2.4 through 6.2.2.7 for the remaining samples to be analyzed.

6.2.3 <u>LFK Order of analysis</u>

6.2.3.1 The following standards are run from low to high:

a.	blank		standard	(Empty sample cup)
b.	300	ppm	standard	(Laboratory # 5103)
c.	900	ppm	standard	(Laboratory # 5113)
d.	1600	ppm	standard	(Labeled as 1600 STD)
e.	6000	ppm	standard	(Laboratory # 4873)
f.	13000	ppm	standard	(Laboratory # 4903)
g.	Laboratory Control Sample (LCS)			(Labeled as 880 STD)

6.2.3.2 Ten laboratory samples are analyzed. (Both duplicates and replicates are considered laboratory samples.)

NOTE: Duplicates are prepared during sample preparation at a rate of one per twenty. Replicates are analyzed at a rate of one per twenty.

6.2.3.3 One of the standards (b - e) is analyzed.

6.2.3.4 Steps 6.3.2.2 and 6.3.2.3 are repeated until the analysis batch is complete, rotating the standards (b - e).

6.2.3.5 Once the analysis batch is complete, all standards are analyzed, including the LCS, as in step 2.2.1.

6.3 SAMPLE QUANTITATION

6.3.1 Determination of Peak Height

6.3.1.1 A straight line is drawn connecting the two low points on either side of the peak.

6.3.1.2 The peak height is then measured, in millimeters, from the straight line to the highest point on the peak.

6.3.1.3 The corresponding number of counts is then determined by:

$$\frac{(\text{RANGE, upper} - \text{RANGE, lower})}{132.5 \text{ mm (Length of full scale)}} \times \text{peak height (mm)} = \text{Counts}$$

6.3.2 Determination of Sample Concentration

6.3.2.1 The analysis results (counts and concentration) of all standards, except the LCS results, are tabulated.

6.3.2.2 Two standard curves are then created using linear regression. A low concentration curve consisting of the blank, 300, 900, 1600, and 6000 standards are used for all sample results less than 6000 ppm. The high concentration curve consisting of blank, 1600, 6000, and 13000 standards are used for all sample results greater than 6000 ppm. Both standard curves are plotted through the point zero, zero.

6.3.2.3 The slope of the appropriate curve is then multiplied by the sample's counts to determine the sample concentration.

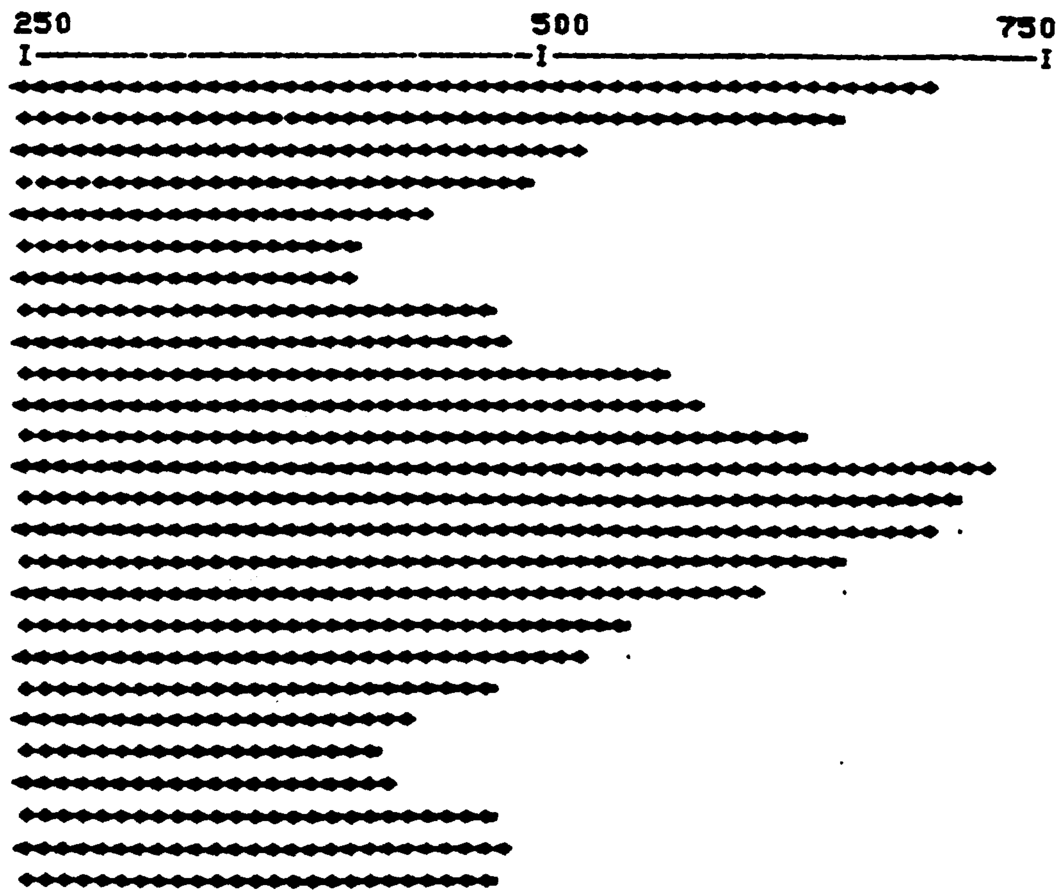
6.3.2.4 The LCS results are determined as in 6.3.2.3 (using the low standard curve). The results must fall within 20% of the true value (880 ppm).

7.0 ATTACHMENTS

Enclosed are two copies of the spectra of a Laboratory Control Sample analysis. The first is the copy is unmarked. The second copy details steps from the SOP for printing the spectra and calculating the peak height in counts.

```
WHAT?

> LCS
DATE: 14.05.91  TIME: 13-21-47
MEASURING:
MODEL 10 PROBE 1 50 SECONDS
ASSAYS:PB 85.97

> SPL
LATEST?
FIRST CHANNEL: 0 ? 140
LAST CHANNEL: 255 ? 190
WINDOW: 1 ? 2
RANGE.lower: 0 ? 250
RANGE.upper: 725 ? 750
40 character per line ?80
◆◆◆◆ LATEST SPECTRUM   MEAS.TIME: 50  DATE: 14.05.91   13-23-25
```

CHANNEL	COUNTS
140	692
142	647
144	531
146	502
148	453
150	421
152	416
154	478
156	491
158	565
160	586
162	629
164	725
166	703
168	690
170	650
172	615
174	546
176	527
178	478
180	449
182	423
184	431
186	478
188	490
190	485



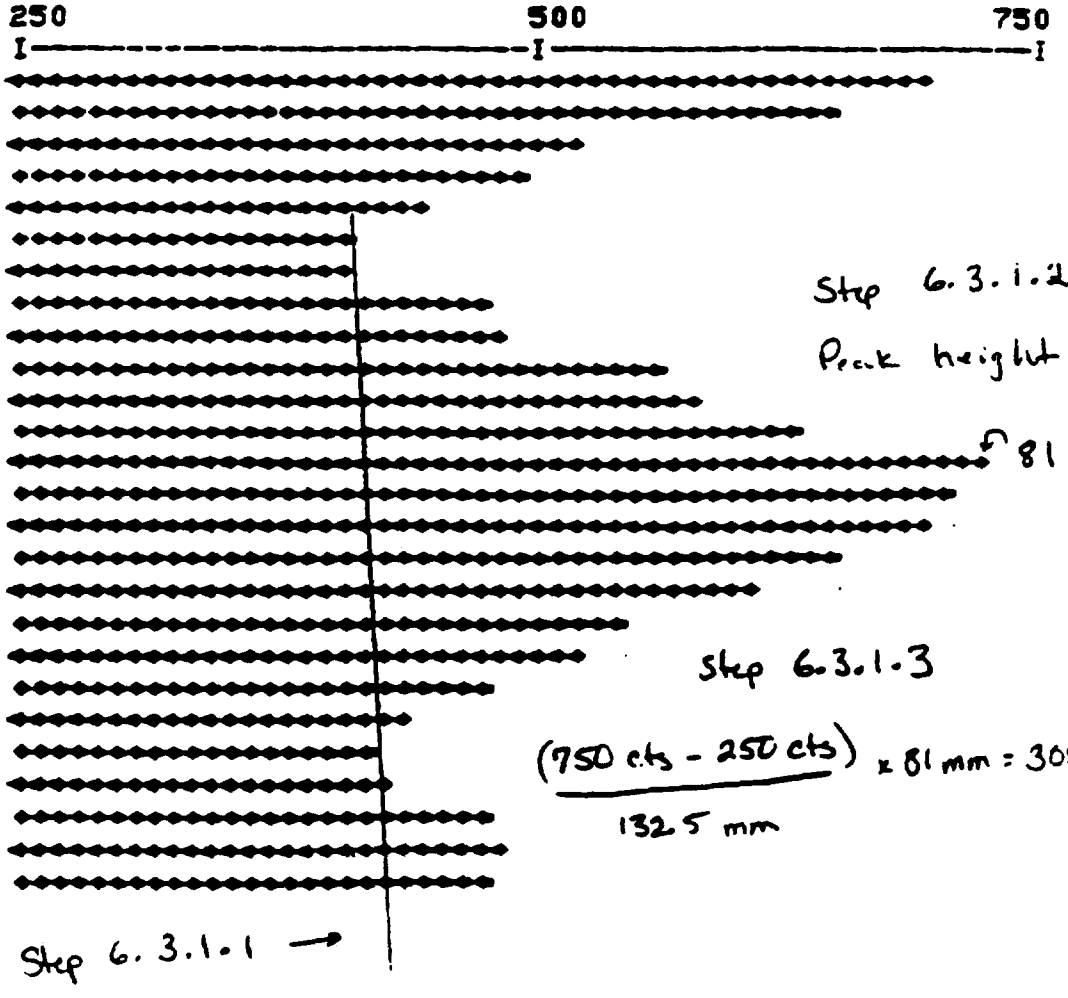

```
LATEST?
```

```
WHAT?

> LCS
DATE: 14.05.91  TIME: 13-21-47
MEASURING:
MODEL 10 PROBE 1 50 SECONDS
ASSAYS:PB 85.97

> SPL
LATEST?
FIRST CHANNEL: 0 ? 140
LAST CHANNEL: 255 ? 190
WINDOW: 1 ? 2
RANGE.lower: 0 ? 250
RANGE.upper: 725 ? 750
40 character per line ?80
◆◆◆◆ LATEST SPECTRUM   MEAS.TIME: 50  DATE: 14.05.91   13-23-25
```

Step 6.2.2.5

Step 6.2.2.7

CHANNEL	COUNTS
140	692
142	647
144	531
146	502
148	453
150	421
152	416
154	478
156	491
158	565
160	586
162	629
164	725
166	703
168	690
170	650
172	615
174	546
176	527
178	478
180	449
182	423
184	431
186	478
188	490
190	485



Step 6.3.1.2

Peak height

Step 6.3.1.3

$$\frac{(750 \text{ cts} - 250 \text{ cts})}{132.5 \text{ mm}} \times 81 \text{ mm} = 305.$$

Step 6.3.1.1

```
LATEST?
```

WESTON
MANAGERS DESIGNERS/CONSULTANTS
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February 12, 1991
K-1-02-05

Mr. Scott Clifford
ESAT Deputy Project Officer
Environmental Services Division
U.S. EPA Region I
60 Westview Street
Lexington, Massachusetts 02173

Re: TID No. 01-9102-17
Lead Free Kids Project
Review of the LFK Protocols Report

Dear Mr. Clifford:

Environmental Services Assistance Team (ESAT) member Paul Killian has completed the review of the Lead Free Kids (LFK) Project Protocols. The request was made by Beverly Fletcher, EPA Task Monitor, and authorized under Technical Instruction Document (TID) number 01-9102-17. The requested start date was February 11, 1991. The estimated completion date was February 12, 1991.

The task was initiated on February 11, 1991, and completed on February 12, 1991. The task required reviewing the LFK Protocols Report, Section II Soil Analysis Protocol, pages A-4 through A-7, and Section IV Dust Analysis pages A-11 through A-13. The methods were compared to the methods submitted by ESAT on February 8, 1991 (Correspondence Number 01-9102-17). The following discrepancies were noted:

Soil Analyses

- The procedure in which ESAT received soil samples is slightly different than the procedure presented on Page A-4 of the LFK Protocols Report. The procedure ESAT followed is: The samples are received from LFK staff. The Chain-of-Custodies (COCs) are checked to verify that all samples are present. The COCs are signed and dated, noting the time of sample receipt. The COCs are then copied, returning the original COC to the LFK staff. Laboratory Identification numbers are then placed on the sample bags and on the laboratory copy of the COCs.

- The procedure in which ESAT prepared soil samples is not the same as the procedures presented in the LFK Protocols Report, steps 3 - 14, pages A-4 through A-6. The procedures that ESAT followed are outlined in Appendix B-4, sections 6.3 and 6.4. (Attachment I)

- ESAT did not use the Kevex X-Ray Fluorescence (XRF) instrumentation to analyze the soil samples. Soil samples were analyzed using the Oxford LAB-X 1000 until May 1990; then analyses were performed using the Columbia X-MET 800 XRF. The procedures followed by ESAT for the analysis of soil samples on the Oxford LAB-X 1000 XRF are presented in section 7.0 of Appendix B-4. The procedures followed by ESAT for the analysis of soil samples on the Columbia X-MET 800 XRF are presented in Attachment II.

Dust Analyses

- The procedure in which ESAT received dust samples is slightly different than the procedure presented on Page A-11 of the LFK Protocols Report. The procedure ESAT followed is: The samples are received from LFK staff. The Chain-of-Custodies (COCs) are checked to verify that all samples are present. The COCs are signed and dated, noting the time of sample receipt. The COCs are then copied, returning the copied COC to the LFK staff. Laboratory Identification numbers are then placed on the sample bags and on the laboratory copy of the COCs. The original COCs are returned when analysis has been completed.

- The procedure in which ESAT prepared dust samples is similar to the procedures presented in the LFK Protocols Report, steps 2 - 6, pages A-11 through A-12. However, step 5a, page A-12, states that "The minimum acceptable sample is 20 mg." In actuality there was no minimum acceptable amount of sample. Several of the samples had only 1 mg of sample.

- The procedure in which ESAT analyzed dust sample is more detailed than the procedures presented in the LFK Protocols Report, pages A-12 through A-13. ESAT followed section 7 of Appendix B-3. (Attachment III)

WESTON

February 12, 1991
K-1-02-05

- The LFK Protocols Report, step 3c, page A-13, states an acquisition time of 100 seconds; however, ESAT used an acquisition time of 30 seconds.

- The LFK Protocols Report, step 4c, page A-13, states that standards should be used to determine a linear least squares calibration curve; however, ESAT determined sample concentrations by directly comparing the sample peak height to appropriate standard peak height. ESAT followed the procedure detailed in section 7.6 of Appendix B-3.

ESAT reviewed the remaining sections of the LFK Protocol Report; however, no comments were made because the sections pertained to areas of the project with which ESAT was not involved. Please contact Paul Killian at 617/229-2050 should you require any additional information.

Very truly yours,

ROY F. WESTON, INC.

Paul F Killian

Paul F. Killian
Associate Project Scientist

John J. Hagopian

John J. Hagopian, P.G.
Team Manager
ESAT Region I

/pfk
Enclosures

cc: Beverly Fletcher

ATTACHMENT I

APPENDIX B-3

STANDARD OPERATING PROCEDURE:
LABORATORY SCREENING METHOD FOR LEAD IN HOUSE DUST

USING ENERGY DISPERSIVE X-RAY FLUORESCENCE
(KEVEX 0700)

1.0 SCOPE AND APPLICATION

1.1 Lead in household dust may be determined by energy dispersive X-ray fluorescence (XRF) spectrometry. This method is simple, rapid, and applicable to Lead in various matrices with little or no sample preparation (i.e., digestion is <u>not</u> required prior to analysis).

1.2 Detection limits, sensitivity, and optimum ranges of the metals will vary with regard to sample matrix as well as the model of XRF instrument utilized.

1.3 This method is applicable for use by Region I ESD and ESAT staff for performing XRF screening analyses in lead in house dust samples as part of the LFK Demonstration Project.

2.0 SUMMARY OF METHOD

This method may be used for the semi-quantitative screening analysis of house dust samples for lead. The dust sample is thoroughly sieved, and placed in a plastic sample cup for XRF analysis. The intensity of the sample response at the L-alpha energy region of lead is compared to known lead reference standards for quantitation.

3.0 INTERFERENCES

Certain elements, such as _____, if present in the soil at concentrations _____ times that of lead, could present difficulties in the identification and quantitation of lead.

4.0 APPARATUS AND MATERIALS

4.1 <u>Energy Dispersive X-Ray Fluorescence Spectrometer</u>

A Kevex Model 7000 XES equipped with:

(a) _____ source;

(b) _____ detector;

(c) sixteen (16) place rotating sample holder; and

(d) computerized data system for analyzing, comparing and storing sample spectra.

4.2 8 inch Floppy Data diskettes, IBM, or equivalent.

4.3 Sample cups, plastic, consisting of cup, o-ring, and cap, Spectra-Cup, Cat. No. 340, Somar Labs. Inc., New York, or equivalent.

4.4 Mylar film, 6 micron.

5.0 REAGENTS

5.1 U.S. Department of Commerce, National Bureau of Standards, Standard Reference Materials

SRM	Unit Type	Certified Lead Size	Concentration
1579	Powdered Lead Base Paint	35g	11.87%
1633a	Coal Fly Ash	75g	72.4 ug/g
1645	River Sediment	70g	714 ug/g
1646	Estuarine Sediment	75g	28.2 ug/g
1648	Urban Particulate	2g	0.655%

5.2 US EPA, Environmental Monitoring and Surveillance Laboratory (EMSL), Quality Control Reference Standards

5.3 Instrument Calibration Standards

Dust M-10	2500 ppm	10 mg.
Dust M-50	2500 ppm	50 mg.
Dust H-10	25,000 ppm	10 mg.
Dust H-50	25,000 ppm	50 mg.

6.0 Sample Collection and Transfer of Custody to the U.S. EPA

Samples are collected in the field by Lead-Free-Kids staff, placed in labeled individual envelopes, and submitted with chain-of-custody (COC) documentation to the U.S. EPA New England Regional Laboratory (NERL) for XRF analysis. U.S. EPA personnel or their contractors will acknowledge receipt of custody by signing and dating the COC document in the presence of the LFK dust sample courier. The COC document is retained until sample analysis has been completed and results have been entered onto it. Then the original COC is returned to LFK with a cover letter.

6.1 Sample Preparation

6.1.1 Samples are assigned unique laboratory identification numbers, a sequential five-digit number, which is subsequently recorded on the sample envelope, chain-of-custody document, XRF Dust preparation worksheet, XRF analytical result summary sheet, and on the cover of the sample analysis container.

6.1.2 Under the ventilation hood, the sample envelope is carefully opened at one end (with scissors) and the dust is placed into a 60 mesh sieve.

6.1.3 The sieve is manually shaken for approximately 15 to 20 seconds.

6.1.4 All the fines are then transferred to the pre weighed sample analysis container using a glass powder funnel centered over and touching the center of the mylar window of the sample container.

6.1.5 Information from the chain-of-custody, including weight of sample, and laboratory ID number is recorded on the analytical results summary form.

6.1.6 All of the excess (non-filtered) soil/dust from the sample preparation is discarded in a special barrel in the laboratory. In some cases filtered

dust may be removed for the analysis container if the quality of dust interferes with container fabrication. However, all the dust ~~amount~~ be weighed before excess dust is removed. must

6.1.7 The powder funnel and sieve are cleaned between samples to remove soil and dust particles, using clean, compressed breathing air (grade D), or the like.

6.1.8 The sampling cup is sequentially placed in the sample tray according to the laboratory ID number for XRF analysis. Empty envelopes are retained and returned to LFK staff along with sample results.

6.2 Sample Container Preparation

The sample containers consist of two small o-rings with tabs, two pieces of 6 micron mylar film, a sample cup (which is slightly larger than the o-rings), and a container cap.

6.2.1 Place a piece of 6 micron mylar film over one o-ring (tabs down).

6.2.2 Snap the sample cup into place on top of the o-ring.

6.2.3 Weigh sample cup parts excluding cap and round to 4 decimal places.

6.2.4 Place dust sample onto mylar film via glass powder funnel. Be sure that sample is centered on film.

6.2.5 Place another piece of mylar onto sample cup over the dust and snap the second o-ring onto the top of the cup (tabs up).

6.2.6 Reweigh sample container and round to 4 decimal places.

6.2.7 Snap container cap into place on top of cup.

Note: The container cap is only used for identification and handling of the sample. All analyses must be performed with container cap removed.

6.2.8 Label the sample container cap with the correct sequential laboratory sample ID number.

6.3 Standards Preparation

Study Control standards are prepared from previously analyzed and concentration verified house dust samples. Standard concentrations should be prepared at concentration levels and weigh ranges as presented below.

			Std.	Sample Calibration Weight Range
Dust M-10	2500 ppm	10 mg	M-10 or	0.0 - ~~0.24g~~ 0.024g
Dust M-50	2500 ppm	50 mg	H-10	
Dust H-10	25,000 ppm	10 mg	M-10 or	~~0.25g~~ 0.025g or greater
Dust H-50	25,000 ppm	50 mg	H10	

6.4 Sample Preservation and Handling

No preservation is required. Handling of the sample, once it is placed in the analysis cup, must be done in a gentle manner to keep the sample centered in the middle of the mylar. This is especially important for samples requiring replicate analysis.

7.0 ANALYSIS PROCEDURE

7.1 The use of the Kevex 7000 XRF is relatively straightforward. The Kevex is normally left in the standby mode (target .8, 30 kV, and 0.5 mA) between analyses to prevent x-ray tube damage. House dust samples for lead are analyzed under the following instrumental conditions: target .4, 30 kV, .5 mA. (Detailed instructions can be found in the User's Manual for Kevex XRF Software.)

7.2 Instrument Set-Up

7.2.1 Turn the video monitor and plotter power on.

7.2.2 Insert the Master floppy disk into disk drive No. 0 (DY0)

7.2.3 Insert formatted floppy disk into disk drive No. 1 (DY1).

7.2.4 Boot the operating system by pressing the "Shift" and "Reset" keys simultaneously. Next, press the "Q Vantx" and then the "Enter" key.

7.2.5 When prompted on the screen, enter the current date.

7.2.6 After the current date has been entered, the spectral region of interest for lead must be established. This is accomplished by pressing the blue double-headed arrow (<------->) key. The region of interest that should be obtained is from 7.04 Kilo-electron Volts (KeV) to 17.28 KeV, where the lead L-alpha (L-a) peak is 10.25 KeV and the lead L-beta (L-b) is 10.___ KeV. After the spectral region has been established for lead analysis, wait for the asterisk (*) prompt and type in ATO, PBSOIL4. Type in sample ID Numbers as 5 digit numbers followed by -D- for each number at the end.

ex: Lab ID # 143 entered as 00143-D-

7.2.7 The first carousel run on the Kevex for the day must contain all four calibration standards. Each additional carousel run must include one of the four study control standard on a rotating basis. Calibration standards are run manually and not on the ATO program.

7.3 Loading the Kevex Sampler (Carousel)

7.3.1 Push the "Reset" key (red) to shut-off the x-ray beam. (As a safety precaution, the lid will not open when the x-ray beam is functioning).

7.3.2 Open the Kevex top and place sample cups into the sixteen (16) available slots (numbered 0 through 15) on the circular carousel.

7.3.3 Set the Kevex XES to ATO (white key). Then proceed with the analysis.

7.4 Manual Analysis of Dust Samples

The analysis will be performed using the ATO and manual modes. The manual method requires that the operator be presented while performing this type of analysis.

Keyboard commands required to initiate and perform XRF analyses are detailed below:

7.4.1 Await (*); type "Clr", then press the "Enter" key.

7.4.2 Make sure white switch is on manual position.

7.4.3 Push yellow key next to sample number. Use numbered key pad on KEVEX to enter desired position then hit enter.

7.4.4 Push yellow key to target display and enter 4 using numbered key pad again.

7.4.5 Continue in this manner and enter 30 for KEV and .5 for mA.

7.4.6 On the screen keyboard hit the yellow ACQ button. When running the standards you will manually stop them at their designated ppm concentration (2500 for medium and 25,000 ppm for high) using the yellow stop key next to the acquire key. Using the blue arrows (up and down) to increase and shrink the size of the peak, let the sample run for between 20 and 30 seconds. Stop the peak when it reaches the 2.5 mark designated by the numbered lines on the left side of the viewing screen.

7.4.7 When you have stopped the peak at its desired height (2.5) type SMO to smooth the curve. If the peak now falls below 2.5 it may be necessary to continue acquiring the peak for a couple more seconds and again hit stop to halt peak. Alternating between acquire, stop and smooth may be done an unlimited number of times until the peak appears in the right position as long as the time count is below 30 seconds. Time of analysis may not run over 30 seconds.

Note: Only calibration standards will be run on manual not dust samples.

7.4.8 Await (*); type "REA"d, press "Enter".

7.4.9 Await (*); type "SAV"e, press "Enter".

7.4.10 Prompt: General Comments.

7.4.11 Response: Section is ignored, press "Enter".

7.4.12 Prompt: Enter Unit: (1) or (2).

7.4.13 Response: Type "1", press "Enter".

* 7.4.14 Prompt: Enter Sample ID":

7.4.15 Response: type in Sample ID as assigned in XRF dust preparation worksheet.

* Manual analysis does not automatically add a 4 onto the end of the identification label and therefore the 4 is not needed for recall purposes.

7.5 <u>Automatic Analysis Procedure</u>

7.5.1 At asteric on screen type <u>ATO.PBSOIL4</u> Enter.

7.5.2 Enter the last sample position but do not include standards that will run manually.

7.5.3 Enter lab ID numbers for each corresponding position.

7.5.4 As the program runs you must be present to observe each lead sample peak as it acquires for 30 seconds.

7.5.5 With screen parameters of <7.04 and 17.28> the compton scatter peak will be the last peak visible on the right hand side. The lead peak will appear directly above the blue arrow at the bottom of the screen.

7.5.6 If the lead peak rises faster then the compton peak it will be calibrated using the high standard. If the lead sample peak does not rise above the compton peak, the medium standard will be used.

7.5.7 To determine if the 10 standard or the 50 standard is to be used, identify the weight of the sample. The sample is:

0.00g - 0.024g use 10 standard
0.025g - 0.100g or above use 50 standard.

7.6 Manual Quantitation and Comparison of Dust Samples

7.6.1 Await (*); type "RCL" (recall), press "Enter".

NOTE: The RCL (recall) command is used to recall a previously analyzed spectra that has been stored on the floppy diskette (DY1). In this case, a previously analyzed lead in dust calibration or reference standard for comparison to the various dust samples analyzed and stored on the same diskette.

7.6.2 Prompt: Enter Unit: 1 or 2.

7.6.3 Response: Type "1", press "Enter".

7.6.4 Prompt: Enter ID:

7.6.5 Response: Type the standard/label ID, press "Enter".

7.6.6 Prompt: Smooth Recalled Spectrum (Y/N)?

7.6.7 Response: Press "Enter".

7.6.8 Await (*); type "OVR" (overlay), press "Enter". The overlay command is used to compare and normalize spectra from the disk. The normalization feature (OVR) allows the operator to mark regions within the displayed spectrum as a basis for normalization. This feature aids in the visual interpretation of data and reduces channel-to-channel statistical fluctuations.

7.6.9 Prompt: Enter ID: add -D-4 to the end of each ID.

7.6.10 Response: Enter the sample ID, press "Enter".

7.6.11 Prompt: Smooth Recalled Spectrum (Y/N)?

7.6.12 Response: Press "Enter".

7.6.13 Prompt: Mark Peak(s) or Region(s) Hit Enter When Ready a cursor will appear on the screen.

7.6.14 Response: Mark the regions to be used for normalization by moving the cursor with the left and right green arrow function keys. The peak to be painted is the compton scatter peak. The screen parameters should be 9.60 - 19.84 use the green" equal (=) key to paint the desired area. Note: the paint cursor will move in the direction it was last set. Press the "Enter" key when finished.

7.6.15 The screen display will now include the standard spectrum overlaid by the sample spectrum normalized to the same energy region of the spectrum. Direct comparison of the lead (L-a) peaks can be made and a concentration (in ppm) can be determined.

Note: The red peak is the standard peak which should read 2.5 (use the Blue up and down arrows to set this). The white peak is the sample peak. Use the blue up and down arrows to best compare the sample peak value ppm. Although the height of

the red and white peaks will change the ppm value of the red (standard) will always remain the same 2500 ppm or 25,000 ppm depending on the standard used.

7.6.16 The OVR sequence can be repeated for each sample on the disk (DY1).

7.7 A Modified Quantitation Procedure - This is basically the same procedure as described above.

Dr. T. Spittler, USEPA Region I, Technical Services Branch Chief, Lexington, Massachusetts initiated the use of a quick and easy method for the semi-quantitative analysis of lead in soil samples.

Dr. Spittler has determined that, when acquiring data for the 2000 ppm lead in soil standard at an attenuation of 512 and the energy level for the compton's back scattering energy peak at 15 KeV is at 50 percent intensity, each horizontal screen division is equivalent to the response of ca. 800 ppm lead. To utilize this technique for dust, follow the XRF instrument set-up guidelines as previously described in Sections 7.2, 7.3, and 7.4 (7.4.1 to 7.4.5). To acquire, quantify, and store data, utilize the following procedure:

7.7.1 Check sampler position at "0".

7.7.2 Await (*); press the yellow "ACQ" key.

7.7.3 Wait for energy level at 15.- KeV to reach 50 percent scale at a range of 512.

7.7.4 Press the yellow "Stop" key.

7.7.5 Await (*); type "SMO", press "Enter".

7.7.6 Await (*); type "REA", press "Enter".

7.7.7 Await (*); type "SAV", press "Enter".

7.7.8 Prompt: General Comments.

7.7.9 Response: Section is ignored, press "Enter".

7.7.10 Prompt: Enter Unit: (1) or (2).

7.7.11 Response: Type "1", press "Enter".

7.7.12 Prompt: Enter Sample ID:

7.7.13 Response: type in sample ID as assigned in the XRF logbook.

7.7.14 Quantify the L(a) lead peak using the following scale:

Attenuation	Concentration Range of Lead (vertical scale division concentration)
64	0 to 700 (100 ppm)
128	0 to 1400 (200 ppm)
256	0 to 2800 (400 ppm)
512	0 to 5600 (800 ppm)
1024	0 to 11,200 (1600 ppm)

7.7.15 Await (*); type "CLR" (clear), press "Enter".

7.7.16 Advance the sample tray one space and repeat the analysis procedure.

8.0 QUALITY CONTROL

8.1 All quality control data should be maintained and available for easy reference or inspection.

8.2 At the beginning of each operating shift all 4 study control standards are analyzed on the first carousel. On following carousel runs analyze one standard (one per sixteen) This is done to assess method accuracy and to correct for normal standard drift and results should agree within ± 20 percent of the true value.

8.3 At least one laboratory replicate should be analyzed for every 20 samples to verify precision of the method. Replicate samples may be run at the end of an analytical day in their own carousel.

8.4 At least one laboratory replicate should be analyzed at a frequency of 1 per 20 samples to verify precision of

the method. Replicate samples maybe run at the end of an operation shift.

NOTE: True replicates of soil and dust samples are usually not possible since chemicals such as lead are typically not uniformly distributed in these materials. Additional handling of the sample may cause the dust to migrate away from the center of the mylar. Care must be taken when handling samples. Care must be taken in the interpretation of soil and dust replicate analytical results.

9.0 METHOD REFERENCE

9.1 Precision and accuracy data are not available at this time.

9.2 The performance characteristics for a dust sample free from interferences are:

Optimum Concentration Range: N/A ug/g
Detection Limit: NA ug/g
N/A: not available at this time.

ATTACHMENT II

Columbia X-MET 800 XRF

Standard Operating Procedures

1.0 SAMPLE PREPARATION

All procedures detailed in section 6.0 of Appendix B-4 were followed for sample preparation.

2.0 SAMPLE ANALYSIS

2.1 Instrument Operation

2.1.1 Turn on the instrument by pressing the switch in back left face of the instrument.

2.1.2 Turn on the printer by pressing the switch in back right face of the printer.

2.1.3 Allow the instrument to warm up for 30 minutes.

2.1.4 Place the sample into the instrument by:
- A. sliding the holder towards you;
- B. opening the holder by lifting the top;
- C. placing the sample into the open holder and closing the top;
- D. sliding the holder back into place.

2.1.5 Turn the printer off line by alternating the ON LINE switch away from the "•".

2.1.6 Type in sample identification (i.e. 300 STD)

2.1.7 Turn the printer on line by aternating the ON LINE switch towards the "•".

2.1.8 Press the START 1 key on the instrument.

Instrument will respond:

```
DATE:  dd,mm,yy        TIME:  hh-mm-ss
MEASURING:
MODEL 10  PROBE 1 50 SECONDS
```

After 50 seconds the analysis is complete, the instrument will signal by beeping. The instrument prints:

```
ASSAYS:  PB  ##.##
>
```

2.1.9 Type the following:

	Instrument response	Analyst Response
a.	>	SPL <RTN>
b.	LATEST?	<RTN>
c.	FIRST CHANNEL: 0 ?	140 <RTN>
d.	LAST CHANNEL: 255 ?	190 <RTN>
e.	WINDOW: 1 ?	2 <RTN>
f.	RANGE, lower: 0 ?	250 <RTN>
g.	RANGE, upper: ### ?	next higher multiple of 25 <RTN>
	(i.e. if ### = 108 then enter 125)	
h.	40 CHARACTERS PER LINE ?	80 <RTN>

The spectra for the sample is printed, and the instrument responds:

LATEST?

If all the points on the spectra fall above the baseline (250), proceed to step 2.1.10. Otherwise, reprint the spectra with the baseline (RANGE, lower) set at 200. This is done by repeating steps 2.1.9.b - 2.1.9.h, and entering 200 at step 2.1.7.f instead of 250. Regardless of whether or not the points still fall below the baseline (200), proceed to step 2.1.10.

2.1.10 Press the ESCAPE key twice.

2.1.11 Follow steps 2.1.4 through 2.1.8 for the remaining samples to be analyzed.

2.2 LFK Order of analysis

2.2.1 The following standards are run from low to high:

a.	blank		standard	(Empty sample cup)
b.	300	ppm	standard	(Laboratory # 5103)
c.	900	ppm	standard	(Laboratory # 5113)
d.	1600	ppm	standard	(Labeled as 1600 STD)
e.	6000	ppm	standard	(Laboratory # 4873)
f.	13000	ppm	standard	(Laboratory # 4903)
g.	Laboratory Control Sample (LCS)			(Labeled as 880 STD)

2.2.2 Ten laboratory samples are analyzed. (Both duplicates and replicates are considered laboratory samples.)

NOTE: Duplicates are prepared during sample preparation at a rate of one per twenty. Replicates are analyzed at a rate of one per twenty.

2.2.3 One of the standards (b - e) is analyzed.

2.2.4 Steps 2.2.2 and 2.2.3 are repeated until the analysis batch is complete, rotating the standards (b - e).

2.2.5 Once the analysis batch is complete, all standards are analyzed, including the LCS, as in step 2.2.1.

3.0 SAMPLE QUANTITATION

3.1 Determining Peak Height

3.1.1 A straight line is drawn connecting the two low points of the curve.

3.1.2 The peak height is then measured, in millimeters, from the straight line to the highest point on the peak.

3.1.3 The corresponding number of counts is then determined by:

$$\frac{(\text{RANGE, upper} - \text{RANGE, lower})}{132.5 \text{ mm (Length of full scale)}} \times \text{peak height (mm)} = \text{Counts}$$

3.2 Determining Sample Concentration

3.2.1 The analysis results (counts and concentration) of all standards, except the LCS results, are tabulated.

3.2.2 Two standard curves are then created using linear regression. A lower curve consisting of the blank, 300, 900, 1600, and 6000 standards are used for all sample results less than 6000 ppm. The high curve consisting of blank, 1600, 6000, and 13000 standards are used for all sample results greater than 6000 ppm. Both standard curves are plotted through the point zero, zero.

3.2.3 The slope of the appropriate curve is then multiplied by the sample's counts to determine the sample concentration.

3.2.4 The LCS results are determined as in 3.2.3 (using the low standard curve). The results must fall within 20% of the true value (880 ppm).

ATTACHMENT III

APPENDIX A

SAMPLING GUIDELINES

APPENDIX A-1

PRELIMINARY SAMPLING

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6.0 REFERENCES
None

7.0 ATTACHMENTS

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1.0 PURPOSE

The purpose of this guideline is to describe specific elements of the preliminary phase of soil sampling for the Lead Free Kids Demonstration Project, Boston, Massachusetts. This guideline was developed for use by field sampling teams to assure that soil sampling and associated activities are consistent throughout the project to meet data quality objectives for qualifying properties for participation in the project.

2.0 SCOPE

The specific elements described in this guideline are applicable to soil sampling and associated activities to include:

- site description documentation;
- schemes for locating sampling points;
- sample collection;
- sample handling and storage; and
- recordkeeping and sample custody.

3.0 DEFINITION

None

4.0 RESPONSIBILITIES

Task Leader - The Task Leader is responsible for the collection of soil samples in accordance with all elements of this guideline. The Task Leader will supervise and participate with field personnel to accomplish this task and be responsible for delivery of samples to the EPA laboratory.

5.0 GUIDELINE

5.1 Overview

The Soil Lead Abatement Demonstration Project involves sampling and analysis and soil removal and restoration of approximately 150 lead contaminated properties in the City of Boston.

Three soil sampling events are associated with the Project; Preliminary, Detailed, and Post Abatement. Preliminary soil sampling phase presented herein will be conducted to determine eligibility of properties for participation in the project. The property will be eligible if two or more soil sample results are equal to or greater than 1500 parts per million lead.

Typically three to four composited surface samples will be collected within two meters of the house; one from each side where soil is present; one composited surface sample will also be taken from any obvious play areas. Sketches of the properties showing key landmarks and sample locations will be made. Samples will be analyzed by x-ray fluoresces at the EPA Region I laboratory.

5.2 Sampling Procedures

5.2.1 General

The quality of sample collection is assured by adhering to sampling procedures. All soil sample collection will be limited to composite surface from 0 to 2 cm. A five-point composite depicted in Figure 6-1 is the technique for all composite soil samples. No preservatives will be required for samples. Sample containers will consist of self sealing Ziplock or equivalent) plastic baggies. Field documentation will include a brief site sketch with amplifying information, labeling of sample bags with the appropriate code (provided by LFK), and chain of custody forms. The procedures presented below will ensure that a representative portion of the source is collected and sample integrity is preserved.

5.2.2 Preliminary Soil Sampling

Site Description and Sampling Locations

For each property, a field sketch shall be made that indicates the boundary of the lot, the position of the main building and any other buildings, such as storage sheds or garages, the position of the sidewalks, driveways, and other paved areas, the position of the play areas, if obvious, and the areas with exposed soils. The property may be divided into separate sub-areas for clarity and detail, if necessary, and be identified with alpha designation i.e., Section "A", Section "B", etc. This may include isolated areas of the

site, such as side or backyards. The resulting sketch(s) will be recorded on separate sheet(s) of paper. Sample locations will be identified on drawing(s) with approximate distance notations from buildings and other landmark structures (see Figure 6-2).

On the detailed sketch, the following information will be included:

- address;
- date and name of artist;
- apparent use of yard, if any (toys, sandbox, children present);
- debris, standing water, vegetation, cover and bare spots, and animals on property; and
- any notable unusual feature.
- Location of sampling points.

5.2.3 Sampling Schemes

The sampling scheme selected for each property must adequately determine eligibility of the property for further abatement activities. It must identify the presence of lead in two or more surface soil samples equal to or greater than 1500 parts per million (ppm). Consequently, selecting the most appropriate sampling scheme is a critical element in site description and should be noted in the drawing. Several sampling schemes are available to the investigator; all or some may be used.

Line Source Pattern

This pattern can be used whenever the source of the lead is thought to be linear, such as along a building foundation, a fencerow, a street, or beside a garage. Draw a line parallel to the source, such as the foundation of the main building within two meters from the foundation.

Small Area Pattern

When the sub-area is less than two square feet in each dimension, a single composited sample may be taken if it appears that such a sample would adequately represent the sub-area.

Targeted Pattern

Select those locations within the sub-area that are likely to reflect potential exposure to lead in soil dust. These may be play areas, paths, drainage collection areas, or areas that are likely to contribute dust to other surfaces that children use. This method may be used alone or with the line source patterns.

From 3 to 4 composite surface soil samples will be collected from each property. Sampling locations will be selected to adequately represent soils present at the site. Further compositing of line source (along the long axis) samples may be required to reduce the total number of samples taken to obtain the desired three to four composites for analytical testing. Small area and targeted pattern samples will not be composited with other line source samples and will be in addition to the 3 or 4 samples submitted for testing.

5.2.4 Equipment List

- plastic sandwich-size sample bags (Zip-lock or equivalent);
- indelible marker (to put sample number on bag);
- cooler or similar container to hold samples;
- measuring tape;
- spoons or spatulas;
- detergent solution;
- wash bowls for decontamination of sampling gear;
- paper towels;
- distilled water;

- plastic trash bags (for disposable items);
- bound logbook, paper and pens; and
- chain-of-custody form.

5.2.5 Sample Collection

Each selected sample point will represent the center of a sampling location. Each sampling location will consist of a two-foot square area from which five surface soil samples will be composited. Samples will be collected as follows:

> Collect two tablespoonfuls of soil from each of the four corners and from the middle. Sample depth should be from 0 to 2 cm. Place the composited sample into a plastic bag, seal it, and mark the bag with the sample number. Maximum volume should be about 1/2 bag (1 cup). A composite will be identified as a single sample. A chain of custody is used to record information about the composite.
>
> The sampling device should be clean and free of soil from the previous sampling location, with decontamination between locations. Vegetation and debris can be removed at the point of collection, being careful not to disturb soil or decayed litter.
>
> The surface soil samples should be composited in sealable plastic polyethylene containers (Ziplock baggies or equivalent) suitable for prevention of cross-contamination and loss of the sample. The sample identification number should be placed on the container (see Figure 7-2), and chain of custody (see Figure 7-1). After each sample composite, the sampling device should be cleaned with distilled water and wiped with a paper towel. Store the composited soil sample at ambient temperature until returned to the NERL.
>
> A field blank should be taken for each sample crew day. This is normally done by taking a sample container with clean quartz sand into the field, opening it to exposure the container for a period of time, representing normal sample procedures, then returning the container to the EPA Region I laboratory in the same manner as other soil

samples. The purpose of the field blank is to detect accidental or incidental contamination during the sampling process.

Duplicate samples should be taken at the frequency of 1 per 20 and collected from the mid-point between regular composite sample cornerpoints (see Figure 6-1). The purpose of the field duplicate is to detect differences in homogeneity of the contaminants in soil and error in sampling techniques.

5.2.6 Sample Handling and Storage

The sample containers should be sealed to prevent loss or cross-contamination of the sample. No special considerations will be given to shipping container labelling as they will be delivered to the EPA Region I laboratory by a member of the LFK Staff. Any storage of shipping containers and/or samples should be in a cool, dry location.

5.2.7 Recordkeeping and Sample Custody

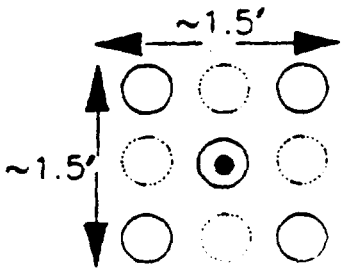
Soil sample records for each property consist of a property diagram with sample location and codes indicated, and chain-of-custody forms.

Samples should be sequentially numbered within each sub-area. Each location diagram and chain-of-custody form should bear all sample numbers and the signature of the person responsible for verifying the quality of the information collected. This signature certifies that there has been no misuse of the sample protocol, no mistake in recording the information, and that the information is sufficient to clearly identify these samples for comparison with other types of samples taken at the same location, such as house dust. These documents also establish the chain of custody required for the for the project.

When the sample is delivered to the laboratory, custody is relinquished by the field investigator or sample courier and received by the laboratory Task Leader or Analyst by signatures on the chain-of-custody form. The original form will remain with the LFK for project files. EPA will keep a copy of the chain-of-custody form.

FIGURE 6-1

5 Point Composite Sample Scheme



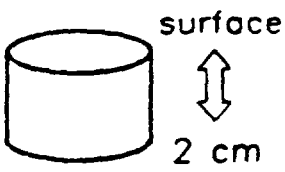
Legend

- ● Sampling Station
- ○ Sample Composite Location
- ◌ Field Duplicate Sample Composite Locations

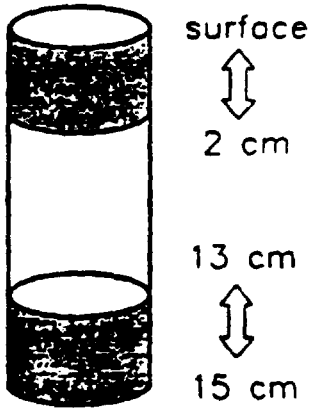
(At selected sampling stations duplicates will be collected at mid-points between sample composite locations.)

A
Preliminary and Post Abatement Phase Surface Sample Composite Location Schematic

B
Detailed Phase Surface and Subsurface Sample Composite Location Schematic



Sample collected from surface to 2cm below surface.



First sample collected from surface to 2 cm below surface.

Second sample collected from 13 cm to 15 cm below surface in same boring location.

APPENDIX A-2

DETAILED SAMPLING

APPENDIX B-4

STANDARD OPERATING PROCEDURE: LABORATORY SCREENING METHOD FOR LEAD IN SOIL USING ENERGY DISPERSIVE X-RAY FLUORESCENCE OXFORD LX1000

1.0 SCOPE AND APPLICATION

1.1 Metals in a solution may be readily determined by energy dispersive x-ray fluorescence (XRF) spectrometry. The method is simple, rapid, and applicable to a large number of metals in various matrices with little or no sample preparation (i.e., digestion is not required prior to analysis).

1.2 Detection limits, sensitivity, and optimum ranges of the metals will vary with the sample matrices and the models of XRF spectrometers utilized.

1.3 This method is applicable to Region I ESD and ESAT staff performing laboratory screening analyses for lead in soil samples collected as part of the LFK Demonstration project.

2.0 SUMMARY OF METHOD

This method is used for the semi-quantitative screening of lead in soil. The soil sample is homogenized, an aliquot is removed and placed in a sampling container. The sample is then analyzed using XRF.

3.0 INTERFERENCES

Certain elements, such as _____, present in the soil sample could interfere with the analysis, if present in concentrations greater than _____ times that of lead.

4.0 APPARATUS AND MATERIALS

4.1 Energy Dispersive X-Ray Fluorescence

An Oxford Analytical Instrument LAB-X 1000 equipped with:

- excitation source: Cadmium 109
  typical activity: 3 milli Curies (3MCi)
  half life: 1.3 years
  principal energy level: silver, K, 22 KeV
  atomic no range: (K) spectra, 24-42; (L) spectra, 72-92
- detector: xenon filled proportional counter
- six (6) position motorized turntable
- microprocessor control consisting of:

- display: 40 column, 2 line liquid crystal display
- printer: 40 column, 2 color dot matrix with graphics, uses 70mm wide plain paper
- keypad: 20 key alphanumeric membrane pad.

4.2 Printer paper, 70mm wide.

4.3 Printer ribbon.

4.4 Sample cups, plastic, spectro-cup, Cat. No. 340, Somar Lab. Inc., New York or equivalent.

4.5 Mylar film, 6 micron

4.6 A stable power supply, whose requirements of 100-120 volt AC, 45-165 Hz, 50 VA maximum consumption are critical to instrument performance. Extreme temperature ranges also effect instrument performance.

5.0 REAGENTS

5.1 U.S. Department of Commerce, National Bureau of Standards, Standard Reference Materials

SRM	Type	Unit Size	Certified Lead Concentration
1579	Powdered Lead Base Paint	35g	11.87%
1633a	Coal Fly Ash	75g	72.4 ug/g
1645	River Sediment	70g	714 ug/g
1646	Estuarine Sediment	75g	28.2 ug/g
1648	Urban Particulate	2g	0.655%

5.2 US EPA, Environmental Monitoring and Surveillance Laboratory (EMSL), Quality Control Reference Standards

5.3 Instrument Calibration Standards

Not available at this time.

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 Samples are collected in the field, placed in labelled, individual, zip-lock plastic bags, and submitted to the ESD laboratory for analysis. Samples are logged into the laboratory logbook and assigned a laboratory identification number.

6.2 Soil samples are thoroughly mixed (homogenized) in the zip-lock bag. An aliquot of the soil, 2 to 3 table spoons (10 to 15 grams), is removed with a spoon or spatula and placed in a wang dish or appropriate drying vessel. The dish is marked with the laboratory identification number and allowed to air dry overnight at ambient laboratory temperature.

6.2.1 Excess sample in the zip lock bag will be stored until the analytical report has been finalized then discarded. However, selected soil samples maybe kept longer for additional testing.

6.3 Sample Preparation

Dried soil samples will be passed through a 60 mesh sieve until approximately 1 gram of fines have been passed. The sieve will be manually shaken, typically 10 to 15 seconds is adequate. The fines are then transferred to the analysis sample container using a glass powder funnel which is placed over the sample container.

6.3.1 All excess soils from sample preparation will be discarded in a special barrel in the laboratory.

6.3.2 The powder funnel, sieve, drying vessel, and spoon (or spatula) will be cleaned between samples to remove soil particles. The funnel and sieve will be blown free of dust with compressed air. The spoon will be wiped with disposal tissues and drying vessel washed vigorously with hot water.

6.4 Sample Container Preparation

6.4.1 Invert cup and place a piece of 6 micron mylar film over the bottom aperture.

6.4.2 Snap a retaining o-ring over the film onto the base of the cup (o-ring teeth down).

6.4.3 Place cup upright and add enough soil to uniformly cover the mylar film bottom of the cup.

6.4.4 Snap cap into place on top of the cup.

6.4.5 Label the sample cup with the sequential laboratory I.D. No. and record that in the XRF instrument logbook.

NOTE: Information to be recorded in the XRF logbook would include:

- field identification numbers;
- laboratory identification numbers;
- date samples prepared;
- date samples and analyzed;
- analysis parameters; and
- analyst's initials affiliation and date.

6.5 Standards Preparation

Calibration standards are prepared from previously analyzed and concentration verified soil samples or known reference standards. Standard concentrations should be prepared at concentration levels of lead at approximately:

- 50 - 100 ppm (ug/g)
- 100 - 500 ppm
- 500 - 1000 ppm
- 1000 - 2000 ppm
- 2000 - 5000 ppm

6.6 No special preservation or handling procedures are required.

7.0 ANALYSIS PROCEDURE

The use of the Oxford Analytical Instrument Model LAB-X 1000 XRF is relatively simple. (Detailed instructions for its use can be found in the LAB-X 1000 Instruction Manual.)

7.1 Instrument Set-Up

7.1.1 Turn power on.

7.1.2 Wait for menu to appear in video display.

7.1.3 Press key "3" to select Utilities routine.

7.1.4 The instrument will print the date and time and display the menu:

1 = Position Turntable
2 = Set Date and Time
3 = Printer Check
4 = Turn Page

Select option 3 to check correct function of printer

Press key "3".

7.1.5 If date and time printed at the start of these routines are incorrect, they can be reset by pressing key "2".

7.1.6 Exit from the utilities routine by pressing option 4 until the main menu (as shown below) is displayed.

1 = Analyses 2 = Calibrate
3 = Utilities 4 = Turn Page

The LAB-X is now ready to begin analyses.

7.2 Manual Analysis of Soil Samples

7.2.1 Place one of the assembled safety windows in position 0 in the sample loading port.

7.2.2 Place the sample cup into the cell or secondary window holder which fits into the safety window of the sample loading port. The cell assembly should be lightly tapped on a clean, hard surface to settle the contents of the cup (i.e., evenly distribute the soil on the mylar film).

7.2.3 Selection option 1, Analyses, on the Main Menu. Press key "1".

7.2.4 Another menu appears, select option 2, Spectrum Scan. Press key "2".

7.2.5 Prompt: enter "Analysis Head".

7.2.6 Response: press key "2".

7.2.7 Prompt: enter "Sample Label".

7.2.8 Response: enter sample ID from XRF log.

7.2.9 Prompt: Is "Sample Label" Inserted?

7.2.10 Response: press "Yes" key.

7.2.11 The measurement cycle now begins. The turntable will rotate 60 degrees, carry out an Energy Lock for Ca. 10 seconds prior to further rotation which transports the sample to the required sampling head. The operator may terminate a measurement by pressing the "Esc"ape key before the programmed time has elapsed.

7.2.12 After completion of the measurement cycle, select option 2, Print Scan. Press key "2".

7.2.13 After the scan has been printed, determine if the lead L-alpha peak is on scale and measurable. If not, select one of the three (3) scaling options: 5, 10, or 20. Press the appropriate key.

7.2.14 After the scale scan has been printed, select option 4, Turn Page, to return to the Analyses Menu. Press key "4".

7.2.15 Place another sample into the sample holder and repeat the analysis process.

7.3 Quantification

7.3.1 A series of calibration standards are analyzed at each scaling factor; 0, 5, 10, and 20. An average response factor (RF) is determined using a minimum of three (3) concentrations and one (1) reagent blank analyzed at least three times.

7.3.2 The peak height of the lead L-alpha (at _____) is measured for each sample. This peak height is multiplied by the RF to determine the concentration of lead (ppm) in the sample.

8.0 QUALITY CONTROL

8.1 All quality control data should be maintained and available for easy reference or inspection.

8.2 A set of calibration standards at each scaling factor should be analyzed in the laboratory prior to initiating field studies. These calibration standards should consist of a minimum of three (3) standards and one (1) reagent blank ("clean soil").

8.3 A minimum of one (1) reagent blank and one (1) standard at or near the mid-range of the calibration curve should be analyzed daily to verify instrument reproducibility. These values should agree within ± 20 percent of the initial calibration.

8.4 If forty-five (45) or more samples per day are analyzed or if samples from more than one site are to be analyzed in one day, then the working standard curve must be verified by analyzing a mid-range standard for every thirty (30) samples or for each site, whichever is more frequent. These check standard results must be within ± 20 percent of the true value.

8.5 At least one (1) field laboratory duplicate sample should be analyzed with every twenty (20) samples to verify the precision of the method.

NOTE: True replicates of soil samples are usually not possible since chemicals such as lead are typically not uniformly distributed in these materials. Care must be taken in the interpretation of soil replicate analytical results.

8.6 At least one (1) lead-in-soil standard reference sample should be analyzed daily or per site, which ever is more frequent. The result should agree within ± 20 percent of the true value.

9.0 METHOD PERFORMANCE

9.1 Precision and accuracy data are not available at this time.

9.2 The performance characteristics for a soil sample free from interferences are:

Optimum Concentration Range: N/A ug/g

Detection Limit: N/A ug/g

NA: not available at this time.

ROY F. WESTON, INC
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(617) 229-2050

March 1, 1990
D-0-2-30

Mr. Scott Clifford
ESAT Deputy Project Officer
Environmental Services Division
US EPA - Region I
60 Westview Street
Lexington, Massachusetts 02173

Re: TID No. 01-9001-25
LFK Demonstration Project
Quality Assurance Project Plan
Revisions to Interim DRAFT

Dear Mr. Clifford:

Environmental Service Assistance Team (ESAT) member Jay Markarian prepared an interim revised draft of the Boston Lead Free Kids Demonstration Project Quality Assurance Project Plan (QAPjP). The task, requested by David McIntyre, EPA task monitor, was authorized under Technical Instruction Document (TID) No. 01-9001-25. The requested start date was January 29, 1990. An interim revised draft QAPjP was requested for submission on February 27, 1990 with the final version due on April 27, 1990.

The first revision of the April 28, 1989 QAPjP was initiated on January 29, 1990. J. Markarian met with D. McIntyre on February 8, 1990 to discuss the scope of revisions required. After this meeting D. McIntyre edited sections 1.0 through 6.0 of the QAPjP, addressing program changes, which included addition of the dust sampling and analysis elements of the project. J. Markarian has reviewed the edits made by D. McIntyre and edited the remaining sections of the QAPjP, which included the following:

- All tables and figures;
- Sections 7.0 through 11.0;
- the Detailed Sampling SOP;
- Deletion of former Appendices B-2, B-3, B-5 and B-6;

WESTON

- Development of a dust sample preparation and analysis SOP and;
- Incorporation of a dust sampling SOP developed by LFK staff, into the sampling guidelines found in Appendix A of the QAPjP.

The enclosed diskette contains a merger of edits provided by D. McIntyre and J. Markarian under the file name QAPP3B1.Jay. "Redline" and "Strikeout" modes, available on WordPerfect software version 5.0, have been used to assist D. McIntyre with the QAPjP's review.

Current status of this TID is summarized below:

- The interim draft QAPjP has been submitted by ESAT to USEPA for comment;
- 76 of the 120 assigned labor hours have been expended (approximately 64 percent);
- The task appears to be on schedule and on budget, barring extensive comments by the US EPA.

Please contact Jay Markarian at 617/229-2050 should you require any additional information.

Very truly yours,

ROY F. WESTON, INC.

Jay Markarian, P.G., CHMM
Senior Investigation Coordinator

Joseph D. Mastone
Team Manager
ESAT Region I

JSM/dam

cc: D. McIntyre, US EPA

1.0 QUALITY ASSURANCE PROJECT PLAN

Project Title: Lead Free Kids (LFK) Demonstration Project

EPA Project Manager: David McIntyre

LFK Principal Investigator: Michael Weitzman, M.D.

Performing Organization: Trustees of Health and Hospitals of the City of Boston, Inc. (Trustees)

Lead Free Kids Project, Department of Health and Hospitals City of Boston

Duration: 2 years (See Project Design)

Type of Project: Superfund Epidemiological/Soil Abatement Demonstration Project

Supporting Organization: EPA Region I

Approvals:

EPA, Region I
Name: David McIntyre Title: Project Manager

Signature _____ Date _____

Name: Carol Wood Title: Quality Assurance Coordinator

Signature _____ Date _____

Name: Dr. Thomas Spittler Title: Technical Project Director

Signature _____ Date _____

LFK Project

Name: Michael Weitzman, M.D. Title: Principal Investigator

Signature _____ Date _____

Name: John L. Christian Title: VP Trustees of Health & Hospitals

Signature: _____ Date _____

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Quality Assurance Project Plan

Distribution List

A copy of this Quality Assurance Project Plan has been provided to the following organizations and their project representatives:

Natalie Zaremba, LFK
Ann Aschengrau, LFK
Michael Wietzman, LFK
John Christian, ~~LFK~~- Trustee
Tom Spittler, U.S. EPA
Carol Wood, U.S. EPA
David McIntyre, U.S. EPA
Jay Markarian, Roy F. Weston, Inc.

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3.0 PROJECT DESCRIPTION

3.1 Introduction

The purpose of the Quality Assurance Project Plan (QAPjP) for the Boston Lead-in-Soil/LFK Demonstration Project is to indicate prime responsibilities and prescribe requirements for assuring that the project is planned and executed in a manner consistent with defined quality assurance objectives. This QAPjP provides guidance and specifications to assure that:

1. All field sampling, methodologies and documentation, sample preparation, handling, and transportation are conducted consistently according to established procedures;

2. All laboratory determinations and analytical results are valid through preventative maintenance, instrument calibration, and analytical protocols;

3. Samples are identified and controlled through sample tracking systems and chain-of-custody protocols;

4. Records are retained as documentary evidence of the sample integrity, applied processes, equipment used, and analytical results;

5. Generated data is validated and its use in calculations documented; and

6. Calculations and evaluations are accurate, appropriate, and consistent throughout the project.

The requirements of this QAPjP apply to the EPA Region I (and its subcontractor activities) and to the Trustees (and its subcontractor activities) as appropriate for the Demonstration Project.

3.2 Project Summary

The following information summarizes the specific tasks required for this Demonstration Project as well as other pertinent information.

3.2.1 Project Background

In 1985, the Centers for Disease Control (CDC), Atlanta, Georgia, published a report entitled, Preventing Lead Poisoning in Young Children, which stated that "lead in soil and dust appears

to be responsible for blood lead levels in children increasing above background levels when the concentration in the soil or dust exceeds 500-1000 parts per million (ppm)."

Data from the City of Boston Childhood Lead Poisoning Prevention Program, coupled with the CDC report, led to the following conclusions:

a. Children playing in the area of exposed, lead-contaminated soil may ingest lead in the course of their normal hand-to-mouth activities.

b. Ingestion of lead ~~through~~ direct contact with lead-contaminated soil may result in an increased body burden of the contaminant.

c. Exposure of humans to lead through ingestion or inhalation can result in toxic effects in the brain, central and peripheral nervous system, kidney, and hematopoietic system. Anemia is an early manifestation of lead poisoning. Peripheral neuropathy also results from lead poisoning. Young children under the age of six are especially prone to the most profound and deleterious effects of lead exposure. Chronic exposure to low levels of lead can cause permanent learning disabilities in children.

3.2.2 Demonstration Project

The Boston Lead Free Kids Demonstration Project shall involve sampling approximately 150 selected children for blood lead levels to determine base line data, sampling their yards to establish soil lead levels, and their residences to determine dust lead levels, removing contaminated soil and dust, and resampling the children during the following year to observe the effects of the soil/dust removal. This QAPjP addresses the soil and dust sampling and analysis.

Preliminary soil sampling will be conducted during 1989, as necessary, at the selected children's properties. Should the preliminary sampling indicate lead concentrations equal to or greater than 1500 ppm in two or more samples, residents of those properties shall be contacted for enrollment in the project. Detailed soil sampling will be conducted at those sites enrolled in the project in order to define the nature and extent of the lead contamination. The surface of those properties which are included in the project will be removed to a depth of 15cm (six inches). Post abatement sampling and analysis will be conducted to evaluate the effectiveness of abatement activities, and to monitor the levels of lead in soil at the project properties at later dates. This is illustrated in the flow diagram presented as Figure 3-1.

Once the properties are signed on to the project, interior dust sampling and interior dust abatement (extensive vacuuming and cleaning) will commence. Dust samples will be analyzed at the EPA lab and the data forwarded to LFK. Dust abatement activity details are available in the project design document prepared by LFK.

Preliminary Soil Sampling to Determine Eligibility

Three to four composited surface samples will be collected from properties with children chosen to be potential study participants. One composited surface sample will also be taken from any obvious play areas. Sketches of the properties indicating key landmarks and sample locations will be made. Samples will be analyzed by XRF at the EPA Region I laboratory. The property will be eligible if two or more sample results are equal to or greater than 1500 ppm.

Detailed Soil Sampling

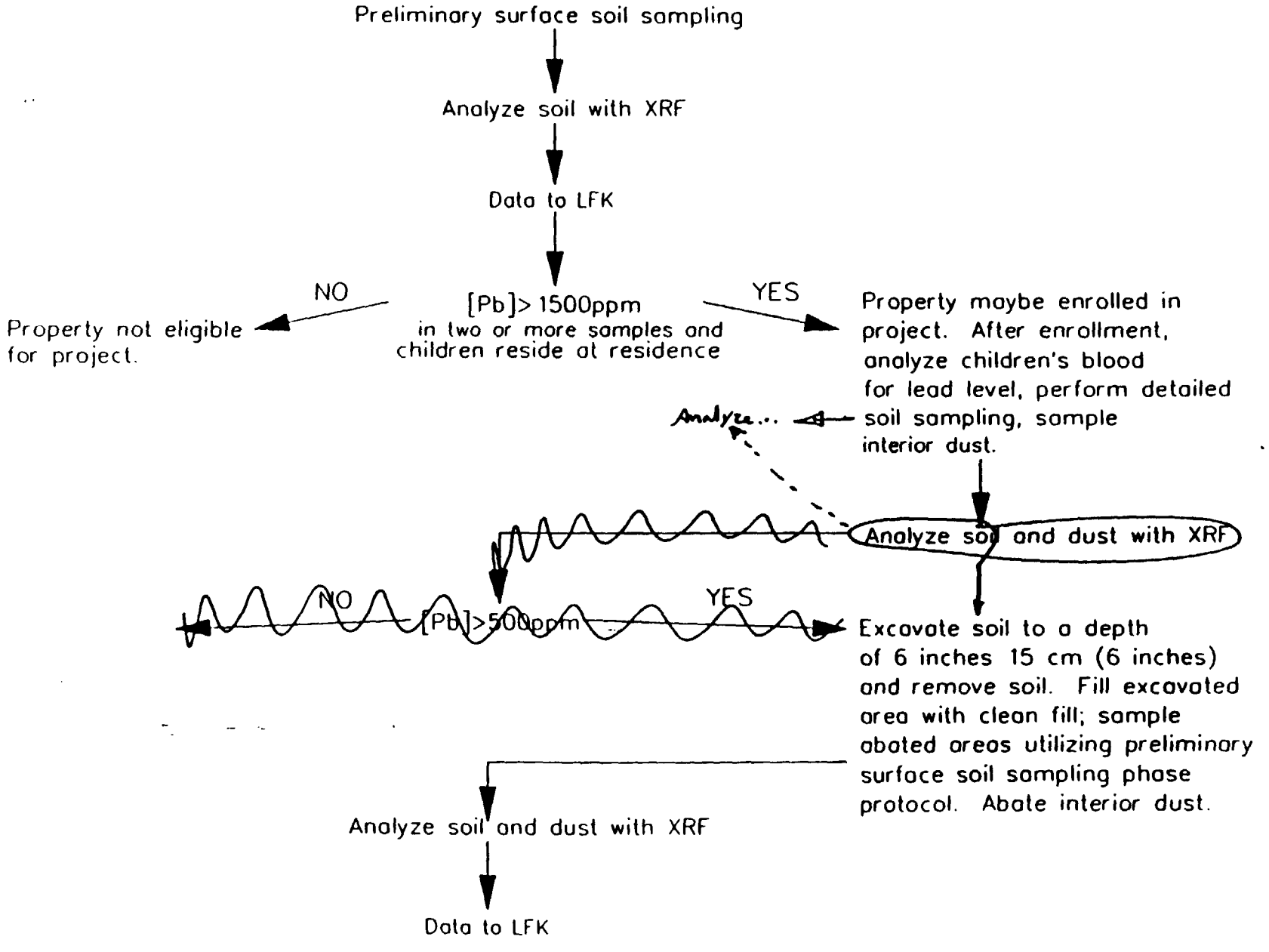
After properties are selected and signed up to be in the project, they will undergo detailed soil sampling. Soil samples will be collected at the surface and from corings 15 centimeters below surface by the project staff according to attached protocols, using one or more of the defined patterns: line source, targeted area, small area, or grid patterns. Pattern selection will be based upon the layout of the subject property at the discretion of the sample crew chief. Sketches indicating property details and sample locations will be made by the samplers. The samples will be transported to the EPA Region I laboratory as described in the protocols and analyzed on XRF. Results of the detailed sampling and analysis will be forwarded to LFK for interpretation.

Post Abatement Soil Sampling

Properties will be sampled after abatement activities. The purpose of this is two-fold. Firstly, to document the effectiveness of abatement activities, and establish a control point (i.e., the abated property). Secondly, to document lead concentrations in the soil at later dates in order to determine if lead concentrations in the soil have changed since abatement activities. Soil sampling conducted immediately after abatement will be confined to the abated areas, and be conducted in the same pattern as was previously used. Periodic, post abatement sampling will be conducted in areas which previously had the highest concentrations of lead, play areas, or any locations otherwise specified by the principal investigator. Soil sampling will follow the protocol utilized during the preliminary sampling phase of the project. Analysis will be by XRF at the EPA Region I laboratory.

Figure 3-1

Demonstration Project Flow Chart



Dust Sampling

Dust sampling will be conducted in interior areas on hard surfaces, according to the LFK protocol. Modified "Dust Busters" will be used to collect dust from areas identified by a template (24x24 or 25x25 inches), the sample will be placed in a paper, legal sized envelope, sealed, and delivered to the EPA lab for XRF analysis.

3.3 Project Objectives

The main objective of the Boston Lead-in-Soil Demonstration Project is: to determine the effects of lead contaminated soil removal from inner city residential areas on blood lead levels of children living on the contaminated properties. A secondary objective is to measure the effects, if any, on the blood lead levels of children after dust abatement on those same properties.

3.3.1 Major Task Summary

The Boston Lead-in-Soil Demonstration Project will include field and laboratory activities by EPA Region I and Trustees. A summary of tasks covered by this QAPjP is presented below.

- preparation of a Health and Safety Plan that will identify potential hazards associated with the planned field activities, establish the level of protection, and provide information and procedures needed to mitigate these hazards for on-site workers;

- preparation of Sampling and Analysis procedures to be utilized by personnel in obtaining soil and dust samples for analysis and for personnel conducting soil and dust analyses in the laboratory. For soil, this will include procedures for conducting site surveys for the purpose of preparing site grids, and obtaining preliminary, detailed and post-abatement soil samples, and procedures for laboratory analysis. For dust, this will include procedures for collecting and analyzing;

- conduct preliminary soil sampling at selected properties according to established protocols;

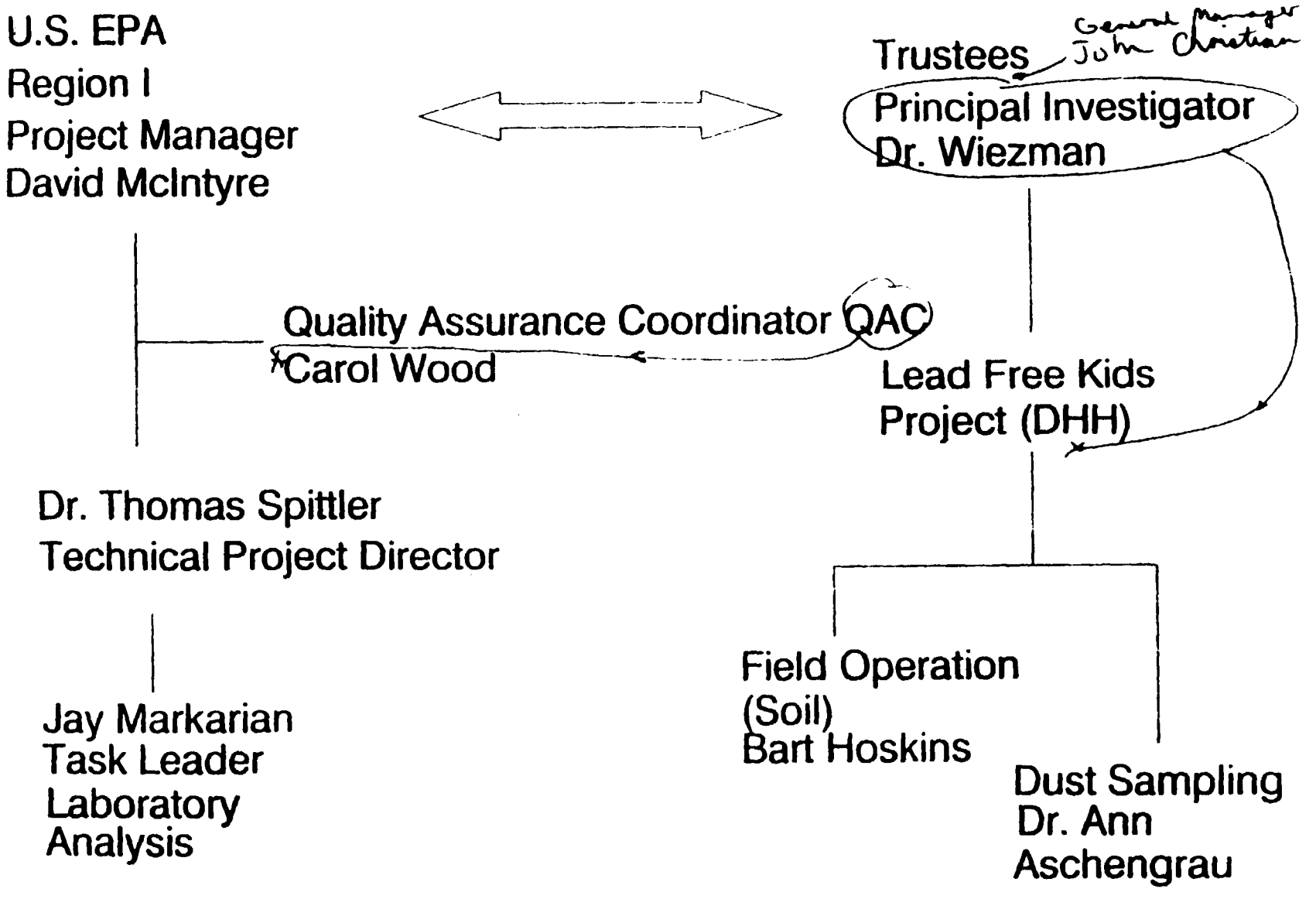
- conduct detailed soil sampling at selected properties with full site documentation as specified in the protocols;

- conduct dust sampling at selected properties as specified in the protocols;

- analysis of all soil and dust samples using the techniques of energy dispersive X-ray fluorescence, and of a fraction of the samples using Inductively Coupled Plasma Emission Spectrophotometry; and

- post abatement soil sampling of properties according to protocols.

FIGURE 4-1
PROJECT ORGANIZATION



4.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

4.1 Organization

This project is being financed through the EPA under SARA as part of a three project effort to define the lead-in-soil/childhood lead poisoning relationship. Each of the three projects are responsible for their own operation and findings. EPA Region I and the Trustees of Health and Hospitals of the City of Boston, Inc. have entered into a cooperative agreement to conduct this Demonstration Project. The Trustees are responsible for the operation and findings of the Boston project, including all scientific and logistical facets. The EPA's responsibility, as a partner in the cooperative agreement with the Trustees, is to ensure that (1) the money allocated to the Boston project is spent appropriately according to federal regulations, (2) that involved federal agencies are coordinated, and (3) that EPA's input as defined in the Special Conditions is provided. It is Region I's position that it will closely monitor the activities of the Trustees and work with them on the project, but that the Trustees are running the project. The responsibilities and project organization are discussed below.

4.2 Responsibility for Quality Assurance

- EPA Support to the Project

  The Region I Environmental Services Division (ESD) Laboratory and their contractors will provide personnel and facilities for energy dispersive x-ray fluorescence spectrometry (XRF), and inductively coupled plasma spectroscopy (ICP) analyses for lead in soil.

  The ESD and their contractors will also provide technical guidance and services related to the collection and chemical analysis of soil samples obtained during field activities and will serve as sample custodian during sample analysis. In addition, they will provide support in developing the QAPjP, perform analytical data review and report generation.

- Trustees Support to the Project

  The Trustees will provide equipment, laboratory supplies and personnel necessary for on-site sampling soil removal activities, blood sampling, dust sampling, and all other project activity not specifically provided by EPA.

Figure 4-1 shows the project organization and its principal lines of communications. The responsibilities of the EPA and Trustees' project staff positions and support organizations are summarized below:

For the EPA:

- The Project Manager is responsible for:

  1. Maintaining coordination between the EPA and the Trustees.
  2. ~~Monitoring all project activities.~~ Ensuring completion of EPA responsibilities as specified in the special conditions of the cooperative agreement.
  3. Providing overall direction for preparation of work plans, sampling plans, and analytical procedures relative to soil and dust.
  4. Administering all contracts with EPA contractors.

  The Project Manager is David McIntyre.

- The Technical Project Director is responsible for:

  1. Approving, maintaining, and implementing this QAPjP for EPA-conducted activities, i.e., sample analysis.
  2. Indicating the types of QA records to be maintained for the analytical portion of the project.
  3. Approving analytical procedures and operating systems.

  The Technical Project Director is Dr. Thomas Spittler or designee.

- The Quality Assurance Coordinator (QAC) will be responsible for:

  1. Evaluating and approving this QAPjP.
  2. Scheduling and conducting systems and performance audits on-site and in the Laboratory.
  3. Providing QA reports to the Project Manager on the results of audits and the need for preventative or corrective actions.

4. Developing and initiating preventative and corrective actions as needed in conjunction with the Project Manager and the Technical Project Director.

The Quality Assurance Coordinator (QAC) is Carol Wood or designee.

For the Trustees:

- The Principal Investigator is responsible for staffing and conducting the project, except for activities having to do with sample analysis which will be provided by EPA. As part of his QA responsibilities he will:

  1. Approve, maintain, and implement this QAPjP as it relates to LFK activities, i.e., sample collection.

  2. Indicate the types of QA records to be retained for the LFK aspects of the project, and retain such records.

  3. Provide for QA audits by EPA.

  4. Approve task plans and operating systems.

  The Principal Investigator is Dr. Michael Weitzman.

- LFK Task Leaders are responsible for specific engineering and scientific operations. As part of this responsibility they will:

  1. Initiate, develop and check subtask plans including initiating, monitoring, and accepting support services and products.

  2. Identify safety hazards and ensure that the associated risks are at acceptable levels.

  3. Supervise and participate in operations, analyses, data collection, and data reduction.

  4. Maintain samples and their identification.

5. Develop site sketches, identify sample locations, buildings, and appropriate structures, identify notable site specific conditions and observations to include photographs, identify clean soil zones and those to be abated.

6. Generate required QA records.

7. Implement corrective actions, when required.

LFK Task Leaders will be named by the Principal Investigator.

5.0 QUALITY ASSURANCE OBJECTIVES

5.1 General

The quality of measurements made during this study will be determined by the following characteristics: accuracy; precision; representativeness; completeness; and comparability. Specific objectives for each characteristic are established to develop sampling protocols, to identify applicable documentation, and to perform sample handling and measurement procedures. These objectives are established based on site conditions, objectives of the project, and knowledge of available measurement systems. The subsequent use of these measurements in calculations and evaluations is also subjected to aspects of this QAPjP as described in the following sections. The Quality Assurance Objectives for chemical analyses conducted in conjunction with the Boston Lead Free Kids project are presented in Table 5-1.

The Trustees (Lead Free Kids) will collect all samples and provide site-specific field documentation and transport samples to the ESD Laboratory maintaining chain of custody from collection to delivery at the ESD Laboratory. Sample collection and field handling will be in accordance with the sampling protocols established in this QAPjP. Soil and dust samples will be analyzed at the EPA Region I ESD Laboratory in Lexington, Massachusetts. Analytical laboratory QA/QC discussion is presented in Section 9.0.

5.2 Representativeness

Sampling procedures (Section 6.0) will be used to assure that samples collected are representative of the media. Sample handling protocols (e.g., storage and transportation) protect the representativeness of the collected sample. Proper documentation will ensure that protocols have been followed and that sample identification and integrity are assured.

Sample preparation procedures (Section 9.3.1 - Soil and Dust) will be used to assure that the samples analyzed are representative of the fraction which poses the greatest risk to the public.

5.3 Precision and Accuracy

Precision, the ability to replicate a value, and accuracy, the ability to reproduce a true value, are addressed for all data generated by EPA. Data quality objectives for precision and accuracy are established for each major parameter to be measured at the site. These objectives are based on prior knowledge of the capabilities of the measurement system to be employed, and are in turn selected in accordance with the requirements of the project. The precision and accuracy requirements vary, dependent on their

TABLE 5-1

Data Quality Objectives for Lead in Soil Analyses

Method Detection Parameter	Method	Instrument	Reference[b]	Precision[d]	Accuracy[e]	Complete-ness[f]	Comparability	Method Limit[g]
Lead (Pb) -Soil	XRF[a]	Oxford LX1000	--	±20	±20	90	mg/kg dry wt.[i]	200 (mg/kg)
Lead (Pb) -Dust	XRF	Kevex 0700	—	±20	±10	90	mg/kg dry wt.[i]	100 (mg/kg)
	ICP[i]	Perkin Elmer	6010[c]	±10	±10	90	mg/kg dry wt.	42 (ug/L)

a. Energy dispersive x-ray fluorescence spectrometry

b. Copies of methods are attached as appendices

c. SW 846, 3rd Ed.

d. Percent relative standard deviation from mean or true value

e. Relative percent difference

f. Percent

g. Nominal detection limits, soil MDL estimated from sample size and concentration factors (units) mg/kg

h. Air dry overnight in laboratory hood at ambient temperatures

i. Inductively Coupled Plasma Emission Spectrophotometry

TBD = To be determined

intended use. For example, a screening tool to identify the general extent of chemical distribution will not require the same precision and accuracy required to define the exact nature and amount of chemicals present at specific locations.

5.4 Completeness

The characteristic of completeness is a measure of the amount of valid data obtained compared to the amount that was specified to be obtained under normal conditions. The amount of valid data specified is established based on the measurements required to accomplish project objectives. The extent of completeness must be reviewed on a relative basis for sample collection activities. Completeness of data handling systems is described in Sections 10.0, 11.0, 12.0, and 14.0. Examples of completeness objectives for specific measurement systems are also provided in Table 5-1.

5.5 Comparability

The characteristic of comparability reflects both internal consistency of measurements made at the site and expression of results in units and methodologies consistent with other organizations reporting similar data. Each value reported for a given measurement should be similar to other values within the same data set and within other related data sets. Comparability of data and measuring procedures must also be addressed. This characteristic implies operating within the calibrated range of an instrument and utilizing analytical methodologies which produce comparable results. (e.g., data obtained for lead (ICP) is not directly comparable to data obtained for lead (XRF). However, it is a Quality Assurance Objective to define the limits of comparability by submitting samples analyzed by XRF for ICP analysis and comparing their results).

5.6 Quality Assurance Objectives

The quality assurance objectives for the Demonstration Project are:

- to produce documented, traceable, and consistent data;
- to collect and analyze sufficient trip blank and field duplicate samples to allow an assessment of sample collection protocol precision;

- to provide sufficient laboratory duplicates, blanks, replicates, and reference standards to allow an assessment of analytical precision and accuracy. Sufficiency of analytical QC procedures is specified by the referenced methods (see Section 9.0);

- to produce documented, consistent, and technically defensible data reports; and

- to conduct site sampling and site-specific documentation according to established protocols.
- to define comparability of XRF and ICP obtained analytical data so as to allow XRF data to be compared to other organizations conducting similar studies.

6.0 SAMPLING PROCEDURES

6.1 General

Soil

Three soil sampling events will be conducted during the Demonstration Project. They are

- Preliminary Sampling;
- Detailed Sampling; and
- Post Abatement Sampling.

Preliminary sampling is the initial phase of sampling, and will qualify a property for further participation in the project. Detailed sampling will indicate the nature and extent of lead contamination. Post abatement sampling will indicate effectiveness of abatement, and provide additional data to be utilized in future lead abatement efforts.

All sampling locations will consist of a five point composite. The center point of the composite will fall upon the pre-determined sample station. Each sample location will consist of soil collected from the center point and four corners of the square. This is illustrated in Figure 6-1.

No preservatives will be required for soil samples. Sample containers will consist of plastic "Zip-Lock" bags. Sample collection schemes and field documentation will differ, based upon which phase of sampling (preliminary, detailed, or post abatement) is being conducted.

Dust

Dust sampling events will be conducted in conjunction with soil sampling and other scheduled activities on-going throughout the Demonstration Project.

For this study, the household dust samples are defined as the samples that are most likely to come into contact with a child's hands during indoor activity. This would include dust on upfacing surfaces accessible to the child such as bare floors, carpets, window sills, and wells, furniture, as well as dust on toys and other objects likely to be handled by children.

Dust sampling has two components that are important to interpreting lead exposure: the concentration of lead in the dust and the amount of dust or loading on the surface. The concentration of lead in dust appears to be closely related to the amount of lead on children's hands whereas the amount of dust on surface is an indicator of the importance of this route of human exposure.

All sampling locations within a home will consist of a measured surface area from which dust will be collected using a modified hand-held vacuum (Dust Buster).

No preservation will be required for dust samples. Sample transferred from the dust buster will be contained in a paper envelope.

Caps

6.2 Equipment List

Several items are required to collect soil and dust samples and document sampling events, site description, etc. Because many properties shall be investigated and several samples collected from each property, an adequate supply of equipment should be available at all times.

A list of equipment is provided in each of the four sampling protocols found in Appendix A. Additional equipment not on the list may be required on a site specific, as-needed basis.

6.3 Sample Collection

Soil

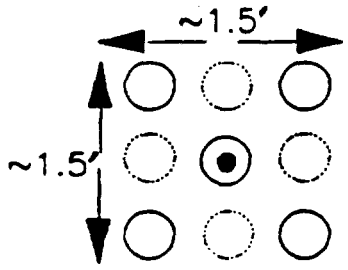
Each sampling point will consist of an approximate two-foot square area. The center of the square will fall upon the decided sampling point, and a composite sample will be collected, composed of soil taken from the four corners and center of the square. Preliminary Phase and Post Abatement Phase samples will be collected from 0 to 2 cm below the surface. Detailed Phase samples will be collected from 0 to 2 cm below the surface, and an additional core sample will be collected from 13 to 15 cm below the surface, from the same point. Figure 6-1 illustrates A - Preliminary and Post Abatement, and B - Detailed Soil Sample Collection. In depth discussion of sampling techniques, to be utilized during all phases of sampling, are provided in Appendices A-1, A-2, A-3 and A-4.

Dust

Each sampling point will be collected from a known square area using a modified Dust Buster. Floor and hallway areas will be sampled first using a 25" x 25" template. These samples will be collected from the center of the floor. Samples will then be collected from window wells and other areas with the square area sampled documented. A minimum of 5 milligrams of sample is

FIGURE 6-1

5 Point Composite Sample Scheme



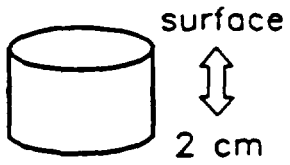
Legend

- ● Sampling Station
- ○ Sample Composite Location
- ◌ Field Duplicate Sample Composite Locations

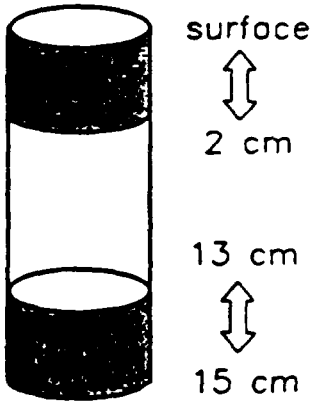
(At selected sampling stations duplicates will be collected at mid-points between sample composite locations.)

A
Preliminary and Post Abatement Phase Surface Sample Composite Location Schematic

B
Detailed Phase Surface and Subsurface Sample Composite Location Schematic



Sample collected from surface to 2cm below surface.

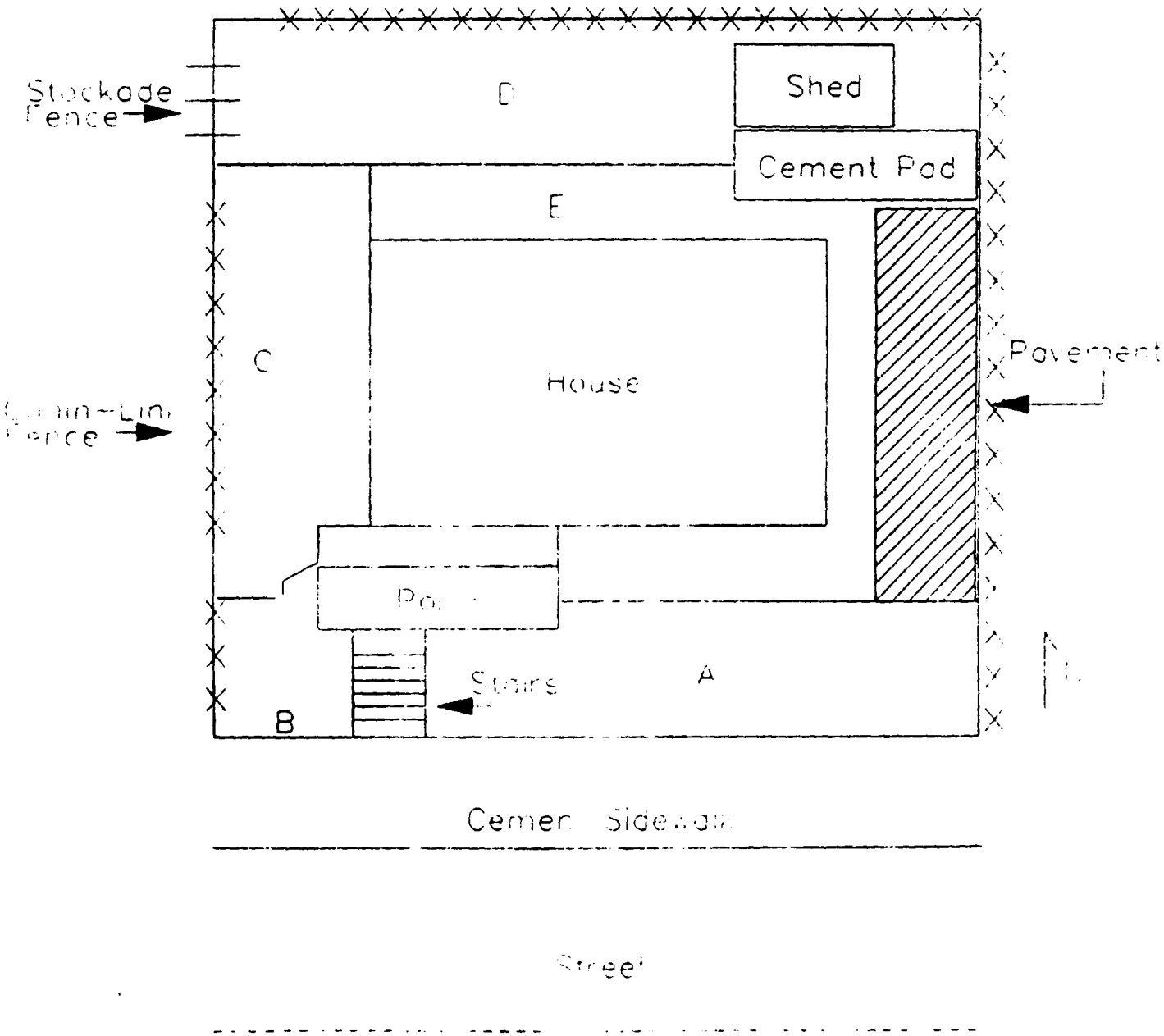


First sample collected from surface to 2 cm below surface.

Second sample collected from 13 cm to 15 cm below surface in same boring location.

FIGURE 6-2
Detailed Site Diagram

Address: _____ Date: _____



required for analysis. This may necessitate sampling and recording a larger floor or window well surface area. In-depth discussion of sampling procedures to be utilized during dust sampling are provided in Appendices A-4.

6.4 Sample Handling and Storage

The soil sample containers (polyethylene "Zip-Lock" bags, or equivalent) should be sealed to prevent loss or cross-contamination of the sample. Dust sample containers (paper envelopes) should be folder over 1/2 inch from the top and then taped down to prevent loss or cross contamination of the sample. No special considerations will be given to sample packaging or shipping papers as the samples will be delivered to Environmental Services Division (ESD) Laboratory by a member of the LFK staff. Pending delivery to EPA, samples should be stored in a cool, dry, and secure location with limited, controlled access. — Tom?

6.5 Record keeping

Sampling records, maintained by LFK, for each property will consist of a site sketch for soils and floor plan for dust with location descriptions and chain of custody record for each sample collected. Samples shall be assigned LFK field identification numbers to include premises identification number with a sequential alpha numeric designation, and located on the site sketch and summarized in a Blood Field Sampling log book. Chain of custody shall be established as described in Section 7.0.

6.6 Preliminary Soil Sampling

6.6.1 Site Description

During this phase of sampling, LFK will generate a detailed drawing that indicates the boundary of the lot, the position of the main building and any other buildings such as storage sheds or garages, the position of the side walks, driveways, and other paved areas, the position of the play areas, if obvious, and the areas with exposed soils, as illustrated in Figure 6-2. The property should be divided into separate sub-areas if necessary for clarity or detail and be identified with alpha designation. Sub-areas may include isolated areas of the site such as front, rear, and side yards. Sample locations will be identified on this drawing, indicating approximate distances from buildings and other landmarks. The resulting sketch will be placed in the property file at the LFK office.

In addition to the sketch, the following information will be included on the page:

- Address;
- Date and name of artist;.
- Apparent use of yard if any (toys, sandbox, children present);
- Debris, standing water, vegetation, cover and bare spots, animals on property; and
- Any notable unusual feature.

6.6.2 Sampling Schemes

The sampling scheme utilized for each property during the Preliminary Phase will be the same for each one, and will involve sampling in the immediate area of the house and in obvious play areas. This protocol is described in Attachment A-1.

6.7 Detailed Soil Sampling

6.7.1 Site Description

During the Detailed Soil Sampling Phase for each location, the project log should briefly describe the sampling locations and sampling schemes used, and include the following information if not provided by preliminary investigation:

- address;
- date and name of Artist;
- type of building construction;
- condition of main building;
- condition of lot (debris, standing water, vegetation cover);
- nature of adjacent property;
- presence and type of fence;
- animals on property;

- apparent use of yard (toys, sandbox, children present); and
- underground utilities.

6.7.2 Sampling Schemes

The sample scheme selected must adequately characterize the potential exposure of children to lead in the soil. The scheme utilized should reflect the size and proportions of the area to be sampled (see the protocols for details). Several options are offered for the best judgement of the investigator, and include:

- Line Source (LS) Pattern;
- Targeted Method (TM);
- Small Area (SA) Pattern; and
- Grid (G) Pattern.

Sampling Schemes are detailed in Appendix A-2.

6.8 Post-Abatement Sampling

Post-abatement sampling will be conducted in order to determine the effectiveness of abatement activities, and to monitor lead levels in the soil. Sampling shall be conducted in the same sampling locations as were used for the Preliminary Soil Phase Sampling (Section 6.6). The principal investigator will designate number of samples and specific location of these points. Detailed description of the sampling procedure is found in Appendix A-3.

7.0 CHAIN-OF-CUSTODY

7.1 General

EPA has established a program of sample chain-of-custody that is followed during sample handling activities in both field and laboratory operations.

Chain-of-custody procedures document the sample history and constitute a crucial part of sampling and analysis programs. Chain-of-custody documentation verifies the identification and history of a sample from collection through the time of analysis.

The objective of sample custody identification and control is to ensure that:

- all samples scheduled for collection, as appropriate for the data required, are uniquely identified;
- the correct samples are analyzed and are traceable to specific analysis records;
- important sample characteristics are preserved;
- samples are protected from loss or damage;
- any alteration of samples (e.g., filtration, preservation) is documented;
- a record of sample integrity is established for legal and technical purposes; and

The chain-of-custody record is used to:

- document sample handling procedures, including sample location, and sample number; and
- describe the chain-of-custody process.

The chain-of-custody description section requires:

- the sample number;
- the name(s) of the sampler(s) and the person shipping the samples;
- the date and time that the samples were delivered for shipping; and
- the names of those responsible for receiving the samples at the laboratory.

Samples of a chain-of-custody record for soils and dust samples are shown in Figure 7-1 and Figure 7-2 respectively.

As samples are collected, entries are made on the chain-of-custody forms. Data to be noted include:

- Date/Time;
- Samplers;
- Sample phase description ie. for soils: preliminary, detailed, post abatement or special study and for dust: post abatement, preabatement or other;
- Client/program;
- Analyses required;
- Special instructions/notes and
- Sample Identification information to include Premiss ID and Field ID numbers.

check

Soil and dust sample containers, will be labelled by LFK samplers with an indelible marker with station number/sample number and other appropriate information necessary to match the sample container to the Chain-of-Custody Record. (see Figure 7-3 and 7-4).

The station number/sample number shall be such as to allow tracking of the sample from its source of collection through analyses and be consistent with other site sample location identification systems.

When samples are received at the laboratory, the Laboratory Task Leader or Analyst will verify each and every sample against the chain-of-custody forms, note any discrepancies or losses of samples, and then sign for receipt of the samples. The laboratory task leader may also contact field personnel to resolve deficiencies, irregularities, discrepancies, etc., prior to accepting the samples. Samples will remain under the control of the laboratory task leader until samples are ultimately disposed of .

A sample is considered to be in custody if it:

- is in the physical possession of the responsible party;
- is in view of the responsible party;
- is secured by the responsible party to prevent tampering; or
- is secured by the responsible party in a restricted area.

Figure 7-1

- Soil -

Lead-In-Soil Demonstrtation Project

Chain-of-Custody Record

Prem. ID	Samp ID	Address	Dist.	Date Collected	Collected By

Relinquished By	Received By	Date	Time	Comments/Instructions

Figure 7-2

- Dust -

Lead-In-Soil Demonstrtation Project
Chain-of-Custody Record

DUST SAMPLES DATA FORM, STUDY PHASE _____

PREMID: _____ Address: _____ Apt No. _____

Date sample taken: _____ Taken by: _____

LFK children in this apartment: NAME, LFK NUMBER, and BEDROOM CODE(if needed)

_____ _____

_____ _____

	ROOM CODE	PLACE CODE	NOTE AREA	OR	CIRCLE TEMPLATE TYPE		SAMPLE WEIGHT	SAMPLE PPM	LABID
1.	____	____	____	x ____	25x25	24X24	_____	_____	_____
2.	____	____	____	x ____	25x25	24X24	_____	_____	_____
3.	____	____	____	x ____	25x25	24X24	_____	_____	_____
4.	____	____	____	x ____	25x25	24X24	_____	_____	_____
5.	____	____	____	x ____	25x25	24X24	_____	_____	_____
6.	____	____	____	x ____	25x25	24X24	_____	_____	_____
7.	____	____	____	x ____	25x25	24X24	_____	_____	_____
8.	____	____	____	x ____	25x25	24X24	_____	_____	_____
9.	____	____	____	x ____	25x25	24X24	_____	_____	_____
10.	____	____	____	x ____	25x25	24X24	_____	_____	_____

ROOM CODES:

K - Kitchen
L - Living Room
D - Dining Room
B1 - Bedroom 1
B2 - Bedroom 2 (etc.)
O1 - Other _____

PLACE CODES:

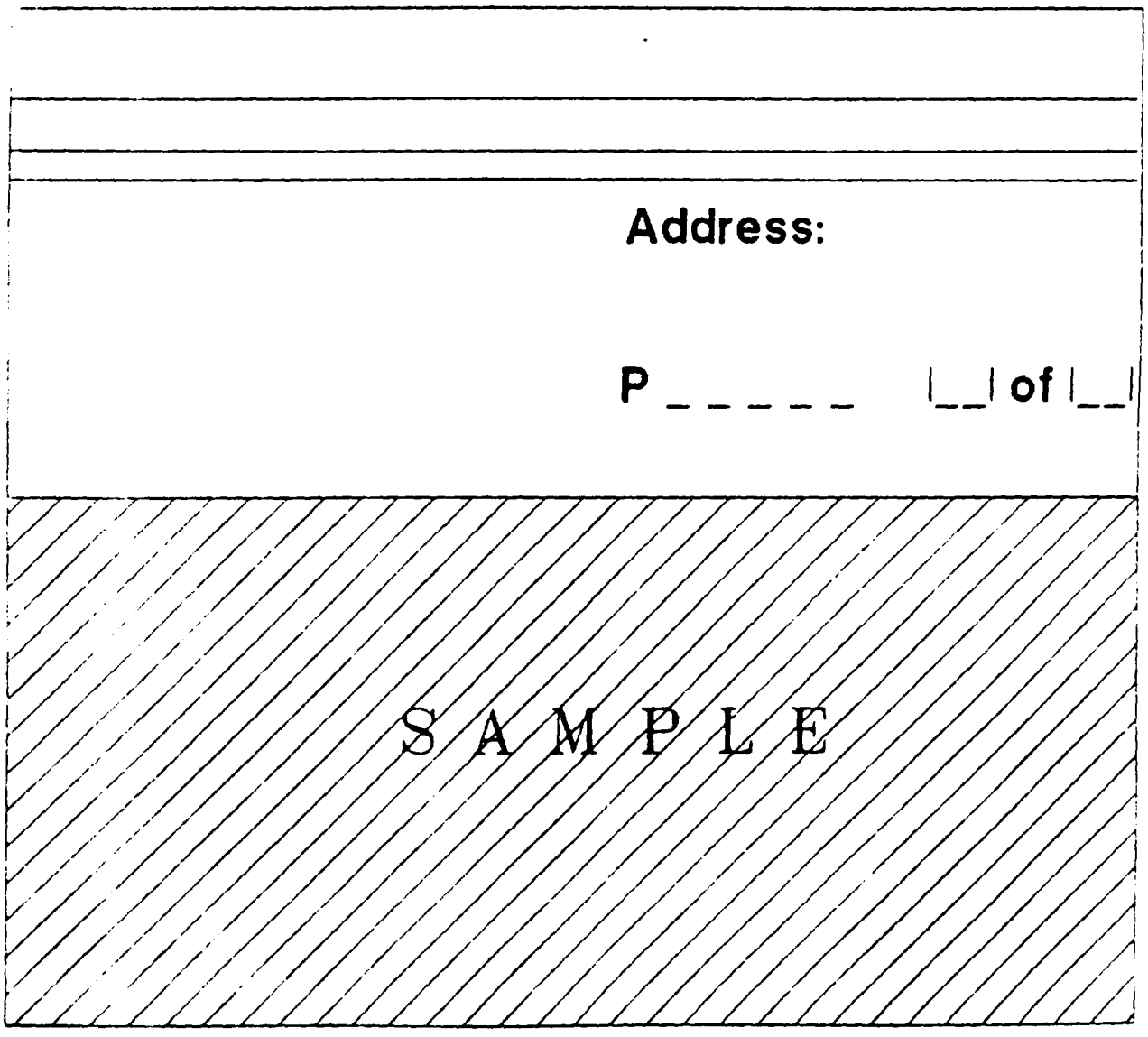
F - Floor
W - Window
O - Other _____

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Relinquished by: (Signature)	Date / Time	Received for Laboratory by: (Signature)	Date / Time	Remarks	

FIGURE 7-3

Soil
Sample Container with
Sample Label

Plastic Ziplock Bag or Equivalent - Soil

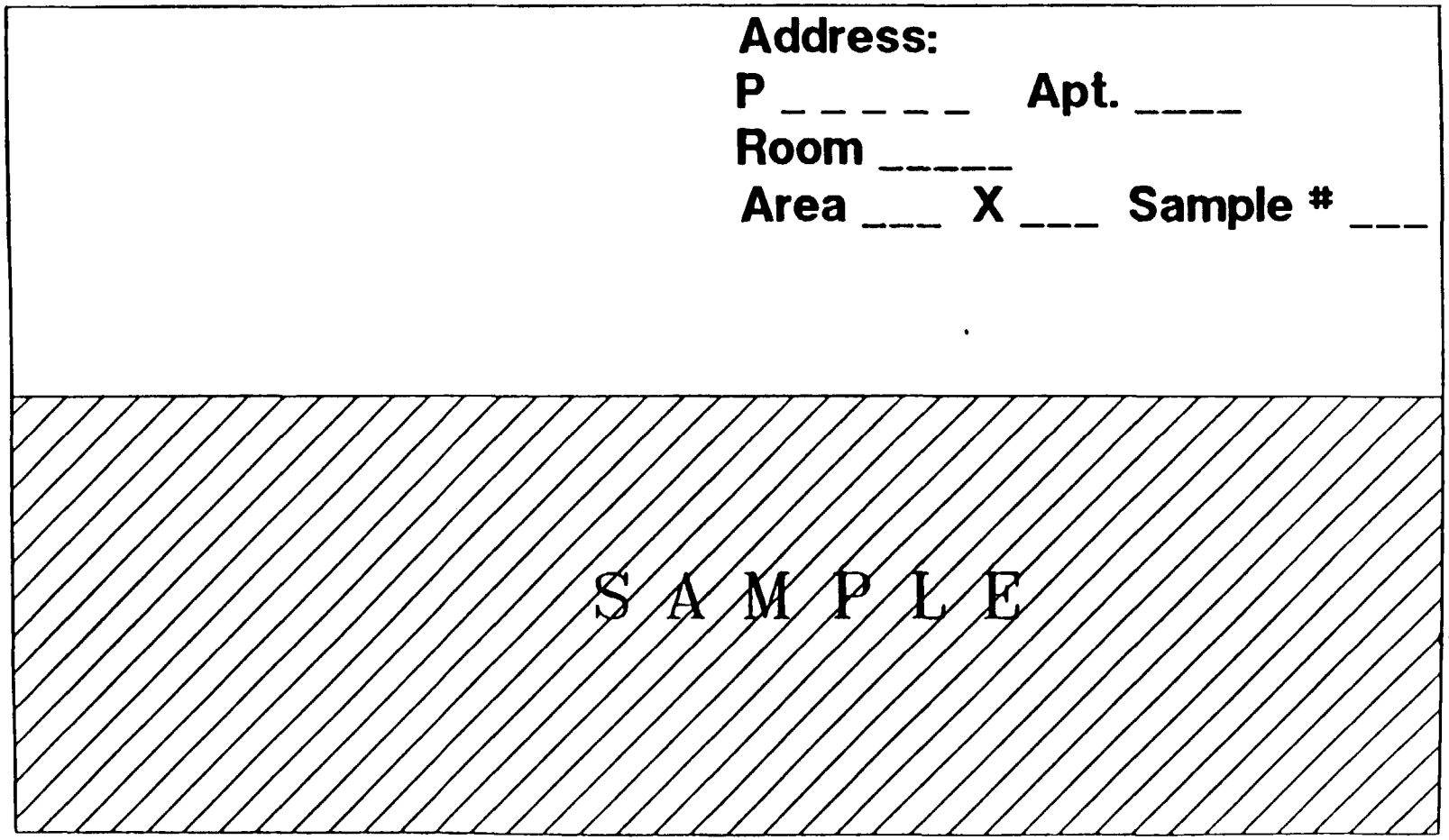


~ To Scale

FIGURE 7-4

Dust
Sample Container with
Sample Label

Paper Envelope - Dust



~ To Scale

7.1 Sample Receipt

All soil samples will be delivered to the Environmental Services Division Laboratory in Lexington, MA. by a member of the LFK field sampling team. Upon receipt chain-of-custody and sample integrity are to be checked and any problems recorded. Samples will then be logged in by EPA personnel or their contractors who will accept and sign the chain-of-custody record. The EPA project Manager will be informed of any deficiencies and will advise the laboratory on the desired disposition of the samples. Chain-of-custody forms and deficiency notices are maintained in the Laboratory's Project file.

Each sample that is received by the laboratory is assigned a unique sequential Laboratory Identification number which will identify the sample in the laboratory's internal tracking system. The flow of samples and analytical data through the laboratory is shown in Figure 7-5 for soil and dust.

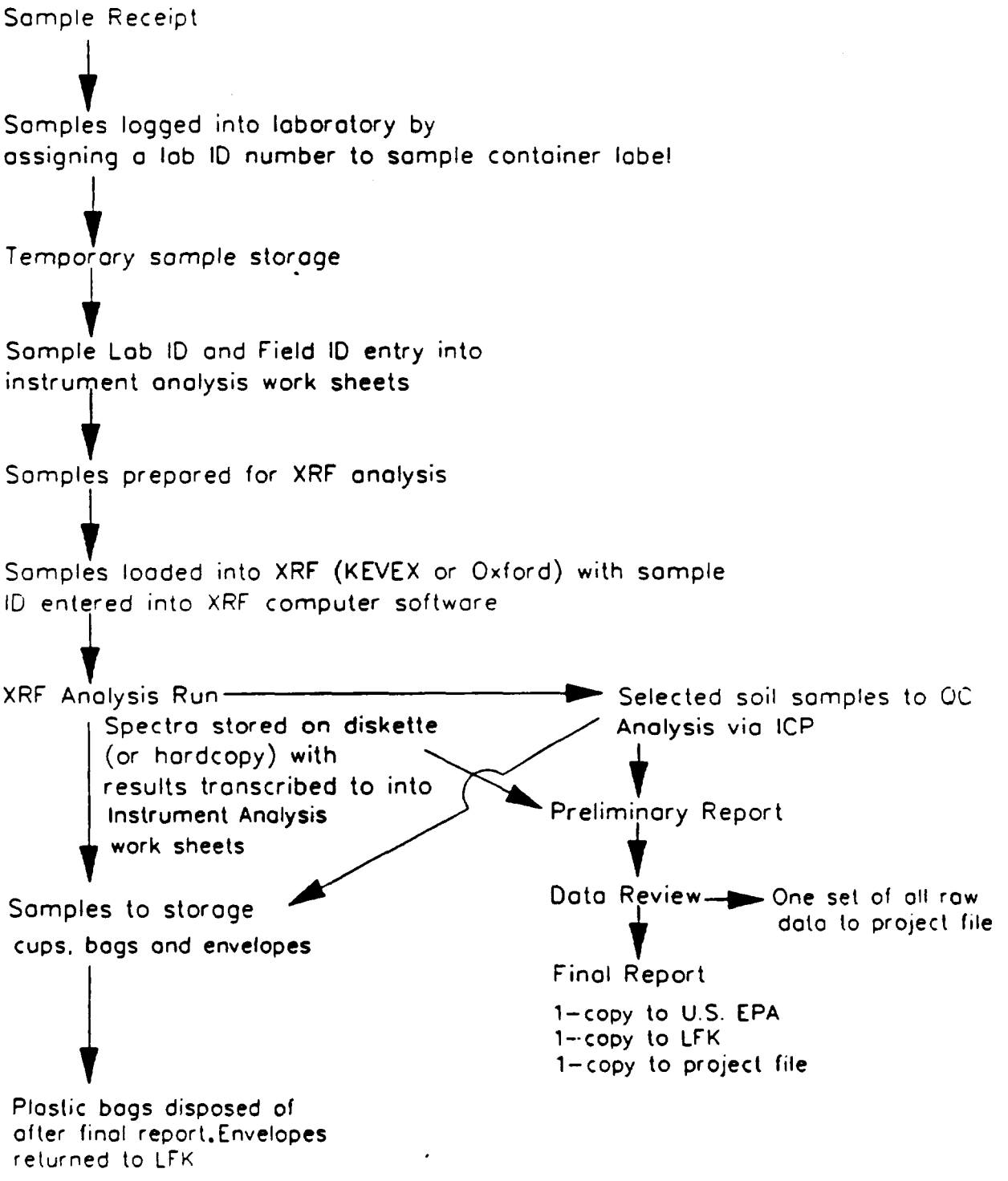
7.2 Sample Storage

All soil samples will be stored in a secure sample storage bank at the Region I ESD Laboratory facility.

Original sample containers (plastic baggies for soil and envelopes for dust), and laboratory analysis containers will be stored until each data report is finalized. Soil containers (plastic baggies) will be disposed of and envelopes returned to LFK staff. Analysis containers will be kept for duration of the project, a minimum of 3 years.

FIGURE 7-5

Sample and Data Progression Through Laboratory



8.0 CALIBRATION PROCEDURES AND FREQUENCY

8.1 Overview

Before any instrument can be used as a measurement device, the instrumental response to known reference materials must be determined. The manner in which the various instruments are calibrated depends upon the particular instrumentation and the intended use of the instrument. All sample measurements will be made within the calibrated range of the instrument. Preparation of all reference materials used for calibration will be documented in a standards preparation notebook. Good laboratory practices require general calibration procedures that should include:

- Preparation of standards that represent the range of concentrations of concern in the samples;
- For soil establishment of a concentration/response factor with a minimum of three points, using the standards prepared above and for dust, establishment of concentration/response spectra with a minimum of two points in both high and low sample weight ranges also using the standards prepared above;
- A set of secondary standards that can ultimately be traced to National Bureau of Standards (NBS) primary standards.

Inductively Coupled Plasma Spectrophotometry and X-ray Fluorescence are the two methods of analysis for the Demonstration Project. A separate discussion of calibration procedures and frequency for each of these measurement systems including each of the two X-Ray units used presented below.

8.2 Calibration and Frequency Procedures for Inductively Coupled Plasma Spectrophotometer

8.2.1 Calibration Procedures

The methods employed will be adapted from established EPA Methods as outlined in "Test Methods for Evaluating Solid Waste", SW 846, 3rd Ed., U.S. EPA Office of Solid Waste and Emergency Response, Nov. 1986. The quality assurance protocols are based upon the guidelines in "Handbook for Analytical Quality Control in Water and Wastewater Laboratories", EPA 600/4-79-0019, March 1979; "Methods for the Chemical Analysis of water and Wastewater", EPA 600/4-79-020, March 1983; and "Test Methods for Evaluating Solid Waste", EPA SW846, Nov. 1986.

Inductively Coupled Plasma spectrophotometer (ICP) will be calibrated each day before samples are analyzed. Calibration standards will be prepared from certified reference materials. Working calibration standards should exceed 6 month past date of preparation or exceed expiration date of the reference material. The working standards will include a blank and a minimum of three (3) concentrations to cover the anticipated range of measurement.

Duplicate injections will be made for each concentration. At least one of the calibration standards will be at the desired instrument detection limit. The correlation coefficient of the plot of known versus found concentrations will be at least 0.990 in order to consider the responses linear over the range to be tested. If a correlation coefficient of 0.990 cannot be achieved, the instrument will be recalibrated prior to analysis of samples. If a secondary wavelength is being used to detect lead a calibration must also conform with calibration procedures below.

Calibration data, to include the correlation coefficient, will be entered into laboratory notebooks to maintain a permanent record of instrument calibrations.

The following standards should be utilized for ICP analyses:

- Initial Calibration - ICP. New standards are prepared for each calibration sequence. Initial calibration is performed using a blank sample and at least three standards. A regression analysis is used to construct the calibration curve. Any regression with a coefficient of correlation below 0.990 is considered unacceptable and a re-calibration is required. Instrument calibrations are from microprocessor outputs, with chart-recorder graphs as supplemental documentation.

- Continuing Calibration. One of the calibration standards preferably at mid-range is analyzed every 10 samples to verify instrument stability. Results for the continuing calibration analysis must fall within the control limit of ±10 percent of the established mean value or re-calibration is required. Verify calibration every 10 samples and at the end of the analytical run, using a calibration and a single point check standard.

- Reference Standard. Independent reference standards traceable to NBS standards are analyzed to verify instrument performance. Any reference standard value outside the 95 percent confidence interval is considered suspect and re-calibration is required. This standard must be from a separate source than that of the certified reference material.

- Interference Check Solution. This solution should be analyzed at the beginning of each operating shift to verify the ability to detect lead at the specified wavelength without spectral interferences. The lead result should be within ± 20 percent of true value.

8.3 Calibration Frequency Procedures for X-Ray Fluorescence

8.3.1 Calibration Procedures for Soils Analysis using the Oxford XRF

The methods employed are based on accepted analytical procedures utilized in XRF analyses. The quality assurance protocols are based upon the guidelines outlined in "Test Methods for Evaluating Solid Wastes", EPA SW846, Nov. 1986.

The Oxford energy dispersive x-ray fluorescence spectrometer (XRF) will be calibrated prior to, during, and at the end of each day of use. A series of study control standards will be prepared from appropriate reference materials. Study control standards should include a blank and a minimum of four (4) concentrations spanning the anticipated range of measurement. Replicate analyses of study control standards will be performed for each concentration through the analysis day. At least one of the working study control standards will be at or below 1/2 the lowest action level. Calibration data to include calculation of the daily response factor will be entered into the laboratory analysis work sheets and placed in project files to maintain a permanent record of instrument calibration.

The following calibration standards should be utilized for Oxford XRF analyses:

- Study Control Standards (SCS). Daily calibration is performed using a blank sample and six SCS's. These will include the following concentrations of SCS's if available:

  0 ppm
  250 ppm
  400 ppm
  950 ppm
  1200 ppm
  2400 ppm
  4400 ppm

One of the SCS's is analyzed every 20 samples on a rotating basis to verify instrument stability. Results for this check sample must fall within the control limit of +/-20 percent of the day's established mean value or re-calibration is required.

- Reference Standard. Independent reference standards traceable to NBS standards are analyzed to verify instrument performance, (ia) available. Any reference outside of the 90 percent confidence interval is considered suspect and re-calibration is required.

8.3.2 - Calibration Procedures for Dust Analysis Using KEVEX 0700 XRF.

The methods employed are based on analytical procedures developed by Dr. Thomas Spittler USEPA for the KEVEX 0700 XRF analysis of dust. The quality assurance protocols are based upon the guidelines outlined in "test method for evaluating solid wastes", EPA SW846, Nov. 1986.

The KEVEX energy dispersive X-Ray Fluorescence Spectrometer (XRF) will be calibrated daily using a blank and a series of the four study control standards to generate calibration spectra for comparison to unknowns.

The first analysis run of the day will contain all four study control standards. In each of the following runs one of the 16 available analysis positions (in KEVEX Carousel) will contain one of these standards (* All standards are run manually).

Replicate analysis will be performed for each SCS through the analysis day. Calibration data to include results of the SCS analysis will be entered onto the laboratory analysis worksheets and the instrument software and placed in project files to maintain permanent record of instrument calibration.

Following calibration standards should be utilized for XRF analysis:

- Study Control Standards (SCS): Calibration is performed using a blank sample and the four SCS standards. These will include the following concentrations of standards and weight ranges.

Concentration	Weight	Name:	Samples to be used on
2500 ppm	10 mg	DustM-10-sequential #	0 - .024g
2500 ppm	50 mg	DustM-50-sequential #	> 0.25g
25,000 ppm	10 mg	DustH-10-sequential #	0 - .024g
25,000 ppm	50 mg	DustH-50-sequential #	> 0.25g

- Reference standard: Independent reference standards traceable to NBS standards are analyzed to verify instrument performance if available. Any reference outside of the 90 percent confidence interval is considered suspect and re-calibration is required.

SCS's have been prepared according to sample preparation procedures however, analysis is done manually as opposed to automatic analysis which is used for unknown samples. Daily calibration for each operating shift will contain all four standards and a blank. The set of SCS's will be run on the first carousel load of the day and will be used to generate comparison spectra used to calculate results of unknowns. The remaining 11 positions available in the carousel will be loaded will samples for analysis. In each of the following carousel runs, one of the 16 positions will contain one of these standards on a rotating basis. Results for this check control samples must fall within the control limit of ± 20 percent of the days established mean value or recalibration is required.

9.0 ANALYTICAL PROCEDURES

9.1 General

Analytical methods are routinely conducted as outlined in published sources (EPA, Standard Methods, ASTM, AOAC, etc.). Modifications to these methods may be necessary in order to provide accurate analyses of particularly complex matrices. When modifications to standard analytical methods are performed, the specific alternatives as well as the reason for the change will be reported with the results of analyses.

Laboratory reagents will be of a quality to minimize or eliminate background concentrations of the analyte to be measured. Reagents must also not contain other contaminants that will interfere with the analyte of concern.

9.2 Method of Analysis

The methods of analysis to be used in this project are Inductively Coupled Plasma (ICP) spectrometry and X-Ray Fluorescence (XRF). The XRF method is the suggested method for routine analyses. The ICP method should be used to verify lead concentrations in soil and dust and for other Quality Control/Quality Assurance determinations. All soil and dust samples for the LFK Demonstration Project will be prepared and analyzed according to the following procedures. A detailed description of sample analysis is found in Appendix B.

9.3 Sample Preparation (ICP/XRF)

A representative "urban soil sample" or "urban household dust sample" is defined as the sample fraction which passes through a 250 micron (#60 mesh) sieve.

Sample preparation requires that the samples be allowed to air dry overnight. Particle separation involves passing soil or dust through a 250 micron sieve. Light grinding of soils may be required to bring soils to disaggregation prior to the 250 micron sieving. This is necessary to provide low/appropriate variance in XRF analysis. For soil, aliquots of fines are then collected for both XRF and/or ICP analysis. Dust sample preparation will not require grinding prior to 250 micron sieving. However, the sample must be completely sieved and weighed. A minimum of 5 milligrams of dust is required for XRF analysis and no aliquots for ICP analysis will be prepared.

During the processing of the sample, it should be remembered that small soil and dust particles may individually be as high as 50,000 ug Pb/g, and paint fragments as high as 300,000 ug/g. Care should be taken to clean equipment (spatula, sieves, powder tunnels) between samples. The sieves and powder tunnels may be cleaned by tapping on a hard surface and blown free using compressed air to remove residual particles. Wet washing is not recommended as this will interfere with the sieving process. Detailed procedures for soil and dust sample preparation are found in Appendix B.

9.4 Atomic Emission Spectroscopy - ICP

9.4.1 Wet Digestion

The procedure used for digesting (solubilizing) the lead in soil is critical to the interpretation of the results of the Lead Free Kids Project - soil sample and dust sample analysis . EPA Method 3050, SW846 is a heated mineral acid digestion capable of leaching lead from the soil matrix and into aqueous matrix.

9.4.2 Analysis

Analysis by ICP, EPA Method 6010, SW846 3rd Edition, should be at 220.353 nm. This is the suggested protocol.

9.4.3 Quality Assurance/Quality Control (ICP)

The Laboratory Task Leader will provide the following QC samples:

- Laboratory Duplicates. One sample out of 20 is prepared and analyzed in duplicate. A control limit of +/-20 percent relative percent difference is used.

- Method Blanks. Procedural blanks are prepared and analyzed at a 5 percent frequency or one per batch digested if less than 20 samples.

- Matrix Spike/Matrix Spike Duplicate (MS/MSD). Duplicate samples are matrix spiked at ten times the detection limit prior to digestion at a frequency of 20 percent. Samples producing either spike recovery outside 75 to 125 percent control limits are re-analyzed by the "Method of Standard Additions". The matrix spike duplicate must fall within ±20 percent of true value.

- Laboratory Control Samples (LCS). Laboratory Control samples are prepared and analyzed according to each of the procedures applied to the samples. One LCS is prepared and analyzed once per operating shift. Percent recovery control limits of 80 to 120 percent must be attained. These maybe obtained through US EPA EMSL Las Vegas, Nevada and should be in a soil matrix.

- Field Blank. The field team will collect one blank per day by carrying a sample of clean quartz sand into the field in a normal sample container. The sample container will be opened and exposed during the collection of one sample, then closed and returned to the laboratory. The field blank represents contamination added in the field during storage and sample preparation.

- Study Control Standards (SCS). Project soil and dust study samples standards will be prepared and distributed at the beginning of the study. These will be analyzed in conjunction with LCS's. SCS samples will be used as calibration standards for XRF analysis. Their analysis via ICP will assist in assessing data quality of XRF data.

These QA/QC analysis will be performed at the frequency detailed below:

Field blank	1 per 20 samples
Laboratory control sample	1 per operating shift
Laboratory duplicate soil	1 per 20 samples
MS/MSD	1 per 20 samples
Method blank	1 per 20 samples or one per batch
SCS	1 per 20 samples

9.5 X-Ray Fluorescence

9.5.1 Sample Preparation for Dust and Soils.

Refer to Section 9.3 for overview and B Appendices for detailed procedures.

9.5.2 Analysis

The Oxford LX 1000 X-Ray Fluorescence Spectrophotometer is used for the identification and quantitation of lead in soil samples. The Kevex 0700 X-Ray Fluorescence Spectrophotometer is used for the

identification and quantitation of lead in dust samples. These protocols are presented in the appendices 3 and 4 respectively.

Quantification

The samples and standards are analyzed under identical conditions and the resulting peak heights of the standard and samples are compared for the Oxford, and after normalizing on the Compton scattering peak for the Mo target for the Kevex. The concentration of the lead in the sample is calculated by direct proportions of peak heights to standard concentrations.

9.5.3 Quality Assurance/Quality Control

Soil

The Laboratory Task Leader will provide the following QC samples:

- Study Control Standard (SCS). Project soil samples will be prepared and distributed at the beginning of this study. The SCS are prepared and analyzed according to the same procedure as applied to the samples. One set of SCS's are analyzed twice per operating shift once at the beginning and once at the end. During an operating shift individual SCS's, will be analyzed on a rotating basis,at the frequency of 1 per 20 samples. Percent recovery control limits of 80 to 120 percent should be attained.

- Method Blank. Procedural blanks consisting an empty analysis cup are analyzed at frequency of twice per operating shift.

- Laboratory Duplicates. One sample out of 20 is prepared and analyzed in duplicate. A control limit of 20 percent relative percent difference is suggested.

- Confirmatory ICP Analysis. Selected samples from XRF analysis will be submitted for ICP confirmatory analysis at the frequency of 1 per 20 samples analyzed. Selected samples will be include SCS's, Duplicate and Replicate samples, and field blanks. The frequency may be decreased to 1 per 40 or more if data suggests a good correlation between ICP and XRF results.

- Field Blank. The field team will collect one blank per day by carrying a sample of clean quartz sand into the field in a normal sample container. The sample container will be opened and exposed during the collection of one sample, then closed and returned to the laboratory. The field blank represents contamination added in the field during storage and sample preparation.

- Laboratory Replicate. One sample per 20 is analyzed in replicate. A control limit of 20 percent relative percent difference is suggested.

These QC analyses will be performed at the following frequency:

Laboratory control samples	At minimum one set if SCS analyzed twice per operating shift, at the beginning and end. Then, one SCS per 20 samples on a rotating basis during the shift.
Field blank	1 per field sampling day
Method blank	2 per operating shift
Laboratory duplicate	1 per 20 samples
Laboratory Replicate	1 per 20 samples
Confirmatory ICP Sample	1 per 20 samples (subject to change)

Dust

The Laboratory Task Leader will provide the following QC samples:

- Study Control Standards (SCS). Project dust samples will be prepared and distributed at the beginning of this study. The SCSs are prepared and analyzed according to the same procedure as applied to samples submitted for anlaysis. One set (consisting of 4 standards) of SCS's are analyzed at the beginning of an operating shift . During an operating shift individual SCS's, will be analyzed on a rotating basis, at the frequency of 1 per 16 samples. Percent recovery control limits of 80 to 120 percent should be attained.

- Method Blank. Procedural blanks consisting an empty analysis cup are analyzed at frequency of twice per operating shift.

- Laboratory Duplicates. Due to the small quantity of sample typically submitted for analysis laboratory duplicates analysis will not be performed.

- Confirmatory ICP Analysis. Selected samples may be submitted for ICP confirmatory analysis at the frequency of 1 per 20 samples analyzed if practical. Selected samples will include SCS's, and samples which contain sufficient quantity for analysis, a minimum of 1 gram requried for analysis. The frequency may be decreased if data suggests a good correlation between ICP and XRF results.

- Field Blank. No field blanks will be prepared for this study.

- Laboratory Replicate. One sample per 20 is analyzed in replicate. A control limit of 20 percent relative percent difference is suggested.

These QC analyses will be performed at the following frequency:

Laboratory control samples	At minimum one set of SCSs are analyzed at the beginning of a shift. Then, one of SCS's per 15 analysis on a rotating basis during the shift.
Method blank	2 per operating shift
Laboratory Replicate	1 per 20 samples
Confirmatory ICP Sample	1 per 20 samples (if applicable)

10.0 DATA ANALYSIS, VALIDATION, AND REPORTING

10.1 Data Analysis and Reduction

In addition to the data collected in the field and recorded on the chain-of-custody forms, data describing the processing and analysis of samples will be accumulated on the laboratory and recorded on laboratory Analytical work sheets. Laboratory analytical work sheet will contain:

- Date of processing or analysis;
- Laboratory sample identification numbers;
- Field identification sample number;
- Analyses or operation performed;
- Calibration data;
- Quality control samples data;
- Concentrations/dilutions required;
- Instrument readings;
- Special observations (operational); and
- Analyst's, reviewer's, and person making calculations signature.

Data reduction is performed by the individual analysts which consists of calculating concentrations in samples from the raw data obtained from the measuring instruments. The complexity of the data reduction will be dependent on the specific analytical method and the number of discrete operations (extractions, dilutions, weighing (dust) and concentrations) involved in obtaining a sample that can be measured.

ICP

For ICP the analytical method which utilizes a calibration curve, sample responses will be applied to the linear regression line to obtain an initial raw result which is then factored into equations to obtain the estimate of the concentration in the original sample. Rounding will not be performed until after the final result is obtained to minimize rounding errors. Results will not normally be expressed in more than two significant figures.

Soil

XRF analysis of soils using the Oxford utilizes a response factor methodology. A response factor is generated on a daily basis by analyzing the SCS. which fall in each of the four concentration ranges of the Oxford instrument. The response factor is calculated by measuring the peak height of the L-Alpha line (in millimeters) for the SCS and then dividing it into the SCS's assigned value. All other unknowns, for a specific concentration

range are then determined by multiplying their peak heights by the response factor. Rounding is performed for the response factor to the nearest 10. Rounding is performed on final results so they may be expressed in no more than two significant figures.

Dust

XRF analysis of dust using the Kevex utilizes a peak comparison methodology. In this procedure SCS Spectra are generated for comparison with unknowns. L-Alpha peaks of the SCS and unknown are overlayed on a video screen after normalizing for the compton scatter and concentrations are read directly by comparison using the screen's grid marks. Measurement of unknowns is dependent on sample weight and concentration. An unknown spectra is generated first, then based on weight and concentration, the appropriate SCS is selected for overlay and the concentration is determined. Rounding is done at the time concentration determination with results expressed in two significant figures.

Copies of all raw data and the calculations used to generate the final results will be retained on file to allow reconstruction of the data reduction process at a later date. ICP laboratory data and Kevex XRF diskettes containing spectra for dust analysis will be maintained by US EPA in Lexington, MA. All other data will be maintained in contractor files until project termination.

10.2 Data Validation and Review

Validation of measurements is a systematic process of reviewing a body of data to provide assurance that the data are adequate for their intended use. The process includes the following activities:

- editing,
- screening,
- checking,
- auditing,
- verification,
- certification, and
- review.

Data validation activities will be documented and records kept of any necessary corrective or remedial action.

System reviews are performed at all levels. The individual analyst constantly reviews the quality of data through calibration checks, quality control sample results, and performance evaluation

samples (ICP Analysis only). These reviews are performed prior to submission to the Data Reviewer or the Task Leader.

The Data Reviewer and/or the Task Leader review data for consistency and reasonableness with other generated data and determine if program requirements have been satisfied. Selected hard copy output of data (chromatograms, spectra, laboratory work sheets, etc.) will be reviewed to ensure that results are interpreted correctly. Unusual or unexpected results will be reviewed, and a resolution will be made as to whether the analysis should be repeated. In addition, the Task Leader or Data Reviewer will recalculate selected results to verify the calculation procedure.

The Region I ESD Quality Assurance Officer independently conducts a complete review of selected projects to determine if laboratory and quality assurance/quality control requirements have been met. Discrepancies will be reported to the Project Manager and/or Technical Project Director for resolution.

10.3 Data Reporting

Laboratory reports of data will be edited by comparing with original calculations. Subsequent data tabulations will be edited by comparing with the laboratory analytical work sheets.

Reports will contain final results (uncorrected for blanks and recoveries), methods of analysis, levels of detection (ICP Analysis only), and method blanks data. In addition, special analytical problems, and/or any modifications of referenced methods will be noted. The number of significant figures reported will be consistent with the limits of uncertainty inherent in the analytical method. Consequently, most analytical results will be reported to no more than two significant figures. Data are normally reported in units commonly used for the analyses performed. Concentrations in liquids are expressed in terms of weight per unit volume (e.g., milligrams per liter). Concentrations in solid or semi-solid matrices are expressed in terms of weight per unit weight of sample (e.g., milligrams/kilogram, ppm).

Reported detection limits will be the concentration in the original matrix corresponding to the low level instrument calibration standard after concentration, dilution, and/or extraction factors are accounted for.

Prior to issuance of a report for soil and dust analysis, results reported for each sample are verified to assure proper identification by comparing the chain-of-custody forms, laboratory analytical work sheets, and raw data. Based on the results of this

validation procedure, the laboratory certifies that the results are in compliance with the quality assurance objectives for accuracy and precision. Upon certification by the Task Leader, the report is reviewed by the QAC (if deemed necessary), then provided to the Project Manager for distribution.

ICP results reported for dust and soil analysis are verified and reported according to US EPA, Lexington, MA Laboratory procedures.

11.0 INTERNAL QUALITY CONTROL CHECKS

11.1 General

For each major measurement parameter, appropriate quality control checks shall be established. Field blanks should be taken to check for contamination introduced during sample collection and shipping. Study control samples should be analyzed to determine the accuracy of the analytical technique. Laboratory replicates and duplicates should be analyzed to determine the precision of the analysis. Spiked (fortified) samples should be used to determine the accuracy of the analysis (ICP only).

ICP Confirmatory Analysis of selected soil and dust will assist in assessing the comparability between XRF and ICP results.

11.2 Field Blanks

No field blanks for dust are required at this time. Field blank samples for soil/sediment matrices are not readily available, however quartz sand will be used. Field blanks will be prepared at the rate of one per sampling event day. Enough sample will be prepared for both XRF and ICP analysis. A Field Blank will be submitted for XRF analysis for each batch of samples associated with a sampling event day. Samples selected for ICP analysis will be accompanied by selected Field Blanks not necessarily representing their sampling event day(s).

11.3 Laboratory Duplicate

For soils and ICP analysis duplicate soil samples should be prepared in the laboratory at a rate of one per every 20 samples analyzed. For dust laboratory duplicate will not be prepared due to the small amount of sample typically collected.

11.4 Laboratory Control Samples (ICP only)

Laboratory control samples (LCS) consisting of secondary standards ultimately traceable to National Bureau of Standards (NBS) or EPA Environmental Monitoring and Surveillance Laboratory (EMSL) primary standards will be prepared for ICP. The LCS will be analyzed at least once per operating shift and should fall within the established recovery control limits of 80 to 120 percent.

11.5 Completeness

Completeness of scheduled sample collection will be controlled in the field by comparing predetermined sample locations on the gridded lot plan for each residential property with samples collected in the field at that site each day. Daily checking of site log books and chain-of-custody logs will provide further control on documentation and completeness. The determination of the completeness objective will be the responsibility of the QAC.

11.6 Study Control Standards (SCS)

XRF analysis Study Control standards for soil and dust have been made available by Dr. Thomas Spittler U.S. EPA. For soil analysis the SCS's are analyzed as a set twice per operating shift once at the beginning and once at the end with individual SCS's analyzed during the shift at a frequency of 1 per 20 samples analyzed on a rotating basis. The daily SCS results should fall within control limit of 80 to 120 percent of their respective concentrations. For dust SCS's are analyzed once at the beginning of the shift and results should also fall within 80 to 120 percent or their respective concentrations.

11.7 Laboratory Replicates

Replicate soil and dust samples analysis will be conducted at a rate of one per 20 samples analyzed.

11.8 Comparability - ICP Confirmatory Analysis

Selected soil and dust XRF samples will be submitted for confirmatory analysis using Inductively Coupled plasma Emission Spectrophotometry at a frequency of one per 20 samples analyzed (this frequency may be decreased at a later date). ICP and XRF analysis will be compared to define the limits of comparability between these two methods.

12.0 AUDITS

Quality assurance audits are performed to assure and document that quality control measures are being utilized to provide data of acceptable quality and that subsequent calculations, interpretation, and other project outputs are checked and validated.

The Quality Assurance Coordinator (QAC) will conduct system and performance audits and reviews of interpretations and reports based on the measurement system outputs. If any of the procedures to assess precision and accuracy described in Section 14.2 indicate potential data problems, an audit will be initiated, if appropriate.

12.1 Systems Audit

A systems audit will be conducted on all components of measurement systems to determine proper selection and utilization. The systems audit includes evaluation of both field and laboratory procedures.

Organization and personnel. The project organization is reviewed for compliance with the proposed organization and for clarity of assigned responsibility. Personnel assigned to the project will be reviewed to determine that assigned responsibility, skill, and training of the personnel are properly matched. The Technical Director maintains firsthand knowledge of his team's capabilities and will discuss the organization's efficacy with the QAC. Assigned personnel may be interviewed by the QAC during an audit.

Facilities and Equipment. The audit will address whether field tools and analytical instruments are selected and used to meet requirements specified by the project objectives stated in the QAPjP. Equipment and facilities provided for personnel health and safety will also be evaluated. Documentation procedures used in the field will receive special attention.

Analytical Methodology. Routine external performance evaluations as well as blind internal performance evaluations are generally conducted. A review of analytical methodology in regard to the data requirements for the project will also be performed. An in-laboratory observation of analyst technique, data reduction, and record keeping may be performed if determined necessary. Periodic review of precision and accuracy data is essential.

Sampling and Sample Handling Procedure. An audit of scheduled samples vs. samples collected vs. samples received for analysis may be performed. Field documentation will be reviewed. If deemed necessary, a site visit will be made to assure that designated control procedures are practiced during sampling activities.

Data Handling. During a systems audit, the QAC will review data handling procedures with the TD and Task Leaders. Accuracy, consistency, documentation, and appropriate selection of methodologies will be discussed.

12.2 Performance Audits

These audits are intended primarily for analytical and data generation systems. The EPA Region I ESD laboratory regularly participates in, and successfully completes U.S. EPA Performance Evaluations (WS and WP Series). Ongoing performance evaluations include duplicates, matrix spikes, QC check samples, etc., with regard to ICP analysis.

12.3 Project Audits

Project audits encompass the aspects of both the systems audit and the performance audits. The project audit typically occurs at least twice for a short-term project and more often during long-term projects. Timing is keyed to the systems involved and the project objectives.

12.4 Quality Assurance (QA) Audit Report

A written report (Figure 12-1) of the QA audit may be prepared to include:

- an assessment of project team status in each of the major project areas;
- clear statements of areas requiring improvement or problems to be corrected. Recommendations and assistance will be provided regarding proposed corrective actions or system improvements. If no action is required, the report will state that the QA audit was satisfactorily completed;
- a timetable for any corrective action required; and
- a follow-up to assure that recommendations have been implemented.

Figure 12-1
QUALITY ASSURANCE AUDIT REPORT

Project: _____

Project No.: _____

Quality Assurance Coordinator: _____

Project Aspects Audited: _____

Laboratory/Technical Director: _____

Audit Conducted By: _____

for the period _____ to _____

Date of Audit: _____

Personnel Interviewed: _____

1.0 Purpose and Objectives of the Project Aspects Audited
2.0 Brief Description of the Sampling and Analytical Requirements
3.0 Organization and Personnel
4.0 Facilities Utilized
5.0 Analytical Methodologies
6.0 Sampling and Sample Handling
7.0 Quality Control Measures Utilized
8.0 Data Handling
9.0 Quality Assurance Deficiencies
10.0 Recommended Correction Actions and Schedule

_____
Signed Date

_____
Title

Distribution:

_____
Reviewed by Date

_____
Title

13.0 PREVENTATIVE MAINTENANCE

Preventative maintenance of field equipment proceeds routinely before each sampling event. More extensive maintenance would be performed based on the number of hours in use. Preventative maintenance of EPA Region I ESD laboratory analytical equipment is the responsibility of that laboratory.

14.0 DATA ASSESSMENT

14.1 General

The purpose of data quality assessment is to assure that data generated under the program are accurate and consistent with project objectives. The quality of data will be assessed based on the precision, accuracy, consistency, and completeness of the data that are measured or generated.

Data quality assessment will be conducted in three phases:

14.1.1 Phase 1

Prior to data collection, sampling, and analysis, procedures are evaluated in regard to their ability to generate the appropriate, technically acceptable information required to achieve project objectives. This QA/QC Plan meets this requirement by establishing project objectives defined in terms of required sampling analysis protocols.

14.1.2 Phase 2

During data collection, results will be assessed to assure that the selected procedures are efficient and effective and that the data generated provide sufficient information to achieve project objectives. Precision and accuracy of measurement systems will also be evaluated. In general, evaluation of data will be based on performance audits, results of duplicate and reference sample analyses, and review of completeness objectives.

Documentation may include:

- number of duplicate and reference samples analyzed;
- identification of statistical techniques, if used, to measure central tendency, dispersion, or testing for outliers;
- use of historical data and its reference; and
- identification of analytical method.

14.1.3 Phase 3

Throughout the data collection activities, an assessment of the adequacy of the data base generated in regard to completing project objectives will be undertaken throughout the project. Recommendations for improved quality control will be developed, if appropriate. In the event that data gaps are identified, the QAC may recommend the collection of additional raw data to fully support the project's findings and recommendations.

14.2 Precision and Accuracy

Assessment of precision and accuracy of analytical data is accomplished via review of duplicate analyses (precision) and reference standard (accuracy) in soil. Precision is generally expressed as the relative percent difference (RPD). Accuracy is expressed as percent recovery. Precision must be assessed for each matrix, since distribution of contaminants may be non-homogeneous, especially in soil. Precision in samples must be reviewed with knowledge of the matrix and level of analyte present. Corrective action or documentation of substandard precision is the laboratory's responsibility. Accuracy is also impacted by matrix interferences. Each method which provides quality control requirements and acceptance criteria also specifies the method of generating the data to be reviewed. It is the laboratory's responsibility to attempt to identify the source of substandard recoveries and either take corrective action or document the cause.

Calculations are presented below:

Accuracy:

$$\%R = \frac{\text{observed value}}{\text{theoretical value}} \times 100$$

where: %R = percent recovery

Precision control requirements and acceptance criteria also specifies the method of generating the data to be reviewed. It is the laboratory's responsibility to attempt to identify the source of substandard recoveries and either take corrective action or document the cause.

Precision (as determined by Relative percent difference):

$$RPD = \frac{(A1 - A_2)}{(A_1 + A_2)/2} \times 100$$

where:

RPD = relative percent difference

A_1 = the value of the first sample

A_2 = The value for the duplicate sample

14.3 Completeness

Completeness is generally assessed as a percentage of data intended to be generated, and is most often utilized in Phase 3 of the data assessment process. Assessment of completeness will be undertaken by the QAC in co-operation with LFK staff.

15.0 CORRECTIVE ACTION

Corrective or preventative action is required when potential or existing conditions are identified that may have an adverse impact on data quantity or quality. Corrective action could be immediate or long-term. In general, any member of the program staff who identifies a condition adversely affecting quality can initiate corrective action by notifying in writing his or her supervisor and the QAC. The written communication will identify the condition and explain how it may affect data quality or quantity.

An analysis or analytical system is considered to be out-of-control when it does not conform to the conditions specified by the method or standard operating procedures which apply. To confirm that an analysis or analytical system is in control, the laboratory routinely performs instrument calibration checks, analysis of method blanks and method blank spikes. These results are compared to the results of quality control samples to laboratory control charts or analytical protocol criteria (e.g., U.S. EPA-CLP).

A Corrective Action Documentation Form, Figure 15-1, is to be completed for each out-of-control situation. The analyst, working with his or her supervisor or Task Leader, will attempt to determine the cause of the problem and take appropriate corrective action. Analysis may not resume until the problem has been corrected and it is determined that the analysis is back in control. Demonstration of the restoration of analytical control will normally be accomplished by generating satisfactory calibration and/or quality control sample data. This documentation will be attached to the corrective action documentation form to be placed in the project files.

15.1 Immediate Corrective Action

Immediate corrective action is applied to spontaneous, non-recurring problems, such as an instrument malfunction. The individual who detects or suspects nonconformance to specify the previously established criteria or protocol in equipment, instruments, data, methods, etc., will immediately notify his/her supervisor. The supervisor and the appropriate Task Leader will then investigate the extent of the problem and take the necessary corrective steps. If a large quantity of data is affected, the Task Leader must prepare a memorandum to the Project Manager, the Technical Project Director and the QAC. These individuals will collectively decide how to proceed. If the problem is limited in scope, the Task Leader will decide on the corrective action measure, document the solution in the appropriate workbook, and notify the Project Coordinator, the Technical Project Director, and the QAC.

15.2 Long-Term Corrective Action

Long-term corrective action procedures are devised and implemented to prevent the recurrence of a potentially serious problem. The QAC will be notified of the problem and will conduct an investigation to determine the severity and extent of the problem. The QAC will then file a corrective action request with the Project Manager.

Corrective actions may also be initiated as a result of other activities, including:

- Performance Audits;
- System Audits;
- Laboratory field/comparison studies; and
- QA Program Audits.

The QAC will be responsible for documenting all notifications, recommendations, and final decisions. The Project Coordinator and the QAC will be jointly responsible for notifying program staff and implementing the agreed upon course of action. The QAC will be responsible for verifying the efficacy of the implemented actions. The development and implementation of preventative and corrective actions will be timed, to the extent possible, so as to not adversely impact either project schedules or subsequent data generation/processing activities. However, scheduling delays will not override the decision to correct any data collection deficiencies or inaccuracies before proceeding with additional data collection. The QAC will also be responsible for developing and implementing routine program controls to minimize the need for corrective action.

FIGURE 15-1
CORRECTIVE ACTION DOCUMENTATION FORM

DESCRIPTION OF PROBLEM and when identified: _____

_____
_____
_____
_____
_____

State cause of problem if known or suspected: _____

_____
_____
_____
_____

SEQUENCE OF CORRECTIVE ACTION: (If no responsible person is identified, bring this form directly to the QA Coordinator)

State date, person, and action planned: _____

_____
_____
_____
_____
_____
_____
_____
_____
_____

CA Initially Approved By: _____

Date: _____

Follow-up dates: _____

Description of follow-up: _____

_____
_____
_____
_____

Final CA Approved By: _____

Date: _____

16.0 REPORTS TO MANAGEMENT

Periodic summary reports will be prepared to inform management of project status. The reports will include:

- periodic assessment of measurement data accuracy, precision, and completeness;
- results of performance audits and/or systems audits;
- significant QA problems and recommended solutions; and
- status of solutions to any problems previously identified.
- Periodic Analytical Summary Progress Reports which includes results for soil and dust sample analysis and an on-going status of samples received, analyzed and reported.

Additionally, any incidents requiring corrective action will be fully documented. Procedurally, the QAC will prepare the reports to management. These reports will be addressed to the Project Manager, with copies to the Technical Project Director and the QAC. The summary of findings shall be factual, concise, and complete. Any required supporting information will be appended to the report.

CATEGORY:	TITLE:	Detailed Soil Sampling Protocol	
Field		Lead Free Kids	No. FT 7-16
Technical		Demonstration Project	Date: 3/90
			Revision: 0

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6.0 REFERENCES
None

7.0 ATTACHMENTS

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Figure 7-23

Prepared By:	Approved By:	Reviewed By:

1.0 PURPOSE

The purpose of this guideline is to describe specific elements of the detailed phase of soil sampling for the Lead Free Kids Demonstration Project, Boston, Massachusetts.

This guideline was developed for use by field sampling teams to assure that soil sampling and associated activities are consistent throughout the project to meet data quality objectives. Adherence to this guideline will assist in defining the extent of lead contamination for soil removal and property restoration activities.

2.0 SCOPE

The specific elements described in this guideline are applicable to soil sampling and associated activities, and include:

- site documentation, updating of preliminary soil sampling site sketches, and other pertinent information;
- schemes for locating sampling points;
- sample collection;
- sample handling and storage; and
- recordkeeping and sample custody.

3.0 DEFINITIONS

None

4.0 RESPONSIBILITIES

Task Leader - The Task Leader is responsible for the collection of soil samples in accordance with all elements of this guideline. The Task Leader will supervise and participate with field personnel to accomplish this task, and be responsible for delivery of samples to the EPA laboratory.

5.0 GUIDELINE

5.1 Overview

The Soil Lead Abatement Demonstration Project involves soil sampling, analysis and soil removal, and restoration of approximately 150 lead contaminated properties in the City of Boston.

Three soil sampling events are associated with the Project; Preliminary, Detailed, and Post Abatement. The detailed soil sampling phase presented herein will be conducted to define the nature and extent of soil lead contamination and obtain additional data from properties qualified as a result of preliminary soil sampling. Information gathered and analytical results will be used by LFK epidemiologists.

Corings will be advanced throughout the property. Soil core samples will be composited from the top, 0 - 2 cm depth and composited from the 13 - 15 cm depth. The sampling schemes used to locate sample locations will vary according to the property layout. Samples will also be collected from any obvious play areas. Samples will be analyzed by x-ray fluorescence at the EPA Region I laboratory.

5.2 Sampling Procedures

5.2.1 General

The quality of sample collection is assured by adhering to sampling procedures. All soil sample collection will be limited to compositing of corings. Separate composites will be made from the 0 - 2 cm fraction and the 13 - 15 cm fraction. A five-point composite depicted in Figure 6-1 is the technique for all composite soil samples. No preservatives will be required for samples. Sample containers will consist of plastic baggies. Field documentation will include locating sampling points on the detailed site sketch developed during the preliminary sampling along with pertinent information, and completion of chain-of-custody forms. The procedures presented below will ensure that a

representative portion of the source is collected and sample integrity is preserved.

5.2.2 Detailed Soil Sampling

Site Description Documentation

During the Detailed Soil Sampling Phase for each location, the project log should briefly describe the sampling locations and sampling schemes used, and include the following information if not provided by investigation:

- address, date, name of artist;
- type of building construction;
- condition of main building;
- condition of lot (debris, standing water, vegetation cover);
- nature of adjacent property;
- presence and type of fence;
- animals on property;
- apparent use of yard (toys, sandbox, children present);
- Location of sampling points; and
- underground utilities.

5.2.3 Sampling Schemes

The sampling scheme for each property must be chosen to adequately define the nature and extent of lead contamination on the property. Several options are offered for the best judgement of the investigator due to the difference in property dimensions and size. The pattern should be selected to fit the property.

Line Source Pattern

Draw a line parallel to the source, such as the foundation of the main building, approximately 0.5 meters (20 inches) from the foundation. Repeat at the property boundary if the subplot is more than three meters (10 feet) wide and add a third parallel line between the first two if the sub-area exceeds five meters (16 feet) in width. Divide each line into segments that do not exceed seven meters (20 feet) in length. Take one composite of 5 cores on each line segment. A sub-area, for example, that is at the side of the main building and measures 12 by 7 meters would have three lines of two segments each. The lines would be parallel and approximately three meters apart. They would be 12 meters long and consist of two 6 meter segments each, making a total of six samples, each being a composite of at five cores divided into a top 2 cm sample and a bottom 2 cm sample.

Targeted Pattern

Select those locations within the sub-area that are likely to reflect potential exposure to lead in soil dust. These may be play areas, paths, drainage collection areas, or areas that are likely to contribute dust to other surfaces that children use. This method may be used alone where grid or line source patterns are not acceptable, or as an overlay on a grid pattern if appropriate. Determine the number of samples to be taken by identifying distinctive land use characteristics (path, swingset, sandbox), and take a composite of 5 cores for each sample.

Small Area Pattern

When the sub-area is less than two meters in each dimension, a single composited sample may be taken if it appears that such a sample would adequately represent the sub-area.

Grid Pattern

Establish a rectangular grid of intersecting lines 2 to 10 meters apart, and sample each rectangular area. For larger areas, randomly select the rectangles to be sampled. In each rectangular area, mark three lines parallel to the longest axis, and composite 5 cores on each line. Since the rectangle should not exceed four meters, there is no need to divide the line into segments. Therefore, each rectangle should have six samples of 5 composites each. Use this pattern when the subarea is generally uniform and there is no reason to suspect large variations in lead concentrations.

5.2.4 Equipment List

- plastic sandwich-size sample bags (Zip-lock or equivalent);
- corer
- indelible marker (to put sample number on bag);

- sample cards (to assign a sample number to each sample);
- cooler or similar container to hold samples;
- measuring tape;
- spoons or spatulas;
- detergent solution;
- wash bowls for decontamination of sampling gear;
- paper towels;
- distilled water;
- plastic trash bags (for disposable items);
- bound logbook, paper and pens; and
- chain-of-custody form.

5.2.5 Sample Collection

The corer should be clean and free of soil particles. Vegetation and debris can be removed at the point of insertion, but do not remove any soils or decayed litter. The corer should be driven into the ground to a depth of at least 10 cm, 15 cm if possible. If the 10 cm depth cannot be reached, the corer should be extracted and cleaned, and another attempt made nearby. If the second attempt does not permit a 10 cm core, the sample should be taken as deep as possible, and the maximum depth of penetration noted on the sample record sheet. Every effort should be made to take all cores of a composited sample at the same depth.

The cores of each plot should be examined for debris, artifacts, and any other evidence of recent soils disturbance. These should be noted on the sub-area description sheet, as should a brief description of the soil color and characteristics.

For each sample location, the top 2 cm segment of each of the cores are composited into one sample, and the 13 to 15 cm segment or the bottom 2 cm segment combined into a second. For the surface segment, debris and leafy vegetation should not be included with the sample. However, no soil or decomposed litter should be removed, as this is the most critical part of the soil sample and is likely to be the highest in lead concentration.

The soil core segments should be composited in sealable plastic bags (Zip-lock baggies or equivalent) suitable for prevention of contamination and loss of the sample. The sample identification number should be placed on the container and the chain-of-custody form. After each sample composite, the corer should be cleaned before reinsertion in the next sampling area. Store the composited soil sample at ambient temperature until returned to the laboratory.

A field blank should be taken for each sample crew day. This is normally done by taking a sample container with clean quartz sand into the field, opening it to expose the container for a period of time representing normal sample procedures, then returning the container to the laboratory in the same manner as other soil samples. The purpose of the field blank is to detect accidental or incidental contamination during the sampling process.

Duplicate samples should be taken at the frequency of 1 per 20 and collected from the mid-point between regular composite sample corner points (see Figure 6-1). The purpose of the field duplicate is to detect differences in homogeneity of the contaminants in soil and error in sampling technique.

5.2.6 Sample Handling and Storage

The sample containers should be sealed to prevent loss or cross-contamination of the sample. No special considerations will be given to shipping container labelling as they will be delivered to the EPA Region I laboratory by a member of the LFK staff. Any storage of shipping containers and/or samples should be in a cool dry location.

5.2.7 Recordkeeping and Sample Custody

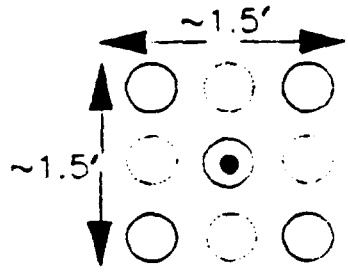
Soil sample records for each property consist of an updated property sketch with sample location and codes indicated, and chain-of-custody forms, (see Figures 6-2, 7-1, and 7-2).

Samples should be sequentially numbered within each sub-area. Each location diagram, and chain of custody should bear all sample numbers and the signature of the person responsible for verifying the quality of the information collected. This signature certifies that there has been no misuse of the sample protocol, no mistake in recording the information, and that the information is sufficient to clearly identify these samples for comparison with other types of samples taken at the same location such as dust. These documents also establish the chain of custody required for the project.

When the sample is delivered to the laboratory, custody is relinquished by the field investigator or sample courier and received by the laboratory Task Leader or Analyst by signatures on the sample record form. Original to remain with the investigator for LFK project files and a copy will be kept for EPA files.

FIGURE 6-1

5 Point Composite Sample Scheme



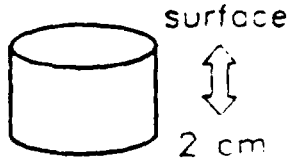
Legend

- ● Sampling Station
- ○ Sample Composite Location
- ◌ Field Duplicate Sample Composite Locations

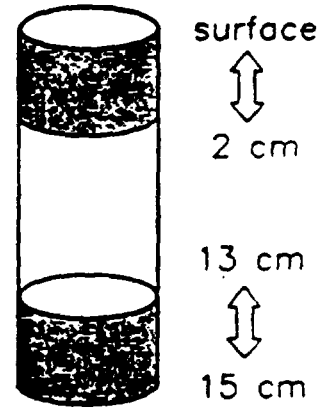
(At selected sampling stations duplicates will be collected at mid-points between sample composite locations.)

A
Preliminary and Post Abatement Phase Surface Sample Composite Location Schematic

B
Detailed Phase Surface and Subsurface Sample Composite Location Schematic



Sample collected from surface to 2cm below surface.



First sample collected from surface to 2 cm below surface.

Second sample collected from 13 cm to 15 cm below surface in same boring location.

FIGURE 6-2
Detailed Site Diagram

Address: _____ Date: _____

Name: _____

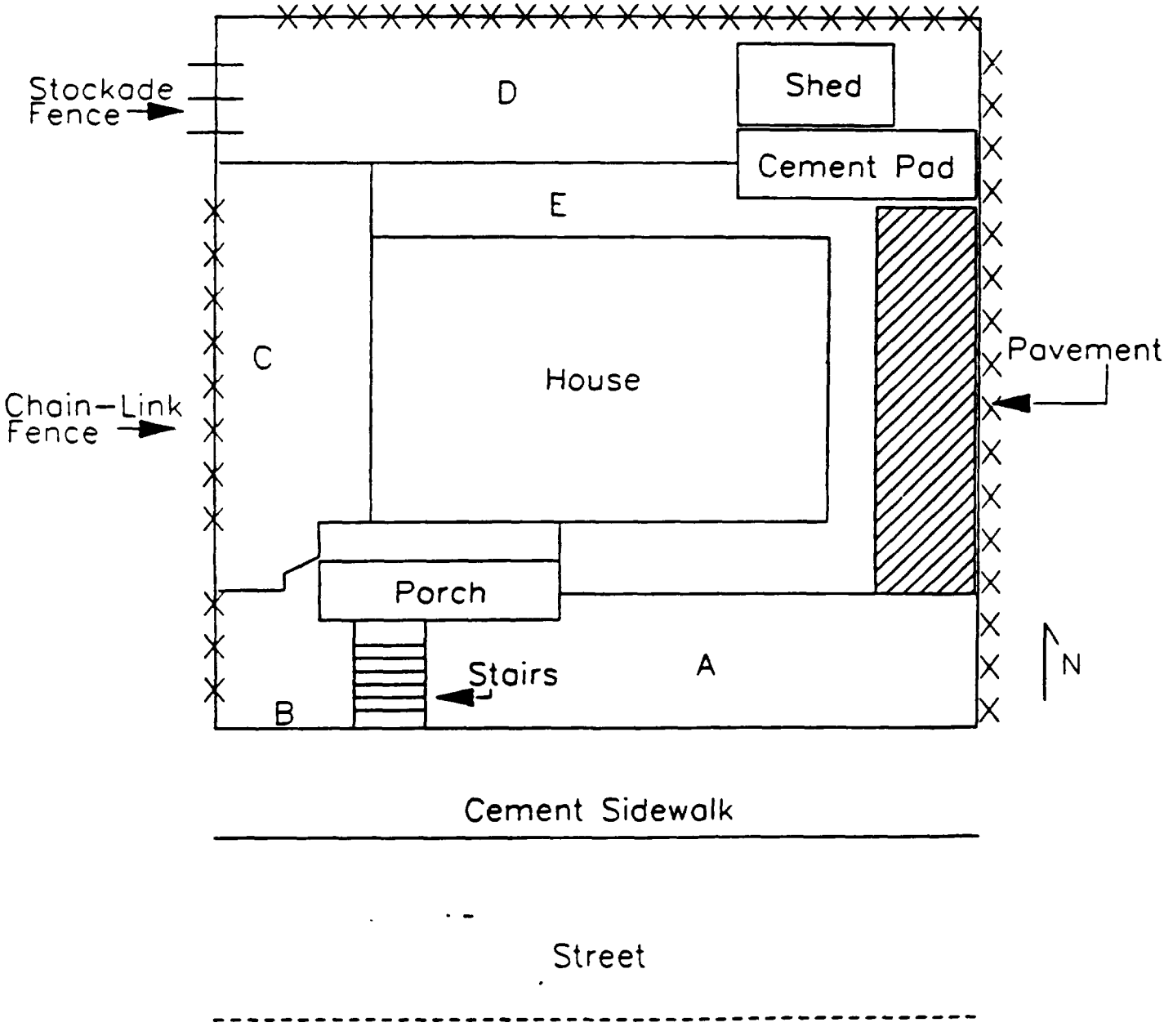


Figure 7-1

- Soil -

Lead-In-Soil Demonstrtation Project

Chain-of-Custody Record

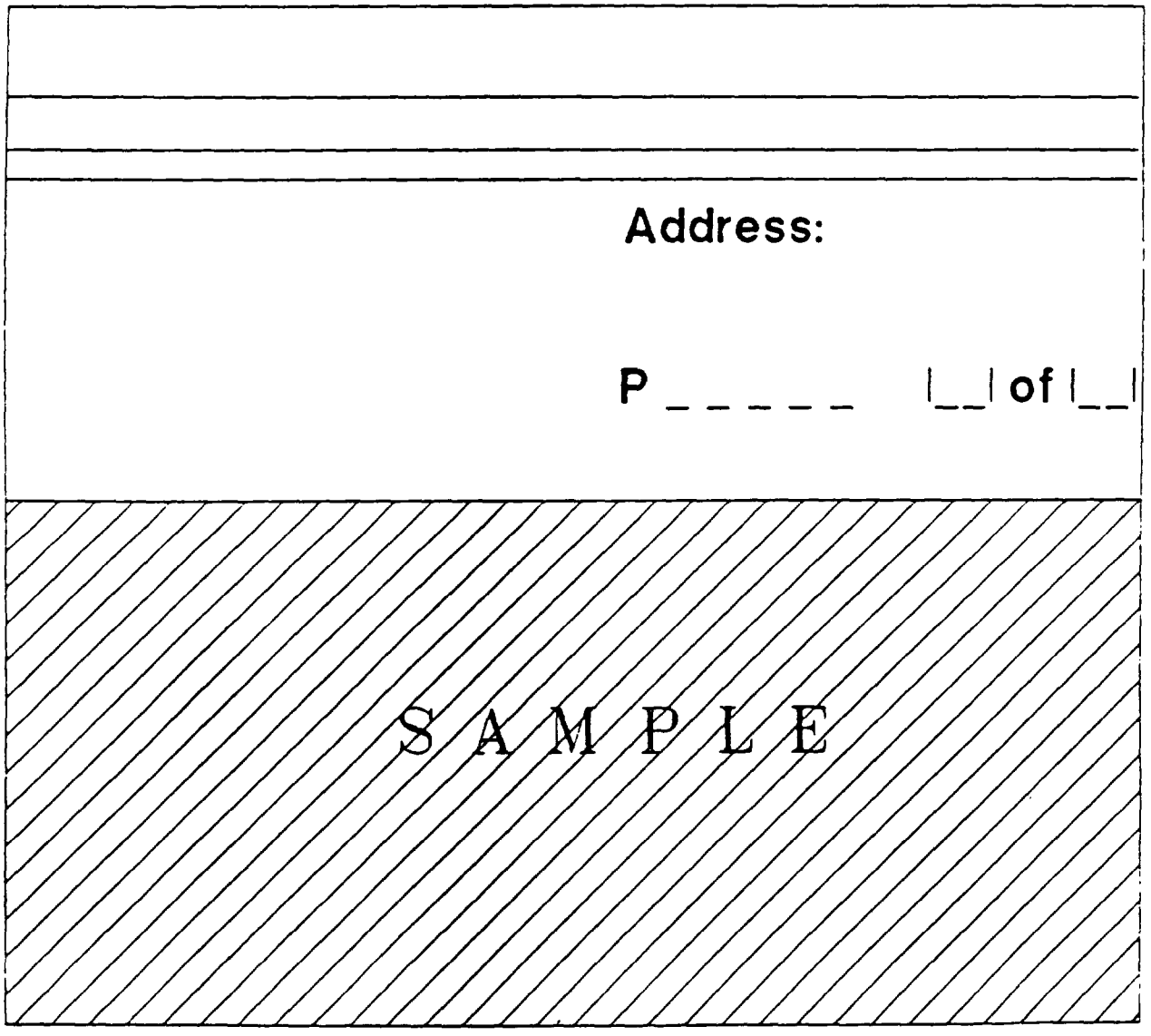
Prem. ID	Samp ID	Address	Dist.	Date Collected	Collected By

Relinquished By	Received By	Date	Time	Comments/Instructions

FIGURE 7-3

Soil
Sample Container with
Sample Label

Plastic Ziplock Bag or Equivalent - Soil



~ To Scale

APPENDIX A-3

POST ABATEMENT SAMPLING

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None

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1.0 PURPOSE

The purpose of this guideline is to describe specific elements of the post abatement phase of soil sampling for the Lead Free Kids Demonstration Project, Boston, Massachusetts.

This guideline was developed for use by field sampling teams to assure that soil sampling and associated activities are consistent throughout the project to meet data quality objectives.

Adherence to this guideline will assist in assessing effectiveness of abatement activities and provide ongoing information regarding re-contamination and abatement longevity. This data will also be correlated with ongoing blood lead monitoring of project participants.

2.0 SCOPE

The specific elements described in this guideline are applicable to soil sampling activities, and include:

- reviewing and updating the site sketch from the preliminary and detailed soil sampling events, if necessary;
- schemes for locating post abatement sampling points, control stations, and recording locations on the site sketch;
- sample collection;
- sample handling and chain of custody; and
- recordkeeping and sample storage.

3.0 DEFINITIONS

None

4.0 RESPONSIBILITIES

Task Leader - The Task Leader is responsible for the collection of soil samples in accordance with all elements of this guideline. The Task Leader will supervise and participate with field personnel to accomplish this task, and be responsible for delivery of samples to the EPA laboratory.

5.0 GUIDELINE

5.1 Overview

The Soil Lead Abatement Demonstration Project involves soil sampling, analysis and soil removal, and restoration of approximately 150 lead contaminated properties in the City of Boston.

Three soil sampling events are associated with the Project, Preliminary, Detailed, and Post Abatement. The post abatement soil sampling phase presented herein will be conducted to assess the effectiveness of abatement, potential for property re-contamination and for correlation with ongoing Blood Lead testing of project participants. Sample collection procedures will be limited to surface composites from 0 - 2 cm depths.

Sample locations for each property will be pre-determined by the Principal Investigator, based on data obtained in the detailed sampling event. Typically those areas with the highest concentration of soil lead, select areas, i.e., children's play areas or any other specified area, will be designated as a post abatement control point sampling location.

Samples will be collected by LFK and analyzed by x-ray fluorescence at the EPA Region I laboratory.

5.2 Sampling Procedures

5.2.1 General

The quality of sample collection is assured by adhering to sampling procedures. All soil sample collection will be limited to compositing of corings. Separate composites will be made from the 0 - 2 cm fraction. A five-point composite depicted in Figure 6-1 is the technique for all composite soil samples. No preservatives will be required for samples.

Sample containers will consist of sealable Ziplock plastic baggies (or equivalent). Field documentation will include a review of the site sketch and additional site information documented during the preliminary and detailed sampling and notation of significant changes, i.e., vinyl siding, re-painted siding, evidence of renovations, re-landscaping, etc. This documentation may require updating the original site sketch or generation of a new one. Notation of significant changes will be made on separate dated sheets of paper. Documentation will also include completion of chain of custody. The procedures presented below will ensure that a representative portion of the source is collected and sample integrity is preserved.

5.2.2 Post Abatement Soil Sampling

Site Description Documentation

For each property, the detailed sampling event drawing will be reviewed to assist the sampling team in finding the pre-determined sampling location or locations. Once the location is found, it will be staked and located by tape measurements from the nearest permanent structure and noted on the site sketch and/or sub-area sketch. A review of the detailed additional site information form will also be reviewed and significant observation noted, such as adjacent buildings demolished, condition of the subject property, vegetative cover, erosional problems, new landscaping, etc. This information will be recorded on a separate additional site information form. Site activities will also be recorded in a site logbook with dates, addresses, samplers, and samples accounted for. Post abatement sampling documentation for subsequent events will include the same process with elimination of steps that are not applicable, such as re-taping distances staking control points at the locations.

5.2.3 Sampling Schemes

The sampling scheme selected for each post abatement sampling must adequately characterize the effectiveness of abatement, the potential exposure of children to lead in the soil, and track over time the potential for recontamination at the soil surface. Since the properties will have been abated with clean soils, post abatement sampling will be limited to surface composites, 0 - 2 cm depth.

Control Point

The Principal Investigator will select a control point sampling location or locations at a property that were previously areas of high lead concentration and reflect potential exposure to lead soil. These may be play areas, drainage collection areas, and areas determined from the detailed sampling event to have been high in soil lead, or areas that are likely to contribute soil dust to other surfaces that children use.

One or more composite surface soil sample will be collected, using the 5 point composite pattern, from each sampling station.

5.2.4 Equipment List

- plastic sandwich-size sample bags (Zip-lock or equivalent);
- indelible marker (to put sample number on bag);
- sample cards (to assign a sample number to each sample);
- cooler or similar container to hold samples;
- measuring tape;
- spoons or spatulas;
- detergent solution;
- wash bowls for decontamination of sampling gear;
- paper towels;
- distilled water;
- plastic trash bags (for disposable items);
- bound logbook, paper, and pens; and
- chain-of-custody.

5.2.5 Sample Collection

Each selected control point will represent the center of a sampling location. Each sampling location will consist of a two-foot square area approximately from which five surface soil samples will be composited. Samples will be collected as follows:

Collect two tablespoonfuls of soil from each of the four corners and from the middle. Sample depth should be from 0 - 2 cm. Place the composited sample into a plastic bag, seal it, and mark the bag with the sample number. Maximum volume should be about 1/2 bag (1 cup). Wash hand between properties. A composite will be identified as a single sample. A chain of custody is used to record information about the composite.

The sampling device should be clean and free of soil particles, with decontamination between composited areas. Vegetation and debris can be removed at the point of collection, being careful not to disturb soil or decayed litter.

The surface soil samples should be composited in sealable plastic containers (Zip-lock baggies or equivalent) suitable for prevention of cross-contamination and loss of the sample. The sample identification number should be placed on the container and chain of custody. After each sample composite, the sampling device should be cleaned with distilled water and wiped with a paper towel. Store the composited soil sample at ambient temperature until returned to the EPA - Region I laboratory.

A field blank should be taken for each sample crew day. This is normally done by taking a sample container with clean quartz sand into the field, opening it to exposure the container for a period of time, representing normal sample procedures, then returning the container to the EPA - Region I laboratory in the same manner as other soil samples. The purpose of the field blank is to detect accidental or incidental contamination during the sampling process.

Duplicate samples should be taken at the frequency of 1 per 20 and collected from the mid-

point between regular composite sample corner points (see Figure 6-1). The purpose of the field duplicate is to detect differences in homogeneity of the contaminants in soil and error in sampling techniques.

5.2.6 Sample Handling and Storage

The sample containers should be sealed to prevent loss or cross-contamination of the sample. No special considerations will be given to shipping container labelling as they will be delivered to the EPA - Region I laboratory by a member of the LFK staff. Any storage of shipping containers and/or samples should be in a cool dry location.

5.2.7 Recordkeeping and Sample Custody

Soil sample records for each property consist of updated site sketch to include approximate location of control point, and updating with additional site information, if necessary, and chain of custody. Logbooks will also be used to document activities and pertinent information through a sampling event day.

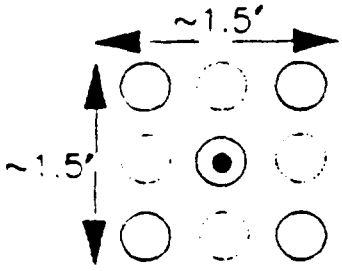
Samples should be numbered according to LFK coder.

Each updated site diagram must identify the date upon which it was revised. Each sample label and chain of custody should bear all sample numbers and the signature of the person responsible for verifying the quality of the information collected. This signature certifies that there has been no misuse of the sample protocol, no mistake in recording the information, and that the information is sufficient to clearly identify these samples for comparison with other types of samples taken at the same location, such as house dust. These documents also establish the chain of custody required for the project.

When the sample is delivered to the laboratory, custody is relinquished by the field investigator or sample Courier and received by the laboratory Task Leader or Analyst by signatures on the sample record form. Originals to remain with the LFK investigator for project files. A copy will be retained for EPA files.

FIGURE 6-1

5 Point Composite Sample Scheme



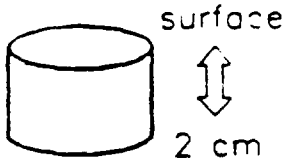
Legend

- ● Sampling Station
- ○ Sample Composite Location
- ◌ Field Duplicate Sample Composite Locations

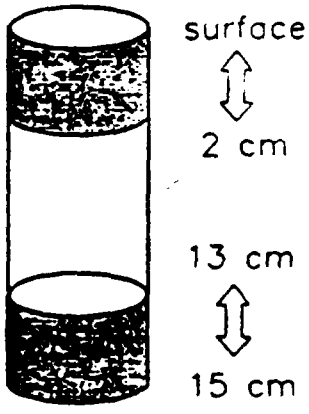
(At selected sampling stations duplicates will be collected at mid-points between sample composite locations.)

A
Preliminary and Post Abatement Phase Surface Sample Composite Location Schematic

B
Detailed Phase Surface and Subsurface Sample Composite Location Schematic



Sample collected from surface to 2cm below surface.



First sample collected from surface to 2 cm below surface.

Second sample collected from 13 cm to 15 cm below surface in same boring location.

FIGURE 6-2
Detailed Site Diagram

Address: _____ Date: _____

Name: _____

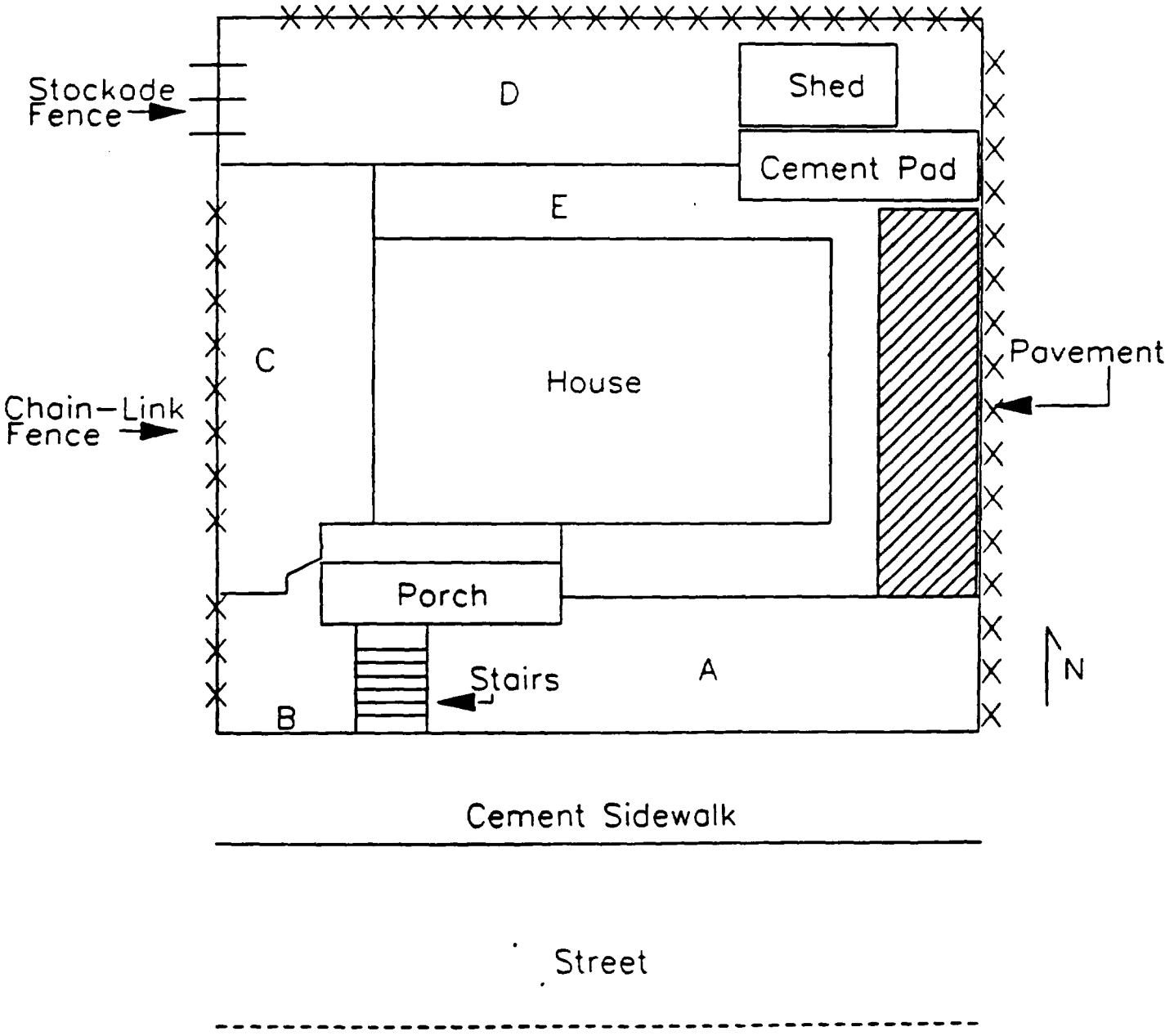


Figure 7-1

- Soil -

Lead-In-Soil Demonstrtation Project

Chain-of-Custody Record

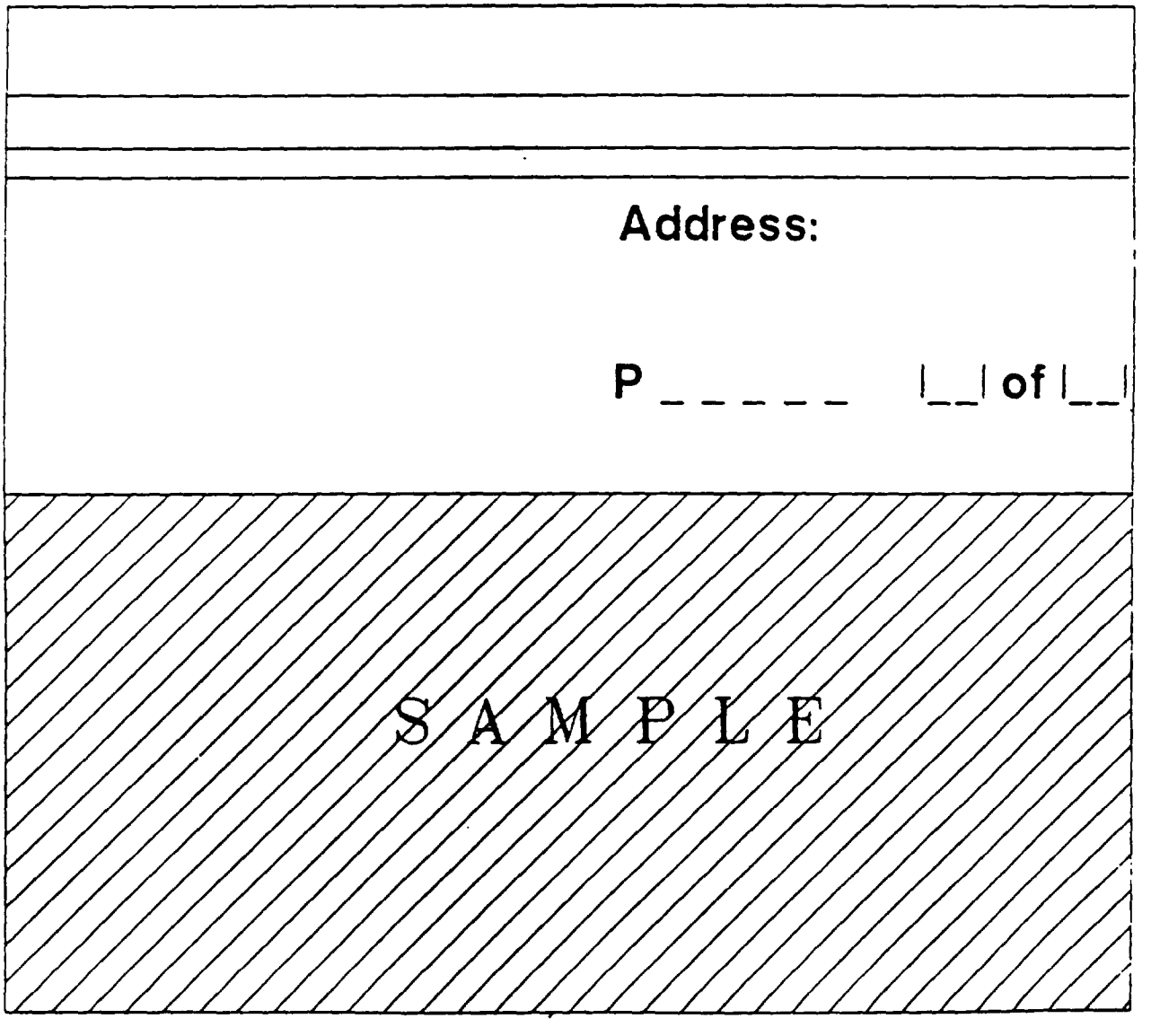
Prem. ID	Samp ID	Address	Dist.	Date Collected	Collected By

Relinquished By	Received By	Date	Time	Comments/Instructions

FIGURE 7-3

Soil
Sample Container with
Sample Label

Plastic Ziplock Bag or Equivalent - Soil



~ To Scale

APPENDIX A-4

HOUSE DUST SAMPLING

For this study, the household dust samples are defined as the samples that are most likely to come with a child's hands during indoor activity. This would include dust on upfacing surfaces accessible to the child such as bare floors, carpets, window sills and wells, furniture, as well as dust on toys and other objects likely to be handled by children.

Dust sampling ~~has~~ focusses on two components: the concentration of lead in dust, and the amount of dust or loading on the surface. The concentration of lead in dust appears to be closely related to the amount of lead on children's hands whereas the amount of dust on surfaces is an indicator of the importance of this route of human exposure.

Dust Collection and Sampling Handling

There is no standard procedure for collecting dust samples. The following protocol was decided upon after reviewing other available methods (such as the personal air pump) and finding them inadequate. The dust sampling method chosen was the Sirchee-Spittler modified dust buster. We believe that it is the best method for collecting numerous dust samples within a reasonable amount of sampling time. Other necessary equipment to conduct the sampling are a ruler to measure the sampling area, a 25" by 25" template for designating the floor sampling are, paper envelopes to which the dust samples will be transferred, tape to seal the envelopes, and a cylinder of compressed air for cleaning the sample collection screen.

Before collection, make certain that the Sirchee-Spittler modified dust buster is fully charged. You can tell this running the dust buster for a few seconds and listening for a high pitched sound from the motor. Another way to monitor the charge in the dust buster is to keep track of the number of samples taken on a change. A maximum of 18 samples (roughly three households) should be taken on one charge. Also, when starting a sampling round in a household make sure that the sample collection screen is clean. Use the compressed air cylinder to blow the screen clean.

Seven dust samples should be taken in each LFK household from each of the following location: entry floor (i.e. right inside the front door of the house or apartment), LFK child's bedroom window well and floor, kitchen window will and floor and living room window well and floor. You may choose which window to sample in a room. The floor samples should be taken roughly from the center of the room. Sometimes it will not be possible to get all six samples in a household because of window that are nailed shut, obstructed by air conditioners, etc. In these instances, obtain as many samples as possible from the designated locations.

CATEGORY: Field Technical
TITLE: Household Dust Samplin Protocol
Lead Free Kids
Demonstration Project
Date: 2-89
Revision: 0

Once the individual sampling locations are decided upon, the size of the sampling area must be measured. For the window wells, measure the sampling area with a ruler. For the floors, set down the 25" by 25" template. If the floor is very clean, it may be necessary to vacuum a surface area larger than 25" by 25". In these cases, vacuum an area whose size is double or triple the analysis (at least 5 mg).

The sampling sequence should be as follows: Collect the bedroom, kitchen and living room floor samples first. Then, collect the floor sample from the entry way. Finally, collect the window well samples.

To collect a dust sample, switch on the dust buster and vacuum the designated area with back and forth strokes about 1-2 inches in width. The vacuum is most efficient f the head parallel to the ground and titled about 5 degrees in the direction of the motion. When the surface has been vacuumed keep finger on the switch while raising the vacuum to an upright position. The constant air flow will prevent loss of dust from the filter before it is in an upright position. Switch of the power and carefully remove the vacuum head without tilting it significantly. Reach in remove the filter screen with a gentle clockwise motion.

Transfer the dust sample to the paper envelope in the following way. Empty the contents of the filter screen into the paper envelope. Tap the envelope to times into the open envelope on a hard surface.

Tap the dust to the bottom of the enveloped and the seal the envelope and fold over 1/2 inch of the top of the envelope and crease carefully. Tape the folded part of the envelope down with at least a 10 inch long piece of Scotch tape. Each envelope should be labelled with the following information: LFK child's name, LFK number, sample location (i.e. bedroom window well) and size of sample area. It would be best if these envelopes and labels were prepared beforehand. Remember to handle the dust containing envelopes carefully; keep them upright in an envelope box. We want to avoid any loss of dust from the envelopes.

Replace the filter screen with a counter clockwise motion, attach the vacuum head and collect the other samples in the household using the same method. When you are finished sampling a household, clean out the filter screen and the vacuum head with a blast of compressed air.

* Parts of this protocol were adapted form Dr. Thomas Spittlers's 12-88 protocol "Instruments for Operation and Maintenance of Sirchee-Spittler Hand-Held Dust Vacuum Units."

APPENDIX B

ANALYTICAL PROCEDURES

FIGURE 6-2
Detailed Site Diagram

Address: _____ **Date:** _____

Name: _____

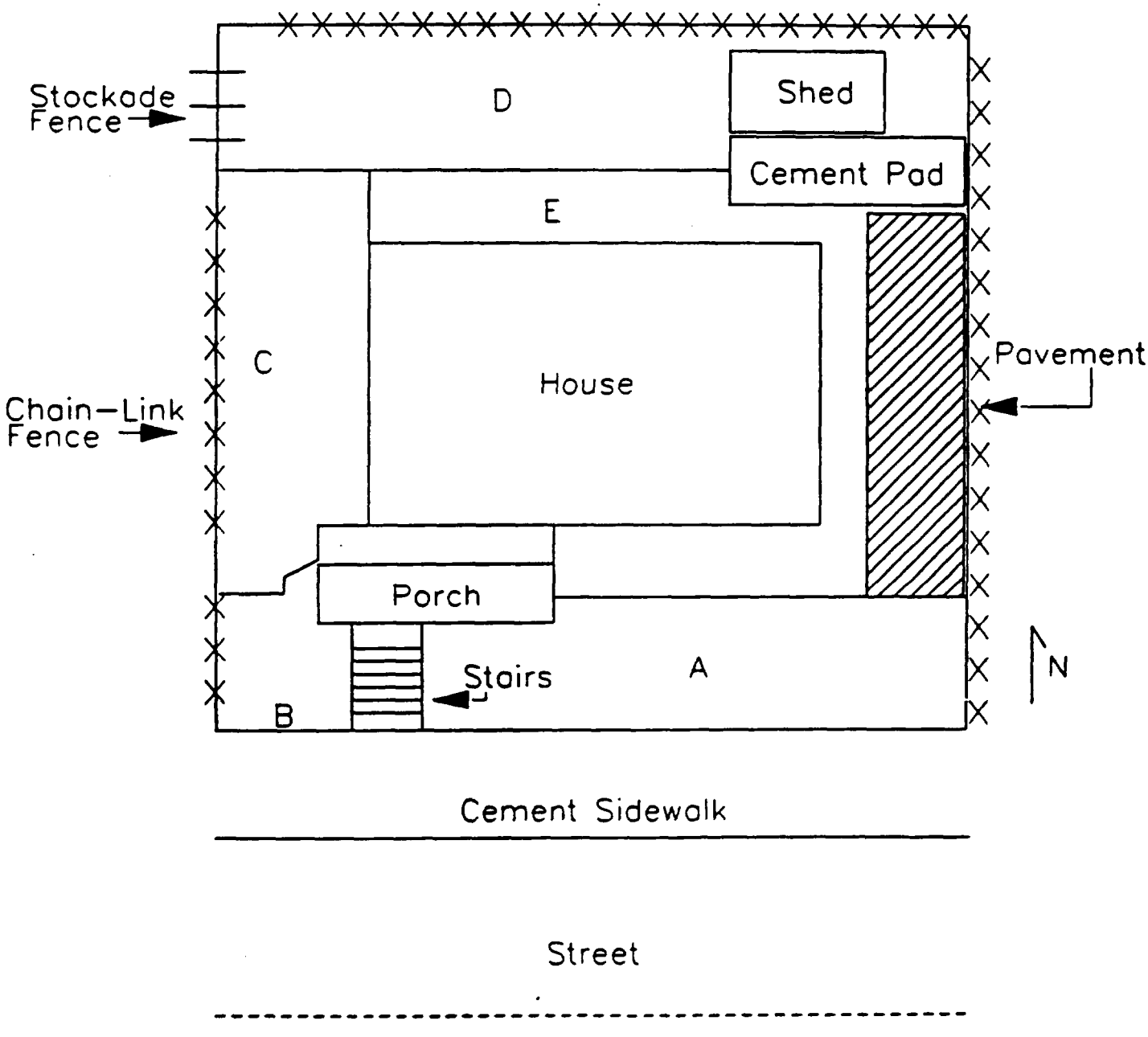


Figure 7-1

- Soil -

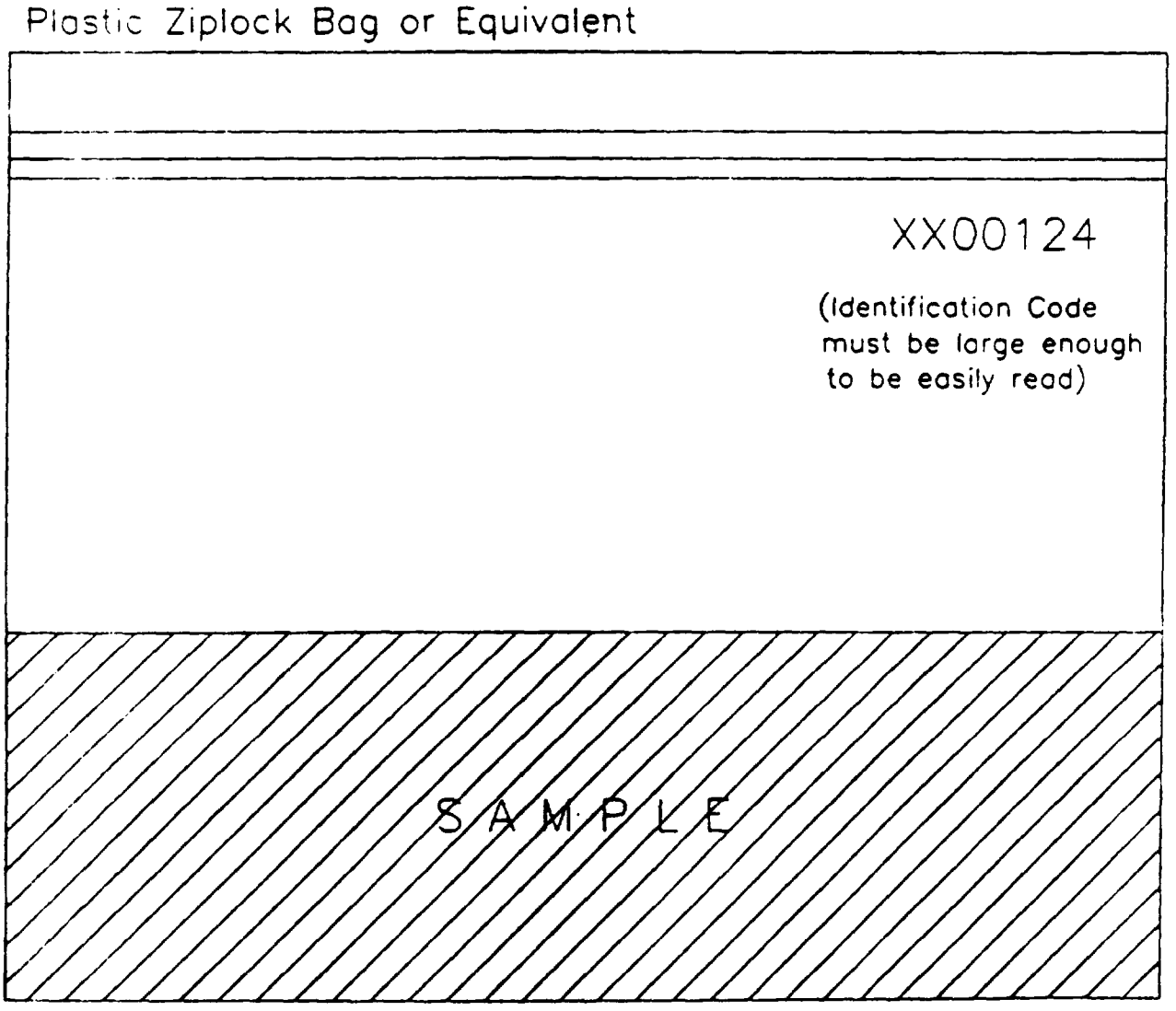
Lead-In-Soil Demonstrtation Project

Chain-of-Custody Record

Prem. ID	Samp ID	Address	Dist.	Date Collected	Collected By

Relinquished By	Received By	Date	Time	Comments/Instructions

FIGURE 7-2
Sample Container with
Sample Identification Marking

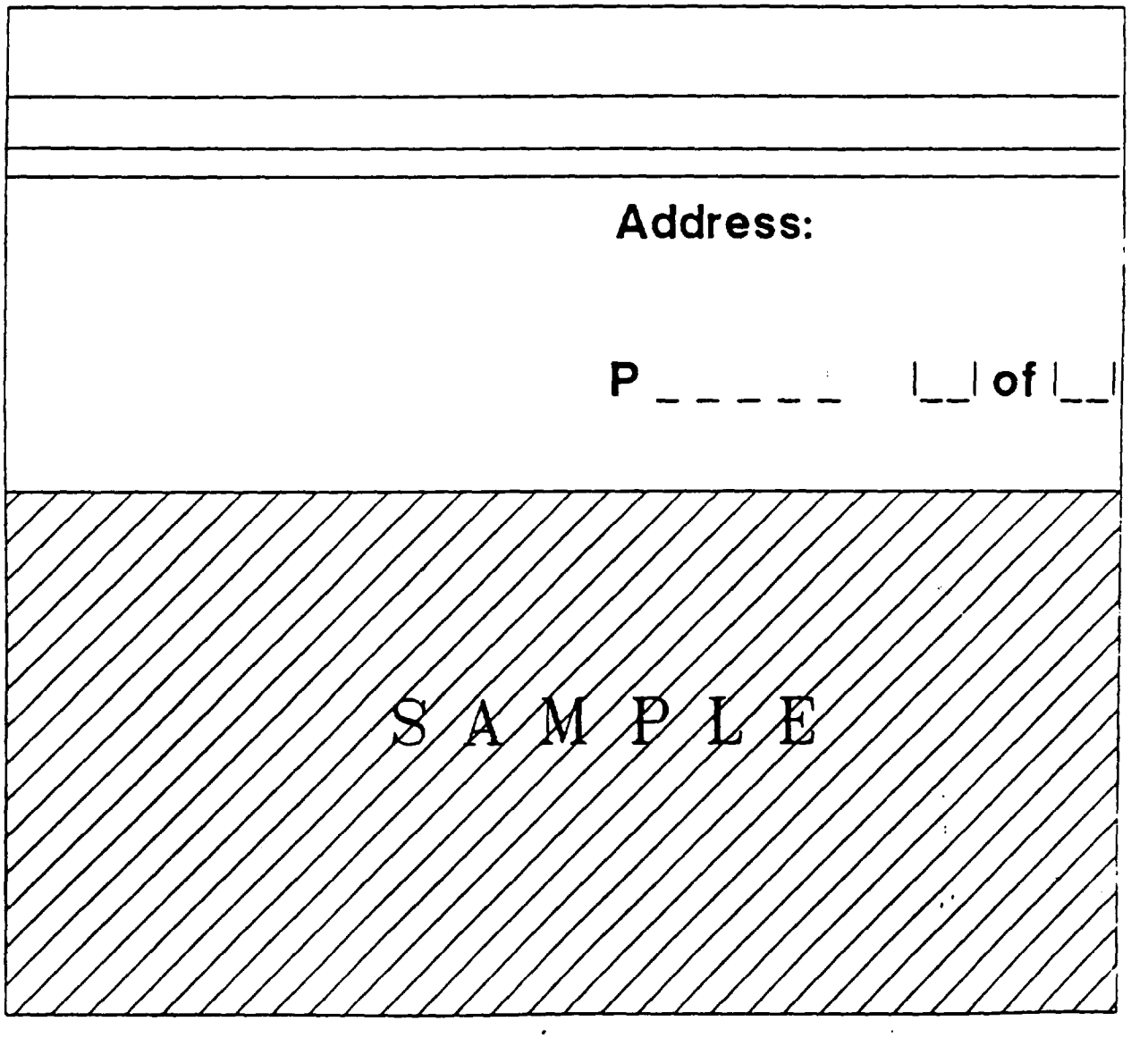


~ To Scale

FIGURE 7-3

Soil
Sample Container with
Sample Label

Plastic Ziplock Bag or Equivalent - Soil



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APPENDIX B-1

METHOD 3050: ACID DIGESTION OF SEDIMENTS SLUDGES, AND SOILS

METHOD 3050

ACID DIGESTION OF SEDIMENTS, SLUDGES, AND SOILS

1.0 SCOPE AND APPLICATION

1.1 This method is an acid digestion procedure used to prepare sediments, sludges, and soil samples for analysis by flame or furnace atomic absorption spectroscopy (FLAA and GFAA, respectively) or by inductively coupled argon plasma spectroscopy (ICP). Samples prepared by this method may be analyzed by ICP for all the listed metals, or by FLAA or GFAA as indicated below (see also Paragraph 2.1):

FLAA		GFAA
Aluminum	Magnesium	Arsenic
Barium	Manganese	Beryllium
Beryllium	Molybdenum	Cadmium
Cadmium	Nickel	Chromium
Calcium	Potassium	Cobalt
Chromium	Sodium	Iron
Cobalt	Thallium	Molybdenum
Copper	Vanadium	Selenium
Iron	Zinc	Thallium
Lead		Vanadium

2.0 SUMMARY OF METHOD

2.1 A representative 1- to 2-g (wet weight) sample is digested in nitric acid and hydrogen peroxide. The digestate is then refluxed with either nitric acid or hydrochloric acid. Dilute hydrochloric acid is used as the final reflux acid for (1) the ICP analysis of As and Se, and (2) the flame AA or ICP analysis of Al, Ba, Be, Ca, Cd, Cr, Co, Cu, Fe, Mo, Pb, Ni, K, Na, Tl, V, and Zn. Dilute nitric acid is employed as the final dilution acid for the furnace AA analysis of As, Be, Cd, Cr, Co, Pb, Mo, Se, Tl, and V. A separate sample shall be dried for a total solids determination.

3.0 INTERFERENCES

3.1 Sludge samples can contain diverse matrix types, each of which may present its own analytical challenge. Spiked samples and any relevant standard reference material should be processed to aid in determining whether Method 3050 is applicable to a given waste.

4.0 APPARATUS AND MATERIALS

4.1 Conical Phillips beakers: 250-mL.
4.2 Watch glasses.
4.3 Drying ovens: That can be maintained at 30°C.
4.4 Thermometer: That covers range of 0 to 200°C.
4.5 Whatman No. 41 filter paper (or equivalent).
4.6 Centrifuge and centrifuge tubes.

5.0 REAGENTS

5.1 ASTM Type II water (ASTM D1193): Water should be monitored for impurities.

5.2 Concentrated nitric acid, reagent grade (HNO_3): Acid should be analyzed to determine level of impurities. If method blank is <MDL, the acid can be used.

5.3 Concentrated hydrochloric acid, reagent grade (HCl): Acid should be analyzed to determine level of impurities. If method blank is <MDL, the acid can be used.

5.4 Hydrogen peroxide (30%) (H_2O_2): Oxidant should be analyzed to determine level of impurities.

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 All samples must have been collected using a sampling plan that addresses the considerations discussed in Chapter Nine of this manual.

6.2 All sample containers must be prewashed with detergents, acids, and Type II water. Plastic and glass containers are both suitable. See Chapter Three, Section 3.1.3, for further information.

6.3 Nonaqeuous samples shall be refrigerated upon receipt and analyzed as soon as possible.

7.0 PROCEDURE

7.1 Mix the sample thoroughly to achieve homogeneity. For each digestion procedure, weigh to the nearest 0.01 g and transfer to a conical beaker a 1.00- to 2.00-g portion of sample.

7.2 Add 10 mL of 1:1 HNO_3, mix the slurry, and cover with a watch glass. Heat the sample to 95°C and reflux for 10 to 15 min without boiling. Allow the sample to cool, add 5 mL of concentrated HNO_3, replace the watch glass, and reflux for 30 min. Repeat this last step to ensure complete oxidation.

Using a ribbed watch glass, allow the solution to evaporate to 5 mL without boiling, while maintaining a covering of solution over the bottom of the beaker.

7.3 After Step 7.2 has been completed and the sample has cooled, add 2 mL of Type II water and 3 mL of 30% H_2O_2. Cover the beaker with a watch glass and return the covered beaker to the hot plate for warming and to start the peroxide reaction. Care must be taken to ensure that losses do not occur due to excessively vigorous effervescence. Heat until effervescence subsides and cool the beaker.

7.4 Continue to add 30% H_2O_2 in 1-mL aliquots with warming until the effervescence is minimal or until the general sample appearance is unchanged.
NOTE: Do not add more than a total of 10 mL 30% H_2O_2.

7.5 If the sample is being prepared for (a) the ICP analysis of As and Se, or (b) the flame AA or ICP analysis of Al, Ba, Be, Ca, Cd, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Na, Tl, V, and Zn, then add 5 mL of concentrated HCl and 10 mL of Type II water, return the covered beaker to the hot plate, and reflux for an additional 15 min without boiling. After cooling, dilute to 100 mL with Type II water. Particulates in the digestate that may clog the nebulizer should be removed by filtration, by centrifugation, or by allowing the sample to settle.

7.5.1 Filtration: Filter through Whatman No. 41 filter paper (or equivalent) and dilute to 100 mL with Type II water.

7.5.2 Centrifugation: Centrifugation at 2,000-3,000 rpm for 10 min is usually sufficient to clear the supernatant.

7.5.3 The diluted sample has an approximate acid concentration of 5.0% (v/v) HCl and 5.0% (v/v) HNO_3. The sample is now ready for analysis.

7.6 If the sample is being prepared for the furnace analysis of As, Be, Cd, Cr, Co, Pb, Mo, Se, Tl, and V, cover the sample with a ribbed watch glass and continue heating the acid-peroxide digestate until the volume has been reduced to approximately 5 mL. After cooling, dilute to 100 mL with Type II water. Particulates in the digestate should then be removed by filtration, by centrifugation, or by allowing the sample to settle.

7.6.1 Filtration: Filter through Whatman No. 41 filter paper (or equivalent) and dilute to 100 mL with Type II water.

7.6.2 Centrifugation: Centrifugation at 2,000-3,000 for 10 min is usually sufficient to clear the supernatant.

7.6.3 The diluted digestate solution contains approximately 5% (v/v) HNO_3. For analysis, withdraw aliquots of appropriate volume and add any required reagent or matrix modifier. The sample is now ready for analysis.

7.7 Calculations:

7.7.1 The concentrations determined are to be reported on the basis of the actual weight of the sample. If a dry weight analysis is desired, then the percent solids of the sample must also be provided.

7.7.2 If percent solids is desired, a separate determination of percent solids must be performed on a homogeneous aliquot of the sample.

8.0 QUALITY CONTROL

8.1 For each group of samples processed, preparation blanks (Type II water and reagents) should be carried throughout the entire sample preparation and analytical process. These blanks will be useful in determining if samples are being contaminated.

8.2 Duplicate samples should be processed on a routine basis. Duplicate samples will be used to determine precision. The sample load will dictate the frequency, but 20% is recommended.

8.3 Spiked samples or standard reference materials must be employed to determine accuracy. A spiked sample should be included with each group of samples processed and whenever a new sample matrix is being analyzed.

8.4 The concentration of all calibration standards should be verified against a quality control check sample obtained from an outside source.

9.0 METHOD PERFORMANCE

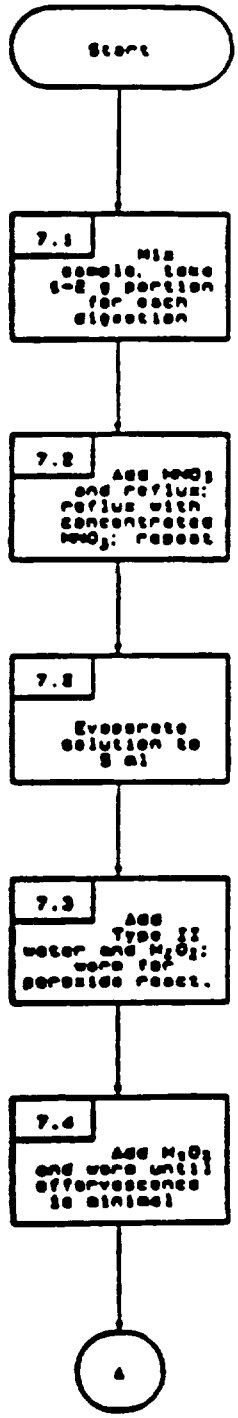
9.1 No data provided.

10.0 REFERENCES

10.1 None required.

METHOD 3050

ACID DIGESTION OF SEDIMENTS, SLUDGES, AND SOILS

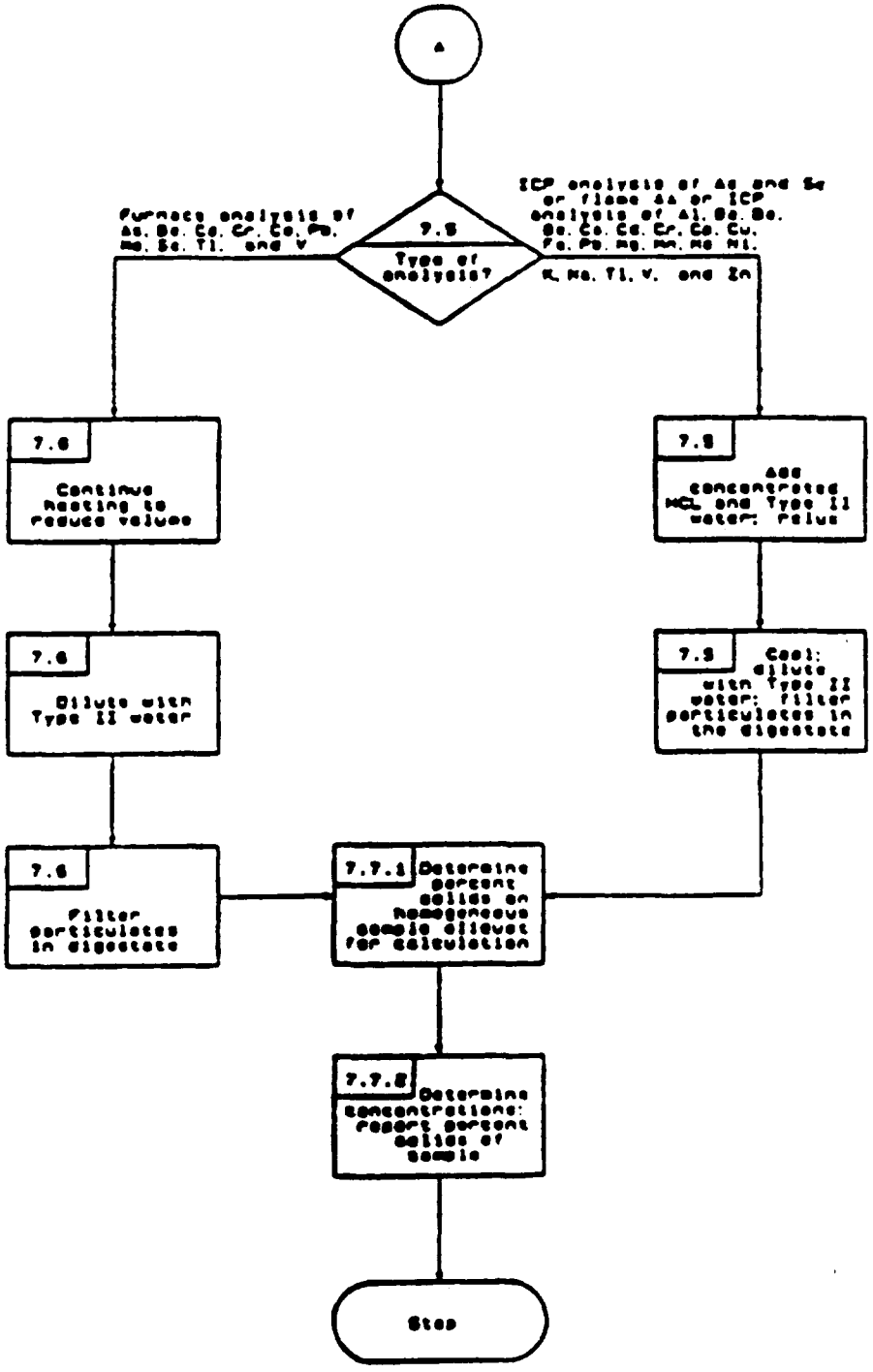


Revision 0
Date September 1986

METHOD 3050

ACID DIGESTION OF SEDIMENTS, SLUDGES, AND SOILS

(Continued)



Revision 0
Date September 1986

APPENDIX B-2

METHOD 6010
INDUCTIVELY COUPLED PLASMA
ATOMIC EMISSION SPECTROSCOPY

METHOD 6010

INDUCTIVELY COUPLED PLASMA ATOMIC EMISSION SPECTROSCOPY

1.0 SCOPE AND APPLICATION

1.1 Inductively coupled plasma atomic emission spectroscopy (ICP) determines elements including metals in solution. The method is applicable to a large number of metals and wastes. All matrices, including ground water, aqueous samples, EP extracts, industrial wastes, soils, sludges, sediments, and other solid wastes, require digestion prior to analysis.

1.2 Elements for which Method 6010 is applicable are listed in Table 1. Detection limits, sensitivity, and optimum ranges of the metals will vary with the matrices and model of spectrometer. The data shown in Table 1 provide concentration ranges for clean aqueous samples. Use of this method is restricted to spectroscopists who are knowledgeable in the correction of spectral, chemical, and physical interferences.

1.3 The method of standard addition (MSA) (Paragraph 8.5.3) shall be used for the analysis of all EP extracts and sample digests unless either serial dilution or matrix spike addition demonstrates that it is not required.

2.0 SUMMARY OF METHOD

2.1 Prior to analysis, samples must be solubilized or digested using appropriate Sample Preparation Methods (e.g., Methods 3005-3050).

2.2 Method 6010 describes the simultaneous, or sequential, multielemental determination of elements by ICP. The method measures element-emitted light by optical spectrometry. Samples are nebulized and the resulting aerosol is transported to the plasma torch. Element-specific atomic-line emission spectra are produced by a radio-frequency inductively coupled plasma. The spectra are dispersed by a grating spectrometer, and the intensities of the lines are monitored by photomultiplier tubes. Background correction is required for trace element determination. Background must be measured adjacent to analyte lines on samples during analysis. The position selected for the background-intensity measurement, on either or both sides of the analytical line, will be determined by the complexity of the spectrum adjacent to the analyte line. The position used must be free of spectral interference and reflect the same change in background intensity as occurs at the analyte wavelength measured. Background correction is not required in cases of line broadening where a background correction measurement would actually degrade the analytical result. The possibility of additional interferences named in Section 3.0 should also be recognized and appropriate corrections made; tests for their presence are described in Section 8.5.

TABLE 1. RECOMMENDED WAVELENGTHS AND ESTIMATED INSTRUMENTAL DETECTION LIMITS

Element	Wavelength[a] (nm)	Estimated Detection Limit[b] (ug/L)
Aluminum	308.215	45
Antimony	206.833	32
Arsenic	193.696	53
Barium	455.403	2
Beryllium	313.042	0.3
Boron	249.773	5
Cadmium	226.502	4
Calcium	317.933	10
Chromium	267.716	7
Cobalt	228.616	7
Copper	324.754	6
Iron	259.940	7
Lead	220.353	42
Magnesium	279.079	30
Manganese	257.610	2
Molybdenum	202.030	8
Nickel	231.604	15
Potassium	766.491	See note c
Selenium	196.026	75
Silicon	288.158	58
Silver	328.068	7
Sodium	588.995	29
Thallium	190.864	40
Vanadium	292.402	8
Zinc	213.856	2

[a]The wavelengths listed are recommended because of their sensitivity and overall acceptance. Other wavelengths may be substituted if they can provide the needed sensitivity and are treated with the same corrective techniques for spectral interference (see Paragraph 3.1). In time, other elements may be added as more information becomes available and as required.

[b]The estimated instrumental detection limits shown are taken from Reference 1 in Section 10.0 below. They are given as a guide for an instrumental limit. The actual method detection limits are sample dependent and may vary as the sample matrix varies.

[c]Highly dependent on operating conditions and plasma position.

3.0 INTERFERENCES

3.1 Spectral interferences are caused by: (1) overlap of a spectral line from another element; (2) unresolved overlap of molecular band spectra; (3) background contribution from continuous or recombination phenomena; and (4) stray light from the line emission of high-concentration elements. Spectral overlap can be compensated for by computer-correcting the raw data after monitoring and measuring the interfering element. Unresolved overlap requires selection of an alternate wavelength. Background contribution and stray light can usually be compensated for by a background correction adjacent to the analyte line.

Users of simultaneous multielement instruments must verify the absence of spectral interference from an element in a sample for which there is no instrument detection channel. Potential spectral interferences for the recommended wavelengths are given in Table 2. The data in Table 2 are intended as rudimentary guides for indicating potential interferences; for this purpose, linear relations between concentration and intensity for the analytes and the interferents can be assumed.

3.1.1 The interference is expressed as analyte concentration equivalents (i.e., false analyte concentrations) arising from 100 mg/L of the interference element. For example, assume that As is to be determined (at 193.696 nm) in a sample containing approximately 10 mg/L of Al. According to Table 2, 100 mg/L of Al would yield a false signal for As equivalent to approximately 1.3 mg/L. Therefore, the presence of 10 mg/L of Al would result in a false signal for As equivalent to approximately 0.13 mg/L. The user is cautioned that other instruments may exhibit somewhat different levels of interference than those shown in Table 2. The interference effects must be evaluated for each individual instrument since the intensities will vary with operating conditions, power, viewing height, argon flow rate, etc.

3.1.2 The dashes in Table 2 indicate that no measurable interferences were observed even at higher interferent concentrations. Generally, interferences were discernible if they produced peaks, or background shifts, corresponding to 2 to 5% of the peaks generated by the analyte concentrations.

3.1.3 At present, information on the listed silver and potassium wavelengths is not available, but it has been reported that second-order energy from the magnesium 383.231-nm wavelength interferes with the listed potassium line at 766.491 nm.

3.2 Physical interferences are effects associated with the sample nebulization and transport processes. Changes in viscosity and surface tension can cause significant inaccuracies, especially in samples containing high dissolved solids or high acid concentrations. If physical interferences are present, they must be reduced by diluting the sample, by using a peristaltic pump or by using the standard additions method. Another problem that can occur with high dissolved solids is salt buildup at the tip of the nebulizer, which affects aerosol flow rate and causes instrumental drift. The problem can be controlled by wetting the argon prior to nebulization, using a

TABLE 2. ANALYTE CONCENTRATION EQUIVALENTS ARISING FROM INTERFERENCE AT THE 100-mg/L LEVEL

Analyte	Wavelength (nm)	Interferent[a,b]									
		Al	Ca	Cr	Cu	Fe	Mg	Mn	Ni	Tl	V
Aluminum	308.215	—	—	—	—	—	—	0.21	—	—	1.4
Antimony	206.833	0.47	—	2.9	—	0.08	—	—	—	0.25	0.45
Arsenic	193.696	1.3	—	0.44	—	—	—	—	—	—	1.1
Barium	455.403	—	—	—	—	—	—	—	—	—	—
Beryllium	313.042	—	—	—	—	—	—	—	—	0.04	0.05
Boron	249.773	0.04	—	—	—	0.32	—	—	—	—	—
Cadmium	226.502	—	—	—	—	0.03	—	—	0.02	—	—
Calcium	317.933	—	—	0.08	—	0.01	0.01	0.04	—	0.03	0.03
Chromium	267.716	—	—	—	—	0.003	—	0.04	—	—	0.04
Cobalt	228.616	—	—	0.03	—	0.005	—	—	0.03	0.15	—
Copper	324.754	—	—	—	—	0.003	—	—	—	0.05	0.02
Iron	259.940	—	—	—	—	—	—	0.12	—	—	—
Lead	220.353	0.17	—	—	—	—	—	—	—	—	—
Magnesium	279.079	—	0.02	0.11	—	0.13	—	0.25	—	0.07	0.12
Manganese	257.610	0.005	—	0.01	—	0.002	0.002	—	—	—	—
Molybdenum	202.030	0.05	—	—	—	0.03	—	—	—	—	—
Nickel	231.604	—	—	—	—	—	—	—	—	—	—
Selenium	196.026	0.23	—	—	—	0.09	—	—	—	—	—
Silicon	288.158	—	—	0.07	—	—	—	—	—	—	0.01
Sodium	588.995	—	—	—	—	—	—	—	—	0.08	—
Thallium	190.864	0.30	—	—	—	—	—	—	—	—	—
Vanadium	292.402	—	—	0.05	—	0.005	—	—	—	0.02	—
Zinc	213.856	—	—	—	0.14	—	—	—	0.29	—	—

[a]Dashes indicate that no interference was observed even when interferents were introduced at the following levels:

Al - 1000 mg/L,
Ca - 1000 mg/L,
Cr - 200 mg/L,
Cu - 200 mg/L
Fe - 1000 mg/L
Mg - 1000 mg/L,
Mn - 200 mg/L,
Tl - 200 mg/L,
V - 200 mg/L

[b]The figures recorded as analyte concentrations are not the actual observed concentrations; to obtain those figures, add the listed concentration to the interferent figure.

tip washer, or diluting the sample. Also, it has been reported that better control of the argon flow rate improves instrument performance; this is accomplished with the use of mass flow controllers.

3.3 Chemical interferences include molecular compound formation, ionization effects, and solute vaporization effects. Normally, these effects are not significant with the ICP technique. If observed, they can be minimized by careful selection of operating conditions (incident power, observation position, and so forth), by buffering of the sample, by matrix matching, and by standard addition procedures. Chemical interferences are highly dependent on matrix type and the specific analyte element.

4.0 APPARATUS AND MATERIALS

4.1 Inductively coupled argon plasma emission spectrometer:

4.1.1 Computer-controlled emission spectrometer with background correction.

4.1.2 Radio frequency generator.

4.1.3 Argon gas supply: Welding grade or better.

4.2 Operating conditions: The analyst should follow the instructions provided by the instrument's manufacturer. For operation with organic solvents, use of the auxiliary argon inlet is recommended, as are solvent-resistant tubing, increased plasma (coolant) argon flow, decreased nebulizer flow, and increased RF power to obtain stable operation and precise measurements. Sensitivity, instrumental detection limit, precision, linear dynamic range, and interference effects must be established for each individual analyte line on that particular instrument. All measurements must be within instrument linear range where coordination factors are valid. The analyst must (1) verify that the instrument configuration and operating conditions satisfy the analytical requirements and (2) maintain quality control data confirming instrument performance and analytical results.

5.0 REAGENTS

5.1 Acids used in the preparation of standards and for sample processing must be reagent grade or better. Redistilled acids may be used.

5.1.1 Concentrated hydrochloric acid (HCl).

5.1.2 Hydrochloric acid (1:1): Add 500 mL concentrated HCl to 400 mL Type II water and dilute to 1 liter.

5.1.3 Concentrated nitric acid (HNO_3).

5.1.4 Nitric acid (1:1): Add 500 mL concentrated HNO_3 to 400 mL Type II water and dilute to 1 liter.

5.2 ASTM Type II water (ASTM D1193): Water should be monitored for impurities.

5.3 Standard stock solutions may be purchased or prepared from ultra-high purity grade chemicals or metals (99.99 to 99.999% pure). All salts must be dried for 1 hr at 105°C, unless otherwise specified.

(CAUTION: Many metal salts are extremely toxic if inhaled or swallowed. Wash hands thoroughly after handling.)

Typical stock solution preparation procedures follow. Concentrations are calculated based upon the weight of pure metal added, or with the use of the mole fraction and the weight of the metal salt added.

Metal

$$\text{Concentration (ppm)} = \frac{\text{weight (mg)}}{\text{volume (L)}}$$

Metal salts

$$\text{Concentration (ppm)} = \frac{\text{weight (mg)} \times \text{mole fraction}}{\text{volume (L)}}$$

5.3.1 Aluminum solution, stock, 1 mL = 100 ug Al: Dissolve 0.10 g of aluminum metal, weighed accurately to at least four significant figures, in an acid mixture of 4 mL of (1:1) HCl and 1 mL of concentrated HNO_3 in a beaker. Warm gently to effect solution. When solution is complete, transfer quantitatively to a liter flask, add an additional 10 mL of (1:1) HCl and dilute to 1,000 mL with Type II water.

5.3.2 Antimony solution, stock, 1 mL = 100 ug Sb: Dissolve 0.27 g $K(SbO)C_4H_4O_6$ (mole fraction Sb = 0.3749), weighed accurately to at least four significant figures, in Type II water, add 10 mL (1:1) HCl, and dilute to 1,000 mL with Type II water.

5.3.3 Arsenic solution, stock, 1 mL = 100 ug As: Dissolve 0.13 g of As_2O_3 (mole fraction As = 0.7574), weighed accurately to at least four significant figures, in 100 mL of Type II water containing 0.4 g NaOH. Acidify the solution with 2 mL concentrated HNO_3 and dilute to 1,000 mL with Type II water.

5.3.4 Barium solution, stock, 1 mL = 100 ug Ba: Dissolve 0.15 g $BaCl_2$ (mole fraction Ba = 0.6595), dried at 250°C for 2 hr, weighed accurately to at least four significant figures, in 10 mL Type II water with 1 mL (1:1) HCl. Add 10.0 mL (1:1) HCl and dilute to 1,000 mL with Type II water.

5.3.5 Beryllium solution, stock, 1 mL = 100 ug Be: Do not dry. Dissolve 1.97 g $BeSO_4 \cdot 4H_2O$ (mole fraction Be = 0.0509), weighed accurately to at least four significant figures, in Type II water, add 10.0 ml concentrated HNO_3, and dilute to 1,000 mL with Type II water. Mole fraction = 0.0509.

5.3.6 **Boron solution, stock 1 mL = 100 ug B:** Do not dry. Dissolve 0.57 g anhydrous H_3BO_3 (mole fraction B = 0.1748), weighed accurately to at least four significant figures, in Type II water and dilute to 1,000 mL. Use a reagent meeting ACS specifications, keep the bottle tightly stoppered, and store in a desiccator to prevent the entrance of atmospheric moisture.

5.3.7 **Cadmium solution, stock, 1 mL = 100 ug Cd:** Dissolve 0.11 g CdO (mole fraction Cd = 0.8754), weighed accurately to at least four significant figures, in a minimum amount of (1:1) HNO_3. Heat to increase rate of dissolution. Add 10.0 mL concentrated HNO_3 and dilute to 1,000 mL with Type II water.

5.3.8 **Calcium solution, stock, 1 mL = 100 ug Ca:** Suspend 0.25 g $CaCO_3$ (mole Ca fraction = 0.4005), dried at 180°C for 1 hr before weighing, weighed accurately to at least four significant figures, in Type II water and dissolve cautiously with a minimum amount of (1:1) HNO_3. Add 10.0 mL concentrated HNO_3 and dilute to 1,000 mL with Type II water.

5.3.9 **Chromium solution, stock, 1 mL = 100 ug Cr:** Dissolve 0.19 g CrO_3 (mole fraction Cr = 0.5200), weighed accurately to at least four significant figures, in Type II water. When solution is complete, acidify with 10 mL concentrated HNO_3 and dilute to 1,000 mL with Type II water.

5.3.10 **Cobalt solution, stock, 1 mL = 100 ug Co:** Dissolve 0.1000 g of cobalt metal, weighed accurately to at least four significant figures, in a minimum amount of (1:1) HNO_3. Add 10.0 mL (1:1) HCl and dilute to 1,000 mL with Type II water.

5.3.11 **Copper solution, stock, 1 mL = 100 ug Cu:** Dissolve 0.13 g CuO (mole fraction Cu = 0.7989), weighed accurately to at least four significant figures), in a minimum amount of (1:1) HNO_3. Add 10.0 mL concentrated HNO_3 and dilute to 1,000 mL with Type II water.

5.3.12 **Iron solution, stock, 1 mL = 100 ug Fe:** Dissolve 0.14 g Fe_2O_3 (mole fraction Fe = 0.6994), weighed accurately to at least four significant figures, in a warm mixture of 20 mL (1:1) HCl and 2 mL of concentrated HNO_3. Cool, add an additional 5.0 mL of concentrated HNO_3, and dilute to 1,000 mL with Type II water.

5.3.13 **Lead solution, stock, 1 mL = 100 ug Pb:** Dissolve 0.16 g $Pb(NO_3)_2$ (mole fraction Pb = 0.6256), weighed accurately to at least four significant figures, in a minimum amount of (1:1) HNO_3. Add 10 mL (1:1) HNO_3 and dilute to 1,000 mL with Type II water.

5.3.14 **Magnesium solution, stock, 1 mL = 100 ug Mg:** Dissolve 0.17 g MgO (mole fraction Mg = 0.6030), weighed accurately to at least four significant figures, in a minimum amount of (1:1) HNO_3. Add 10.0 mL (1:1) concentrated HNO_3 and dilute to 1,000 mL with Type II water.

5.3.15 Manganese solution, stock, 1 mL = 100 ug Mn: Dissolve 0.1000 g of manganese metal, weighed accurately to at least four significant figures, in acid mixture (10 mL concentrated HCl and 1 mL concentrated HNO_3) and dilute to 1,000 mL with Type II water.

5.3.16 Molybdenum solution, stock, 1 mL = 100 ug Mo: Dissolve 0.20 g $(NH_4)_6Mo_7O_{24}\cdot 4H_2O$ (mole fraction Mo = 0.5772), weighed accurately to at least four significant figures, in Type II water and dilute to 1,000 mL with Type II water.

5.3.17 Nickel solution, stock, 1 mL = 100 ug Ni: Dissolve 0.1000 g of nickel metal, weighed accurately to at least four significant figures, in 10.0 mL hot concentrated HNO_3, cool, and dilute to 1,000 mL with Type II water.

5.3.18 Potassium solution, stock, 1 mL = 100 ug K: Dissolve 0.19 g KCl (mole fraction K = 0.5244) dried at 110°C, weighed accurately to at least four significant figures, in Type II water and dilute to 1,000 mL.

5.3.19 Selenium solution, stock, 1 mL = 100 ug Se: Do not dry. Dissolve 0.17 g H_2SeO_3 (mole fraction Se = 0.6123), weighed accurately to at least four significant figures, in Type II water and dilute to 1,000 mL.

5.3.20 Silica solution, stock, 1 mL = 100 ug SiO_2: Do not dry. Dissolve 0.47 g $Na_2SiO_3\cdot 9H_2O$ (mole fraction Si = 0.09884), weighed accurately to at least four significant figures, in Type II water. Add 10.0 mL concentrated HNO_3 and dilute to 1,000 mL with Type II water.

5.3.21 Silver solution, stock, 1 mL = 100 ug Ag: Dissolve 0.16 g $AgNO_3$ (mole fraction Ag = 0.6350), weighed accurately to at least four significant figures, in Type II water and 10 mL concentrated HNO_3. Dilute to 1,000 mL with Type II water.

5.3.22 Sodium solution, stock, 1 mL = 100 ug Na: Dissolve 0.25 g NaCl (mole fraction Na = 0.3934), weighed accurately to at least four significant figures, in Type II water. Add 10.0 mL concentrated HNO_3 and dilute to 1,000 mL with Type II water.

5.3.23 Thallium solution, stock, 1 mL = 100 ug Tl: Dissolve 0.13 g $TlNO_3$ (mole fraction Tl = 0.7672), weighed accurately to at least four significant figures, in Type II water. Add 10.0 mL concentrated HNO_3 and dilute to 1,000 mL with Type II water.

5.3.24 Vanadium solution, stock, 1 mL = 100 ug V: Dissolve 0.23 g NH_4VO_3 (mole fraction V = 0.4356), weighed accurately to at least four significant figures, in a minimum amount of concentrated HNO_3. Heat to increase rate of dissolution. Add 10.0 mL concentrated HNO_3 and dilute to 1,000 mL with Type II water.

5.3.25 Zinc solution, stock, 1 mL = 100 ug Zn: Dissolve 0.12 g ZnO (mole fraction Zn = 0.8034), weighed accurately to at least four significant figures, in a minimum amount of dilute HNO_3. Add 10.0 mL concentrated HNO_3 and dilute to 1,000 mL with Type II water.

5.4 Mixed calibration standard solutions: Prepare mixed calibration standard solutions by combining appropriate volumes of the stock solutions in volumetric flasks (see Table 3). Add 2 mL (1:1) HNO_3 and 10 mL of (1:1) HCl and dilute to 100 mL with Type II water (see NOTE, below). Prior to preparing the mixed standards, each stock solution should be analyzed separately to determine possible spectral interference or the presence of impurities. Care should be taken when preparing the mixed standards to ensure that the elements are compatible and stable together. Transfer the mixed standard solutions to FEP fluorocarbon or previously unused polyethylene or polypropylene bottles for storage. Fresh mixed standards should be prepared, as needed, with the realization that concentration can change on aging. Calibration standards must be initially verified using a quality control sample (see Paragraph 5.8) and monitored weekly for stability. Some typical calibration standard combinations are listed in Table 3. All mixtures should then be scanned using a sequential spectrometer to verify the absence of interelement spectral interference in the recommended mixed standard solutions.

NOTE: If the addition of silver to the recommended acid combination results in an initial precipitation, add 15 mL of Type II water and warm the flask until the solution clears. Cool and dilute to 100 mL with Type II water. For this acid combination, the silver concentration should be limited to 2 mg/L. Silver under these conditions is stable in a tap-water matrix for 30 days. Higher concentrations of silver require additional HCl.

TABLE 3. MIXED STANDARD SOLUTIONS

Solution	Elements
I	Be, Cd, Mn, Pb, Se and Zn
II	Ba, Co, Cu, Fe, and V
III	As, Mo, and Si
IV	Al, Ca, Cr, K, Na, and Ni
V	Ag (see Note to Paragraph 5.4), B, Mg, Sb, and Tl

5.5 Two types of blanks are required for the analysis. The calibration blank is used in establishing the analytical curve, and the reagent blank is used to correct for possible contamination resulting from varying amounts of the acids used in the sample processing.

5.5.1 The calibration blank is prepared by diluting 2 mL of (1:1) HNO_3 and 10 mL of (1:1) HCl to 100 mL with Type II water. Prepare a sufficient quantity to flush the system between standards and samples.

5.5.2 The reagent blank must contain all the reagents and in the same volumes as used in the processing of the samples. The reagent blank must be carried through the complete procedure and contain the same acid concentration in the final solution as the sample solution used for analysis.

5.6 The instrument check standard is prepared by the analyst by combining compatible elements at concentrations equivalent to the midpoint of their respective calibration curves (see Paragraph 8.6.2.1 for use).

5.7 The interference check solution is prepared to contain known concentrations of interfering elements that will provide an adequate test of the correction factors. Spike the sample with the elements of interest at approximate concentrations of 10 times the instrumental detection limits. In the absence of measurable analyte, overcorrection could go undetected because a negative value could be reported as zero. If the particular instrument will display overcorrection as a negative number, this spiking procedure will not be necessary.

5.8 The quality control sample should be prepared in the same acid matrix as the calibration standards at 10 times the instrumental detection limits and in accordance with the instructions provided by the supplier.

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 See the introductory material in Chapter Three, Inorganic Analytes, Sections 3.1 through 3.3.

7.0 PROCEDURE

7.1 Preliminary treatment of all matrices is always necessary because of the complexity and variability of sample matrices. Solubilization and digestion procedures are presented in Sample Preparation Methods (Methods 3005-3050). The method of standard addition (MSA) (Paragraph 8.5.3) shall be used for the analysis of all EP extracts and sample digests unless either serial dilution or matrix spike addition demonstrates that it is not required. An internal standard may be substituted for the MSA.

7.2 Set up the instrument with proper operating parameters established in Paragraph 4.2. The instrument must be allowed to become thermally stable before beginning (usually requiring at least 30 min of operation prior to calibration).

7.3 Profile and calibrate the instrument according to the instrument manufacturer's recommended procedures, using the typical mixed calibration standard solutions described in Paragraph 5.4. Flush the system with the calibration blank (5.5.1) between each standard (see NOTE, below). (Use the average intensity of multiple exposures for both standardization and sample analysis to reduce random error.)

NOTE: For boron concentrations greater than 500 ug/L, extended flush times of 1 or 2 min may be required.

7.4 Before beginning the sample run, reanalyze the highest mixed calibration standard as if it were a sample. Concentration values obtained should not deviate from the actual values by more than 5% (or the established control limits, whichever is lower). If they do, follow the recommendations of the instrument manufacturer to correct for this condition.

7.5 Flush the system with the calibration blank solution for at least 1 min (Paragraph 5.5.1) before the analysis of each sample (see Note to Paragraph 7.3). Analyze the instrument check standard (5.6) and the calibration blank (5.5.1) after each 10 samples.

7.6 Calculations: If dilutions were performed, the appropriate factors must be applied to sample values. All results should be reported in ug/L with up to three significant figures.

8.0 QUALITY CONTROL

8.1 All quality control data should be maintained and available for easy reference or inspection.

8.2 Dilute and reanalyze samples that are more concentrated than the linear calibration limit or use an alternate, less sensitive line for which quality control data is already established.

8.3 Employ a minimum of one laboratory blank per sample batch to determine if contamination or any memory effects are occurring.

8.4 Analyze one duplicate sample for every 20 samples. A duplicate sample is a sample brought through the whole sample preparation and analytical process.

8.5 It is recommended that whenever a new or unusual sample matrix is encountered, a series of tests be performed prior to reporting concentration data for analyte elements. These tests, as outlined in 8.5.1 through 8.5.3, will ensure the analyst that neither positive nor negative interferences are operating on any of the analyte elements to distort the accuracy of the reported values.

8.5.1 Serial dilution: If the analyte concentration is sufficiently high (minimally, a factor of 10 above the instrumental detection limit after dilution), an analysis of a 1:4 dilution should agree within ±10% of the original determination. If not, a chemical or physical interference effect should be suspected.

8.5.2 Matrix spike addition: An analyte spike added to a portion of a prepared sample, or its dilution, should be recovered to within 75% to 125% of the known value. The spike addition should produce a minimum level of 10 times and a maximum of 100 times the instrumental detection limit. If the spike is not recovered within the specified limits, a matrix effect should be suspected. The use of a standard-addition analysis procedure can usually compensate for this effect.

CAUTION: The standard-addition technique does not detect coincident spectral overlap. If suspected, use of computerized compensation, an alternate wavelength, or comparison with an alternate method is recommended.

8.5.3 Standard addition: The standard-addition technique involves adding known amounts of standard to one or more aliquots of the processed sample solution. This technique compensates for a sample constituent that enhances or depresses the analyte signal, thus producing a different slope from that of the calibration standards. It will not correct for additive interferences which cause a baseline shift. The simplest version of this technique is the single-addition method, in which two identical aliquots of the sample solution, each of Volume V_x, are taken. To the first (labeled A) is added a small volume V_s of a standard analyte solution of concentration c_s. To the second (labeled B) is added the same volume V_s of the solvent. The analytical signals of A and B are measured and corrected for nonanalyte signals. The unknown sample concentration c_x is calculated:

$$c_x = \frac{S_B V_s c_s}{(S_A - S_B)\, V_x}$$

where S_A and S_B are the analytical signals (corrected for the blank) of solutions A and B, respectively. V_s and c_s should be chosen so that S_A is roughly twice S_B on the average. It is best if V_s is made much less than V_x, and thus c_s is much greater than c_x, to avoid excess dilution of the sample matrix. If a separation or concentration step is used, the additions are best made first and carried through the entire procedure. For the results of this technique to be valid, the following limitations must be taken into consideration:

1. The analytical curve must be linear.

2. The chemical form of the analyte added must respond the same way as the analyte in the sample.

3. The interference effect must be constant over the working range of concern.

4. The signal must be corrected for any additive interference.

The absorbance of each solution is determined and then plotted on the vertical axis of a graph, with the concentrations of the known standards plotted on the horizontal axis. When the resulting line is extrapolated back to zero absorbance, the point of interception of the abscissa is the concentration of the unknown. The abscissa on the left of the ordinate is scaled the same as on the right side, but in the opposite direction from the ordinate. An example of a plot so obtained is shown in Figure 1.

8.6 Check the instrument standardization by analyzing appropriate quality control check standards as follows.

8.6.1 Check instrument calibration using a calibration blank and two appropriate standards.

8.6.2 Verify calibration every 10 samples and at the end of the analytical run, using a calibration blank (5.5.1) and a single point check standard (5.6).

8.6.2.1 The results of the check standard are to agree within 10% of the expected value; if not, terminate the analysis, correct the problem, and recalibrate the instrument.

8.6.2.2 The results of the calibration blank are to agree within three standard deviations of the mean blank value. If not, repeat the analysis two more times and average the results. If the average is not within three standard deviations of the background mean, terminate the analysis, correct the problem, recalibrate, and reanalyze the previous 10 samples.

8.6.3 Verify the interelement and background correction factors at the beginning and end of an analytical run or twice during every 8-hour work shift, whichever is more frequent. Do this by analyzing the interference check sample (Paragraph 5.7). Results should be within ±20% of the true value obtained in 8.6.2.1.

8.6.4 Duplicate spiked samples are to be analyzed at a frequency of 20%.

8.6.4.1 The relative percent difference between duplicate determinations is to be calculated as follows:

$$RPD = \frac{D_1 - D_2}{(D_1 + D_2)/2} \times 100$$

where:

RPD = relative percent difference.
D_1 = first sample value.
D_2 = second sample value (duplicate).

(A control limit of ±20% for RPD shall be used for sample values greater than 10 times the instrument detection limit.)

8.6.4.2 The duplicate matrix spike sample recovery is to be within ±20% of the actual value.

8.6.5 The method of standard addition (Paragraph 8.5.3) shall be used for the analysis of all EP extracts.

9.0 METHOD PERFORMANCE

9.1 In an EPA round-robin Phase 1 study, seven laboratories applied the ICP technique to acid-distilled water matrices that had been spiked with various metal concentrates. Table 4 lists the true values, the mean reported values, and the mean percent relative standard deviations.

9.2 In a single laboratory evaluation, seven wastes were analyzed for 22 elements by this method. The mean percent relative standard deviation from triplicate analyses for all elements and wastes was 9±2%. The mean percent recovery of spiked elements for all wastes was 93±6%. Spike levels ranged from 100 ug/L to 100 mg/L. The wastes included sludges and industrial wastewaters.

10.0 REFERENCES

1. Winge, R.K., V.J. Peterson, and V.A. Fassel, Inductively Coupled Plasma-Atomic Emission Spectroscopy: Prominent Lines, Final Report, March 1977 - February 1978, Ames Laboratory, Ames, IA, sponsored by Environmental Research Laboratory, Athens, GA, EPA-600/4-79-017, March 1979.

2. Methods for Chemical Analysis of Water and Wastes, EPA-600/4-82-05, December 1982, Method 200.7.

3. Patel, B.K., Raab, G.A., et al., Report on a Single Laboratory Evaluation of Inductively Coupled Optical Emission Method 6010, EPA Contract No. 68-03-3050, December 1984.

TABLE 4. ICP PRECISION AND ACCURACY DATA[a]

Element	Sample No. 1			Sample No. 2			Sample No. 3		
	True Value (ug/L)	Mean Reported Value (ug/L)	Mean SD[b] (%)	True Value (ug/L)	Mean Reported Value (ug/L)	Mean SD[b] (%)	True Value (ug/L)	Mean Reported Value (ug/L)	Mean SD[b] (%)
Be	750	733	6.2	20	20	9.8	180	176	5.2
Mn	350	345	2.7	15	15	6.7	100	99	3.3
V	750	749	1.8	70	69	2.9	170	169	1.1
As	200	208	7.5	22	19	23	60	63	17
Cr	150	149	3.8	10	10	18	50	50	3.3
Cu	250	235	5.1	11	11	40	70	67	7.9
Fe	600	594	3.0	20	19	15	180	178	6.0
Al	700	696	5.6	60	62	33	160	161	13
Cd	50	48	12	2.5	2.9	16	14	13	16
Co	700	512	10	20	20	4.1	120	108	21
Ni	250	245	5.8	30	28	11	60	55	14
Pb	250	236	16	24	30	32	80	80	14
Zn	200	201	5.6	16	19	45	80	82	9.4
Se[c]	40	32	21.9	6	8.5	42	10	8.5	8.3

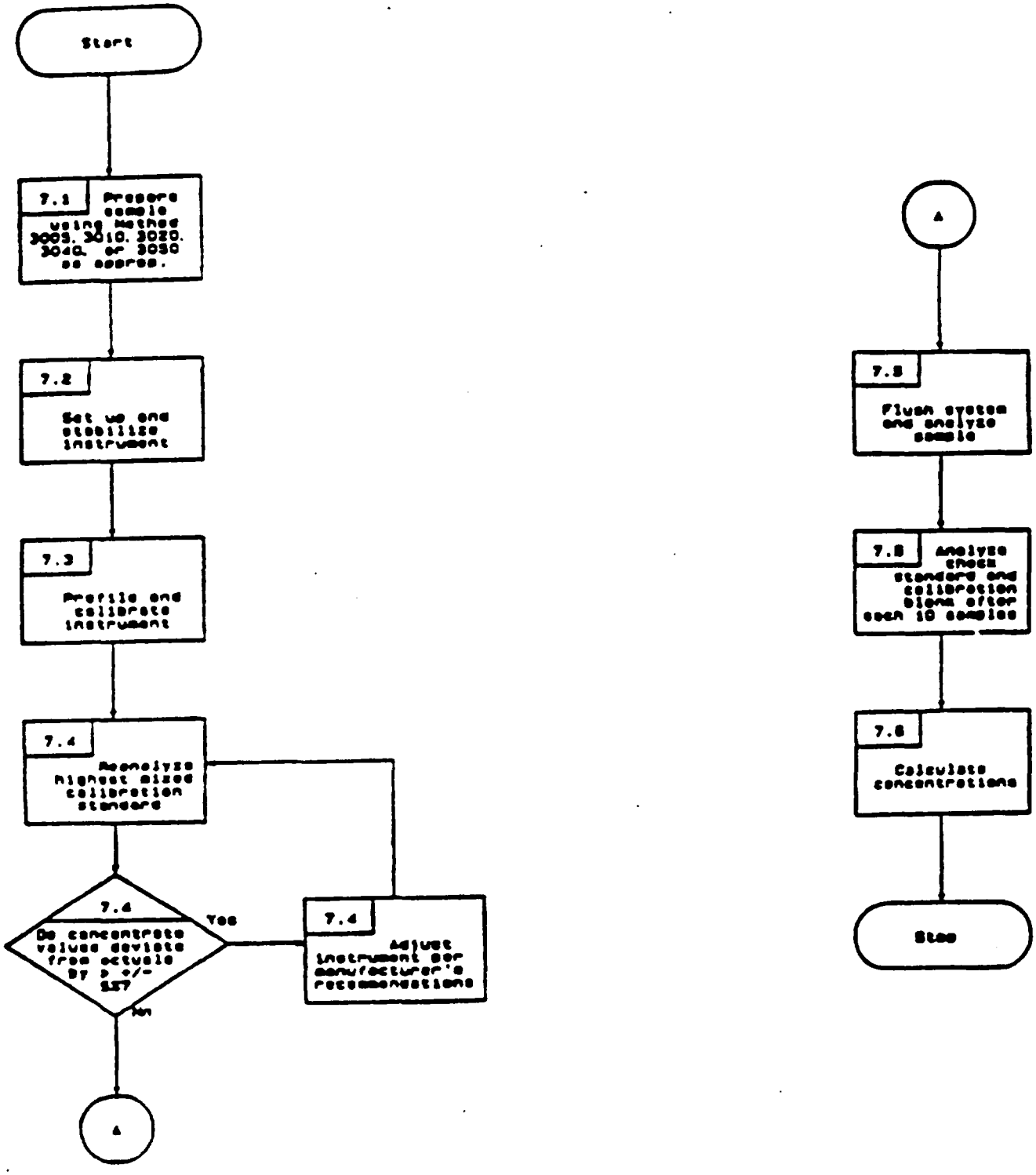
[a]Not all elements were analyzed by all laboratories.

[b]SD = standard deviation.

[c]Results for Se are from two laboratories.

METHOD 6010

INDUCTIVELY COUPLED ATOMIC EMISSION SPECTROSCOPY



Revision 0

APPENDIX B-3

STANDARD OPERATING PROCEDURE:
LABORATORY SCREENING METHOD FOR LEAD IN HOUSE DUST

USING ENERGY DISPERSIVE X-RAY FLUORESCENCE
(KEVEX 0700)

1.0 SCOPE AND APPLICATION

1.1 Lead in household dust may be determined by energy dispersive X-ray fluorescence (XRF) spectrometry. This method is simple, rapid, and applicable to Lead in various matrices with little or no sample preparation (i.e., digestion is not required prior to analysis).

1.2 Detection limits, sensitivity, and optimum ranges of the metals will vary with regard to sample matrix as well as the model of XRF instrument utilized.

1.3 This method is applicable for use by Region I ESD and ESAT staff for performing XRF screening analyses in lead in house dust samples as part of the LFK Demonstration Project.

2.0 SUMMARY OF METHOD

This method may be used for the semi-quantitative screening analysis of house dust samples for lead. The dust sample is thoroughly sieved, and placed in a plastic sample cup for XRF analysis. The intensity of the sample response at the L-alpha energy region of lead is compared to known lead reference standards for quantitation.

3.0 INTERFERENCES

Certain elements, such as _____ _____, if present in the soil at concentrations _ _ that of lead, could present difficulties in the identification and quantitation of lead.

4.0 APPARATUS AND MATERIALS

4.1 Energy Dispersive X-Ray Fluorescence Spectrometer

A Kevex Model 7000 XES equipped with:

(a) _____ source;

(b) _____ detector;

(c) sixteen (16) place rotating sample holder; and

(d) computerized data system for analyzing, comparing and storing sample spectra.

4.2 8 inch Floppy Data diskettes, IBM, or equivalent.

4.3 Sample cups, plastic, consisting of cup, o-ring, and cap, Spectra-Cup, Cat. No. 340, Somar Labs. Inc., New York, or equivalent.

4.4 Mylar film, 6 micron.

5.0 REAGENTS

5.1 U.S. Department of Commerce, National Bureau of Standards, Standard Reference Materials

SRM	Unit Type	Certified Lead Size	Concentration
1579	Powdered Lead Base Paint	35g	11.87%
1633a	Coal Fly Ash	75g	72.4 ug/g
1645	River Sediment	70g	714 ug/g
1646	Estuarine Sediment	75g	28.2 ug/g
1648	Urban Particulate	2g	0.655%

5.2 US EPA, Environmental Monitoring and Surveillance Laboratory (EMSL), Quality Control Reference Standards

5.3 Instrument Calibration Standards

Dust M-10	2500 ppm	10 mg.
Dust M-50	2500 ppm	50 mg.
Dust H-10	25,000 ppm	10 mg.
Dust H-50	25,000 ppm	50 mg.

6.0 Sample Collection and Transfer of Custody to the U.S. EPA

Samples are collected in the field by Lead-Free-Kids staff, placed in labeled individual envelopes, and submitted with chain-of-custody (COC) documentation to the U.S. EPA New England Regional Laboratory (NERL) for XRF analysis. U.S. EPA personnel or their contractors will acknowledge receipt of custody by signing and dating the COC document in the presence of the LFK dust sample courier. The COC document is retained until sample analysis has been completed and results have been entered onto it. Then the original COC is returned to LFK with a cover letter.

6.1 Sample Preparation

6.1.1 Samples are assigned unique laboratory identification numbers, a sequential five-digit number, which is subsequently recorded on the sample envelope, chain-of-custody document, XRF Dust preparation worksheet, XRF analytical result summary sheet, and on the cover of the sample analysis container.

6.1.2 Under the ventilation hood, the sample envelope is carefully opened at one end (with scissors) and the dust is placed into a 60 mesh sieve.

6.1.3 The sieve is manually shaken for approximately 15 to 20 seconds.

6.1.4 All the fines are then transferred to the pre weighed sample analysis container using a glass powder funnel centered over and touching the center of the mylar window of the sample container.

6.1.5 Information from the chain-of-custody, including weight of sample, and laboratory ID number is recorded on the analytical results summary form.

6.1.6 All of the excess (non-filtered) soil/dust from the sample preparation is discarded in a special barrel in the laboratory. In some cases filtered

dust may be removed for the analysis container if the quality of dust interferes with container fabrication. However, all the dust amount be weighed before excess dust is removed.

6.1.7 The powder funnel and sieve are cleaned between samples to remove soil and dust particles, using clean, compressed breathing air (grade D), or the like.

6.1.8 The sampling cup is sequentially placed in the sample tray according to the laboratory ID number for XRF analysis. Empty envelopes are retained and returned to LFK staff along with sample results.

6.2 Sample Container Preparation

The sample containers consist of two small o-rings with tabs, two pieces of 6 micron mylar film, a sample cup (which is slightly larger than the o-rings), and a container cap.

6.2.1 Place a piece of 6 micron mylar film over one o-ring (tabs down).

6.2.2 Snap the sample cup into place on top of the o-ring.

6.2.3 Weigh sample cup parts excluding cap and round to 4 decimal places.

6.2.4 Place dust sample onto mylar film via glass powder funnel. Be sure that sample is centered on film.

6.2.5 Place another piece of mylar onto sample cup over the dust and snap the second o-ring onto the top of the cup (tabs up).

6.2.6 Reweigh sample container and round to 4 decimal places.

6.2.7 Snap container cap into place on top of cup.

Note: The container cap is only used for identification and handling of the sample. All analyses must be performed with container cap removed.

6.2.8 Label the sample container cap with the correct sequential laboratory sample ID number.

6.3 Standards Preparation

Study Control standards are prepared from previously analyzed and concentration verified house dust samples. Standard concentrations should be prepared at concentration levels and weigh ranges as presented below.

			Std.	Sample Calibration Weight Range
Dust M-10	2500 ppm	10 mg	M-10 or	0.0 - 0.24g
Dust M-50	2500 ppm	50 mg	H-10	
Dust H-10	25,000 ppm	10 mg	M-10 or	0.25g or greater
Dust H-50	25,000 ppm	50 mg	H10	

6.4 Sample Preservation and Handling

No preservation is required. Handling of the sample, once it is placed in the analysis cup [illegible] be done in a gentle manner to keep the sample center [illegible] the middle of the mylar. This is especially important for samples requiring replicate analysis.

7.0 ANALYSIS PROCEDURE

7.1 The use of the Kevex 7000 XRF is relatively straightforward. The Kevex is normally left in the standby mode (target .8, 30 kV, and 0.5 mA) between analyses to prevent x-ray tube damage. House dust samples for lead are analyzed under the following instrumental conditions: target .4, 30 kV, .5 mA. (Detailed instructions can be found in the User's Manual for Kevex XRF Software.)

7.2 Instrument Set-Up

7.2.1 Turn the video monitor and plotter power on.

7.2.2 Insert the Master floppy disk into disk drive No. 0 (DY0)

7.2.3 Insert formatted floppy disk into disk drive No. 1 (DY1).

7.2.4 Boot the operating system by pressing the "Shift" and "Reset" keys simultaneously. Next, press the "Q Vantx" and then the "Enter" key.

7.2.5 When prompted on the screen, enter the current date.

7.2.6 After the current date has been entered, the spectral region of interest for lead must be established. This is accomplished by pressing the blue double-headed arrow (<------->) key. The region of interest that should be obtained is from 7.94 Kilo-electron Volts (KeV) to 17.28 KeV where the lead L-alpha (L-a) peak is 10.25 and the lead L-beta (L-b) is 10.___ KeV. After the spectral region has been established for lead analysis, wait for the asterisk (*) prompt and type in ATO, PBSOIL4. Type in sample ID Numbers as 5 digit numbers followed by -D- for each number at the end.

ex: Lab ID # 143 entered as 00143-D-

7.2.7 The first carousel run on the Kevex for the day must contain all four calibration standards. Each additional carousel run must include one of the four study control standard on a rotating basis. Calibration standards are run manually and not on the ATO program.

7.3 Loading the Kevex Sampler (Carousel)

7.3.1 Push the "Reset" key (red) to shut-off the x-ray beam. (As a safety precaution, the lid will not open when the x-ray beam is functioning).

7.3.2 Open the Kevex top and place sample cups into the sixteen (16) available slots (numbered 0 through 15) on the circular carousel.

7.3.3 Set the Kevex XES to ATO (white key). Then proceed with the analysis.

7.4 Manual Analysis of Dust Samples

The analysis will be performed using the ATO and manual modes. The manual method requires that the operator be presented while performing this type of analysis.

Keyboard commands required to initiate and perform XRF analyses are detailed below:

7.4.1 Await (*); type "Clr", then press the "Enter" key.

7.4.2 Make sure white switch is on manual position.

7.4.3 Push yellow key next to sample number. Use numbered key pad on KEVEX to enter desired position then hit enter.

7.4.4 Push yellow key to target display and enter 4 using numbered key pad again.

7.4.5 Continue in this manner and enter 30 for KEV and .5 for mA.

7.4.6 On the screen keyboard hit the yellow ACQ button. When running the standards you will manually stop them at their designated ppm concentration (2500 for medium and 25,000 ppm for high) using the yellow stop key next to the acquire key. Using the blue arrows (up and down) to increase and shrink the size of the peak, let the sample run for between 20 and 30 seconds. Stop the peak when it reaches the 2.5 mark designated by the numbered lines on the left side of the viewing screen.

7.4.7 When you have stopped the peak at its desired height (2.5) type SMO to smooth the curve. If the peak now falls below 2.5 it may be necessary to continue acquiring the peak for a couple more seconds and again hit stop to halt peak. Alternating between acquire, stop and smooth may be done an unlimited number of times until the peak appears in the right position as long as the time count is below 30 seconds. Time of analysis may not run over 30 seconds.

Note: Only calibration standards will be run on manual not dust samples.

7.4.8 Await (*); type "REA"d, press "Enter".

7.4.9 Await (*); type "SAV"e, press "Enter".

7.4.10 Prompt: General Comments.

7.4.11 Response: Section is ignored, press "Enter".

7.4.12 Prompt: Enter Unit: (1) or (2).

7.4.13 Response: Type "1", press "Enter".

* 7.4.14 Prompt: Enter Sample ID":

7.4.15 Response: type in Sample ID as assigned in XRF dust preparation worksheet.

* Manual analysis does not automatically add a 4 onto the end of the identification label and therefore the 4 is not needed for recall purposes.

7.5 <u>Automatic Analysis Procedure</u>

7.5.1 At asteric on screen type <u>ATO,PBSOIL4</u> Enter.

7.5.2 Enter the last sample position but do not include standards that will run manually.

7.5.3 Enter lab ID numbers for each corresponding position.

7.5.4 As the program runs you must be present to observe each lead sample peak as it acquires for 30 seconds.

7.5.5 With screen parameters of <7.04 and 17.28> the compton scatter peak will be the last peak visible on the right hand side. The lead peak will appear directly above the blue arrow at the bottom of the screen.

7.5.6 If the lead peak rises faster then the compton peak it will be calibrated using the high standard. If the lead sample peak does not rise above the compton peak, the medium standard will be used.

7.5.7 To determine if the 10 standard or the 50 standard is to be used, identify the weight of the sample. The sample is:

0.00g - 0.024g use 10 standard
0.025g - 0.100g or above use 50 standard.

7.6 Manual Quantitation and Comparison of Dust Samples

7.6.1 Await (*); type "RCL" (recall), press "Enter".

NOTE: The RCL (recall) command is used to recall a previously analyzed spectra that has been stored on the floppy diskette (DY1). In this case, a previously analyzed lead in dust calibration or reference standard for comparison to the various dust samples analyzed and stored on the same diskette.

7.6.2 Prompt: Enter Unit: 1 or 2.

7.6.3 Response: Type "1", press "Enter".

7.6.4 Prompt: Enter ID:

7.6.5 Response: Type the standard/label ID, press "Enter".

7.6.6 Prompt: Smooth Recalled Spectrum (Y/N)?

7.6.7 Response: Press "Enter".

7.6.8 Await (*); type "OVR" (overlay), press "Enter". The overlay command is used to compare and normalize spectra from the disk. The normalization feature (OVR) allows the operator to mark regions within the displayed spectrum as a basis for normalization. This feature aids in the visual interpretation of data and reduces channel-to-channel statistical fluctuations.

7.6.9 Prompt: Enter ID: add -D-4 to the end of each ID.

7.6.10 Response: Enter the sample ID, press "Enter".

7.6.11 Prompt: Smooth Recalled Spectrum (Y/N)?

7.6.12 Response: Press "Enter".

7.6.13 Prompt: Mark Peak(s) or Region(s) Hit Enter When Ready a cursor will appear on the screen.

7.6.14 Response: Mark the regions to be used for normalization by moving the cursor with the left and right green arrow function keys. The peak to be painted is the compton scatter peak. The screen parameters should be 9.60 - 19.84 use the green" equal (=) key to paint the desired area. Note: the paint cursor will move in the direction it was last set. Press the "Enter" key when finished.

7.6.15 The screen display will now include the standard spectrum overlaid by the sample spectrum normalized to the same energy region of the spectrum. Direct comparison of the lead (L-a) peaks can be made and a concentration (in ppm) can be determined.

Note: The red peak is the standard peak which should read 2.5 (use the Blue up and down arrows to set this). The white peak is the sample peak. Use the blue up and down arrows to best compare the sample peak value ppm. Although the height of

the red and white peaks will change the ppm value of the red (standard) will always remain the same 2500 ppm or 25,000 ppm depending on the standard used.

7.6.16 The OVR sequence can be repeated for each sample on the disk (DY1).

7.7 A Modified Quantitation Procedure - This is basically the same procedure as described above.

Dr. T. Spittler, USEPA Region I, Technical Services Branch Chief, Lexington, Massachusetts initiated the use of a quick and easy method for the semi-quantitative analysis of lead in soil samples.

Dr. Spittler has determined that, when acquiring data for the 2000 ppm lead in soil standard at an attenuation of 512 and the energy level for the compton's back scattering energy peak at 15 KeV is at 50 percent intensity, each horizontal screen division is equivalent to the response of ca. 800 ppm lead. To utilize this technique for dust, follow the XRF instrument set-up guidelines as previously described in Sections 7.2, 7.3, and 7.4 (7.4.1 to 7.4.5). To acquire, quantify, and store data, utilize the following procedure:

7.7.1 Check sampler position at "0".

7.7.2 Await (*); press the yellow "ACQ" key.

7.7.3 Wait for energy level at 15.- KeV to reach 50 percent scale at a range of 512.

7.7.4 Press the yellow "Stop" key.

7.7.5 Await (*); type "SMO", press "Enter".

7.7.6 Await (*); type "REA", press "Enter".

7.7.7 Await (*); type "SAV", press "Enter".

7.7.8 Prompt: General Comments.

7.7.9 Response: Section is ignored, press "Enter".

7.7.10 Prompt: Enter Unit: (1) or (2).

7.7.11 Response: Type "1", press "Enter".

7.7.12 Prompt: Enter Sample ID:

7.7.13 Response: type in sample ID as assigned in the XRF logbook.

7.7.14 Quantify the L(a) lead peak using the following scale:

Attenuation	Concentration Range of Lead (vertical scale division concentration)
64	0 to 700 (100 ppm)
128	0 to 1400 (200 ppm)
256	0 to 2800 (400 ppm)
512	0 to 5600 (800 ppm)
1024	0 to 11,200 (1600 ppm)

7.7.15 Await (*); type "CLR" (clear), press "Enter".

7.7.16 Advance the sample tray one space and repeat the analysis procedure.

8.0 QUALITY CONTROL

8.1 All quality control data should be maintained and available for easy reference or inspection.

8.2 At the beginning of each operating shift all 4 study control standards are analyzed on the first carousel. On following carousel runs analyze one standard (one per sixteen) This is done to assess method accuracy and to correct for normal standard drift and results should agree within ± 20 percent of the true value.

8.3 At least one laboratory replicate should be analyzed for every 20 samples to verify precision of the method. Replicate samples may be run at the end of an analytical day in their own carousel.

8.4 At least one laboratory replicate should be analyzed at a frequency of 1 per 20 samples to verify precision of

the method. Replicate samples maybe run at the end of an operation shift.

NOTE: True replicates of soil and dust samples are usually not possible since chemicals such as lead are typically not uniformly distributed in these materials. Additional handling of the sample may cause the dust to migrate away from the center of the mylar. Care must be taken when handling samples. Care must be taken in the interpretation of soil and dust replicate analytical results.

9.0 METHOD REFERENCE

9.1 Precision and accuracy data are not available at this time.

9.2 The performance characteristics for [illegible] free from interferences are:

Optimum Concentration Range: N/A ug/g
Detection Limit: NA ug/g
N/A: not available at this time.

APPENDIX B-4

STANDARD OPERATING PROCEDURE: LABORATORY SCREENING METHOD FOR LEAD IN SOIL USING ENERGY DISPERSIVE X-RAY FLUORESCENCE OXFORD LX1000

1.0 SCOPE AND APPLICATION

1.1 Metals in a solution may be readily determined by energy dispersive x-ray fluorescence (XRF) spectrometry. The method is simple, rapid, and applicable to a large number of metals in various matrices with little or no sample preparation (i.e., digestion is <u>not</u> required prior to analysis).

1.2 Detection limits, sensitivity, and optimum ranges of the metals will vary with the sample matrices and the models of XRF spectrometers utilized.

1.3 This method is applicable to Region I ESD and ESAT staff performing laboratory screening analyses for lead in soil samples collected as part of the LFK Demonstration project.

2.0 SUMMARY OF METHOD

This method is used for the semi-quant[illegible] screening of lead in soil. The soil sample is homo[illegible] aliquot is removed and placed in a sampling containe[illegible] sample is then analyzed using XRF.

3.0 INTERFERENCES

Certain elements, such as _____, present in the soil sample could interfere with the analysis, if present in concentrations greater than _____ times that of lead.

4.0 APPARATUS AND MATERIALS

4.1 <u>Energy Dispersive X-Ray Fluorescence</u>

An Oxford Analytical Instrument LAB-X 1000 equipped with:

- excitation source: Cadmium 109
  typical activity: 3 milli Curies (3MCi)
  half life: 1.3 years
  principal energy level: silver, K, 22 KeV
  atomic no range:(K) spectra, 24-42; (L) spectra, 72-92
- detector: xenon filled proportional counter
- six (6) position motorized turntable
- microprocessor control consisting of:

- display: 40 column, 2 line liquid crystal display
- printer: 40 column, 2 color dot matrix with graphics, uses 70mm wide plain paper
- keypad: 20 key alphanumeric membrane pad.

4.2 Printer paper, 70mm wide.

4.3 Printer ribbon.

4.4 Sample cups, plastic, spectro-cup, Cat. No. 340, Somar Lab. Inc., New York or equivalent.

4.5 Mylar film, 6 micron

4.6 A stable power supply whose requirements of 100-120 volt AC, 45-165 Hz, 50 VA maximum consumption are critical to instrument performance. Extreme temperature ranges also effect instrument performance.

5.0 REAGENTS

5.1 U.S. Department of Commerce, National Bureau of Standards, Standard Reference Materials

SRM	Type	Unit Size	Certified Lead Concentration
1579	Powdered Lead Base Paint	35g	11.87%
1633a	Coal Fly Ash	75g	72.4 ug/g
1645	River Sediment	70g	714 ug/g
1646	Estuarine Sediment	75g	28.2 ug/g
1648	Urban Particulate	2g	0.655%

5.2 US EPA, Environmental Monitoring and Surveillance Laboratory (EMSL), Quality Control Reference Standards

5.3 Instrument Calibration Standards

Not available at this time.

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 Samples are collected in the field, placed in labelled, individual, zip-lock plastic bags, and submitted to the ESD laboratory for analysis. Samples are logged into the laboratory logbook and assigned a laboratory identification number.

6.2 Soil samples are thoroughly mixed (homogenized) in the zip-lock bag. An aliquot of the soil, 2 to 3 table spoons (10 to 15 grams), is removed with a spoon or spatula and placed in a wang dish or appropriate drying vessel. The dish is marked with the laboratory identification number and allowed to air dry overnight at ambient laboratory temperature.

6.2.1 Excess sample in the zip lock bag will be stored until the analytical report has been finalized then discarded. However, selected soil samples maybe kept longer for additional testing.

6.3 <u>Sample Preparation</u>

Dried soil samples will be passed through a 60 mesh sieve until approximately 1 gram of fines have been passed. The sieve will be manually shaken, typically 10 to 15 seconds is adequate. The fines are then transferred to the analysis sample container using a glass powder funnel which is placed over the sample container.

6.3.1 All excess soils from sample preparation will be discarded in a special barrel in the laboratory.

6.3.2 The powder funnel, sieve, drying vessel, and spoon (or spatula) will be cleaned between samples to remove soil particles. The funnel and sieve will be blown free of dust with compressed air. The spoon will be wiped with disposal tissues and drying vessel washed vigorously with hot water.

6.4 <u>Sample Container Preparation</u>

6.4.1 Invert cup and place a piece of 6 micron mylar film over the bottom aperture.

6.4.2 Snap a retaining o-ring over the film onto the base of the cup (o-ring teeth down).

6.4.3 Place cup upright and add enough soil to uniformly cover the mylar film bottom of the cup.

6.4.4 Snap cap into place on top of the cup.

6.4.5 Label the sample cup with the sequential laboratory I.D. No. and record that in the XRF instrument logbook.

NOTE: Information to be recorded in the XRF logbook would include:

- field identification numbers;
- laboratory identification numbers;
- date samples prepared;
- date samples and analyzed;
- analysis parameters; and
- analyst's initials affiliation and date.

6.5 Standards Preparation

Calibration standards are prepared from previously analyzed and concentration verified soil samples or known reference standards. Standard concentrations should be prepared at concentration levels of lead at approximately:

- 50 - 100 ppm (ug/g)
- 100 - 500 ppm
- 500 - 1000 ppm
- 1000 - 2000 ppm
- 2000 - 5000 ppm

6.6 No special preservation or handling procedures are required.

7.0 ANALYSIS PROCEDURE

The use of the Oxford Analytical Instrument Model LAB-X 1000 XRF is relatively simple. (Detailed instructions for its use can be found in the LAB-X 1000 Instruction Manual.)

7.1 Instrument Set-Up

7.1.1 Turn power on.

7.1.2 Wait for menu to appear in video display.

7.1.3 Press key "3" to select Utilities routine.

7.1.4 The instrument will print the date and time and display the menu:

1 = Position Turntable
2 = Set Date and Time
3 = Printer Check
4 = Turn Page

Select option 3 to check correct function of printer

Press key "3".

7.1.5 If date and time printed at the start of these routines are incorrect, they can be reset by pressing key "2".

7.1.6 Exit from the utilities routine by pressing option 4 until the main menu (as shown below) is displayed.

1 = Analyses 2 = Calibrate
3 = Utilities 4 = Turn Page

The LAB-X is now ready to begin analyses.

7.2 Manual Analysis of Soil Samples

7.2.1 Place one of the assembled safety windows in position 0 in the sample loading port.

7.2.2 Place the sample cup into the cell or secondary window holder which fits into the safety window of the sample loading port. The cell assembly should be lightly tapped on a clean, hard surface to settle the contents of the cup (i.e., evenly distribute the soil on the mylar film).

7.2.3 Selection option 1, Analyses, on the Main Menu. Press key "1".

7.2.4 Another menu appears, select option 2, Spectrum Scan. Press key "2".

7.2.5 Prompt: enter "Analysis Head".

7.2.6 Response: press key "2".

7.2.7 Prompt: enter "Sample Label".

7.2.8 Response: enter sample ID from XRF log.

7.2.9 Prompt: Is "Sample Label" Inserted?

7.2.10 Response: press "Yes" key.

7.2.11 The measurement cycle now begins. The turntable will rotate 60 degrees, carry out an Energy Lock for Ca. 10 seconds prior to further rotation which transports the sample to the required sampling head. The operator may terminate a measurement by pressing the "Esc"ape key before the programmed time has elapsed.

7.2.12 After completion of the measurement cycle, select option 2, Print Scan. Press key "2".

7.2.13 After the scan has been printed, determine if the lead L-alpha peak is on scale and measurable. If not, select one of the three (3) scaling options: 5, 10, or 20. Press the appropriate key.

7.2.14 After the scale scan has been printed, select option 4, Turn Page, to return to the Analyses Menu. Press key "4".

7.2.15 Place another sample into the sample holder and repeat the analysis process.

7.3 Quantification

7.3.1 A series of calibration standards are analyzed at each scaling factor; 0, 5, 10, and 20. An average response factor (RF) is determined using a minimum of three (3) concentrations and one (1) reagent blank analyzed at least three times.

7.3.2 The peak height of the lead L-alpha (at _____) is measured for each sample. This peak height is multiplied by the RF to determine the concentration of lead (ppm) in the sample.

8.0 QUALITY CONTROL

8.1 All quality control data should be maintained and available for easy reference or inspection.

8.2 A set of calibration standards at each scaling factor should be analyzed in the laboratory prior to initiating field studies. These calibration standards should consist of a minimum of three (3) standards and one (1) reagent blank ("clean soil").

8.3 A minimum of one (1) reagent blank and one (1) standard at or near the mid-range of the calibration curve should be analyzed daily to verify instrument reproducibility. These values should agree within ± 20 percent of the initial calibration.

8.4 If forty-five (45) or more samples per day are analyzed or if samples from more than one site are to be analyzed in one day, then the working standard curve must be verified by analyzing a mid-range standard for every thirty (30) samples or for each site, whichever is more frequent. These check standard results must be within ± 20 percent of the true value.

8.5 At least one (1) field laboratory duplicate sample should be analyzed with every twenty (20) samples to verify the precision of the method.

NOTE: True replicates of soil samples are usually not possible since chemicals such as lead are typically not uniformly distributed in these materials. Care must be taken in the interpretation of soil replicate analytical results.

8.6 At least one (1) lead-in-soil standard reference sample should be analyzed daily or per site, which ever is more frequent. The result should agree within ± 20 percent of the true value.

9.0 METHOD PERFORMANCE

9.1 Precision and accuracy data are not available at this time.

9.2 The performance characteristics for a soil sample free from interferences are:

Optimum Concentration Range: N/A ug/g

Detection Limit: N/A ug/g

NA: not available at this time.

LEAD FREE KIDS STUDY

EXTERNAL QUALITY ASSURANCE/QUALITY CONTROL

QUALITY ASSURANCE FOR BLOOD LEAD ANALYSIS (CENTERS FOR DISEASE CONTROL)

A. INTRODUCTION

The lead in soil demonstration project of its nature requires blood lead data of the highest quality. Expected differences in blood lead levels from successful abatement are of the order of 2-4 μg/dL, thus placing unusually stringent requirements on long term laboratory precision. The quality control issues including establishment and maintenance of a high degree of precision over the entire duration of the project. The key function of the quality assurance system is to ensure the absence of any "drift" (downward or upward) with analytical values with time, such that any difference in blood lead values over time cannot be attributed to changes in the analytical system. Simply stated, this will help insure that statistically speaking, observed changes in blood lead are real- that is, due to intervention and not attributable to changes in the laboratory method over time. Si[illegible] CDC has extensive experience in such activities from the National Health and Nutrition Exar[illegible] (NHANES) and other long term studies, we were asked by the USEPA to provide a [illegible] material following is a summary of laboratory related issues that were included in the overall QC program.

B. ELEMENTS OF A QUALITY CONTROL SYSTEM

In order for any analytical measurements to be valid and interpretable, the sources of error for each unique measurement system must be identified and minimized. This, then, is the major function of quality control. In the specific example of blood lead measurements, the following have been shown from experience to be the major sources of error:

1) contamination of the specimen during collection, storage, or analysis

2) deterioration of the specimen by clotting, denaturation, or other processes

3) instability of the measurement system, either over a short (within run/day) or long time span

4) improper calibration of the measurement system

5) errors in data handling, storage, or reporting

Quality control therefore must include a number of components, both within and external to the laboratory: 1) collection of an uncontaminated specimen; 2) preservation and shipping (if needed) of the specimen under conditions that assure integrity; 3) monitoring of analytical method performance, to include instrumental stability, maintenance, and performance of the analyst(s); and 4) accuracy and completeness of all data, to include specimen identification, data reduction, and data interpretation.

Some critical components of each of these areas include:

1. Specimen Collection

Proper screening of all specimen collection equipment to define any detectable levels of the analyte, and estimate variability of this contamination.

Written protocols for specimen collection which describe in detail all sampling equipment and its use, precautions to avoid contamination, and other requirements (time of day, fasting/non-fasting state of subject) which might affect specimen integrity.

2. Specimen Preservation and Shipping

Proper packing, storage and shipping temperatures, suggested means of conveyance for timely receipt of specimens.

Detailed shipping [illegible] specimen log forms to allow description of each specimen to record any variances from collection or shipping protocols.

3. Analytical Method Performance

Method selected must demonstrate precision and accuracy in the appropriate analytical range and should be [illegible]ged, rapid and cost-effective. Ideally, the detection limit should be ca. 2 μg/dL with precis[illegible] about 5% at the 10 μg/dL level for the proposed study.

Instrumental stability, and by inference "method" stability, should be documented by analysis of control materials, both "bench" and "blind". It is desirable that materials with certified values of the analyte of interest be analyzed regularly to demonstrate method accuracy. It is suggested that at least 10% of the specimens be quality control pools.

4. Be[illegible] Control Materials

Blind quality control pools should be inserted at a rate of 5% by a source external to the laboratory. These specimens should be in the same container type and labelled with pseudopatient numbers such that they are indistinguishable from patient samples. It is suggested that the blind (and bench) pools have two concentrations - one in the "expected" range of values for the majority of patient samples and one at or near the "decision level" for undue exposure. It is important that the blind materials by truly blind to the analyst for maximum effectiveness in the detection of a[illegible]ytical system error The "pseudopatient" numbers used in labelling of the blinds will be decoded by the supervisor only, and that analytical run evaluated on the basis of pre-established control limits.

Use of quality control charts for means (X bar) and ranges (R) is essential; it is suggested that 20 runs be made for characterization of all quality control materials, and that these data be analyzed by two-way analysis of variance (ANOVA) to produce these charts. These charts should be in use by the analyst for each run for the evaluation of "bench" or known blood controls (and

by the supervisor for blinds) by use of mean and range control limits, such that corrective actions needed may be made in a timely way.

Criteria for repeat analytical runs (due to "out of control" condition as indicated by results from quality control samples) are dependent on the number of pools in the quality control system.

Inclusion of blind splits (duplicate samples within run, with different identification numbers such that identification by the analyst is prevented) is suggested at a 5% rate; some split specimens may be submitted to an external laboratory for verification of accuracy or comparability. If specimen collection constraints allow, it is recommended that at least 10% of the specimens be split with an external laboratory.

- Criteria should be established as to "acceptable" agreement with the external laboratory.

5. Accuracy and Blanks

Blanks, consisting of samples in which ultrapure water is processes through the entire analytical procedure, are a useful part of quality assurance. The data from these determinations can be used to evaluate potential contamination in the laboratory environment as well as estimate the limit of detection of the analytical method.

Establishment of accuracy through the regular analysis of reference materials or proficiency testing pools is an essential part of good laboratory practice, and will help establish the accuracy of the method. The pools used for this accuracy assessment should be as close to identical to the survey samples as possible.

6. Data Integrity

Data logging should be performed for each run in approved notebooks or other data forms as soon as possible following each run. Electronic data entry may be desirable either as an adjunct to or replacement for "hard copy". It is recommended, however, that instrumental data be collected on hard copy in such a way that all data can be independently verified or reconstructed.

Data reduction should be standardized; all records of calculations should be secured and available for review.

C. DESCRIPTION OF QUALITY CONTROL SYSTEM USED

From previous experience in "long-term" quality control, a system was established that is similar to that used in the NHANES surveys, The cardinal features of such a system include written protocols for specimen collection, shipping, and analysis, a systematic screening of all specimen collection equipment and containers, establishment of statistical "control" limits by each individual laboratory, and supervision of all QC activities by a local laboratory supervisor. Since the three laboratories already had QC systems in place, there was a need to establish a common set of protocols and procedures for the entire project.

1 Initial Activities

Each laboratory was provided with a description of the sample collection and shipping protocols developed at CDC[1], as well as a reprint of our analytical method for blood lead (Appendix A). Summary descriptions of the QC system used in NHANES, as well as general descriptions of the NHANES quality control system were distributed (Appendix B, C).

Four whole bovine blood pools were collected at CDC, evaluated for lead content, and aliquoted into 2 mL Vacutainer brand whole blood collection containers (blind pools) or plastic screw-capped vials (bench pools). The Vacutainer specimen containers (as well as the plastic vials for the bench controls) were screened by established protocol[1], and had been purchased in sufficient quantity to allow all the projects to use them as standard specimen containers. Pools such as these (whole bovine blood, stabilized with 1.5 mg/mL disodium EDTA) have been shown to be stable at least two years at 4°C, the recommended storage temperature. Data from this screening are presented in Table 1. Aliquots of these four pools were distributed to the laboratories, and duplicate analysis of the four pools was performed over a series of twenty analytical runs. The data generated from these analyses were used to calculate the QC limits for both means (X bar) and ranges of duplicate measurements of these pools. The method of calculation is presented in Appendix D, using POOL "A" from Standard Reference Material (SRM) 955 from the National Institutes of Standards and Technology (NIST). The calculations are based on two-way analysis of variance (ANOVA) as described by Shewhart[2,3].

Results of the calculated limits for these four pools were sent to the three laboratories to be used as part of the laboratory quality control program. Results of the calculations for the three laboratories, as well as CDC, are presented in Table 2. The quality control limits could then be used in two ways:

1) the limits for the "blind" pools were used to evaluate the blind quality control pools, which were inserted into each analytical run by the supervisor; and

2) the limits for the "bench" pools could be used by the analyst (along with those for any additional pools) to evaluate the degree of statistical control of the analysis.

Insertion of the "blind" pools was random, using a random number table numbering scheme presented by Taylor[4], with identical labels as study subject specimens and identical Vacutainers (2 mL liquid EDTA, lot # 8E014 EXP 5/90). If names were provided on the sample labels, then fictitious names were provided for the "blinds" by the supervisor. The source of names could be random names from a metro phone book, or any other appropriate source.

2. Calibration

Since three different analytical methods were used in the study, the issue of calibration of the analytical systems was very important. The CDC recommendation to all three laboratories was that either SRM 3128 (from NIST) or equivalent aqueous standards for lead be used. In the case of the graphite furnace AAS methods (Boston and Baltimore), a version of the CDC published method was used for analysis, which includes "matrix matched" standards and lead nitrate aqueous

standards. The DPASV method used by Cincinnati[5] includes standards analyzed by isotope dilution mass-spectroscopy (IDMS). In all three laboratories the ultimate test of the accuracy of calibration is generation of accurate values for reference materials. As can be seen from Table 2, all three laboratories agreed well (within 5%) with each other, and generated comparable results on the four pools provided by CDC (Figure 1).

3. Interpretation of Data

The quality control system outlined here has multiple uses:

1) evaluation of "day-to-day" statistical control of the analytical system;
2) verification of analytical performance on "blinds" - known samples inserted in each analytical run to verify precision
3) evaluation of any "trends" in the analytical performance of the method over time - either short term (days/weeks) or long term (months/years)

With the use of common rules for the verification of statistical control[4], all the laboratories would follow a statistically valid and proven method for data evaluation. Any problems not resolved at the local level were presented to CDC for resolution.

D. RESULTS OF QUALITY CONTROL SYSTEMS

Data from the initial characterization of the four whole blood pools used in this project are presented in Table 2. Each laboratory can be individually compared as to within-run precision, among runs precision, and total precision. Using the definition of the limit of detection as 3 SD(wr) developed by Winefordner[6], the laboratory detection limits may also be compared.

Of equal importance are the long-term quality control data. [illegible] of time trends. The Shewhart plots for the three laboratories are presented in Figure 2. As can be readily seen, no long-term trends in analytical values with time are evident. Statistical tests of the null hypothesis (that is, a "0" slope of X bar versus time) revealed no statistically significant trends with time.

The conclusions that can be drawn from these three systems are as follows:

1) comparable values were obtained on common quality control materials, which covered the analytical concentration range of interest;

2) laboratory data for blood lead were produced from analytical systems in statistical control (as defined by Shewhart); and

3) no statistically significant time trends were observed in the data - that is, the difference in pre- and post abatement blood lead values are real and not the product of unstable analytical systems.

TABLE 1: DATA FROM LEAD SCREENING

2 mL Vacutainers (B D lot #8E016 Exp. 5/90) Catalog #6384

Analytical result N=42 tubes;
soaked overnight (12 hr in 1% v/v nitric acid)

X = 0.0964 μg/dL lead (SD=0596 μg/dL CV=62%)

3 mL plastic vials (linear polyethylene) Falcon Catalog #

Analytical result N=42 tubes;
soaked [illegible] in 1% v/v nitric acid)

X = 0.51 ng/mL equivalent to 0.025 μg/dL (SD=0.36 ng/mL CV=71%)

Capillary Collection (Butterflies B D Catalog #7251; 7253)

Analytical Results; One mL 1% v/v nitric acid passed through each collector)
N = 5 results/collectors each size

X = < 0.1 ng/mL (cat 7251)
X = < 0.1 ng/mL (cat 7253)

TABLE 2: QUALITY CONTROL LIMITS - MEANS AND RANGES

LAB	POOL	MEAN MEAN	95% CONF LIMITS RANGE	MEAN	99% CONF LIMITS RANGE	
CDC	BLIND	4.6	3.0-6.2	1.6	2.5-6.7	2.1
	BENCH2	43.5	38.2-48.8	2.2	36.5-50.5	2.9
	BENCH1	1.8	1.0-2.5	1.4	0.8-2.7	1.9
	BLIND2	10.7	8.5-12.9	1.4	7.8-13.6	1.8
MD	BLIND1	5.1	4.2-5.9	0.87	4.0-6.2	1.1
	BENCH2	45.7	43.9-47.6	1.1	43.3-48.2	1.5
	BENCH1	2.0	1.45-2.63	0.6	1.27-2.8	0.8
	BLIND2	11.1	9.6-12.6	1.0	9.2-13.1	1.4
CN	BLIND1	3.5	1.9-5.1	3.2	1.4-5.6	4.2
	BENCH2	43.3	40.5-46.1	2.2	39.6-46.9	2.9
	BENCH1	2.4	0.9-4.0	2.0	0.4-4.5	2.6
	BLIND2	8.9	7.1-10.7	3.1	6.5-11.2	4.1
BOS	BLIND1	4.0	2.4-5.6	0.8	1.9-6.1	1.0
	BENCH2	47.0	42.9-51.2	2.9	41.6-52.6	3.8
	BENCH1	0.2	-1.2-1.5	0.85	-1.6-1.9	1.1
	BLIND2	10.6	8.6-12.5	1.3	8.0-13.1	1.7

E. REFERENCES

1. "Lake Couer d"Alene Idaho Cadmium and Lead Study-Specimen Collection and Shipping Protocol" Division of Environmental Health Laboratory Sciences, Center for Environmental Health, Centers for Disease Control, Atlanta, GA 30333 8/6/86.

2. "A Multi-Rule Shewhart Chart for Quality Control in Clinical Chemistry", J.O. Westgaard, P.L. Barry, and M.R. Hunt, Clinical Chemistry, 27:493-501, 1981.

3. "A Quality Assurance Program for Health and Environmental Chemistry", M.A. Gaultier and E.S. Gladney, American Laboratory, pp 17-22, July, 1987.

4. "Quality Assurance of Chemical Measurements", John Taylor, Lewis Publishers, Chelsea, MI, 1987.

5. "Anodic Stripping Voltammetry Procedure Modified for Improved Accuracy of Blood Lead Analysis", S.M. Roda, R.D. Greenland, R.L. Bornschein, and P.B. Hammond, Clinical Chemistry 34:563-567, 1988.

LEAD FREE KIDS STUDY

EXTERNAL QUALITY ASSURANCE/QUALITY CONTROL
QA/QC FOR SOIL, DUST, AND HANDWIPES (US EPA/EMSL/LV)

Section 1
Preparation Laboratory Operations

1.1 Sample Receipt

Three cities are involved in the Superfund Lead Abatement Program; Baltimore, Boston, and Cincinnati. EMSL-LV supplies the field samples in each city with 30-gallon plastic barrels for soil samples and 1-gallon metal containers for interior dust samples. A minimum of two soil and two dust samples are collected in each city and shipped to EMSL-LV. The preparation laboratory manager records the arrival data of all samples received.

1.2 Sample Labeling

1.2.1 Soil and Dust

Each soil sample is labeled and identified by a unique sample code as described below.

	A	BOS	H	01	001	(example)
digits	1	234	5	67	8-10	

Digits	Representation
1	Sample type - "A" - audit "C" = calibration
2-4	City code - "BOS", "BAL, "CIN"
5	Concentration - "H" = high, "M" = medium, "L" = low
6-7	2 kg sample - represents number of the 2 kg container in which soil was subsampled. If sample is dust the number would represent the 100g container.
8-10	20 g aliquot - numbered aliquot from soil 2 kg container or 2 g aliquot from dust 100 g container.

Analytical laboratories at each city provide sample labels and containers to be used for that city. Prior to shipping, the EMSL labels are removed and the city labels are affixed to the sample containers. Also, the EMSL-LV codes and corresponding city codes are recorded in a log book for each sample.

1.2.2 Handwipes

Each handwipe sample is labeled and identified by a unique sample code as described below.

	A	BOS	H	001	(example)
digits	1	234	5	6-8	

Digits	Representation
1	Sample type - "A" - audit "C" = calibration
2-4	City code - "BOS", "BAL, "CIN"
5	Concentration - "H" = high. "M" = medium, "L" = low
6-8	Internal ID - the last three numbers of the internal LESC ID.

Analytical laboratories at each city provide sample labels and containers to be used for that city. Prior to shipping, the EMSL labels are removed and the city labels are affixed to the sample containers. Also, the EMSL-LV codes and corresponding city codes are recorded in a log book for each sample.

1.3 Sample Tracking

1.3.1 Soil and Dust

The preparation laboratory manager tracks each sample as it progresses through the preparation procedures and records progress in a logbook.

The following information is recorded on a daily basis.

Sample Type - soil, interior dust

City - Boston, Baltimore, Cincinnati

Concentration - high, medium. low

Dried - whether sample has been dried (yes/no)

Crushed - whether sample has been crushed (yes/no)

Bulk homogenization - whether bulk sample has been homogenized (yes/no)

Pulverized - whether sample has been pulverized (yes/no)

2 kg split - whether bulk sample has been split into 2 kg samples. If this step is partially complete, the number of aliquots prepared will be recorded.

100 g split - whether 2 kg soil aliquots have been split into 100 g aliquots or whether the bulk dust sample have been split into 100 g aliquots. If this step is partially complete, the number of aliquots prepared will be recorded

20 g split - whether 100 g soil aliquots have been split into 20 g aliquots or 100 g dust aliquots have been split into 2 g aliquots. If this step is partially complete, the number of aliquots prepared will be recorded.

The appropriate types of information will be made available for dust and handwipe samples. As aliquots are sent to analytical laboratories, this information will also be recorded (see sample shipment).

1.3.2 Handwipes

The preparation laboratory manager tracks each sample as it progresses through the preparation procedures and records progress in a logbook.

The following information is recorded on a daily basis.

Sample Type - handwipe

City - Boston, Baltimore, Cincinnati

Concentration - high, medium, low

Spiked - whether sample has been spiked (yes/no)

The appropriate types of information will be made available for dust and handwipe samples. As aliquots are sent to analytical laboratories, this information will also be recorded (see sample shipment).

1.4 Sample Custody

Custody is transferred from the field samples to the preparation laboratory manager when the samples are received. The samples remain in the custody of the preparation laboratory manager until they are shipped to the analytical laboratories.

1.5 Sample Storage

All samples are placed in cold storage upon receipt until there is room for them in the drying room. After air drying, the samples are returned to cold storage until processing.

1.6 Sample Shipment

As samples are shipped a shipping form (Figure 1.1) is sent to both the laboratory manager and QA manager. The form sent to the laboratory manager contains only the types and numbers of samples sent and the city sample code information for each sample. The form sent to the QA manager contains information as well as the EMSL sample code, which identifies the concentrations of each sample.

LEAD ABATEMENT QA SAMPLE SHIPMENT FORM

LAB_____ SAMPLE TYPE_____

BATCH_____

DATE SHIPPED_____

NO OF SAMPLES_____

Sample Code	City Sample Code	EMSL Sample Code
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		

Figure 1.1 Lead Abatement Sample Shipment Form

Section 2
Soil Audit Sample Preparation Procedures

2.1 Overview

Specific areas of the preparation laboratory are designated for sample processing. Sample integrity during processing is ensured by: (1) the use of detailed sample labels, (2) documenting the status of each sample during the processing, (3) following the preparation protocols, and (4) avoiding physician or chemical contamination during each processing step.

Bulk soil samples are processed as outlined in Figure 2.1. Each step is detailed in sections 2.2 - 2.8.

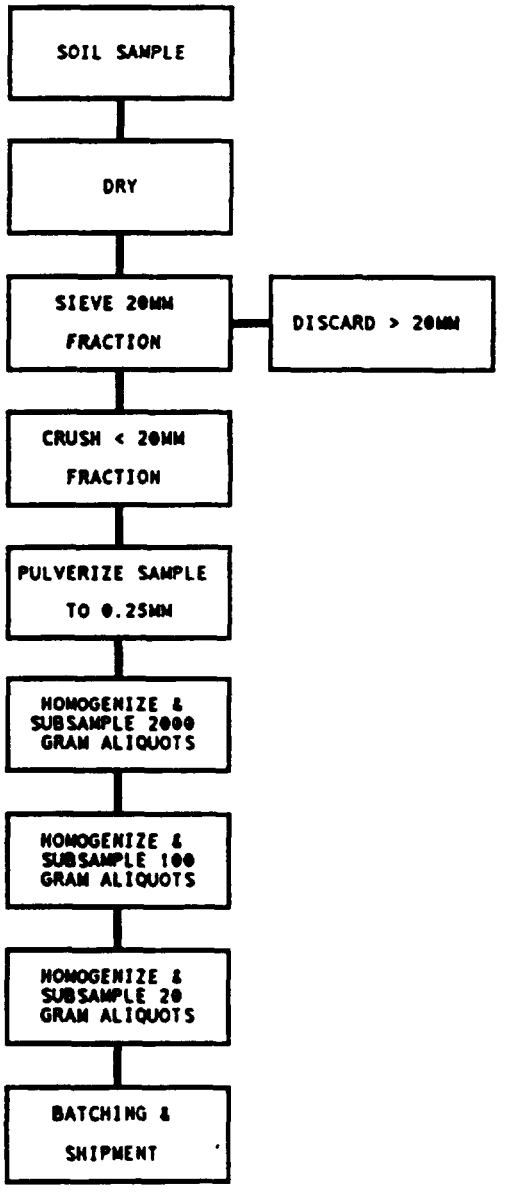


Figure 2.1 Soil Audit Sample Preparation Flow

2.2 Sample Drying

2.2.1 Summary

Sample tables constructed of PVC and heavy nylon mesh are used to air dry the samples. Use of the mesh enhances air circulation and increases the rate of sample drying. These tables are located in a dust free drying room.

Chemicals as well as food, drinks and smoking are prohibited in the drying area. A separate pair of gloves is worn when handling each sample. Care is exercised during the cleaning operation to avoid contamination of samples. Only one sample at a time is dried to avoid cross contamination. Weekly vacuuming or sweeping is performed to clean the floors of the drying room. Sweep EZ, (a sweeping compound) is used at least once a week to control dust accumulation in the drying area.

2.2.2 Equipment

Drying tables with nylon mesh surface
Kraft paper, 36-inch wide rolls
Rubber gloves, unpowdered

2.2.3 Procedure

Label a bulk sample processing data form for each sample to be air dried. Place two fresh sheets of kraft paper, approximately 1 square meter in area, on the drying table. Wearing gloves, slowly spread the sample on top of the paper, taking care not to lose any soil off the paper or contaminate any adjacent samples. Disaggregate any large peds. Soils high in clay may harden nearly irreversibly if allowed to dry without a preliminary disaggregation of medium and coarse peds. Place an additional sheet of kraft paper loosely over the sample. Daily stir the soil sample to facilitate drying. During the first few days replace the bottom sheet of paper in order to alleviate excessive moisture accumulation. Note any observations of fungal or algal growth on the data form.

Allow the sample to air dry for a minimum of four days. Prior experience indicates that samples dry to a constant moisture content (1-2.5%) within three days at the EMSL-LV preparation laboratory.

2.2.4 Quality Control

When samples are received, labels are checked and recorded. Wearing gloves, the samples are spread out on kraft paper, which is an effective barrier separating the samples from the PVC mesh tables. A cover sheet of kraft paper is used to reduce potential contamination. When handling the samples, gloves are always worn.

2.3 Initial Disaggregation and Sieving

2.3.1 Summary

When a bulk soil sample is air dry, it is disaggregated and sieved in order to remove large rock fragments and to prepare the sample for crushing, pulverization, homogenization and subsampling.

This procedure is accomplished in two steps: (1) disaggregation and sieving through a 20mm sieve and, (2) crushing, pulverizing, and sieving through a 2mm sieve.

2.3.2 Equipment

Fumehood
Kraft paper
Plastic bags
Respirator
Rolling pin
Rubber stopper
Tyvek suite
2mm sieve
20mm sieve

2.3.3 Procedure

Place a 1 m^2 sheet of kraft paper on the sieving table under a vented fumehood. Place a 60 cm^2 sheet of kraft paper on the larger piece of paper and spread a portion of one bulk sample within the confines of the 60 cm^2 sheet. Carefully examine the nature of the rock fragments within the sample and determine the amount of pressure necessary in order to disaggregate the soil peds without fracturing or crushing the fragments. Place another 60 cm^2 sheet of kraft paper over the sample and gently roll the rolling pin across the sample. Enough force should be applied to break up the peds, but not so much that weathered rock fragments are crushed. Place this crushed sample in the 20mm mesh sieve and push the soil through the sieve with a rubber stopper onto the kraft paper. Attempt to include any soil adhering to rock fragments. Place the sieved material in a clean container and repeat the process until all of the soil of from one bulk sample is sieved. All rock fragments and other material larger than 20mm is placed in a plastic bag and properly discarded.

Crush the minus 20mm fraction (The Crushing procedure is described in section 2.4) then passed through a 2mm sieve using the procedure described above.

2.3.4 Quality Control

The disaggregation and sieving areas should be covered with kraft paper and cleaned after each sample has been sieved. When sieving, gloves must be worn, as well as an appropriate mask and protective clothing. The laboratory manager will frequently check the sieving operation for proper equipment and for adherence to protocol. A member of the EMSL-LV QA staff will visit the preparation laboratory to ensure adherence to protocol.

2.4 Crushing

2.4.1 Summary

After soils are sieved through the 20mm sieve, the < 20mm material is passed through a rock crusher. The intent of crushing is to further reduce the particle size to < 2mm.

2.4.2 Equipment

Brush
Compressed air
Crusher
Gloves
Mask
Protective Clothing
Plastic bags
Scoop
2mm sieve

2.4.3 Procedure

With a scoop, place a portion of the minus soil fraction to the crusher opening. Turn the crusher on. The crusher deposits the resulting crushed material into a collection bin at the bottom of the machine. After the first scoop is crushed, shut the machine off and sieve the crushed material through the 2mm sieve (described in Section 2.4). If all the material passes through this sieve, the crushing plates are sufficiently close enough to continue processing. If not, adjust the plates and repeat the procedure on the same sample until all the material passes through the 2mm sieve. Once the collection bin is full, turn the machine off and deposit the material into a clean labeled plastic bag. Repeat the operation until all soil from one bulk sample is crushed. Thoroughly clean the machine with compressed air and a brush between samples.

2.4.4 Quality Control

When crushing, gloves must be worn, as well as a mask and protective clothing. The machine opening should be tightly fastened to minimize dust. The laboratory manager will frequently check processing equipment for proper operations, for adherence to protocol including proper maintenance. A member of the EMSL QA staff will visit the preparation laboratory to ensure adherence to protocol.

2.5 Pulverizing

2.5.1 Summary

The routine soil samples that are analyzed by the cities are ground to a particle size of less than 0.25mm. Therefore, it is necessary to provide audit materials with the same particle size fraction. The preparation laboratory pulverizes the minus 2mm soil fraction to a particle size of less than 0.25mm.

2.5.2 Equipment

Brush
Compressed air
Gloves
Mask
Protective Clothing
Plastic bags

Pulverizer
Scoop
0.25mm sieve

2.5.3 Procedure

With a scoop, place a portion of the minus 2mm soil fraction material into the pulverizer opening. Turn the power on. The pulverizer grinds the soil and deposits it into a collection bin at the bottom of the machine. After the first scoop is pulverized, shut the machine off and sieve the material through the 0.25mm sieve. If all the material passes through this sieve, the grinding plates are sufficiently close enough to continue pulverization. If not, adjust the plates and repeat the procedure on the same sample until all the material passes through the 0.25mm sieve (described in Section 3.6). Once the collection bin is full, turn the machine off and deposit the pulverized material into a clean labeled container. Repeat the operation until all soil is pulverized. Thoroughly clean the machine with compressed air and a brush.

2.4.4 Quality Control

When pulverizing, gloves must be worn, as well as a mask and protective clothing. The machine opening should be tightly fastened to minimize dust. The labor[illegible] [illegible]nager will frequently check processing equipment for proper operations, for ad[illegible] [illegible]rotocol including proper maintenance. A member of the EMSL QA staff will vis[illegible] [illegible] preparation laboratory to ensure adherence to protocol.

2.6 Final Sieving

2.6.1 Summary

To ensure that the pulverized audit sample has a particle size < 0.25mm it is resieved through a 0.25mm sieve.

2.6.2 Equipment

Fumehood
Kraft paper
Paint brush
Plastic bags
0.25mm sieve
3 X 5 card

2.6.3 Procedure

Place a 1 m^2 sheet of kraft paper on the sieving table under a vented fumehood. Place a 60 cm^2 sheet of kraft paper on the larger piece of paper. Place a portion of the soil material in the 0.25mm sieve and screen the material using a rocking motion. Use a paint brush or 3 X 5 card to gently push the material through. Place any material > 0.25mm into a separate pile. Continue this procedure until the complete sample is sieved. Save the material not passing through the .25mm sieve for further pulverization.

2.6.4 Quality Control

When sieving, gloves must be worn, as well as a mask and protective clothing. The laboratory manager will frequently check the sieving processing equipment for proper operation and for adherence to protocol. A member of the EMSL QA staff will visit the preparation laboratory to ensure adherence to protocol.

2.7 Homogenization and Subsampling to 2kg Aliquots

2.7.1 Summary

Prior to splitting the 2kg aliquots into 20g aliquots, the bulk soil (minus 0.25mm fraction) is homogenized using a combination of three techniques; drum-rolling, cone and quartering, and riffle-splitting. After homogenizing, the bulk sample is split into 2kg aliquots using a riffle splitter.

2.7.2 Equipment

Drum homogenizer
Gloves
Kraft paper
Labels
Large riffle splitter
Mask
Protective clothing
Shovel
Top loading balance
2-L sample bottles

2.7.3 Procedure

2.7.3.1 Drum homogenization/Cone and Quartering

Place all of the < 0.25mm fraction from one soil sample into the drum homogenizer. Slowly rotate the drum for five minutes. Pour the entire sample onto piece of kraft paper so that the sample takes on the shape of a cone. Homogenize the cone by dividing the cone into four equal quarters by lines going clockwise from 1 to 4. Using a shovel, remove the first quarter to form a new cone The third, second and fourth quarters are piled sequentially over the first quarter. This procedure is performed seven times in succession

2.7.3.2 Riffle Splitting

Position the two collecting bins under the large riffle splitter. Pour the entire sample evenly across the baffles of the riffle splitter. Transfer the soil from each collecting bin into the distribution pan and replace the receiving pans under the riffle splitter. Repeat this procedure five times in succession.

2.7.3.3 Subsampling

After the homogenization, 2kg aliquots are obtained If the cone and quartering technique is used.

place a clean 2-L sample bottle at the bottom of the cone and, with an upward movement, collect a sample weighing approximately 2000 grams (+/- 20 grams). If the riffle splitting technique is used, place a clean 2-L sample bottle at one end of the collecting bin and move to the other end to fill the bottle. The sample is labeled using the procedure described in Section 2.2. The first 2kg aliquots for each audit concentration is identified with "01" and subsequent aliquots numbered consecutively. The other information within the sample code will ensure a unique sample identity. Repeat this procedure for the entire amount of homogenized audit sample. Store the audit samples in cold storage until further processing.

2.7.4 Quality Control

When homogenizing, gloves must be worn, as well as a mask and protective clothing. Prepare labels for the 2kg samples prior to the processing step in order to avoid mislabeling. The laboratory manager will frequently check the homogenization operation for proper processing equipment and for adherence to protocol. A member of the EMSL QA staff will visit the preparation laboratory to ensure adherence to protocol.

2.8 Homogenization and Subsampling to 100g and 20g Aliquots

2.8.1 Summary

Each 2kg aliquot prepared in section 2.7 is further homogenized in a medium sized riffle splitter and split into 100g aliquots. The 100g aliquots are then homogenized in a small riffle splitter and split into 20g aliquots. These two procedures are done simultaneously in order toe avoid the use of intermediate sample containers and the possibility of mislabeling.

2.8.2 Equipment

Gloves
Fumehood
Laboratory containers (20g samples)
Open pan balance
Plastic bags
Riffle splitters, medium (24 chute 13-1/2" X 15-3/8") and small (32 chutes 6-5/8" X 9")
Scoop

2.8.3. Procedure

2.8.3.1 Homogenization and Subsampling to 100 grams

2.8.3.1.1 **Initial Homogenization** - Position the two receiving pans under the medium riffle splitter. Pour the entire 2kg sample evenly across the baffles of the riffle splitter. Transfer the soil from each receiving pan into the distribution pan and replace the receiving pans under the riffle splitter. Repeat this procedure five times in succession.

2.8.3.1.2 **Splitting to 500g Aliquots** - Pour the sample evenly across the baffles and place the soil from one receiving pan aside. Transfer the soil in the other receiving pan to the distribution pan and split once more. This should produce approximately a 500g sample in each receiving pan. Place these samples on separate sheets of kraft paper. Split the soil form the other receiving pan

similarly. This produces a total of four 500g aliquots from each 2kg aliquot.

2.8.3.1.3 **Splitting to 100g Aliquots** - Pour the 500g sample evenly across the baffles and place the soil from one receiving pan into a plastic bag. Transfer the soil in the other receiving pan to the distribution pan and continue splitting as necessary until approximately 100g of soil occupies one of the receiving pans. Place the entire contents of this pan into the distribution pan of the small riffle splitter (see section below). Repeat the procedure until all of the 2kg aliquot is split into 100g aliquots

2.8.3.2 Homogenization and Subsampling to 20 grams

2.8.3.2.1 **Initial Homogenization** - Position the two receiving pans under the small riffle splitter. Pour the entire 100g aliquot from the distribution pan evenly across the baffles of the riffle splitter. Transfer the soil from each receiving pan into the distribution pan and replace the receiving pans under the riffle splitter. Repeat this step five times in succession.

2.8.3.2.2 **Splitting into 20g Aliquots** - Pour a 100g aliquots evenly across the baffles of the small riffle splitter. Place the soil from one receiving pan into a plastic bag. Transfer the soil from other receiving pan to the distribution pan and continue splitting as necessary until approximately 20g of soil occupies one of the receiving pans. Place the entire contents of the pan into the pre-labeled sample container provided by the analytical laboratories. Repeat the procedure until all of the 100g sample is split into five 20g aliquots.

2.8.4 Quality Control

When homogenizing and subsampling, gloves must be worn, as well as a mask and protective clothing. The laboratory manager will frequently check the operation for proper use of equipment and for adherence to protocol. A member of the EMSL QA staff will visit the preparation laboratory to ensure adherence to protocol. As samples are characterized, precision estimates for each audit sample type will be developed. If the pooled relative precision estimate (RSD) for an audit sample whose concentration is above 10 times the detection limit (~ 100ppm) is greater than ten percent, the preparation laboratory will combine all 20g aliquots, rehomogenize, then resplit the sample.

Section 3
Dust Audit Sample Preparation Procedures

3.1. Overview

Dust samples of different concentrations will be supplied to EMSL-LV from each city. From these samples, EMSL-LV will provide three audit samples with Pb at low, mid, and high concentration ranges and three calibration standards at similar concentrations. The bulk samples are air dried, sieved, homogenized and split into 2 gram aliquots as outlined in Figure 4.1. Participating laboratories supply EMSL-LV with sample containers, labels, and the appropriate labeling techniques for the samples.

A random subsample of the audit samples will be characterized by EMSL-LV. Fifty samples at each concentration range will be analyzed for Pb by XRF. A subset of these samples will be analyzed by ICPES after nitric acid extraction. Characterization data will be supplied to the Lead Abatement QA manager.

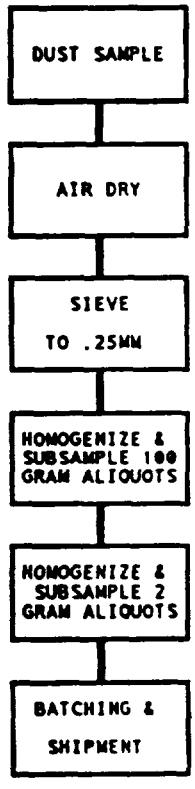


Figure 3.1 Dust Audit Sample Preparation Flow

3.2 Sample Drying

Interior dust audit samples will be sent from the participating cities of Boston, Baltimore and Cincinnati in one gallon containers. Upon arrival, remove the lid of each container and allow it to air dry before further preparation. The samples are kept in the shipping container during air-drying to prevent loss of sample.

3.3. Sieving to 0.25mm

3.3.1 Equipment

Fumehood
Kraft paper
Paint brush
0.25mm Sieve
3 X 5 index cards

3.3.2 Procedure

Place a $1m^2$ sheet of kraft paper onto the preparation table. On top of this sheet, place a $60cm^2$ sheet of kraft paper. Set a 0.25mm mesh sieve on top of the smaller sheet of kraft paper. Portions of the dust sample are placed into the sieve and gently pushed through with either a paint brush or a 3 X 5 card. Material greater than 0.25mm is placed in a plastic bag for proper disposal.

3.4 Homogenization and Subsampling to 2 Gram Aliqouts

Each bulk dust sample is homogenized in a medium sized riffle splitter and split into 100g aliquots and then these 100g aliquots are homogenized in a mini riffle splitter and split into 2g aliquots.

3.4.1 Equipment

Fumehood
Gloves
Laboratory containers (2 gram samples)
Open pan balance
Plastic bags
Riffle splitter, medium (24 chute 13-1/2" X 15-3/8")
Riffle splitter, mini (14 chutes, 2-1/16" X 3-3/4")
Scoop

3.4.2 Procedure

3.4.2.1 Homogenization and Subsampling to 100 grams

Position the two receiving pans under the small riffle splitter. Pour the entire contents of the minus 0.25mm dust fraction evenly across the baffles of the riffle splitter Transfer the dust from each receiving pan into the distribution pan and replace the receiving pans under the riffle splitter. Repeat this step five times in succession with the material in each receiving pan.

Pour the sample evenly across the baffles and place the dust from one receiving pan into a plastic bag. Transfer the soil in the other receiving pan to the distribution pan and splitting as necessary until approximately 100g of dust occupies one of the receiving pans. Place the entire contents of this pan into the distribution pan of the mini riffle splitter (see section below). Repeat the procedure until all of the dust sample is split into 100g aliquots.

3.4.2.2 Homogenization and Subsampling to 2 Grams

Position the two receiving pans under the mini riffle splitter. Pour the 100g dust aliquot evenly across the baffles of the riffle splitter. Transfer the dust from each receiving pan into the distribution pan and replace the receiving pans under the riffle splitter. Repeat this step five times in succession with the material in each receiving pan.

3.4.2.2.1 **Splitting to 25g Aliquots** - Pour the 100g aliquot evenly across the baffles and place the dust from one receiving pan aside. Transfer the dust in the other receiving pan to the distribution pan and split once more. This produces a 25g aliquot in each receiving pan. Place the 25g aliquots on separate sheets of kraft paper. Similarly split the remaining dust to produce an additional total of two 25g aliquots.

3.4.2.2.2 **Splitting to 2g Subsamples** - Pour the 25g aliquot evenly across the baffles of the mini riffle splitter and place the soil from one receiving pan into a plastic bag. Transfer the soil in the other receiving pan to the distribution pan and continue splitting as necessary until approximately 2g of soil occupies one of the receiving pans. Place the entire contents of this pan into the pre-labeled sample container provided by the analytical laboratories. Similarly split the dust set aside in the plastic bag. Repeat the procedure until all of the 25g aliquots are split into 2g samples.

3.4.3 Quality Control

When homogenizing and subsampling, gloves must be worn, as well as a mask and protective clothing. The laboratory manager will frequently check the operation for proper use of equipment and for adherence to protocol. A member of the EMSL QA staff will visit the preparation laboratory to ensure adherence to protocol. As samples are characterized, precision estimates at each concentration will be developed. If the pooled precision estimate for an audit sample whose concentration is above 10 times the detection limit (~ 100ppm) is greater than ten percent relative standard deviation, the preparation laboratory will resplit and rehomogenize the sample.

Section 4
Handwipe Audit Sample Preparation

4.1. Summary

As part of the Superfund Lead Abatement program, children's hands are swabbed with handwipes which are then analyzed for lead. As part of the quality control, handwipes audit samples are included with the unknown handwipe samples for analysis. Handwipe audit samples are spiked with lead at three different levels; 5μg, 20μg, and 40μg lead.

4.2 Equipment

Box of wet handwipes
200 mg/L and 1000 mg/L lead solutions
ml pipette
Ziploc type plastic bags
Plastic gloves

4.3. Procedure

4.3.1 Reagents

- 1000 mg/L Pb - Certified standard obtained commercially.
- 200 mg/L Pb - Dilute 1000 mg/L Pb solution 1:5 with reagent water.

4.3.2 Spiking Procedure

- Unopened containers of wet-wipes are provided by the participating cities.
- Working in a laminar flow clean hood, wearing clean gloves, pull out 6 wet wipes from the same container and place into a stack (i.e., one on top of the other). Using a micropipet, add the spike to the center of the wet wipe stack (between the third and fourth wipe). The spike volumes are given below;

- 5μg spike - 25 μL of 200 mg/L Pb standard
- 20μg spike - 20μL of 1000 mg/L Pb standard
- 40μg spike - 40μL of 1000 mg/L Pb standard

- Fold and crumple the wet wipe stack and place into a zip-lock bag. Seal and label the bag with lab ID number. Record the lab ID and spike level into a lab notebook.

Section 5
Urban Soil, Urban Dust, and Wet-Wipe

Audit Sample Characterization

5.1 Sample Preparation

5.1.1 Reagents

Concentrated nitric acid (ACS Reagent grade)
Concentrated nitric acid (Double deionized)
Hydrofluoric acid (48% high purity)
Reagent water (ASTM type II)

5.1.2 Hot Nitric Acid (HNO_3) Extraction

Place 1g sample (weighed to nearest 0.1 mg) or packet of wet wipes into a clean 100mL beaker. Add 50mL 7N HNO_3 to soil or dust samples. Add 50mL 1N HNO_3 to wet wipe samples. Push wet wipes down with glass stirring rod to ensure complete c[illegible] with a watch glass and heat gently at 95°C for 2 hours. Maintain at least 25mL vol[illegible] by adding 7N HNO_3 (1N for wet wipe samples) as necessary. After digesting [illegible] of water. Filter through Whatman No. 1 filter paper into a 100mL volumetric flask. Rinse beaker and filter with additional water. Dilute to volume with water.

5.1.3 Total Digestion of Urban Soil and Dust Samples

• Add 0.5g (weighed to nearest 0.1 mg) sample into a clean teflon microwave digestion vessel. Add 9mL of concentrated HNO_3, and 4mL of 48% HF. Cap and seal the vessels. Weigh capped vessel to the nearest .01g and place in microwave oven. A total of 12 vessels must be placed in oven. Use blanks if extra spaces must be filled. Heat at 520 Watts for 30 minutes. Let the samples cool and irradiate again at the same setting.

• Cool. Weigh capped vessels. Rinse condensate from cap and vessel walls into vessel. Transfer quantitatively to a 100mL polypropylene volumetric flask. Dilute with reagent water to the mark.

• If not determined previously, determine percent solids as in Section 6.2..

5.1.4 Preparation of Loose Powder Samples for XRF Analysis

• Pour a 5g soil sample or 2g dust sample into a powder cup and seal with 3.6 μm mylar film.

5.2 Percent Solid Determination

Determine the percent solids in the soil or dust samples by drying a 5g aliquot at 105°C for 24 hours. Place a 5g sample (weighed to the nearest mg) in a tared aluminum weighing dish. Dry at 105°C for 24 hours. Cool in a desiccator. Reweight to the nearest mg.

Percent solids = {100 (wet wt. - dry wt.) /wet wt.}.

5.3 Sample Analysis

5.3.1 Summary

Samples were analyzed by XRF to determine Pb concentrations and homogeneity. The XRF soil audit concentrations were verified by ICP or GFAAS. From the fifty aliquots of each soil analyzed by XRF, a subset of 7 aliquots were analyzed by ICP and GFAAS.

5.3.2 ICPAES and GFAAS Analysis

The acid digests are analyzed by either ICPAES or GFAAS depending on the lead concentration in the digestate. S[illegible] containing Pb concentrations greater than 10 times the ICPAES IDL are analyzed b[illegible] .DL is about 50 ppb). Lower concentrations are measured by GFAAS. The instrument[illegible] are calibrated and the digestates analyzed. HF resistant components are used for the total digest solutions. Quality control is described in Section 5.5.

5.3.3 XRF Analysis

Loose powder samples are analyzed by XRF. The analysis conditions for lead are: Ag secondary target, X-ray tube voltage = 35 Kev, X-ray tube current = 3 mA, atmosphere = air, counting time = 200 sec. live time. The lead L-beta peak/Ag compton peak ratio is calculated. The lead concentration is determined from the ratio and the calibration curve (Ratio vs. Concentration). Quality control is described in Section 6.5.

5.4 Instrument Calibration

5.4.1 ICPAES and GFAAS Analysis

The instruments are calibrated following the manufacturer's guidelines. A series of calibration standards are analyzed and a calibration line calculated using linear regression of intensity vs. standard concentration.

5.4.2 XRF Analysis

The XRF is calibrated by acquiring spectra from a series of urban soil standards with known lead concentrations. Acquisition conditions are given in Section 5.3.3 The Pb L-beta peak and Ag compton peak are measured from the spectra and the Pb LB peak/Ag Compton peak ratios are calculated. A calibration line is calculated using linear regression of ratio vs. standard concentration.

5.5 Quality Control

5.5.1 Sample Related Quality Control

The following QC samples are prepared for ICPEAS and GFAAS analysis

- Matrix Spike Sample - one sample per 20 will be spiked with lead prior to digestion.
- Reagent Blank Sample - One reagent blank will be prepared per group of 20 samples

• Laboratory Control Sample (LCS) - One LCS sample will be prepared and analyzed per group of 20 sample.s

5.5.2 Analysis Related Quality Control

The following QC samples are analyzed along with routine samples:

5.5.2.1 ICPAES and FGAAS Analyses

Initial Calibration Verification (ICV) Standard - After calibration, the ICV is analyzed. The percent recovery must be 90-110%. The ICV solution is a standard from a different source than the calibration standards.

Initial Calibration Blank (ICB) - After analysis of the ICV, the ICB is analyzed. The measured concentration must be less than 2 times the IDL.

Interference Check Solution (ICS) - An ICS solution is analyzed after the ICV and ICB are analyzed. The ICS contains 500 ppm of major interferents (Mg, Ca, Fe, Al) and a known Pb concentration. The % recovery of Pb must be 75-125%.

Detection Limit Sample (DL) - A DL sample is analyzed after the ICS solution. The concentration of the DL solution is twice the IDL.

Continuing Calibration Verification Standard (CCV) - A CCV is analyzed every 10 samples and after the last sample. The CCV concentration is in the mid-calibration range. The % recovery must be 90-110%. If not, the instrument must be recalibrated and all samples up to the last acceptable CCV must be reanalyzed.

Continuing Calibration Blank Sample (CCB) - A CCB is analyzed after every CCV. The concentration must be less than twice the IDL.

5.5.2.2 XRF Analyses

Reference Monitor (RM) - Prior to analysis, a reference monitor sample is measured. The reference monitor intensity provides a standard measure of the x-ray flux that irradiates the samples being analyzed. The reference monitor provides a method of standardizing and/or compensating for changes in the x-ray tube flux.

High Initial Calibration Verification Standard (ICVH) - An ICVH sample is analyzed after the RM and after the last sample in a run. The concentration of Pb is at the high end of the range of interest.

Low Initial Calibration Verification Sample (ICVL) - An ICVL is analyzed after the ICVH. The concentration of Pb is at low end of the range of interest.

Section 6
Audit Sample Window Generation

6.1 Soil, Dust, and Handwipe Audit Samples

At least 50 aliquots from each soil and dust are analyzed by XRF, wet wipes are analyzed by ICPES A biweight statistical procedure is used to calculate audit windows. The biweight approach has an advantage over the classical approach in that it identifies outliers and weights them in a manner that gives them less influence on the accuracy window.

After analysis, enter the data into the program, which then generates three estimates of prediction intervals for single future observation from a univariate normal population (Figure 7.1).

(1) Classical - Based on all data Reference: Whitmore, G.A. "Prediction Limits for a Univariate Normal Observation", The American Statistician, Vol. 40, No. 2, May 1986, pp. 141-143.

(2) W/O Outliers - Outliers Removed by Grubbs' Test Reference: Barnett, V. and Lewis, T. "Outliers in Statistical Data", 2nd Ed., John Wiley and Sons, New York, 1984, p. 167.

(3) Biweight - Robust Estimation Using Biweight Procedure Reference: Kafadar, K. "A Biweight Approach to the One Sample Problem", Journal of the American Statistical Association, Vol. 77, No. 378, pp. 416-424.

PREDICTION INTERVAL SUMMARY REPORT

DATA FILE:

TYPE OF ESTIMATOR	# OF DATA	SAMPLE MEAN	SAMPLE STD DEV	95% INTERVAL LOWER	95% INTERVAL UPPER	99% INTERVAL LOWER	99% INTERVAL UPPER
CLASSICAL	50	927.1480	41.4193	843.0907	1011.2050	814.9757	1039.3200
W/O OUTLIERS	50	927.1480	41.4193	843.0907	1011.2050	814.9757	1039.3200
BIWEIGHT	50	923.4212	43.1311	835.8742	1011.9680	806.5920	1040.2500

Figure 7.1 Example of Audit Sample Prediction Interval Summary Report

The program also performs the following:

1) Tests for normality using the Kolmogorov-Smirnov and the Anderson-Darling statistic

2) Presents a histogram of the data

3) Lists the data and the biweight weighting factors

The information is sent to the project QA manager for review before audit samples are sent to laboratories for inclusion in sample batches.

Section 7

Safety

7.1 Laboratory Safety

Environmental samples invariably involve undesirable if no' hazardous materials and must be handled with respect. Special equipment and facilities are provided to prevent cross contamination of space and other samples. Special training in the use of the above may be needed (Section 1.3.3).

Personnel engaged in handling hazardous samples undergo initial and periodic medical examinations to insure that they have not contracted medical problems related to the materials with which they are involved.

7.1.1 Equipment and Supplies

Dust mask
Full face respirator
Laboratory coat
PVC gloves
Tyvek suits

7.1.2 Preparation Laboratory

Dedicated equipment and special facilities are used d[illegible] preparation. The LESC warehouse has two rooms dedicated to sample drying, sieving, homogenization, riffle splitting, and sample aliquoting. During each of the above procedures the following equipment is required: full face respirator, tyvek suit, and PVC gloves.

7.1.3 Characterization Laboratory

The analytical laboratory requires personnel to: 1) work in a [illegible] hood and wear a dust mask while splitting samples, 2) wear PVC gloves while handling

LEAD FREE KIDS STUDY

SEPTEMBER 1990

PARTICIPANT IDENTIFICATION, SIGN-UP AND ELIGIBILITY PROTOCOL

The following protocol describes the process by which children are identified, eligibility criteria assessed, and children enrolled in the Lead Free Kids Study. A flow chart describing the protocol and the eligibility and consent forms are attached at the end of this document. Children can become ineligible for a variety of reasons; a list of such reasons (and accompanying ineligibility codes) is also attached at the end of this document.

I. Office of Environmental Affairs Screening Data

Potential participants will be identified from screening data sent from health care providers (e.g. neighborhood health centers, hospital-based outpatient departments, and health maintenance organizations) to the Office of Environmental Affairs (OEA), the office through which the Boston Childhood Lead Poisoning Prevention Project (BCLPPP) is administered. Starting in January 1989 the Office of Environmental Affairs began subsetting screening data so as to identify children with the following characteristics:

A. born on or after August 1, 1985

B. resident of Dorchester, Roxbury, Jamaica Plain or Mattapan

C. blood lead level between 10 and 20ug/dl

D. no history of lead poisoning

II. Drive by Assessment

If a child meets all of the above criteria, then LFK staff drive by the child's home. This procedure, which is referred to as a "drive-by" assessment, is employed to determine if the following eligibility criteria are met:

A. the child resides in a dwelling with eight or fewer residential units;

B. the cumulative amount of chipping paint on the exterior walls (excluding trim, including porches) does not exceed 30% of the total surface area;

C. there is a yard of at least ten square feet composed of dirt, grass, or a combination thereof, which is accessible to a child; and

D. the total amount of chipping exterior trim and/or wall paint does not exceed 40% on any adjacent wall of an abutting building within 6 feet of the premises and/or within 12 feet of the property line.

III. Preliminary Soil Sample

If all the above criteria are met then preliminary soil samples are taken. (See Preliminary Soil Sampling and Analysis Protocol for details.)

IV. Family Interview

If the soil analysis indicates that at least 50% or two of the soil samples contain > 1500 ppm lead and/or the average of the soil samples is greater than or equal to 1500 ppm lead, a home visit will be made by a team of two case managers. The family will be interviewed to determine if**:

A. there are other children (besides the screened child) living in the dwelling who are less than four years old;

B. the child and his/her family have resided in the dwelling for at least 3 months as of the baseline blood draw;

C. the child and his/her family have no definite plans to move within the next three months;

D. the child is mobile* (this applies only to non-infants);

E. the child has no known history of lead poisoning;

F. the premises where the child lives is not scheduled to receive an environmental intervention (i.e. deleading) during the eligibility phase and/or project; and

G. the parents or guardians of the child are willing to participate.

* defined as not confined to a crib, bed, or wheelchair
** B-F are additional eligibility requirements

V. Search for Other Children on Premises

If screened children live in multi-unit dwellings, case managers will contact other residents in the building to ascertain if other children under four years old reside on the premises. These children are referred to as "other children" and the process by which they are identified and signed up is described in this section. Attempts to identify other children will be made by knocking on doors and interviewing other families in the building as well as by asking the screened child's family to identify other children. For each "other child" identified, the eligibility process will be started by interviewing the families. The case manager will determine if the child meets the three month residency criterion, his/her family has no plans to move within the next three months, is mobile, has no known history of lead poisoning, and his/her parents or guardians consent to participate. The case manager will also determine that no environmental interventions are scheduled to take place during the eligibility phase and/or project. OEA screening results will be reviewed to determine if the other child has a history of lead poisoning.

VI. Landlord Recruitment

If a child meets all the above criteria then the landlord of the dwelling will be contacted and his/her participation will be solicited and consent obtained.

Landlords will be contacted in person or by a letter or telephone call. The study will be described in writing and/or verbally. LFK staff will follow-up with meetings and/or telephone calls to discuss further the project with both on-premises and absentee landlords, and to see if landlord consent can be obtained. (see Landlord Consent form).

VII. Consent

If all the above criteria are met then case managers will conduct a home visit to obtain final family consent. If the family gives formal consent to participate (i.e. signs attached IRB approved consent form), the child will receive a pre-abatement blood lead test then be randomized into the study or control groups.

VIII. Pre-abatement Blood

In fall 1989 a blood lead level will be performed by an LFK phlebotomist to determine if the child's blood lead level has remained in the eligibility range (7-24ug/dl). The results of the test will be forwarded to the child's primary care provider and parents.

Drafted June 1990
Revised August 1990

LEAD FREE KIDS STUDY

LEAD PAINT AND SITE INSPECTION PROTOCOL

LFK participants' homes will be inspected to provide information on the extent of leaded paint to deleading contractors and the project epidemiologist. The contractors will be given this information so that they can make informed estimates on the cost of interior and exterior deleading. The project epidemiologist will use the measurements for scientific purposes to estimate the contribution of leaded paint to participant children's blood and hand lead levels.

The first part of this document describes how lead paint inspections will be conducted to gather information for the deleading contractors. The second part describes how this and additional information will be used for scientific purposes.

Lead Paint Inspection

Lead paint inspections will be performed according to current Massachusetts Department of Public Health requirements by registered inspectors. The following forms will be used to record the needed information on all properties:

1. Adapted Massachusetts lead paint inspection forms
2. LFK interior deleading information form
3. LFK exterior deleading information form

Instructions for filling out these forms are as follows:

Make sure the address of each property is recorded on each page of each form and that the participant child's room is designated on the appropriate form. Also record which machine (PGT or Microlead) was used to measure the amount of leaded paint. The sides of the house will be labelled as follows: A - front, B - left, C - rear, and D - right. Window and doors in each room will be numbered from left to right. Window measurements should be taken from the header to the sill and from casing to casing. A list of definitions and abbreviations that may be used on these forms is attached.

Lead Paint Measurements

Lead in paint will be measured using x-ray fluorescence (XRF). Two different brands of XRF machines will be used to measure lead in paint for the deleading contractors: Princeton Gamma-Tech (PGT) XK-3 and Microlead. The two different brands will be used because they are the only machines that are available to the study and both are needed to conduct the inspections in a timely fashion. Only PGT XK-3 measurements will be used for the scientific study data since the two machines are not sufficiently comparable for research purposes

Differences between the machines are as follows: The possible measurements on the PGT range from 0 to 10 mg/cm^2 and those on the Microlead range from 0 to approximately 50 mg/cm^2. In general, the Microlead XRF reads leaded paint many more inches below the surface than the PGT does. When we tested the comparability of the two machines, we observed that repeated Microlead readings of the LFK conference room windowsill were 2.5, 2.2, 2.2 and 2.9 and repeated PGT readings of the same spot were 0.2, 0.7, 1.4, and 0.6. (Note: the first two readings were taken on one day and the second two readings were taken two days later).

XRF Machine Calibration

Both machines will be calibrated twice a day: once in the morning and again in the early afternoon. An XRF calibration form will be filled out each time a machine is calibrated (see attached). Calibration will involve making two sets of ten readings. The first set of ten readings will be done using a zero standard and the other set will be done using known lead standards of various levels (i.e. 1.45, 3.5 mg/cm^2).

XRK Machine Use in the Field

XRF readings of lead paint concentrations are read directly from the digital read-out on the machine. If the reading is 2.0 mg/cm^2 or less, three readings will be taken and the average will be recorded on the lead paint inspection form. If the inspector believes that there is lead present on a surface despite a negative or very low XRF reading, sodium sulfide will be used to test for leaded paint. The results of both the XRF measurement and the sodium sulfide test will be recorded on the inspection form.

XRF measurements will be taken on painted and on (non-vinyl) wallpapered surfaces. The determination of what constitutes an appropriate surface will be made by the inspector. Measurements will be taken on the interior and exterior of the participant's dwelling. The interior is defined as the apartment or living quarters of the LFK participant. The exterior is defined as the common hallways, stairs, entrances, porches, accessible basements as well as the exterior walls of the building. The exterior may also include any other buildings (i.e. garages) and fences on the property. Interior measurements will be taken on walls and woodwork including baseboards, windowsill, etc. in each room of the participant's unit. Ceiling measurements will be taken only if the paint on the ceiling is peeling.

Additional Deleading Information and Instructions

Besides taking the lead paint readings, the inspectors will record other pertinent information/instructions for the deleading contractors. Examples of such instructions are:

1. In general, baseboards will be made intact and capped with quarter round moldings. When lead painted decorative moldings are present, record the width that will be needed for replacement

2. When porch rails or other items require replacement, specify materials and workmanship common to the area. Also note that this will require further negotiation with the landlord.

3. Indicate whether the door and window trim are decorative or flat. Flat boards will be replaced with #2 pine. Decorative moldings will be dipped off-site.

4. Ceilings will be tested for lead only if they are peeling. If peeling ceilings are not accessible, note that they should be made intact on the comment sheet.

5. Lead painted basement windows wherever possible will be covered with plexiglass.

6. Measure rails and count ballisters on exterior porches.

7. Exterior window sills and wells will be covered with aluminum and caulked.

Lead Paint Measurements for Scientific Purposes

Since the Microlead and PGT XRF machines are not sufficiently comparable, only the PGT measurements taken by the lead paint inspectors will be used for the project's scientific data. Thus, only about 50% of the properties initially inspected will have measurements useful to test the study hypothesis. Once the lead paint inspectors finish gathering all the data needed for deleading, they will return to the properties where the Microlead was used to take the measurements and will re-take six measurements using the PGT XK-3.

The six measurements will re-taken in each of the following rooms since it is likely that the participant child spends most of his/her time there: the child's bedroom, the kitchen, and the living room. One measurement will be taken on the lower part of the wall and one on the window sill (i.e. woodwork) in each of these rooms. The calibration and

measurement procedures described previously will also be followed during this round of measurements. Special study data collection forms will be developed for recording these data. These same data will be abstracted from the inspection forms for the properties that were originally tested using the PGT.

Abbreviations and Definitions for Lead Paint Inspe[illegible]

n/a = not accessible
cov = covered
rep = replace
y = yes
n = no
dip = off-site removal of lead from surface by an approved
R & R = remove and replace (unless otherwise noted, the rep[illegible] will be #2 pine)
neg = negative
pos = positive
upper walls = walls above five feet
lower walls = walls below five feet
mit = make intact

porch = the area extending from the house, the wall the porch is attached to is the exterior of the house.

scrape = delead on-site

interior = the apartment or living quarters of only the LFK participant, excludes common areas within the building.

exterior = the common hallways, stairs, entrances and porches as well as the exterior walls of the building, and all other buildings and fences located on the property.

All other abbreviations are described on the individual forms.

Summary of 1989 and 1990 Soil Removal Projects

Soil Abatement was conducted on 36 properties in the Study group during the fall of 1989, and on 58 properties in the Control groups during the fall of 1990. The overall goal of the work was the same during the two abatements, however there are significant differences in how the work was carried out. This outline begins with a description of the general goals and methods during the two years, which is followed by a discription of what actually occurred in each case.

Objectives of Soil Abatement

The objective of soil abatement was to significantly reduce exposure to lead through soil on LFK project properties. This was achieved by removing most or all of the lead-contaminated soil from project yards, then replacing that soil with a layer of clean topsoil and sod. The initial plan was to remove six inches of soil, then test the remaining soil at a six-inch depth, and continue to remove soil until a level of under 500 ppm lead was achieved.

This approach called for on-site soil testing, to be carried out with all of the workers and equipment standing by for the results of the analysis. After a pilot testing of this method during the fall of 1989, it was decided that this approach was far too time-consuming to be practical, given the large number of properties to be abated. It was eventually decided that lead-contaminated soil would be removed to a set depth of six inches, and replaced with 8" of clean topsoil. The objective remained to eliminate childrens' contact with contaminated soil. This was accomplished through removal of most contaminated soil, followed by the addition of a thick protective layer of clean soil over whatever remained.

Description of soil removal process, fall 1989

Soil was removed, to a depth of 6", from all unpaved areas of the project properties, with the exception of gardens. In garden areas soil was removed to a depth of 12". Immediately after excavation a layer of geotextile fabric was put down over all excavated areas. This was done because there was a possibility of some contaminated soil remaining after excavation. The fabric is a non-woven polyethlylene/polypropylene material which is water-permeable and very durable. It has the appearance of a

thick gray felt. The geotextile served as a barrier between the clean soil and any remaining contaminated soil, and prevented mixing of the old and new soil.

Clean soil was spread to a depth of 8" over the geotextile fabric. In garden areas 16" of new soil would be spread. The clean soil was obtained by the contractor. It was tested for lead and other metals, volatile organic compounds, and other contaminants. Laboratory documentation was given to LFK indicating that no lead was detected in the soil, and that it all came from the same [illegible]ce. Where there was sufficient sunlight to support grass, the soil was covered with sod.

There were many yards where sod would not grow well due to insufficient sunlight. There were [illegible] many unpaved driveways and paths where the soil ha[illegible]bated, and something other than new soil and sod was needed to cover the geotextile fabric.

The solution for parts of the yard where grass would not grow was to use bark mulch, which is the shredded tree bark used for shrub beds and gardens in landscaping. In areas where bark mulch was used, 6" of clean soil would be put down, followed by 4" of bark mulch.

For driveways and heavily travelled walkways, gravel was

used. During the fall of 1989 the geotextile fabric was covered with 2" of soil, then 6" of gravel.

Site preparation

The [illegible]ion started well before the abatements. Homer Lopez, the abatement coordinator, attempted to meet with all of the property owners prior to abatement. He had mixed success, because he often found the owners difficult to reach. Homer also had the assistance of one site monitor. Many yards were found to have abandoned cars, trash, and other debris which had to be removed before abatement. This work was done in large part by ACP Cleaning, Inc., the contractor for the interior loose paint and dust abatements. Cars were generally moved off the area to be ab[illegible] procedure for having abandoned cars towed and dispo[illegible] was too time-consuming, so this was not pursued.

Health and Safety Plan

The health and safety plan served two purposes. First, it contained measures to prevent contaminated soil from being spilled outside the work area, or from becoming

airborne. Second, it protected the workers from lead exposure and accidents while work was being done. The plan was changed very little between the 1989 and 1990 soil abatements. The main difference was that respiratory protection was listed as required in the 1989 plan. It was found to be unnecessary after air monitoring was conducted on the first site abated in 1989, and was abandoned for the duration of 1989 and for 1990.

The soil was prevented from becoming airborne through frequent spraying with water during the excavation of the property. This worked well in most instances, as evidenced by air monitoring during the first few properties in the 1989 abatements. When the ground was very dry, as it was during the first days of the 1990 abatements, the ground needed to be watered for several hours the day before abatement was to take place. Very dry soil will become airborne even as a result of water being sprayed onto it unless the water is given time to soak in.

Safety measures for preventing soil from being tracked or spilled off-site consisted of establishing work areas, and surrounding the areas with plastic dropcloths. Decontamination areas were set up on the plastic, where workers would wash off, then remove, their boots and tyvek suits. The decontamination area consisted of wading pools filled with water, with scrub-brushes for the boots, and

trash bags for the tyvek suits worn by the workers.

The waste water from the decontamination pools was poured back into the area which was just abated, prior to the geotextile fabric being put down. Equipment such as shovels, rototillers, and Bobcat bulldozer blades and tires were hosed off in a place where the wash water would drain back into the work area.

Site Verification

Several different methods were use to verify that the appropriate amount of soil had been taken out. One method involved running a string between two reference points on onjects such as the edge of a sidewalk or a fencepost. By measuring down from the string to the soil surface before and after excavation a determination could be made as to how much soil was removed. This method was adequate for level yards, but for any uneven terrain it was not practical.

The technique that was used for most of the sites also involved using permanant features of the property as reference points. Orange paint was sprayed onto fenceposts, building foundations, and tree trunks at ground level, and notes were made on existing slopes and hills before excavation. In most yards this worked well, but it was

necessarily approximate on very uneven yards. In general, the contractor was urged to err on the side of taking out too much soil.

When the ground froze and heavy equipment was use for excavation, it was often impossible to take out less than 12" of soil, because large thick slabs of frozen soil would come up.

Soil Disposal

The ability to dispose of the lead-contaminated soil in a cost-effective manner was critical to the success of the project. During both years of soil removal this proved to be a difficult problem. A disposal site had been selected at Barry's Quarry in Hyde Park, Massachusetts. This was an inactive granite quarry which was being filled in for use as a cemetary. This site was ideal because it was very close to the project sites, and was not an area where anyone would be exposed to the soil. We began using this site in October of 1989. The owners of the quarry had bulldozers operating every day to change the grade of the property. The project arranged for our soil to be placed in a designated area of the site where it would be buried with un-contaminated soil from other parts of the quarry each day.

On November 3, 1989, the quarry was closed to our use temporarily, and we were left to scramble for an alternate disposal site. The soil was not considered a hazardous

waste by the Environmental Protection Agency or by the Massachusetts Department of Environmental Management. Still, it turned out to be difficult to find an alternate permanent disposal site. Most landfills in the area are closed. The landfills which are open are unwilling to accept lead-contaminated soil, because the operators of these facilities fear that by accepting the soil they would be exposing themselves to penalties under future regulations. It is in the nature of the disposal industry that material legally accepted by a landfill today might be declared hazardous tomorrow, with potentially costly results to the owner of the landfill.

The project resorted to using a temporary storage facility until access to the quarry was regained. The temporary disposal site was a parking lot at the Mattapan Chronic Care Hospital in Mattapan, MA. Permission to use the site was gained from the Commissioner of Health and Hospitals. The Project had a trench cut in the pavement, and installed a silt fence to prevent run-off. Plastic drop-cloths were used to cover the soil and to prevent dust being blown off the site. The parking lot was surrounded by woods on two sides, and an abandoned building on another. It was well within the grounds of the hospital, near a little-travelled road. The combination of the precautions taken to keep the soil in place and the remote location made

this a good temporary solution.

On December 2, 1990, permission was granted at a community meeting to resume use of the quarry. Soil from 14 properties which had been stored at Mattapan were moved to the quarry on December 7 and 8, 1989.

Overview of Fall 1989 Soil Removal

Several different abatement methods were used during the 1989 soil removal. The initial method was to loosen the soil with rototillers, then vacuum it into a truck using an industrial vacuum similar to what is used by municipalities to pick up leaves. The second method used was to dig up large areas with a Bobcat (brand-name) bulldozer, and use shovels for areas with narrow access. The third method was adopted for digging up properties after the ground has frozen. This calls for jackhammers to loosen the soil and backhoes to remove it. Paving parts of the property was another option used after the ground froze. This is an account of which properties were done with each method, with comments of the effectiveness of each method.

For the first two weeks of soil abatement, the soil was picked up using a truck-mounted (Supersucker) vaccuum. The

soil first had to be loosened with rototillers. This method was abandoned relatively quickly for a number of reasons. The soil had to be gathered into piles, then fed into the vaccuum. At best of times this meant handling each shovelfull of soil twice. After heavy rains the soil would be wet, and extra labor was needed to feed the soil into the vaccuum. Rental of the vaccuum itself was extremely expensive. The machine was so big that it could not move around the property, so all the soil from the back yard would have to be taken to the front to be fed into the machine. The following properties were abated using this method before it was abandoned.

2\4 Tupelo St. Dor. (double property)

7 Doris St. Dor.

5 Claridge Terr. Dor.

133 Seldon St. Dor.

17-19 Chilcott Pl. J.P. (double property)

2A Thane St. Dor.

Most of the properties were excavated using the Bobcat bulldozer combined with hand labor. The Bobcat was able to lift the soil into a dump truck with a capacity of 10 cubic yards. In areas of the yard which were done by hand, soil was dug out with shovels, then taken by wheelbarrow to a point where the Bobcat could scoop it up and place it in the

truck. This is definitely the preferred method for doing the excavation, because it can be adapted to almost any property. We were forced to stop using this combination when the ground froze in December of 1989. These are the properties which were excavated using Bobcat and hand-labor.

27-29 Mt. Bowdoin St. Dor. (double property)

62 Armandine St. Dor.

368 Park St. Dor.

75 Cheney St. Dor.

46 Ch[illegible] . J P.

126 Bird St. Dor.

23 Rockdale St. Mat.

60 Waverly St. Rox

671 Columbia Rd. Dor.

40 Mozart St. J.P.

12 Homestead St Dor.

42 Clarkson St. Dor.

47 Cameron St. Dor.

22 Darlington St. Dor.

27-29 Bowdoin St. Dor (double property)

78 Ballou St. Dor.

32 E. Cottage St. Dor

64 Idaho St. Mat.

The last twelve properties in 1989 were abated during an unusually severe cold spell that began in late November and continued through December. The ground quickly froze to a depth of over 14", which made it impossible to penetrate using Bobcats or hand tools. Jackhammer crews and backhoes were added to the work force. The work was very slow, and it became difficult to remove exactly six inches of soil. The backhoe would often remove a slab of frozen soil 12" thick and 10 square feet in area. The workday was shortened because the temperatures of -40 degrees Farenheit stressed workers and equipment.

During this period we offered some property owners the option of having part or all of their property paved with asphalt. We ended up paving one entire property and parts of three others. This provided at least as permanent encapsulation of soil as our normal procedure, and saved quite a lot of labor in excavation. Since we could not plant sod during this period, we settled for spreading grass seed on the new soil, then reseeding as needed in the spring. Decontamination procedures were cut back because water was not available. The properties abated in this way were as follows.

50 Elmore St. Rox.

46 Brook Ave. Rox.

52 Hewins St. Dor. (paved back yard, new soil in front)

45 Julian St. Dor. (paved driveway, new soil back and front)

67 Fayston St. Dor. (paved back yard, new soil in front)

124-126 Minden St. Rox. (entire area paved)(double property)

11 Dalrymple St. J.P.

26 Melbourne St. Dor.

34 Melbourne St. Dor.

406 Centre St. J.P.

3 Page St. Dor.

28 Charles St. Dor.

Fall 1990 Soil Removal

Description of abatement process, 1990

The general techniques used in the 1990 were similar to those used during most of 1989. The contractor used a Bobcat bulldozer to excavate large areas. Smaller areas were excavated by hand, and soil was wheelbarrowed to a place where the Bobcat could scoop it up and lift it into a

truck. On some occasions a rototiller would be used to loosen the soil in preparation for hand digging.

There were a few important changes from 1989. In place of gravel for driveways and walks, a better material, called "crushed bank", was used. This is a mixture of ground stone (or stone dust) and gravel. It forms a packed surface which is not subject to being scattered, as gravel can be. When this was used, a layer 8" deep would be spread over the geotextile fabric, then packed down with a compacting machine. It creates an attractive and durable gray gravel-like surface. This was used extensively [illegible] surface dirt paths and driveways.

Another important change was more organizational than material: We had a single contractor doing all of the work. A variety of types of contractors bid on the project, including landscapers, hazardous waste firms, and deleading firms. The contract was awarded to Franklin Environmental Inc., of Wrentham, MA. This company performs underground storage tank removals, hazardous waste removal and hauling, and asbestos work. Having one contractor made it much easier to have the landscaping follow the excavation promptly, and cleared lines of communication.

Preparations For Soil Abatement

The schedule for the soil abatement required that every property be prepared for abatement well in advance. Based on experience from 1989, it was clear that additional staff would be needed to do advance work and monitor abatement. An ad was placed in the Boston Globe for site monitors. Three site monitors, Jack Bonjura, Gary Ameral, and Joe Grillo were were hired on August 27, 1990. They started visiting properties to be abated and meeting with landlords. The following is a list of items to be addressed during site visits.

Note presence of:

Debris blocking access to yards
Locked gates
6 foot access for bobcat bulldozer
Dogs
Abandoned cars
Cars blocking access to yard
Bad traffic or busy intersections
Narrow streets
Access to outdoor spigot

Also obtain:

Preferences of owner for sod, crushed bank, bark mulch
Plan for access to water if not available outside
Drop off letter explaining process to owner
If owner does not want soil removal, obtain signed cancellation form

Health and Safety

There were two major changes in the health and safety plan from 1989. One was that respirators were not required at any time for workers, and hardhats were required for workers when the Bobcat was in operation. Respiratory protection had been required in 1989 until air monitoring revealed that the dust generated by abatement was negligible.

Procedures for monitoring\verifying soil removal

One of the most persistant problems with the soil removal during the fall of 1989 was how to verify that 6" of soil was removed from the site. Various methods were tried last year, including spray-painting benchmarks on building foundations, fence posts, and other permanent structures. None of these methods proved entirely satisfactory for uneven ground.

On the first property to be abated, we started off using marked stakes in several parts of the yard. Most of the stakes did not survive the first hours of the Bobcat moving around the yard. We ended up using our prior estimate for the number of cubic yards to be removed, and comparing this with the number actually taken out. While this matched quite well, it was clear that there had to be a more substantive way to verify the depth of soil removed. We decided to try using a transit level and taking measurements before and after abatement. On August 13 we rented a transit level and began using this for site verification at 52\54 Bowdoin Ave. Dorchester, using the following method.

First we would select a benchmark in a location where no abatement was to take place, such as the sidewalk in front of the house. We would place a measuring rod, marked in tenths of a foot, on the benchmark and set up the level some distance away. Once the transit level was set up, we would note the elevation of the level using the measuring rod. We would then spray orange paint on the benchmark for future reference. We would then place the measuring rod on various locations around the property and take readings of the elevations before abatement. These elevations would be noted on the map of the property.

When excavation was nearly complete, we would again set

up the transit level at the same elevation(to make the math easy) using the benchmark. We would check the elevation of the ground in the places measured before abatement. If the surface was 0.5 ' lower than when we started, that area was excavated to the proper depth. If further excavation was needed it would be done immediately while the level was set up. In this way we were able to assure that the proper amount of soil was removed without making the contractor return to a site and set up their equipment again.

This is definitely the best way to verify the depth of soil removed. Unfortunately, we were not able to do this with every site. In some cases there was no place to set up the level. In other cases the site monitors were occupied with other tasks and were not available to check a property. (Two people are required to use the transit level.) We finally settled on checking at least every fifth property with the level, and using the estimated number of yards to be removed on the others. These two methods agreed extremely well. Often our estimate was within one or two cubic yards of the actual amount removed.

Soil Disposal

We had planned to dispose of our soil in Barry's Quarry in Hyde Park, MA., as we had done in 1989. Once again we discoved in August that our disposal site was not accepting material. It appeared that the site had been closed to dumping due to a problem with an unstable slope of material which was threatening to fall into the back of a shopping center. We delayed the start of the project by one week while we searched for alternative sites and worked to gain access to Barry's Quarry. Franklin Environmental Services, the contractor for the job, pushed it back another week. The work finally began on September 10, 1990.

Jack Bonjura, one of the site monitors, obtained tentative permission to use the Holbrook Rifle Club grounds as a disposal site for our soil during a club meeting on August 28, 1990. The Rifle Club needed soil to build up berms behind their rifle ranges which had become worn down over the years. The existing berms had large quantities of lead in them from many years' accumulation of bullets being fired into them. The site was away from homes and schools, and was kept locked. It appeared to be an ideal disposal site.

Preliminary estimates of the cost of using Mattapan as a

staging area and shipping soil to Holbrook indicated that it would be extremely expensive. We tentatively budgeted $30,000.00 for this purpose, and it was unclear whether this would be sufficient. In the meantime, we continued to press for the reopening of Barry's Quarry in Hyde Park.

We eventually received permission to use an area of the site which was well away from the slope. We were told that we could use the quarry on October 1, 1990. This year the quarry owners did not have bulldozers operating on the site, and the Project had to rent a bulldozer to cover the contaminated soil. One of the site monitors was a liscensed bulldozer operator, and he covered the soil between 3 and 5 times per week.

While the quarry was closed, we once again used a parking lot in the Mattapan Chronic Care Hospital as a temporary storage area. This involved repairing the silt fence to contain run-off from the site. This year, we used heavy-duty tarps to cover the soil, and weighted them with tires to keep them from blowing away. On October 4 we moved the soil from Mattapan to the quarry. In the following weeks we cleaned the Mattapan site and had the trench in the pavement repaired.

Overview of 1990 soil removal

During the fall of 1990 lead-contaminated soil was removed from 58 residential properties in Dorchester, Roxbury, Jamaica Plain and Mattapan.

The schedule for the fall 1990 soil removal included 63 separate sites. Two of these were considered "double properties" because they were much larger than average. The planned start date for this project was August 27, 1990. The planned finish date was November 16, 1990. This meant that an average of five properties per week had to be abated. The original schedule called for the soil removal to be done soon after the last blood sample was taken and after the exterior deleading was complete. The schedule of five properties per week was almost maintained, in spite of several difficulties which caused delays at various points during the project.

Three site monitors were employed to assist with the soil removal. Their duties were meant to be limited to contacting property owners in preparation for the soil removal, and watching each site as work went on to ensure that work was being done according to the specifications.

When Barry's Quarry was openned to us, we needed to have a bulldozer covering over the soil on a regular basis. One of the site monitors, Gary Ameral, was a licensed heavy equipment operator. We rented a bulldozer, and Gary spent much of his time at the quarry covering over the soil as it arrived.

Soil removal began on September 10, 1990. The first day the crew from Franklin consisted of four people. The foreman was operating the Bobcat, and the other three laborers were digging. It was a large site, and this was obviously an inadequate number of people. Franklin quickly rectified the situation, and the crew size ranged from 6 to 12 people, and averaged 8 or 9. This typically included a foreman, who coordinated movement of mat[illegible] and people, a truck driver, a Bobcat operator, and about 5 laborers. The contractor would work on as many as four sites at once. Often four sites would be excavated in two to three days, then they would all be landscaped in another two days.

The sites varied in size and difficulty. Some sites had to be abated entirely by hand, because there was no access for the Bobcat. This meant taking all of the soil out by wheelbarrow, and bringing all of the clean soil back in by wheelbarrow. Fortunately most sites were a combination of areas that could be done by Bobcat and smaller areas to be done by hand.

There were only a few minor delays after the start date. The last property was abated on December 11, 1990. The average time it took to complete one site was about a day. The largest sites took two to three days.

The following are the addresses of the properties which were scheduled to be abated during the fall of 1990.

102 Geor[illegible] St Rox.

79 Church St. Dor.

104 Devon St. Dor. -----Dropped out

73 Topliff St. Dor.

11 Emrose Terr. Dor.

30 [illegible] . Dor

1 Lynnville Terr. Dor.

20 Minot St. Dor.

15 Morse St. Dor.

36 Theodore St. Dor.

68 Clarkwood St. Mat.

31 Hiawatha Rd. Mat.

11 Landor Rd. Mat.

79 Barry St Dor.

15 Bellflower St. Dor.

70 Bloomfield St. Dor.

7 Capen St. Dor.

95 Dakota St. Dor.

54 East St. Dor.

43 Hutchings St. Rox.

12 Jerome St. Dor.

11 Homes Ave. Dor.

13 Ridgewood St. Dor.

142 Spencer St. Dor.

6 Winter St. Dor.

200 Boylston St. J.P.

6 Hosmer St. Mat.--------Dropped out

52 Bowdoin Ave. Dor.

10 Erie Pl. Rox.

74 School St. Rox.

99 Adams St. Dor.

7 Kenberma Rd. Dor.

10 Gannett St. Dor.

53 Woolson St. Mat.

39 Woodbine St. Rox.

28 Ballou Ave. Dor.

117 Hancock St. Dor.

37 Standish St. Dor.

33 Thetford Ave. Dor.

578 Warren St. Dor.

24 Algonquin St. Dor.

47 Aspinwall Rd. Dor.

46 Clarkson St. Dor.

6 Dahlgren St. Dor.

8 Elwyn Rd. Dor.

20 Fairmount St. Dor.

20 Faulkner St. Dor.

26 Fernboro St. Dor.----Dropped out

37 Humphreys St. Dor.

14 Inwood St. Dor.

10 Johnston Rd. Dor.

28 Mt Ida Rd. Dor.

24 Salcombe St. Dor.

83 Sumner St. Dor.

130 Talbot Ave. Dor.

43 Wilcock St. Dor.

64 Williams St. J.P.

26 Temple St. Mat.

16 Rockland St. Rox.

1745 Dorchester Ave. Dor.

3 Trull St. Dor.

I

Y

APPENDIX B

LEAD FREE KIDS DEMONSTR[illegible]ECT

SOIL SAMPLING AND [illegible]

SAFETY PLAN

BOSTON, MASSACHUSETTS

MARCH 1989

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A. EMERGENCY PHONE NUMBERS

In the event of a medical emergency, the Field Supervisor or designee will notify the appropriate authority. The following list of phone numbers will be completed and distributed to all supervisory personnel.

1. Fire _____

2. Ambulance _____

3. Hospital _____

4. Lead-Free Kids Project Contact:

   Natalie Zaremba (617) 424-5970

5. EPA Contact: David McIntyre (617) 860-4363

   EPA 24 hour hotline (617) 223-7265

6. Poison Information:.

7. Site Abatement Contractor:

B. DIRECTIONS TO THE HOSPITAL

The LFK Project will distribute to all supervisory personnel as part of this Safety Plan a base map of the City of Boston with area hospitals identified. It is the responsibility of the Field Supervisor to identify the nearest hospital and determine the most timely route between the work site and the hospital.

C. INTRODUCTION AND PROJECT BACKGROUND

The Boston Lead-in-Soil Demonstration (Lead Free Kids (LFK) Project is a major epidemiological study authorized under the 1986 SARA Amendments to determine if the removal of lead contaminated soil from inner city neighborhoods is an effective preventive treatment for lead poisoning in young children. The project will involve measurement of blood lead levels of participating children, removal of approximately six inches of lead contaminated soil from their properties, and continued measurement of blood lead levels over a one year period to see if they decline. Further information is available from the project office at 20 Church St 3rd Floor, Boston, MA, 02116 or by calling (617)426-8686.

D. LEAD HAZARDS

Exposure of humans to lead occurs predominantly through ingestion or inhalation of lead dust and/or fumes. Acute exposure is most common in children with history of pica (mouthing of non-food items). Acute exposure symptoms include anorexia, vomiting, malaise, and convulsions due to increased intercranial pressure. Chronic exposure in children results in weight loss, weakness, anemia, permanent learning disabilities, and permanent brain damage. Lead poisoning in adults is usually occupational due to inhalation of lead dust or fumes. Exposure can result in toxic effects to the brain, central and peripheral nervous system, gastrointestinal tract, kidneys, and hematopoietic system. Peripheral neuropathy also results from lead poisoning.

E. PURPOSE OF PLAN

The purpose of this plan is to assign responsibilities to field personnel relative to safety and site security, establish personnel safety and protection standards, state mandatory safety operating procedures relative to physical and chemical hazards encountered on the properties, distinguish various zones of contamination, establish decontamination procedures, and provide for contingencies which may arise during the course of this project.

F. APPLICABILITY

This Plan addresses the safety procedures that will be followed by any and all soil abatement personnel involved in this project. All contractor supervisory personnel or other personnel specified by LFK who enter the work sites shall read and sign this safety plan. It does not supersede any Federal OSHA or state and local regulations but it is in addition to them. In the event of a conflict between this Plan and a regulation, the more stringent of the two will be enforced. The Plan is in accordance with, and refers to, the terminology used in the Office of Emergency and Remedial Response (OERR), <u>Standard Operating Safety Guides.</u>

G. RESPONSIBILITIES

1. <u>Field Supervisor/Safety Officer</u>

During this project, the primary Field Supervisor responsibilities relative to safety include the following:

a. to ensure that all personnel allowed to enter the work site are aware of the potential hazards associated with lead in soil;

b. to ensure that said personnel are aware of the provisions of this plan and are instructed in the safety practices defined in the plan, including its emergency procedures;

c. to ensure that the appropriate safety equipment is available and properly utilized by all personnel on site;

d. to direct the safety monitoring efforts of the Site Safety Officer; and

e. to correct any work practices or conditions under his control that may result in exposure to hazardous substances or injury to personnel.

In accordance with EPA's Occupational Health and Safety Manual as ordered by the Executive Order 12196: "The Safety Officer is responsible for implementing the safety plan on the site".

During this Project, the primary Safety Officer responsibilities include the following:

a. monitor compliance of workers relative to pre-established personnel protection levels (i.e., use of necessary clothing and equipment to ensure the safety of personnel); and

b. evaluate weather, lead, and other hazard information, and if necessary, modify work plans and personnel protection levels to maintain personnel safety.

The Field Supervisor/Safety Officer for this project is

John B. Hoskins (Bart), or designated LFK staff

H. SAFETY PROCEDURES AND LEVEL OF PROTECTION

1. <u>Training</u>

Personnel will have either formal training or on-the job training for those tasks they are assigned to perform on site.

2. General Safety Rules and Equipment

a. Do not work alone when performing tasks in areas that require protective clothing unless the work will be of short duration and another person has been informed of your location, or while performing any task that could be potentially incapacitating.

b. There will be no eating, drinking, or smoking in the Exclusion Zones (see below).

c. A first-aid kit will be on-scene at all times during operational hours.

d. Parking of vehicles should be in accordance with City of Boston ordinance.

e. No work will be performed at properties during hours of darkness unless adequate lighting is provided.

f. All personnel shall use caution and wear hard hats when working near heavy equipment in compliance with OSHA 26 CFR 1926 Subpart O.

g. No unauthorized personnel will be allowed on site during sampling/construction activities.

h. Overnight storage of soils in dumpsters shall require dumpsters to be secured.

i. All equipment will be secured at the end of day to prevent injury to the public.

j. Any steep changes in grade shall be properly flagged or marked to alert the public.

k. Any excavations deeper than 18 inches will be filled at the day's end.

l. Soils being removed from the Exclusion Zone (see below), and/or present in the Clean Zone accessway will be kept wetted during abatement to minimize off-site migration of particles. Soils inadvertently spilled or carried into the accessway, sidewalk, or area outside of dumpster shall be cleaned up daily.

3. Site Access

Site access must be controlled to eliminate the risk of spreading contaminants and to protect the public. Access will be the responsibility of the ranking supervisory person on site (Field Supervisor/Safety Officer, etc.)

4. Designation of Work Zones

Generally, each site will be divided into two zones. However, specific situations may arise in which a single site may have multiple zones due to its layout:

a. The Exclusion Zone (EZ) shall be that area which is known to be or has a potential for becoming contaminated, during the sampling phase, the entire site shall be considered the EZ and treated as such. In addition, the soil dumpster, which will be located on the street, will be considered part of the EZ.

b. The Clean Zone (CZ) shall be any area which is not contaminated due to abatement activity.

Should travel through a portion of the CZ be required to access the EZ, special care must be taken to minimize contamination to this accessway. Any contaminated soil which inadvertently is deposited on the accessway (or other clean areas) through accidental spillage, or on the tires of equipment, etc., shall be removed from the accessway and deposited in the soil dumpster. Any soil inadvertently deposited on the sidewalk or outside of the dumpster, shall be collected and deposited in to the dumpster. That area deemed Clean Zone Which will not be used as access shall be flagged or otherwise marked, and not entered.

5. Personnel Protection

Personnel protective equipment and safety requirements must be appropriate to protect against the known or potential hazards of a site. Prior to sampling and analysis on this project, it is assumed that lead from the weathering of lead-bearing paint is present in the soil and is the sole contaminant at the properties. There has been no indication that other contaminants have been deposited. Protective equipment has been selected based on the concentrations and possible routes of personnel exposure to lead contaminated soils, and on physical (earth moving, etc.) hazards likely to be encountered.

The main route of exposure to site workers other than to be in direct contact with the soil is through dust.

The typical, nonhazardous particulates which are present in ambient air, such as soils, etc., are considered nuisance dusts. According to the American Conference of Governmental Industrial Hygienists (ACGIH), nuisance particulates (also known as nuisance dusts) are those particulates which, when inhaled in excessive amounts, have little adverse effect on lungs and do not produce significant disease or toxic effects when exposures are kept under reasonable control. The lung tissue reaction caused by inhalation of nuisance dusts has the following characteristics:

the structure of the air space remains intact;

scar tissue is not formed to significant extent; and

the tissue reaction is potentially reversible.

Ten (10) mg/m3 of total dust with less than 1 percent quartz is the recommended threshold limit for substances considered nuisance dusts.

Although 10 mg/m3 of dust in air is typical of a normal indoor work area, it will not be reached in typical outdoor ambient air situations. Using it for ou[illegible]imates therefor provides a safety margin. Also, excavat[illegible]il be moistened throughout the excavation proc[illegible], thus minimizing particulates in air.

By knowing the concentration of soil lead at a property and estimating the airborne dust level, it is possible to calculate the concentration of lead-bearing dusts which could be present. At residential properties in Boston which were previously sampled and analyzed, the average concentration of lead in soils was 4000 ppm or less. (An anomolously high value of 16,000 ppm was detected at one site but will not be use[illegible] these calculations because the soil lead concentrations on [illegible] project will be known prior to abatement, allowing appropriate adjustments to be made if necessary).

The 1986-1987 ACGIH time-weighted average (TWA) value (allowable value) for worker exposure to lead dust and fumes during a ten-hours work day is 0.15 mg/m^3, or 150 ug/m^3.

If 10 mg/m^3 of dust is presumed to be present in the air at the Lead Free Kids sites, multiplying this by 4,000 ppm, or 4 ug/mg, gives 40 ug/m^3 . This is less than one third of the TWA value of 150 ug/m^3 per 10 hour day recommended by the ACGIH.

6. Selection of the Level of Personnel Protection

As a result of the above analysis and field monitoring results from similar projects, Level D protection has been

selected as the entry level of protection for this project. Samplers operating prior to abatement may use street clothes. Subsequent information may result in changing the originally specified level. The following equipment shall be used in this level:

<u>Personnel Protective Equipment</u> - Level D

Coveralls or work clothes. Workers shall not work in street clothes;

Leather work boots - with steel toes and shank;

Overboots, unless exempted by the Safety Officer; and

Hard [illegible] [illegible]ional when no earth moving equipment is in use)

<u>[illegible]</u>

no significant indication of airborne health hazards present;

work functions preclude splashes, immersion, or unexpected inhalation of any hazardous substance; and

none of the criteria for using level of protection A,B, or C is met.

7. <u>Alternative Levels of Protection</u>

The site safety Officer may determine if alternate levels of protection are necessitated under adverse site conditions. Should this occur, the protocol will follow procedures outlined in U.S. EPA <u>Standard Operating Safety Guides.</u>

I. DECONTAMINATION PROTOCOL

T[illegible]tion procedure shall be communicated to employees and [illegible]ed before any employees or equipment may enter areas on site (EZ) where potential for exposure to hazardous substances exists.

The decontamination procedures shall be monitored by the Field Supervisor/Safety Officer.

All equipment or supplies used for decontamination shall be decontaminated or disposed of properly.

Protective clothing and equipment shall be decontaminated, cleaned, laundered, maintained or replaced as needed to maintain their effectiveness.

Commercial laundries or cleaning establishments that decontaminate protective clothing or equipment should be informed of the potentially harmful effects of exposures to lead.

The decontamination protocol will be adhered to by all personnel exiting the EZ.

Decontamination Steps for Personnel:

1. Employees whose clothing becomes soiled shall brush off excess soil while in the EZ.

2. Proceed through the boot brush-off area (at the edge of the EZ.)

3. Wash hands.

4. Change clothes prior to departing for home.

Decon Steps for Equipment:

1. Equipment decontamination shall be accomplished by rinsing equipment with water in the EZ to remove soil particles. Care should be taken to ensure that the rinse water does not enter the Clean Zone.

2. Soil deposits resulting from equipment decontamination shall not be left on the surface. They shall either be removed to the dumpster or covered by replacement soil.

J. HEAT STRESS

It is the duty of the Safety Officer, or his designee, to see that heat stress does not occur in site personnel. As a result, full cooperation by all such personnel will be given at all times. All personnel will be familiar with, and abide by, the following information so that the problem of heat stress does not arise. Instances of uncooperativeness will be reported to contractor and LFK management for resolution.

Following the guidelines for prevention and monitoring given below will greatly minimize the possibility of heat stress. However, personnel will be aware of the symptoms of the various forms of heat stress, and be able to readily carry out treatments, also noted below.

1. Prevention

a. Provide plenty of liquids. Available at temperatures above 85F will be a 0.1 percent solution of salt and water, a 50 percent solution of fruit punch/juice or the like in water, plain water to be taken with salted foods such as pretzels, potato chips, or the like, or other suitable noncarbonated liquids.

b. Work in pairs. Activities requiring vigorous physical exertion in unshaded areas on days when the temperature exceeds 85F should not be accomplished alone.

c. Adjustment of the work schedule. As is practical, the most labor intensive tasks should be carried out during the coolest part of the day.

2. Recognition and Treatment

Any personnel who observes any of the following forms of heat stress, either in themselves or in another worker, will report this information to the Field Supervisor/Safety Officer or ranking site person as soon as possible.

a. Heat Rash (or Prickly Heat)

Cause: Continuous exposure to hot and humid air; aggravated by chafing clothing.

Symptoms: Eruption of red pimples around sweat ducts accompanied by intense itching and tingling.

b Heat Cramps (or Heat Prostration)

Cause: Profuse perspiration accompanied by inadequate replenishment of body water and electrolytes.

Symptoms: Sudden development of pain and/or muscle spasms in the abdominal region.

Treatment: Remove the worker to the Clean Zone. Decrease body temperature and allow a period of rest in a cool location.

c. Heat Exhaustion - SERIOUS

Cause: Over-exertion in a hot environment and profuse persperation accompanied by inadequate replenishment of body water and electrolytes.

Symptoms: Muscular weakness, staggering gait, nausea, dizziness, shallow breathing.

Treatment: (Perform the following while simultaneously making arrangements for transport to a medical facility.) Remove the worker to the clean zone. Lay the worker down on his or her back, in a cool place, and raise the f[illegible] to 12 inches. Loosen all clothing. If conscious, provide s[illegible] f a salt water solution of one teaspoon in 12 ounces. Transport the worker to a medical facility.

d. Heat Stroke - EXTREMELY SERIOUS

Cause: Same as heat exhaustion

Symptoms: No Perspiration, dry mouth, pain in the head, dizziness, nausea.

Treatment: (Perform the following while making arrangements for transport to a medical facility.) Re[illegible] worker to the Clean Zone. Lie the worker down in a cool [illegible] raise the head and shoulders slightly. Cool without ch[illegible] Apply ice bags or cold wet cloths to the head. Sponge [illegible] skin with cool water or rubbing alcohol. If possible, place the worker in a tub of cool water. Do not give stimulants. Transport to a medical facility.

K. EMERGENCY CONTINGENCY PLAN

1. Procedures for Handling Emergency Incidents

The Field Supervisor shall identify, to the extent possible, all hazardous conditions present at each of the properties entered.

Based on the hazardous conditions prese[illegible] Field Supervisor shall assure that the personal protective equipment worn is appropriate for the hazards to be encountered. No provisions have been made for entering sites that require a level of protection of "C" or greater. Should observations indicate an entry to the site requiring greater than Level "D", entry will not be made.

When activities are judged by the Safety Officer/Field Supervisor to be unsafe and/or to involve an imm[illegible] danger condition, then he/she will suspend or terminate those [illegible]ities. The Safety Officer/Field Supervisor will immediately inform the LFK management of any actions taken to correct these hazards during emergency operations.

L. Signatures

Contractor supervisory personnel working on-site in any capacity and any other personnel ordered to by the Field Supervisor/Safety Officer are required to read this Safety Plan and verify that they understand and will comply with its contents by signi[illegible]w.

NAME [illegible] IZATION DATE

1. _____

2 _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

10. _____

11. _____

12. _____

13. _____

14. _____

15. _____

16. _____

17. _____

18. _____

19. _____

20. _____

M. APPROVAL PAGE

I approve this Safety Plan for the Lead in Soils Project in Boston, Massachusetts. It adequately provides for the health and safety of persons who will or may be affected by soil sampling and abatement operations.

_____ _____

David McIntyre Date

Project Manager
Environmental Services Division
U.S. EPA Region I

_____ _____

John L. Christian Date

Vice President and General Manager
Trustees of Health and Hospitals
of the City of Boston, Inc.

April 10, 1991

LFK
LOOSE PAINT
AND
DUST ABATEMENT
PROJECT SUMMARY

Loose paint and dust abatement was performed between October 5, 1989 and January 1990. A total of approximately 129 households were involved. 89 units received loose paint and dust abatements. 40 units received loose paint only. Pre/post sampling was done in eight units that received only loose paint abatement and in fourteen units that received both loose paint and dust abatement.

It became apparent early on that the processes involved in the interior abatements were going to be more time consuming and complicated than one would expect. Also, after close examination of the exterior pilot project, it was decided that the benefits to be gained did not justify the cost and there were interior revisions being made that would require additional expenditures. Cancellations and postponements of the interior work, resulting in the need to reschedule, were common. The LFK Staff attempted several different strategies to limit the number of cancellations but little improvement was realized. All scheduled work was reconfirmed twice and attempts were made to have "backups" that could be used to fill openings in schelules made by cancellations. (see attached memos describing cancellations and associated fees)

Occupants were required to be out of their homes during abatement activities. Many families attempted to cancel because they had no where to go during the several hours it took to perform the abatement. Incentives were offered to participant families to provide entertainment or an activity for them to partake in. Transportation was also provided by LFK. Families were offered lunch at McDonalds and arrangements were made to provide access to the Children's Museum, the New England Aquarium, The Tropical Rain Forrest exhibit at the Franklin Park Zoo, or admission to the Museum of Science.

Two LFK case managers supervised all on-site abatement activities and used documentation forms to record progress.

ACP Cleaning Inc. was the Contractor that performed all interior abatement activities. Their multi-lingual staff

was extremely helpful in translating and communicating with many participant families.

Twenty-two units were sampled before and after the abatement processes took place.

The project coordinator collected all samples. 44 site visits were made to accomplish this. Each site visit took aprox one hour.

The total number of samples collected was 132. Cost of analysis was $15 each. Materials for sample collection were $2.00 each.

Comparisons of pre-post samples:

Analysis of samples was reported in micrograms per sqare foot.

What follows combines results from both processes, loose paint (8 units) and loose paint/dust (14 units)

Each sample set included a one sq ft area on the floor, a measured window sill and a measured window well.
66 pre- samples and 66 post samples were taken: 22 sets of pre samples and 22 sets of post samples.

Twelve post samples showed little or no change (18%)

Ten post samples showed an increase in pb content (most of these increases were slight) the average increase was 100 ug/sq ft (15%)

Forty-four post samples showed a significant reduction in lead content (average reduction was 2787ug/sq ft)(67%)

Two thirds of the post sample results showed a significant inprovement due to the methods involved. (can this be compared with the deleading final sampling results to show any real comparison of methods?)

Loose paint and dust abatement appears to be a valid means of reducing the readily available lead hazard in a child's living environment.

attachments :

specifications
site documentation form
cancellation memos

APRIL 10, 1991

3

Cost Report - Lead Free Kids
February 25, 1991

Cost of Interior/Exterior Abatements

Development: The abatement procedures were developed by the Project Investigators and the Project Administrator as part of the initial Project planning. Their time was not tracked on this development. Trustees assisted the Project with the bidding process and securing a contractor.

Exterior Abatement:

Abatement work - 8 units @ $528/unit	$ 4,224
-the work was discontinued due to the small amount of benefit and the need to utilize additional funds on the interior work.	
Pilot cost:	$ 525

Interior Abatement:

Interior Dust and Loose Paint Abatement:	
Abatement work - 84 units @ $ 873	$73,332
4 units @ $1,748	$ 6,992
1 units @ $1,310	$ 1,310
Total	$ 81,634
Pilot Cost:	$ 873
Cancellations (time & materials)	
9 units @$873	$ 7,857
Interior Loose Paint Abatement Only:	
Abatement work - 32 units @ $ 499	$ 15,968
8 units @ $ 988	$ 7,904
Total	$ 23,872
Cancellations (time & materials)	
4 units @ $499	$ 1,996

Preparation time: 407.25 hours @ $20/hour $ 8,145

Participants were expected to prepare their units for work to commence on interior abatements. This routinely did not occur, therefore, after a short time the Project paid the contractor to prepare the unit at a labor charge of $20/hour. This work entailed moving all items to the middle of the room and making abatement preparations possible. These two activities were distinct.

Monitors:

Case managment staff monitored all interior abatement work. Check lists for compliance were maintained on all work.

**One full-time Interior Abatement Coordinator oversaw every detail of the work from August 1989 - January 1990 @$15,832

Total Direct Costs for Interior/Exterior Contract and management-$144,958

April 10, 1991

LEAD FREE KIDS
DELEADING PROJECT
final report
Summary

Deleading was originally offered to 125 households. Thirty of these households either moved or refused to have an inspection performed. Refusals of inspections were generally due to the legal obligation to delead the owner would be under after an inspection detected lead paint.

(the dates of the offers and refusals are not easily retrieved from files - refusals occurred throughout the project - deleading was first offered to participants upon recruitment.)

The 95 remaining units were given full inspections for lead paint. Six of these units had been previously deleaded and 32 refused deleading after inspection (when faced with the move and disruption). 7 refused deleading after bids went out. The reasons for refusal included 1) unwillingness to prepare for the move, 2) disruption to lifestyle, 3) children were in school and transportation would be complicated, 4) commute to work would be difficult.

A total of 92 deleading operations at 50 locations were accomplished within a five month period under the LFK program. Work started on August 20, 1990. All of the work that could be considered actual "deleading" was finished by December 31, 1990, but punch list items and other loose ends brought the project completion date to February 14, 1991. Forty-five deleading compliance letters were issued at the program's end.

The vast majority of deleading involved a single unit within buildings having two or more living units. However, only four of the addresses involved deleading of 2 units within the same building. Four of the participants families were from single family houses.

There were three addresses that were non-owner occupied. LFK offered to pay up to $ 2000.00 per unit for these. One owner, who had two units at the same address, chose to hire his own deleading contractor to perform the work. LFK paid $4,000 directly to the contractor and monitored the deleading activities in the same manner as the rest of the project. The remaining two non-owner occupied addresses involved the LFK contractors.

One non-owner occupied address was not issued a deleading compliance letter because only the building's exterior was

deleaded under the LFK program. Although the LFK family's unit had been previously deleaded, it was done under an older version of the law and was only to four feet. The law does not permit issuance of a certificate for exterior deleading only and does not provide for grandfathering of work performed under the old law.

In one dwelling, (the only household where no compliance certificate was issued although both interior and exterior deleading was completed) the children's access to the basement was prevented due to a locked door on initial inspection. During the final inspection this door was found to be open and was used as an entrance to office space that had been recently opened up by the owners. The LFK inspectors would not issue a compliance letter because this allowed children access to an area that had not been previously inspected. The owners must now have this area inspected, and deleaded if necessary, in order to obtain a compliance letter. Unfortunately, Lead Free Kids will not be involved in any further inspection or deleading activities so this responsibility is up to the owners. This was the only unit that was deleaded for which LFK could not issue a letter of compliance. The total number of compliance letters was 45.

Weekly progress meetings that were held at the LFK office were extremely helpful. Contractors, inspectors and the

deleading coordinator made up the core of this meeting and whenever necessary, other members of the LFK staff would attend to bring up issues or problems that required attention. This forum was used to update all changes in field activities, schedules moving issues etc., and to keep inspectors, contractors, and the project coordinator informed of other changes that were required to make things flow in the order that was expected. Many problems were resolved and avoided as a result of these meetings.

EXTERIOR DELEADING:

Exterior deleading work involved four separate deleading contracts addressing 46 exterior deleading operations addresses. This work included all common interior areas as well as other buildings on the properties. Exterior window sills were considered part of the exterior work except in the LFK participant unit(s) where they were addressed from the interior of the apartment. Deleading compliance letters were issued for only 42 of the 46 exterior addresses . The owners and occupants at 4 of the addresses declined to have interior deleading done and the law prohibits issuance of compliance certificates for exterior deleading work only.

Exterior deleading ranged from 1 day to 41 days. 1156 days were involved in the exterior operations at 46 sites. The average exterior deleading time was 25 days. These figures include all of the work activities performed on the exteriors, including non-hazardous finish work.

All four of the exterior contracts were completed within the scheduled time frame that was prepared by LFK in order to provide sufficient time to accomplish the soil abatement following exterior deleading but bef[illegible] ound started to freeze.

Exterior deleading work did not require occupants to move or relocate. All work was performed without interruptions to any of the building's occupants excep[illegible] for requiring alternate access when stairways were being worked on.

No exterior deleading took place when a property was undergoing soil removal or landscaping. It was the responsibility of the contractor to ch[illegible] the soil abatement schedule to make sure exterior deleading work did not interrupt the soil work.

Lead painted surfaces above five feet were freed of loose or peeling lead paint and given a primer coat of paint. Priming of any new construction and application of

finish coats of paint were the owner's responsibility.

Common hallways, inside multi-unit buildings were considered part of the exterior. The contractor was responsible to inform other building occupants of the work activities occurring in these areas and to make sure alternate access rules were observed. HEPA exhaust units were installed at the entrance to the building on the first floor [illegible] barriers were set up to make sure that the [illegible] area was isolated and that no contamination could be spread outside of the work area. A warning sign, as required by the Massachusetts Lead Law, was affixed to the outer flap of the containment area entrance. Work in the common hallways/staircases began on the top floor and proceeded down to the first floor level. Deleading was performed according to the methods developed specifically for the LFK Project and were monitored by the program's inspection team to insure compliance.

INTERIOR DELEADING:

Interior deleading involved the inside of the living units of the program participants only. (common areas within the building were excluded) Exterior window sills of the LFK participant units were included in the interior

deleading. The unit's occupants and all of their belongings had to be relocated for the duration of the interior deleading work. A moving contractor was hired by LFK to remove the occupant's belongings and furniture prior to the deleading contractor's arrival at the site. All belongings were bombed to exterminate insects and placed into storage for the duration of the deleading. Damages caused as a result of the movers were amended in some way prior to final release of a 15% retainer .

The moving contractor billed additional charges for items that remained in storage for over 7 days at a rate of $6.00 per household per day. Additional storage ranged from 1 day per household to 43 days. 41 households were moved under the moving/storage contract. (five households did not require moving assistance.) 391 extra storage days were charged totaling $2,346. Extra storage time averaged 9.5 days per household.

If a site was not prepared on the scheduled start date it was to be eliminated from the deleading project. This rule was bent about as far as possible on several occasions. Case managers and contractors occasionally would be helping families pack as the moving truck arrived. In a five instances, extra charges were incurred when it was necessary to cancel moving due to the occupants being unprepared. The cost for these cancellations was $1,800. There was only one

last minute cancellation required by LFK that was not re-schedule because the occupants absolutely would not get things packed so they could be moved (46 Clarkson St. apt. #2). The other four cancellations were rescheduled. No compensation was made to the deleading contractor in cases where sites were eliminated prior to the scheduled start date. The moving contractor did receive compensation for costs incurred when a move was cancelled or postponed at the site.

The total cost of moving and storage (including additional storage costs and cancellation fees) was $33,666.00.

Interior deleading ranged from 3 days to 58 days. 716 days were involved in the deleading of 46 interior sites. The average deleading time was 15.6 days. This time involves only the actual hazardous deleading work that required occupants to be out of their homes.

Interior deleading work included 46 households that were addressed under 4 separate contracts. A total of 45 compliance letters were issued for these. Most work was started according to schedule, but in several instances work was not completed according to schedule. Some of these time overruns were unavoidable. No penalties were assessed against contractors if the explanations for schedule delays

were reasonable. However, there were cases where these delays were avoidable and penalties in the form of liquidated damages of $ 1000.00 were assessed six times. All of the penalties were assessed against the same contractor and only after other attempts by the LFK staff to rectify problems were exhausted. It should be stressed that these penalties were used as a last resort and only when it was absolutely necessary to do so to maintain the projects best interests. Alterations of time schedules were rarely permitted, and only with approval of the deleading coordinator and were avoided whenever possible.

Interior deleading involved the removal of lead paint from chewable surfaces below five feet, doors and windows within the living unit. Owners had the option to have items that had ornamental detail taken off site to have the lead paint removed by a process called dipping. However, the dipping process did cause some of the older deteriorated materials to separate or dissolve, but this kind of damage was minimal. Items that had little or no ornamental detail were replaced with #2 pine. When doors were dipped, the door jamb was scraped free of lead paint to a height of five feet on site. This was the only general allowance for dry scraping when working on interiors. Dry scraping or the use of chemical solvents was allowed only when there was an architectural or structural reason for not being able to remove the surface from the site or when it was required for

some reason to satisfy the requirements of the Massachusetts Lead Law. Since the LFK deleading coordinator believes dry scraping is an extremely hazardous process, this type of deleading was kept to an absolute minimum whenever possible. When new doors were installed the pre-hung/hollow-core type was used. This eliminated the need for scraping jambs.

Dipping presented some minor problems as far as damage goes. The majority of the materials that were dipped were returned in very good condition even though many of the items appeared to be very old and in poor condition. This process turned out to be even more successful than was originally expected.

All items deleaded off site and replaced, and items that were deleaded on site were given a coat of primer paint by the deleading contractor. This was done to make sure that any fine film, dust or residue left on the surface was sealed in.

New materials were not painted by the contractor. Painting of new construction was the responsibility of the property owner.

Deleading, not painting or home improvement, was the purpose of the Lead Free Kids deleading program. There was an enormous task to be undertaken with limited deleading

funds. We were able to devise a strategy for deleading that would accomplish the task without compromise to safety. However, replacement materials used in the project were not top quality and some finish work, such as painting new materials, was left for the owners to take care of. Making the surfaces above five feet intact involved priming the repaired surfaces only. The entire wall surface required painting by the owner after deleading was completed. The contractors addressed peeling and chipped areas only, and then primed just these areas. Wherever finish painting was needed it was the responsibility of the property owner.

TEMPORARY HOUSING

The ability of participants to find short term housing presented a major obstacle. If LFK was to provide housing, it would have to be confirmed that it had been deleaded or LFK would have to delead it. Community relations found that deleaded units were in extremely short supply in Boston and were not available for short term rental. We looked into the possibility of deleading several units in exchange for use as temporary housing for participant families when their units were deleaded. This option of deleading several units in exchange for use as temporary housing was later ruled out because of insurance issues, liability and other legal reasons. Finally, the policy decided on was to urge

participants to find their own alternate housing. LFK would pay for lodging only after families had demonstrated a sincere effort, and were unable, to find a place to stay. The LFK staff provided participants with a list of hotels/guest houses that had agreed to provide lodging. The families had to make arrangements for their stay and LFK set up purchase orders to handle payment.

Seven families were provided with temporary lodging while deleading was being performed. Their stays ranged from one night to 19 nights. A total of 78 nights of lodging were provided for by LFK. The total cost of lodging was $11,612. The average amount of time of a stay was 11 days.

DAMAGE CONTROL

Pre-existing damage was recorded prior to commencement of deleading. The contractor was responsible to give a written pre-existing damage report to the LFK site representative before beginning work. Damage that was pre existing but uncovered after the work had started was brought to the attention of the LFK site representative and was recorded in the Inspector's daily log..

The LFK staff inspectors were on each site daily, throughout deleading activities to assure that the deleading

CHILD'S BACKGROUND

950. Which of the following best describes (CHILD'S NAME) background -- Black not of Hispanic origin, White not of Hispanic origin, Hispanic, Asian, Native American, or something else?

1 Black not of Hispanic origin

2 White not of Hispanic origin

3 Hispanic

4 Asian

5 Native American

8 Other

9 Unknown

951. From what country did (your/CHILD'S NAME mother's) family come before coming to the U.S.? (FILL IN DK IF R DOESN'T KNOW)

_____

952. From what country did (your/CHILD'S NAME father's) family come before coming to the U.S.? (FILL IN DK IF R DOESN'T KNOW)

_____

953 A. Are there any languages besides English that are regularly spoken in (your/CHILD'S NAME) household?

1 Yes

2 No.....(Go to Question 1000)

9 Unknown..(Go to Question 1000)

953 B. What are they?

1 Spanish

2 Portugese

3 Creole/French

4 Other (Specify)_____

9 Unknown

IF NO MORE LFK CHILDREN, SAY: This completes the interview. Thank you very much for cooperation and time. We really appreciate your help.

IF THERE ARE MORE LFK CHILDREN IN THE HOUSEHOLD, SAY: Now, I'm going to ask you the same questions about (OTHER LFK CHILD'S NAME).

1000. RECORD THE ENDING TIME OF THE CHILD INTERVIEW. __ __:__ __ AM / PM

1001. PLEASE SIGN BELOW.

_____
Interviewer's Signature

FILL IN 1002 AFTER YOU LEAVE.

1002. The quality of this interview is:

1 Reliable

2 Some doubt

3 Unreliable Explain:_____

_____

903 B. What is (your/his) job title?

_____

903 C. What are (your/his) job duties?

_____

903 D. What sort of business or industry is the place where (you/he) works? That is, what does the place where (you/he) works make or do?

_____

904. What is the highest grade in school that (you/he) completed? (IF HIGH SCHOOL OR COLLEGE: Did (you/he) graduate?)

1 Less than 8th grade

2 Eighth grade

3 1-3 years high school

4 High school graduate

5 Vocational school or other non-college post

6 1-3 college

7 A college degree

8 Graduate work

9 Unknown

905. What is (your/his) age? _____

906. Has a doctor ever told (you/CHILD'S NAME birth father) that (you/he) (have/has) high blood pressure?

1 Yes

2 No

9 Unknown

907. Has a doctor ever told (you/CHILD'S NAME birth father) that (you/he) (have/has) asthma?

1 Yes

2 No

9 Unknown

908. How tall (are you/is CHILD'S NAME birth father)?

_____feet _____inches (FILL IN DK IF R DOESN'T KNOW)

909. How much (do you/does CHILD'S NAME birth father) weigh?

_____Pounds (FILL IN DK IF R DOESN'T KNOW)

862 B. What is the name of the vitamin?
(FILL IN DK IF R DOESN'T KNOW)

_____

862 C. How often does (he/she) take the vitamins? Would you say every day, almost every day, about once a week, or less than once a week?

1 Every day

2 Almost every day

3 Once a week

4 Less than once a week

9 Unknown

863. Does (CHILD'S NAME) take an iron supplement? (OR: Do the vitamins contain iron?)

1 Yes

2 No

9 Unknown

ASK TO SEE BOTTLE IF RESPONDENT IS UNCLEAR ABOUT IRON OR VITAMIN DOSE OR SAYS THAT THE CHILD TAKES A MULTIVITAMIN.

FATHER OR MALE GUARDIAN CHARACTERISTICS

Now I have a few questions about (CHILD'S NAME) father or male guardian.

900. INTERVIEWER CHECK: IS R CHILD'S FATHER OR MALE GUARDIAN?

1 ( ) YES....(Ask Questions 903A-905)

2 ( ) No.....(Ask Questions 901-902)

901. Does (CHILD'S NAME) father or male guardian live here with (him/her)?

1 Yes.....(Go to Question 903)

2 No

9 Unknown

902. How often does (CHILD'S NAME) see his father or male guardian?

1 Never.....(Go to Question 905)

2 Less than once a year...(Go to Question 905)

3 A few times a year.....(Go to Question 905)

4 About once a week

5 At least once a week

903 A. Which of the following best describes (your/his) occupational status? (READ ALL CHOICES BELOW.)

1 Unemployed.....(Go to Question 904)

3 Employed part-time, that is, less than 20 hours a week

4 Employed full-time, that is, 20 or more hours a week

5 Something else such as disabled ...(Go to Question 904)

855 A. Do you buy any canned foods that you think have been imported from another country?

1 Yes

2 No.....(Go to Question 856 A)

9 Unknown..(Go to Question 856 A)

855 B. Does (CHILD'S NAME) eat any of these imported foods?

1 Yes

2 No

9 Unknown

856 A. Does (CHILD'S NAME) drink plain tap water?

1 Yes

2 No.....(Go to Question 857)

9 Unknown..(Go to Question 857)

856 B. On an average day, about how many 8 ounce glasses of tap water does (he/she) drink? (SHOW 8 OZ CUP.)

_____8 oz. glasses per day (FILL IN DK IF R DOESN'T KNOW)

857. Do you put ice cubes made from tap water into any of (CHILD'S NAME) drinks?

1 Yes

2 No

9 Unknown

858 Do you use tap water to mix with powdered foods that (he/she) might eat?

1 Yes

2 No

9 Unknown

859. Do you use tap water to mix into powdered or frozen drinks like Kool-Aid or orange juice that (he/she) might drink?

1 Yes

2 No

9 Unknown

860. Do you ever mix tap water with any other juices that (CHILD'S NAME) drinks?

1 Yes

2 No

9 Unknown

861. Do you use tap water when you cook (CHILD'S NAME) foods?

1 Yes

2 No

9 Unknown

862 A. Does (CHILD'S NAME) take any vitamins?

1 Yes

2 No.....(Go to Question 863)

9 Unknown..(Go to Question 863)

	854 A. In the past six months did (he/she) ever eat (READ dd,ee)?	854 B. How much did (he/she) usually eat at a time? Was it less than 1/2 cup, 1/2 cup, 1 cup, or more than 1 cup?	854 C. How often did (he/she) eat (READ dd,ee)? Was it everyday, 5-6 times a week, 2-4 times a week, once a week, 1-3 times a month, or less than once a month?
dd. Baby fruits or vegetables (like Beech Nuts or Gerbers)	1 Yes 2 No 9 Unknown	1 < 1/2 cup (< 4 oz) 2 1/2 cup (4 oz) 3 1 cup (8 oz) 4 >1 cup (>8 oz) 9 Unknown	1 Everyday 2 5-6/week 3 2-4/week 4 1/week 5 1-3/month 6 <1/month 9 Unknown
	(IF EVERYDAY) How many times a day? _____		
ee. Baby Meats (like Beech Nuts or Gerbers)	1 Yes 2 No 9 Unknown	1 <1/2 cup (< 4 oz) 2 1/2 cup (4 oz) 3 1 cup (8 oz) 4 >1 cup (> 8 oz) 9 Unknown	1 Everyday 2 5-6/week 3 2-4/week 4 1/week 5 1-3/month 6 <1/month 9 Unknown
	(IF EVERYDAY) How many times a day? _____		

	854 A. In the past six months did (he/she) ever eat (READ ff)?	854 B. How much did (he/she) usually eat at a time? Was it less than 1/2 cup, 1/2 cup, 1 cup, or more than 1 cup?	854 C. How often did (he/she) eat (READ ff)? Was it everyday, 5-6 times a week, 2-4 times a week, once a week, 1-3 times a month, or less than once a month?
ff. Baby Cereals (like Beech Nuts or Gerbers)	1 Yes 2 No 9 Unknown	1 < 1/2 cup (<4 oz) 2 1/2 cup (4 oz) 3 1 cup (8 oz) 4 >1 cup (>8 oz) 9 Unknown	1 Everyday 2 5-6/week 3 2-4/week 4 1/week 5 1-3/month 6 <1/month 9 Unknown

(IF EVERYDAY) How many times a day? _____

	854 A. In the past six months, did (he/she) ever eat (READ z)?	854 B. How much did (he/she) usually eat at a time? Was it less than 1 slice, 1 slice, or more than 1 slice?	854 C. How often did (he/she) eat (READ z)? Was it everyday, 5-6 times a week, 2-4 times a week, once a week, 1-3 times a month, or less than once a month?
z. Cakes	1 Yes	1 <1 Slice (<3 oz)	1 Everyday
	2 No	2 1 slice (3 oz)	2 5-6/week
	9 Unknown	3 >1 Slice (>3 oz)	3 2-4/week
		9 Unknown	4 1/week
			5 1-3/month
			6 <1/month
			9 Unknown

(IF EVERYDAY) How many times a day? _____

	854 A. In the past six months, did (he/she) ever eat (READ aa)?	854 B. How much did (he/she) usually eat at a time? Was it less than 1 cookie, 1 cookie, 2 cookies, 3 cookies, or more than 3 cookies?	854 C. How often did (he/she) eat (READ aa)? Was it everyday, 5-6 times a week, 2-4 times a week, once a week, 1-3 times a month, or less than once a month?
aa. Cookies	1 Yes	1 <1 Cookie	1 Everyday
	2 No	2 1 Cookie	2 5-6/week
	9 Unknown	3 2 Cookies	3 2-4/week
		4 3 Cookies	4 1/week
		5 >3 Cookies	5 1-3/month
		9 Unknown	6 <1/month
			9 Unknown

(IF EVERYDAY) How many times a day? _____

	854 A. In the past six months, did (he/she) ever eat (READ bb)?	854 B. How much did (he/she) usually eat) at a time? Was it less than 1 donut, 1 donut, or more than 1 donut?	854 C. How often did (he/she) eat (READ bb)? Was it everyday, 5-6 times a week, 2-4 times a week, once a week, 1-3 times a month, or less than once a month?
bb Donuts	1 Yes	1 < 1 Donut	1 Everyday
	2 No	2 1 Donut	2 5-6/week
	9 Unknown	3 > 1 Donut	3 2-4/week
		9 Unknown	4 1/week
			5 1-3/month
			6 <1/month
			9 Unknown

(IF EVERYDAY) How many times a day? _____

	854 A. In the past six months, did (he/she) ever eat (READ cc)?	854 B. How much did (he/she) usually eat at a time? Was it less than 1 egg, 1 egg, 2 eggs, or more than 2 eggs?	854 C. How often did (he/she) eat (READ cc)? Was it everyday, 5-6 times a week, 2-4 times a week, once a week, 1-3 times a month, or less than once a month?
cc Eggs	1 Yes	1 Less than 1 Egg	1 Everyday
	2 No	2 1 Egg	2 5-6/week
	9 Unknown	3 2 Eggs	3 2-4/week
		4 More than 2 Eggs	4 1/week
		9 Unknown	5 1-3/month
			6 <1/month
			9 Unknown

(IF EVERYDAY) How many times a day? _____

	854 A. In the past six months, did (he/she) ever eat (READ w)?	854 B. How much did (he/she) usually eat at a time? Was it less than 1 roll, 1 roll, 2 rolls, or more than 2 rolls?	854 C. How often did (he/she) eat (READ w)? Was it everyday, 5-6 times a week, 2-4 times a week, once a week, 1-3 times a month, or less than once a month?
w. White rolls	1 Yes	1 < 1 Roll	1 Everyday
	2 No	2 1 Roll	2 5-6/week
	9 Unknown	3 2 Rolls	3 2-4/week
		4 >2 Rolls	4 1/week
		9 Unknown	5 1-3/month
			6 <1/month
			9 Unknown

(IF EVERYDAY) How many times a day? _____

	854 A. In the past six months, did (he/she) ever eat (READ x,y)?	854 B. How much did (he/she) usually eat at a time? Was it less than 1 cracker, 1 cracker, 2 crackers, 3 crackers, or more than three crackers?	854 C. How often did (he/she) eat (READ x,y)? Was it everyday, 5-6 times a week, 2-4 times a week, once a week, 1-3 times a month, or less than once a month?
x. White crackers like Saltines	1 Yes 2 No 9 Unknown	1 < 1 cracker 2 1 cracker 3 2 crackers 4 3 crackers 5 >3 crackers 9 Unknown	1 Everyday 2 5-6/week 3 2-4/week 4 1/week 5 1-3/month 6 <1/month 9 Unknown
	(IF EVERYDAY) How many times a day? _____		
y. Whole wheat, rye, other dark crackers (like Wheat Thins)	1 Yes 2 No 9 Unknown	1 < 1 cracker 2 1 cracker 3 2 crackers 4 3 crackers 5 >3 crackers 9 Unknown	1 Everyday 2 5-6/week 3 2-4/week 4 1/week 5 1-3/month 6 <1/month 9 Unknown
	(IF EVERYDAY) How many times a day? _____		

	854 A. In the past six months did (he/she) ever eat (READ s)?	854 B. How much did (he/she) usually eat at a time? Was it less than one tablespoon, one tablespoon, two tablespoons, or more than two tablespoons?	854 C. How often did (he/she) eat (READ s)? Was it everyday, 5-6 times a week, 2-4 times a week, once a week, 1-3 times a month, or less than once a month?
s. Peanut butter	1 Yes	1 < 1 tablespoon	1 Everyday
	2 No	2 1 tablespoon	2 5-6/week
	9 Unknown	3 2 tablespoons	3 2-4/week
		4 >2 tablespoons	4 1/week
		9 Unknown	5 1-3/month
			6 <1/month
			9 Unknown

(IF EVERYDAY) How many times a day? _____

	854 A. In the past six months did (he/she) ever eat (READ t)?	854 B. How much did (he/she) usually eat at a time? Was it less than one hot dog, one hot dog, or more than one hot dog?	854 C. How often did (he/she) eat (READ t)? Was it everyday, 5-6 times a week, 2-4 times a week, once a week, 1-3 times a month, or less than once a month?
t. Hot dogs	1 Yes	1 <1 hot dog (<3 oz)	1 Everyday
	2 No	2 1 hot dog (3 oz)	2 5-6/week
	9 Unknown	3 >1 hot dog (>3 oz)	3 2-4/week
		9 Unknown	4 1/week
			5 1-3/month
			6 <1/month
			9 Unknown

(IF EVERYDAY) How many times a day? _____

LFK_NUM _____

	854 A. In the past six months did (he/she) ever eat (READ u,v)?	854 B. How much did (he/she) usually eat at a time? Was it less than 1 slice, 1 slice, 2 slices, or more than 2 slices?	854 C. How often did (he/she) eat (READ u,v)? Was it everyday, 5-6 times a week, 2-4 times a week, once a week, 1-3 times a month, or less than once a month?
u. White bread	1 Yes	1 <1 Slice	1 Everyday
	2 No	2 1 Slice	2 5-6/week
	9 Unknown	3 2 Slices	3 2-4/week
		4 >2 slices	4 1/week
		9 Unknown	5 1-3/month
			6 <1/month
			9 Unknown
	(IF EVERYDAY) How many times a day? _____		
v. Whole wheat, rye, other dark bread	1 Yes	1 <1 slice	1 Everyday
	2 No	2 1 slice	2 5-6/week
	9 Unknown	3 2 slices	3 2-4/week
		4 >2 slices	4 1/week
		9 Unknown	5 1-3/month
			6 <1/month
			9 Unknown
	(IF EVERYDAY) How many times a day? _____		

	854 A. In the past six months did (he/she) ever eat (READ o,p)?	854 B. How much did (he/she) usually eat at a time? Was it less than 1/2 cup, 1/2 cup, 1 cup, or more than 1 cup?	854 C. How often did (he/she) eat (READ o,p)? Was it everyday, 5-6 times a week, 2-4 times a week, once a week, 1-3 times a month, or less than once a month?
o. Leafy green vegetables (such as spinach, lettuce, broccoli, mustard and collard greens, kale (NOT GREEN BEANS OR PEAS)	1 Yes 2 No 9 Unknown	1 < 1/2 cup(<4 oz) 2 1/2 cup (4 oz) 3 1 cup (8 oz) 4 >1 cup (>8 oz) 9 Unknown	1 Everyday 2 5-6/week 3 2-4/week 4 1/week 5 1-3/month 6 <1/month 9 Unknown
	(IF EVERYDAY) How many times a day? _____		
p. Nuts	1 Yes 2 No 9 Unknown	1 < 1/2 cup (<4 oz) 2 1/2 cup (4 oz) 3 1 cup (8 oz) 4 >1 cup (> 8oz) 9 Unknown	1 Everyday 2 5-6/week 3 2-4/week 4 1/week 5 1-3/month 6 <1/month 9 Unknown
	(IF EVERYDAY) How many times a day? _____		

	854 A. In the past six months did (he/she) ever eat (READ q,r)?	854 B. How much did (he/she) usually eat at a time? Was it less than 1/2 cup, 1/2 cup, 1 cup, or more than 1 cup?	854 C. How often did (he/she) eat (READ q,r)? Was it everyday, 5-6 times a week, 2-4 times a week, once a week, 1-3 times a month, or less than once a month?
q. Cold cereals	1 Yes	1 < 1/2 cup (<4 oz)	1 Everyday
	2 No	2 1/2 cup (4 oz)	2 5-6/week
	9 Unknown	3 1 cup (8 oz)	3 2-4/week
		4 >1 cup (>8 oz)	4 1/week
		9 Unknown	5 1-3/month
			6 <1/month
			9 Unknown
	(IF EVERYDAY) How many times a day? _____		
r. Spaghetti or macaroni	1 Yes	1 <1/2 cup (<4 oz)	1 Everyday
	2 No	2 1/2 cup (4 oz)	2 5-6/week
	9 Unknown	3 1 cup (8 oz)	3 2-4/week
		4 >1 cup (>8 oz)	4 1/week
		9 Unknown	5 1-3/month
			6 <1/month
			9 Unknown
	(IF EVERYDAY) How many times a day? _____		

	854 A. In the past six months did (he/she) ever eat (READ k,l)?	854 B. How much did (he/she) usually eat at a time? Was it less than 1/2 cup, 1/2 cup, 1 cup, or more than 1 cup?	854 C. How often did (he/she) eat (READ k,l)? Was it everyday, 5-6 times a week, 2-4 times a week, once a week, 1-3 times a month, or less than once a month?
k. Any other red meat (including hamburgers, meatloaf, steak, roast beef)	1 Yes 2 No 9 Unknown	1 < 1/2 cup (<4 oz) 2 1/2 cup (4 oz) 3 1 cup (8 oz) 4 >1 cup (>8 oz) 9 Unknown	1 Everyday 2 5-6/week 3 2-4/week 4 1/week 5 1-3/month 6 <1/month 9 Unknown
	(IF EVERYDAY) How many times a day? _____		
l. Beans (such as kidney, navy, soy, or pinto beans)	1 Yes 2 No 9 Unknown	1 < 1/2 cup (< 4oz) 2 1/2 cup (4 oz) 3 1 cup (8 oz) 4 >1 cup (>8 oz) 9 Unknown	1 Everyday 2 5-6/week 3 2-4/week 4 1/week 5 1-3/month 6 <1/month 9 Unknown
	(IF EVERYDAY) How many times a day? _____		

	854 A. In the past six months did (he/she) ever eat (READ m,n)?	854 B. How much did (he/she) usually eat at a time? Was it less than 1/2 cup, 1/2 cup, 1 cup, or more than 1 cup?	854 C. How often did (he/she) eat (READ m,n)? Was it everyday, 5-6 times a week, 2-4 times a week, once a week, 1-3 times a month, or less than once a month?
m. Shellfish	1 Yes	1 <1/2 cup (<4 oz)	1 Everyday
	2 No	2 1/2 cup (4 oz)	2 5-6/week
	9 Unknown	3 1 cup (8 oz)	3 2-4/week
		4 >1 cup (>8 oz)	4 1/week
		9 Unknown	5 1-3/month
			6 <1/month
			9 Unknown
	(IF EVERYDAY) How many times a day? _____		
n. Any other fish	1 Yes	1 < 1/2 cup (<4 oz)	1 Everyday
	2 No	2 1/2 cup (4 oz)	2 5-6/week
	9 Unknown	3 1 cup (8 oz)	3 2-4/week
		4 >1 cup (>8 oz)	4 1/week
		9 Unknown	5 1-3/month
			6 <1/month
			9 Unknown
	(IF EVERYDAY) How many times a day? _____		

	854 A. In the past six months did (he/she) ever eat (READ g)?	854 B. How much did (he/she) usually eat at a time? Was it less than 1 slice, 1 slice, 2 slices, or more than 2 slices?	854 C. How often did (he/she) eat (READ g)? Was it everyday, 5-6 times a week, 2-4 times a week, once a week, 1-3 times a month, or less than once a month?
g. Any other cheeses	1 Yes	1 < slice (<1 oz)	1 Everyday
	2 No	2 1 slice (1 oz)	2 5-6/week
	9 Unknown	3 2 slices (2 oz)	3 2-4/week
		4 >2 slices (>2 oz)	4 1/week
		9 Unknown	5 1-3/month
			6 <1/month
			9 Unknown

(IF EVERYDAY) How many times a day? _____

	854 A. In the past six months did (he/she) ever eat (READ h)?	854 B. How much did (he/she) usually eat at a time? Was it less than 1/2 cup, 1/2 cup, 1 cup, or more than 1 cup?	854 C. How often did (he/she) eat (READ h)? Was it everyday, 5-6 times a week, 2-4 times a week, once a week, 1-3 times a month, or less than once a month?
h. Beef liver	1 Yes	1 < 1/2 cup (<4 oz)	1 Everyday
	2 No	2 1/2 cup (4 oz)	2 5-6/week
	9 Unknown	3 1 cup (8 oz)	3 2-4/week
		4 >1 cup (>8 oz)	4 1/week
		9 Unknown	5 1-3/month
			6 <1/month
			9 Unknown

(IF EVERYDAY) How many times a day? _____

LFK_NUM _____

	854 A. In the past six months did (he/she) ever eat (READ i,j)?	854 B. How much did (he/she) usually eat at a time? Was it less than 1/2 cup, 1/2 cup, 1 cup, or more than 1 cup?	854 C. How often did (he/she) eat (READ i,j)? Was it everyday, 5-6 times a week, 2-4 times a week, once a week, 1-3 times a month, or less than once a month?
i. Pork or ham	1 Yes 2 No 9 Unknown	1 < 1/2 cup (< 4oz) 2 1/2 cup (4 oz) 3 1 cup (8 oz) 4 >1 cup (> 8oz) 9 Unknown	1 Everyday 2 5-6/week 3 2-4/week 4 1/week 5 1-3/month 6 <1/month 9 Unknown
	(IF EVERYDAY) How many times a day? _____		
j. Lunch meats like bologna or salami	1 Yes 2 No 9 Unknown	1 < 1/2 cup (<4 oz) 2 1/2 cup (4 oz) 3 1 cup (8 oz) 4 >1 cup (>8 oz) 9 Unknown	1 Everyday 2 5-6/week 3 2-4/week 4 1/week 5 1-3/month 6 <1/month 9 Unknown
	(IF EVERYDAY) How many times a day? _____		

	854 A. In the past six months did (he/she) ever (eat/drink) (READ c,d)?	854 B. How much did (he/she) usually (eat/drink) at a time? Was it less than 1/2 cup, 1/2 cup, 1 cup, or more than 1 cup?	854 C. How often did (he/she) (eat/drink) (READ c,d)? Was it everyday, 5-6 times a week, 2-4 times a week, once a week, 1-3 times a month, or less than once a month?
c. Powdered Milk	1 Yes 2 No 9 Unknown	1 < 1/2 cup (<4oz) 2 1/2 cup (4 oz) 3 1 cup (8 oz) 4 >1 cup (>8 oz) 9 Unknown	1 Everyday 2 5-6/week 3 2-4/week 4 1/week 5 1-3/month 6 <1/month 9 Unknown
	(IF EVERYDAY) How many times a day? _____		
d. Ice Cream, or Sherbet	1 Yes 2 No 9 Unknown	1 <1/2 cup (<4 oz) 2 1/2 cup (4 oz) 3 1 cup (8 oz) 4 >1 cup (>8 oz) 9 Unknown	1 Everyday 2 5-6/week 3 2-4/week 4 1/week 5 1-3/month 6 <1/month 9 Unknown
	(IF EVERYDAY) How many times a day? _____		

	854 A. In the past six months did (he/she) ever eat (READ e,f)?	854 B. How much did (he/she) usually eat at a time? Was it less than 1/2 cup, 1/2 cup, 1 cup, or more than 1 cup?	854 C. How often did (he/she) eat (READ e,f)? Was it everyday, 5-6 times a week, 2-4 times a week, once a week, 1-3 times a month, or less than once a month?
e. Pudding or custard	1 Yes 2 No 9 Unknown	1 <1/2 cup (<4 oz) 2 1/2 cup (4 oz) 3 1 cup (8 oz) 4 >1 cup (>8 oz) 9 Unknown	1 Everyday 2 5-6/week 3 2-4/week 4 1/week 5 1-3/month 6 <1/month 9 Unknown
	(IF EVERYDAY) How many times a day? _____		
f. Cottage cheese	1 Yes 2 No 9 Unknown	1 < 1/2 cup (<4 oz) 2 1/2 cup (4 oz) 3 1 cup (8 oz) 4 >1 cup (>8 oz) 9 Unknown	1 Everyday 2 5-6/week 3 2-4/week 4 1/week 5 1-3/month 6 <1/month 9 Unknown
	(IF EVERYDAY) How many times a day? _____		

	853 A. In the past six months did (he/she) ever eat (READ g,h)?	853 B. How much did (he/she) usually eat at a time? Was it less than 1/2 cup, 1/2 cup, 1 cup, or more than 1 cup?	853 C. How often did (he/she) eat (READ g,h)? Was it everyday, 5-6 times a week, 2-4 times a week, once a week, 1-3 times a month, or less than once a month?
g. Canned spaghetti	1 Yes 2 No 9 Unknown	1 < 1/2 cup 2 1/2 cup 3 1 cup 4 >1 cup 9 Unknown	1 Everyday 2 5-6/week 3 2-4/week 4 1/week 5 1-3/month 6 <1/month 9 Unknown
	(IF EVERYDAY) How many times a day? _____		
h. Canned beans	1 Yes 2 No 9 Unknown	1 < 1/2 cup 2 1/2 cup 3 1 cup 4 >1 cup 9 Unknown	1 Everyday 2 5-6/week 3 2-4/week 4 1/week 5 1-3/month 6 <1/month 9 Unknown
	(IF EVERYDAY) How many times a day? _____		

Now I'm going to ask you about other foods that (CHILD'S NAME) may eat that are not canned. Please tell me if in the past six months (he/she) has ever eaten any of these other non-canned foods.

	854 A. In the past six months did (he/she) ever drink (READ a,b)?	854 B. How much did (he/she) usually drink at a time? Was it less than 1/2 cup, 1/2 cup, 1 cup, or more than 1 cup?	854 C. How often did (he/she) drink (READ a,b)? Was it everyday, 5-6 times a week, 2-4 times a week, once a week, 1-3 times a month, or less than once a month?
a. Milk	1 Yes	1 < 1/2 cup (<4 oz)	1 Everyday
	2 No	2 1/2 cup (4 oz)	2 5-6/week
	9 Unknown	3 1 cup (8 oz)	3 2-4/week
		4 >1 cup (>8 oz)	4 1/week
		9 Unknown	5 1-3/month
			6 <1/month
			9 Unknown
	(IF EVERYDAY) How many times a day? _____		
b. Milk on cold or hot cereals	1 Yes	1 < 1/2 cup (<4 oz)	1 Everyday
	2 No	2 1/2 cup (4 oz)	2 5-6/week
	9 Unknown	3 1 cup (8 oz)	3 2-4/week
		4 >1 cup (>8 oz)	4 1/week
		9 Unknown	5 1-3/month
			6 <1/month
			9 Unknown
	(IF EVERYDAY) How many times a day? _____		

	853 A. In the past six months did (he/she) ever eat (READ c,d)?	853 B. How much did (he/she) usually eat at a time? Was it less than 1/2 cup, 1/2 cup, 1 cup, or more than 1 cup?	853 C. How often did (he/she) eat (READ c,d)? Was it everyday, 5-6 times a week, 2-4 times a week, once a week, 1-3 times a month, or less than once a month?
c. Canned meats and fish including tuna fish	1 Yes 2 No 9 Unknown	1 < 1/2 cup 2 1/2 cup 3 1 cup 4 >1 cup 9 Unknown	1 Everyday 2 5-6/week 3 2-4/week 4 1/week 5 1-3/month 6 <1/month 9 Unknown
	(IF EVERYDAY) How many times a day? _____		
d. Canned fruits and vegetables	1 Yes 2 No 9 Unknown	1 < 1/2 cup 2 1/2 cup 3 1 cup 4 >1 cup 9 Unknown	1 Everyday 2 5-6/week 3 2-4/week 4 1/week 5 1-3/month 6 <1/month 9 Unknown
	(IF EVERYDAY) How many times a day? _____		

	853 A. In the past six months did (he/she) ever (eat/drink) (READ e,f)?	853 B. How much did (he/she) usually (eat/drink) at a time? Was it less than 1/2 cup, 1/2 cup, 1 cup, or more than 1 cup?	853 C. How often did (he/she) (eat/drink) (READ e,f) Was it everyday, 5-6 times a week, 2-4 times a week, once a week, 1-3 times a month, or less than once a month?
e. Canned juices	1 Yes	1 < 1/2 cup	1 Everyday
	2 No	2 1/2 cup	2 5-6/week
	9 Unknown	3 1 cup	3 2-4/week
		4 >1 cup	4 1/week
		9 Unknown	5 1-3/month
			6 <1/month
			9 Unknown
	(IF EVERYDAY) How many times a day? _____		
f. Canned soups	1 Yes	1 < 1/2 cup	1 Everyday
	2 No	2 1/2 cup	2 5-6/week
	9 Unknown	3 1 cup	3 2-4/week
		4 >1 cup	4 1/week
		9 Unknown	5 1-3/month
			6 <1/month
			9 Unknown
	(IF EVERYDAY) How many times a day? _____		

CHILD'S DIET

Now, I'm going to ask you about (CHILD'S NAME)'s diet and eating habits.

850. Does (CHILD'S NAME) eat any vegetables from your garden or any other garden in your neighborhood?

1 Yes

2 No

9 Unknown

851. About how often does (CHILD'S NAME) eat food with (his/her) fingers? Would you say a lot of the time, some of the time, or almost never?

1 A lot of the time

2 Some of the time

3 Almost never

9 Unknown

852. Is (CHILD'S NAME) currently being breast fed?

1 Yes

2 No

9 Unknown

853. I have some things to show you that might help you answer the next set of questions about foods that (CHILD'S NAME) may eat. (TAKE OUT SHOW CARDS, FOOD LISTS AND MODELS, CUPS, BOWLS AND EXPLAIN THEIR USE TO R.)
First, I'm going to ask you about some canned foods (CHILD'S NAME) may eat. Please tell me if, in the past six months, (he/she) has ever eaten any of these canned foods.

	853 A. In the past six months, did (he/she) ever drink (READ a,b)?	853 B. How much did (he/she) usually drink at a time? Was it less than 1/2 cup, 1/2 cup, 1 cup, or more than 1 cup?	853 C. How often did (he/she) drink (READ a,b)? Was it everyday, 5-6 times a week, 2-4 times a week, once a week, 1-3 times a month, or less than once a month?
a. Canned Milk	1 Yes 2 No 9 Unknown	1 < 1/2 cup 2 1/2 cup 3 1 cup 4 >1 cup 9 Unknown	1 Everyday 2 5-6/week 3 2-4/week 4 1/week 5 1-3/month 6 <1/month 9 Unknown
	(IF EVERYDAY) How many times a day? _____		
b Canned liquid formula	1 Yes 2 No 9 Unknown	1 < 1/2 cup 2 1/2 cup 3 1 cup 4 >1 cup 9 Unknown	1 Everyday 2 5-6/week 3 2-4/week 4 1/week 5 1-3/month 6 <1/month 9 Unknown
	(IF EVERYDAY) How many times a day? _____		

803 A. Has (CHILD'S NAME) been tested for sickle cell?

1 Yes

2 No .....(Go to question 804 A)

9 Unknown.(Go to question 804 A)

803 B. Was the result negative or positive?

1 Positive

2 Negative .....(Go to question 804 A)

9 Unknown.....(Go to question 804 A)

803 C. Was it positive for sickle cell trait?

1 Yes.....(Go to question 804 A)

2 No

9 Unknown

803 D. Was it positive for sickle cell disease?

1 Yes

2 No

9 Unknown

804 A. Has a doctor ever told (you/CHILD'S NAME parent) that (CHILD'S NAME) had anemia or low blood iron?

1 Yes

2 No .....(Go to question 805 A)

9 Unknown.(Go to question 805 A)

804 B. In what year (were you/was CHILD'S NAME parent or guardian) told that (CHILD'S NAME) had anemia or low blood iron?

1 9 __ __ (FILL IN "99" IF R DOESN'T KNOW)

804 C. Is (he/she) presently being treated for anemia or low blood iron?

1 Yes

2 No

9 Unknown

805 A. Has (CHILD'S NAME) ever received medical care for lead poisoning?

1 Yes

2 No .....(Go to Question 806 A)

9 Unknown...(Go to Question 806 A)

805 B. Did (CHILD'S NAME) stay in the hospital overnight for this care?

1 Yes

2 No

9 Unknown

806 A. Are there any other medical problems that (CHILD'S NAME) has that I have not mentionned?

1 Yes

2 No.....(Go to Question 850)

9 Unknown.....(Go to Question 850)

806 B. What are they?

_____

HAND WASHING

Very few children like to wash their hands and it is often difficult for a parent to make them. Fortunately, there are no rules about how many times a day a child's hands should be washed. Now, I'm going to ask you some questions about washing (CHILD'S NAME) hands. (USE SHOW CARD.)

750. Are (CHILD'S NAME) hands almost always, sometimes or almost never washed before eating meals?

1 Almost always

2 Sometimes

3 Almost Never

9 Unknown

751. Are (his/her) hands almost always, sometimes or almost never washed after eating meals?

1 Almost always

2 Sometimes

3 Almost Never

9 Unknown

752. What about eating snacks? Are (CHILD'S NAME) hands almost always, sometimes or almost never washed before eating snacks?

1 Almost always

2 Sometimes

3 Almost Never

9 Unknown

753. Are (his/her) hands almost always, sometimes or almost never washed after eating snacks?

1 Almost always

2 Sometimes

3 Almost Never

9 Unknown

754. What about playing outdoors? Are (his/her) hands almost always, sometimes or almost never washed after playing outdoors?

1 Almost always

2 Sometimes

3 Almost Never

9 Unknown

755. What about bedtime? Are (his/her) hands almost always, sometimes or almost never washed before bed?

1 Almost Always

2 Sometimes

3 Almost Never

9 Unknown

CHILD'S HEALTH

Now I am going to ask you a few questions about (CHILD'S NAME) medical care and health.

800 A. What is the name of the clinic or hospital where (CHILD'S NAME) usually gets (his/her) medical care?

_____

800 B. What is (his/her) doctor's name? _____

IF R DOESN'T KNOW USUAL PLACE OF MEDICAL CARE, ASK:

801. Where was the last place that (CHILD'S NAME) received medical care?

_____

802. Has a doctor ever told (you/CHILD'S NAME parent) that (CHILD'S NAME) has any of the following problems?

A. Asthma	1	Yes	2	No	9	Unknown
B. Seizures	1	Yes	2	No	9	Unknown
C. G6PD Deficiency	1	Yes	2	No	9	Unknown
D. Failure to thrive (LITTLE OF NO WEIGHT GAIN)	1	Yes	2	No	9	Unknown

702. Children often explore with their mouths by tasting and touching things with their tongues. Have you ever seen (CHILD'S NAME) put (his/her) mouth or tongue on a windowsill when (he/she) is looking out?

1 Yes

2 No

9 Unknown

703. Have you ever seen (CHILD'S NAME) pick at a windowsill with (his/her) fingers while looking out?

1 Yes

2 No

9 Unknown

704 A. Have you ever seen (CHILD'S NAME) put paint chips in (his/her) mouth?

1 Yes

2 No....(Go to Question 705)

9 Unknown ...(Go to Question 705)

704 B. How often does (CHILD'S NAME) do this? Would you say usually, sometimes, or never?

1 Usually

2 Sometimes

3 Never

9 Unknown

705. Have you ever seen (CHILD'S NAME) eat dirt or sand?

1 Yes

2 No

9 Unknown

706 A. Does (CHILD'S NAME) have a favorite blanket or stuffed toy?

1 Yes

2 No.....(Go to Question 707 A)

9 Unknown..(Go to Question 707 A)

706 B. Does (he/she) carry this around during the day?

1 Yes

2 No

9 Unknown

706 C. How often does (he/she) put this in (his/her) mouth? Is it usually, sometimes, or never?

1 Usually

2 Sometimes

3 Never

9 Unknown

707 A. Are there any other things that I have not mentioned that you have seen (CHILD'S NAME) put in (his/her) mouth?

1 Yes

2 No.....(Go to Question 750)

9 Unknown...(Go to Question 750)

707 B. What are these? (LIST ALL MENTIONNED BELOW.)

_____

_____

SKIP QUESTIONS 606 AND 607 IF CHILD NEVER PLAYED OUTSIDE THIS PAST SUMMER.

606 A. This past summer, did (CHILD'S NAME) ever take a baby bottle with (him/her) when (he/she) played outdoors?

1 Yes

2 No (Go to Question 607 A)

9 Unknown (Go to Question 607 A)

606 B. About how often did (he/she) do this? Would you say at least once a day, at least once a week but not everyday, a few times a month, or once a month or less? (USE SHOW CARD.)

1 At least once per day

2 At least once per week but not everyday

3 A few times a month

4 Once per month or less

9 Unknown

607 A. This past summer, did (CHILD'S NAME) ever eat food when (he/she) played outside?

1 Yes

2 No (Go to Question 608)

9 Unknown (Go to Question 608)

607 B. About how often did (he/she) do this? Would you say at least once a day, at least once a week but not everyday, a few times a month, or once a month or less?

1 At least once per day

2 At least once per week but not everyday

3 A few times a month

4 Once per month or less

9 Unknown

608. This past summer when (CHILD'S NAME) was inside at home, did (he/she) play or sit on the floor a lot of the time, some of the time or almost never?

1 A lot of the time

2 Some of the time

3 Almost never.....(Go to question 700)

9 Unknown.....(Go to question 700)

609. About how many hours on an average day do you think (CHILD'S NAME) usually sat or played on the floor at home?

_____Hours a day playing on floor at home (FILL IN DK IF R DOESN'T KNOW)

MOUTHING BEHAVIOR

Children often put things other than food in their mouths such as toys or fingers. Its very natural for them to do this and doesn't necessarily hurt them. Now, I'm going to ask you some questions about things that (CHILD'S NAME) may put in (his/her) mouth.

700. Does (CHILD'S NAME) use a pacifier?

1 Yes

2 No

9 Unknown

701. How often does (CHILD'S NAME) suck (his/her) thumb or fingers? Would you say often, sometimes, rarely, or never?

1 Often

2 Sometimes

3 Rarely

4 Never

9 Unknown

604 B. About how many days a week did (he/she) usually play there?

1 Once a week

2 Two days

3 Three days

4 Four days

5 Five days

6 Six days

7 Everyday

9 Unknown

604 C. On average, how many hours a day did (he/she) usually spend there? (FILL IN DK IF R DOESN'T KNOW)

_____

604 D. Where did (he/she) usually play in your home's yard? Did (he/she) play in your_____? (READ LIST. IF MORE THAN ONE, CIRCLE ALL THAT APPLY. USE SHOW CARD.)

1 Back yard

2 Left side of the yard when you face the house

3 Right side of the yard when you face the house

4 Front yard

7 Some other place in your yard (SPECIFY)_____

9 Unknown

604 E. (Was this area/Were these areas) where (he/she) played grassy? Concrete or asphalt? Plain dirt or soil? A sandbox? Or some other surface?
(IF MORE THAN ONE, CIRCLE ALL THAT APPLY. USE SHOW CARD.)

1 Grassy

2 Concrete or asphalt

3 Dirt or soil

4 Sandbox

7 Other (SPECIFY)_____

9 Unknown

605 A. In a typical sunny week this past summer, did (CHILD'S NAME) spend any time playing outside in other areas around the house such as the porch, sidewalk or street?

1 Yes

2 No.....(Go to question 606 A)

9 Unknown....(Go to question 606 A)

605 B. How many days a week did (he/she) usually play there?

1 Once a week

2 Two days

3 Three days

4 Four days

5 Five days

6 Six days

7 Everyday

9 Unknown

605 C. This past summer, how many hours a day did (he/she) usually spend on the porch, sidewalk, or street?

_____

(FILL IN DK IF R DOESN'T KNOW)

602 A. This past summer, did (CHILD'S NAME) regularly, that is at least once a week, visit a park or playground with you or anyone else?

1 Yes

2 No.....(Go to question 603 A)

9 Unknown..(Go to question 603 A)

602 B. What is the name of the park or playground? (FILL IN DK IF R DOESN'T KNOW. IF THERE IS MORE THAN ONE PARK, GET INFORMATION ON EACH ONE.)

_____

602 C. What street and neighborhood is it in? (FILL IN DK IF R DOESN'T KNOW)

_____

602 D. This past summer, how many days a week did (he/she) usually go there?

1 Once a week

2 Two days

3 Three days

4 Four days

5 Five days

6 Six days

7 Everyday

9 Unknown

602 E. This past summer, how many hours a day did (he/she) usually spend there? (FILL IN DK IF R DOESN'T KNOW)

_____

603 A. This past summer, did (CHILD'S NAME) regularly play in any empty lots in your neighborhood?

1 Yes

2 No.....(Go to question 604 A)

9 Unknown.(Go to question 604 A)

603 B. What street is the lot on?
(FILL IN DK IF R DOESN'T KNOW)

_____

603 C. This past summer, how many days a week did (he/she) usually go there?

1 One day a week

2 Two days

3 Three days

4 Four days

5 Five days

6 Six days

7 Everyday

9 Unknown

603 D. This past summer, how many hours a day did (he/she) usually spend there?

_____
(FILL IN DK IF R DOESN'T KNOW)

Now, I am going to ask you some questions about how (CHILD'S NAME) spent (his/her) time in and around your home this past summer. (IF R IS IN THE STUDY GROUP ADD: I would like to know about (CHILD'S NAME) activities in and around your home before the soil was removed.)

604 A. In a typical sunny week this past summer, did (CHILD'S NAME) spend any time playing outdoors in your home's yard?

1 Yes

2 No.....(Go to question 605 A)

9 Unknown...(Go to question 605 A)

600 A. This past summer, did (CHILD'S NAME) regularly, that is at least once a week, spend time away from home at a .....(READ f).

	600 A.	600 B. Was the (READ f) in Roxbury, Dorchester, Mattapan, or Jamaica Plain?	600 C. This past summer, how many days a week did (he/she) usually go there?	600 D. This past summer, how many hours a day did (he/she) usually spend there?	600 E. This past summer when it was sunny, how many hours a day did (he/she) usually spend outdoors there?
				(FILL IN DK IF R DOESN'T KNOW)	
f. Camp	1 Yes →	1 Yes	1 One day	_____	_____
	2 No	2 No	2 Two days		
	3 Unknown	3 Unknown	3 Three days		
			4 Four days		
			5 Five days		
			6 Six days		
			7 Everyday		
			9 Unknown		

601 A. Were there any other places like these that I have not mentioned where (CHILD'S NAME) regularly, that is at least once a week, spent time away from home this past summer?

1 Yes

2 No.....(Go to question 602 A)

9 Unknown..(Go to question 602 A)

601 B. What was the place? _____
(FILL IN DK IF R DOESN'T KNOW)

601 C. Was it in Roxbury, Dorchester, Mattapan, or Jamaica Plain?

1 Yes

2 No

9 Unknown

601 D. This past summer, how many days a week did (he/she) usually go there?

1 One day a week

2 Two days

3 Three days

4 Four days

5 Five days

6 Six days

7 Everyday

9 Unknown

601 E. This past summer, how many hours a day did (he/she) usually spend there?

_____
(FILL IN DK IF R DOESN'T KNOW)

601 F. This past summer when it was sunny, how many hours a day did (he/she) usually spend outdoors there?

_____
(FILL IN DK IF R DOESN'T KNOW)

600 A. This past summer, did (CHILD'S NAME) regularly, that is at least once a week, spend time away from home at a .....(READ b-c).

	600 A.	600 B. Was the (READ b,c) in Roxbury, Dorchester, Mattapan, or Jamaica Plain?	600 C. This past summer, how many days a week did (he/she) usually go there?	600 D. This past summer, how many hours a day did (he/she) usually spend there?	600 E. This past summer when it was sunny, how many hours a day did (he/she) usually spend outdoors there?
				(FILL IN DK IF R DOESN'T KNOW)	
b. Nursery or pre-school	1 Yes →	1 Yes	1 One day	_____	_____
	2 No	2 No	2 Two days		
	3 Unknown	3 Unknown	3 Three days		
			4 Four days		
			5 Five days		
			6 Six days		
			7 Everyday		
			9 Unknown		
c. Baby Sitters' Homes	1 Yes →	1 Yes	1 One day	_____	_____
	2 No	2 No	2 Two days		
	3 Unknown	3 Unknown	3 Three days		
			4 Four days		
			5 Five days		
			6 Six days		
			7 Everyday		
			9 Unknown		

600 A. This past summer, did (CHILD'S NAME), regularly that is at least once a week, spend time away from home at a .....(READ d-e).

	600 A.	600 B. Was the (READ d,e) in Roxbury, Dorchester, Mattapan, or Jamaica Plain?	600 C. This past summer, how many days a week did (he/she) usually go there?	600 D. This past summer, how many hours a day did (he/she) usually spend there?	600 E. This past summer when it was sunn how many hours a day did (he/she) usually spend outdoors there?
				(FILL IN DK IF R DOESN'T KNOW)	
d. Relatives' Homes	1 Yes →	1 Yes	1 One day	_____	_____
	2 No	2 No	2 Two days		
	3 Unknown	3 Unknown	3 Three days		
			4 Four days		
			5 Five days		
			6 Six days		
			7 Everyday		
			9 Unknown		
e. Friends' Homes	1 Yes →	1 Yes	1 One day	_____	_____
	2 No	2 No	2 Two days		
	3 Unknown	3 Unknown	3 Three days		
			4 Four days		
			5 Five days		
			6 Six days		
			7 Everyday		
			9 Unknown		

LEAD FREE KIDS STUDY CHILD INVERVIEW

FAMID_____ LFK_NUM _____

1. RECORD INTERVIEWER'S (YOUR) FIRST AND LAST NAME

   FIRST:_____ LAST:_____

2. RECORD INTERVIEWEE'S (PARENT, GUARDIAN, ETC.) FIRST AND LAST NAME

   FIRST:_____ LAST:_____

3. RECORD LFK CHILD'S FIRST AND LAST NAME:

   FIRST _____ LAST:_____

4. RECORD DATE OF CHILD INTERVIEW. __ __ / __ __ / __ __
   Month Day Year

5. RECORD STARTING TIME OF CHILD INTERVIEW. __ __ : __ __ AM / PM

6. HEIGHT __ __ __.__ centimeters

7. Weight __ __.__ kilograms

8. Blood Pressure __ __ __ / __ __ __ mm Hg

CHILD'S ACTIVITIES DURING PAST SUMMER

Now, I am going to ask how (CHILD'S NAME) spent (his/her) time this past summer (JUNE, JULY, AUGUST 1989). I know that it's already winter but I want you to tell me, as best you can, about (CHILD'S NAME) activities this past summer. I am particularly interested in the amour of time (CHILD'S NAME) spent outdoors.

600 A. This past summer, did (CHILD'S NAME) regularly, that is at least once a week, spend time away from home at a .....(READ a).

	600 A.	600 B. Was the (READ a) in Roxbury, Dorchester, Mattapan, or Jamaica Plain?	600 C. This past summer, how many days a week did (he/she) usually go there?	600 D. This past summer, how many hours a day did (he/she) usually spend there?	600 E. This past summer when it was sunn how many hours a day did (he/she) usually spend outdoors there?
				(FILL IN DK IF R DOESN'T KNOW)	
a. Day care center or family day care	1 Yes →	1 Yes	1 One day	_____	_____
	2 No	2 No	2 Two days		
	3 Unknown	3 Unknown	3 Three days		
			4 Four days		
			5 Five days		
			6 Six days		
			7 Everyday		
			9 Unknown		

BIRTH MOTHER'S CHARACTERISTICS

Now, I'm going to ask you some questions about (you/CHILD'S NAME birth mother).

500 A. Has a doctor ever told (you/CHILD'S NAME birth mother) that (you/she) (have/has) high blood pressure?

1 Yes

2 No...(Go to Question 501)

9 Unknown...(Go to Question 501)

500 B. Did the high blood pressure occur <u>only</u> during pregnancy?

1 Yes

2 No

9 Unknown

501. Has a doctor ever told (you/CHILD'S NAME birth mother) that (you/she) (have/has) asthma?

1 Yes

2 No

9 Unknown

502. How tall (are you/is CHILD'S NAME birth mother)?

_____feet _____inches (FILL IN DK IF R DOESN'T KNOW)

503. How much (do you/does CHILD'S NAME birth mother) weigh ?

_____Pounds (FILL IN DK IF R DOESN'T KNOW)

PLANS TO MOVE

And now just a few more questions about your household.

550. In what month and year did (your/CHILD'S NAME) family move to this address?

__ __ (MONTH) 1 9 __ __ (YEAR) (FILL IN "99" IF R DOESN'T KNOW)

551 A. Do (you/they) have definite plans to move within the next few months?

1 Yes

2 No.....(Go to Question 552 A)

9 Unknown....(Go to Question 552 A)

551 B. Where do (you/they) expect to be living? (GET STREET AND TOWN IF POSSIBLE)

_____

552 A. Whether or not (you/they) plan to move, it is important for us to be able to stay in touch with (you/them) over the next year. Will you give us the name of a friend or relative whom we can contact if we ever have trouble reaching (you/them)?

1 Yes... RECORD NAME, ADDRESS, AND TELEPHONE NUMBER OF CONTACT BELOW

2 No

B. What is the person's name? _____

C. What is (his/her) address? _____
(GET STREET AND TOWN)

D. What is (his/her) telephone number? (____) - _____

We've just completed the family interview. Now, I need to record the time and then we'll be ready to start the child interview(s).

553. RECORD THE ENDING TIME OF THE FAMILY INTERVIEW. __ __:__ __ AM / PM

407 A. Which of the following groups best describes (your/her) occupational status? (Are you/is she).....(READ ALL CHOICES LISTED BELOW.)

1 Unemployed..(Go to Question 408)

2 Homemaker...(Go to Question 408)

3 Employed part time, that is, less than 20 hours a week

4 Employed full time, that is, 20 or more hours a week

5 Something else such as disabled....(Go to Question 408)

407 B. What is (your/her) job title?

_____

407 C. What are (your/her) job duties?

_____

407 D. What sort of business or industry (do you/does she) work in? That is, what does the place where (you work/she works) make or do?

_____

408. What is the highest grade in school that (you/she) completed? (IF HIGH SCHOOL OR COLLEGE: Did (you/she) graduate?)

1 Less than 8th grade

2 Eighth grade

3 1-3 years high school

4 High school graduate

5 Vocational school or other non-college post

6 1-3 college

7 A college degree

8 Graduate work

9 Unknown

409. What is (your/her) age? _____

410. Does (your/CHILD'S NAME) family use the WIC (WOMEN, INFANTS AND CHILDREN) program?

1 Yes

2 No

9 Unknown

411 A. What kind of medical insurance or health care coverage does (your/CHILD'S NAME) family have? Do (you/they) have_____? (READ ALL CHOICES BELOW.)

a. Private insurance, for example, Blue Cross/Blue Shield	1 Yes	2 No	9 Unknown
b. Medicaid	1 Yes	2 No	9 Unknown
c. A health maintenance organization (HMO) plan, for example, Harvard Community Health	1 Yes	2 No	9 Unknown

411 B. Is there any other kind of medical or health insurance that I have not mentioned that either your family or (CHILD'S NAME) has?

1 Yes

2 No.....(Go to question 500)

9 Unknown..(Go to question 500)

411 C. What is it?

_____

DEMOGRAPHICS

400. What is your relationship to (CHILD'S NAME)?

1 Mother (include stepmother).....(Go to Question 402)

2 Father (include stepfather).....(Go to Question 402)

3 Female Guardian (non relative)....(Go to Question 402)

4 Male Guardian (non relative).....(Go to Question 402)

5 Sister

6 Brother

7 Other Relative

8 Friend of the family or baby sitter

IF R IS A SISTER, BROTHER, OTHER RELATIVE, FRIEND OR BABY SITTER, ASK Q 401.

401. Do you consider yourself (CHILD'S NAME) guardian?

1 Yes

2 No

9 Unknown

NOTE: QUESTIONS 402 to 411 REFER TO THE PARENTS OR GUARDIANS OF THE LFK CHILD(REN).

402. Do (you/CHILD'S NAME parents or guardians) own or rent (your/their) (apartment/house)?

1 Rent

2 Own

9 Unknown

403. What is (your/CHILD'S NAME parent's/guardian's) current marital status? Are (you/they).....(READ ALL CHOICES LISTED BELOW.)

1 Married

2 Single but living together

3 Never Married

4 Divorced

5 Separated

6 Widowed

404 INTERVIEWER CHECK: IS R CHILD'S MOTHER OR FEMALE GUARDIAN?

1 ( ) YES.....Ask Questions 407A-409

2 ( ) NO.....Ask Questions 405-406

405. Does (CHILD'S NAME) mother or female guardian live with (him/her)?

1 Yes (Go to Question 407 A)

2 No

9 Unknown

406. About how often does (CHILD'S NAME) see his mother or female guardian?

1 Never (Go to Question 409)

2 Less than once a year (Go to Question 409)

3 A few times a year (Go to Question 409)

4 About once a month

5 At least once a week

350. HOBBIES (CONTINUED) In the last year (FEBRUARY 1989 TO TODAY), has anyone around your house been involved in .....? (READ LIST)

G. Soldering electronic parts	1 Yes	2 No	3 Unknown
H. Soldering pipes or doing plumbing	1 Yes	2 No	3 Unknown
I. Making lead-glazed pottery	1 Yes	2 No	3 Unknown
J. Making jewelry	1 Yes	2 No	3 Unknown

HOUSING CHARACTERISTICS

375 A. To the best of your knowledge, was your house or apartment building built before World War II, that is, before 1940?

1 Yes

2 No

9 Unknown (Go to question 376 A)

375 B. In what year was it built?

Year __ __ __ __ (FILL IN "9999" IF R DOESN'T KNOW)

376 A. Since you have been living here, have you or anyone else <u>ever</u> removed or sanded paint from the walls or woodwork <u>inside</u> your house?

1 Yes

2 No.....(Go to question 377 A)

9 Unknown..(Go to question 377 A)

376 B. What month and year was the last time this work was done?

Month __ __ Year 1 9 __ __ (FILL IN "99" IF R DOESN'T KNOW)

377 A. Since you have been living here, have you or anyone else ever removed or sanded paint from any part of the outside of your house?

1 Yes

2 No.....(Go to question 390)

9 Unknown..(Go to question 390)

377 B. What month and year was the last time this work was done?

Month __ __ Year 1 9 __ __ (FILL IN "99" IF R DOESN'T KNOW)

FOOD PREPARATION

390. Do you have any pottery or ceramics that might have come from a foreign country that you use for cooking or serving food?

1 Yes

2 No

9 Unknown

391. Do you have any pottery or ceramics that might be hand-made that you use for cooking or serving food?

1 Yes

2 No

9 Unknown

392. Is any of your family's food stored in the original cans after they are opened, for example, canned fruit juice?

1 Yes

2 No

9 Unknown

LEAD WORK

300 A. Now I'm going to ask you about jobs that you and other members of your household have held. I want you to tell me, as best you can, if any member of your household has worked in any of these jobs in the last year. These jobs may involve exposure to lead. I want you to include anyone who was living here this year even if they aren't here now. In the past year (FEBRUARY 1989 TO TODAY), has anyone in your household worked in a job that included.....(READ LIST)

(REMEMBER TO REPEAT "IN THE PAST YEAR.... " EVERY SO OFTEN)

a. Battery work

b. Metal work

c. Oil refining

d. Painting

e. Demolition

f. Welding

g. Chemical processing

h. Plumbing

i. Sandblasting

j. Glass Work

k. Window replacement

l. Autobody work

m. Road stripe painting

n. Metal recycling

o. Radiator repair

p. Shooting guns

q. Lead smelting

r. Foundry work

s. Mechanical work, that is a mechanic

t. Paint-pigment, zinc or copper work

u. Deleading

v. Any other lead handling work

RECORD "YES" IF R ANSWERS TO ANY ONE OF THESE JOBS, CIRCLE LETTER(S) THAT APPLIES AND CONTINUE WITH QUESTIONS 300 B.- 300 D. RECORD "NO" IF R ANSWERS TO NONE OF THESE CATEGORIES AND CONTINUE THE INTERVIEW WITH 350.

1 Yes

2 No (Go to Question 350)

ASK Q 300 B.- 300 D. CONSECUTIVELY FOR ONE ITEM, THEN REPEAT FOR ANY OTHER.

	#1	#2	#3	#4	#5
300 B. LIST SEPARATELY EACH OF THE ITEMS CIRCLED.	_____	_____	_____	_____	_____
300 C. Does the person doing _____ usually change out of his or her clothes and leave them at work?	1 Yes 2 No 9 Unknown	1 Yes 2 No 9 Unknown	1 Yes 2 No 9 Unknown	1 Yes 2 No 9 Unknown	1 Yes 2 No 9 Unknown
300 D. Does the person usually shower before coming home from work?	1 Yes 2 No 9 Unknown	1 Yes 2 No 9 Unknown	1 Yes 2 No 9 Unknown	1 Yes 2 No 9 Unknown	1 Yes 2 No 9 Unknown

HOBBIES

350. Now I'm going to ask you about hobbies or activities. I'm interested in hobbies and activities that any people may do in your house or right around your house whether or not they live with you. In the last year (FEBRUARY 1989 TO TODAY), has anyone around your house been involved in .....? (READ LIST BELOW.)

A. Remodeling or repairing your house or apartment	1 Yes	2 No	3 Unknown
B. Painting parts of your house or furniture in your house	1 Yes	2 No	3 Unknown
C. Painting pictures with artists' paints	1 Yes	2 No	3 Unknown
D. Painting bicycles or cars	1 Yes	2 No	3 Unknown
E. Working with stained glass	1 Yes	2 No	3 Unknown
F. Making fishing sinkers, bullets or anything else with lead	1 Yes	2 No	3 Unknown

	Smoker #1	Smoker #2	Smoker #3
200 B. What (is/are) the first name(s) of the (person/people) who smoke(s)?	_____	_____	_____
200 C. How many cigarettes (does SMOKER #1/#2,#3/do you) smoke a day? (FILL IN DK IF R DOESN'T KNOW)	_____	_____	_____
200 D. How many years total (has SMOKER #1,#2,#3/have you) smoked? (FILL IN DK IF R DOESN'T KNOW)	_____	_____	_____

PETS

Now, just a few questions about your household.

250 A. Do you have any dogs in your household?

1 No.....(Go to question 251 A)

2 Yes

9 Unknown.....(Go to question 251 A)

250 B. Does the dog go in and out of the house or does it never come inside?

1 Goes in and out

2 Never comes inside

9 Unknown

251 A. Do you have any cats in your household?

1 No.....(Go to question 261 A)

2 Yes

9 Unknown.....(Go to question 261 A)

251 B Does the cat never go outside, never come inside, or does it go in and out of the house?

1 Never goes outside

2 Never comes inside

3 Goes in and out

9 Unknown

HOUSEKEEPING

261 A. Do you use an electric vacuum cleaner to clean the floors and carpets in your home?

1 Yes

2 No .....(Go to Question 300 A)

9 Unknown...(Go to Question 300 A)

261 B. About how often do you vacuum? Would you say more than once a week, about once a week, or less than once a week?

1 More than once a week

2 Once a week

3 Less than once a week

9 Unknown

261 C. About how often do you change or empty out the vacuum cleaner bag? Would you say often, sometimes or never?

1 Often

2 Sometimes

3 Never

9 Unknown

LEAD FREE KIDS STUDY FAMILY INVERVIEW

FAMID_____ LFK_NUM _____

LFK_NUM _____

LFK_NUM _____

1. RECORD INTERVIEWER'S (YOUR) FIRST AND LAST NAME

FIRST:_____ LAST:_____

2. RECORD INTERVIEWEE'S (PARENT, GUARDIAN, ETC.) FIRST AND LAST NAME

FIRST:_____ LAST:_____

3. RECORD DATE OF FAMILY INTERVIEW. __ __ / __ __ / __ __

Month Day Year

4. RECORD STARTING TIME OF FAMILY INTERVIEW. __ __ : __ __ AM / PM

THE LFK INTERVIEW CONSISTS OF TWO PARTS. THE FIRST PART IS THE FAMILY/HOUSEHOLD INTERVIEW. THE SECOND PART IS A CHILD SPECIFIC INTERVIEW. IF THERE IS MORE THAN ONE LFK CHILD IN A HOUSEHOLD, REPEAT THE CHILD INTERVIEW FOR EACH LFK CHILD. THERE IS NO NEED TO REPEAT THE FAMILY/HOUSEHOLD INTERVIEW.

FAMILY/HOUSEHOLD SECTION

First, I'm going to ask you some questions about your household and family and then I'll ask you about (CHILD'S NAME/CHILDREN'S NAME) who (is/are) participating in the Lead Free Kids study.

CENSUS

(NOTE: A PERSON "LIVES" IN THE HOME IF HE/SHE SPENDS THE NIGHT AT LEAST 50% OF THE TIME.)

100. Including yourself, how many people are living in your home?

__ __ persons

101. How many of the people living in your home are 18 years or older?

__ __ persons

102. How many are less than 18 years of age?

__ __ persons

(REMEMBER NUMBER OF PERSONS MENTIONNED IN Q'S 101 AND 102 SHOULD ADD UP TO THE NUMBER OF PERSONS MENTIONNED IN Q 100.)

103. How many children under 5 years of age live in your home?

__ __ children

SMOKING

200 A. How many people in your household currently smoke cigarettes?

__ __ persons

IF NONE, SKIP TO 250 A. IF ONE OR MORE PERSONS, ASK QUESTIONS 200 B.- 200 D. CONSECUTIVELY FOR ONE PERSON, THEN REPEAT FOR ANY OTHER.

In August 1990, an LFK picnic will be held at Franklin Park, and LFK participant families will be invited to attend. There will be food and games with prizes for the children, musical groups from Boston will be invited to perform, and public officials will attend. The event will be called "LFK Family Appreciation Day" and planning for the event will begin immediately.

From September, 1990 until the end of the project in December, 1990 (deleading phase), the CRD will combine participant retention activities with another project -- assisting participant families in leaving their houses during deleading. To ensure that the deleading phase begins and proceeds smoothly, the CRD will mail out letters reminding participant families when deleading will occur. These letters will be followed up with telephone calls and visits to allay any concerns families may have about leaving their houses.

The CRD will facilitate the moving process by providing boxes for belongings, masking tape, bags, etc. The LFK staff recognize that not all participant families have access to temporary housing. To respond to the needs of these families, the CRD is researching alternative housing. Groups and organizations which the CRD has contacted include: Urban Edge Housing, the Boston Housing Authority, Relocation Associates, John Cruz Construction Co., and other private organizations. The CRD is negotiating for reduced or free housing (20-30 units) in exchange for free deleading. To make the participants' stay as comfortable as possible the CRD is researching and pricing second hand furniture at places such as Morgan Memorial Goodwill and the MIT Furniture Exchange.

In December, 1990 LFK will hold a "Grand Prize" drawing for a 1- week free trip (LFK family will go) to Disney World in Orlando, Florida. The CRD is currently researching this trip and will approach: Pan Am, US Air, Piedmont, American Airlines, United Airlines, Holiday Inn, Viscount Hotel, etc. The trip will take several months of careful planning beginning at the end of January and continuing through early December. If the trip is found to be unfeasible, the CRD will hold a December Xmas drawing for a color TV, Stereo, or VCR.

EDUCATION/AWARENESS

The Community Advisory Committee (CAC) has been formed to facilitate the dissemination of information about LFK and lead poisoning to organizations accessible by the CAC.membership. The CAC is drawn from a broad range of public officials, academics, and agency heads. Among its members are: State Representative Nelson Merced, Boston City Councilman Charles Yancey, Paul Bracy, an official in the Department. of Public Health , and Wornic Reed, PhD, Director of the Trotter Institute at the University of Massachusetts. These community leaders have affiliations through their places of employment, social organizations, etc.

CAC members are currently involved in mobilizing their networks to establish a commitment to lead poisoning prevention. In addition, CAC members have been in the process of heightening sensitivity to the lead problem, by motivating their organizations to place lead on their agenda as a priority. The fruit of these efforts is becoming apparent as evidenced by the appearance of lead poisoning in Boston on the agenda of a statewide conference convened on 6/6/89. attended by several hundred community members and leaders.

The CAC is scheduled to meet every other month with the CRD to provide members with updated information on the LFK project and to be informed of their progress in executing the plan. Due to landlord recruitment and retention activities during the summer and fall of 1989, the CRD was unable to convene CAC meetings on a regular basis. In 1990, this will be a priority, and meetings will be scheduled on a monthly basis until the project ends in December 1990.

The third round of presentations will be made to churches in Roxbury, Dorchester, Mattapan, and Jamaica Plain. As the primary institution serving the minority community in these areas, the church is in a good position to disseminate information on lead poisoning. Churches will be sent a letter and information about lead poisoning beginning mid-February. Like the health and daycare centers, these letters will be followed by telephone calls. Appointments will be scheduled for March, April, May, and June with the Thirty churches (See list, Attachment D). Presentations will be scheduled at the larger churches, since they have Monday-Friday business hours. The target churches will be: Resurrection Lutheran Church, Eliot Congregational Church, Charles Street AME Church, Mohammad's Mosque #11, Holy Tabernacle Church, Twelfth Baptist Church. St. Mark Congregational Church, St. Francis deSalles Catholic Church, Mission Church, and the Presbytarian Church of Roxbury. The Rev. Thomas of Charles St. AME Church and Minister Muhammed of the Mosque are members of the Community Advisory Committee. Their assistance in contacting churches and arranging presentations will facilitate the process.

In recognition of the cultural and linguistic diversity of LFK participant families, presentations will be made in March to ethnic community centers. These centers and directors are:

Luis Prado,
Executive Director
Alianza Hispana
409 Dudley Street
Roxbury, MA 02119
(617) 427-7175

James Talero
Executive Director
Oficina Hispana
de la Comunidad
125 Amory St.- Bldg. A
Roxbury, MA 02119
(617) 522-2222

Charles Victor
League of Haitian
Families
16a Mass. Ave.
Roxbury, MA 02119
(617) 266-3363

RETENTION ACTIVITIES/ALTERNATIVE HOUSING

In addition to landlord recruitment and education/ awareness activities, a primary focus of the Community Relations Department is participant retention. LFK is by nature a very intrusive project. As a result, it is critical that incentives be provided for participants to continue. Retention will be particularly important as the deleading phase begins. The plan to retain participants began in July 1989 when the CRD contacted local merchants in order to secure department store gift certificates, supermarket discounts and gift certificates, and donations of toys.

The following stores were contacted during the months of July and August: Star Market, Stop & Shop, Purity Supreme , Robell's Department Store, Ames Dept. Store, Bradlee's, Filene's, Edward's Food House, McDonald's, and Jordan Marsh. All responded positively. Attached are copies of the letter that was mailed to area merchants and the gift certificate selection form. (Attachment E) Each month, participant families will receive a $25. coupon/gift certificate to the store of their choice. At the end of the project in December 1990, LFK will give each participant family a large gift such as a vacuum cleaner.

In addition to the monthly gift certificates, the CRD plans to hold monthly lotteries beginning in May and ending in November. At the beginning of each month, participant families will be notified of the "prize of the month." Prizes will include tickets to events in Boston (comedy acts, movies, plays, special museum exhibitions, concerts, and dinners to selected restaurants). Family names will be placed in a container, and a drawing will be held by LFK to choose the winning family. .

During the months of June, July, August, and September CRD will plan events which focus exclusively on the 156 children in the project. Each week, a group of ten-fifteen children will be taken to the following places: Franklin Park Zoo, Jamaica Pond, Arnold Arboretum, Blue Hills, the Boston Harbor Islands (George's, Castle and Thompson), The Aquarium, the Museum of Fine Arts, the Museum of Science, Plumb Beach, etc. By the end of September, all 156 children will have gone on an LFK field trip.

The Community Relations Department will prepare slide presentations, (slide presentation courtesy of the Office of Environmental Affairs) for community organizations such as daycare centers, churches, neighborhood centers, and health centers. The presentations will explain the Lead Free Kids program and its impact on Roxbury, Dorchester, Mattapan, and Jamaica Plain and will be done as a slide show (see attachment A). The narrative for the slide show addresses the problem of lead in the Boston area and explains the sources of lead (paint, dust, soil, etc.) and its impact on the environment and people. Some data indicating the effects of exposure to lead in children and pregnant women is also provided. The accompanying slides show the Emergency Lead Poisoning areas, statistics indicating the disastrous effects of lead poisoning, lead paint chips and other photos.

The target community organizations are in Roxbury, Dorchester, Mattapan, and Jamaica Plain and are receiving the most attention, because they are the areas most adversely affected by lead contamination. The slide show, which will be shown two - three times a week for the next four - five months, is a valuable medium through which crucial, little- known information can be disseminated. Attached is a list of all the organizations contacted. Some presentations have already been made to (Upham's Corner Health Center on 12/8/89 and Bowdoin St. Health Center on 7/27/89.)

The first group of organizations to be contacted is community health centers. On January 3, 1990, a letter (Attachment B) requesting time for a slide show presentation was mailed out to nine centers in Roxbury, Dorchester, and Jamaica Plain. Follow-up calls were made by the CRD on January 12, 1990. Appointments have been scheduled for the month of February (beginning with the Codman Square Health Center on 1/6/90 at 1:00pm). Enclosed is the list of Community Health Centers and a copy of the letter that was sent. The goal is to make presentations at three centers per week. At this rate the Community Relations Department will complete presentations at CHC's by the third week in February.

The second round of presentations will be made to community daycare centers located in Roxbury, Dorchester, and Jamaica Plain. There are 32 daycare centers, all of which were contacted by telephone between January 16th and January 19th. These initial telephone calls were made to ascertain the name of the center director, and to briefly discuss the LFK project. Letters requesting time for presentations will be mailed out by the end of January. Presentations will be made 3 times per week over a ten-week period, commencing the first week in February and continuing through the first week in May. Attached is the list of daycare centers and the letter sent out by the C.R.D. (Attachment C).

LEAD FREE KIDS COMMUNITY RELATIONS

AND RETENTION PLAN FOR 1990

EXPLANATION:
-CAC meetings were held on: 5/23/89, Planning Committee - meeting with Ron Jones, Wornie Reed, & Paul Bracy; 5/24/89 - CAC meeting; 9/18/89 - planning meeting; 9/29/89 - CAC meeting. (See CAC Advisory Board Membership List)

TECHNIQUES:
-Develop a lead poisoning agenda for the community.

EXPLANATION:
-The vehicle for developing a lead poisoning agenda is the CAC. (Attachment D).

TECHNIQUES:
-Convene LFK Community Relations Project meeting with EPA staff.

EXPLANATION:
-Not done/time constraints, will plan for 1990.

OBJECTIVE 10: To prepare LFK staff for interactions with the community.

TECHNIQUES:
-Conduct briefing meetings, trainings and role playing sessions with field staff prior to specific interactions with community (recruitment, presentations).

EXPLANATION:
-Began April 1989 - and as needed.(Attachment E)

OBJECTIVE 11: To be prepared to aggressively and effectively address any community relations concerns which may develop as the program progresses.

TECHNIQUES:
-Institute a referral protocol for office staff.

EXPLANATION:
-Done.

TECHNIQUES:
-Utilize the CAC to hold meetings as warranted to respond to concerns.

EXPLANATION:
-Under discussion among CAC (Meetings were held at: Roslindale Community Meeting 11/20 9-10pm)

TECHNIQUES:
-Develop a community relations concerns sub-plan.

EXPLANATION:
-Not done- will consider if appropriate.

OBJECTIVE 12: To provide updates on the progress of the community relations aspects of LFK to EPA and other interested parties.

TECHNIQUES:
-Convene LFK Community Relations Project Team meeting with EPA.

EXPLANATION:
-Not Done in 1989, but will plan for 1990.

TECHNIQUES:
-Provide CRP implementation updates at Lead Team meetings.

EXPLANATION:
-Updates given at weekly staff meetings.

TECHNIQUES:
-Publish revised plan as needed.

OBJECTIVE 13: To complete preparation activities necessary for the implementation of the CRP.

TECHNIQUES:
-Conduct interviews with key individuals who can offer suggestions on CRP.

EXPLANATION:
-As needed .

TECHNIQUES:
-Conduct interview with key individuals at BCLPPP and other agencies who are currently, have been or will be involved in lead services and prevention activities to ensure clear communications.

EXPLANATION:
-CRD took case managers to the lead clinic at BCH on June 12, 1989.

EXPLANATION:
-Not done/change in project protocols.

TECHNIQUES:
-Issue a press release and hold a press conference when project is announced.
-Issue press releases at program milestones.
-Distribute fact sheets, newsletters, updates to press

EXPLANATION:
-After extensive conversations with Trustees Public Relations Department, it was determined that it was in the best interest of the project not to publicize each milestone with extensive media coverage. Instead, a press release was released to announce that the project had signed a contract with AOHS. This was in New Hampshire newspapers - not in Boston area papers.

TECHNIQUES:
-Sponsor special events which encourage press coverage.
-Kick-off
-Parent sign-up
-Property owner sign-up
-Announcement of community project
-Soil abatement/blood drawings
-Sponsor special interviews with reporters for articles,TV spots etc.

EXPLANATION:
-Not done - project protocols and sign up procedures are different from those of the initial LFK project.

OBJECTIVE 7: To provide the public with ongoing project information and with information regarding outcomes of the project.

TECHNIQUES:
-Publish newsletter
-Publish/facilitate newspaper/magazine articles

EXPLANATION:
-Not done/may not be appropriate to our participant population.

TECHNIQUES:
-Conduct F/U briefing meetings with public officials, clergy, community service agency heads, health centers, CDC/neighborhood groups (some of these will be group meetings).

EXPLANATION:
-See list of meetings under Objective 1. (Also Attachment D).

TECHNIQUES:
-Sponsor conference to present outcome and discuss next steps.

EXPLANATION:
-Not done due to time constraints and project focus.

TECHNIQUES:
-Utilize media to provide updates to public.

EXPLANATION:
-Will consider utilizing media as project progresses.

TECHNIQUES:
-Sponsor special meetings with collaborating health centers to share information; target nurses and others directly working with LFK clients.

EXPLANATION:
-Meetings with Community Health Centers conducted on: 6/2/89,Fields Corner Health Center; 6/12/89 Upham's Corner Health Center; 6/22/89 Bowdoin Street Health Center; 7/12/89 Dorchester House Health Center; 7/14/89 Dimock St. Health Center; 12/8/89 Uphams Corner Health Center. More meetings are scheduled for 1990. See CRD Plan for 1990.

OBJECTIVE 8: To provide health centers and hospital primary care clinics with information about LFK and develop collaborative relationships.

TECHNIQUES:
-Produce targeted correspondence for key health care professionals (Ex Director, Pediatrics.)

-Conduct additional briefing meetings to discuss details of project implementation.

EXPLANATION:
-See last explanation under Objective 7.

OBJECTIVE 9: To involve the public in advising the project in implementing LFK and in supporting expanded lead poisoning services and prevention efforts.

TECHNIQUES:
-Convene CAC

EXPLANATION:

-Planned for 1990 - not done in 1989 due to time constraints and Community Relations focus on recruitment of landlords. (See CRD plan for 1990 - Retention Activities Section)

TECHNIQUES:

-Initiate family project, such as LFK Cookbook

EXPLANATION:

-Will not be done as part of project.

TECHNIQUES:

-Maintain high profile for project stressing its importance through the use of the media, by maintaining support of community agencies/leaders, and by maintaining the CAC

EXPLANATION:

-This was accomplished in 1989 mainly through CAC meetings held in March, May, and September 1989. See list of CRD meetings under Objective 1 . (See also CRP 1990 -Education/Awareness Section),

OBJECTIVE 5: To encourage property owners on target streets to participate in the Project and to recruit Project participants.

TECHNIQUES:

-Produce a property owner brochure English/Spanish.
-Produce a property owner brochure French/Portuguese.
-Produce a lead and law pamphlet/fact sheet English/ Spanish.

EXPLANATION:

-A fact sheet was produced in English/Spanish and translated into Haitian and Cape Verdean Creole for property owners highlighting the benefits in the LFK project.

TECHNIQUES:

-Produce a lead and law pamphlet/fact sheet (French/Portuguese).

EXPLANATION:

-This was not done - too costly and not necessary for our participant population. Materials were available from OEA that had useful information on the lead law. These were distributed to participants.

TECHNIQUES:

-Conduct door to door recruitment
-Conduct door to door flyering

EXPLANATION:
-Not appropriate to current project protocols.

TECHNIQUES:
-Identify absentee property owners, mail project information with introductory letter, F/U with meeting or telephone call.

EXPLANATION:
-Landlord recruitment began in May and ended on December 8, 1989..

TECHNIQUES:
-Solicit a home improvement service/item as lottery prize for participants.

EXPLANATION:
-The CRD will attempt to secure a large item, such as vacuum cleaner, to be distributed to participants at the end of the project.

TECHNIQUES:
-Provide window decals for participants

EXPLANATION:
-Window decals were distributed to participants.

TECHNIQUES:
-Conduct special events at key periods of the project
-sign-up testing
-soil abatement
-post abatement
-soil abatement 2nd group

EXPLANATION:
-Due to the nature of the project and procedures for participation it was not necessary or appropriate to conduct special events.

TECHNIQUES:
-Sponsor/Facilitate some home/neighborhood beautification project/contest (create window boxes, clean lots and plant flowers, etc.).

EXPLANATION:
-Not done/may consider.

TECHNIQUES:
-Conduct briefing meeting and sign-up in conjunction with neighborhood groups and real estate groups, property owner groups, etc.

TECHNIQUES:

-Produce a lead poisoning pamphlet/fact sheet (French/Portuguese)

-Produce a lead poisoning pamphlet/fact sheet (English/Spanish)

EXPLANATION:

-Fact sheets were produced and distributed in English, Spanish, Haitian & Cape Verdean Creole about the project, its advantages to participants and benefits that are part of participating.

TECHNIQUES:

-Distribute PR materials to project participants (T shirts, buttons, etc).

EXPLANATION:

-As participants signed up they received T shirts, buttons, balloons and decals (See Attachment B).

TECHNIQUES:

-Conduct special events at key periods, such as blood drawing.

EXPLANATION:

-Due to the nature of the project and procedures for participation it was not necessary or appropriate to make sign-up, blood drawing, etc., special events.

TECHNIQUES:

-Solicit a special prize, such as a gift certificate for the LFK child - furniture, educational toy, etc to be used in a lottery for participants.

EXPLANATION:

-During the last week in July, a letter was mailed to: Star Market, Stop & Shop, Purity Supreme, Bradlee's, Filene's, Jordan Marsh, and Edward's Food Warehouse Follow-up calls were made on 8/2/89. The letter and telephone call requested gift certificates, discounts, and donations. These merchants, along with McDonald's responded positively. These incentives are designed to facilitate participant retention. Participant families began receiving monthly gift certificates in 1/90. (Attachment C)

TECHNIQUES:

-Conduct door to door recruitment through nursing
-Conduct door to door flyering
-Conduct briefing meetings and sign-up meetings in conjunction with community agencies such as day care/social service agencies

EXPLANATION:

-Not done - change in recruitment procedures/project needs.

TECHNIQUES:

-Participate in health fairs, community days and other opportunities to publicize project. (Attachment Ba)

EXPLANATION:

-LFK was publicized at: 5/7/89 World Health Day - State House, Boston; 6/2/89 King School Health Fair; 6/7/89 Black Agenda, Roxbury Community College; 6/24/89 U Mass Boston, "Future of our Urban Environment"; 10/14/89 Upham's Corner Fair.

OBJECTIVE 4: To retain participation of registered families in the LFK Project.

TECHNIQUES:

-Conduct special recognition events at key period, such as Parent sign-up.

EXPLANATION:

-Since participant sign-up was ongoing this was not applicable to current project protocols. Special events are projected for 1990 as incentives to project retention. For example, picnics and photo sessions with local politicians/dignitaries. (See CRD Plan for 1990 - Retention Activities Section)

TECHNIQUES:

-Blood Screening.
-Post Blood Screening recognition event.

EXPLANATION:

-Not applicable to current project procedures.

TECHNIQUES:

-Solicit special giveaways such as gift certificates to be used in a lottery for participants.

EXPLANATION:

-The Community Relations Department contacted daycare centers in Dorchester and Roxbury but was unable to follow-up with any meetings or presentations about the project in 1989. Sign up meetings are incompatible with the current project design. Instead letter will be mailed out and follow up telephone calls made to schedule dates for presentations about the project during 1990. Churches were not contacted in 1989, but will be in 1990.(See CR Plan for 1990 Attachment C).

TECHNIQUES

-Conduct "LFK Sunday" at key churches in Roxbury, Dorchester, Mattapan, and Jamaica Plain.

EXPLANATIONS:

-The Community Relations Department was unable to conduct "LFK Sunday" at churches during 1989. A decision regarding "LFK Sunday" will be made in 1990, after consulting with Rev. Thomas of Charles St. AME, and Minister Don Muhammad of Mosque #11. These two clergymen are on the Community Advisory Committee of the LFK Project.

TECHNIQUES:

-Community Relations Department will develop a 20 - 30 minute slide presentation to disseminate information about lead poisoning. This slide show will be presented to health centers, community centers, day care centers and churches.

EXPLANATION:

-The CRD did not develop a slide show in 1989. This will be done in 1990. (See CRP 1990 p.1)

TECHNIQUES:

-Conduct/facilitate TV commentary/news spots and radio talk shows to discuss the LFK project. Produce/facilitate newspaper/magazine articles.

-Publish/distribute 1st LFK Newsletter introducing project and providing background information.

EXPLANATION:

-Based on project needs and current project focus a decision was made not to conduct TV spots or to publish articles and newsletters.

TECHNIQUES:

-Develop fact sheets for project staff as needed to ensure consistent communication with public

Objective 2: To encourage name recognition and gain broad public exposure for LFK

TECHNIQUES:

-Purchase window decals (5000)
-Purchase LFK T shirts (325)
-Purchase buttons (10000)
-Purchase stickers (10000)
-Purchase balloons (10000)

EXPLANATION:

-These items were obtained and made available for distribution in early 1989. All participant family members received an item. (Attachment B)

TECHNIQUES:

-Produce/distribute radio PSA.

EXPLANATIONS:

-Because recruitment procedures for the LFK Project were different from those of the first LFK project, it was determined that extensive public exposure would not be necessary.

TECHNIQUES:

-Produce poster.

EXPLANATION:

-Posters were not made because:
(1) cost
(2) lack of need

TECHNIQUES:

-Utilize the media to augment name recognition.

EXPLANATION:

-It was decided that the project would not be enhanced in the Boston area by utilizing the media.

Objective 3: To encourage parents with children under 6 from the LFK areas to participate in the Project and to recruit project participants.

TECHNIQUES:

-Produce a parent brochure (English/Spanish).
-Produce a parent brochure (French/Portuguese).

EXPLANATION:

-A parent brochure was produced in May 1989 in Spanish/English. The same information in the brochure was produced in Haitian Creole and Cape Verdean Creole. (See Attachment A).

Objective 1: To provide the public with information about the LFK Project, the effects of lead exposure, and the rate of lead poisoning.

TECHNIQUES:

-Publish generic brochure (brief) - English/Spanish.
-Publish generic brochure (brief) - French/Portuguese.
-Publish generic brochure - English.
-Publish Lead Poisoning pamphlet /fact sheet-
-English/Spanish.
-Publish Lead and the Law pamphlet/fact sheet -
-English/Spanish.

EXPLANATION:

-Based on discussions among project management staff, a decision was made to create a parents' brochure in English. This brochure was translated into Spanish, Portuguese Creole, and Haitian Creole. These translations have proven effective, as many Lead Free Kids participants do not speak English. (Attachment A)

TECHNIQUES:

-Conduct briefing meetings with community public officials.
-Conduct briefing meetings with community service agency heads.
-Conduct briefing meetings with CDC/neighborhood associations. (Attachment 1A)

EXPLANATION:

-In order to alert the broader Boston community about the Lead Free Kids Project, briefing meetings were held with community public officials, community service agency heads, and neighborhood associations. These organizations are located in the LFK target areas: Roxbury, Dorchester, Mattapan, and Jamaica Plain. During 1989, meetings were held with the following:

MAY 1989

-5/5/89 - Roxbury Police Dept.-Deputy Superintendent.
-5/7/89 - World Health Day - State House.
-5/23/89 -Cross Cultural Workshop - Boston City Hospital.
-5/31/89 -Phyllis Cater, Dir., Member Services, Neighborhood Health Plan.

JUNE 1989

-6/1/89 - Long School Health Fair.
-6/2/89 - Fields Corner Health Center.
-6/12/89 - Upham's Corner Health Center.
-6/15/89 - Roxbury Community College.
-6/22/89 - Bowdoin Street Health Center.
-6/24/89 - University of Massachusetts, Boston - "Future of our Urban Environment" conference.

JULY 1989

-7/12/89 - Dorchester House Community Health Center.
-7/14/89 - Dimock Street Health Center.
-7/29/89 - Charles Turner - Episcopal City Mission.

AUGUST 1989

-8/9/89 - Marcus Mitchell of Metropolitan Council for Educational Opportunities, Inc. (METCO)

OCTOBER 1989

-10/27/89 Frank O'Brien - Office of the Mayor.

NOVEMBER 1989

-11/10/89 - Al Plough.
-11/16/89 - Roslindale Councilman, Thomas Menino.
-11/20/89 - Roslindale Community Meeting.
-11/28/89 - Reginald Nunnally - Boston Housing Partnership.

DECEMBER 1989

-12/8/89 - Upham's Corner Health Center.
-12/13/89 - Boston Housing Partnership.
-12/21/89 - Boston School Department.

TECHNIQUES:

-Send introductory letter and project information to daycare centers and churches and follow-up with briefing meetings.

-Send follow-up letter to community individuals and organizations

LEAD FREE KIDS COMMUNITY RELATIONS PLAN

AND REVISIONS FOR 1989

Exterior Contracts:

A. Escalada - 23 properties (2 exterior contracts)	$124,963
Tri-State Restorations - 22 properties (2 exterior contracts)	$136,315
Toland & Sons - 1 property	$ 1,000
Total Exterior Deleading Costs	$ 262,278

Dust Wipes: Dust wipe analysis necessary to allow occupants to re-enter their homes clear of lead dust hazard -738@$14.5 $10,701

Materials 738* $2 $ 1,476

Laboratory Start-up for Analysis - equipment $ 997

Total Development, Deleading and Analysis Costs $755,775

Moving and Storage:

41 moves and the storage of possessions $ 33,666

- this figure includes standard moves and storage at $720/move plus 5 cancellations which charged time and materials and extended storage when indicated by the deleading operations -this also includes 391 extra days for storage at a cost of $2,346 in excess of the storage included in the move agreement .- see Billing Record for Relocation Specialists for detail.

** Community Relations and Case Management staff oversaw every detail of moving and storage - monitor the packing, move, unpacking, scheduling details, collection of keys and distribution to deleaders and back to owners, etc.

Alternate Housing:

on 7 occasions families absolutely could not find suitable alternate housing and the Project arranged and paid for housing in local guest accommodations - this represents 78 nights of alternate housing $ 11,612

** Community Relations staffhandled all details of alternate housing!!!!

The Department of Labor and Industries refused to grant a waiver of their deleading regulations that would allow on site monitoring (even though there was no provision in the regulation for monitoring). The only possible way to perform on-site safety monitoring, and be in compliance with the law was to keep the inspection staff intact throughout the deleading project. The final compliance letters would then be issued by the inspector who had performed the initial inspection.

Inspections were performed between June and August, 1990. Monitoring of deleading activities took place between August and the end of December.

attachments:

1 Deleading info forms(see Comm relations section in quarterly report)
2 Inspection protocol
3 Specifications
4 Sampling protocol

Cost Report - Lead Free Kids
February 25, 1991

Cost of Interventions:

Deleading:

Development,Inspection and Monitoring:

Three-four full-time temporary staff were hired from April 1990 through approximately February 15, 1991 to help LFK develop an appropriate inspection plan that complied with state regulations, was sensitive to the Project participants, supplied the research component with accurate data and could develop a safe deleading operation where indicated and desired. These same individuals carried out the inspections, monitored the deleadings and issued the compliance certificates.

Approximate costs for staffing:	
April - June 1990 for development	
$1,800/week X 10 weeks	$18,000
June - August 1990 for inspections	
$2,000/week X 12 weeks	$24,000
September 1990 - February 15,1991	$48,000
Total salary cost approx.	$90,000
**One full-time Deleading Coordinator	$40,748

Inspection/Monitoring Costs:	
Equipment -	
Portable XRF	$ 4,147
Respirators -	
4 PAPT Respirators @$546/each	$ 2,186

Deleading Contracts:	
Interior Contracts:	
Paint By Numbers - 11 units	$ 66,700
Action Deleading - 22 units	$190,542
(2 interior contract minus $6,000 in liquidated damages)	
A. Escalada - 11 units	$ 83,000
Toland & Sons - 2 units	$ 3,000
Total Interior Deleading Costs	$343,242

DIVISION OF WORK

Exterior work included the removal of lead paint from chewable surfaces below five feet on the siding , porches, rails, stairs windows and doorways of the building's common areas as well as the exterior surface and required that loose paint above five feet be made intact. In some cases where deteriorated materials existed or when it was too difficult or hazardous to attempt to remove the lead paint from a surface, the item was removed and replaced with new materials similar to materials and workmanship of other like items in the neighborhood or consistent with replacement materials the owner had used. Columns with chewable surfaces were be covered or scraped to a height of 5 feet.

Interior deleading required that more attention be paid to keeping the hazards involved in deleading to a minimum by avoiding dust generating methods whenever possible. Replacement and off site dipping was the general rule, but some use of dry scraping and other hazard generating methods were unavoidable.

DEVELOPMENT OF INSPECTION PROCEDURES

Originally, an inspector from the Office of Environmental

Affairs was going to perform limited inspections and these would provide information on which bids would be based. Several problems arose from this plan. Because these inspections would be performed by a "code enforcement inspector", the law required every unit to be deleaded. Trial limited inspections, performed later, showed that these would not be useful in preparing a deleading plan.

After meetings with the Dept of Public Health it was determined that it was necessary for LFK to hire private inspectors who were not bound by code enforcement inspection requirements. The inspections reports performed by LFK would be filed with the Lead paint Poisoning Prevention Program but would not be perused by the state to force deleading. This allowed LFK to obtain information necessary to the program without putting participant families or owners in legal jeopardy.

In April 1990 private inspectors were hired. Inspection procedures were developed that were consistent with LFK needs and legal requirements. It was expected at the time that the inspectors would perform initial inspections only. LFK case managers would then be trained by an industrial hygiene consulting firm to monitor deleading operations. Final deleading compliance letters would be issued by the OEA inspector after work was completed.

DEVELOPMENT OF THE DELEADING PLAN

PRE-DELEADING PLANNING

Planning of deleading activities began in January, 1990 as the loose paint and dust abatement work came to a close. At this time it was expected that over 100 units would be involved and because of the enormous task that was ahead advice was sought from as many sources possible. All deleading contractors licensed to work in Massachusetts were invited to attend a pre-request for bids "brainstorming" meeting which took place on February 14, 1990. Mark Farfel and Susan Guyeaux, who had been involved in research and development of deleading procedures in Baltimore, were also asked to come to Boston and provide suggestions. Our objective was to lay out tasks and preliminary specifications and get feedback from local contractors and use this information to put together the best project design

possible. Although many issues were settled as a result of this meeting, many more were raised.

It was apparent that no single contractor could handle a project of this size. In fact, several contractors would be required to preform the work.

The most obvious problem was to schedule deleading around the soil abatement project and not cause the soil work to extend into cold weather months when the ground would freeze. It was also necessary to delead the exteriors of buildings <u>before</u> soil removal to prevent possible re-contamination from deleading. These problems lead to developing separate interior and exterior contracts that could be performed independent of each other and prevent delays that could interfere with the soil abatement. It was decided that a total of eight contracts would be needed, four interior and four exterior. This would satisfy the soil abatement needs and allow medium sized, as well as larger deleading companies to bid on the project.

Requests for bids were put out in three phases due to the time involved in preparing lead paint inspections and bid documents. Each phase ended up in competitive negotiations due to budget restraints.

total $33,666

CONTRACTORS

The following contractors working on the Lead Free Kids Project were Licensed by the State of Massachusetts to engage in deleading activities:

Action Deleading
Point West Plaza
21 Torrey Street
Brockton, MA 02401 1-800-649-5323
projects B&G

Paint By Numbers
P.O. Box 128
N. Easton, MA 02356 (508) 230-3777
Project A

A. Escalada Painting Co.
633 Ferry Street
Marshfield, MA 02050 (617) 965-6868
Projects C,D&E

Tri-State Restoration
16 Hazel Drive
Hampstead, NH 03841 (603) 329-5626

Projects F&H

Contractor hired by owner of 40 mozart st:

Tolan and Sons Deleading

44 Coburn Street

Framingham, MA 01701 (508) 879-1382

subcontractor to action deleading:

Webster Environmental

161 Granite Ave.

Dorchester, MA 02124 (617) 265-8004

COST SUMMARY

WIPE SAMPLES

A total of 738 samples were taken (including pre and post interior samples, exterior samples and blanks) and analyzed. (5 samples were not used in assembly of data). At $14.50 per sample, total analytical cost was $10,701.

Materials for sampling cost about $2.00 per sample (guesstimate) resulting in a total expense of $1476.00

There is no breakdown of the inspector's time involved in sample collection and preparation.

INSPECTIONS

Inspectors were involved in three separate phases of work activities; 1) Development of the inspection process

April - June

$1,800/wk X 10 weeks $18,000

2) Lead paint inspections

June - August

$2,000/wk X 12 weeks $24,000

3) Monitoring of deleading

September - February 14, '91

$2,000/wk X 24 weeks $48,000

Total inspection/monitoring $90,000

The inspection staff consisted of three inspectors who worked through the project, one inspection assistant who worked from April through July, and one intern inspector who worked as a monitor from September through early December. Only the three inspectors who were present throughout the project incurred any expenses other than travel. The total amount of misc. expenses was $913.51.

LAB EQUIPMENT: $997. (acid dispenser/centrifuge shaker)

DELEADING CONTRACTS

46 exterior deleadings were performed at a total cost of $262,278.

46 interior deleadings were performed at a total cost of $343,242.

The combined total of interior and exterior deleading came to $605,520.

MOVING AND STORAGE

41 moves X 720	$29,520
5 cancellations X 360	$1,800
extra storage	$2,346

digestion period. Analysis was performed by the Lead Lab at Boston City Hospital using atomic absorption spectrophotomotry (spectroscopy).

By starting the digestion of clearance samples at the LFK office, at least one day per unit was reduced from the turn around time involved in preparation and analysis. Each time re-sampling was required, an additional day was saved. (75 days may have been eliminated from the sample preparation process by beginning digestion at the LFK office.)

The original plan was to do clearance sampling only due to cost restraints. as the deleading project progressed it became possible to do some additional sampling that would allow some pre-deleading sampling to be preformed that would provide some information of the pre-existing conditions. Pre deleading sampling was performed at 17 household interiors.

Clearance sampling performed at the 46 household interiors presented the following information: 32 (70%) of the households were found to have acceptable lead dust levels upon initial clearance sampling. 14 (30%) of the households were found to have unacceptable lead dust levels and required a second cleaning and an additional set of samples was taken. 2 (4% of the total households and 14 % of the households that didn't pass initial clearance

sampling) required an additional cleaning before acceptable lead levels were determined.

The incident of final wipe sample failure was very high. All deleading contractors working for LFK were monitored during deleading activities and wipe samples were not taken unless areas were visibly clean of dust and dirt, according to the regulations and project specifications. This, along with limiting dry scraping to areas where it was absolutely necessary should have provided a work area that was as lead dust free as possible. (Work that is not monitored, where dry scraping is done, and final sampling is not performed may be presenting serious lead dust hazards. These situations should be investigated to determine if they are causing more problems than they are curing.)

Clearance sampling was preformed in conjunction with final inspection activities. An estimate of time spent in sample collection and analysis is about 1 hour per 6 samples. This includes collection, digestion and transport. The total increased time was approximately 123 hours to handle 738 samples. If this sampling was to be done separately from other responsibilities the time involved would take about three times as long.

LEAD FREE KIDS STUDY FOLLOW-UP FAMILY INVERVIEW

FAMID_____ LFK_NUM _____

LFK_NUM _____

LFK_NUM _____

1. RECORD INTERVIEWER'S (YOUR) FIRST AND LAST NAME

FIRST:_____ LAST:_____

2. RECORD INTERVIEWEE'S (PARENT, GUARDIAN, ETC.) FIRST AND LAST NAME

FIRST:_____ LAST:_____

3. RECORD DATE OF FOLLOW-UP FAMILY INTERVIEW. __ __ / __ __ / __ __

Month Day Year

4. RECORD STARTING TIME OF FOLLOW-UP FAMILY INTERVIEW. __ __ : __ __ AM/PM

THE LFK FOLLOW-UP INTERVIEW CONSISTS OF TWO PARTS. THE FIRST PART IS THE FAMILY/HOUSEHOLD INTERVIEW. THE SECOND PART IS A CHILD SPECIFIC INTERVIEW. IF THERE IS MORE THAN ONE LFK CHILD IN A HOUSEHOLD, REPEAT THE CHILD INTERVIEW FOR EACH LFK CHILD. THERE IS NO NEED TO REPEAT THE FAMILY/HOUSEHOLD INTERVIEW.

FAMILY/HOUSEHOLD SECTION

First, I'm going to ask you some questions about your household and family and then I'll ask you about (CHILD'S NAME/CHILDREN'S NAME) who (is/are) participating in the Lead Free Kids study.

SMOKING

200 A. How many people in your household currently smoke cigarettes?

__ __ persons

IF NONE, SKIP TO 250 A. IF ONE OR MORE PERSONS, ASK QUESTIONS 200 B.- 200 D. CONSECUTIVELY FOR ONE PERSON, THEN REPEAT FOR ANY OTHER.

	Smoker #1	Smoker #2	Smoker #3
200 B. What (is/are) the first name(s) of the (person/people) who smoke(s)?	_____	_____	_____
200 C. How many cigarettes (does SMOKER #1/#2,#3/do you) smoke a day? (FILL IN DK IF R DOESN'T KNOW)	_____	_____	_____
200 D. How many years total (has SMOKER #1,#2,#3/have you) smoked? (FILL IN DK IF R DOESN'T KNOW)	_____	_____	_____

PETS

250 A. Do you have any dogs in your household?

1 No.....(Go to question 251 A)

2 Yes

9 Unknown.....(Go to question 251 A)

250 B. Does the dog go in and out of the house or does it never come inside?

1 Goes in and out

2 Never comes inside

9 Unknown

251 A. Do you have any cats in your household?

1 No.....(Go to question 261 A)

2 Yes

9 Unknown.....(Go to question 261 A)

251 B. Does the cat never go outside, never come inside, or does it go in and out of the house?

1 Never goes outside

2 Never comes inside

3 Goes in and out

9 Unknown

HOUSEKEEPING

261 A. Do you use an electric vacuum cleaner to clean the floors and carpets in your home?

1 Yes

2 No .....(Go to Question 262)

9 Unknown...(Go to Question 262)

261 B. About how often do you vacuum? Would you say more than once a week, about once a week, or less than once a week?

1 More than once a week

2 Once a week

3 Less than once a week

9 Unknown

261 C. About how often do you change or empty out the vacuum cleaner bag? Would you say often, sometimes or never?

1 Often

2 Sometimes

3 Never

9 Unknown

262. Compared to when (CHILD'S NAME) first joined the Lead Free Kids Study, would you say that (CHILD'S NAME/your) house is now cleaned more often, less often, or about the same amount?

1 More often

2 Less often

3 About the same

9 Unknown

activities were done safely and with a minimum amount of damage. However, due to the nature of the work involved some damage was inevitable. This was understood by the LFK participant families and owners beforehand, and it was understood that certain corrections would be the responsibility of the property owner.

In order to avoid damage and excess ripping the contractor was required to cut a seam between door and window casings and wallpapered surfaces before removing them, to limit damage. By requiring this there was only one case where wallpaper was torn during the removal of a window casing and because the owner was aware of possible damage and it was pointed out that there was a possibility that this would occur there was no conflict.

Owners were required to remove telephone and electrical cords that came into contact with lead painted surfaces that were addressed before the scheduled deleading start date. If lines were left in place the contractor would take appropriate action to safely work around these areas. However, there were several cases where phone lines were cut or broken due to there being left in place. The contractors were not held responsible for repairs of these lines except when there was obvious lack of consideration taken when removing the lines.

Any damage to walls was corrected by the contractor by filling with joint compound, again all painting was the property owner's responsibility.

Any damage that occurred through neglect or carelessness of work crews was corrected by the party responsible. In cases where there was a dispute as to where responsibility lies the LFK site monitors' and deleading coordinator would determine what course of action, if any was appropriate.

All work sites were strictly monitored by an on site LFK Representative who would interrupt or redirect work for reasons of safety or to request corrections according to the specifications.

CLEARANCE SAMPLING

Clearance sampling was required in two rooms per floor of each interior unit and in the common hallway areas for the exterior contracts. These were required to meet the lead levels indicated in the Massachusetts Lead Law before the unit was considered complete. Three samples were taken in each room from the floor, window sill and window well. In order to reduce the down time involved in preparation of the samples, equipment was obtained by LFK to initiate the sample preparation by adding hydrochloric acid into the samples and rocking them for 10 minutes starting the 15 hour

LEAD WORK

300 A. Now I'm going to ask you about jobs that you and other members of your household have held. I want you to tell me, as best you can, if any member of your household has worked in any of these jobs in the last year. These jobs may involve exposure to lead. I want you to include anyone who was living here this year even if they aren't here now. In the past year (AUGUST 1989 TO TODAY), has anyone in your household worked in a job that included.....(READ LIST)

(REMEMBER TO REPEAT "IN THE PAST YEAR.... " EVERY SO OFTEN)

a. Battery work	l. Autobody work
b. Metal work	m. Road stripe painting
c. Oil refining	n. Metal recycling
d. Painting	o. Radiator repair
e. Demolition	p. Shooting guns
f. Welding	q. Lead smelting
g. Chemical processing	r. Foundry work
h. Plumbing	s. Mechanical work, that is a mechanic
i. Sandblasting	t. Paint-pigment, zinc or copper work
j. Glass Work	u. Deleading
k. Window replacement	v. Any other lead handling work

RECORD "YES" IF R ANSWERS TO ANY ONE OF THESE JOBS, CIRCLE LETTER(S) THAT APPLIES AND CONTINUE WITH QUESTIONS 300 B.- 300 D. RECORD "NO" IF R ANSWERS TO NONE OF THESE CATEGORIES AND CONTINUE THE INTERVIEW WITH 350.

1 Yes

2 No (Go to Question 350)

ASK Q 300 B.- 300 D. CONSECUTIVELY FOR ONE ITEM, THEN REPEAT FOR ANY OTHER.

	#1	#2	#3	#4	#5
300 B. LIST SEPARATELY EACH OF THE ITEMS CIRCLED.	_____	_____	_____	_____	_____
300 C. Does the person doing _____ usually change out of his or her clothes and leave them at work?	1 Yes 2 No 9 Unknown	1 Yes 2 No 9 Unknown	1 Yes 2 No 9 Unknown	1 Yes 2 No 9 Unknown	1 Yes 2 No 9 Unknown
300 D. Does the person usually shower before coming home from work?	1 Yes 2 No 9 Unknown	1 Yes 2 No 9 Unknown	1 Yes 2 No 9 Unknown	1 Yes 2 No 9 Unknown	1 Yes 2 No 9 Unknown

HOBBIES

350. Now I'm going to ask you about hobbies or activities. I'm interested in hobbies and activities that any people may do in your house or right around your house whether or not they live with you. In the last year (AUGUST 1989 TO TODAY), has anyone around your house been involved in .....? (READ LIST BELOW.)

A. Remodeling or repairing your house or apartment	1 Yes	2 No	3 Unknown
B. Painting parts of your house or furniture in your house	1 Yes	2 No	3 Unknown
C. Painting pictures with artists' paints	1 Yes	2 No	3 Unknown
D. Painting bicycles or cars	1 Yes	2 No	3 Unknown
E. Working with stained glass	1 Yes	2 No	3 Unknown
F. Making fishing sinkers, bullets or anything else with lead	1 Yes	2 No	3 Unknown

350. HOBBIES (CONTINUED) In the last year (AUGUST 1989 TO TODAY), has anyone around your house been involved in .....? (READ LIST)

G. Soldering electronic parts	1 Yes	2 No	3 Unknown
H. Soldering pipes or doing plumbing	1 Yes	2 No	3 Unknown
I. Making lead-glazed pottery	1 Yes	2 No	3 Unknown
J. Making jewelry	1 Yes	2 No	3 Unknown

MOVED

360 A. (Have/Has) (you/CHILD'S NAME family) moved from the original apartment or house where (your/CHILD'S NAME) family lived when (you/they) first joined the Lead Free Kids Project? (MOST FAMILIES FIRST JOINED THE PROJECT LAST SUMMER AND FALL.)

1 Yes

2 No.....(Go to question 376 A)

9 Unknown..(Go to question 376 A)

360 B. What is the exact month, day and year that (you/they) moved?

_____ / _____ / _____ (FILL IN 99 IF R DOESN'T KNOW)
Month / Day / Year

RENOVATIONS, DELEADING

Now, I have a few questions about renovations and deleading that might have been done in your (apartment/house).
IF MOVED, SAY: These questions apply to the original premises, house or apartment where (your/CHILD'S NAME) family lived at the start of the project.

376 A. In the past year (AUGUST 1989 TO TODAY), have you or anyone else removed or sanded paint from the walls or woodwork inside your house?

1 Yes

2 No.....(Go to question 377 A)

9 Unknown..(Go to question 377 A)

376 B. What month was the last time this work was done?

Month __ __ (FILL IN "99" IF R DOESN'T KNOW)

377 A. In the past year (AUGUST 1989 TO TODAY), have you or anyone else removed or sanded paint from any part of the outside of your house?

1 Yes

2 No.....(Go to question 378 A)

9 Unknown..(Go to question 378 A)

377 B. What month was the last time this work was done?

Month __ __ (FILL IN "99" IF R DOESN'T KNOW)

378 A. In the past year (AUGUST 1989 TO TODAY), was the outside of your house deleaded?

1 Yes

2 No.....(Go to question 379 A)

9 Unknown..(Go to question 379 A)

378 B. What month was the last time this work was done?

Month __ __ (FILL IN "99" IF R DOESN'T KNOW)

379 A. In the past year (AUGUST 1989 TO TODAY), was the inside of your house deleaded?

1 Yes

2 No.....(Go to question 380 A)

9 Unknown..(Go to question 380 A)

379 B. What month was the last time this work was done?

Month __ __ (FILL IN "99" IF R DOESN'T KNOW)

379 C. Did (your/CHILD'S NAME'S) family move off the premises while the interior deleading was being done?

1 Yes

2 No

9 Unknown

379 D. Who did the deleading? Was it done by yourselves or a contractor?

1 Yourselves....(Go to question 380 A)

2 Contractor

3 Don't Know

379 E. What was the name of the contractor?

_____

379 F. Was the contractor a certified deleader?

1 Yes

2 No

9 Unknown

380 A. In the past year (AUGUST 1989 TO TODAY), have you or anyone else renovated or remodeled the inside of your house?
(RENOVATIONS MIGHT INCLUDE REMODELLING THE KITCHEN, BATHROOM, PLASTERING, KNOCKING DOWN WALLS, ETC. PAINTING OR WALLPAPERING ALONE WOULD NOT COUNT.)

1 Yes

2 No.....(Go to question 381 A)

9 Unknown..(Go to question 381 A)

380 B. Please describe, as best you can, what renovations were done on the inside of the house.

_____

_____

380 C. What month was the last time this work was done?

Month __ __ (FILL IN "99" IF R DOESN'T KNOW)

381 A. In the past year (AUGUST 1989 TO TODAY), have you or anyone else renovated or remodeled the outside of your house?
(RENOVATIONS MIGHT INCLUDE CHANGES IN STRUCTURE, ADDITIONS, ETC.)

1 Yes

2 No.....(Go to question 382 A)

9 Unknown..(Go to question 382 A)

381 B. Please describe, as best you can, what renovations were done on the outside of the house.

_____

_____

_____

381 C. What month was the last time this work was done?

Month __ __ (FILL IN "99" IF R DOESN'T KNOW)

382 A. (IF PARTICIPANT HAS MOVED SAY: The next few questions are also about the house/apartment (you/CHILD'S NAME family) lived in at the start of the study)
In the past year (AUGUST 1989 TO TODAY) did any of your next door neighbors remove or sand paint from any part of the outside of their house?

1 Yes

2 No.....(Go to question 383)

9 Unknown.....(Go to question 383)

382 B. Which neighbor was it? When facing the front of your house, was it the neighbor to the left of your house, to the right of your house, in back of your house, or somewhere else? (DIRECTIONS SHOULD BE DETERMINED WHEN FACING THE FRONT OF THE PARTICIPANT'S HOME)

1 To the left

2 To the right

3 In back

4 Somewhere else SPECIFY: _____

9 Unknown

383. THIS QUESTION IS ONLY FOR FAMILIES THAT HAVE MOVED. GO TO QUESTION 390 IF THE FAMILY HAS NOT MOVED.

Since you have moved to your new (house/apartment), have you or anyone else sanded paint on the inside or outside of your new place? Renovated the inside or outside? Deleaded the inside or outside?

A. Sanded Paint	1 Yes	2 No	3 Unknown
B. Renovated	1 Yes	2 No	3 Unknown
C. Deleaded	1 Yes	2 No	3 Unknown

LEAD KNOWLEDGE

Now, just a few questions about your thoughts on lead.

390. Compared to when (CHILD'S NAME) first joined the Lead Free Kids Study, would you say that your knowledge about the places where lead is found in and around the home has increased or stayed about the same?

1 Increased

2 Stayed about the same

9 Unknown

391. Compared to when (CHILD'S NAME) first joined the Lead Free Kids Study, would you say that your knowledge about the child health problems associated with lead has increased or stayed about the same?

1 Increased

2 Stayed about the same

9 Unknown

392. Compared to when (CHILD'S NAME) first joined the Lead Free Kids Study, would you say that your opinion about how dangerous lead is to health has increased, decreased, or stayed about the same?

1 Increased

2 Decreased

3 Stayed about the same

9 Unknown

We've just completed the family interview. Now, I need to record the time and then we'll be ready to start the child interview(s).

400. RECORD THE ENDING TIME OF THE FOLLOW-UP FAMILY INTERVIEW.

__ __:__ __ AM / PM

LEAD FREE KIDS STUDY CHILD FOLLOW-UP INTERVIEW

FAMID_____ LFK_NUM _____

1. RECORD INTERVIEWER'S (YOUR) FIRST AND LAST NAME

   FIRST:_____ LAST:_____

2. RECORD INTERVIEWEE'S (PARENT, GUARDIAN, ETC.) FIRST AND LAST NAME

   FIRST:_____ LAST:_____

3. RECORD LFK CHILD'S FIRST AND LAST NAME:

   FIRST _____ LAST:_____

4. RECORD DATE OF FOLLOW-UP CHILD INTERVIEW. __ __ / __ __ / __ __
   Month Day Year

5. RECORD STARTING TIME OF FOLLOW-UP CHILD INTERVIEW. __ __ : __ __ AM/PM

CHILD'S ACTIVITIES DURING THIS SUMMER

Now, I am going to ask how (CHILD'S NAME) spent (his/her) time this summer (JUNE, JULY, AUGUST 1990). I am particularly interested in the amount of time (CHILD'S NAME) spent outdoors.

600 A. This summer, did (CHILD'S NAME) regularly, that is at least once a week, spend time away from home at a .....(READ a).

	600 A.	600 B. Was the (READ a) in Roxbury, Dorchester, Mattapan, or Jamaica Plain?	600 C. This past summer, how many days a week did (he/she) usually go there?	600 D. This past summer, how many hours a day did (he/she) usually spend there?	600 E. This past summer when it was sunny, how many hours a day did (he/she) usually spend outdoors there?
				(FILL IN DK IF R DOESN'T KNOW)	
a. Day care center or family day care	1 Yes 2 No 3 Unknown	1 Yes 2 No 3 Unknown	1 One day 2 Two days 3 Three days 4 Four days 5 Five days 6 Six days 7 Everyday 9 Unknown	_____	_____

600 A. This summer, did (CHILD'S NAME) regularly, that is at least once a week, spend time away from home at a .....(READ b-c).

	600 A.	600 B. Was the (READ b,c) in Roxbury, Dorchester, Mattapan, or Jamaica Plain?	600 C. This past summer, how many days a week did (he/she) usually go there?	600 D. This past summer, how many hours a day did (he/she) usually spend there?	600 E. This past summer when it was sunny, how many hours a day did (he/she) usually spend outdoors there?
				(FILL IN DK IF R DOESN'T KNOW)	
b. Nursery or pre-school	1 Yes 2 No 3 Unknown	1 Yes 2 No 3 Unknown	1 One day 2 Two days 3 Three days 4 Four days 5 Five days 6 Six days 7 Everyday 9 Unknown	_____	_____
c. Baby Sitters' Homes	1 Yes 2 No 3 Unknown	1 Yes 2 No 3 Unknown	1 One day 2 Two days 3 Three days 4 Four days 5 Five days 6 Six days 7 Everyday 9 Unknown	_____	_____

600 A. This summer, did (CHILD'S NAME), regularly that is at least once a week, spend time away from home at a .....(READ d-e).

	600 A.	600 B. Was the (READ d,e) in Roxbury, Dorchester, Mattapan, or Jamaica Plain?	600 C. This past summer, how many days a week did (he/she) usually go there?	600 D. This past summer, how many hours a day did (he/she) usually spend there?	600 E. This past summer when it was sunny, how many hours a day did (he/she) usually spend outdoors there?
				(FILL IN DK IF R DOESN'T KNOW)	
d. Relatives' Homes	1 Yes 2 No 3 Unknown	1 Yes 2 No 3 Unknown	1 One day 2 Two days 3 Three days 4 Four days 5 Five days 6 Six days 7 Everyday 9 Unknown	_____	_____
e. Friends' Homes	1 Yes 2 No 3 Unknown	1 Yes 2 No 3 Unknown	1 One day 2 Two days 3 Three days 4 Four days 5 Five days 6 Six days 7 Everyday 9 Unknown	_____	_____

600 A. This summer, did (CHILD'S NAME) regularly, that is at least once a week, spend time away from home at a .....(READ f).

	600 A.	600 B. Was the (READ f) in Roxbury, Dorchester, Mattapan, or Jamaica Plain?	600 C. This past summer, how many days a week did (he/she) usually go there?	600 D. This past summer, how many hours a day did (he/she) usually spend there?	600 E. This past summer when it was sunny, how many hours a day did (he/she) usually spend outdoors there?
				(FILL IN DK IF R DOESN'T KNOW)	
f. Camp	1 Yes	1 Yes	1 One day	_____	_____
	2 No	2 No	2 Two days		
	3 Unknown	3 Unknown	3 Three days		
			4 Four days		
			5 Five days		
			6 Six days		
			7 Everyday		
			9 Unknown		

601 A. Were there any other places like these that I have not mentioned where (CHILD'S NAME) regularly, that is at least once a week, spent time away from home this summer?

1 Yes

2 No.....(Go to question 602 A)

9 Unknown..(Go to question 602 A)

601 B. What was the place? _____
(FILL IN DK IF R DOESN'T KNOW)

601 C. Was it in Roxbury, Dorchester, Mattapan, or Jamaica Plain?

1 Yes

2 No

9 Unknown

601 D. This summer, how many days a week did (he/she) usually go there?

1 One day a week

2 Two days

3 Three days

4 Four days

5 Five days

6 Six days

7 Everyday

9 Unknown

601 E. This summer, how many hours a day did (he/she) usually spend there?

_____
(FILL IN DK IF R DOESN'T KNOW)

601 F. This summer when it was sunny, how many hours a day did (he/she) usually spend outdoors there?

_____
(FILL IN DK IF R DOESN'T KNOW)

602 A. This summer, did (CHILD'S NAME) regularly, that is at least once a week, visit a park or playground with you or anyone else?

1 Yes

2 No.....(Go to question 603 A)

9 Unknown..(Go to question 603 A)

602 B. What is the name of the park or playground? (FILL IN DK IF R DOESN'T KNOW. IF THERE IS MORE THAN ONE PARK, GET INFORMATION ON EACH ONE.)

_____

602 C. What street and neighborhood is it in? (FILL IN DK IF R DOESN'T KNOW)

_____

602 D. This summer, how many days a week did (he/she) usually go there?

1 Once a week

2 Two days

3 Three days

4 Four days

5 Five days

6 Six days

7 Everyday

9 Unknown

602 E. This summer, how many hours a day did (he/she) usually spend there? (FILL IN DK IF R DOESN'T KNOW)

_____

603 A. This summer, did (CHILD'S NAME) regularly play in any empty lots in your neighborhood?

1 Yes

2 No.....(Go to question 604 A)

9 Unknown.(Go to question 604 A)

603 B. What street is the lot on?
(FILL IN DK IF R DOESN'T KNOW)

_____

603 C. This summer, how many days a week did (he/she) usually go there?

1 One day a week

2 Two days

3 Three days

4 Four days

5 Five days

6 Six days

7 Everyday

9 Unknown

603 D. This summer, how many hours a day did (he/she) usually spend there?

_____
(FILL IN DK IF R DOESN'T KNOW)

Now, I am going to ask you some questions about how (CHILD'S NAME) spent (his/her) time in and around your home this summer.

604 A. In a typical sunny week this summer, did (CHILD'S NAME) spend any time playing outdoors in your home's yard? (DO NOT INCLUDE THE PORCH, STREET OR SIDEWALK HERE. THOSE AREAS ARE ASKED ABOUT IN QUESTION 605.)

1 Yes

2 No.....(Go to question 605 A)

9 Unknown...(Go to question 605 A)

604 B. About how many days a week did (he/she) usually play there?

1 Once a week

2 Two days

3 Three days

4 Four days

5 Five days

6 Six days

7 Everyday

9 Unknown

604 C. On average, how many hours a day did (he/she) usually spend there?
(FILL IN DK IF R DOESN'T KNOW)

_____

604 D. Where did (he/she) usually play in your home's yard? Did (he/she) play in your_____? (READ LIST AND USE SHOW CARD.)

1	Back yard	1	Yes	2	No	9 Unknown
2	Left side of the yard when you face the house	1	Yes	2	No	9 Unknown
3	Right side of the yard when you face the house	1	Yes	2	No	9 Unknown
4	Front yard	1	Yes	2	No	9 Unknown
7	Some other place in your yard (SPECIFY)_____	1	Yes	2	No	9 Unknown

604 E. (Was this area/Were these areas) where (he/she) played grassy? Concrete or asphalt? Plain dirt or soil? A sandbox? Or some other surface?
(USE SHOW CARD.)

1	Grassy	1	Yes	2	No	9 Unknown
2	Concrete or asphalt	1	Yes	2	No	9 Unknown
3	Dirt or soil	1	Yes	2	No	9 Unknown
4	Sandbox	1	Yes	2	No	9 Unknown
7	Other (SPECIFY)_____	1	Yes	2	No	9 Unknown

605 A In a typical sunny week this summer, did (CHILD'S NAME) spend any time playing outside in other areas around the house such as the porch, sidewalk or street?

1 Yes

2 No.....(Go to question 606 A)

9 Unknown....(Go to question 606 A)

605 B How many days a week did (he/she) usually play there?

1 Once a week

2 Two days

3 Three days

4 Four days

5 Five days

6 Six days

7 Everyday

9 Unknown

605 C. This summer, how many hours a day did (he/she) usually spend on the porch, sidewalk, or street?

_____

(FILL IN DK IF R DOESN'T KNOW)

606 A. IF PARTICIPANT HAS MOVED FROM ORIGINAL PREMISES, SKIP QUESTIONS 606 A-C. Compared to when (CHILD'S NAME) first joined the Lead Free Kids Study, have there been any changes in the places outdoors around your home where (he/she) is allowed to play or go? That is, are there any places outdoors around your home where (he/she) is no longer allowed to play or go?

1 Yes

2 No.....(Go to question 607 A)

9 Unknown...(Go to quesiton 607 A)

606 B. Exactly where is (he/she) no longer allowed to play or go?

_____

606 C Why is (he/she) no longer allowed to go or play there?

_____

SKIP QUESTIONS 607 AND 608 IF CHILD NEVER PLAYED OUTSIDE THIS SUMMER.

607 A. This summer, did (CHILD'S NAME) ever take a baby bottle with (him/her) when (he/she) played outdoors?

1 Yes

2 No (Go to Question 608 A)

9 Unknown (Go to Question 608 A)

607 B. About how often did (he/she) do this? Would you say at least once a day, at least once a week but not everyday, a few times a month, or once a month or less? (USE SHOW CARD.)

1 At least once per day

2 At least once per week but not everyday

3 A few times a month

4 Once per month or less

9 Unknown

608 A. This summer, did (CHILD'S NAME) ever eat food when (he/she) played outside?

1 Yes

2 No (Go to Question 609)

9 Unknown (Go to Question 609)

608 B. About how often did (he/she) do this? Would you say at least once a day, at least once a week but not everyday, a few times a month, or once a month or less?

1 At least once per day

2 At least once per week but not everyday

3 A few times a month

4 Once per month or less

9 Unknown

609. This summer when (CHILD'S NAME) was inside at home, did (he/she) play or sit on the floor a lot of the time, some of the time or almost never?

1 A lot of the time

2 Some of the time

3 Almost never.....(Go to question 611 A)

9 Unknown.....(Go to question 611 A)

610. About how many hours on an average day do you think (CHILD'S NAME) usually sat or played on the floor at home?

_____Hours a day playing on floor at home (FILL IN DK IF R DOESN'T KNOW)

611 A. IF PARTICIPANT HAS MOVED FROM ORIGINAL PREMISES, SKIP QUESTIONS 611 A-C. Compared to when (CHILD'S NAME) first joined the Lead Free Kids Study, have there been any changes in the places inside your home where (he/she) is allowed to play or go? That is, are there any places inside your home where (he/she) is no longer allowed to play or go?

1 Yes

2 No.....(Go to question 612)

9 Unknown....(Go to question 612)

611 B. Exactly where is (he/she) no longer allowed to play or go?

_____

611 C. Why is (he/she) no longer allowed to play or go there?

_____

612. In the past year, that is, since AUGUST 1989 has (CHILD'S NAME) slept away from home for more than one consecutive month? (TIME AWAY FROM HOME MIGHT INCLUDE VACATIONS, VISITS TO RELATIVES, OVERNIGHT CAMP, ETC. IT HAS TO BE FOR ONE CONSECUTIVE MONTH TO COUNT.)

1 Yes

2 No

9 Unknown

LFK_NUM _____ PREMID _____ CHILD'S NAME _____

613 A. In the past year, that is, since August 1989 did (CHILD'S NAME) ever spend time away from home at a place that was being renovated?

(PLACES MIGHT INCLUDE DAYCARE CENTER, BABYSITTER'S, FRIEND'S OR RELATIVE'S HOMES. RENOVATIONS WOULD INCLUDE REMODELLING, PLASTERING, KNOCKING DOWN WALLS. PAINTING OR WALLPAPERING ALONE WOULD NOT COUNT.)

1 Yes

2 No

9 Unknown

613 B. Exactly what place was this?

_____

613 C. About how often would (he/she) go there? Would you say often or sometimes?

1 Often

2 Sometimes

9 Unknown

614. In the past year, that is, since August 1989 did (CHILD'S NAME) ever spend time away from home at a place that was being deleaded?

(SAME PLACES AS QUESTION 613 A WOULD BE APPLICABLE.)

1 Yes

2 No

9 Unknown

MOUTHING BEHAVIOR

Children often put things other than food in their mouths such as toys or fingers. Its very natural for them to do this and doesn't necessarily hurt them. Now, I'm going to ask you some questions about things that (CHILD'S NAME) may put in (his/her) mouth.

700. Does (CHILD'S NAME) use a pacifier?

1 Yes

2 No

9 Unknown

701. How often does (CHILD'S NAME) suck (his/her) thumb or fingers? Would you say often, sometimes, rarely, or never?

1 Often

2 Sometimes

3 Rarely

4 Never

9 Unknown

702. Children often explore with their mouths by tasting and touching things with their tongues. Have you ever seen (CHILD'S NAME) put (his/her) mouth or tongue on a windowsill when (he/she) is looking out?

1 Yes

2 No

9 Unknown

703. Have you ever seen (CHILD'S NAME) pick at a windowsill with (his/her) fingers while looking out?

1 Yes

2 No

9 Unknown

704 A. Have you ever seen (CHILD'S NAME) put paint chips in (his/her) mouth?

1 Yes

2 No....(Go to Question 705)

9 Unknown ...(Go to Question 705)

704 B. How often does (CHILD'S NAME) do this? Would you say usually, sometimes, or never?

1 Usually

2 Sometimes

3 Never

9 Unknown

705. Have you ever seen (CHILD'S NAME) eat dirt or sand?

1 Yes

2 No

9 Unknown

706 A. Does (CHILD'S NAME) have a favorite blanket or stuffed toy?

1 Yes

2 No.....(Go to Question 707 A)

9 Unknown..(Go to Question 707 A)

706 B Does (he/she) carry this around during the day?

1 Yes

2 No

9 Unknown

706 C. How often does (he/she) put this in (his/her) mouth? Is it usually, sometimes, or never?

1 Usually

2 Sometimes

3 Never

9 Unknown

707 A. Are there any other things that I have not mentioned that you have seen (CHILD'S NAME) put in (his/her) mouth?

1 Yes

2 No.....(Go to Question 750)

9 Unknown...(Go to Question 750)

707 B. What are these? (LIST ALL MENTIONNED BELOW.)

_____

_____

HAND WASHING

Very few children like to wash their hands and it is often difficult for a parent to make them. Fortunately, there are no rules about how many times a day a child's hands should be washed. Now, I'm going to ask you some questions about washing (CHILD'S NAME) hands. (USE SHOW CARD.)

750. Are (CHILD'S NAME) hands almost always, sometimes or almost never washed before eating meals?

1 Almost always

2 Sometimes

3 Almost Never

9 Unknown

751. Are (his/her) hands almost always, sometimes or almost never washed after eating meals?

1 Almost always

2 Sometimes

3 Almost Never

9 Unknown

752. What about eating snacks? Are (CHILD'S NAME) hands almost always, sometimes or almost never washed before eating snacks?

1 Almost always

2 Sometimes

3 Almost Never

9 Unknown

753. Are (his/her) hands almost always, sometimes or almost never washed after eating snacks?

1 Almost always

2 Sometimes

3 Almost Never

9 Unknown

754. What about playing outdoors? Are (his/her) hands almost always, sometimes or almost never washed after playing outdoors?

1 Almost always

2 Sometimes

3 Almost Never

4 Never plays outdoors

9 Unknown

755. What about bedtime? Are (his/her) hands almost always, sometimes or almost never washed before bed?

1 Almost Always

2 Sometimes

3 Almost Never

9 Unknown

756. Compared to when (CHILD'S NAME) first joined the Lead Free Kids Study, would you say that (CHILD'S NAME) hands are washed more often, less often, or about the same?

1 More often

2 Less often

3 About the same

9 Unknown

WATER CONSUMPTION

Now, a few questions about tap water use.

856 A. Does (CHILD'S NAME) drink plain tap water?

1 Yes

2 No.....(Go to Question 857)

9 Unknown..(Go to Question 857)

856 B. On an average day, about how many 8 ounce glasses of tap water does (he/she) drink? (SHOW 8 OZ CUP.)

_____8 oz. glasses per day (FILL IN DK IF R DOESN'T KNOW)

857. Do you put ice cubes made from tap water into any of (CHILD'S NAME) drinks?

1 Yes

2 No

9 Unknown

858. Do you use tap water to mix with powdered foods that (he/she) might eat?

1 Yes

2 No

9 Unknown

859. Do you use tap water to mix into powdered or frozen drinks like Kool-Aid or orange juice that (he/she) might drink?

1 Yes

2 No

9 Unknown

860. Do you ever mix tap water with any other juices that (CHILD'S NAME) drinks?

1 Yes

2 No

9 Unknown

861. Do you use tap water when you cook (CHILD'S NAME) foods?

1 Yes

2 No

9 Unknown

862. Before using tap water for drinking or cooking, do you let the water run to flush out the system?

1 Yes

2 No

9 Unknown

Now, we have reached the last part of the interview. This section concerns your view of (CHILD'S NAME) behavior. We want to ask about (CHILD'S NAME) behavior because exposure to lead may influence it.

We want you to tell us what you think about (his/her) behavior even if other people might not agree. We are going to read a list of items that describe normal children. We want you to think about (CHILD'S NAME) behavior now or within the last two months and tell us, as best you can, if the item is not true of the child, somewhat or sometimes true of the child, or very true or often true of the child. If there are any items that you do not feel comfortable answering, just tell us and we will skip to the next one.

TAKE OUT SHOW CARD WITH THE ABOVE RESPONSES. GO TO THE CHILD BEHAVIOR CHECK LIST AND ASK ABOUT ALL ITEMS LISTED. CIRCLE THE APPROPRIATE RESPONSES ON THE CHECK LIST. BE SURE TO FILL IN CHILD'S NAME AND LFK NUMBER ON EACH PAGE OF THE CHECK LIST.

CHILD BEHAVIOR CHECKLIST FOR AGES 2-3

For office use only
ID #

CHILD'S NAME

SEX ☐ Boy ☐ Girl

AGE

ETHNIC GROUP OR RACE

TODAY'S DATE Mo _____ Day _____ Yr. _____

CHILD'S BIRTHDATE Mo _____ Day _____ Yr. _____

Please fill out this form to reflect *your* view of the child's behavior even if other people might not agree about the behavior.

PARENT'S TYPE OF WORK *(Please be specific – for example, auto mechanic, high school teacher, homemaker, laborer, mine operator, shoe salesman, army sergeant, even if parent does not live with child.)*

FATHER'S TYPE OF WORK: _____

MOTHER'S TYPE OF WORK: _____

THIS FORM FILLED OUT BY:

☐ Mother (name) _____

☐ Father (name) _____

☐ Other – name & relationship to child: _____

Below is a list of items that describe children. For each item that describes the child now or within the past 2 months, please circle the 2 if the item is very true or often true of the child. Circle the 1 if the item is somewhat or sometimes true of the child. If the item is not true of the child, circle the 0. Please answer all items as well as you can, even if some do not seem to apply to the child.

0 = Not True (as far as you know) 1 = Somewhat or Sometimes True 2 = Very True or Often True

0 1 2 1. Aches or pains (without medical cause)
0 1 2 2. Acts too young for age
0 1 2 3. Afraid to try new things
0 1 2 4. Avoids looking others in the eye
0 1 2 5. Can't concentrate, can't pay attention for long
0 1 2 6. Can't sit still or restless
0 1 2 7. Can't stand having things out of place
0 1 2 8. Can't stand waiting; wants everything now
0 1 2 9. Chews on things that aren't edible
0 1 2 10. Clings to adults or too dependent
0 1 2 11. Constantly seeks help
0 1 2 12. Constipated, doesn't move bowels
0 1 2 13. Cries a lot
0 1 2 14. Cruel to animals
0 1 2 15. Defiant
0 1 2 16. Demands must be met immediately
0 1 2 17. Destroys his/her own things
0 1 2 18. Destroys things belonging to his/her family or other children
0 1 2 19. Diarrhea or loose bowels when not sick
0 1 2 20. Disobedient
0 1 2 21. Disturbed by any change in routine
0 1 2 22. Doesn't want to sleep alone
0 1 2 23. Doesn't answer when people talk to him/her
0 1 2 24. Doesn't eat well (describe): _____
0 1 2 25. Doesn't get along with other children
0 1 2 26. Doesn't know how to have fun, acts like a little adult
0 1 2 27. Doesn't seem to feel guilty after misbehaving
0 1 2 28. Doesn't want to go out of home
0 1 2 29. Easily frustrated
0 1 2 30. Easily jealous
0 1 2 31. Eats or drinks things that are not food (describe): _____
0 1 2 32. Fears certain animals, situations, or places (describe): _____
0 1 2 33. Feelings are easily hurt
0 1 2 34. Gets hurt a lot, accident-prone
0 1 2 35. Gets in many fights
0 1 2 36. Gets into everything
0 1 2 37. Gets too upset when separated from parents
0 1 2 38. Has trouble getting to sleep
0 1 2 39. Headaches (without medical cause)
0 1 2 40. Hits others
0 1 2 41. Holds his/her breath
0 1 2 42. Hurts animals or people without meaning to
0 1 2 43. Looks unhappy without good reason
0 1 2 44. Angry moods
0 1 2 45. Nausea, feels sick (without medical cause)
0 1 2 46. Nervous movements or twitching (describe): _____
0 1 2 47. Nervous, highstrung, or tense
0 1 2 48. Nightmares
0 1 2 49. Overeating
0 1 2 50. Overtired
0 1 2 51. Overweight
0 1 2 52. Painful bowel movements
0 1 2 53. Physically attacks people
0 1 2 54. Picks nose, skin, or other parts of body (describe): _____
0 1 2 55. Plays with own sex parts too much
0 1 2 56. Poorly coordinated or clumsy
0 1 2 57. Problems with eyes without medical cause (describe): _____
0 1 2 58. Punishment doesn't change his/her behavior
0 1 2 59. Quickly shifts from one activity to another
0 1 2 60. Rashes or other skin problems (without medical cause)
0 1 2 61. Refuses to eat
0 1 2 62. Refuses to play active games
0 1 2 63. Repeatedly rocks head or body
0 1 2 64. Resists going to bed at night

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0 = Not True (as far as you know) 1 = Somewhat or Sometimes True 2 = Very True or Often True

0 1 2 65. Resists toilet training (describe). _____

0 1 2 66. Screams a lot
0 1 2 67. Seems unresponsive to affection
0 1 2 68. Self conscious or easily embarrassed
0 1 2 69. Selfish or won't share
0 1 2 70. Shows little affection toward people
0 1 2 71. Shows little interest in things around him/her
0 1 2 72. Shows too little fear of getting hurt
0 1 2 73. Shy or timid
0 1 2 74. Sleeps less than most children during day and/or night (describe). _____

0 1 2 75. Smears or plays with bowel movements
0 1 2 76. Speech problem (describe): _____

0 1 2 77. Stares into space or seems preoccupied
0 1 2 78. Stomachaches or cramps (without medical cause)
0 1 2 79. Stores up things he/she doesn't need (describe): _____

0 1 2 80. Strange behavior (describe): _____

0 1 2 81. Stubborn, sullen, or irritable

0 1 2 82. Sudden changes in mood or feelings
0 1 2 83. Sulks a lot
0 1 2 84. Talks or cries out in sleep
0 1 2 85. Temper tantrums or hot temper
0 1 2 86. Too concerned with neatness or cleanliness
0 1 2 87. Too fearful or anxious
0 1 2 88. Uncooperative
0 1 2 89. Underactive, slow moving, or lacks energy
0 1 2 90. Unhappy, sad, or depressed
0 1 2 91. Unusually loud
0 1 2 92. Upset by new people or situations (describe): _____

0 1 2 93. Vomiting, throwing up (without medical cause)
0 1 2 94. Wakes up often at night
0 1 2 95. Wanders away from home
0 1 2 96. Wants a lot of attention
0 1 2 97. Whining
0 1 2 98. Withdrawn, doesn't get involved with others
0 1 2 99. Worrying
100. Please write in any problems your child has that were not listed above.

0 1 2 _____
0 1 2 _____
0 1 2 _____

PLEASE BE SURE YOU HAVE ANSWERED ALL ITEMS

UNDERLINE ANY YOU ARE CONCERNED ABOUT

WHEN YOU FINISH THE CHILD BEHAVIOR CHECK LIST AND IF NO MORE LFK CHILDREN, SAY: This completes the interview. Thank you very much for cooperation and time. We really appreciate your help.

IF THERE ARE MORE LFK CHILDREN IN THE HOUSEHOLD, SAY: Now, I'm going to ask you the same questions about (OTHER LFK CHILD'S NAME).

1000. RECORD THE ENDING TIME OF THE FOLLOW-UP CHILD INTERVIEW.

__ __:__ __ AM / PM

1001. PLEASE SIGN BELOW.

_____
Interviewer's Signature

FILL IN 1002 AFTER YOU LEAVE.

1002. The quality of this interview is:

1 Reliable

2 Some doubt

3 Unreliable Explain:_____

_____

LEAD FREE KIDS STUDY

LEAD IN SOIL DEMONSTRATION PROJECT, BOSTON

DATA MANAGEMENT PLAN

CONTENTS

General Information:

Data management plan overview ..... p. 1
Database configuration ..... p. 2
File descriptions overview ..... p. 4
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DATA MANAGEMENT PLAN OVERVIEW

1. Introduction

The Lead Free Kids (LFK) database consists of about 21 data files, which are either created by data entry using the Paradox database management system, received from the EPA as Lotus files, or received from the Boston Childhood Lead Poisoning Prevention Program (BCLPPP) as Dbase III+ files. All received files are imported into Paradox for data correction. All Paradox files are converted into Statistical Analysis System (SAS) files for data management and analysis.

2. Organization of Project

The Lead Free Kids project has two distinct data collection phases, the "eligibility" phase and the "study" phase, and each phase requires its own set of data files. During the eligibility phase, information pertaining to criteria for study enrollment were collected in order to identify subjects who were willing and eligible to participate in the study. Computer files generated during the subject recruitment period were used for project management and for a descriptive analysis of the non-participants were transferred from the eligibility data files to the study files. The eligibility data files were archived.

3. Organization of Data

Data collected about four separate units of observation: child, family, unit (premises and apartment concatenated), and premises. Some data files contain repeated measures type data, i.e., the same set of data items for the same unit of observation collected at different times. For instance, blood test results will be collected three times for each child. The goal of the organization of the database is to make it possible to (1) easily match a child to the data that apply to his or her premises or apartment, and to (2) easily match information pertaining to a stage of the study (e.g., pre-abatement, post-abatement, etc.) across all files with repeated measures data (e.g. soil lead measures, dust lead measures, blood lead measures).

The central data file is the KID file which provides the means by which data from different files can be combined to form composite case records. The unit of observation for the KID file is a child, and each observation will contain all the identifiers for that child (child id, family id, premises id, unit id). Any files that do not have identifiers in common can be merged through the KID file.

The repeated measure data contains variables that designate the phase of the study when the test was done. By selecting test results based on values of PHASE, data from different stages of the study can be compared.

DATABASE CONFIGURATION

FILE	DESCRIPTION	OTHER IDENTIFIERS
Files pertaining to children (Identifier is LFK_NUM):		
KID	Data about child, KEY file	
BLOODPB	Blood lead and FEP blood test results	PHASE
KIDINT	First portion of initial child interview	
DIET1-2	Diet portions of initial child interview	
KIDINT_B	Final portion of initial child interview	
FERRITIN	Ferritin blood test results	
HANDWIPE	Handwipe lead results	PHASE
SOURCE	Health care center or provider	
STATUS	Change of status (moved, quit)	STATDATE
FUKID	First follow-up child interview	
HEIGHT	Child's height, weight and blood pressure at first follow-up interview	
PARKID	Assignment of id numbers to parks where children played	
FU2KID	Second follow-up child interview	
Files pertaining to premises (Identifier is PREMID):		
PREMISES	Location of premises, landlord info	
DETAILED	Soil lead results from detailed sampling	SAMPNUM, POSITION
SAMPNUMS	Location of detailed soil samples by soil sample number	SAMPNUM

DATABASE CONFIGURATION

FILE	DESCRIPTION	OTHER IDENTIFIERS
Files pertaining to families (Identifier is FAMID):		
FAMILY	Data that applies to all children in the family	
DATES	Dates of LFK interventions, by FAMID PREMID	
FAMINT	Initial family interview	
FUFAM	First follow-up family interview	
FU2FAM	Second follow-up family interview	
WATER	Water lead results	HK_DATE
CHIPPEEL	Chipping and peeling paint assessment	
PAINT	Interior paint lead measurement	PREMID-APT_NO
Files pertaining to a living unit (Identifier is PREMID-APT_NO):		
DUST	Dust lead results	ROOM, PLACE, PHASE

FILE DESCRIPTIONS OVERVIEW

The following items are described for each data file in the database. An explanation of these items and general information that applies to all data files are given here.

(1) **FILE NAME:**

The file name listed is the SAS dataset name. In almost all cases, the corresponding PARADOX file has the same name. The exceptions are: (1) FAMILY.SSD, which is called FAMILIES.DB in PARADOX (because FAMILY is not a valid PARADOX dataset name), and (2) DETAILED.SSD, which is created by a SAS program (DETAILED.SAS) that concatenates the data received in batches from the EPA. The batches are named by the EPA report number (SOIL12, SOIL13, SOIL14, etc.) in both PARADOX and SAS.

(2) **FILE DESCRIPTION:**

General description of the data in the dataset.

(3) **UNIT OF OBSERVATION:**

Description of unit that one record represents. (One record per child, one record for each phase of study for each child, etc.)

(4) **IDENTIFIER:**

The KEY identifying variable for merging datasets through file KID. (PREMID, LFK_NUM, FAMID, or PREMID-APT_NO).

(5) **ADDITIONAL IDENTIFIERS NEEDED TO UNIQUELY IDENTIFY AN OBSERVATION:**

If there are multiple observations in the data set by the principal identifier, the additional identifiers necessary to identify an observation uniquely are listed here.

(6) **ORIGIN OF DATA:**

The origin of the data is either data entry through PARADOX or, in the case of data files received from the EPA, file conversion from LOTUS.

(7) **LOCATING ORIGINAL SOURCE FOR DATA ITEMS:**

In order to expedite data verifications, each dataset contains all the data items necessary to locate the original paper source (data collection instrument, lab report, etc.) for an observation.

(8) QUALITY ASSURANCE:

The standard data entry validation tools (range checks, picture formats, etc.) were used for all datasets created through data entry. In addition, double entry and hand-checking were used, as specified. The quality of identifiers was assured through table-lookup at data entry. The principal identifiers were validated against a table of valid values, and invalid values were rejected. Valid values called up additional identifying information (name, address, etc.) to verify a correct match.

If the datasets were received from EPA as LOTUS files, SAS programs were used to match the identifiers to the table of valid values, and the validity of the matches was checked by hand.

LEAD FREE KIDS STUDY

ORIGINAL ENROLLED CHILDREN

PREMISES

Group	Frequency	Percent	Cumulative Frequency	Cumulative Percent
---				
A	36	35.6	36	35.6
B	30	29.7	66	65.3
S	35	34.7	101	100.0

FAMILIES

Group	Frequency	Percent	Cumulative Frequency	Cumulative Percent
---				
A	43	34.1	43	34.1
B	39	31.0	82	65.1
S	44	34.9	126	100.0

UNITS

Group	Frequency	Percent	Cumulative Frequency	Cumulative Percent
---				
A	42	34.1	42	34.1
B	38	30.9	80	65.0
S	43	35.0	123	100.0

KIDS

Group	Frequency	Percent	Cumulative Frequency	Cumulative Percent
---				
A	51	33.6	51	33.6
B	47	30.9	98	64.5
S	54	35.5	152	100.0

LEAD FREE KIDS

FILE DESCRIPTION

(1) **FILE NAME:**

KID

(2) **FILE DESCRIPTION:**

Key file containing identifiers for merging data files between levels of relational database structure. Also contains demographical data about child.

(3) **UNIT OF OBSERVATION:**

One observation per child.

(4) **IDENTIFIER:**

LFK_NUM

(5) **ADDITIONAL IDENTIFIERS NEEDED TO UNIQUELY IDENTIFY AN OBSERVATION:**

(6) **ORIGIN OF DATA:**

Data were transferred from data files created during eligibility phase. These data came originally from OEA data files, and were corrected by LFK staff during the preliminary interview.

(7) **LOCATING ORIGINAL SOURCE FOR DATA ITEMS:**

See preliminary interview cover sheet, filed by PREMID.

(8) **QUALITY ASSURANCE:**

Data were verified by families during preliminary interview and again during administration of initial family questionnaire. Changes were made from data correction sheets completed by Assistant Epidemiologist.

LEAD FREE KIDS

FILE DESCRIPTION

(1) **FILE NAME:**

BLOODPB

(2) **FILE DESCRIPTION:**

Blood lead and FEP from all phases of study. (Includes baselines results for children who were not enrolled.)

(3) **UNIT OF OBSERVATION:**

One observation per child and phase of study.

(4) **IDENTIFIER:**

LFK_NUM

(5) **ADDITIONAL IDENTIFIERS NEEDED TO UNIQUELY IDENTIFY AN OBSERVATION:**

PHASE (Values are PRE, POST1, POST2)

(6) **ORIGIN OF DATA:**

Results from ESA blood test reporting slips were copied to data entry sheets. Data entry done from data entry sheets.

(7) **LOCATING ORIGINAL SOURCE FOR DATA ITEMS:**

ESA lab results and data entry sheet on file by ESA receive date (ESADATE). Use LINENUM to reference line on data entry sheet with child's result.

(8) **QUALITY ASSURANCE:**

Computer listing of data file checked against original ESA report slip by hand.

LEAD FREE KIDS

FILE DESCRIPTION

(1) **FILE NAME:**

KIDINT

(2) **FILE DESCRIPTION:**

Initial interview questionnaire data pertaining to a child. KIDINT contains pages 1 through 18 of questionnaire (items 600-806). Other portions of the child interview are in DIET1 & DIET2 (pp. 19-40, items 850-854) and KIDINT_B (pp. 41-48, items 855-1002).

(3) **UNIT OF OBSERVATION:**

One observation per child.

(4) **IDENTIFIER:**

LFK_NUM

(5) **ADDITIONAL IDENTIFIERS NEEDED TO UNIQUELY IDENTIFY AN OBSERVATION:**

(6) **ORIGIN OF DATA:**

Data entry from interview form.

(7) **LOCATING ORIGINAL SOURCE FOR DATA ITEMS:**

Interview forms filed by PREMID.

(8) **QUALITY ASSURANCE:**

100% visual comparison/correction.

LEAD FREE KIDS

FILE DESCRIPTION

(1) **FILE NAME:**

DIET1 and DIET2

(2) **FILE DESCRIPTION:**

Initial interview questionnaire data pertaining to the child's diet. DIET1-2 contains pages 19-40 (items 850-854) of the questionnaire. Other portions of the initial child interview are in KIDINT (pp. 1-18, items 600-804) and KIDINT_B (pp. 41-48, items 855-1002).

(3) **UNIT OF OBSERVATION:**

One observation per child.

(4) **IDENTIFIER:**

LFK_NUM

(5) **ADDITIONAL IDENTIFIERS NEEDED TO UNIQUELY IDENTIFY AN OBSERVATION:**

(6) **ORIGIN OF DATA:**

Data entry from interview form.

(7) **LOCATING ORIGINAL SOURCE FOR DATA ITEMS:**

Interview forms filed by PREMID.

(8) **QUALITY ASSURANCE:**

100% visual comparison/correction.

LEAD FREE KIDS

FILE DESCRIPTION

(1) **FILE NAME:**

KIDINT_B

(2) **FILE DESCRIPTION:**

Initial interview questionnaire data pertaining to a child's father, tap water use, and demographic information. KIDINT_B contains pages 41 to 48 (items 855-1002) of the questionnaire. Other portions of the initial child interview are in KIDINT (pp. 1-18, items 600-804) and DIET1 & DIET2 (pp. 19-40, items 850-854).

(3) **UNIT OF OBSERVATION:**

One observation per child.

(4) **IDENTIFIER:**

LFK_NUM

(5) **ADDITIONAL IDENTIFIERS NEEDED TO UNIQUELY IDENTIFY AN OBSERVATION:**

(6) **ORIGIN OF DATA:**

Data entry from interview form.

(7) **LOCATING ORIGINAL SOURCE FOR DATA ITEMS:**

Interview forms filed by PREMID.

(8) **QUALITY ASSURANCE:**

100% visual comparison/correction.

LEAD FREE KIDS

FILE DESCRIPTION

(1) **FILE NAME:**

FERRITIN

(2) **FILE DESCRIPTION:**

Ferritin test results from Bioran.

(3) **UNIT OF OBSERVATION:**

One observation per child (only baseline obtained).

(4) **IDENTIFIER:**

LFK_NUM

(5) **ADDITIONAL IDENTIFIERS NEEDED TO UNIQUELY IDENTIFY AN OBSERVATION:**

(6) **ORIGIN OF DATA:**

Data entry from Bioran blood test report slips.

(7) **LOCATING ORIGINAL SOURCE FOR DATA ITEMS:**

Filed by LFK_NUM, each result on an individual slip.

(8) **QUALITY ASSURANCE:**

Double entry.

LEAD FREE KIDS

FILE DESCRIPTION

(1) **FILE NAME:**

HANDWIPE

(2) **FILE DESCRIPTION:**

Handwipe test results.

(3) **UNIT OF OBSERVATION:**

One observation per child and phase of study.

(4) **IDENTIFIER:**

LFK_NUM

(5) **ADDITIONAL IDENTIFIERS NEEDED TO UNIQUELY IDENTIFY AN OBSERVATION:**

PHASE (Values are PRE, POST1, POST2)

(6) **ORIGIN OF DATA:**

Lab reports from Dennison Laboratories.

(7) **LOCATING ORIGINAL SOURCE FOR DATA ITEMS:**

Handwipe Analysis Reports filed by form sequence (analysis date).

(8) **QUALITY ASSURANCE:**

100% visual comparison/correction.

LEAD FREE KIDS

FILE DESCRIPTION

(1) **FILE NAME:**

SOURCE

(2) **FILE DESCRIPTION:**

Contains health care provider code for each child for reporting blood lead and FEP to provider. (Health care provider information is also collected during the child interview).

(3) **UNIT OF OBSERVATION:**

One observation per child.

(4) **IDENTIFIER:**

LFK_NUM

(5) **ADDITIONAL IDENTIFIERS NEEDED TO UNIQUELY IDENTIFY AN OBSERVATION:**

(6) **ORIGIN OF DATA:**

Data were transferred from data files created during eligibility phase. These data items came originally from OEA data files, and were corrected by LFK staff during the preliminary interview.

(7) **LOCATING ORIGINAL SOURCE FOR DATA ITEMS:**

See preliminary interview cover sheets, which are filed by PREMID.

(8) **QUALITY ASSURANCE:**

Validated by LFK staff with parents and health care providers.

LEAD FREE KIDS

FILE DESCRIPTION

(1) **FILE NAME:**

STATUS

(2) **FILE DESCRIPTION:**

Any change of status involving participation in the study is registered in STATUS. If a child moves out of his/her original unit, the move is noted here, as well as the new address, if known.

(3) **UNIT OF OBSERVATION:**

An observation for each change of status for each child. A child could have more than one change of status by moving more than once, or moving and later dropping out of the study.

(4) **IDENTIFIER:**

LFK_NUM

(5) **ADDITIONAL IDENTIFIERS NEEDED TO UNIQUELY IDENTIFY AN OBSERVATION:**

Date of change of status report (STATDATE).

(6) **ORIGIN OF DATA:**

Data entry done from "Change of Status" form.

(7) **LOCATING ORIGINAL SOURCE FOR DATA ITEMS:**

Forms filed by LFK_NUM.

(8) **QUALITY ASSURANCE:**

Computer sheet generated at data entry and validated by Assistant Epidemiologist.

LEAD FREE KIDS

FILE DESCRIPTION

(1) FILE NAME:

PREMISES

(2) FILE DESCRIPTION:

Contains data that apply to the premises occupied by the children (address, neighborhood, etc.) and to the owner of the property. Also contains randomization group assignment.

(3) UNIT OF OBSERVATION:

One observation for each premises.

(4) IDENTIFIER:

PREMID

(5) ADDITIONAL IDENTIFIERS NEEDED TO UNIQUELY IDENTIFY AN OBSERVATION:

(6) ORIGIN OF DATA:

Data were transferred from data files created during the eligibility phase. The address information originated at OEA, and the landlord information was entered from the LANDLORD RECRUITING FINAL SHEET.

(7) LOCATING ORIGINAL SOURCE FOR DATA ITEMS:

See premises folders, filed by PREMID.

(8) QUALITY ASSURANCE:

Address and landlord information is continually updated and corrected by the LFK staff through home visits and landlord contacts.

LEAD FREE KIDS

FILE DESCRIPTION

(1) **FILE NAME:**

DETAILED

(2) **FILE DESCRIPTION:**

Contains baseline detailed soil sample results. Each sample is identified by the premises from which it came (PREMID), the assigned sequence number of the sample as noted on the sampling map of the year (SAMPNUM) and by the variable POSITION (TOP or BOTTOM)

(3) **UNIT OF OBSERVATION:**

One observation for each sample result reported. (Usually, a top and a bottom sample for each location)

(4) **IDENTIFIER:**

PREMID

(5) **ADDITIONAL IDENTIFIERS NEEDED TO UNIQUELY IDENTIFY AN OBSERVATION:**

SAMPNUM, POSITION

(6) **ORIGIN OF DATA:**

Data received in LOTUS files from the EPA and converted into SAS files.

(7) **LOCATING ORIGINAL SOURCE FOR DATA ITEMS:**

The variable FILE denotes the EPA report file (and diskette) from which the observation originated. LFK has retained both the diskettes and the hard copies of the file reports as received from the EPA for reference and verification. An observation can be located within a file by the lab ID (LABID), which is a sequential sample number assigned by the EPA. The same method can be used to locate the original result at the EPA labs, which also keeps a record of the results.

(8) **QUALITY ASSURANCE:**

Values can be verified against EPA records using method described above.

LEAD FREE KIDS

FILE DESCRIPTION

(1) FILE NAME:

RECONTAM

(2) FILE DESCRIPTION:

Contains recontamination (surface) soil sample results. Each sample is identified by the premises from which it came (PREMID), the assigned sequence number of the sample as noted on the sampling map of the yard (SAMPNUM).

(3) UNIT OF OBSERVATION:

One observation for each sample result reported.

(4) IDENTIFIER:

PREMID

(5) ADDITIONAL IDENTIFIERS NEEDED TO UNIQUELY IDENTIFY AN OBSERVATION:

SAMPNUM, POSITION

(6) ORIGIN OF DATA:

Data received in LOTUS files from the EPA and converted into SAS files.

(7) LOCATING ORIGINAL SOURCE FOR DATA ITEMS:

The variable FILE denotes the EPA report file (and diskette) from which the observation originated. LFK has retained both the diskette and the hard copies of the file reports as received from the EPA for reference and verification. An observation can be located within a file by the lab ID (LABID), which is a sequential sample number assigned by the EPA. The same method can be used to locate the original result at the EPA labs, which also keeps a record of the results.

(8) QUALITY ASSURANCE:

Values can be verified against EPA records using method described above.

LEAD FREE KIDS

FILE DESCRIPTION

(1) **FILE NAME:**

POSTSOIL

(2) **FILE DESCRIPTION:**

Contains immediate post-abatement (surface) soil sample results. Each sample is identified by the premises from which it came (PREMID), the assigned sequence number of the sample as noted on the sampling map of the yard (SAMPNUM).

(3) **UNIT OF OBSERVATION:**

One observation for each sample result reported.

(4) **IDENTIFIER:**

PREMID

(5) **ADDITIONAL IDENTIFIERS NEEDED TO UNIQUELY IDENTIFY AN OBSERVATION:**

SAMPNUM, POSITION

(6) **ORIGIN OF DATA:**

Data received in LOTUS files from the EPA and converted into SAS files.

(7) **LOCATING ORIGINAL SOURCE FOR DATA ITEMS:**

The variable FILE denotes the EPA report file (and diskette) from which the observation originated. LFK has retained both the diskette and the hard copies of the file reports as received from the EPA for reference and verification. An observation can be located within a file by the lab ID (LABID), which is a sequential sample number assigned by the EPA. The same method can be used to locate the original result at the EPA labs, which also keeps a record of the results.

(8) **QUALITY ASSURANCE:**

Values can be verified against EPA records using method described above.

LEAD FREE KIDS

FILE DESCRIPTION

(1) FILE NAME:

SAMPNUMS

(2) FILE DESCRIPTION:

Contains data about location from which each detailed soil sample was taken within the yard. The location is specified by the side of the house (Left, Right, Front, Back) and the distance in meters between the sample location and that side of the house (M_AWAY). The distance in meters is calculated by the computer from a map measurement (noted in mm.) and from the scale used for that map.

(3) UNIT OF OBSERVATION:

One observation for each sampling location. (NB: Each location will match 2 samples, a TOP and a BOTTOM)

(4) IDENTIFIER:

PREMID

(5) ADDITIONAL IDENTIFIERS NEEDED TO UNIQUELY IDENTIFY AN OBSERVATION:

SAMPNUM

(6) ORIGIN OF DATA:

Data entry from transcription form. A data transcription form was completed for each premises map. The distances were measured by ruler in mm and noted for each sample taken. The scale of the map was also noted (mm/m).

(7) LOCATING ORIGINAL SOURCE FOR DATA ITEMS:

Maps and data transcription forms filed by PREMID.

(8) QUALITY ASSURANCE:

100% visual comparison/correction.

LEAD FREE KIDS

FILE DESCRIPTION

(1) **FILE NAME:**

PARKID

(2) **FILE DESCRIPTION:**

Parks and playgrounds frequented by LFK children were identified by an ID number and linked to each child.

(3) **UNIT OF OBSERVATION:**

One observation for each park or playground.

(4) **IDENTIFIER:**

PARKID

(5) **ADDITIONAL IDENTIFIERS NEEDED TO UNIQUELY IDENTIFY AN OBSERVATION:**

LFK_NUM

(6) **ORIGIN OF DATA:**

Data entry from "PARKID LIST."

(7) **LOCATING ORIGINAL SOURCE FOR DATA ITEMS:**

Forms filed in PARKID folder in results file drawer.

(8) **QUALITY ASSURANCE:**

Computer sheet generated at data entry and validated by Data Analyst.

LEAD FREE KIDS

FILE DESCRIPTION

(1) **FILE NAME:**

FAMILY

(2) **FILE DESCRIPTION:**

Contains data collected during eligibility phase that pertains to all children in a family (telephone numbers, apartment number, parent information).

(3) **UNIT OF OBSERVATION:**

One observation per family.

(4) **IDENTIFIER:**

FAMID

(5) **ADDITIONAL IDENTIFIERS NEEDED TO UNIQUELY IDENTIFY AN OBSERVATION:**

(6) **ORIGIN OF DATA:**

Data were transferred from data files created during eligibility phase. These data came originally from OEA data files, and were corrected by LFK staff during the preliminary interview.

(7) **LOCATING ORIGINAL SOURCE FOR DATA ITEMS:**

See preliminary interview cover sheet, filed by PREMID.

(8) **QUALITY ASSURANCE:**

Data were verified by families during preliminary interview and again during administration of initial family questionnaire. Changes were made from data correction sheets completed by Assistant Epidemiologist.

LEAD FREE KIDS

FILE DESCRIPTION

(1) **FILE NAME:**

FAMINT

(2) **FILE DESCRIPTION:**

Initial interview questionnaire data pertaining to a family.

(3) **UNIT OF OBSERVATION:**

One observation per family.

(4) **IDENTIFIER:**

FAMID

(5) **ADDITIONAL IDENTIFIERS NEEDED TO UNIQUELY IDENTIFY AN OBSERVATION:**

(6) **ORIGIN OF DATA:**

Data entry from interview form.

(7) **LOCATING ORIGINAL SOURCE FOR DATA ITEMS:**

Interview forms filed by FAMID.

(8) **QUALITY ASSURANCE:**

100% visual comparison/correction.

LEAD FREE KIDS

FILE DESCRIPTION

(1) **FILE NAME:**

WATER

(2) **FILE DESCRIPTION:**

Contains tap water sample test results.

(3) **UNIT OF OBSERVATION:**

Two observations for each family.
NB: The actual unit of observation should have been UNIT (The concatenation of PREMID and APT_NO), because it is possible for more than one family to occupy the same unit. If necessary, the file FAMILY can be merged with the WATER file to attach the unit numbers, and the WATER results duplicated for multiple families in the same unit.

(4) **IDENTIFIER:**

FAMID

(5) **ADDITIONAL IDENTIFIERS NEEDED TO UNIQUELY IDENTIFY AN OBSERVATION:**

HK_DATE

(6) **ORIGIN OF DATA:**

Data entry from Hall-Kimbrell test report slip.

(7) **LOCATING ORIGINAL SOURCE FOR DATA ITEMS:**

Use the date received at Hall-Kimbrell (HK_DATE) to locate the original report. Use the Hall-Kimbrell lab ID (HKES_NUM) to locate a result within a report.

(8) **QUALITY ASSURANCE:**

100% visual comparison/correction.

LEAD FREE KIDS

FILE DESCRIPTION

(1) **FILE NAME:**

DUST

(2) **FILE DESCRIPTION:**

Contains dust sample lead level, sample weight, and area samples for each sample reported. NB: The variable LESSTHAN has a value of '<' if the sample weight is less than .005.

(3) **UNIT OF OBSERVATION:**

One observation for each dust sample reported.

(4) **IDENTIFIER:**

UNIT (Concatenated from PREMID and APT_NO)

(5) **ADDITIONAL IDENTIFIERS NEEDED TO UNIQUELY IDENTIFY AN OBSERVATION:**

ROOM (Bedroom, Kitchen, etc.)
PLACE (Window, Floor)
PHASE (PRE, POST1, POST2)

(6) **ORIGIN OF DATA:**

Data entry from DUST SAMPLES DATA FORM. The identifying data and sample description data are filled in by the LFK staff member who obtained the samples. The weight, PbD, and LABID are filled in by the EPA.

(7) **LOCATING ORIGINAL SOURCE FOR DATA ITEMS:**

Each page of results received by LFK from the EPA is assigned a sequential page number (FORM_SEQ). A page contains all the sample data about one unit for one phase of the study. The DUST SAMPLE DATA FORMS are filed by FORM_SEQ.

(8) **QUALITY ASSURANCE:**

100% visual comparison/correction.

LEAD FREE KIDS

FILE DESCRIPTION

(1) **FILE NAME:**

FUFAM

(2) **FILE DESCRIPTION:**

First follow-up interview questionnaire data pertaining to a family.

(3) **UNIT OF OBSERVATION:**

One observation per family.

(4) **IDENTIFIER:**

FAMID

(5) **ADDITIONAL IDENTIFIERS NEEDED TO UNIQUELY IDENTIFY AN OBSERVATION:**

(6) **ORIGIN OF DATA:**

Data entry from interview form

(7) **LOCATING ORIGINAL SOURCE FOR DATA ITEMS:**

Interview forms filed by PREMID.

(8) **QUALITY ASSURANCE:**

100% visual comparison/correction.

LEAD FREE KIDS

FILE DESCRIPTION

(1) **FILE NAME:**

FUKID

(2) **FILE DESCRIPTION:**

First follow-up interview questionnaire data pertaining to a child.

(3) **UNIT OF OBSERVATION:**

One observation per child.

(4) **IDENTIFIER:**

LFK_NUM

(5) **ADDITIONAL IDENTIFIERS NEEDED TO UNIQUELY IDENTIFY AN OBSERVATION:**

(6) **ORIGIN OF DATA:**

Data entry from interview form.

(7) **LOCATING ORIGINAL SOURCE FOR DATA ITEMS:**

Interview forms filed by PREMID.

(8) **QUALITY ASSURANCE:**

100% visual comparison/correction.

LEAD FREE KIDS

FILE DESCRIPTION

(1) FILE NAME:

HEIGHT

(2) FILE DESCRIPTION:

Height, weight, and blood pressure from the first follow-up period were recorded by the nurse/case manager at a time different from the first follow-up interview. Results are found in HEIGHT and can be merged with the interview by LFK_NUM.

(3) UNIT OF OBSERVATION:

One observation per child.

(4) IDENTIFIER:

LFK_NUM

(5) ADDITIONAL IDENTIFIERS NEEDED TO UNIQUELY IDENTIFY AN OBSERVATION:

(6) ORIGIN OF DATA:

Data entry done from "2nd Height, Weight, and Blood Pressure" form.

(7) LOCATING ORIGINAL SOURCE FOR DATA ITEMS:

Forms filed by LFK_NUM within family (FAMID) within premises (PREMID)

(8) QUALITY ASSURANCE:

Computer sheet generated at data entry and validated by Data Analyst.

LEAD FREE KIDS

FILE DESCRIPTION

(1) **FILE NAME:**

FU2FAM

(2) **FILE DESCRIPTION:**

Second follow-up interview questionnaire data pertaining to a family.

(3) **UNIT OF OBSERVATION:**

One observation per family.

(4) **IDENTIFIER:**

FAMID

(5) **ADDITIONAL IDENTIFIERS NEEDED TO UNIQUELY IDENTIFY AN OBSERVATION:**

(6) **ORIGIN OF DATA:**

Data entry from interview form

(7) **LOCATING ORIGINAL SOURCE FOR DATA ITEMS:**

Interview forms filed by PREMID.

(8) **QUALITY ASSURANCE:**

100% visual comparison/correction.

LEAD FREE KIDS

FILE DESCRIPTION

(1) **FILE NAME:**

FU2KID

(2) **FILE DESCRIPTION:**

Second follow-up interview questionnaire data pertaining to a child.

(3) **UNIT OF OBSERVATION:**

One observation per child.

(4) **IDENTIFIER:**

LFK_NUM

(5) **ADDITIONAL IDENTIFIERS NEEDED TO UNIQUELY IDENTIFY AN OBSERVATION:**

(6) **ORIGIN OF DATA:**

Data entry from interview form.

(7) **LOCATING ORIGINAL SOURCE FOR DATA ITEMS:**

Interview forms filed by PREMID.

(8) **QUALITY ASSURANCE:**

100% visual comparison/correction.

LEAD FREE KIDS

FILE DESCRIPTION

(1) **FILE NAME:**

CHIPPEEL

(2) **FILE DESCRIPTION:**

Contains interior chipping and peeling paint assessments by room.

(3) **UNIT OF OBSERVATION:**

One observation for each family.

(4) **IDENTIFIER:**

FAMID

(5) **ADDITIONAL IDENTIFIERS NEEDED TO UNIQUELY IDENTIFY AN OBSERVATION:**

(6) **ORIGIN OF DATA:**

Data entry from INTERIOR PAINT ASSESSMENT FORM. The identifying data and sample description data are filled in by the LFK staff member who made the assessments. The codes for NOT APPLICABLE and other codes are filled in by the assistant epidemiologist or the data analyst.

(7) **LOCATING ORIGINAL SOURCE FOR DATA ITEMS:**

Each page of results received by the data analyst from the LFK staff is assigned a sequential page number (FORM_SEQ). A page contains all the chipping and peeling paint data about one unit. The INTERIOR PAINT ASSESSMENT FORMS are filed by FORM_SEQ.

(8) **QUALITY ASSURANCE:**

100% visual comparison/correction.

LEAD FREE KIDS

FILE DESCRIPTION

(1) **FILE NAME:**

PAINT

(2) **FILE DESCRIPTION:**

Contains interior paint lead measurements (with PGT) by room and location (wall or woodwork).

(3) **UNIT OF OBSERVATION:**

One observation for each unit or family.

(4) **IDENTIFIER:**

FAMID

(5) **ADDITIONAL IDENTIFIERS NEEDED TO UNIQUELY IDENTIFY AN OBSERVATION:**

(6) **ORIGIN OF DATA:**

Data entry from XRF LEAD PAINT MEASUREMENT FORM. The identifying data and sample description data are filled in by the LFK staff member who obtained the samples or, in some cases, by the staff member who abstracted the data from inspection reports. The codes for NOT APPLICABLE and other codes are filled in by the data analyst.

(7) **LOCATING ORIGINAL SOURCE FOR DATA ITEMS:**

Each page of results received by the data analyst from the LFK staff is assigned a sequential page number (FORM_SEQ). A page contains all the interior paint lead data about one unit. The XRF LEAD PAINT MEASUREMENT FORMS are filed by FORM_SEQ.

(8) **QUALITY ASSURANCE:**

100% visual comparison/correction.

LEAD FREE KIDS

FILE DESCRIPTION

(1) **FILE NAME:**

DATES

(2) **FILE DESCRIPTION:**

Contains dates of all LFK interventions, i.e. dust, loose paint, soil abatements, and exterior and interior deleading, for each family.

(3) **UNIT OF OBSERVATION:**

One observation for each family.

(4) **IDENTIFIER:**

FAMID

(5) **ADDITIONAL IDENTIFIERS NEEDED TO UNIQUELY IDENTIFY AN OBSERVATION:**

(6) **ORIGIN OF DATA:**

Data entry from DATES OF INTERVENTIONS FOR LFK UNITS form. Dates of LFK interventions were filled in by LFK staff members responsible for monitoring the interventions.

(7) **LOCATING ORIGINAL SOURCE FOR DATA ITEMS:**

Form organized by FAMID and filed.

(8) **QUALITY ASSURANCE:**

100% visual comparison/correction.

LEAD FREE KIDS STUDY

INSTRUCTIONS TO PARTICIPANTS

The copy of the consent form should be kept in a secure place for future reference. It is also important that you have the telephone number of the "Lead Free Kids Program" easily available, so that you can get in touch with us whenever you want to.

LEAD FREE KIDS STUDY

PARTICIPANT CONSENT FORM

I understand that the Department of Health and Hospitals of the City of Boston's Childhood Lead Poisoning Prevention Program, with the assistance of the United States Environmental Protection Agency, is conducting the Lead Free Kids Project to determine the possible effectiveness of the removal of lead contaminated soil on reducing blood lead levels of pre-school children in certain areas of Boston.

I understand that I have been asked to participate in this project because I live in Roxbury, Dorchester, Mattapan, or Jamaica Plain and have a child/children up to four years of age with a blood lead level in the upper end of the normal range (between 12 and 24 ug/dl). Blood lead levels refer to the amount of lead in a child's blood. All children between the ages of 9 months and 6 years should have their blood lead levels checked at least twice a year to make sure they are not too high.

I understand that the project will take place from January 1989 to January 1991 and will involve several visits to my residence for blood samples, an interview, soil, dust, water and paint samples, and soil and dust removal.

_____

Subject's Initials

I understand that I will be assigned to one of three study groups. The first group will receive loose paint and contaminated soil and dust removal starting in the fall of 1989. The second group will receive loose paint and dust removal starting in the fall of 1989 and soil removal starting in the fall of 1990. The third group will receive loose paint removal starting in the fall of 1989 and soil and dust removal starting in the fall of 1990. I understand that my assignment to any one of these groups will be by chance (like flipping a coin) and that I have an equal chance of being assigned to any one group.

I understand that if I move, I and my child/children may continue to be part of the project. In addition, I understand that I will be asked for the names of several people (friends, neighbors, or relatives) whom the staff may contact to obtain my new address if I do not notify the staff that I have moved. If I do not wish to give out these names, I and my child/children may still participate in the study.

I understand there will be three parts to the project:

A. Interview -- Collection of information concerning:

(1) Health history and activities of participating children in my home that may be related to lead poisoning;

(2) Occupations of adults in my home that may involve lead;

(3) Types of cooking utensils used in my home (cooking utensils may contain lead);

(4) Hobbies of any family member involving lead.

_____
Subject's Initials

B. Environmental Testing and Cleanup

(1) Collection of dust samples in my home;

(2) Collection of soil samples in the yard of my home;

(3) Collection of tap water samples in my home;

(4) Collection of paint samples in my home;

(5) Removal of the top several inches of soil from my yard, if that soil has a lead content greater than 500 parts per million, and

(6) Replacement of all excavated soil with clean soil and grass seed or sod.

(7) Vacuuming of the interior of my home to remove dust;

C. Taking of blood samples and hand lead measurements

(1) A blood sample, approximately 2-3 ml. or less than the amount of fluid on a teaspoon will be taken from a vein in the arm of each participating child to be tested for indicators of lead toxicity. Lead toxicity is a lead level that is high enough to cause changes in certain aspects of a child's body function. There will be at least three with the possibility of five blood samples taken. There should be no problems associated with collecting the blood sample, other than slight, temporary discomfort and the possibility of a small bruise where the needle enters the skin, which will disappear in a few days. Needles used for this purpose are pre-sterilized and disposed of after each sampling.

(2) Lead on the hands of each participating child will also be measured. This measurement involves thoroughly wiping both hands of each child with commercial wet-wipes. There should be no discomfort associated with this procedure.

(3) Project teams will take blood samples and conduct hand lead measurements in each participating child three times over the next one and one-half years.

I understand that all of the information from the interview and test results will be held in the strictest confidence.

_____
Subject's Initials

I understand that participation in this study will involve a certain level of intrusion into my family's routine. Project staff will need to come into my home on several occasions to obtain the samples described above and carry out loose paint and interior dust removal. I also understand that I may need to close certain windows and doors when the soil is being removed.

I also understand that I will receive compensation from the study for my participation. This compensation will consist of monthly food packages for as long as I participate and an appliance when I complete my participation in the study. I understand that I will receive this compensation even if I move away from my current home provided that I stay in touch with the study staff.

I also understand that this study may benefit my children because it may reduce their chances of lead poisoning. The study may also benefit scientific knowledge since it may provide information on the amount and sources of lead in and around homes and may help determine the best ways to prevent lead poisoning, a very serious child health problem.

I, as the legal guardian of the child/children participating in the study voluntarily agree to take part in the study and consent to having my child/children participate. I understand that my and my child's (or childrens') participation may involve:

_____
Subject's Initials

(1) being interviewed regarding the topics described above;

(2) contributing samples of blood and hand lead measurements;

(3) allowing soil, dust and water samples to be taken at my residence, and allowing soil removal/replacement activities and interior vacuuming to occur;

(4) allowing the examination of paint at my residence.

I have been assured that personal information will be kept in confidence by the Lead Free Kids Project. Any data from the project that are given to the Environmental Protection Agency (EPA) will not contain identifying information. I also understand that neither I, nor any member of my family, will be identified by name in any reports of the results of the Lead Free Kids Project.

I understand that I may decline to answer specific questions as I see fit and that I am free to withdraw my child's participation in the project at any time. I also understand that my withdrawl will not jeopardize receipt of medical care for myself or my child/children.

I understand that I will be informed, in writing, of the results of all of the blood, soil, dust, water and paint tests described above by the project staff in a timely fashion and that these results will be explained to me.

_____
Subject's Initials

I understand that if any blood test results indicate that my child/children should receive medical follow up, the project staff will provide a referral to my regular health care provider or will assist me in finding an appropriate health care provider.

I understand that if the test indicates a need for medical follow-up, I will be notified immediately. I can obtain additional information about this study, medical follow-up, and questions I may have about the results of the study by writing or calling my Lead Free Kids staff team (names) at:

Lead Free Kids Project
818 Harrison Avenue
Boston, MA 02118
534-5965

I understand that if I am not happy with any part of the study and don't want to talk to my study staff team about it, I can call or write to the project administrator (Natalie Zarimba) or director (Mr. Ronald R. Jones) at the above address and phone number.

In addition, you may wish to discuss this study and/or your participation in it with your regular doctor or nurse. You may also request the person who is in charge of the study to speak with your doctor.

_____
Subject's Initials

Statement of subject's approval of consent

_____ _____
Subject Date

I have witnessed that the elements of the above informed consent have been adequately and appropriately explained to the subject.

_____ _____
Witness Date

I attest the I have fully and appropriately informed the subject of the nature of the above study and have offered to answer any questions that he/she may have.

_____ _____
Principal Investigator Date

Furthermore, if you have any questions concerning the study and/or your consent to be a participant, you may also contact the Human Studies Committee of the Trustees of Health and Hospitals of The City of Boston, Inc. (Chairperson, 424-5842) created for the protection of the human subjects involved in proposed studies. Although the Human Studies Committee has approved this study as protocol #__-____, on _____(date), your participation is entirely voluntary.

LEAD FREE KIDS STUDY

PARTICIPANT LANDLORD CONSENT FORM

I understand that the Department of Health and Hospitals of the City of Boston's Childhood Lead Poisoning Prevention Program, with the assistance of the United States Environmental Protection Agency, is conducting the Lead Free Kids Project to determine the possible effectiveness of the removal of lead contaminated soil on reducing blood lead levels of non-poisoned children in certain areas of Boston.

I understand that my tenant ___(NAME)_____ who lives at __(ADDRESS)___ has been asked to participate in this project.

I also understand that the project will take place from January 1989 to January 1991 and will involve several visits to my tenant's residence for activities including testing for lead in paint, soil, dust and loose paint removal.

I understand that my tenant will be assigned to one of three study groups. The first group will receive interior loose paint and contaminated soil and interior dust removal starting in the fall of 1989. The second group will receive loose paint and dust removal starting in the fall of 1989 and soil removal starting in the fall of 1990. The third group will receive loose paint removal starting in the fall of 1989 and soil and dust removal starting in

_____
Landlord's Initials

the fall of 1990. I understand that my tenant's assignment to any one of these groups will be by chance (like flipping a coin) and that they have an equal chance of being assigned to any one group. I also understand that I will be informed of which group my tenant has been assigned.

I also understand that at the end of the study (fall 1990), the project will test the interior of my tenant's apartment, common hallways and the exterior of my property for lead paint. I also understand that if violations of the Massachusetts Lead Law are found, the project will help me by identifying or providing financial assistance, if applicable, for bringing my property into compliance with the law.

I understand that, as initial part of this assistance, I will receive $500 (actual amount not yet determined) compensation from the study for my participation when all of the activities described above are completed. I also understand that I will receive this compensation even if my tenant moves before he/she completes participation in the study.

I understand the project will need to gain access to my property for the following activities:

_____

Landlord's Initials

(1) Removal of the top several inches of soil from my property's yard if that soil has a lead content greater than 500 parts per million,

(2) Replacement of all excavated soil with clean soil and grass seed or sod.

I understand that the project will be responsible for replacing any landscaping, flowers, fences or other structures on my property that are damaged as a result of the project's activities.

I, as owner of the property at _____(ADDRESS)_____, voluntarily agree to take part in the study. I understand that my participation will involve allowing soil removal and replacement activities to occur.

I have been assured that personal information will be kept in confidence by the Lead Free Kids Project. Any data from the project that are given to the Environmental Protection Agency (EPA) will not contain identifying information. I also understand that I will not be identified by name in any reports of the results of the Lead Free Kids Project.

_____

Landlord's Initials

I can obtain additional information about this study and questions I may have about the results of the study by writing or calling my Lead Free Kids staff team (names) at:

Lead Free Kids Project
818 Harrison Avenue
Boston, MA 02118
424-5965

I understand that if I am not happy with any part of the study and don't want to talk to my study staff team about it, I can call or write to the project administrator (Natalie Zaremba) or director (Mr. Ronald R. Jones) at the above address and phone number.

Statement of landlord's approval of consent

_____ _____
Landlord Date

I have witnessed that the elements of the above informed consent have been adequately and appropriately explained to the landlord.

_____ _____
Witness Date

I attest the I have fully and appropriately informed the landlord of the nature of the above study and have offered to answer any questions that he/she may have.

_____ _____
Principal Investigator Date

Furthermore, if you have any questions concerning the study and/or your consent to be a participant, you may also contact the Human Studies Committee of the Trustees of Health and Hospitals of The City of Boston, Inc. (Chairperson, 424-5842) created for the protection of the human subjects involved in proposed studies. Although the Human Studies Committee has approved this study as protocol #_____, on _____(date), your participation is entirely voluntary.