Agency for Toxic Substances and Disease Registry
Division of Health Studies

FINAL REPORT
Technical Assistance to the Montana Department of Health and Environmental Sciences

Arsenic and Lead Exposure Study of Residents Living Near the Rocker Operable Unit of the Silver Bow Creek Superfund Site Rocker, Montana

January 1992

U.S. DEPARTMENT OF HEALTH & HUMAN SERVICES
Public Health Service
Agency for
Toxic Substances and Disease Registry
Atlanta, Georgia 30333

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PUBLIC HEALTH SERVICE
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TECHNICAL ASSISTANCE TO THE MONTANA DEPARTMENT OF HEALTH AND ENVIRONMENTAL SCIENCES FINAL REPORT

ARSENIC AND LEAD EXPOSURE STUDY OF RESIDENTS LIVING NEAR THE ROCKER OPERABLE UNIT OF THE SILVER BOW CREEK SUPERFUND SITE ROCKER, MONTANA

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DISCLAIMER

Mention of the name of any company or product does not constitute endorsement by the Agency for Toxic Substances and Disease Registry, the Public Health Service, or the U.S. Department of Health and Human Services and the Montana Department of Health and Environmental Sciences.

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ABSTRACT

During August 1989, the Agency for Toxic Substances and Disease Registry (ATSDR) provided technical assistance to the Montana Department of Health and Environmental Sciences (MDHES) in conducting a study to assess arsenic and lead exposure among residents of Rocker, Montana. Arsenic concentrations up to 214,000 parts per million (ppm) had been detected in soil from a Superfund site located in Rocker. Biological and questionnaire data collected from Rocker residents were compared to data collected from residents of an area with no known community source of arsenic exposure. No statistically significant difference was found between the two populations with respect to the geometric mean of the urine arsenic levels (1.94 versus 1.96 $\mu g/L$; $p = 0.90$). When data were combined from both groups, the following factors were found to be associated with detectable urine arsenic levels: recent seafood ingestion (odds ratio (OR) = 3.8, 95-percent confidence interval (CI) 1.9-7.7), female gender (OR = 2.2, 95-percent CI 1.0-4.6), and leaving household windows open less than 50 percent of the time OR = 2.5, 95-percent CI 1.1-5.9). Stratified analyses suggested that gender and the frequency with which household windows remained open might be confounders in the association between seafood ingestion and having a detectable urine arsenic level. However, when these potential confounders were controlled for through logistic regression, the adjusted odds ratio for having a detectable urine arsenic level among persons who had recently eaten seafood compared with persons who had not (OR = 3.5, 95-percent CI 1.7-6.2) differed little from the crude odds ratio.

Although blood lead levels in the target area (range: 5.1-31.3 $\mu g/dL$) differed significantly from those in the comparison area (range: 3.8-4.9 $\mu g/dL$, $p = 0.01$, Mann-Whitney Test), a significant association was not detected between blood lead levels ≥ 10 $\mu g/dL$ and area of residence ($p = 0.16$, Fisher's Exact Test). Specimens from five of nine children in the target area were ≥ 10 $\mu g/dL$. Lead was detected in the blood of two of these children, siblings, at levels of 20.7 and 31.3 $\mu g/dL$. A lead-based paint hazard and elevated concentrations of soil lead from the children's play area were detected in this household.

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INTRODUCTION

Rocker, Montana, is a small community located in Silver Bow County, and is the location of the Rocker operable unit of the Silver Bow Creek Superfund site. The Rocker Timber and Framing Plant operated there from the late 1880's until 1957. The plant used timber to produce posts for underground mines and reportedly used arsenic and creosote for timber treatment. This area was designated by the Environmental Protection Agency (EPA) as a separate operable unit of the Silver Bow Creek Superfund site due to the fact that contaminants onsite differed from those in other sections of the site.

Environmental sampling was conducted onsite during a remedial investigation (RI) in 1987 and during a two-phased site investigation in 1988 and 1989. Elevated concentrations of arsenic were detected in samples of sediment, soil, surface water, and groundwater. In addition, mine tailings were detected at depths of up to 15 feet below ground surface; however, environmental samples were not analyzed for lead content. In 1989, the Montana Department of Health and Environmental Sciences (MDHES) requested technical assistance from the Agency for Toxic Substances and Disease Registry (ATSDR) in studying arsenic exposure among all residents of Rocker and lead exposure among children from 9 through 71 months of age to determine whether the contamination presented a public health problem.

Objectives

The objectives of this study were to ascertain: (1) whether urine arsenic levels (a measure of recent exposure) among residents of Rocker differed from urine arsenic levels among residents of a selected comparison area; and (2) whether blood lead levels among children from 9 through 71 months of age residing in Rocker differed from blood lead levels among children of the same age residing in the comparison area.

BACKGROUND

History

The Rocker Timber and Framing facility consisted of a framing mill, boiler house, wood treating plant, and a carpenter shop. According to historical records, the plant employed approximately 36 workers during peak production *(1)*. In addition to arsenic and creosote used for timber treatment, records indicate that pentachlorophenol may have also been used as a preservative. Operations stopped at the plant in 1957, at which time the plant was abandoned and razed. Silver Bow Creek lies approximately 75 to 100 feet north of the treatment plant and flows toward the west.

Site Characterization

<u>Soils/Sediment</u>

Environmental samples of soils and sediment were obtained onsite only. This included near-surface grab samples collected during the remedial investigation (RI) in 1987 and surface and subsurface soil and sediment collected during both phases of the site investigation in 1988 and 1989. Concentrations of arsenic in the soil samples ranged from 149 to 10,400 ppm (mg/kg). During the first phase (Phase I) of the site investigation, sediment was sampled from 6 backhoe test pits and 10 monitoring well boreholes. Arsenic concentrations in these samples ranged from 10 to 1,400 ppm. During the second phase (Phase II) of the site investigation, arsenic was detected at concentrations from 12 to 1,300 ppm in subsurface sediment sampled from backhoe test pits. Although the highest concentration was detected in a sample 67 to 75 inches below ground, there was no consistent pattern of arsenic concentration with depth, as arsenic increased with depth in some test pits and decreased with depth in others.

Surface soil was sampled on a surveyed grid system during Phase II of the site investigation. Five areas were found to have arsenic concentrations ranging from 13,000 to 214,000 ppm. The highest level was adjacent to a mound of wood chips and waste material with a total volume of 200 to 400 cubic yards *(1)*. This area was enclosed with an open wired fence. Soil samples collected onsite were not analyzed for lead.

Surface Water

Surface water samples were obtained from onsite sampling stations only within the Silver Bow Creek Superfund site. These samples were collected during each of the three investigations from several sampling stations located along Silver Bow Creek. Samples were collected during relatively dry conditions in the Rocker area; thus, these data may not have been representative of detections likely to be found during runoff events, which might occur during heavy rain or snow melt.

The Phase I and II site investigations detected increases of total arsenic between upstream and downstream sampling locations ranging from 27 to 31 percent, and increases of dissolved arsenic ranging from 13 to 16 percent. The majority of arsenic measured in Silver Bow Creek was in the dissolved phase.

Total and dissolved concentrations of lead were measured in surface water samples. Maximum concentrations were .005 mg/L and .007 mg/L, respectively.

Surface water samples were also analyzed for volatile and semi-volatile organics. Pentachlorophenol (PCP) was the only organic detectable in Silver Bow Creek. Concentrations of PCP ranged from a minimum of <0.001 mg/L downstream to a maximum of 0.018 upstream. Environmental contractors believed the source of PCP to be upstream of Rocker.

Hydrogeology and Groundwater

During Phase I of the site investigation, tailings were detected at depths 15 feet below the ground surface at the eastern portion of the site. It is suspected that tailings were probably hauled onsite as filled material *(1)*. A coarse sand underlies the filled material throughout most of the site, ranging from 1 to 5 feet in thickness. Under the sand lies 5 to 10 feet of stiff, silty clay, followed by alternating beds of clay, silt, and sand.

During Phase I of the site investigation, 12 monitoring wells were installed; 9 were installed in the tailings or upper sand layer and 3 in the alternating beds of clay, silt, and sand. Two additional monitoring wells were installed during Phase II. Concentrations of dissolved arsenic and cadmium in five of the monitoring wells exceeded Federal primary drinking water standards of 0.05 and 0.01 mg/L, respectively. Arsenic concentrations ranged from 0.01 to 3.1 mg/L. Cadmium ranged from <0.005 to 0.088 mg/L. The maximum concentration of dissolved lead detected was .026 mg/L. Groundwater samples from the monitoring wells were also analyzed for volatile and semivolatile organics and polynuclear aromatic hydrocarbons (PAHs). Only one well exhibited elevated concentrations of organic compounds, including benzene-related compounds, toluene, and xylene. The source of these contaminants is unknown.

Groundwater samples from two domestic wells in Rocker north of Silver Bow Creek were analyzed for total and dissolved metals concentrations. These were found to be within primary and secondary drinking water standards, with the highest concentration reaching 0.02 mg/L. The maximum concentration of total lead detected in these wells was .0041 mg/L.

Air

No air sampling data were collected. However, high winds reportedly cause a fugitive dust problem in the area *(2)*.

Human Exposure

Arsenic is used in a variety of manufacturing operations. In the United States, approximately 81 percent of arsenic use occurs in the agricultural industry, which has used arsenic for manufacturing insecticides, herbicides, feed additives, wood preservatives, and desiccants. Arsenic is also used in glass and ceramic formation, and in the chemical industry *(3)*.

The toxicity and absorption of arsenic depend on its chemical form. Ingestion of high concentrations of inorganic arsenic and its derivatives may result in acute intoxication, characterized by inflammation of the gastrointestinal tract, cardiac abnormalities, and coma *(4)*. Systemic absorption may result in peripheral neuritis, liver and kidney damage, skin changes, and gastrointestinal problems. Dermatoses and other skin abnormalities are seen following dermal contact with arsenic *(5)*.

Organic forms of arsenic are, in general, less toxic than inorganic forms *(6)*. Phenylarsonate, an organic form used as feed additives for poultry and swine, has resulted in sensory and peripheral nerve injury in animals exposed to high doses, but the relationship between exposure and potential human health effects has not been examined extensively *(6,7)*. When taken orally, methanearsonates, which are widely used in pesticides, produce symptoms in humans similar to those caused by exposure to inorganic arsenic, including gastrointestinal irritation and renal and hepatic injury. However, the potency of methanearsonates is much lower than that of inorganic forms of arsenic.

Arsenic is widely distributed in the environment and low-level human exposure is fairly common *(3,4,7)*. The most common route of exposure for humans is through diet; however, the concentration of arsenic in food is usually below 1 ppm *(4)*. An exception to this is freshwater fish and seafood. Freshwater fish contain arsenic at concentrations from 1 through 10 ppm, although arsenic in fish from uncontaminated waters usually is below 2 ppm *(3)*. Arsenic concentration in seafood is usually higher than that in freshwater fish. Arsenic has been detected in canned clams at 16 ppm, canned shrimp at 20 ppm, fresh cod at 32 ppm, and canned smoked oysters at 46 ppm. Data available on arsenic exposure through fish ingestion indicate that the organic arsenic compounds common in fish have low toxicity *(7-9)*.

Most epidemiologic studies investigating the health effects of arsenic exposure have focused on occupational settings. Several studies of workers exposed to inorganic forms of arsenic in mining and smelting operations have found an increased incidence of lung, respiratory, and skin cancer *(10-14)*. However, arsenic has not been found to cause these cancers in animal studies.

Arsenic exposure can be estimated from analysis of hair, nails, or urine. Although hair and nail analyses can be used to estimate chronic arsenic exposure, concentrations may reflect external absorption of arsenic into these tissues rather than systemic levels of arsenic. Thus, such analyses are not reliable for detecting low levels of arsenic exposure. Analysis of urine is the best way to determine exposure that has occurred within the last 1 to 2 days *(3,7)*. Urine arsenic levels from 2 through 100 μg/L are considered within the reference range; typically, values range from 20 through 50 μg/L in nonoccupational settings. The World Health Organization (WHO) has established a reference value for urine arsenic of 100 μg/L *(15)*.

Offsite environmental sampling was not conducted in the target area chosen for this study. However, human exposure to arsenic in onsite soil was considered possible because the site was highly accessible. Although the area in which the highest levels of arsenic were detected was enclosed by a wire fence, the remainder of the site was accessible. In addition, high winds reported in the area could easily have blown the highly contaminated soil from the fenced area.

Many health effects of exposure to lead are well known. The fetus is especially susceptible to the effects of lead. Exposure in utero may result in preterm birth, reduced birth weight, and a decreased intelligent quotient (IQ) *(16,17)*. Young children are more likely to be exposed to lead in the environment than older children and adults, due to pica and the greater frequency of hand-to-mouth activities. Health effects seen in young children exposed to lead include reduced growth, reduced IQ, and learning disabilities *(16,18,19)*. In adults, lead exposure may result in anemia, hypertension, and neurologic and kidney damage *(16,20,21)*.

Lead in blood, which has a half-life of 28 through 36 days, is the best indicator of recent lead exposure *(22)*. In 1985, the Centers for Disease

Control (CDC) identified a confirmed blood lead level of 25 μg/dL along with an elevated erythrocyte protoporphyrin (EP) ≥35 μg/dL as evidence of lead toxicity in children *(23)*. However, more recent research suggests that blood lead levels from 10 through 15 μg/dL may result in adverse neurobehavioral effects in children *(24)*. In October 1991, the CDC lowered the blood lead level at which follow-up prevention activities are recommended to 10 μg/dL *(25)*.

METHODS

Rationale for Study Design

This study was designed to ascertain: (1) whether urine arsenic levels (a measure of recent exposure) among residents of Rocker differed from urine arsenic levels among residents of a selected comparison area; and (2) whether blood lead levels among children from 9 through 71 months of age residing in Rocker differed from blood lead levels among children of the same age residing in the comparison area. Although the primary onsite contaminant of public health concern was arsenic, and environmental samples collected from the site prior to the study had not been analyzed for lead, blood lead levels in children were measured because children are particularly vulnerable to adverse health effects from lead exposure.

The contaminated medium of concern in this study was soil. The assumption was made that contact with soil would be greater during the summer than other seasons due to more favorable weather for outdoor activities. Therefore, this study took place during August to maximize the likelihood of detecting arsenic and lead in biologic samples. For the analytic comparisons that this study was designed to address, a cross-sectional study design was appropriate *(26)*.

Selection of Target Area

The town of Rocker, which was the target area for this study, consisted of approximately 58 residential dwellings (10 of which are trailers) within a 1/2-mile radius of the site, a former schoolhouse, a fire hall, and a few commercial properties. The area was approximately 0.6-mile long and 1.0-mile wide. It was bordered on the north by Interstate 90 and on the east by a railroad underpass located at the end of the main street of Rocker. The trailers and approximately 13 of the homes were located south of Silver Bow Creek. The remaining homes and the commercial properties were located north of the creek.

Voter registration, census, and school records were used to obtain a population estimate for the target area prior to the study. The resident population was estimated to be 100, including 10 children younger than 6 years of age. Of the population in the area, approximately 90 percent are white and 10 percent are American Indian. The per capita annual income for Silver Bow County in 1985 was $8,785.

Selection of Comparison Area

The town selected for comparison was Whitehall, Montana, located in Jefferson County, adjacent to Silver Bow County. This town was demographically similar to Rocker, and had no known environmental source of arsenic or lead exposure. The population estimate for Whitehall from the 1980 census was 1,030 residents. Approximately 98.0 percent of these residents were white, 1.4 percent were American Indian, 0.4 percent were Chinese-American, and 0.2 percent were Hispanic. The per capita income in Whitehall in 1985 was $7,862.

A rectangular section of 15 blocks in Whitehall was selected for the comparison area. This area consisted of homes which appeared to be of similar age and construction as those in the target area. Approximately 139 homes were located in this area, along with a town hall, a library, and an elementary school.

Sample Selection

All residents of the target area and comparison area were invited to participate in the study. Initially, the aim was to have an equal number of participants from the target and the comparison areas. A 50 percent sample from the comparison area appeared adequate to achieve this aim. On the first day of data collection, the survey teams began visiting every second household on each block in Whitehall. However, it was apparent after the first day that participation in the comparison area was going to be lower than expected. Therefore, the sample was enlarged to include all households.

Data Collection

Data collected from persons in the target and comparison areas included a household census survey, a questionnaire interview, and the collection of biological specimens (blood and urine) for analysis.

Initial census data were collected at a public meeting, which was held in the fire hall of Rocker to inform the residents about the study, encourage participation, and answer questions. A notice alerting residents to the public meeting had been published in a local newspaper during the preceding week. Each resident attending the meeting was asked to record the first name, age, and sex of each member of his/her household on a census form, along with street address and telephone number. Fewer than 50 percent of the residents attended the meeting, and not all of those in attendance completed the census. Flyers were distributed in both neighborhoods the following week, again alerting residents to the study and inviting them to participate.

A training session was held for all interviewers. The training session focused on appropriate techniques for census taking, interviewing, urine collection, recordkeeping, and management of completed study forms. Interviewers were assigned to the target and comparison areas on a rotating schedule, so that each interviewer worked in both areas, and both areas had staff assigned on each day of data collection. Interviews were conducted during door-to-door visits. An adult within each household was asked to provide the first name and age of all household members. (Some residents who had attended the town meeting in Rocker had already provided this information. In these cases, the interviewer merely confirmed the recorded data.) The interviewers explained the study and determined the eligibility of household members. To be eligible for the study, children had to be from 9 through 71 months of age and had to have resided in the area during the 60 days prior to the study period. All other household members had to have resided in the area for a minimum of 1 week preceding the interview.

A location was selected in each area to serve as a central office. Interviewers reported to the appropriate central office each morning to receive their assignments, and returned completed forms to the same office at the end of the workday. In both areas, at least three attempts were made to contact residents for the survey at different times of day and on different days.

Interviews

Residents who met the eligibility criteria and wished to participate signed an informed consent form prior to the interview (Appendix 1). Signed consent was obtained from a parent or legal guardian of children younger than 16 years of age, in addition to the verbal consent of all minors 6 years of age or older.

The questionnaire was adapted by the MDHES from those used by ATSDR in previous studies of contaminant metal exposures from smelters and mining sites (Appendix 2). Questions were asked pertaining to demographics; occupations and hobbies; selected behaviors in children; and other potential confounders such as recent consumption of wine or seafood (fresh, frozen, or canned), including tuna fish, sardines, shrimp, oysters, crabs, or clams. Interviewers returned periodically to the appropriate central office, where questionnaires were immediately reviewed for completeness and consistency. If a questionnaire was found to be incomplete, the interviewer returned to or telephoned the household to obtain any missing information.

Biological Specimens

Biological specimens consisted of urine obtained from all participants and venous blood obtained from children 9 through 71 months of age.

Following each interview, the interviewer provided each participant with a 250-ml urine specimen collection cup and a ziplock plastic bag. The interviewer attached a label printed with the participant's study identification number to the cup. To avoid confusion between household members about the correct cup to use, each participant's name was written on his/her cup. Verbal and written instructions were provided to each participant regarding the appropriate way to collect the urine specimen (Appendix 3). Pediatric urine collection bags were provided to the parents of children who were not yet toilet trained, along with verbal and written instructions for urine collection (Appendix 4). Participants were asked to collect a sample of the first morning void on the day following the interview. They were instructed to cap the specimen container, place it in the sealed bag, and then place the sealed bag in the refrigerator. Arrangements were made for staff to collect urine specimens from households between 7 and 10 a.m. each morning. Specimens were immediately placed in a cooler with cold packs, and chain-of-custody information was recorded in a logbook.

Blood specimens from children from 9 through 71 months of age were drawn by a pediatrician or nurse at the central offices in both communities. Venous blood (3 to 6 ml) was drawn into anticoagulant vacutainer tubes and immediately stored in a cooler with cold packs.

At least once each day, blood and urine specimens were hand delivered by members of the study team to the MDHES Public Health Chemistry Laboratory in Helena for storage and processing.

Laboratory Analysis

Biological specimens were analyzed by the MDHES. Total arsenic in urine was analyzed by the method described by Paschal et al. *(27)*. Specific gravity and creatinine were also determined for urine specimens. The blood lead levels were determined using the method described by Proszhowska, et al. *(28)*.

Environmental Samples

No environmental sampling was done in this study.

Privacy and Notification

This final report does not contain any laboratory data or other information in association with any individual subject or person. Only aggregate data are reported. All such records will be maintained in compliance with the Privacy Act of 1974.

Privacy Act of 1974

Under the Privacy Act of 1974 (5 U.S.C. Section 552a[e]), employees of Federal agencies are responsible for protecting data collected on identifiable persons or organizations when the supplier of that data has not given consent to the agency to make the data public. This responsibility for protection extends to unauthorized visual observation, accidental loss, and or theft. Accordingly, confidential records were kept out of sight of unauthorized persons, stored in locked cabinets or locked rooms when not being used, copied only when absolutely necessary, and stored in sealed containers when transferred to archives. Statistics derived from such confidential data were reported without inadvertent disclosure about particular study subjects.

Individual Notification

After the results were received from the laboratory, the study team reviewed them to interpret the findings and recommend specific actions, where appropriate. Individual test results, interpretations, and recommendations were transmitted in letters to adult subjects and to the parents or guardians of minor subjects by the MDHES and the Butte-Silver Bow Health Department (B-SBHD).

Findings of Immediate Significance

Participants (or a parent or guardian) were also notified personally of any urine arsenic levels ≥100 μg/L. The parents or guardians of any children with blood lead levels ≥25 μg/dL were notified personally of the laboratory results by either an official of the MDHES or the B-SBHD, and a local pediatrician. In such cases repeat specimens of urine or blood were obtained for testing. If elevated levels were confirmed, participants were provided with recommendations expected to educe exposure.

Data Analysis Methods

The Statistical Analysis System (SAS), Release 5.18, (SAS Institute, Cary, North Carolina) was used for data management and statistical analyses.

Data Entry

Questionnaires were inspected for completeness before being keypunched. Laboratory test results were reported by the MDHES to ATSDR and merged with the corresponding records in the SAS data file. The computerized data file was inspected, and inconsistent responses or outliers were verified by comparison with the original questionnaires. Identified keypunch errors were corrected.

Data Transformation

Laboratory values that were below the limit of detection were redefined as half of the detectable level. Urine arsenic was adjusted to account for urine concentration as in previous reports *(29,30)*. The following formulas were applied to the unadjusted values:

$$\text{UrAsCr (ug/g of creatinine)} = \frac{\text{UrAs ng/ml}}{\text{UrCr mg/dl}} \times 100$$

UrAsCr = Urine arsenic, adjusted to urine creatinine
UrAs = Urine arsenic, unadjusted
UrCr = Urine creatinine

$$\text{UrAsSP (ng/ml)} = \frac{\text{(UrAs ng/ml) (1.024 - 1)}}{\text{(UrSP - 1)}}$$

UrAsSP = Urine arsenic, adjusted to urine specific gravity
UrAs = Urine arsenic, unadjusted
UrSP = Urine specific gravity

Because these laboratory values were not normally distributed, urine arsenic levels (adjusted and unadjusted) were transformed to natural logarithms, which more closely approximated a normal distribution for analytic purposes.

Data Analyses

Analytical methods were chosen to determine whether urine arsenic levels among persons of all age groups residing in the target area differed significantly from those of persons residing in the comparison area. Similarly, data were analyzed to determine whether blood lead levels of children from 9 through 71 months of age residing in the target area differed significantly from blood lead levels among children of the same age in the comparison area. Results of the first specimen were used in analysis if more than one specimen was obtained from a participant. Data from the target and comparison areas were combined to perform additional analyses to determine associations between other independent variables and biologic levels of arsenic.

Student's t-test was applied to log-transformed urine arsenic levels to determine whether the difference between the means of the two groups was statistically significant, with the primary independent variable of interest being area of residence. Student's t-test was also applied to mean urine arsenic levels of the two groups combined to examine the significance of other independent variables.

Odds ratios and 95-percent confidence intervals were used to determine the association between urine arsenic results and area of residence, as well as other independent and potentially confounding variables. The association with arsenic was examined in two ways. Persons with urine arsenic levels >50 μg/L were compared with those with urine arsenic levels ≤50 μg/L. This level was chosen because most urine arsenic levels in unexposed populations do not exceed 50 μg/L *(7,31)*. In addition, persons who had detectable levels of arsenic in their urine were compared with persons who did not. Stratified analyses were performed to examine variables which might be effect modifiers or confounders. The Breslow-Day Test of homogeneity was used to determine the presence of interaction, with a probability value of 0.05 considered suggestive of interaction. Logistic regression was performed to estimate the odds ratio of the main effect while controlling for confounding variables.

The Mann-Whitney test was used to determine the statistical significance of differences between the blood lead levels among children in the target and comparison areas. Nonparametric tests were selected due to the unequal variances of blood lead levels from the two areas. Fisher's Exact Test was used to examine the association between blood lead levels ≥10 μg/dL and area of residence.

RESULTS

Participation Rates

In the door-to-door census 158 occupied households were identified; 56 (35.0 percent) in the target area and 102 (65.0 percent) in the comparison area (Table 1). In the target area, contact was made with residents of 49 (87.5 percent) of the homes, housing 137 residents. In the comparison area, contact was made with residents of 74 (72.5 percent) homes, housing 181 residents. All 137 residents identified in the target area and

169 (93.4 percent) in the comparison area were eligible to participate in the study.

Of the 137 eligible residents in the target area, 113 (82.5 percent) agreed to be interviewed. In the comparison area, 116 (68.6 percent) of the 169 eligible residents agreed to be interviewed. In the target area, 97 (70.8 percent) of the eligible residents provided a urine specimen for analysis. The volume of one of these specimens was insufficient for laboratory analysis. Of the 169 eligible residents from the comparison area, 94 (55.6 percent) provided a urine specimen for analysis.

Twenty children from 9 through 71 months of age in the target area were eligible for blood lead testing (Table 2). Parents or guardians of 18 (90 percent) of the children consented to be interviewed concerning their children. Parental or guardian consent was granted to obtain a urine specimen from 10 (50 percent), and a blood sample from 9 (45 percent) of the 20 eligible children. In the comparison area, 21 children from 9 through 71 months of age were identified, and 19 (90.5 percent) were eligible for the study. Interviews were completed for 17 (89.5 percent) of the eligible children. Consent to collect urine and blood samples was granted for 9 (47.4 percent) and 3 (15.8 percent) of the children, respectively.

Children in the target area who were tested for lead ranged in age from 9 to 71 months (mean 38 $\pm$17.0 months). Children in the comparison area ranged in age from 16 to 57 months (mean 36.7 $\pm$20.9 months). This difference was not statistically significant (Student's t-test, $p = 0.90$).

Arsenic

About 77 percent of all specimens were below the detection limit of 10 μg/L (Table 3). Six participants who had urine arsenic levels >50 μg/L reported having eaten "fresh, frozen, or canned seafood in the last three days, including tuna fish, sardines, shrimp, oysters, crabs, or clams." Four (4.2 percent) of 96 urine specimens obtained from target area residents and 2 (2.1 percent) of 94 urine specimens obtained from comparison area residents exceeded 50 μg arsenic/L urine. In the target area, all of the participants with urine arsenic levels >50 μg/L were from a single family and lived in the same house, including the only child found to have a urine arsenic level >50 μg/L.

Two persons from the target area and one from the comparison area had urine arsenic levels >100 μg/L. Each of these persons was asked to provide a second urine specimen at a later date, while not eating any fish 3 days prior to this. At the request of the two target area residents with urine arsenic levels >100 μg/L, second specimens from two other members of their households were also accepted (whose urine arsenic levels in the first specimens were >50 μg/L but <100 μg/L). All urine arsenic levels in the second specimens tested were below the limit of detection. For purposes of data analysis, the results from the first urine specimens were used.

Neither the difference between the arithmetic mean nor the geometric mean of the urine arsenic levels in the two study areas was statistically significant (Tables 4 and 5).

Geometric mean urine arsenic levels were significantly higher in participants who: (1) ate seafood (as defined previously) within the 3 days preceding the interview, (2) were female, (3) had not been onsite within the 3 days preceding the interview, and (4) had not been onsite within the 3 months preceding the interview (Table 5).

The crude odds ratio for detectable urine arsenic in the target group versus the comparison group was not statistically significant (OR = 0.8, 95-percent CI 0.4-1.5). This OR changed little when stratified by potential confounders (Table 6). Among participants who had not recently eaten seafood, those from the target area were less likely to have detectable levels of arsenic in their urine than those in the comparison area (OR = 0.2, 95-percent CI 0.1-0.8).

The crude odds ratio of detectable urine arsenic among children from 9 months to <16 years of age in the target area versus the comparison area was not significant (OR = 1.3, 95-percent CI 0.3-5.5), and did not change significantly when stratified by potential confounders (Table 7).

This analysis did not indicate that Rocker residents were more likely to have urine arsenic levels above detection than were residents of Whitehall. Because of this and the fact that a few residents of both areas had elevated urine arsenic levels, data from the two study areas were combined to examine potential risk factors other than area of residence for arsenic exposure (Table 8). Recent seafood consumption (as defined previously) was associated with an arsenic level above the detection limit (OR = 3.8, 95-percent CI 1.8-8.2, $p < 0.001$). Females (OR = 2.2, 95-percent CI 1.0-4.6, $p = 0.03$) and participants whose household windows were open less than 50 percent of the time (OR = 2.5, 95-percent CI 1.1-5.9, $p = 0.02$) were more likely to have a detectable arsenic level.

Stratified analyses were performed to determine whether the effect of gender and the frequency with which household windows remained open were independent of the effect of seafood ingestion (Table 9). The association between female gender and having a detectable urine arsenic level was greater among persons who had not recently ingested seafood (OR = 3.9, 95-percent CI 1.1-17.2) than among persons who had (OR = 1.4, 95-percent CI 0.5-3.7). However, this difference was not suggestive of significant interaction ($p = 0.19$, Breslow-Day Test). Females were approximately twice as likely as males to have a detectable urine arsenic level, controlling for fish consumption, although this difference was of borderline significance (adjusted OR = 2.2, 95-percent CI 1.0-4.5). Similarly, the stratum-specific estimates of the association detected between windows being open less than 50 percent of the time and detectable urine arsenic differed among persons who had not recently ingested seafood (OR = 1.5, 95-percent CI 0.4-5.9) and persons who had (OR = 2.6, 95-percent CI 0.9-7.7). Again, this difference was not suggestive of significant interaction ($p = 0.5$, Breslow-Day Test). The effect of windows being open less than 50 percent of the time, detected in crude analysis, was not statistically significant when the odds ratio was adjusted for recent seafood ingestion (OR = 2.1, 95-percent CI 0.9-4.9).

Both adjusted measurements discussed previously differed from the crude estimate of 3.8, suggesting that gender and the frequency with which windows were open confounded the association between recent seafood ingestion and having a detectable urine arsenic level, biasing the estimate away from the null. Logistic regression was performed to determine the association between seafood ingestion and urine arsenic level while controlling for these potential confounders (Table 10). The relative odds of a detectable urine arsenic level associated with recent seafood ingestion, adjusted for gender and the frequency of having household windows open, was 3.5 (95-percent CI 1.7-7.2).

When urine arsenic was dichotomized at 50 μg/L, only seafood consumption was statistically significant. The odds ratio of a urine arsenic level >50 μg/L was 24.29 for persons who ate seafood within the previous 3 days compared to those who had not (95-percent CI 1.35-438.00). This odds ratio was 7.74 (95-percent CI 1.59-37.57) after adjusting urine arsenic to urine creatinine.

Lead

The three lowest blood lead levels were detected in the three children from the comparison area (Table 11). The two highest levels of 31.3 and 20.7 μg/dL were found in siblings from a single household in the target area. Urine arsenic levels from all tested members of this household were <50 μg/L. The blood lead levels in the nine children participating from the target area were significantly different from those in the three children from the comparison area (p = 0.01, Mann-Whitney test). When the blood lead levels were dichotomized at 10 μg/dL, a significant association was not found between area of residence and a blood lead level ≥10 μg/dL (p = 0.16, Fisher's Exact Test, 1-tailed).

The B-SBHD obtained three additional blood specimens from the child whose blood lead level was 31.3 μg/dL. These were obtained on September 26, October 27, and December 4; the blood lead levels were 28 μg/dL, 30 μg/dL, and 24 μg/dL, respectively. The questionnaire data did not reveal any behavioral differences between this child and the other children in the study. The B-SBHD conducted environmental sampling on the property to identify potential sources of lead exposure. Samples were analyzed by a certified laboratory that participated in the EPA's Contract Laboratory Program. X-ray fluorescence (XRF) analyses detected lead in painted surfaces ranging from 3.76 to 10.0 mg/cm^2 (upper limit of detection = 10 mg/cm^2).

Sampling locations with levels >0.7 mg/cm^2 included the entry door trim to the kitchen, the trim of a window sill in the kitchen, a window and trim in the bathroom/utility area in the interior of the house, and the front door trim and several walls on the exterior of the house. Environmental contractors noted that paint in this house was chipping and flaking to the ground surface. In addition, the paint appeared to have been peeled from the wall next to the affected child's bed; on a repeat visit the peeled section was enlarged, suggesting this as a source of exposure for this child (Dan Dennehy, B-SBHD, personal communication). According to CDC, an immediate lead hazard exists when lead-based paint: (1) is chipping, peeling, or flaking; (2) is chalking, thereby producing lead dust; (3) is on a part of a window which is abraded through the opening and closing of the window; (4) is on any surface which is walked on (like floors) or otherwise abraded; (5) can be mouthed by a child (for example, window sills); or (6) is distributed by repainting or remodeling *(25)*. Paint chips obtained from the interior of the home were found to have a lead content of 20,000 to 21,000 ppm. The lead content of paint chips obtained from the exterior of the house ranged from 72,000 to 150,000 ppm. Soil lead ranged from 90 to 1,200 ppm, with the highest concentration in soil found in the sample from the children's play area in the rear of the house. Lead was detected in a single dust sample from the front porch (on the exterior of the house) at 1,700 ppm. Lead was not detectable in the tap water sample obtained from the kitchen. Staff of the B-SBHD counseled this family regarding potential ways to reduce exposure, and both children in the household were referred to a pediatrician for follow-up blood lead testing and counseling.

Continued communication with the B-SBHD approximately 18 months after the original data collection revealed that lead was detected at 44 μg/dL and erythrocytic protoporphyrin at 57 μg/dL in a recent blood specimen from the child who originally had a blood lead level of 31.3 μg/dL. Medical follow-up for this child has continued.

DISCUSSION

Arsenic Levels

No significant differences were found between urine arsenic levels in the target area and the comparison area. Prior to this study, there was concern that onsite visits and behaviors that might mobilize soil (such as running, bicycling, or play) might increase arsenic exposure. However, this study was unable to address this possibility because only five (2.6 percent) of the participants reported visits to the site within the 3 days preceding the study. The only onsite behavior reported by these five participants was walking, and arsenic was not detected in their urine specimens.

When the data from the two groups were combined, persons who had eaten seafood within the 3 days prior to the interview were significantly more likely to have a urine arsenic level above detection (and >50 μg/L) than persons who had not recently eaten seafood. The fact that all follow-up specimens obtained from the same participants after 3 days without any seafood consumption were below the limit of detection suggests that this was the source of exposure in these persons. Because the organic arsenic commonly present in seafood is nontoxic, these exposures were unlikely to be of clinical significance. Factors which confounded the association between recent seafood ingestion and a detectable urine arsenic level included gender and the frequency with which household windows were open. However, the confounding was minimal, as the adjusted odds ratio differed little from the crude.

Lead Levels

Blood lead levels among nine children in the target area were higher and differed significantly from those in three children from the comparison area. However, the small sample size limited the power and number of statistical tests that could be performed. Although a statistically significant association with area of residence was not found, it is noteworthy that five of the nine blood lead levels from children in the target area were >10 μg/dL. This is the level at which community prevention activities should be triggered, as specified by CDC, with the goal of reducing children's blood lead levels to below 10 μg/dL *(25)*.

Two of the five children had blood lead levels above 15 μg/dL, the level at which individual case management and environmental investigation are recommended *(25)*. These children were from a single family in the target area and had the highest blood lead levels in the study (31.3 and 20.7 μg/dL). This study did not identify the cause of these higher values. However, follow-up environmental sampling suggested that interior and exterior lead paint on the home, in addition to the soil lead concentration in the play area, provided opportunities for the children's exposure to lead. This family was counseled regarding the health risks of lead exposure, and the children were referred for follow-up with a pediatrician.

Study Limitations

The primary limitations of this study were: (1) the ability to address only short-term, recent exposure to arsenic based on urine specimen results; (2) the lack of environmental samples from the residential sections of the target and comparison areas; (3) the possibility of selective recall among participants; and (4) low statistical power due to the small available population and low participation rates among children.

The analysis of urine is the standard method used to determine recent arsenic exposure. However, such an analysis reflects exposure only for the 2 to 3 days prior to urine collection. Thus, this study was not able to evaluate long-term exposure. Although only 5 individuals reported that they had walked on the site within the 3 days preceding the interview, 25 reported having walked on the site at some point during the summer. Long-term exposure might have been partially addressed by obtaining several specimens in a serial manner during the summer months; such action might have increased the probability of detecting exposure had it occurred.

Prior to this study, elevated levels of arsenic were detected in onsite soil, leading to concern about the potential for exposure among nearby residents. However, no soil or dust samples were collected in the residential sections of Rocker, and environmental sampling was not conducted in this study. Therefore, although the primary medium of concern was onsite soil or soil that had migrated offsite, the possibility of other offsite environmental sources for arsenic exposure could not be eliminated. Environmental sampling of both residential areas might have been helpful in interpreting the results of this study.

Selective recall might have affected the results of this study. Residents of the target area knew they were living near a Superfund site and may have underreported activities on the site if they believed such activities might be less socially acceptable. For example, a parent whose child frequently played on the site might not wish to admit this. If onsite activity truly increased exposure to arsenic, denial of the activity could result in a false-negative or null association between the activity and urine arsenic level. However, this type of bias seems unlikely because of the observed difference in the reported frequency of being onsite for two time periods (<3 days versus <3 months prior to interview). The frequencies probably would have been more similar if underreporting of onsite activities was common.

The small population in the target area limited the statistical power and analytical options for this study. Given the prevalence of urine arsenic levels >50 μg/L in the comparison area (2 percent), only a 12 percent chance existed of detecting a twofold difference in the risk for urine arsenic above this level in the two areas as statistically significant (alpha = 0.05). More than 1,000 participants in each area would have been needed to detect such a difference. The actual specimen size (190) provided an 80 percent chance of detecting a statistically significant (p = 0.05) difference in the mean urine arsenic concentrations of approximately 6.7 μg/L between participants from the target and comparison areas. A smaller difference would have a lower probability of detection.

Testing for blood lead levels was offered for children from 9 through 71 months of age, but interpretation of results for the community was hindered by poor participation rates. Although the questionnaire was completed for approximately 90 percent of eligible children in both areas, blood specimens were obtained from only 9 (45 percent) of these children in the target area and only 3 (15.8 percent) children in the comparison area.

Comparability With Other Studies

The mean urine arsenic levels detected in this study were lower than the levels reported among residential children of four other Montana communities studied in 1985 *(32)*. Three of those communities surrounded a former copper smelter which ceased operations in 1980. The fourth community, which did not have a history of mining or smelting, was chosen as a control community. Arsenic was detected in soil samples from yards in these communities at mean concentrations ranging from 44 ppm in the control community to 715 ppm in a community downwind and adjacent to the smelter. Arithmetic mean urine arsenic levels from 123 children, from 2 through 6 years of age, tested in the month of July, ranged from 15.3 μg/L in the community 6 kilometers (3.73 miles) from the smelter stack, to 54.0 μg/L at the site, downwind and adjacent to the smelter. In an arsenic exposure study conducted in a section of Houston, Texas, where arsenic concentrations in soil samples reached 27,000 ppm, the mean urine arsenic level was 39.7 μg/L among adults and children who were exposed to potentially contaminated areas during the week preceding the interview, and 26.5 μg/L in the comparison group *(29)*.

In the present study, the arithmetic mean urine arsenic level from children 2 through 6 years of age was 10.9 μg/L in the target area and 7.0 μg/L in the comparison area. The lower levels of urine arsenic found in this study might be explained if the concentration of arsenic in the soils from yards of participants was low. However, no offsite soil samples were obtained from the areas in this study.

CONCLUSIONS

1. The small difference between geometric mean urine arsenic levels in residents of the target and comparison areas was not statistically significant.

2. The only independent variable found to be associated with urine arsenic levels >50 μg/L was seafood consumption during the 3 days preceding urine collection.

3. Assuming that the arsenic exposure detected in this study was from recent seafood ingestion, it is unlikely that this finding was of clinical significance because arsenic contained in seafood is normally organic and nontoxic.

4. No consistent conclusions could be made regarding the risk of lead exposure in the two study areas because of the small number of children tested. The blood lead levels among nine children aged 6 through 71 months in the target area were significantly different from those among three children in the comparison area, and five of nine children tested in the target area had blood lead levels that exceeded 10 μg/dL.

RECOMMENDATIONS

1. Although excessive arsenic exposure was not documented by this study, persons entering the site should be aware of the potential for exposure to arsenic from contaminated soil and should take appropriate precautions to avoid inhaling wind blown dust and soil.

2. The community should be alerted to the need for blood lead screening of children who have not yet been tested, and should be advised as to how this screening can be obtained.

3. Because of the large proportion of blood lead levels that exceeded 10 μg/dL in children from the target area (five of nine), community-level intervention, including blood lead screening, may be appropriate for this area as specified by the CDC *(25)*.

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REFERENCES

1. Hydrometrics. Investigation of potential resources contamination near Rocker, Montana. Project Report, 1988.

2. CH2M HILL. Evaluation of data needs site-wide public health and environmental assessment Silver Bow Creek CERCLA site. Draft technical memorandum. Nov 1986.

3. Dickerson OB. Arsenic. In: Waldron HA, ed. Metals in the environment. New York, NY: Academic Press Inc., 1980.

4. Leonard A, Lauwery RR. Carcinogenicity, teratogenicity and mutagenicity of arsenic. Mutat Res 1980;75:49-62.

5. Hine CH, Pinto SS, Nelson KW. Medical problems associated with arsenic exposure. J Occup Med 1977;19:391-6.

6. Buck WB. Diagnosis of feed-related toxicoses. J Am Vet Med Assoc 1970. May 15;156(10):1434-42.

7. Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological Profile for Arsenic. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service, March 1989.

8. Kaise T, Watanabe S, Itoh K. The acute toxicity of arsenobetaine. Chemosphere 1985;14(9):1327-1332.

9. Jongen WMF, Cardinaals JM, Bos PMJ. Genotoxicity testing of arsenobetaine, the predominant form of arsenic in marine fishery products. Food Chem Toxicol 1985;23(7):669-673.

10. Pershagen G. The carcinogenicity of arsenic. Environ Health Perspect 1981;40:93-100.

11. Ott MG, Holder BB, Gordon HL. Respiratory cancer and occupational exposure to arsenicals. Arch Environ Health 1974;29:250-255.

12. Lee AM, Fraumeni JF. Arsenic and respiratory cancer in man: an occupational study. J Natl Cancer Inst 1969;(42):1045-1052.

13. Pinto SS, Henderson V, Enterline PE. Mortality experience of arsenic-exposed workers. Arch Environ Health 1978;33:325-330.

14. Enterline PE, Marsh GM. Cancer among workers exposed to arsenic and other substances in a copper smelter. Am J Epidemiol 1982;116;895-910.

15. World Health Organization (WHO). Recommended health-based limits in occupational exposure to heavy metals. Report of a WHO study group. Geneva: World Health Organization, 1980 (Technical Report Series 647).

16. Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological Profile for Lead. Atlanta, Georgia: U.S. Department of Health and Human Services, Public Health Service, June 1990.

17. Bellinger D, Leviton A, Waternaux C, Needleman H, Rabinowitz M. Longitudinal analyses of prenatal and postnatal lead exposure and early cognitive development. N Engl J Med 1987;316:1037-43.

18. Agency for Toxic Substances and Disease Registry. The nature and extent of lead poisoning in children in the United States: A report to Congress. Atlanta, Georgia: U.S. Department of Health and Human Services, Public Health Service, July 1988.

19. McMichael AJ, et al. Port Prairie cohort study: environmental exposure to lead and children's abilities at the age of four years. N Engl J Med 1988;319(8):468-475.

20. Zimmerman-Iansella C, Campara P, D'Andrea F, Savonitto C, Tansella M. Psychological and physical complaints of subjects with low exposure to lead. Hum Toxicol 1983;2:615-623.

21. Pocock SJ, Shaper AG, Ashby D, Delves T. Blood lead and blood pressure in middle aged men. In: Lekkas TD, ed. International Conference: Heavy metals in the environment, vol. 1, Athens Greece. Edinburgh, U.K.: CEP Consultants, Ltd., Sept 1985:303-5.

22. Carson BL, Ellis HV, McCann JL. Toxicology and biological monitoring of metals in humans. Chelsea, MI: Lewis Publishers, Inc., 1987.

23. Centers for Disease Control (CDC). Preventing lead poisoning in young children. Atlanta, Georgia: U.S. Department of Health and Human Services, Public Health Service, 1985 publ. no. 99-2230.

24. Needleman HL, Schell A, Bellinger D, Leviton A, Allred EN. The long-term effects of exposure to low doses of lead in childhood - an 11-year follow-up report. N Engl J Med 1990;322:83-88.

25. Centers for Disease Control (CDC). Preventing lead poisoning in young children. Atlanta, Georgia: U.S. Department of Health and Human Services, Public Health Service, 1991.

26. MacMahon B, Pugh TF. Strategies of epidemiology. In: Epidemiology, principles and methods. Boston: Little, Brown and Company, 1970.

27. Paschal DC, Kimberly MM, Bailey GG. Determination of urinary arsenic by electrothermal atomic absorption spectrometry with the L'VOV platform and matrix modification. Analytica Chimica Acta 1986;181:179-186.

28. Proszkowska E, Carnrick GR, Slavin W. Blood lead determination with the platform furnace technique. Atomic Spectroscopy 1983;4:59-61.

29. Kaye WE, Brender JD, Suarez L. The Crystal Chemical Company arsenic exposure study; Houston, Texas. Agency for Toxic Substances and Disease Registry (ATSDR). Atlanta, Georgia: U.S. Department of Health and Human Services, Public Health Service, July 1989.

30. Amler RW, Baburich SB, Jones PA, Kaye WE, Lybarger JA, Richter BS. The Silver Creek mine tailings exposure study; Park City, Utah. Agency for Toxic Substances and Disease Registry (ATSDR). Atlanta, Georgia: U.S. Department of Health and Human Services, Public Health Service, June 1988.

31. Landrigan PJ. Arsenic. In: Rom WN, ed. Environmental and occupational medicine. Boston: Little, Brown, and Company, 1983.

32. Binder S, Forney D, Kaye W, Paschal D. Arsenic exposure in children living near a former copper smelter. Bull Environ Contam Toxicol 1987;39:114-121.

Table 1 - Participation by area of residence, all ages, Arsenic and Lead Exposure Study, Rocker, Montana, August 1989.

	Target Area	Comparison Area	Total
a. Number of occupied households	56	102	158
b. Number of households contacted	49	74	123
c. Number of residents in contacted households	137	181	318
d. Number of residents eligible for study	137	169	306
e. Percent of contacted residents who were eligible for study	100.0	93.4	96.2
f. Number of completed interviews	113	116	229
g. Participation rate (%): interviews of eligible residents	82.5	68.6	74.8
h. Number of urine tests	97*	94	191*
i. Participation rate (%): urine tests of eligible residents	70.8	55.6	62.4

* Includes one specimen of insufficient quantity for laboratory analysis.

Table 2 - Participation by area of residence, children 9-71 months of age, Arsenic and Lead Exposure Study, Rocker, Montana, August 1989.

	Target Area	Comparison Area	Total
a. Children 9-71 months	20	21	41
b. Children eligible for interview	20	19	39
c. Interviews of eligible children	18	17	35
d. Participation rate (%): interviews of eligible children	90.0	89.5	89.7
e. Urine tests of eligible children	10	9	19
f. Participation rate (%): urine tests of eligible children	50.0	47.4	48.7
g. Blood tests of eligible children	9	3	11
h. Participation rate (%): blood tests of eligible children	45.0	15.8	30.8

Table 3 - Distribution of urine arsenic levels (unadjusted), Arsenic and Lead Exposure Study, Rocker, Montana, August 1989.

Urine Arsenic	Target Area		Comparison Area		Total	
µg/L	n	Cumulative %	n	Cumulative %	n	Cumulative %
< detection	76	79.17	70	74.50	146	76.80
10	1	80.21	3	77.69	4	78.90
11	1	81.25	1	78.75	2	80.00
12	0	81.25	3	81.94	3	81.60
13	2	83.33	1	83.00	3	83.20
14	0	83.33	4	87.26	4	85.30
15	1	84.37	0	87.26	1	85.80
16	2	86.45	1	88.32	3	87.40
17	2	88.53	1	89.38	3	88.90
20	0	88.53	1	90.44	1	89.50
21	1	89.57	1	91.50	2	90.50
23	2	91.65	0	91.50	2	91.60
24	0	91.65	1	92.56	1	92.10
25	1	92.69	0	92.56	1	92.60
26	1	93.73	1	93.62	2	93.70
27	1	94.77	0	93.62	1	94.20
29	0	94.77	1	94.68	1	94.70
30	1	95.81	0	94.68	1	95.30
32	0	95.81	1	95.74	1	95.80
38	0	95.81	1	96.80	1	96.30
50	0	95.81	1	97.86	1	96.80
51	1	96.85	1	98.92	2	97.90
95	1	97.89	0	98.92	1	98.40
109	1	98.93	0	98.92	1	98.90
117	1	99.97	0	98.92	1	99.50
129	0	99.97	1	99.98	1	100.00
Total	96		94		190	

Table 4 - Mean urine arsenic levels ($\mu g/L$)*: adjusted and unadjusted values, Arsenic and Lead Exposure Study, Rocker, Montana, August 1989.

	Target Area			Comparison Area		
	Mean	SD	Range	Mean	SD	Range
Arsenic ($\mu g/L$)	11.05	18.95	ND-117.00	10.10	15.26	ND-129.00
AsCr§ (ug/g)	13.87	22.76	ND-142.68	13.23	19.61	ND-125.24
AsSP¶ (ng/mL)	16.36	30.03	ND-216.00	15.78	22.78	ND-140.73

*Includes urine arsenic levels below the detection limit redefined as one-half of the limit of detection.

†ND = Below the detection limit of 10 $\mu g/L$

§AsCr = Arsenic adjusted to urine creatinine

¶AsSp = Arsenic adjusted to urine specific gravity

SD = Standard Deviation

Table 5 - Geometric mean urine arsenic levels by variables of interest, Arsenic and Lead Exposure Study, Rocker, Montana, August 1989.

Variable	n*	Geometric Mean of Urine Arsenic Level (Unadjusted)†	Standard Deviation	p-Value§
Group				
Target	96	1.94	0.73	0.90
Comparison	94	1.96	0.67	
Seafood¶ ingestion ≤3 days				
Yes	70	2.24	0.94	0.0002
No	120	1.78	0.44	
Gender				
Female	98	2.05	0.80	0.04
Male	92	1.84	0.57	
Days since last onsite				
≤3 days	5	1.61	0.00	0.0001
>3 days	185	1.96	0.05	
Months since last onsite				
≤3 months	25	1.72	0.39	0.01
>3 months	164	1.98	0.73	
Water source				
City	146	1.98	0.75	0.20
Private well	44	1.85	0.51	
Frequency of having household windows open				
≥75%	128	1.89	0.64	0.10
<75%	62	2.08	0.80	

Table 5 (continued)

Variable	n*	Geometric Mean of Urine Arsenic Level (Unadjusted)†	Standard Deviation	p-Value§
Have storm windows				
No	26	1.82	0.52	0.32
Yes	163	1.97	0.72	
Days since house was last vacuumed				
>3 days	60	1.84	0.60	0.14
≤3 days	130	2.00	0.74	
Where are pets kept?				
Indoors and outdoors	97	1.87	0.54	0.52
Indoors or outdoors only	31	1.94	0.61	

* Total number of subjects was 190; responses shown do not include responses of unknown or NA.

† Includes urine arsenic levels below the detection limit redefined as half of the detection limit.

§ Student's t-test applied to natural log-transformed values.

¶ Defined as having eaten any fresh, frozen, or canned seafood in the last 3 days, including tuna fish, sardines, shrimp, oysters, crabs, or clams.

Table 6 - Odds ratios for unadjusted urine arsenic level (< detection or ≥ detection)* associated with area of residence and other independent or potentially confounding factors (all ages), Arsenic and Lead Exposure Study, Rocker, Montana, August 1989.

Independent or Potentially Confounding Factor (n)	Odds Ratios (Target vs. Comparison)	95% Confidence Interval
None	0.8	0.4 - 1.5
Seafood ingestion† ≤3 days		
Yes (70)	1.3	0.5 - 3.6
No (120)	0.2	0.1 - 0.8
Gender		
Male (92)	1.3	0.4 - 4.1
Female (98)	0.6	0.2 - 1.4
Any pets in household		
Yes (128)	0.9	0.4 - 2.2
No (62)	0.5	0.2 - 1.8
Where are pets kept?		
Outdoors only (21)	1.0	0.1 - 7.5
Indoors and outdoors (97)	1.0	0.4 - 2.6
Indoors only (10)	0.3	0.0 - 8.2
Lead pipes in plumbing		
Yes (52)	1.9	0.1 - 33.9
No (126)	0.5	0.2 - 1.1
Frequency of having household windows open		
50-100% (156)	1.1	0.5 - 2.3
<50% (34)	0.3	0.1 - 1.2
Days since house last vacuumed		
>3 days ago (59)	0.2	0.0 - 1.6
≤3 days ago (130)	0.8	0.4 - 1.8
Frequency at which home is vacuumed per month		
0-7 (96)	0.8	0.3 - 2.5
≥8 (94)	0.5	0.2 - 1.3
Have storm windows		
Yes (163)	0.7	0.3 - 1.4
No (26)	1.0	0.1 - 8.4

Table 6 - (continued)

Age		
<6 (19)	0.9	0.1 - 5.9
6-16 (38)	2.4	0.2 - 28.7
≥17 (133)	0.6	0.3 - 1.4

* Detection limit = 10 μg/L

† Defined as having eaten any fresh, frozen, or canned seafood in the last 3 days, including tuna fish, sardines, shrimp, oysters, crabs, or clams.

Table 7 - Odds ratios for unadjusted urine arsenic level (< detection or ≥ detection)* associated with area of residence and other independent or potentially confounding factors (children 9 months to <16 years of age), Arsenic and Lead Exposure Study, Rocker, Montana, August 1989.

Independent or Potentially Confounding Factor (n)	Odds Ratios (Target vs. Comparison)	95% Confidence Interval
None	1.3	0.3 - 5.5
Most frequent daytime place		
Home or in neighborhood (46)	1.7	0.3 - 8.8
Elsewhere (8)	0.2	0.0 - 6.7
Average number of hours spent outdoors per day		
>4 (25)	1.8	0.2 - 20.9
≤4 (29)	1.1	0.2 - 8.0
Usual play surface		
Dirt, soil or sand (25)	1.4	0.1 - 17.7
Grass, concrete/asphalt, other (29)	1.6	0.3 - 9.5
Takes food outside		
often or occasionally (29)	1.1	0.2 - 7.1
rarely or never (25)	1.1	0.1 - 13.9
Mouths toys		
Yes (24)	0.6	0.1 - 4.1
No (26)	1.2	0.1 - 21.2
Sucks fingers, chews fingernails		
Yes (33)	1.1	0.2 - 6.3
No (21)	2.0	0.2 - 26.2
Average number of hours per day spent on floor		
>4 (26)	0.2	0.0 - 1.3
≤4 (28)	8.0	0.6 - 106.9

* Detection limit = 10 μg/L

Table 8 - Odds ratios for unadjusted urine arsenic level, (< detection or ≥ detection)* associated with independent factors, (target and comparison areas, combined, all ages), Arsenic and Lead Exposure Study, Rocker, Montana, August 1989.

Independent or Potentially Confounding Factor (n)	Odds Ratios	95% Confidence Interval
Hands washed		
<4 times/day (37)	1.4	0.2 - 8.0
≥4 times/day (17)	1.1	0.1 - 15.5
Frequency at which home is vacuumed per month		
≤7 times/month (24)	1.1	1.0 - 1.3
>7 times/month (30)	0.9	0.1 - 5.8
Age		
<6 (19)	1.0	
6 - 17 (38)	0.2	0.04 - 0.90
≥17 (133)	0.8	0.30 - 2.20
Months since last onsite		
>3 months (164)	1.0	
≤3 months (25)	0.3	0.10 - 1.20
Seafood ingestion ≤3 days†		
No (120)	1.0	
Yes (70)	3.8	1.80 - 8.20
Gender		
Male (92)	1.0	
Female (98)	2.2	1.01 - 4.63
Any pets in household		
No (62)	1.0	
Yes (128)	0.8	0.40 - 1.60

* Detection limit = 10 μg/L

Table 8 - (continued)

Independent or Potentially Confounding factor (n)	Odds Ratios	95% Confidence Interval
Where are pets kept?		
Indoors only (10)	1.0	
Indoors and outdoors (97)	1.1	0.20 - 5.30
Outdoors only (21)	1.6	0.30 - 9.80
Lead pipes in plumbing		
No (126)	1.0	
Yes (28)	0.2	0.05 - 1.00
Frequency of having household windows open		
50-100% of time (156)	1.0	
<50% of time (34)	2.5	1.10 - 5.90
Days since house last vacuumed		
≤3 days (130)	1.0	
>3 days (59)	0.6	0.30 - 1.30
Frequency with which home is vacuumed per month		
≥8 times per month (94)	1.0	
<8 times per month (96)	0.8	0.40 - 1.50
Water source		
City water (146)	1.0	
Well water (44)	1.2	0.50 - 2.80
Storm windows		
Yes (26)	1.0	
No (163)	1.7	0.60 - 5.00

* Detection limit = 10 µg/L

† Defined as having eaten any fresh, frozen, or canned seafood in the last 3 days, including tuna fish, sardines, shrimp, oysters, crabs, or clams.

Table 9 - Odds ratios for unadjusted urine arsenic level (< detection or ≥ detection)* associated with independent or potentially confounding factors, stratified by recent seafood ingestion†, Arsenic and Lead Exposure Study, Rocker, Montana, August 1989.

Independent or Potentially Confounding Factor	Recent Seafood Ingestion†(n)	Odds Ratio	95% Confidence Interval
Gender (female vs. male)	Yes (70)	1.4	0.5 - 3.7
	No (120)	3.9	1.1 - 17.2
Gender adjusted for fish ingestion		2.2	1.0 - 4.5
Frequency of having windows open (<50% vs. ≥50% of time)	Yes (70)	2.6	0.9 - 7.7
	No (120)	1.5	0.4 - 5.9
Window estimate adjusted for fish ingestion		2.1	0.9 - 4.9

† Defined as having eaten any fresh, frozen, or canned seafood in the last 3 days, including tuna fish, sardines, shrimp, oysters, crabs, or clams.

Table 10 - Adjusted* relative odds for urine arsenic level ≥ detection estimated from logistic regression, Arsenic and Lead Exposure Study, Rocker, Montana, August 1989.

Variable Rates	Odds Ratio	95% Confidence Interval
Recent seafood ingestion†	3.5	1.7 - 7.2
Gender (females/males)	2.6	1.2 - 5.5
Windows open (<50% of time vs. ≥50% of time)	2.6	1.1 - 6.3

* Adjusted for all variables shown in table

† Defined as having eaten any fresh, frozen, or canned seafood in the last 3 days, including tuna fish, sardines, shrimp, oysters, crabs, or clams.

Table 11 - Distribution of blood lead levels, children 9-71 months of age, Arsenic and Lead Exposure Study, Rocker, Montana, August 1989.

Blood Lead Level	Target area		Comparison area		Total	
μg/dL	n	Cumulative %	n	Cumulative %	n	Cumulative %
3.8		0	1	33.3	1	8.3
4.7		0	1	66.6	1	16.7
4.9		0	1	100.0	1	25.0
5.1	1	11.1			1	33.3
6.1	1	22.2			1	41.7
7.9	1	33.3			1	50.0
8.6	1	44.4			1	58.3
10.7	1	55.5			1	66.7
11.4	1	66.6			1	75.0
12.0	1	77.7			1	83.3
20.7	1	88.8			1	91.7
31.3	1	100.0			1	100.0
Total	9	100.0	3	100	12	100.0

The contents of Appendices 1 through 4 are presented in their entirety as submitted by the authors and have not been revised or edited to conform with Agency for Toxic Substances and Disease Registry guidelines.

Appendix 1

Participant Consent Form

PARTICIPANT CONSENT
for Interview, Blood and Urine Testing

The Butte-Silver Bow City-County Health Department, with assistance from the Montana Department of Health and Environmental Sciences and the Agency for Toxic Substances and Disease Registry, is conducting a survey of possible exposure to lead and arsenic, among residents of Rocker. My participation will help determine if there is exposure to lead and arsenic in Rocker, Montana.

The survey has three parts: a questionnaire, a blood test for exposure to lead for children under six years of age, and a urine test for exposure to arsenic. My part in the survey will include:

1. Answering questions about habits and activities of children in my home, the occupations of adults in my home, and hobbies of adults and children in my home.

2. Allowing blood and urine testing (described below) on:

   (___) Myself
   (___) My child/ward, __________________________

   a. A blood sample, approximately 3-6 ml (about 1 teaspoon), will be taken with a needle from a vein in the arm. There is little risk associated with this procedure. Temporary discomfort and a small bruise may occur at the site where the needle enters the skin.

   b. A first morning urine sample in a specimen cup will be requested. Instructions will be provided to help me/my child/ward use the specimen collector and/or cup correctly.

Participation: I understand that my household's participation will take about thirty minutes. There will be no physical examination. There is no provision for compensation or medical treatment in the event of injury as a result of my participation. I understand that I can stop my or my children's participation at any time. If I choose not to participate or to stop at any time there will be no penalty. Any benefits which I now receive or to which I am entitled will be not affected by this decision.

Results: As a result of my/my child/ward's participation in this survey, my child/ward will receive a blood test for lead and a urine test for arsenic, at no charge. The Butte-Silver Bow City/County Health Department will send me a letter within six to eight weeks with my/my child/ward's test results and will refer to us for a medical evaluation if it is indicated from our test results.

Confidentiality: I understand that the city-county health department will take every reasonable precaution to keep my records confidential. Any information shared with the Agency for Toxic Substances and Disease Registry or Montana Department of Health and Environmental Sciences will be kept in accordance with the federal Privacy Act of 1974. Any reports of this survey will not identify specific individuals, and will only give group information.

PARTICIPANT CONSENT
Page Two

Participant consent: I have read the description of this problem survey. All of my questions have been satisfactorily answered. I voluntarily request that I (my child/ward, named above) be included in this survey.

Participant/guardian name (print) ______________________________

Participant/guardian signature ______________________________

Date ______________ Witness: ______________________________

If you have any questions, please contact:

Butte-Silver Bow County Health Department
Dan Dennehy, Health Officer, Telephone: 723-3275

JG/war-36xt

Appendix 2

Household Questionnaire

(80-83) Household No. __ __ __ __

(84-85) Household Member ID __ __

(86-91) Today's Date __ __/__ __/__ __

PART A: HOUSEHOLD QUESTIONS, TO BE ANSWERED BY ADULT

I would like to begin by asking you a few questions about your home.

A-1. How long has your family been living in this house?

(92-93) __ __ Months

OR

(94-95) __ __ Years

(96) A-2. What is the source of water for this house?

City water lines .... = 1

Private well .... = 2

Other:____________________............ = 3

Unknown .... = 9

(97) A-3. Does your house have lead pipes for plumbing?

Yes................................. = 1

No .... = 2

Unknown............................. = 9

(98) A-4. Does your home have storm or thermal windows?

Yes................................. = 1

No.................................. = 2

Unknown .... = 9

(99) A-5. During the last 3 months how often would you say windows in the kitchen, living/family room, or bedrooms have been left open?

100% of the time...................... = 1

75 - 99% of the time.................. = 2

50 - 74% of the time.................. = 3

25 - 49% of the time.................. = 4

1 - 24% of the time................... = 5

Not at all............................ = 6

Household No. ___ ___ ___ ___

Household Member ID ___ ___

(100-101) A-6. Approximately how many times has your home been vacuumed in the last month?

___ ___ times

(102) A-7. When was it last vacuumed?

Within the last 3 days.................. = 1

More than 3 days ago but within the last week......................... = 2

More than a week ago but within the last 2 weeks....................... = 3

More than 2 weeks ago but within the last month......................... = 4

>1 month ago........................... = 5

Unknown................................ = 9

(103) A-8. Do you have an air cleaner (electrostatic precipitator) on the furnace in your home?

Yes.................................... = 1

No..................................... = 2

Unknown................................ = 9

(104) A-9. Do you have any pets?

Yes (proceed to 10) .... = 1

No (proceed to 11) .... = 2

(105) A-10. Are your pets kept in the house only, outside only, or allowed to come in and out of the house?

All pets are kept in the house only..= 1

All pets are kept outdoors only .....= 2

At least one pet is allowed inside and outside...................= 3

Unknown...........................= 9

Household No. _ _ _ _

Household Member ID _ _

(106-107) A-11. What is the highest grade or year of regular school that was completed by the head of this household?

Enter grade level (01 - 12) for grammar school
13 - 16 for college undergraduate year
17 - 20 for graduate school........... _ _

(108) A-12. Which of the following categories comes closest to the total household income for this family before taxes in 1988?

< $5,000.................................... = 1

$5,000 or more but less than $10,000......... = 2

$10,000 or more but less than $15,000........ = 3

$15,000 or more but less than $20,000........ = 4

$20,000 or more but less than $25,000........ = 5

$25,000 or more but less than $30,000........ = 6

$30,000 or more.............................. = 7

Unknown...................................... = 9

Refused...................................... = 0

I'd like to ask you a few questions about yourself now.
(GO TO PART B)

(109-112) Household No. __ __ __ __

(113-114) Household Member ID __ __

PART B: ADULT INTERVIEW: FOR PERSONS $\geq$ 16

(115-120) B-1. Could you please tell me your birthdate ?

__ __/__ __/__ __
mm / dd / yy

(121) B-2. To which of the following racial groups do you belong?

White................................ = 1

Black................................ = 2

Asian or Pacific Islander............. = 3

American Indian or Alaskan Native..... = 4

Refused.............................. = 5

Unknown.............................. = 9

(122) B-3. Are you of Hispanic descent?

Yes.................................. = 1

No................................... = 2

Unknown.............................. = 9

(123) B-4. This person's gender is:

Male................................. = 1

Female............................... = 2

B-5. Have you worked in any of the following jobs during the last 3 months? (Circle all that apply.)

(124) Worker in copper smelter......... Yes = 1 No = 2

(125) Worker in active mining. .... Yes = 1 No = 2

(126) Pesticide sprayer . ... Yes = 1 No = 2

(127) Pesticide manufacturer or distributer.................... Yes = 1 No = 2

(128) Work involving the application of preservatives to wood/timber.... Yes = 1 No = 2

Household No. __ __ __ __

Household Member ID __ __

B-6. Do you currently work in any of the jobs which I just listed? (Circle all that apply.)

(129)	Worker in copper smelter.........	Yes = 1	No = 2
(130)	Worker in active mining..........	Yes = 1	No = 2
(131)	Pesticide sprayer	Yes = 1	No = 2
(132)	Pesticide manufacturer or distributer......................	Yes = 1	No = 2
(133)	Work involving the application of preservatives to wood/timber......	Yes = 1	No = 2

B-7. I am now going to read a list of outdoor activities to you, and would like you to indicate each one that you have participated in within the last 3 days IN THIS NEIGHBORHOOD. (Circle all that apply.)

(134)	Gardening........................	Yes = 1	No = 2
(135)	Lawn mowing......................	Yes = 1	No = 2
(136)	Other yard work..................	Yes = 1	No = 2
(137)	Outdoor field sports, such as baseball/catch/football/soccer	Yes = 1	No = 2
(138)	Bicycling on dirt surface, or dirt bike riding..................	Yes = 1	No = 2
(139)	Hiking, walking, jogging...........	Yes = 1	No = 2
(140)	Any other activities involving soil contact in the neighborhood...	Yes = 1	No = 2

IF Yes to OTHER ACTIVITIES, please SPECIFY____________________

(141) B-8. As far as you remember, have you ever taken any materials, such as wood or scrap pieces of metal, from the site where the timber treatment plant used to be that lies next to Silver Bow Creek between Rocker and Fredricksburg?

Yes................................ = 1

No................................. = 2

Unknown............................ = 9

Household No. __ __ __ __

Household Member ID __ __

(142) B-9. Within the last 3 months, have you been on the site?

Yes.................................... = 1

No..................................... = 2

Unknown................................ = 9

(143) B-10. Have you been on the site within the last 3 days?

Yes. .... = 1

No..................................... = 2

Unknown................................ = 9

B-11. Please tell me whether you have participated in any of the following activities on the site within the last 3 days? (Circle all that apply.)

(144) Walking, jogging or running........Yes = 1 No = 2

(145) Bicycling.........................Yes = 1 No = 2

(146) Riding motorcycle or dirt bike.....Yes = 1 No = 2

(147) Other, describe:__________________ Yes = 1 No = 2

(148) B-12. Have you eaten any fresh, frozen, or canned seafood in the last 3 days, including tuna fish, sardines, shrimp, oysters, crabs, or clams?

Yes.................................... = 1

No..................................... = 2

Unknown................................ = 9

(149) B-13. In the last 3 days, have you drunk any red wine?

Yes.................................... = 1

No..................................... = 2

Unknown................................ = 9

Thank you. Those are all of the questions that I have which concern yourself.

IF THERE ARE CHILDREN IN THE HOUSEHOLD FROM 9 MONTHS TO <16 YEARS OF AGE IN THE HOUSEHOLD, SAY THE FOLLOWING: I'd now like to ask you some questions about your child/children, beginning with the youngest. (GO TO PART C)

IF THERE ARE NO CHILDREN <16 YEARS OF AGE, SAY THE FOLLOWING: I'd now like to interview (name of next household member ≥16 years of age). (COMPLETE SECTION B WITH EACH HOUSEHOLD MEMBER ≥16 YEARS OF AGE)

(150-153) Household No. __ __ __ __

(154-155) Household Member ID OF RESPONDENT __ __

PART C: CHILD INTERVIEW

THE QUESTIONS IN THIS SECTION ARE FOR CHILDREN FROM 6 MONTHS TO <16 YEARS OF AGE AND SHOULD BE ANSWERED BY THE PARENT. IF POSSIBLE, CHILDREN 6 YEARS OF AGE OR OLDER SHOULD BE PRESENT WHILE THE ADULT IS RESPONDING.

REFER TO HOUSEHOLD LOG SHEET TO SELECT THE YOUNGEST CHILD NOT YET INTERVIEWED, AND SAY: I see that your (youngest/next youngest) child is (child's name). The questions I will be asking you now concern (child's name). IF THIS CHILD IS 6 YEARS OF AGE OR OLDER, SAY: Would it be possible for this child to be present while we conduct this part of the interview?

ENTER RESPONSES TO THE FOLLOWING QUESTIONS IN TABLE 1 (page bottom).

C-1. Could you please verify for me the child we will be talking about now by telling me again (his/her) first name?

C-2. What was (CHILD'S NAME) date of birth?

C-3. What is (CHILD'S NAME) sex? 1 = male 2 = female

C-4. Which of the following best describes (CHILD'S NAME) race?

1 = White
2 = Black
3 = Asian or Pacific Islander
4 = American Indian or Alaskan Native
5 = Refused
9 = Unknown

C-5. Is (CHILD'S NAME) of Hispanic descent?

1 = Yes
2 = No
9 = Unknown

TABLE 1 (questions C-1 through C-5)

	Household member ID	C-1 First name	C-2 Birthdate	C-3 Sex	C-4 Race	C-5 Hispanic
(156-166)	0 1	________	__ __/__ __/__ __	__	__	__
(167-177)	0 2	________	__ __/__ __/__ __	__	__	__
(178-188)	0 3	________	__ __/__ __/__ __	__	__	__
(189-199)	0 4	________	__ __/__ __/__ __	__	__	__
(200-210)	0 5	________	__ __/__ __/__ __	__	__	__
(211-221)	0 6	________	__ __/__ __/__ __	__	__	__

PART C: CHILD INTERVIEW (CONT.) Household No. ___ ___ ___ ___

Household Member ID OF RESPONDENT ___ ___

ENTER RESPONSES TO THE FOLLOWING QUESTIONS IN TABLE 2 (page bottom).

C-6. Where does (CHILD'S NAME) spend most of his/her daytime hours?

1 = At home
2 = Elsewhere in the immediate neighborhood (i.e., Rocker, Fredricksburg, or White Hall).
3 = Outside of the immediate neighborhood.
9 = Unknown

C-7. Approximately how many hours a day, on average, does (CHILD'S NAME) play outdoors around the house or in your neighborhood?

C-8. When (CHILD'S NAME) plays outdoors does he/she play most often in areas that have a concrete or asphalt surface, that are grassy, are mainly dirt or soil, in sandy areas (such as a sandbox), or another type of area?

1 = Concrete/asphalt
2 = Grassy
3 = Dirt/soil
4 = Sandy/sandbox
5 = Other, describe: ______________________
9 = Unknown

C-9. Does (CHILD'S NAME) take food or drink, including a bottle, or pacifier for younger children, outside with him/her often, occassionally, rarely, or never?

1 = Often
2 = Occassionally
3 = Rarely
4 = Never
9 = Unknown

TABLE 2 (questions C-6 through C-9)

	Household member ID	C-6 Daytime Place	C-7 # Hours Outdoors	C-8 Outdoor Play Surface	C-9 Food/Drink Outdoors
(222-228)	0 1	___	___ ___	___	___
(229-235)	0 2	___	___ ___	___	___
(236-242)	0 3	___	___ ___	___	___
(243-249)	0 4	___	___ ___	___	___
(250-256)	0 5	___	___ ___	___	___
(257-263)	0 6	___	___ ___	___	___

PART C: CHILD INTERVIEW (CONT.)   Household No. __ __ __ __

Household Member ID OF RESPONDENT __ __

ENTER RESPONSES TO THE FOLLOWING QUESTIONS IN TABLE 3 (page bottom).

C-10. Does (CHILD'S NAME) have any toys which he/she takes both indoors and outdoors to play?

1 = Yes
2 = No
9 = Unknown

C-11. Does he/she ever put these toys in his/her mouth?

1 = Yes
2 = No
8 = Not applicable
9 = Unknown

C-12. Does (CHILD'S NAME) suck his/her thumb or fingers, or chew on his/her fingernails?

1 = Yes
2 = No
9 = Unknown

C-13. Approximately how many hours during the day, on average, do you think (CHILD'S NAME) spends playing on the floor in the house?

C-14. Has (CHILD'S NAME) been on the site where the timber treatment plant used to be, by Silver Bow Creek between Rocker and Fredricksburg, within the last 3 months?

1 = Yes
2 = No
9 = Unknown

TABLE 3 (questions C-10 though C-14)

	Household Member ID	C-10 Indoor/Outdoor Toys	C-11 Mouth Toys	C-12 Fingers in mouth	C-13 Hours on floor	C-14 Onsite 3-months
(264-271)	0 1	__	__	__	__ __	__
(272-279)	0 2	__	__	__	__ __	__
(280-287)	0 3	__	__	__	__ __	__
(288-295)	0 4	__	__	__	__ __	__
(296-303)	0 5	__	__	__	__ __	__
(304-311)	0 6	__	__	__	__ __	__

PART C: CHILD INTERVIEW (CONT.) Household No. __ __ __ __

Household Member ID OF RESPONDENT __ __

ENTER RESPONSES TO THE FOLLOWING QUESTIONS IN TABLE 4 (page bottom).

C-15 Has (CHILD'S NAME) been on the site within the last 3 days?

1 = Yes
2 = No
9 = Unknown

C-16 Which of the following best describes the most frequent activity of (CHILD'S NAME) on the site?

1 = Walking or being walked through area
2 = Running in or through area
3 = Bicycling in area
4 = General play

C-17. Does (CHILD'S NAME) put his/her mouth on furniture or the window sill often, occassionally, rarely, or never?

C-18. Does (CHILD'S NAME) put paint chips in his/her mouth often, occassionally, rarely, or never?

CODES FOR QUESTIONS C-17 AND C-18:

1 = Often
2 = Occassionally
3 = Rarely
4 = Never
9 = Unknown

C-19. Approximately how many times in an average day are (CHILD'S NAME) hands washed?

C-20. In the last 3 days, how many meals did (CHILD'S NAME) eat which included seafood, including tuna, shrimp, clams, crabs, or other ?

TABLE 4 (questions C-15 though C-20)

	Household Member ID	C-15 Onsite 3-days	C-16 Activity Onsite	C-17 Mouth Furniture	C-18 Paint Chips	C-19 # times Hands washed	C-20 # meals seafood
(312-321)	0 1	___	___	___	___	__ __	__ __
(322-331)	0 2	___	___	___	___	__ __	__ __
(332-341)	0 3	___	___	___	___	__ __	__ __
(342-351)	0 4	___	___	___	___	__ __	__ __
(352-361)	0 5	___	___	___	___	__ __	__ __
(362-371)	0 6	___	___	___	___	__ __	__ __

Appendix 3

Urine Collection Instructions

URINE COLLECTION INSTRUCTIONS FOR STUDY PARTICIPANTS

1. Collect your first morning urine. Be sure the correct name is on the cup.

2. Wash hands with soap and water.

3. Do not open the bag and cup until just before urinating. The inside of the container and cap should not be touched or come in contact with any parts of the body, clothing, or any object.

4. Fill the cup with at least 2 ounces (one fourth of the plastic cup) of urine and recap it immediately.

5. Place the cup back in the plastic bag and store it in the refrigerator until it is picked up by the study personnel. DO NOT FREEZE

URINE COLLECTION FOR CHILDREN

1. Collect the child's first morning urine. Be sure the correct name is on the cup.

2. Your child will need help in urinating into the cup.

3. Wash your hands and the child's hands with soap and water.

4. Do not open the bag containing the urine cup and moist towelettes until your child is ready to urinate into the cup.

   For a girl: Use the moist towelette to wipe her bottom from front to back.

   For a boy: Wipe the tip of the penis with the moist towelette.

5. Have the child urinate into the cup.

6. Put the lid on the cup as soon as the child is finished urinating.

7. Be careful not to let the inside of the cup or lid touch clothes, body or other objects.

8. Refrigerate the urine sample immediately. DO NOT FREEZE.

Appendix 4

Urine Collection And Handling for Children Not Yet Toilet Trained

Urine Collection And Handling for Children Not Yet Toilet Trained

First morning void specimens from children who are not yet toilet trained generally are not practical. Attempt to collect urine from these children using the following instructions:

1. Collect the specimen during the child's nighttime sleeping period. Clean the infant's genital area with a handwipe before affixing the collection bag.

2. Place a transparent plastic, sterile urine collection bag over the perineum.

3. Affix the adhesive side of the bag firmly against the surrounding skin.

4. (Optional) On the child, put a disposable diaper with a hole torn in-it to allow the urine collector to protrude.

5. Upon the child awakening, remove the bag and pour the urine into a sterile specimen cup.