Survey of
Typical Soils Arsenic Concentrations
In Residential Areas of University Place

Quality Assurance Project Plan

by
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Introduction

This survey study of arsenic levels in residential soils within a study unit in University Place is in response to concern about elevated levels of arsenic and lead in the area. Arsenic, lead, and other metals were emitted by a stack at the Asarco Tacoma Smelter (Figure 1). Metals deposited by aerial deposition from the smelter have been found to have caused increased levels of some metals in soils in areas of King and Pierce County.

Project Description

In response to the finding of elevated metals concentrations in background soil samples from University Place, this pilot study will assess the degree of contamination of typical residential soils in the area. Arsenic is the metal of concern in this study because arsenic levels in the University Place background study and in other studies of soils impacted by aerial deposition from the Asarco smelter were highest with respect to MTCA cleanup levels for uncontrolled use in residential areas. Samples will be collected from the front and back yards of 60 residences. Laboratory analyses will be conducted by the Ecology Manchester Environmental Laboratory. A report prepared by the Department of Ecology will describe the findings of this project.

Study Area

University Place can be described as consisting of a northern portion that is predominantly residential and densely developed and a southern portion that is less densely developed. Because the data resulting from samples of the 60 properties will be pooled to describe the overall characteristics of the study area, it is important to establish a study area with a relatively uniform density of housing units. For this reason, the study area selected is composed of the more densely developed northern portion of the city, the portion containing the majority of the city's housing units. The study area is bounded by the city's northern and western boundaries and on the east by 67th Avenue W. It is bounded on the south by a line extending from the portion of Cirque Drive W. which runs east-west through the center of the city (Figure 2).

Study Design Overview

The objective of the study is to characterize typical arsenic concentrations in residential soils from the University Place area. In this pilot study the objective is to be able to describe the overall characteristics of the soils being studied with respect to arsenic concentrations. It is not within the scope of this study to gain the depth of information needed to describe any spatial differences in the data or to link specific data sets with particular properties. In order to address property owner concerns about the confidentiality of results, information about samples and sample locations will be dissociated. Before samples are sent to the laboratory, samples will be labeled with random numbers. Samples will be unlabeled with respect to property identification but labeled with respect to front or backyard location and the age range of each residence.

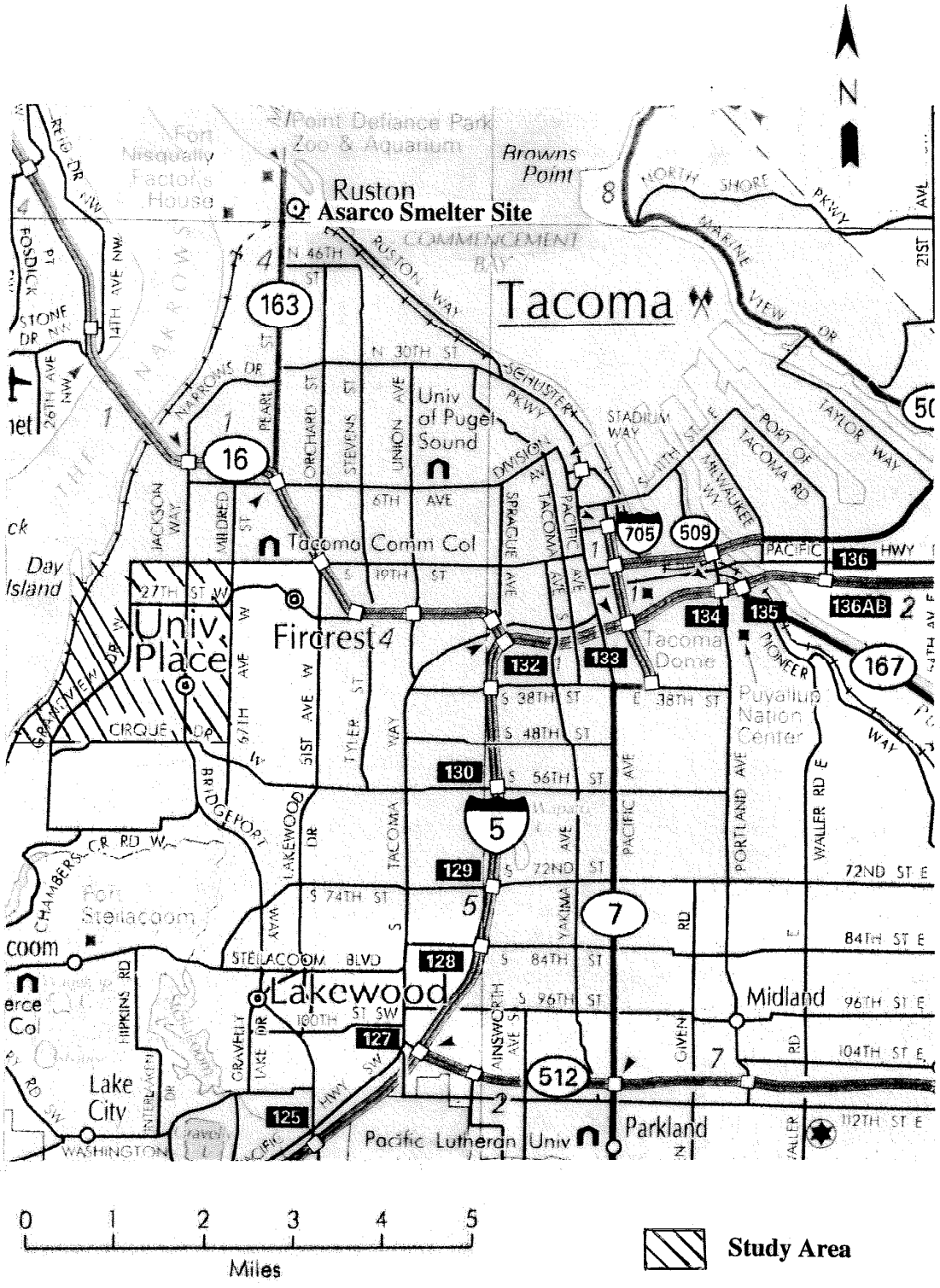

Figure 1 – Location Map – Typical Soils Arsenic Concentrations in Residential Areas of University Place.

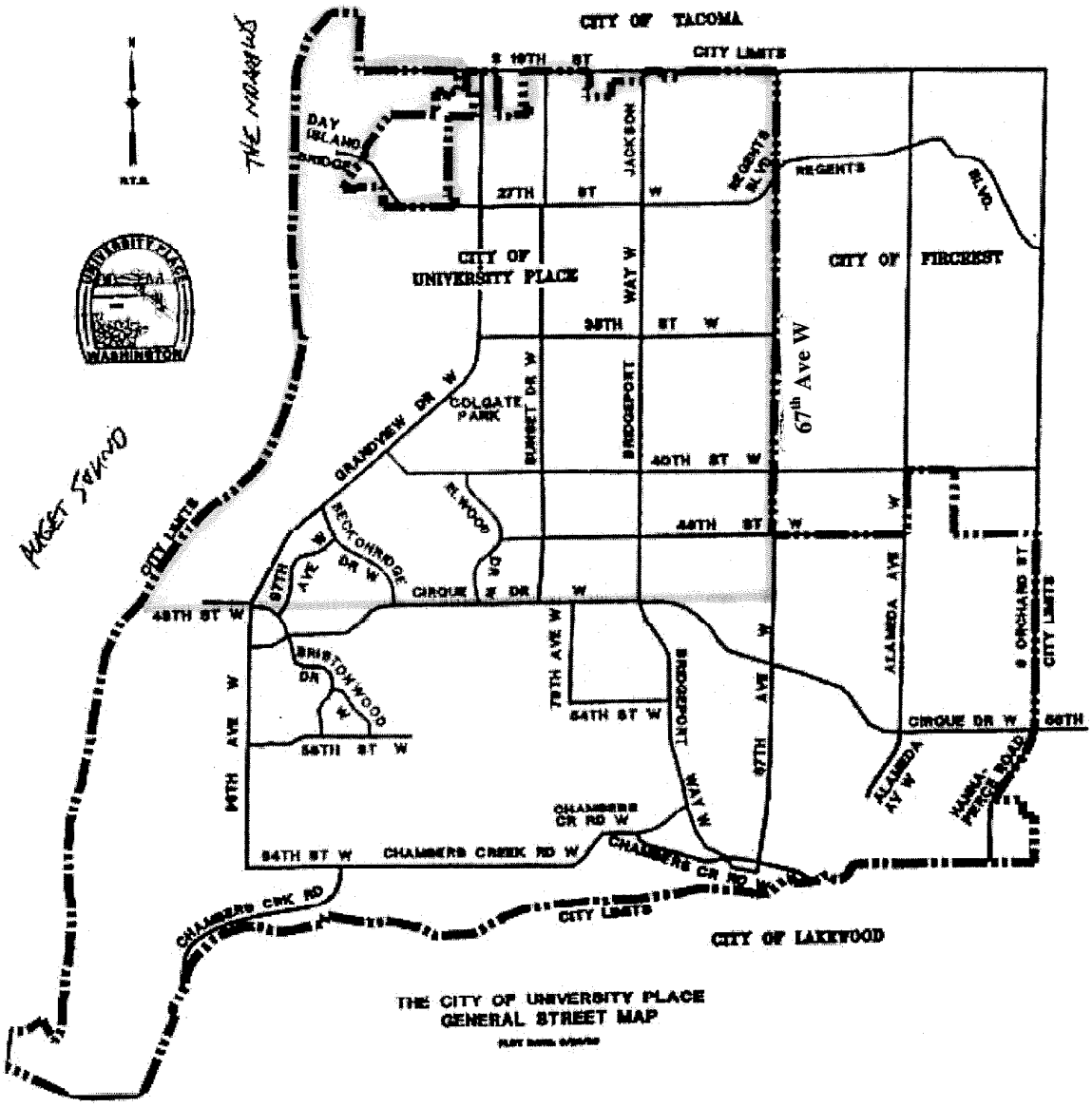

Figure 2 – Study Area – Typical Soils Arsenic Concentrations in Residential Areas of University Place.

Age ranges will consist of ten year intervals. Although elevated lead concentrations have also been associated with aerial deposition from the Asarco smelter in some locations, lead analysis will not be within the scope of this study. All samples will be archived, providing for the possibility of further analysis of some samples, including analysis for lead. Neither archived samples nor analyzed samples will be traceable to particular locations.

Background

The Asarco Tacoma Smelter is located in Ruston and Tacoma (Figure 1). The smelter operated from 1890 until 1986, first as a lead smelter, and later as a copper smelter that processed ores containing high levels of arsenic (EPA, 1991). Smelting operations were discontinued in 1985 and the facility closed permanently in 1986. During the time it operated, the Asarco Smelter used high temperature furnaces to melt the metals away from raw materials. The smelter stack and other parts of the plant released dust particles containing arsenic, lead, and other metals into the air. Much of the dust settled onto soils throughout Ruston and north Tacoma. Most of the dust that fell on land remains in the soil today (EPA, 1991). Contamination at the facility has been addressed by several federal Superfund projects.

After the smelter closed, studies were conducted to determine the extent of nearby soil contamination. In 1988 Ecology collected 288 soil samples from an area approximately 950 acres surrounding the smelter. This area included about 1,800 housing units and 4,300 residents. Asarco agreed to remove contaminated topsoil from 11 publicly accessible properties and to replace the contaminated soil with clean soil. In 1989 EPA collected 222 additional samples. EPA concluded that the highest levels of arsenic and other contaminants are generally found on properties located closest to the smelter, with concentrations decreasing with distance from the smelter. Test results showed that the amount of arsenic in surface soils in the Ruston and north Tacoma residential study area ranged from 2 to 3,000 parts per million (ppm - EPA, 1991). The Model Toxics Control Act (MTCA) Method A soil cleanup level for arsenic is 20 ppm for residential areas, uncontrolled use.

Most previous soil monitoring efforts had concentrated on the Asarco Smelter site and nearby surrounding area. The highest known arsenic concentration near University Place was 166 ppm on the eastern end of Fox Island. University Place is at its closest point, three miles south-southwest of the smelter (Fig.1). A recent study of surface soil samples from undisturbed locations in University Place five to seven miles from the smelter shows significant aerial deposition of arsenic from the Asarco Smelter there. The study took place after significant lead and arsenic contamination was found at a site owned by Tacoma Water where two water tanks had been sandblasted (City of Tacoma and Glass, 1998). It was suspected that aerial deposition from the Asarco Smelter may have been the primary source of arsenic found at the site. An area background study was conducted to determine the concentrations of arsenic and lead in surficial soils from 64 samples at 7 sites in and near University Place (City of Tacoma and Glass, 1999). The area background clearly showed elevated arsenic and lead concentrations in relatively

undisturbed soils. Maximum values were 281 ppm and 1,175 ppm for arsenic and lead, respectively. The MTCA Method A soil cleanup level for lead is 250 ppm. Statistical analyses were performed on the University Place data according to Ecology guidance, resulting in calculated background values of 265 ppm and 561 ppm for arsenic and lead, respectively, under the Model Toxics Control Act (City of Tacoma and Glass, 1999).

Project Organization

Client:	Joyce Mercuri, Southwest Regional Office, TCP Section
Lead Person:	Steven Golding, E.A. Program, Watershed Ecology Section
Field Assistance:	Dave Rogowski, Katina Kapantais, Larry Dexter, Randy Coots, Paul Anderson
Laboratory Services:	Ecology Manchester Environmental Laboratory

Project Schedule

Field Work:	May 22 – June 16, 2000
Laboratory Analysis:	August, 2000
Draft Investigative Report:	October, 2000
Final Investigative Report:	December, 2000

Laboratory Costs

Laboratory costs for 320 samples @ $31/sample (based on the original request of analysis by ICP) including sample preparation = $9,920 estimated lab cost

Data Quality Objectives

This project is a survey study. The intent is primarily informative and descriptive, and is not intended as a thorough evaluation of the arsenic concentrations in the study area or as an evaluation of site-specific arsenic concentrations. Data quality should be such that the mean and median of the sample data can be determined with an accuracy of +/- 10% and an evaluation of the overall distribution of data can be made. The reporting limit must be lower than the 20 ppm MTCA cleanup level and overall accuracy at 20ppm arsenic should be within 15%.

Graphite furnace atomic absorption (GFAA) meets the above data quality objectives. The standard limits for accuracy and precision for arsenic at 5 mg/Kg with GFAA are +/- 25% and 20% respectively. In practice, the Manchester Environmental Laboratory achieves accuracy generally better than +/- 15% and precision better than +/- 10% (Ross, 2000). The reporting limit is 0.3 mg/Kg for GFAA arsenic soils analyses (Ecology, 1999). For contaminated samples the reporting limit can be as high as 6 mg/Kg (20 times higher). This is acceptable, as it is below the maximum reporting limit of 20 mg/Kg specified for this project.

NIST 2711 (Montana soil) will be used in the laboratory as a standard reference material for this project. NIST 2711 is a soil with an arsenic concentration of 105 mg/Kg (ppm) +/- 8 mg/Kg , within the anticipated range of the results for this study. A control sample analysis will be performed for every 20 samples.

Representativeness

The sampling design described in *Sampling Strategy* and *Sampling Procedures* (below) is intended to generate representative data for the study area (a portion of the City of University Place). Representativeness will be enhanced through the use of composite sampling, although composites can mask variability. 264 soil samples will be collected from 60 residential properties, with an additional 40 samples taken as split samples and field duplicate samples. A review of data from previous sampling for arsenic in residential yards in North Tacoma indicate that the number of samples should be sufficient to characterize general levels of arsenic in the study area (data from Hydrometrics, 1999)

Sampling Strategy

The locations sampled in this study will be selected randomly so that they represent the study area. A map of the study area will be developed using Arcview with a Geographic Informations System (GIS) database. A 50-foot grid will be overlayed onto the study area and grid cells within the study area will be selected from among the cells by random number generation. A list of 60 randomly chosen cells will be developed and the residential property within or closest to each cell will be selected for sampling. If no residential property is present within the cell or an adjacent cell, a residential property will be chosen from an alternative cell. Alternative randomly generated lists of cells will be developed for this purpose.

Consideration has been given to the possibility that some of the residential yards included in this study are on former orchard lands. In the past, lead arsenate has been applied on some Washington orchard lands, resulting in elevated levels of lead and arsenic in the affected soils. Glass (1999) found relatively low levels of arsenic (32 ppm maximum) in soils from two orchards in University Place. It may be that while lead arsenate use was common in the large orchards of eastern Washington, it was not used in University Place area orchards (Glass, 2000). Consequently, historical land use will not be a criteria for sample site selection in this study.

Homeowners or apartment building owners will be contacted to obtain permission to collect soil samples on their properties. The nature of the study will be discussed with each property owner. Any turndowns will be noted and the percentage of properties for which owners refused permission for sampling will be determined. The Utility Underground Location Center will be notified, as required by law, two business days to one week prior to sampling so that underground utilities will be marked.

Sixty residential properties will be sampled. Soil will be sampled from five locations in each front yard and each backyard, with the five subsamples from each front yard forming one composite sample and the five subsamples from each back yard forming another composite sample. The front and back yard composite samples will be analyzed separately. Composite rather than discrete sampling was chosen to increase the information gained from each sample analyzed.

Five subsamples per each front and back yard is consistent with the sampling protocol for the initial soils sampling study for the smelter site in Everett, Washington. In the Everett study, five samples was found to be a minimum number to adequately characterize the arsenic concentration of a property. A review of results from sampling for arsenic in residential yards in North Tacoma (Hydrometrics, 1999) gives an indication that five subsamples per sample can be expected to yield results close to those that could be obtained by increasing the number of subsamples per front or back yard beyond five. In this University Place pilot study, the yards of 60 residences will be sampled, with a total of ten subsampling sites per property. The sampling strategy is summarized below in Table 1.

Soil sampling for this pilot study will be limited to a depth of 1-foot because this is the depth interval for which there is the greatest potential human exposure and because the highest concentrations of arsenic are expected to be found at or above 1-foot depth. Previous studies in Ruston and North Tacoma found the highest arsenic concentrations in the top foot, with concentrations declining at greater depths (Bechtel, 1990).

Separate soil samples will be taken at 0-2 inch, 2-6 inch and 6-12 inch depths. The 0-2 inch depth represents surface soil that residents, particularly children, are likely to be exposed to. Data collected at these intervals will be comparable to data collected at these same depth intervals in previous studies, such as in Everett (Aldrich, 1998) and in the 1999 University Place area background arsenic study. Ruston/North Tacoma soil samples were collected at depth intervals: 0-1", 1-6", and 6-12".

Table 1: Sampling Summary

The following summarizes the samples to be collected, including quality assurance samples. Samples are to be collected at two depths at 48 residential properties and at 3 depths at 12 residential properties, for a total of 60 residential properties to be sampled.

48 properties: (192 samples)	front yard:	0-2 inch depth (composite of five subsamples) 2-6 inch depth (composite of five subsamples)
	back yard:	0-2 inch depth (composite of five subsamples) 2-6 inch depth (composite of five subsamples)
12 properties: (72 samples)	front yard:	0-2 inch depth (composite of five subsamples) 2-6 inch depth (composite of five subsamples) 6-12 inch depth (composite of five subsamples)
	back yard:	0-2 inch depth (composite of five subsamples) 2-6 inch depth (composite of five subsamples) 6-12 inch depth (composite of five subsamples)
	QA samples: (16 samples)	Split sample composites at 4 properties, front & back yards, 0-2 & and 2-6"
	Duplicate Field Samples: (24 samples)	Samples collected apart from principal samples 6 properties, front & back yards, 0-2" and 2-6"
	Laboratory Spike Samples (16 samples)	

TOTAL SAMPLES = 320

Sampling Procedures

Before collecting a sample, all sampling and collection equipment will be cleaned with liquinox soap and water, ultrapure distilled water, and 10% nitric acid followed by a distilled water rinse. Samples will be collected with a 3" inner diameter stainless steel hand auger or 3" inner diameter stainless steel pipe sections adapted for sampling use. Nitrile disposable gloves will be worn by personnel during sampling. The surface layer of vegetative material will be removed and consecutive samples from each sampling hole will be collected at 0-2", 2-6", and 6-12". Samples will be thoroughly mixed in stainless steel mixing bowls and protected from wind so as not to lose fines. Composite samples will be mixed until the entire sample is of uniform consistency. Rocks, vegetation, debris, and other large materials will be removed in the field using stainless steel tweezers cleaned for metals sampling. Samples will be transferred to laboratory-cleaned

jars with teflon lids. Sample splits will be transferred from the mixing bowls to sample containers. Sample containers will be placed in ice chests and chain of custody procedures will be followed to ensure security of the samples. All samples will be sieved in the laboratory (2 mm sieve) before analysis.

Samples will be taken from lawn areas only. Although samples will not be identified with particular properties, front and back yard samples will be paired and identified as coming from the same property, so that average arsenic concentrations for the properties sampled can be calculated.

Sampling spots will be located from a starting point at the center of each yard. Using a compass and measuring tape, sampling spots will be located at the center point and midway between the center point and the edge of the property at compass bearings northeast (45°), southeast (135°), southwest (225°) and northwest (315°) from the center point. Duplicate samples will be collected at the center of the lawn and lawn midpoints east (90°), south (180°), west (270°) and north (0°) compass bearings.

If a potential sampling spot is located in a garden, the sampling spot will be relocated to the nearest spot away from the center of the lawn, three feet from the edge of the garden. If a tree or utility is in the way, or a potential sampling site is within five feet of a road or within three feet of a structure, the sample will be taken from the nearest available location.

Analytical Procedures

Samples will be sieved in the laboratory as part of sample preparation. The portion of the samples passing a 2 mm sieve will be analyzed for arsenic by GFAA (EPA SW846, Method 7060A). The samples will first be digested by method 3050B. Analyses will be performed by the Manchester Environmental Laboratory. The inductively coupled plasma (ICP) method was initially chosen for this project because of its lower cost. GFAA was chosen instead because of availability of analytical equipment.

Spike samples will be analyzed in the laboratory to determine the extent of any interference affecting results. There will be no spike duplicate samples for this study. Because this is a pilot study and because significant arsenic concentrations are expected to be found in the samples, spike duplicate samples are not considered essential. Split samples and laboratory duplicates will be expected to provide an estimate of precision.

Quality Control Procedures

Sixteen samples will be split in the field by homogenizing the material in cleaned stainless steel mixing bowls. These samples will consist of samples of material from the yards of four residences (front and back yards separately) at depths of 0-2" and 2-6". The split samples will provide a check on the repeatability of results and the effectiveness of field homogenizing technique and laboratory analyses.

Twenty-four duplicate field samples will be taken from 6 of the properties sampled, each duplicate sample consisting of five subsamples from each front and back yard at 0-2" depth and 2-6" depth. The results between the duplicate field samples and the regular samples will give an indication of sampling variability.

The twelve properties for duplicate sampling will be selected by grouping the 60 properties in the study spatially and selecting at random one property to represent each grouping of 5 properties. This will eliminate the potential for spatial clumping of the relatively few duplicate sample sites.

Spike samples will be analyzed in the laboratory to determine the extent of any interference affecting results. There will be no spike duplicate samples for this study. Because this is a pilot study and because significant arsenic concentrations are expected to be found in the samples, spike duplicate samples are not considered essential. Split samples and laboratory duplicates will be expected to provide an estimate of precision.

A standard reference material, NIST 2711, supplied by the Manchester Environmental Laboratory, will be analyzed in the laboratory. This will provide a check on analytical accuracy.

Data Reduction, Review, and Reporting

Results for any particular property will be unknown but results will be summarized with respect to the age range of the residence and to front and backyard locations. The final report will include a summary of data collected, an analysis of results, and a discussion of quality assurance of the data. Because data are limited in this pilot study, with 60 residences representing all of the residences in the study area and ten sample locations per residence, results can be presented meaningfully only in a general way. The following measures of results will be applied to the data from this study and reported:

- Mean arsenic concentration
- Median arsenic concentration
- 75^{th} percentile of arsenic concentrations among the yards sampled
- Percentage of yards with arsenic concentrations averaging greater than the 20 ppm MTCA cleanup level

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