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CONSTRUCTION QUALITY ASSURANCE PLAN FOR RESIDENTIAL REMEDIATION OPERABLE UNIT 1 VASQUEZ BOULEVARD/INTERSTATE 70 SUPERFUND SITE DENVER, COLORADO

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TABLE OF CONTENTS

1.0 INTRODUCTION 1

2.0 PROJECT ORGANIZATION AND SUPPORTING INFORMATION 2

3.0 REMEDIAL ACTION CONSTRUCTION 4
- 3.1 Quality Control (Construction Contractor's Responsibility) 4
  - 3.1.1 Pre-Remediation Construction Characterization 4
  - 3.1.2 Remediation Construction 4
- 3.2 Quality Assurance (Supervising Contractor's Responsibility) 6
  - 3.2.1 Pre-Remediation Construction Characterization 6
  - 3.2.2 Remediation Construction 7

4.0 ENVIRONMENTAL SAMPLING AND ANALYSIS 10
- 4.1 Project Responsibilities 10
- 4.2 Sampling Objectives and Procedures 11
  - 4.2.1 Garden and Flowerbed Sampling 11
  - 4.2.2 Yard Soil Composition Sampling 12
  - 4.2.3 Disposal Characteristics Sampling 13
  - 4.2.4 Sampling of Replacement Materials 14
  - 4.2.5 Sampling of Ambient Dust 14
- 4.3 Quality Assurance Objectives 15
  - 4.3.1 Garden and Flowerbed Sampling 15
  - 4.3.2 Yard Soil Composition Sampling 16
  - 4.3.3 Disposal Characteristics Sampling 16
  - 4.3.4 Replacement Material Sampling 17
  - 4.3.5 Sampling of Ambient Dust 17
- 4.4 Sampling Procedures 18
  - 4.4.1 Garden and Flowerbed Sampling 18
  - 4.4.2 Yard Soil Composition Sampling 18
  - 4.4.3 Disposal Characteristics Sampling 19
  - 4.4.4 Replacement Material Sampling 19
  - 4.4.5 Sampling of Ambient Dust 20
- 4.5 Sample Custody 20
- 4.6 Analytical Procedures and Calibration 22
  - 4.6.1 Analytical Parameters and Methods 22
  - 4.6.2 Field Calibration Procedures 23
  - 4.6.3 Preventative Maintenance 23
- 4.7 Data Reduction, Validation and Reporting 23
  - 4.7.1 Field Measurement Data 23
  - 4.7.2 Laboratory Measurement Data 23
  - 4.7.3 Data Review and Evaluation 24
  - 4.7.4 Data Validation 25
  - 4.7.5 Data Management and Reporting 25
- 4.8 Internal Quality Control Checks 26
  - 4.8.1 Field Quality Control Checks 26
    - 4.8.1.1 Garden and Flowerbed Samples 27

1.0 INTRODUCTION

This Construction Quality Assurance Plan (CQAP) presents requirements for quality assurance (QA) inspection and testing of remedial action construction at the Off-Facility Soils Operable Unit of the Vasquez Boulevard and Interstate 70 (VB/I70) Superfund Site located in the north-central section of Denver, Colorado.

The United States Environmental Protection Agency (USEPA) is the lead agency responsible for remediation of the VB/I70 site. USEPA will identify an independent third party, possibly the U.S. Army Corps of Engineers or an engineering contractor, to serve as the Supervising Contractor for remediation construction. This CQAP specifies procedures to provide for compliance with the remedial design to be performed by the Supervising Contractor's Field Project Supervisor and Environmental Quality Assurance Official. It also provides a brief summary of Quality Control (QC) procedures to be utilized by the construction contractor(s) to achieve compliance with the plans and specifications. This CQAP is supported by and included as an appendix to the Remedial Design Work Plan.

2.0 PROJECT ORGANIZATION AND SUPPORTING INFORMATION

This section provides an overview of the relationships between the project participants and their respective roles and responsibilities during preparation for and implementation of the remedial action construction at the site. A list of the key participants follows:

USEPA: Overall responsibility for remedial actions at the VB/I70 site.

Supervising Contractor: Represents USEPA during construction and has overall responsibility for management and documentation of remedial actions, to provide for compliance with project requirements and achievement of project objectives.

Construction Contractor: Independent, qualified contractor retained by USEPA or the Supervising Contractor to carry out the remedial actions in accordance with approved designs and work plans.

USEPA's Work Assignment Manager (WAM) is to be determined. The Project Manager (PM) for the Supervising Contractor will be identified prior to construction. The PM for the Supervising Contractor will report directly to the USEPA WAM. A full-time onsite Field Project Supervisor (FPS) for the Supervising Contractor will be determined prior to construction. The FPS will have authority as USEPA's representative onsite, and will report directly to the Supervising Contractor's PM. The FPS will be responsible for day-to-day inspection and management of remediation activities to provide for compliance with the project plans and specifications and will document all inspections and work progress for compliance and for construction contract administration purposes. The FPS will also coordinate all quality assurance (QA) activities performed by third parties to provide for compliance with the project plans and specifications.

All contractor technical submittals and project design changes will be routed through the PM for review and approval, and all design or scope changes will be subject to review and approval by the PM and WAM. All major project change orders will be subject to review by the PM based on recommendations from the WAM.

An Environmental Quality Assurance Official (EQAO) will be identified by the Supervising Contractor prior to construction. The EQAO will be responsible for ensuring that the testing procedures are performed in accordance with this CQAP and will consult with the FPS to confirm that the field procedures are performed in accordance with the design. The EQAO's duties will include reviewing documentation of field sampling procedures, verifying that the laboratory is adhering to project specifications, and working with the laboratory to identify the need for corrective measures and their completion.

3.0 REMEDIAL ACTION CONSTRUCTION

This section describes the procedures and testing frequencies to be used in achieving project quality assurance/quality control (QA/QC) as specified in the Construction Technical Specifications (Appendix G of the Remedial Design Work Plan). In this CQA Plan, quality control (QC) refers to the procedures, methods and tests utilized by the Construction Contractor to achieve compliance with the plans and specifications, and quality assurance (QA) refers to the site inspection, checks and tests performed by the Supervising Contractor to ensure that the substantive requirements and intent of the plans and specifications are met. Quality Control requirements are described herein, because QA activities include inspection of the QC tests and performance of QA tests at a lesser frequency.

3.1 Quality Control (Construction Contractor's Responsibility)

This section describes the Construction Contractor's responsibilities for QC during preparation for and implementation of the remedial actions. The Construction Contractor shall be responsible for all QC requirements specified in this section and the Construction Technical Specifications, including functions delegated to subcontractors.

3.1.1 Pre-Remediation Construction Characterization

The Construction Contractor will not participate in the pre-remediation characterization activities and will not be responsible for any QC functions during this phase of the project. All pre-remediation construction activities will be performed by the Supervising Contractor as described in Section 3.2.1.

3.1.2 Remediation Construction

The primary QC procedures to be utilized by the Construction Contractor during remediation construction include the use of adequately skilled personnel for the work being performed and compliance with the Construction Contract Documents. In addition, the contractor

will be required to perform periodic level and survey controls and material testing to achieve compliance with the plans and specifications. These QC requirements are summarized on Table 3-1 and discussed below.

Pre-and post-excavation construction (elevation) surveys will be required to demonstrate that the minimum excavation depth of 12-inches has been achieved. The Construction Contractor will establish elevation control points within and around the perimeter of each area to be excavated at a minimum frequency of one control point per 500 square feet or a minimum of three points per excavation. Pre- and post-excavation elevations at each control point will be determined to within +/- 0.1 feet and the calculated net difference will be used to demonstrate compliance with the minimum excavation depth.

The Construction Contractor will continuously monitor the active excavation and contaminated material handling areas for visible dust. Additional dust control measures will be implemented if visible dust emissions are observed or as otherwise required by the Supervising Contractor.

Physical and chemical testing of the replacement materials will be required for construction QC. Representative samples of the proposed replacement materials will be tested prior to initial source approval. As shown on Table 3 -1, physical tests for the replacement materials will include texture/grain-size by the American Society for Testing and Materials (ASTM) method D422, to demonstrate that the materials meet the minimum material specifications. Chemical tests for the replacement soils will include analyses for metal, pesticide, polychlorinated biphenyl (PCB), semi-volatile and volatile constituents by USEPA-approved methods (see Table 3-1) to demonstrate that the materials meet the replacement material chemical criteria (Table 2-1 in the Remedial Design Work Plan). Chemical tests for the replacement gravel will include analyses for arsenic and lead by USEPA-approved methods.

Following initial material and source approval, on-going quality control testing of the replacement materials will be performed. Samples of each material will be collected at a rate of one sample per 1,000 cubic yards (cy) for arsenic and lead analyses to confirm that the

concentration of these constituents meet the replacement material criteria. These values are listed on Table 2-1 of the Remedial Design Work Plan. Samples for on-going testing of the physical parameters will be collected and analyzed at a rate of one sample per 5,000 cy to demonstrate continued compliance with the material specifications. In addition, the Supervising Contractor may request supplemental quality control samples for physical and chemical testing if changes are observed in the material consistency.

Quality control measures for replacement vegetation will include review and submittal of supplier certificates, material safety data sheets (MSDSs), and manufacturer -provided information regarding material use. These information sources will be reviewed for initial approval of the materials and on-going construction QC.

3.2 Quality Assurance (Supervising Contractor's Responsibility)

The primary QA procedures to be performed by the Supervising Contractor will include full-time inspection of the construction by the FPS with periodic inspections by the PM. All procedures, materials, and equipment used in the construction will be observed and monitored by the FPS on a daily basis. All QC data supplied by the Construction Contractor will be reviewed for testing adequacy and compliance with the plans and specifications. QC data or installed elements that are not in compliance with the plans and specifications will be reworked or replaced by the Construction Contractor so that the element is in compliance. All QC data and information supplied by the Construction Contractor will be documented by the FPS to allow complete project tracking of all components of the construction. Site project meetings will be held as necessary with the Construction Contractor, the FPS and oversight personnel to discuss work progress, QA/QC issues and upcoming work to maintain the overall project quality.

3.2.1 Pre-Remediation Construction Characterization

In preparation for remediation construction, soil samples will be collected to further characterize select gardens and flowerbeds, to identify the composition of existing yard soils, and to characterize the residential yard soils for disposal purposes. Details of the pre-remediation sampling activities are summarized on Table 3-1 and discussed below.

Soil samples will be collected from gardens and flowerbeds identified by the property owners during the initial visit to scope the property remediation activities. Gardens and flowerbeds for which property owners express a strong desire to preserve will be sampled to determine if the soil lead or arsenic concentrations exceed the Site residential action levels. Based on the sampling results, flowerbeds and gardens with soil arsenic and/or lead concentrations at or above the action level will be remediated while those with soil concentrations below the action level will be preserved. The flowerbed and garden characterization samples will be collected and analyzed by the Supervising Contractor in accordance with the procedures specified in Section 4.0.

Soil samples will be collected and analyzed to characterize the existing yard soils and support an evaluation of the composition requirements (i.e., percent clay, silt, and sand) for the replacement soil. A representative subset of yards scheduled for remediation will be sampled to assess the composition of the existing yard soils. Results of these analyses will be used to identify acceptable composition limits for the replacement soil. The yard composition samples will be collected and analyzed by the Supervising Contractor as described in Section 4.0.

Samples of the soil to be removed will be collected and analyzed to assist in identifying suitable disposal alternatives for the materials. Representative in-place composite samples will be collected from yards scheduled for remediation according to the procedures specified in Section 4.0. The samples will be analyzed for leachable metal, pesticide, herbicide, semi-volatile, and volatile constitutes in order to support classification of the material as solid waste. Results of the analyses will be used to identify a suitable disposal site(s) for the materials.

3.2.2 Remediation Construction

As discussed in Section 3.1.1, measurement of the depth of the required excavation areas will be evaluated through construction elevation surveys to be performed as part of the Construction Contractor's QC testing. The Supervising Contractor will review the raw data and calculations generated by the surveys and will visually observe the excavations for compliance

with the extent and depth requirements. The general observations will be supplemented by random spot checks of the excavation sidewall depths by yardstick, tape measure or level. Interior grade stakes may be specified at the discretion of the FPS. Where interior grade stakes are used, the areas around the stake will be excavated to the required depth while preserving the original grade at the stake. The elevation difference between the original and final grades will then be measured by yardstick, tape or level to confirm that the required excavation depth has been achieved. Once the excavation depth has been confirmed, the soil around the grade stake will be excavated flush with the finished grade of the excavation. The Supervising Contractor will record the results of all quality assurance measurements.

The Supervising Contractor will monitor the active work areas for fugitive dust emissions. Monitoring will include use of field instruments and collection and analysis of laboratory samples. Details of the dust monitoring program are specified in Section 4.0 and the Fugitive Emissions Dust Control Plan (Appendix E of the Design Work Plan).

The physical and/or chemical properties of the replacement soils and gravel materials will be identified through quality control testing by the Construction Contractor, as described in Section 3.1.1. The Supervising Contractor will review the laboratory testing reports provided by the Construction Contractor to confirm that the materials meet the replacement materials chemical criteria (Table 2 -1 of the Remedial Design Work Plan) prior to approving the material sources. If the testing results indicate that the materials do not meet project requirements, the Construction Contractor will provide testing results for alternative sources until suitable materials are identified.

Once acceptable material sources have been identified, the Supervising Contractor will routinely monitor the replacement materials as they are brought to work area for changes in consistency. If changes in the material consistency are observed, the Supervising Contractor will direct the Construction Contractor to collect additional samples to confirm the material's physical and chemical characteristics.

As indicated in Section 3.1.1, the Construction Contractor will sample and analyze the replacement materials (soil and gravel) for arsenic and lead at 1,000 cy intervals. The Supervising Contractor will review these results to confirm on-going acceptability and collect its own quality assurance samples for arsenic and lead analyses with every fifth QC sample. In conjunction with the QA samples for arsenic and lead, the Supervising Contractor will also collect samples of the soils for additional metal, pesticide, PCB, semi-volatile and volatile criteria constituent analyses to provide continuing confirmation that the replacement materials meet the replacement material chemical criteria (Table 2-1 of the Remedial Design Work Plan). Further details of the sampling and analysis procedures for the QA samples are discussed in Section 4.0.

Quality assurance for the replacement vegetation will include reviewing the labels, certificates, MSDSs and manufacturer's recommendations submitted by the Construction Contractor to verify that the materials meet the specifications. The Supervising Contractor will also visually observe and confirm that the vegetation materials and procedures meet the project requirements and are conducted in accordance with the manufacturer's recommendations, where applicable. In addition, the restored properties will be inspected by the Supervising Contractor on or shortly before the final day of the post-remediation maintenance/watering period to confirm that all replacement vegetation is in good condition.

4.0 ENVIRONMENTAL SAMPLING AND ANALYSIS

This section describes the environmental sampling and analysis procedures, including quality assurance requirements to support implementation of the remedial actions. Environmental sampling tasks to be performed in support of remedial construction actions will include:

- Sampling and analysis of soil from select gardens and flowerbeds to identify areas that warrant removal and replacement;
- Sampling and analysis of soil from select residential yards to support evaluation of the replacement soil composition requirements;
- Sampling and analysis of materials to be removed from the residential yards to support classification of the materials for disposal;
- Sampling and analysis of the replacement materials to confirm that they meet the Site clean soil criteria and verify the Construction Contractor's quality control sample results; and
- Sampling and analysis of ambient dust collected as part of the air monitoring program to assess air quality.

This plan briefly describes sampling and analysis of dust to assess fugitive emissions. Details are provided in the Fugitive Emissions Dust Control Plan (Appendix E to the Remedial Design Work Plan). Analyses of samples for health and safety purposes will be addressed in the Construction Health and Safety Plan. The Construction Health and Safety Plan will be prepared by the Construction Contractor (see Technical Specifications; Appendix G of the Remedial Design Work Plan).

4.1 Project Responsibilities

Key positions of the environmental quality assurance team are the EQAO, the Project Chemist and the Laboratory Quality Assurance Officer (LQAO). The individuals who will fill the environmental quality assurance team roles will be designated by the WAM or the Supervising Contractor's PM prior to initiating the pre-remediation sampling or remediation construction.

The EQAO will be responsible for ensuring that the analytical procedures are performed in accordance with this CQAP and will consult with the FPS to confirm that the field procedures are performed in accordance with the plan. The EQAO's duties will include reviewing documentation of field sampling procedures, verifying that the laboratory is adhering to project specifications and working with the laboratory if corrective measures are necessary and require resolution. The EQAO may assist the Project Chemist in performing data evaluation or validation, if necessary. The EQAO will discuss any systematic errors or other anomalous data with the Supervising Contractor's PM and FPS. If corrective actions are necessary, the EQAO will be responsible for confirming that they are initiated and completed.

The Project Chemist will be responsible for coordinating with the laboratory regarding analytical requirements and scheduling. Upon receipt of the analytical data, the Project Chemist will perform the necessary data evaluation or validation (refer to Section 4.7); the EQAO may assist the Project Chemist in this function, if necessary. The Project Chemist will also provide support to the FPS and the EQAO regarding issues concerning sample collection, handling and storage.

The LQAO is responsible for all aspects of the sample analyses. The LQAO will be responsible for ensuring that sample holding times and custody requirements are met, overseeing the analyses, confirming that the laboratory QA requirements are met, and reviewing the data packages prior to distribution. The LQAO will coordinate with the Project Chemist regarding any issues related to the sample analyses.

4.2 Sampling Objectives and Procedures

This section describes the sampling objectives and procedures for the four types of environmental sampling to be performed to support the remedial action.

4.2.1 Garden and Flowerbed Sampling

At the request of an individual property owner, pre-remediation sampling and analysis of select gardens and flowerbeds will be conducted to determine if the flowerbed and garden soils

contain arsenic and/or lead in concentrations that exceed the Site residential action levels. Sampling will generally be conducted in gardens and flowerbeds that the property owners wish to exclude from the overall yard remediation program. Analytical results for the samples will be used by the PM to determine if the flowerbeds and gardens can be excluded or if they must be removed and replaced during property remediation.

Samples will be collected from the gardens and flowerbeds on a property-by-property basis. One composite sample will be collected from each garden and/or flowerbed identified for sampling. The garden or flowerbed will be divided into two approximately equal -area units and a soil core from the 0-2 inch depth interval will be retrieved from the approximate center of each unit. The recovered soil will then be thoroughly blended and the sample will be collected from the composited material.

The samples will be analyzed using inductively coupled plasma (ICP) atomic emission spectrometry (USEPA SW-846 Method 6010). An analytical laboratory identified by the Supervising Contractor and approved by the WAM will analyze the samples. Specific procedures regarding collection, preparation and analysis of the garden and flowerbed soil samples are provided in Section 4.4.

4.2.2 Yard Soil Composition Sampling

Soil samples will be collected from a subset of the residential yards scheduled for remediation to characterize the existing yard soils and support an evaluation of the composition requirements (i.e., percent clay, slit and sand) for replacement soil.

One soil sample will be collected from ten residential properties to be remediated. To provide for the results to be representative of the site, samples will be collected as follows: 2 from the Cole neighborhood; 2 from the Clayton neighborhood; 3 from the Elyria neighborhood (at least one from north and south of I-70); and 3 from the Swansea neighborhood (at least one from north and south of I-70). Within each neighborhood, the Supervising Contractor will select properties that are spatially distant from each other to provide data across the site. More samples

will be collected from Elyria and Swansea because they are greater in area than Cole and Clayton. At each selected property, soil will be uniformly retrieved over the 0 -12 inch depth interval at a single location near the center of the yard.

Each sample will be analyzed for clay, silt and sand content according to ASTM method D-422, or other suitable method. A geotechnical laboratory identified by the Supervising Contractor and approved by the WAM will analyze the samples. Specific procedures regarding collection, preparation and analysis of the soil samples are provided in Section 4.4.

4.2.3 Disposal Characteristics Sampling

Samples of materials to be removed from the residential yards will be collected and analyzed to support classification of the materials for disposal. The purpose of the sampling is to measure the concentrations of metal, pesticide, herbicide, semi-volatile and volatile constituents in sample leachate to determine if the materials may be managed as solid waste.

One composite sample will be collected for every twenty residential properties. The composite sample will be prepared by randomly selecting four of the properties for sampling. At each property, the planned excavation area will be divided into four approximately equal area sampling units. Soil cores from the 0 -12 inch depth interval will be retrieved from the approximate center of each unit. The recovered soil from all four properties will then be thoroughly blended and the sample will be collected from the blended material.

Each sample will be extracted using the appropriate Toxicity Characteristic Leaching Procedure (TCLP) extraction procedure (USEPA SW-846 Method 1311) and analyzed for metals (Method 6010B/7470), pesticides (Method 8081A), herbicides (Method 8150), semi-volatiles (Method 8270) and volatiles (Method 8260). An analytical laboratory identified by the Supervising Contractor and approved by the WAM will analyze the samples. Specific procedures regarding collection, preparation and analysis of the disposal characteristics soil samples are provided in Section 4.4.

4.2.4 Sampling of Replacement Materials

Samples of each type of replacement material (soil and gravel) used in property restoration will be collected and analyzed to confirm that the materials meet the replacement material chemical criteria (Table 2-1 in the Remedial Design Work Plan). The sample results will also be used to verify the Construction Contractor's quality control sample data for arsenic and lead concentrations in the replacement materials.

Samples will be collected from each type of replacement material at a rate of one sample per 5,000 cubic yards of material used. Each sample will be collected as a single grab sample collected from the transport truck carrying the material, a material stockpile or directly following placement during restoration.

The soil samples will be analyzed for the replacement material chemical criteria metals (Method 6010B/7470), pesticides (Method 8081A), semi-volatiles (Method 8270), volatiles (Method 8260), and PCBs (Method 8082). The laboratory will only report the concentrations of the specified replacement material chemical criteria constituents. The gravel samples will be analyzed for arsenic and lead (Method 6010B). An analytical laboratory identified by the Supervising Contractor and approved by the WAM will analyze the samples. Specific procedures regarding collection, preparation and analysis of the replacement soil samples are provided in Section 4.4.

4.2.5 Sampling of Ambient Dust

The effectiveness of dust control measures in meeting air quality standards will be evaluated using real-time monitoring equipment and laboratory analysis of dust samples. The real-time monitoring equipment will be used to determine the immediate effectiveness of fugitive dust control measures. Exceedances of the established action levels for PM_{10}, $PM_{2.5}$,lead or arsenic, will trigger the implementation of additional dust control measures or temporary suspension of activities. At the same time, filter samples of the ambient dust will also be collected and analyzed for lead and arsenic. These data will be used to document compliance

with the air quality standards; help identify the source and nature of the dust; and assess the potential for offsite, airborne transport of arsenic and lead.

Sampling objectives for dust monitoring are described in detail in the Fugitive Emissions Dust Control Plan (Appendix E to the Remedial Design Work Plan).

4.3 Quality Assurance Objectives

The project QA objectives are directly tied to the data needs and data uses described in Section 4.2. Prior to and during construction, environmental samples will be collected for the following: (1) identify if select flowerbeds and gardens warrant removal and replacement; (2) support an evaluation of the replacement soil composition requirements; (3) support classification of the materials to be removed for disposal purposes; (4) confirm that the replacement materials meet the project quality requirements and verify the replacement material quality control sample results, and (5) assess ambient dust for comparison to action levels. The QA objectives for these types of data, including acceptable levels of precision, accuracy, representativeness and comparability, are described below. Data that meet their stated QA objectives will be of appropriate quality for use in managing construction-related activities at the site.

4.3.1 Garden and Flowerbed Sampling

Soil samples will be collected from select gardens and flowerbeds to determine if they contain soil with arsenic or lead concentrations at or above the residential action level, and therefore, warrant removal and replacement during the remediation action. A sampling plan has been designed to provide representative samples from each flowerbed and garden sampling unit, as described in Section 4.2.1. The sampling plan provides a sufficient number of samples from which to describe mean arsenic concentration in the flowerbed and garden soils. The arsenic and lead concentrations measured in each flowerbed and garden sampling unit will be compared to the Site residential action levels for arsenic and lead. The sampling plan has been designed to result in collection of samples that are representative of Site conditions using consistent methods to provide comparable results.

The contract laboratory will analyze the soil samples for arsenic and lead by ICP. Table 4-1 provides the precision, accuracy, quantitation limit, and completeness objectives for arsenic and lead analyses of soil samples by ICP. The representativeness of laboratory analyses will be evaluated from analyses of blanks, including equipment blanks and method blanks.

4.3.2 Yard Soil Composition Sampling

Samples of the existing soil in a portion of the yards scheduled for remediation will be collected and analyzed for composition (i.e., percent clay, silt, and sand) to support an evaluation of the composition requirements for the replacement soil. A sampling plan has been designed to provide representative samples of the soil to be removed, as described in Section 4.2.2. The sampling plan provides representative samples that describe the composition of the existing yard soils. Sample results will be plotted on a textural triangle and used by the Supervising Contractor to identify composition requirements for acceptable replacement soil. The sampling plan has been designed to result in collection of samples that are representative of the target material using consistent methods to provide comparable results.

The selected geotechnical laboratory will analyze the samples by the method specified on Table 4-1.

4.3.3 Disposal Characteristics Sampling

Samples of the soils to be removed during property remediation will be collected and analyzed for leachate concentrations of metal, pesticide, herbicide, semi-volatile and volatile constituents to support management of the material as solid waste. A sampling plan has been designed to provide representative samples from the areas to be removed, as described in Section 4.2.3. The sampling plan provides representative samples that describe the concentrations of the target leachate constituents in the materials scheduled for removal. The measured leachate concentrations will be compared to the toxicity characteristic concentration thresholds for hazardous waste (40 CFR 261), and materials with leachate concentrations that exceed the

threshold concentrations will be identified as hazardous waste. The sampling plan has been designed to result in collection of samples that are representative of the target materials using consistent methods to provide comparable results.

The contract laboratory will analyze the samples by the specified methods. The precision, accuracy, quantitation limit, and completeness objectives for the analyses are listed on Table 4-1.

4.3.4 Replacement Material Sampling

Samples of the replacement soil used in property restorations will be collected and analyzed for metal, pesticide, semi-volatile, volatile and PCB criteria constituents to confirm that the materials meet the replacement material chemical criteria. Samples of the replacement gravel will be collected and analyzed for arsenic and lead. A sampling plan has been designed to provide representative samples of the replacement materials, as described in Section 4.2.4. The sampling plan provides a sufficient number of samples from which to describe the concentrations of the target constituents in the replacement materials. The constituent concentrations will be compared to the replacement material chemical criteria to confirm that the replacement materials are acceptable. The sampling plan has been designed to result in collection of samples that are representative of each type of replacement material using consistent methods to provide comparable results.

The contract laboratory will analyze the samples by the specified methods. The precision, accuracy, quantitation limit, and completeness objectives for the analyses are listed on Table 4-1.

4.3.5 Sampling of Ambient Dust

Ambient air monitoring will be performed during construction activities to produce two types of data for evaluating the effectiveness of dust control measures:

- Real time TSP concentration data (which will provide estimates of PM_{10} and $PM_{2.5}$ lead and arsenic concentrations); and
- Arsenic and lead concentration data from TSP samples.

These data will be used for direct comparison to action levels for PM_{10}, $PM_{2.5}$, lead and arsenic and to identify when additional dust control measures are necessary. The Fugitive Emissions Dust Control Plan (Appendix E to the Remedial Design Work Plan) provides details of monitoring activities, including quality assurance objectives.

4.4 Sampling Procedures

4.4.1 Garden and Flowerbed Sampling

As discussed in Section 4.2.1, one composite sample will be collected from each flowerbed and garden identified for sampling. The composite sample will be collected by dividing the flowerbed or garden into two approximately equal-area units, and a soil core from the 0-2 inch depth interval will be retrieved from the approximate center of each unit. The recovered soil will then be thoroughly blended and the sample will be collected from the blended material. Specific procedures and protocols to be used to collect the samples are described in the Standard Operating Procedure for Soil Sampling (Attachment A). Information in the SOP includes procedures for delineation of sampling units, sample collection, sample preparation, documentation and equipment decontamination.

4.4.2 Yard Soil Composition Sampling

Samples of the soil in a subset of the yards scheduled for removal will be collected and analyzed to assess its composition of clay, silt and sand. One soil sample will be collected from 10 residential properties across the site. To provide for the results to be representative of the site, samples will be collected as follows: 3 from the Cole neighborhood; 3 from the Clayton neighborhood; 1 from the Elyria neighborhood; and 3 from the Swansea neighborhood (at least

one from north and south of I-70). Within each neighborhood, the Supervising Contractor will select properties that are spatially distant from each other to provide data across the site.

At each selected property, soil for the sample will be uniformly retrieved over the 0 to 12 inch depth interval at a single location near the center of the yard. Specific procedures and protocols to be followed while collecting the samples are described in the Standard Operating Procedure for Soil Sampling (Attachment A).

4.4.3 Disposal Characteristics Sampling

As discussed in Section 4.2.3, samples of the yard soils to be removed will be collected and analyzed for leachate constituents to support management of the material as solid waste. One composite sample will be collected for every twenty residential properties. The composite sample will be prepared by randomly selecting four of the properties for sampling. The four properties will be identified by numbering the properties from one to twenty and using a spreadsheet-based random number generator to select four properties.

At each of the four properties, the planned excavation area will be divided into four approximately equal-area sampling units. Soil cores from the 0-12 inch depth interval will be retrieved from the approximate center of each unit. The recovered soil from all four sampling locations in the four properties will then be thoroughly blended and the sample will be collected from the blended material. Specific procedures and protocols to be followed while collecting the soil samples are described in the Standard Operating Procedure for Soil Sampling (Attachment A).

4.4.4 Replacement Material Sampling

Samples of the replacement materials (soil and gravel) will be collected and analyzed to confirm that the materials meet the Site clean replacement material chemical criteria and verify the quality control sample results.

review the results of laboratory QC analyses, instrument calibration and maintenance records, calculations, and the record of sample custody (including holding times) within the laboratory. The laboratory data packages will include:

- Copies of the Chain-of-Custody records;
- Sample results and units;
- Date analyzed;
- Analytical method;
- Quantitation limits;
- Laboratory QC results (laboratory control samples, matrix spikes, etc.); and
- Method blank result.

The data packages from the analyses will be used for validation and will also include back-up information concerning instrument calibration, sample preparation, sample run logs, and analytical raw data. Analytical data packages will be sent directly from the laboratory, in a hard-copy format, to the Project Chemist. The data will be reviewed by the Project Chemist or EQAO, as described below, and will be reported as described in Section 4.7.5.

4.7.3 Data Review and Evaluation

Upon receipt of the analytical results and data packages from the laboratory, the data will be reviewed by the Project Chemist or the EQAO for accuracy, precision, and completeness. The analytical data will be reviewed for the following items:

- Analyses performed and sample identifications conform to the information on the Chain-of-Custody records;
- Sample holding times;
- Specified quantitation limits (Table 4-1);
- Laboratory QC results (laboratory control samples, matrix spikes) meet measurement objectives (Table 4-1);
- Target analyte concentrations in method and equipment blanks; and
- Reproducibility of field duplicate results.

Data that satisfy the quality assurance objectives for this project will be considered usable for comparison to the appropriate standards identified in Section 4.2. If anomalies or nonconformances are discovered, the laboratory will be instructed to review the submitted data and the methods used to obtain the data. Laboratory or field QC sample results that do not meet the QA objectives will be evaluated to determine whether the sample data are usable. Corrective actions, as necessary, will be implemented per the procedures described in Section 4.11.

4.7.4 Data Validation

The data obtained from the analyses will be validated according to the procedures provided in the USEPA Functional Guidelines for Inorganic Data Review (USEPA, 1994) or the USEPA Functional Guidelines for Organic Data Review (USEPA, 1999). If anomalies or nonconformances are discovered, the laboratory will be instructed to review the submitted data and the methods used to obtain the data. Laboratory QC or field QC sample results that do not meet the QA objectives will be evaluated to determine whether the data are potentially biased and whether data qualifiers should be applied. Corrective actions will be implemented, as necessary, per the procedures described in Section 4.11. Unless rejected by the data validator, all validated data will be considered usable for comparison to the applicable standards. Data rejected by the data validator will not be considered usable.

4.7.5 Data Management and Reporting

Field measurements and laboratory analytical results will be presented in the monthly and annual progress reports. The laboratory data will be tabulated to include the following:

- Sample location;
- Sample identification;
- Date of sample collection;
- Analytical method;
- Analytes and measured concentrations;
- Quantitation limits; and

- Laboratory qualifiers.

Copies of field and laboratory reports will be maintained by the Supervising Contractor during the course of the project at the site.

4.8 Internal Quality Control Checks

Internal QC will be achieved by collecting and/or analyzing a series of field and laboratory QC samples to ensure that the analytical results meet the measurement objectives detailed in Section 4.3. Results from analyses of QC samples are used to quantify precision and accuracy and identify any problems or limitations of those data.

4.8.1 Field Quality Control Checks

Field QC will be controlled by compliance with standard sample collection and handling methods and by the periodic collection of field QC samples. QC samples will be collected as blind samples so that the laboratory remains unaware of the nature of those samples and performs analyses identically to the sample analyses. The appropriate types and frequency of field QC samples depend on the sample type, sample matrix and intended data use.

Three types of quality control samples will be collected during construction-related environmental sampling: equipment blanks, field duplicates, and air filter blanks.

Equipment blanks consist of analyte-free reagent water (i.e., ASTM Type II) poured through the sampling device or equipment, collected in a clean sampling bottle, preserved as needed, and analyzed with the samples. Equipment blanks may be used to demonstrate that sampling devices have been adequately cleaned between uses and provide representative samples.

A field duplicate sample is a second sample collected at the same location as the original sample. It is collected simultaneously with or in immediate succession to the original sample using identical recovery techniques, and it is treated in an identical manner during storage, transportation and analysis. Field duplicate sample results may be used to provide a measure of

method variability, including both sampling and analytical precision. Field duplicates will be collected for dust samples, as described in the Fugitive Emissions Dust Control Plan (Appendix E of the Remedial Design Work Plan).

An air filter blank consists of an air filter that has not been exposed to air drawn through the sampler. The filter blank is prepared from an unused filter that has been pre -weighed by the laboratory. The filter blank is submitted for analysis in an identical manner as the filters used for sampling, and it is analyzed for the same parameters as the sample filters. Filter blank results describe the background TSP and arsenic and lead concentrations of filters used to collect ambient dust and may be used to assess bias introduced as a result of measurement error or blank concentrations.

4.8.1.1 Garden and Flowerbed Samples

Equipment blanks will be collected with the flowerbed and garden samples. Equipment blanks will be collected by pouring reagent water through the decontaminated re-usable equipment used to obtain and composite soil subsamples (e.g., soil scoops and mixing bowls). One equipment blank will be collected with every 20 soil samples submitted for laboratory analysis. Equipment blanks associated with flowerbed and garden sampling will be analyzed for arsenic and lead.

4.8.1.2 Yard Soil Composition Sampling

No field QC samples will be collected during the yard composition sampling.

4.8.1.3 Disposal Characteristics Samples

No field QC samples will be collected with the disposal characteristics samples. Given the nature of the sample collection/compositing procedures and subsequent extractions and analyses, it is unlikely that poor equipment decontamination would bias the sample results. Therefore, field audits of the equipment decontamination procedures will be used as the quality check and no equipment blanks will be collected.

4.8.1.4 Replacement Material Samples

No field QC samples will be collected with the replacement material samples. Disposable sampling equipment will be used to obtain the samples. Therefore, no equipment decontamination or quality check (equipment blank) of the decontamination procedure will be needed.

4.8.1.5 Ambient Dust (TSP) Samples

Filter blanks will be collected with the ambient TSP dust samples at a frequency of one for every 20 filter samples. The filter blank will be collected by containerizing an unused, pre-weighed filter and submitting it for the same analyses as the TSP filters (TSP, lead and arsenic). The filter blanks will be blind blanks sent to the laboratory. In addition, field duplicates will be collected once each month (see the Fugitive Emissions Dust Control Plan for details.)

4.8.2 Laboratory Quality Control Checks

Laboratory quality control is necessary to control the analytical process, to assess the precision and accuracy of analytical results and to identify assignable causes for atypical analytical results. The internal QC practices of the contract laboratory will provide quality control for laboratory analyses. Initial calibration will be performed for all analytical methods. The measurement objectives for the QC samples are identified on Table 4-1. The laboratory's other QC practices vary depending on the analysis performed, as described below.

For all constituent analyses, the laboratory will analyze and report the results from method blanks, analytical duplicates and matrix spike samples, as applicable. These data will be used to evaluate data quality relative to the measurement objectives given in Section 4.3. In addition, initial and continuing calibration verifications will be performed. Calibration results must meet the laboratory's acceptance criteria.

The precision and accuracy of gravimetric measurements will be controlled through replicate measurements and instrument calibration. One in 10 measurements will be replicates. The scale used to weigh filters will be calibrated and calibration checks will be performed at least

daily. In addition, LCS and Matrix Spikes will be analyzed to verify the precision and accuracy of the analytical method, as described previously.

4.9 Technical System Audits

The purpose of a quality assurance audit is to provide an assessment of the ability of the measurement system to produce data of a quality commensurate with the project's measurement objectives. In addition to documenting the performance of the sampling, analytical and data management systems, the audit provides a mechanism whereby inadequacies in the measurement systems can be identified and necessary corrective actions implemented in a timely manner.

Internal technical systems audits of field and/or laboratory activities may be performed during construction-related activities. Internal audits will be performed by the EQAO. The USEPA may also perform external systems audits.

An individual audit plan will be developed to provide a basis for each audit. This plan will identify the audit scope, activities to be audited, audit personnel, any applicable documents, and the schedule. Checklists will be prepared by the auditors to structure the review process and document the results of the audit.

4.9.1 Systems Audits

A technical systems audit is an on-site, qualitative review of the various aspects of a total sampling and/or analytical system. It consists of observations and documentation of all aspects of the measurement effort, including adherence to approved sampling and analysis plans, quality assurance plans and standard operating procedures. A systems audit also includes review of record keeping and data handling systems, including:

- Calibration documentation;
- Completeness of data forms and notebooks;
- Data review and validation procedures;
- Data storage and filing procedures;

- Sample custody procedures;
- Documentation of QC data;
- Documentation of maintenance activities; and
- Corrective action reporting procedures.

A technical systems audit will include an audit plan, schedule, audit scope and checklists. An audit report will be prepared for the construction oversight manager with recommendations for corrective action, if needed.

4.9.2 Frequency and Scheduling

The necessity for internal systems audits will be determined by the Supervising Contractor's PM or EQAO. Audits will be scheduled at intervals appropriate to assure quality control for the activity type or task in progress and will be planned to coincide with appropriate activities on the project calendar. Such scheduled audits may be supplemented by additional audits for one or more of the following reasons:

- When significant changes are made in the QA plan;
- When it is necessary to verify that corrective action has been taken on a nonconformance reported in a previous audit; or
- When requested by the Supervising Contractor's PM or EQAO.

4.9.3 Audit Reports

During an audit and upon its completion, the auditor may discuss the findings with the individuals audited, and discuss and agree on corrective actions to be initiated. Minor administrative findings which can be resolved to the satisfaction of the auditor during an audit may not be cited as items requiring corrective action. Findings that are not resolved during the course of the audit, and findings affecting the overall quality of the project, will be noted on the audit checklists and included in the audit report.

Audit results will be reported to the Supervising Contractor's PM and FPS. The audit report will be retained in the project file, and copies of audit reports will be included in progress reports prepared by the Supervising Contractor for USEPA.

The PM will submit a reply to the audit report addressing each finding cited, the corrective action(s) to be taken and a schedule for implementation. This reply will be sent to the auditor and will be filed in the project file. The findings cited in the audit and addressed in the reply will be treated as nonconformances and will become subject to review at the time of the next audit.

4.10 Calculation of Data Quality Indicators

The parameters that will be used to assess data quality include accuracy, precision, completeness and representativeness. Definitions of these parameters are provided below. Since the environmental sampling data will be used to evaluate and direct construction-related activities, the accuracy and representativeness of the data will be considered the data quality parameters of most importance. The field and laboratory QC samples and methods that will be employed to assess the data quality are discussed in Section 4.8.

4.10.1 Precision

Precision (analytical error) is the level of agreement among repeated measurements of the same characteristic. Data precision will be assessed by determining the agreement among replicate measurements of the same sample and measurements of duplicate samples. As discussed in Section 4.8, these samples will include MS/MSD samples, LCS/LCSD samples, and field duplicates. The comparison is made by calculating the relative percent difference (RPD), given by:

$$RPD(\%) = \frac{|S_1 - S_2|}{(S_1 + S_2)/2} \times 100$$

where: S_1 = measured sample concentration; and

S_2 = known sample or duplicate concentration.

The goals for precision are provided in Section 4.3, Quality Assurance Objectives. When analytes are present at concentrations below or near the quantitation limit, precision will be evaluated using duplicates of a matrix-spike sample (if available).

4.10.2 Accuracy

Accuracy (bias) is the degree of difference between measured or calculated value and the true value. Data accuracy will be evaluated using sample recoveries, expressed as the percentage of the true (known) concentration, from laboratory-spiked samples (including matrix spikes) and from standard reference materials (i.e., laboratory control standards) generated by the analytical laboratory (see Section 4.8). Equipment, field and laboratory blanks will be analyzed to quantify artifacts introduced during sampling, transport, or analysis that may affect the accuracy of the data. The percentage recovery for spiked samples will be used to evaluate the accuracy of analyses as given by:

$$Recovery(\%) = \frac{A - B}{T} \times 100$$

where: A = measured concentration of the spiked sample;

B = concentration of unspiked sample; and

T = amount of spike added.

In addition, the initial and continuing calibration results will be reviewed to verify that the sample concentrations are accurately measured by the analytical instrument. The project goals for accuracy are provided in Section 4.3, Quality Assurance Objectives.

4.10.3 Completeness

Completeness is the percentage of valid measurements (data points) obtained, as a proportion of the number of measurements (data points) planned for the investigation.

Completeness is affected by such factors as sample-bottle breakage, and acceptance/non-acceptance of analytical results. Percentage completeness (C) is given by:

$$C(\%) = \frac{V}{P} \times 100$$

where: V = number of valid measurements (data points) obtained by the investigation; and
P = number of measurements (data points) planned for the investigation.

Completeness goals are provided in Section 4.3, Quality Assurance Objectives.

4.10.4 Representativeness

Representativeness is a qualitative objective, defined as the degree to which data accurately and precisely represent the medium being studied. Representativeness is achieved by collecting a sufficient number of unbiased samples, as determined through the QA objectives. Representativeness will be evaluated based on blank results (field and laboratory), laboratory methods and QC, sampling locations and methods, and sampling frequencies. Samples will be collected in accordance with the methods described in this CQAP to ensure that the samples are representative of the site conditions. The samples will be contained, preserved, and stored appropriately, as discussed in Section 4.5. Laboratory blanks, calibration standards and methods, and QC sample results will be reviewed as described in Sections 4.6 and 4.7 to ensure that analytical results are representative of actual site conditions.

4.11 Corrective Action

Nonconforming equipment, items, activities, conditions and unusual incidents that could affect compliance with project quality assurance goals will be identified, controlled and reported in a timely manner. A nonconformance is defined as a malfunction, failure, deficiency, or deviation that renders the quality of an item unacceptable or indeterminate. Project staff, a project subcontractor, or analytical laboratory personnel will inform the FPS or Project Chemist (as applicable) immediately when a nonconformance is identified or suspected. The Project

Chemist or FPS will in turn notify the EQAO to discuss the nonconformance and identify an appropriate response, the "corrective action".

If the analytical results of laboratory control samples fall outside of the project's control limits, the laboratory will initiate corrective actions. The EQAO will also review field data and narrative records related to the samples in question for the potential source of the error. If the laboratory cannot correct the situation that caused the nonconformance and an out-of-control situation continues to occur or is expected to occur, the laboratory will immediately contact the Supervising Contractor's PM or EQAO. Completion of corrective action should be evidenced by data once again falling within prescribed quality control limits. If an error in laboratory procedures or sample collection and handling procedures can not be found, the Supervising Contractor's PM will review the results and assess whether reanalysis or resampling is required.

4.12 Quality Assurance Reports

Effective management of the environmental sampling effort requires timely assessment and review of field activities that in turn requires effective interaction and feedback between the FPS, EQAO and PM.

The FPS will be responsible for documenting any conditions or situations that might adversely affect data quality. These conditions should be communicated in writing to the EQAO and PM. In addition, routine quality assurance reports will be prepared by the FPS for the EQAO and PM. These reports will include elements such as project activities, modifications to or deviations from the CQAP and any corrective actions taken, status of unresolved problems and audit results. These reports may be provided as informal memos or other documented presentations.

Data quality evaluations will be prepared by the EQAO, based on the procedures described in Section 4.7. The usability of data will be determined and described. The impact of any deviations or exceptions to the method protocols or performance indicators will also be described. This information will be provided in data quality reports prepared for the PM and included in the Construction Completion Report.

5.0 CONSTRUCTION DOCUMENTATION & REPORTING

This section presents a summary of the construction documentation necessary for the pre-remediation sampling phase, the construction startup phase, the construction inspection and QA/QC procedures, the construction management and contract administration procedures, and the construction phase closeout.

5.1 Pre-Remediation Sampling Phase

The pre-remediation sampling phase is the time period during which the Supervising Contractor will perform activities necessary to support the remediation phase. The primary activities during this phase will include collection and analysis of the flowerbed and garden samples, collection and analysis of yard soil composition samples and collection and analysis of the disposal characteristics samples. These activities may be conducted in conjunction with or in advance of the construction start-up phase, as applicable.

Reporting requirements during this phase will include the documentation of sample collection and analysis activities as specified in Section 4.0. Required reports will include daily reports associated with field sampling, laboratory analytical reports and data validation reports. These reports will be prepared by the Supervising Contractor's FPS, Project Chemist/EQAO and the contract laboratory. Summaries of these reports will be provided to the USEPA WAM in the form of monthly progress reports prepared by the Supervising Contractor's PM.

5.2 Project Startup Phase

The project startup phase includes the period between the award of the remediation construction contract(s) and mobilization of the construction contractor(s) to the site. The principal item required for planning during this phase of the project is development of a submittal control sheet listing all required contractor submittals in the order in which they appear in the technical specifications. This will be prepared during the construction bidding process. Summaries of the actions accomplished during the project start-up phase will be provided to the USEPA WAM in the monthly progress reports prepared by the Supervising Contractor's PM.

5.3 Construction Phase

The construction phase of the project includes the period between contractor mobilization and substantial completion of the project. The basic reporting required for construction inspection during this phase of the project will include the daily record of work progress (by the FPS), which will include the weather conditions, the contractor's work force, site visitors, the equipment used and the general construction activities. Records associated with air monitoring will be maintained per the requirements of the Fugitive Emissions Dust Control Plan. Additional reporting procedures will include the actual log of contractor submittals including the action taken on each submittal, laboratory analytical reports generated by the contract laboratory, and data validation reports prepared by the Project Chemist/EQAO. Records for QC and QA activities described in this CQAP will be maintained by the FPS with periodic submittal to the USEPA WAM as requested. Construction progress reports, which summarize the activities performed and the data generated, will be prepared by the Supervising Contractor's PM and provided to the USEPA WAM on a monthly basis and at the end of each construction season.

6.0 REFERENCES

U.S. Environmental Protection Agency (USEPA), 1994. USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review. USEPA 540/R-94/013, Office Emergency and Remedial Response. February.

U.S. Environmental Protection Agency (USEPA), 1999. USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review. USEPA 540/R-99/008, Office of Emergency and Remedial Response.

Washington Group 2001. Remedial Investigation Report for Operable Unit 1, Vasquez Boulevard/Interstate 70 Superfund Site. Prepared by Washington Group International for USEPA.

TABLES

TABLE 3-1

Summary of Construction Quality Control/Quality Assurance Monitoring & Testing

Item	Construction Element	Parameter	Acceptance Criteria	*Construction Quality Control (by Construction Contractor)*		*Construction Quality Assurance (by Supervising Contractor)*	
				Method	Minimum Frequency	Method	Minimum Frequency
I.	PRE-REMEDIATION CHARACTERIZATION						
A.	*Gardens & Flower Beds*	Arsenic & Lead	*Arsenic and Lead concentration below* Site residential action level	-	-	EPA 6010B	Each Sampling Unit
						Equipment Blank	1/20 samples
B.	Yard Soil Composition	Texture and particle size	Establish replacement soil requirements	-	-	ASTM D422	10 properties total
C.	Disposal Characteristics	Leachable (TCLP) Metals Pest/Herb SVOCs/VOCs	Meets disposal site requirements	-	-	EPA 1311/6010B/7470 1311/8081A/8150 1311/8270/8260	1/20 properties
II.	REMEDIATION CONSTRUCTION						
A.	Soil Removal	Excavation extent	Remove soil to marked limits shown on Site Remediation Map	Visual observation	Each property	Visual observation	Each property
		Excavation depth	12 inches, min. (4 inches under decks)	Elevation Survey	1 point/ 500 ft^2, min. 3 points/excavation	Visual observation and random spot checks with tape measure; review Contractor's survey data	Each property
		Fugitive dust emissions	No visible dust emissions. Field and laboratory monitoring results confirm compliance with Fugitive Emissions Dust Control Plan	Visual inspection	Continuous	Field and laboratory monitoring as specified in the Fugitive Emissions Dust Control Plan	As specified in the Fugitive Emissions Dust Control Plan
B.	Replacement Soil	Arsenic & Lead	Arsenic & Lead concentrations meet residential soil criteria	EPA 6010B	Source approval + 1/1000 cy and when requested based on observed material change	Review test results for acceptability, Observe material for changes in consistency	Continuous
						EPA 6010B	1/5 samples
		Texture and particle size	Meets textural and particle size requirements	ASTM D422	Source approval + 1/5000 cy and when requested based on observed material change	Review test results for acceptability, Observe material for changes in consistency	Continuous
		Metals Pest/PCB SVOCs/VOCs	Meets residential soil criteria	EPA 6010B/7470 8081A/8082 8270/8260	Source approval and when requested based on observed material change	Review test results for acceptability, Observe material for changes in consistency	Continuous
						EPA 6010B/7470 8081A/8082 8270/8260	1/5000 cy
		Replaced Thickness	12 inches, min. 4 inches, min. (under decks)	Grade Stakes	1 stake/ 500 ft^2, min. 3 stakes/excavation	Visual observation and random spot checks with additional grade stakes	Each property

TABLE 3-1

Summary of Construction Quality Control/Quality Assurance Monitoring & Testing

Item	Construction Element	Parameter	Acceptance Criteria	Construction Quality Control (by Construction Contractor)		Construction Quality Assurance (by Supervising Contractor)	
				Method	Minimum Frequency	Method	Minimum Frequency
C.	Replacement Gravel	Arsenic & Lead	Arsenic & Lead concentrations meet gravel criteria	EPA 8010B	Source approval + 1/1000 cy and when requested based on observed material change	Review test results for acceptability. Observe material for changes in consistency	Continuous
						EPA 8010B	1/5 samples
		Gradation	Meets gradation requirements	ASTM D422	Source approval + 1/5000 cy and when requested based on observed material change	Review test results for acceptability. Observe material for changes in consistency	Continuous
		Replaced Thickness	4 inches, min.	Grade Stakes	1 stake/ 500 ft^2, min. 3 stakes/excavation	Visual observation and random spot checks with additional grade stakes	Each property
D.	Replacement Vegetation	Vegetation Extent	Install vegetation as specified on Site Remediation Plan	Visual Confirmation	Each Area	Visually observe and confirm vegetation placement	Each Area
		Vegetation Type	Meets vegetation type and quality requirements	Provide labels and certificates provided by supplier	1/souce & type	Review submittals for acceptability	1/source & type
		Fertilizer	Applied in accordance with manufacturer's recommendations	Provide MSDSs & manufacturer's recommended application procedures	1/soucre & type	Review submittals for acceptability. Observe field procedures	1/source & type
		Vegetation Condition	All replacement vegetation shall be in good condition at end of maintenance/watering period	Visual inspection at end of maintenance/watering period	Each Property	Visual inspection at end of maintenance/watering period	Each Property

TABLE 4-1

QUANTITATIVE MEASUREMENT OBJECTIVES FOR ANALYSES SOIL, REPLACEMENT MATERIALS AND WATER SAMPLES

Sample Matrix	Analytical Method Description	EPA Method Reference	Precision	Accuracy	Completeness
Flowerbed & Garden Soil	ICP (Arsenic and Lead)	6010B; 3052 - hydrofluoric acid digestion	LCS/LCSD or MS/MSD RPD = <20% Analytical duplicate RPD = <30%	LCS = 80 – 120% recovery MS = 75 – 125% recovery Lab Blank = < MDL	95
In-situ Yard Soil	TCLP – Metals	1311/ 6010B	LCS/LCSD or MS/MSD RPD = <20% Analytical duplicate RPD = <30%	LCS = 80 – 120% recovery MS = 75 – 125% recovery Lab Blank = < MDL	95
	TCLP – Mercury	1311/ 7471A	LCS/LCSD or MS/MSD RPD = <20% Analytical duplicate RPD = <30%	LCS = 80 – 120% recovery MS = 75 – 125% recovery Lab Blank = < MDL	95
	TCLP – Pesticides	1311/ 8081A	LCS/LCSD RPD = within lab control limits Analytical duplicate RPD = <30%	LCS = 75 – 125% Lab Blank = < MDL	95
	TCLP – Herbicides	1311/ 8151A	LCS/LCSD or MS/MSD RPD = within lab control limits Analytical duplicate RPD = <30%	LCS = 75 – 125% Lab Blank = < MDL	95
	TCLP – Semi-volatiles	1311/ 8270C	LCS/LCSD or MS/MSD RPD = within lab control limits Analytical duplicate RPD = <30%	LCS = 75 – 125% Lab Blank = < MDL	95
	TCLP – Volatiles	1311/ 8260B	LCS/LCSD or MS/MSD RPD = within lab control limits Analytical duplicate RPD = <30%	LCS = 75 – 125% Lab Blank = < MDL	95
Soil Composition	ASTM D-422	N/A	N/A	95	Soil Composition

TABLE 4-1 (CONTINUED)

QUANTITATIVE MEASUREMENT OBJECTIVES FOR ANALYSES SOIL, REPLACEMENT MATERIALS AND WATER SAMPLES

Sample Matrix	Analytical Method Description	EPA Method Reference	Precision	Accuracy	Completeness
Replacement Materials	Metals [1]	6010B	LCS/LCSD or MS/MSD RPD = <20% Analytical duplicate RPD = <30%	LCS = 80 – 120% recovery MS = 75 – 125% recovery Lab Blank = < MDL	95
	Mercury	7471A	LCS/LCSD or MS/MSD RPD = <20% Analytical duplicate RPD = <30%	LCS = 80 – 120% recovery MS = 75 – 125% recovery Lab Blank = < MDL	95
	Pesticides [1]	8081A	LCS/LCSD or MS/MSD RPD = within lab control limits Analytical duplicate RPD = <30%	LCS = 75 – 125% Lab Blank = < MDL	95
	PCBs [1]	8082	LCS/LCSD or MS/MSD RPD = within lab control limits Analytical duplicate RPD = <30%	LCS = 75 – 125% Lab Blank = < MDL	95
	Semi-volatiles [1]	8270C	LCS/LCSD or MS/MSD RPD = within lab control limits Analytical duplicate RPD = <30%	LCS = 75 – 125% Lab Blank = < MDL	95
	Volatiles [1]	8260B	LCS/LCSD or MS/MSD RPD = within lab control limits Analytical duplicate RPD = <30%	LCS = 75 – 125% Lab Blank = < MDL	95
Water – Equipment Blanks	ICP (Arsenic and Lead)	6010B	LCS/LCSD or MS/MSD RPD = <20% Analytical duplicate RPD = <20%	LCS = 80 – 120% recovery MS = 75 – 125% recovery Lab Blank = < MDL	95

Notes: [1] All replacement materials will be analyzed for the analytes listed on the Replacement Material Chemical Criteria. Only those constituents shall be reported.

TABLE 4-2

ANALYTICAL METHODS, SAMPLE CONTAINERS, PRESERVATION AND HOLDING TIMES

Sample Matrix	Analytical Method Description	EPA Method Reference	Container and Preservation	Storage Recommendation	Holding Time Recommendations
Flowerbed & Garden Soil	ICP (Arsenic and Lead)	6010B; 3052-hydrofluoric acid digestion	Clean bags or glass jars 50 grams	None	180 days
In-situ Yard Soil	TCLP – Metals	1311/ 6010B	Clean 8 oz. glass jar	Cool	180 days
	TCLP – Mercury	1311/ 7471A			14 days
	TCLP – Pesticides	1311/ 8081A	Clean 8 oz. glass jar	Cool	Extraction = 7days Analysis = 40 days after extraction
	TCLP – Herbicides	1311/ 8151A			Extraction = 7days Analysis = 40 days after extraction
	TCLP – Semi-volatiles	1311/ 8270C			Extraction = 7days Analysis = 40 days after extraction
	TCLP – Volatiles	1311/ 8260B			14 days
	Soil Composition	ASTM D-422	Clean 5-gallon bucket	N/A	N/A

TABLE 4-2 (CONTINUED)

ANALYTICAL METHODS, SAMPLE CONTAINERS, PRESERVATION AND HOLDING TIMES

Sample Matrix	Analytical Method Description	EPA Method Reference	Container and Preservation	Storage Recommendation	Holding Time Recommendations
Replacement Materials	Metals [1]	6010B	Clean 8 oz. glass jar 50 grams	Cool	180 days
	Mercury	7471A			14 days
	Pesticides [1]	8081A	Clean 8 oz. glass jar 100 grams	Cool	Extraction = 7days Analysis = 40 days after extraction
	PCBs [1]	8082			Extraction = 7days Analysis = 40 days after extraction
	Semi-volatiles [1]	8270C			Extraction = 7days Analysis = 40 days after extraction
	Volatiles [1]	8260B	Clean 8 oz. glass jar 50 grams	Cool	14 days
Water – Equipment Blanks	ICP (Arsenic and Lead)	6010B	Plastic or glass bottle 500 mL Preserve to pH < 2 with nitric acid	N/A	180 days

Notes: [1] All replacement materials will be analyzed for the analytes listed on the Replacement Material Chemical Criteria. Only those constituents shall be reported.

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PROJECT PLAN

for the

VASQUEZ BOULEVARD & I-70 SITE
DENVER, CO

PHASE III FIELD INVESTIGATION

August 4, 1999

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APPROVAL PAGE

This Project Plan for the Vasquez Boulevard and I-70 Site - Phase III Field Investigation has been prepared at the request of the U.S. Environmental Protection Agency, Region 8, by ISSI Consulting Group, Inc. Study investigations and activities addressed in this Project Plan are approved without condition.

Bonita Lavelle

Program Approval
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8-4-99
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TABLE OF CONTENTS

1.0 BACKGROUND AND STUDY OBJECTIVES 1-1
1.1 Key Personnel 1-1
1.2 Project Background 1-2
1.3 Study Objectives 1-4
1.4 Project Description 1-5

2.0 DATA QUALITY OBJECTIVES AND STUDY DESIGN 2-1
2.1 Residential Soil Sampling 2-1
2.1.1 Data Quality Objectives 2-1
2.1.2 Study Design 2-4
2.2 Indoor Dust Sampling 2-10
2.2.1 Data Quality Objectives 2-10
2.2.2 Study Design 2-12
2.3 Alley Soil Pilot Study 2-14
2.3.1 Data Quality Objectives 2-14
2.3.2 Study Design 2-15
2.4 Characterization of Schools and Parks 2-17
2.4.1 Data Quality Objectives 2-17
2.4.2 Study Design 2-18

3.0 FIELD SAMPLING PLAN 3-1
3.1 Staff Identification 3-1
3.2 Property Access Agreements 3-1
3.2.1 Obtaining Access Agreements 3-2
3.2.1.1 Site-Wide Mailing 3-2
3.2.1.2 Door-to-Door Recruitment 3-3
3.2.1.3 Follow-up Mailings and Recruitment Activities 3-3
3.2.2 Documentation 3-3
3.3 Phase III Field Sampling 3-4
3.4 Residential Yard Soils 3-4
3.4.1 Residence Identification 3-5
3.4.2 Identification and Collection of Yard Soil Samples 3-5
3.4.3 Field Documentation 3-8
3.4.4 Sample Preparation 3-9
3.4.5 Analytical Method Requirements 3-10
3.5 Indoor Dust Samples 3-11
3.5.1 Identification of Indoor Dust Samples 3-11
3.5.2 Scheduling Dust Sampling 3-11

3.5.3 Collection of Indoor Dust Samples 3-12
3.5.4 Field Documentation 3-12
3.5.5 Sample Preparation 3-13
3.5.6 Analytical Method Requirements 3-13
3.6 Alley Samples 3-13
3.6.1 Identification and Collection of Alleyway Soil Samples 3-13
3.6.2 Field Documentation 3-15
3.6.3 Sample Preparation 3-15
3.6.4 Analytical Method Requirements 3-18
3.7 Schools and Parks 3-18
3.7.1 Identification and Collection of Soil Samples at Schools and Parks 3-18
3.7.2 Field Documentation 3-20
3.7.3 Sample Preparation 3-21
3.7.4 Analytical Method Requirements 3-22
3.8 Sample Identification 3-23
3.9 Sample Handling and Custody Requirements 3-24
3.10 Decontamination Procedures 3-24
3.11 Sample Archives 3-25
3.12 Health and Safety 3-25
3.13 Waste Generation and Management 3-25

4.0 QUALITY ASSURANCE PROJECT PLAN 4-1
4.1 Project Task And Organization (A4) 4-1
4.1.1 Project Task 4-1
4.1.2 Project Organization 4-1
4.2 Problem Definition and Background 4-1
4.3 Project Task Description and Schedule 4-1
4.4 Data Quality Objectives 4-1
4.4.1 Criteria for Measurement Data 4-2
4.5 Special Training Requirements and Certification 4-3
4.6 Documentation and Records 4-4
4.6.1 Field Data 4-4
4.6.2 Laboratory Data 4-4
4.6.3 Data Management 4-7
4.7 Measurement And Data Acquisition 4-7
4.8 Quality Control Requirements 4-7
4.8.1 Field Quality Control Samples 4-7
4.8.2 Laboratory Quality Control Samples 4-9
4.9 Detection Limits 4-10
4.10 Instrument/Equipment Testing, Inspection and Maintenance Requirements 4-12

4.11 Instrument Calibration and Frequency 4-12
4.12 Assessment and Oversight 4-13
4.12.1 Assessment and Response Actions 4-13
4.12.1.1 Audits 4-13
4.12.1.2 Corrective Action Procedures 4-14
4.13 Data Validation And Useability 4-15
4.13.1 Data Review Validation and Verification 4-15
4.13.2 Validation and Verification Methods 4-15
4.14 Final Reporting 4-16
4.15 Reconciliation with Data Quality Objectives 4-16

5.0 DATA MANAGEMENT PLAN 5-1
5.1 DMP Objectives 5-1
5.2 Organizational Relationships 5-1
5.3 Organizational Responsibilities for the Database 5-1
5.4 Data Management Team Responsibilities 5-2
5.5 Forms of Data 5-3
5.5.1 Primary Data 5-4
5.5.2 Secondary Data 5-4
5.6 Data Flow 5-5
5.6.1 Reference Data Sources 5-5
5.6.2 Data Acquisition 5-6
5.6.2.1 Field Sampling 5-6
5.6.2.2 Laboratory Data Entry 5-7
5.7 Database Organization 5-7
5.8 Data Screening, Verification, and Validation 5-9
5.8.1 Data Verification 5-9
5.8.2 Data Validation 5-9
5.8.3 Data Amendment/Correction 5-10
5.9 Records Management 5-12
5.9.1 Short-Term Records Management 5-12
5.9.1.1 Hard copy Data Files 5-12
5.9.1.2 Electronic Data Files 5-12
5.9.2 Long Term Records Management 5-13

6.0 REFERENCES 6-1

APPENDICES

Appendix A	Selection of Chemicals of Potential Human Health Concern at the Vasquez Boulevard & I-70 Site
Appendix B	Site Map Depicting Arsenic Levels across VBI70 for Phases I & II
Appendix C	Phase III Investigation- Rationale for Collecting Surface Soil Samples Only
Appendix D	Screening Level Evaluation of Risks from Acute and Subchronic Exposure to Arsenic in Soil
Appendix E	Monte Carlo Simulations Performed to Support Surface Soil Sampling Strategy
Appendix F	Standard Operating Procedures
Appendix G	Method Detection Limit Study and Proficiency Demonstration
Appendix H	Data Management Plan Additions

FIGURES AND TABLES

Tables

Table 1-1	Past and Proposed Investigations for the VBI70 Site
Table 2-1	List of Schools and Parks
Table 4-1	Project-Required Detection Limits for Phase III Investigations
Table 4-2	Required Quality Control and Recommended Corrective Action for Phase III Investigations

Figures

Figure 1-1	Organizational Chart for the Phase III Activities at the VBI70 Site
Figure 1-2	VBI70 site Boundary for Phase III
Figure 1-3	Vasquez Boulevard & I-70 Phase III Field Investigation Project Schedule
Figure 2-1	Distribution of Arsenic Values at Impacted Properties
Figure 2-2	Probability Plots of Arsenic Distribution at Impacted Properties
Figure 2-3	Probability Plots of Arsenic Distribution for Minimally Impacted Properties
Figure 2-4	Arsenic Levels in Surface Soil at Unimpacted Residences
Figure 3-1	Phase III Sample Flow Chart
Figure 3-2	Proposed Grid Sampling Design for Residential Surface Soil- Step 1
Figure 3-3	Proposed Grid Sampling Design for Residential Surface Soil- Step 2
Figure 3-4	Surface Soil Data Sheet
Figure 3-5	Soil Preparation Flow Chart

Figure 3-6 Field Sample Preparation Logbook
Figure 3-7 QC Data Sheet- Blind Soil Field Splits
Figure 3-8 QC Data Sheet- Soil Performance Evaluation Standards
Figure 3-9 QC Data Sheet- Equipment Blank Data Sheet
Figure 3-10 Indoor Dust Scheduling Sheet
Figure 3-11 Indoor Dust Sample Data Sheet
Figure 3-12 Typical Sampling Plan at an Alleyway
Figure 3-13 Alleyway Soil Sample Data Sheet
Figure 3-14 Sample Chain of Custody Record
Figure 3-15 Sample Chain of Custody Record for Field Samples
Figure 3-16 Sample Chain of Custody Record for Samples Submitted to the Contract Laboratory
Figure 5-1 Data Amendment/Correction Form

TABLE OF ABBREVIATIONS

ATSDR	Agency for Toxic Substances and Disease Registry
CAR	Corrective Action Request
CCOD	City and County of Denver
CDPHE	Colorado Department of Public Health and Environment
CLP	Contract Laboratory Program
COC	Chain of Custody
COPC	Chemical of Potential Concern
DCN	Document Control Number
DMP	Data Management Plan
DQA	Data Quality Assessment
DQOs	Data Quality Objectives
FPL	Field Project Leader
FQAC	Field Quality Assurance Coordinator
FSP	Field Sampling Plan
GFAA	Graphite Furnace Atomic Absorption
GLP	Good Laboratory Practices
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Responder
HSO	Health and Safety Officer
ICP	Inductively Coupled Plasma
ICP-MS	Inductively Coupled Plasma-Mass Spectrometry
IDL	Instrument Detection Limit
IDW	Investigation Derived Waste
IEUBK	Integrated Exposure Uptake Biokinetic Model
ISSI	ISSI Consulting Group, Inc.
LCS	Laboratory Control Sample
MDL	Method Detection Limit
MK	Morrison Knudsen Corporation
NIST	National Institute of Standards and Technology
OSHA	Occupational Safety & Health Administration
PARCC	Precision, Accuracy, Representativeness, Completeness and Comparability
PDC	Property Data Center, Inc.
PE	Performance Evaluation
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RBC	Risk-Based Concentration
REAC	Response Engineering and Analytical Contract
RME	Reasonable Maximum Exposure

RPD	Relative Percent Difference
RPM	Remedial Project Manager
SDMS	Superfund Document Management System
SOPs	Standard Operating Procedures
START	Superfund Technical Assessment and Response Team
TL	Team Leader
UCL	Upper Confidence Limit
USEPA	U.S. Environmental Protection Agency
VBI70	Vasquez Boulevard and Interstate 70
WAM	Work Assignment Manager
XRF	X-ray Fluorescence

1.0 BACKGROUND AND STUDY OBJECTIVES

The U.S. Environmental Protection Agency (USEPA), Region 8, is working in cooperation with the City and County of Denver (CCOD), the Colorado Department of Public Health and Environment (CDPHE), the Agency for Toxic Substances Disease Registry (ATSDR), and representatives of several citizens groups to investigate and remediate environmental contamination that has been discovered at the Vasquez Boulevard and Interstate 70 (VBI70) site, located in Denver, Colorado.

Although substantial data regarding the nature and extent of contamination have been collected at the site (see Section 1.2, below), additional data are required to support reliable risk assessment and remedial risk management decisions. These additional data will be collected during a set of field activities that are referred to as the Phase III Field Investigation. This project plan presents the data quality objectives for the Phase III activities, along with the sampling and analysis design, rationale, and specific quality assurance and quality control activities needed to achieve those data quality objectives.

1.1 Key Personnel

The following key USEPA personnel will serve as contacts and provide technical expertise during implementation of this project plan.

- Bonita Lavelle, USEPA Remedial Project Manager. Ms. Lavelle will be responsible for overall project management, technical oversight and coordination among USEPA and its contractors, the State of Colorado and the City and County of Denver. Ms. Lavelle will be a principal decision-maker for this project.

- Christopher P. Weis Ph.D., USEPA Regional Toxicologist. Dr. Weis will serve as the primary technical contact for this project. He will be responsible for technical oversight and evaluating the human health risk to residents of the VBI70 site. Dr. Weis will be a principal data user and decision-maker for this project.

- Tony Selle, USEPA Data Management and GIS Mapping Specialist. Mr. Selle will provide oversight of data management and GIS mapping activities associated with the Phase III project.

- Ted Fellman, USEPA Community Involvement Specialist. Mr. Fellman will provide community involvement support for all aspects of the VBI70 Phase III field investigation.

Several USEPA contractors will provide technical support to the key USEPA personnel. Figure

1-1 is an organizational chart outlining the key USEPA personnel and its contractors who will participate in operations planned for development, implementation, oversight and interpretation of data generated from the Phase III field investigation.

1.2 Project Background

The VBI70 site is located in the northern section of Denver, Colorado. The study area is bounded on the west by the South Platte River and is approximately bounded on the east by Colorado Boulevard. Northern and southern boundaries for the study area are East 52nd Avenue and Martin Luther King Boulevard, respectively. A small area south of Globeville is also included. Its boundaries are: Interstate 70 on the north, West 39th Avenue on the south, Huron Street to the west, the South Platte River on the east and the Burlington Northern Railroad on the southeast. Refer to Figure 1-2 for a map of the site boundaries. The VBI70 site is comprised mainly of residential neighborhoods, but also includes some areas used for commercial and industrial purposes. Contained within the site boundary are two historic smelters (Omaha-Grant and Argo). One current smelter is located north and west of the site (Globe).

Investigations begun in the vicinity of the Globe Smelter revealed the presence of residential soil contamination with metals associated with historic operations of the smelter. As sampling activities were extended further from the smelter, a number of residential properties with higher than anticipated levels of metals in yard soil were identified. The discovery of these elevated soil levels in residential areas is the basis for establishing the VBI70 site.

A number of investigations have been performed to date at the site, as summarized below:

Table 1-1 Past and Proposed Investigations for the VBI70 Site

Title	Description	Dates of Implementation	Reference
Phase 1	Approximately 2500 grab samples from 1200 properties	Spring 1998	UOS 1998a
Phase 2	Surface soil grab samples from 300 additional properties	Summer 1998	UOS 1998b
Removal action	Two 5-point composite samples from 44 properties	Summer/Fall 1998	UOS 1998b
Physico-chemical Characterization of Soils	Comparison of sieved and un-sieved soils; Speciation of arsenic and lead; Estimates of bioaccessiblity	Summer 1998	ISSI 1998a
Risk-based sampling	High density surface sampling at 8 properties; Relationship between soil and dust; Garden vegetable, paint and tap water analyses; Biomonitoring	Summer/Fall 1998	ISSI 1999b
Pilot Scale Soil Characterization Study	Comparison of chemical and physical characteristics of site soils with proposed source soils and materials	Projected for Summer 1999	ISSI 1999d

Key findings and conclusions from these studies are summarized below:

- The chemicals of principal human health concern are arsenic and lead (see Appendix A).
- The spatial pattern of contaminated properties across neighborhoods appears to be unpredictable, with impacted yards occurring at widely separated locations, often surrounded by non-impacted properties (UOS 1998a, 1998b; see map in Appendix B).

- Within a property that has elevated levels of arsenic, the pattern of contamination is generally wide-spread (covering most of the yard), but concentrations may vary significantly from place to place (ISSI 1999b).

- Contamination is generally highest at the surface, diminishing at depths of 12-24 inches (ISSI 1999b, 1999c [see Appendix C]).

- The chemical form of the arsenic is arsenic trioxide (ISSI 1998b).

Based on these data, USEPA has concluded that concentrations of arsenic and, to a lesser extent, lead in surface soil may be of health concern to some (but not all) area residents. Because of this concern, USEPA proposed this site for inclusion on the National Priorities List in January, 1999.

1.3 Study Objectives

USEPA's overall objective is to collect sufficient data to adequately characterize the nature and extent of soil contamination at this site, and to support reliable risk assessment calculations and risk management decisions at the site regarding the need to remediate residential soil. Phase III comprises a set of field activities that specifically targets four data gaps associated with exposure of residents to contaminated soil:

1. Location of Residences with Contaminated Soil

Because of the apparent lack of spatial pattern in the location of contaminated residences, a yard-by-yard sampling effort is required to locate and identify all properties with elevated levels of arsenic and lead. Thus, the principal study objective of this project is:

> ***Collect sufficient soil data from each residential property within the site boundaries to support reliable exposure and risk calculations at each property, including an evaluation of both short-term and long-term risks.***

2. Relation Between Contaminant Levels in Residential Yard Soil and Indoor Dust

Contaminants in outdoor soil are able to enter homes through airborne and direct transport pathways, and can contribute to contamination of indoor dust on floors, tables, counter tops, etc. Data collected to date suggest that indoor dust contamination at residences may not be extensive at this site (ISSI 1999b), but the data are too limited to draw firm conclusions regarding the importance of the soil-to-dust contaminant transport. Consequently, the objective of this

component of the Phase III project is to:

> ***Collect sufficient numbers of paired soil-dust samples to reliably quantify the average relationship between outdoor yard soil contamination and indoor dust contamination in area residences.***

3. Characterization of Soil in Alleyways

Unpaved alleyways exist at some locations in the study area. If the soil in these alleyways is contaminated with arsenic and/or lead, this could be a source of concern for nearby residents. Currently, no data exist on contaminant levels in alleyways within the study area. Therefore, the objective of this part of the Phase III program is to:

> ***Collect sufficient samples from selected unpaved alleyways to determine whether levels of arsenic and/or lead in alleyway soil are likely to be of potential health concern to area residents, and if so, to provide initial information that will help determine the likely source and spatial pattern of alleyway contamination.***

4. Characterization of Soil at Schools and Parks

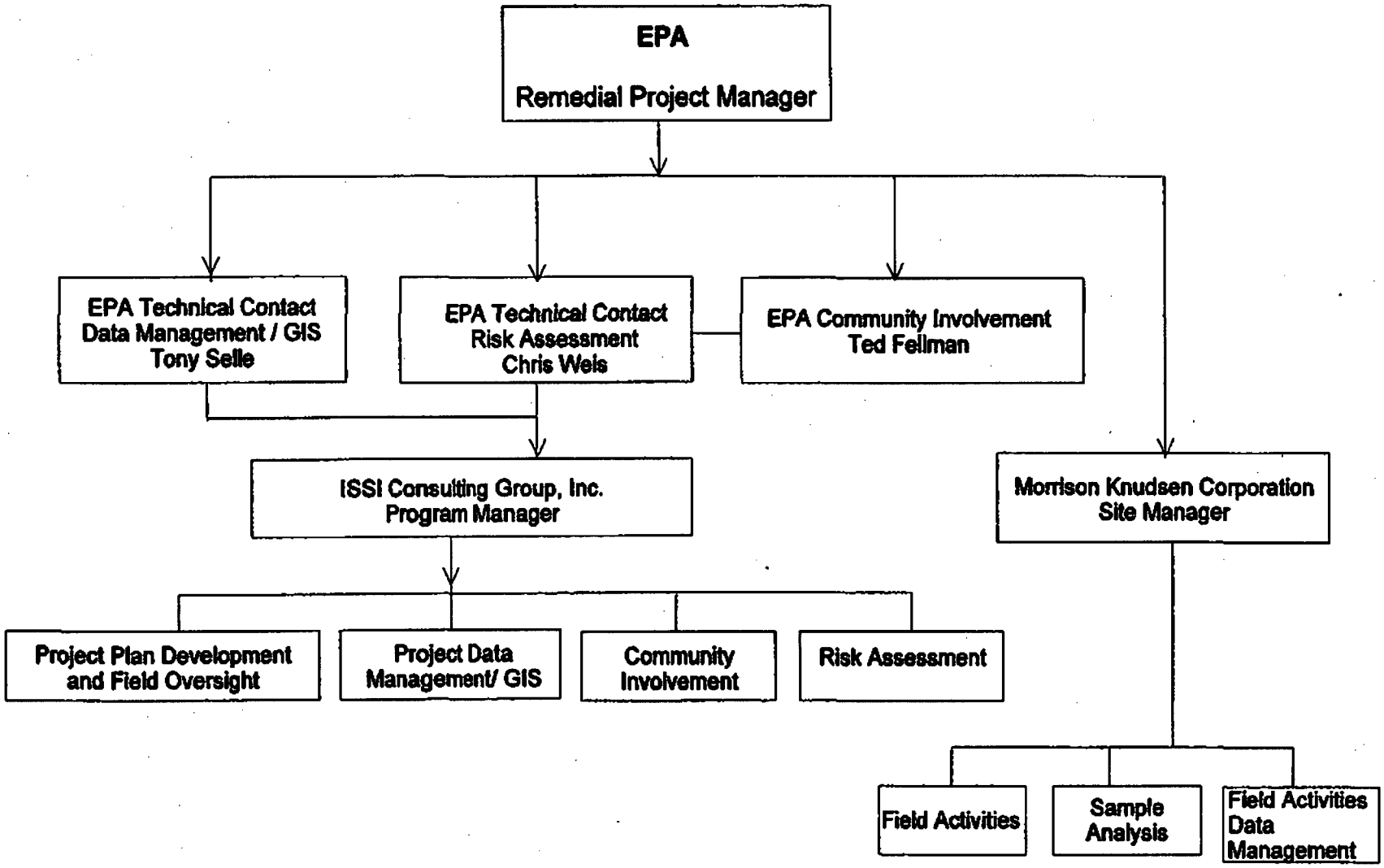
Area children are likely to be exposed not only at their residences but also at neighborhood schools and parks. Available data (UOS 1998a, 1998b) suggest that contamination at these locations is not of concern, but not all locations have been sampled. Therefore, the objective of this component of the Phase III project is to:

> ***Collect sufficient samples of surface soil from un-tested schools and parks to support reliable exposure and risk calculations at each location, including an evaluation of both short-term and long-term risks.***

1.4 Project Description

These objectives will be accomplished by collection of environmental samples during field work to be completed in the summer of 1999. This work will be performed by Morrison Knudsen Corporation (MK), with planning and oversight provided by ISSI Consulting Group, Inc. (ISSI). All work will be conducted in accord with the detailed specifications contained within this project plan. Figure 1-3 provides a schedule of planned activities for the Phase III Field Investigation.

Figure 1-1: Organizational Chart for the Phase III Activities at the VBI70 Site



Color Map(s)

The following pages contain color that does not appear in the scanned images.

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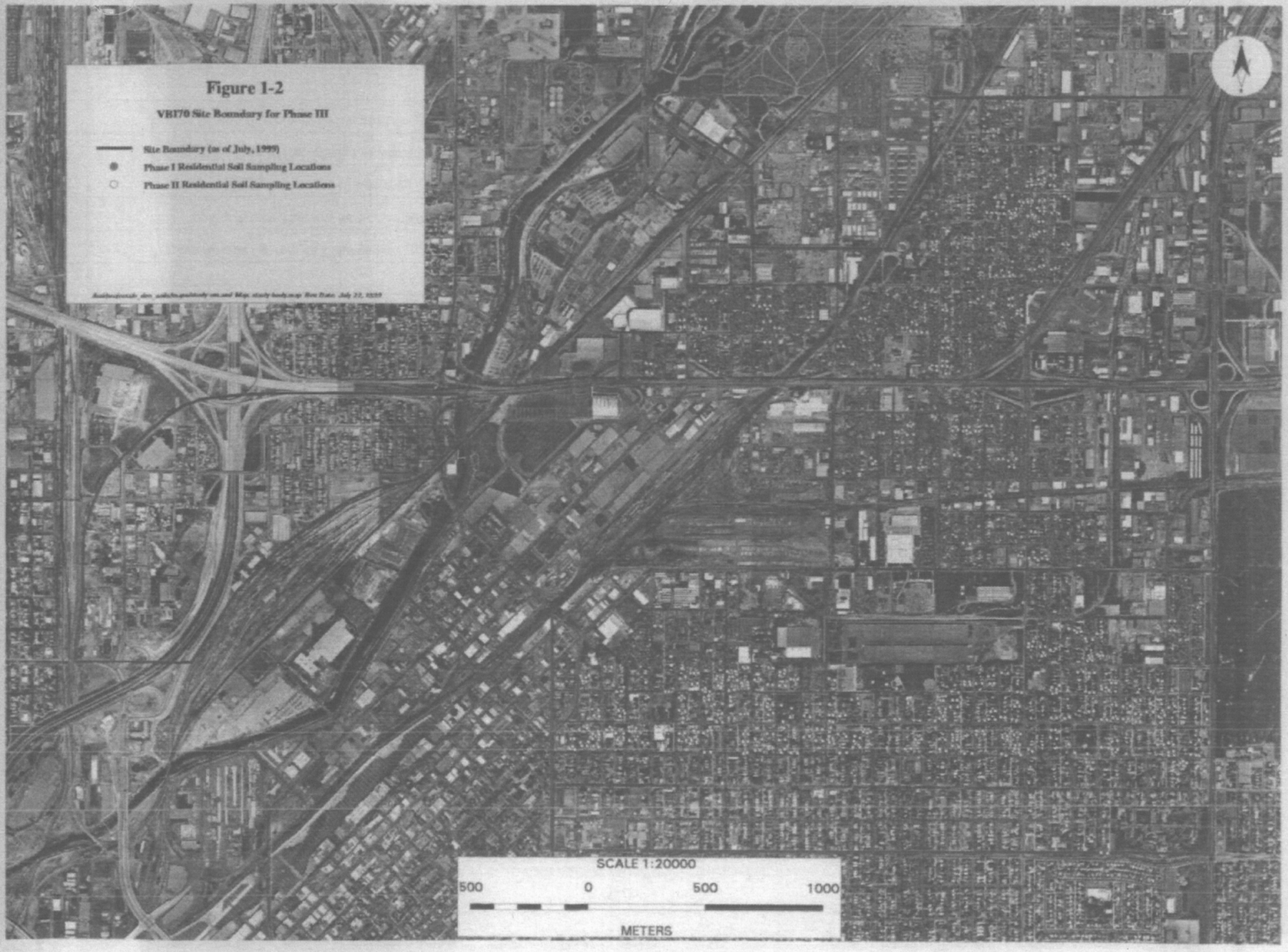
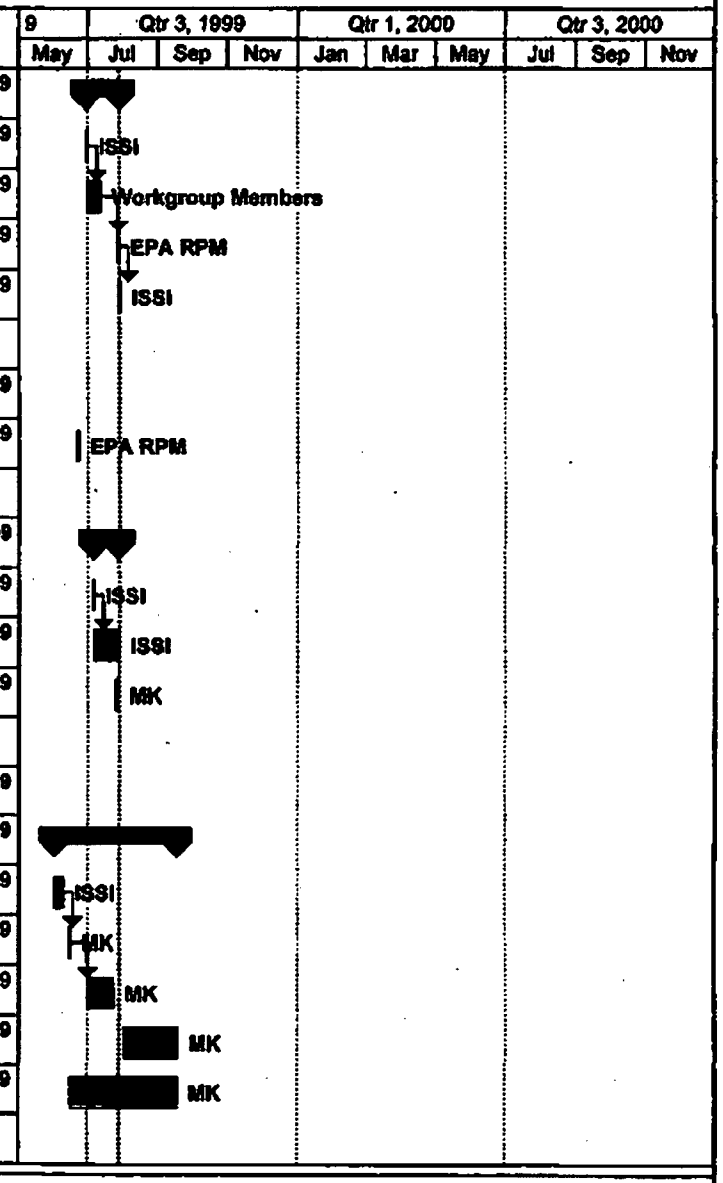


Figure 1-2
VBI70 Site Boundary for Phase III
Site Boundary (as of July, 1999)
Phase I Residential Soil Sampling Locations
Phase II Residential Soil Sampling Locations
SCALE 1:20000
500
0
500
1000
METERS

Figure 1-3
Vasquez Boulevard & I-70
PHASE III FIELD INVESTIGATION :
Project Schedule

ID	Task Name	Start	Finish
1	1: Phase III Project Plan	6/30/99	7/29/99
2	Distribute Draft Project Plan	6/30/99	6/30/99
3	VBI70 Workgroup Review and Comment	7/1/99	7/12/99
4	Final Project Plan Approval	7/28/99	7/28/99
5	Distribute Final Project Plan	7/29/99	7/29/99
6			
7	2: Community Relations	6/22/99	6/22/99
8	Public Meeting	6/22/99	6/22/99
9			
10	3: Method Detection Limit Study & Proficiency Test (XRF)	7/6/99	7/28/99
11	Collect Site Soils and PE Samples	7/6/99	7/6/99
12	Prepare and Certify Site Soils and Standards	7/7/99	7/28/99
13	Perform XRF MDL Study & Proficiency Test	7/26/99	7/27/99
14			
15	4: Phase III Field Investigation	6/2/99	11/30/99
16	Property Access	6/2/99	9/17/99
17	Prepare Access Agreement Database	6/2/99	6/9/99
18	Mail Property Access Request for Soil Sampling	6/15/99	6/15/99
19	Door-to-door Recruitment for Soil Sampling	7/1/99	7/23/99
20	Follow-up Mailings or Recruitment Activities (as requested by RPM)	6/2/99	9/17/99
21	Update Access Agreement Database	6/16/99	9/17/99
22			



2.0 DATA QUALITY OBJECTIVES AND STUDY DESIGN

Data Quality Objectives (DQOs) are statements that define the type, quality, quantity, purpose and use of data to be collected. The design of a study is closely tied to the data quality objectives, which serve as the basis for important decisions regarding key design features such as the number and location of samples to be collected, the chemical analyses to be performed, etc.

USEPA has published a number of guidance documents on the DQO process (USEPA 1994a, 1994a, 1996), and this project plan has been developed in accord with that guidance. In brief, the DQO process follows a seven-step procedure, as follows:

1. State the problem that the study is designed to address
2. Identify the decisions to be made with the data obtained
3. Identify the types of data inputs needed to make the decision
4. Define the bounds (in space and time) of the study
5. Define the decision rule which will be used to make decisions
6. Define the acceptable limits on decision errors
7. Optimize the design for obtaining data in an iterative fashion using information and DQOs identified in Steps 1-6

Following these seven steps helps ensure that the project plan is carefully thought out and that the data collected will provide sufficient information to support the key decisions which must be made. The following sections summarize the application of the DQO process to the design of each of the four component parts of the VBI70 Phase III included in this project plan.

2.1 Residential Soil Sampling

2.1.1 Data Quality Objectives

State the Problem

As noted previously, data from previous investigations at the site suggest that contaminated residential properties exist in an unpredictable pattern, and that the location of a contaminated property cannot be identified based on data from other nearby residences. Thus, the basic problem is to develop a method for identifying all individual properties that have contaminant levels above a level of health concern, and to obtain data from these properties that will allow evaluation of the health risks from direct and indirect contact with the soil.

Decisions to Be Made

Each individual property within the study area will be evaluated to determine whether the concentrations of contaminants are either a) acceptable, or b) potentially unacceptable. These risk-based decisions will, in turn, form an important input to risk management decision-making at the site.

Types of Input Needed

The information needed to make risk-based decisions at a residential property is reliable data on the concentration values in soil at the residence. The key statistic is the arithmetic mean concentration within that property. However, because the true mean concentration within a property cannot be derived with certainty from a limited set of samples from the residence, USEPA specifies that the decision for most chemicals (including arsenic) will be based on the 95% upper confidence limit of the mean (95% UCL) (USEPA 1992a). This, in turn, requires information on the inter-sample variability, and on the shape of the distribution of grab samples from a property (e.g., normal, lognormal).

Bounds of the Study

Spatial Bounds

All residential properties within the site boundary that have not been sampled to date will be sampled during Phase III, if authorization for access is granted by the owner. It is estimated that there are approximately 3000 such residential properties. Residential properties that have been sampled previously will not be re-sampled during Phase III unless it is determined that the existing data for a property are not adequate to support a reliable risk assessment and remedial decisions. This determination will be presented in a separate document.

Temporal Bounds

All data will be collected during the summer and fall of 1999. However, because concentration values in soil are unlikely to vary significantly over time, the precise time period when collection occurs is not important. Results will be applied to current and future exposure conditions.

Decision Rule

Available data indicate that the basic unit of contamination is an individual property (ISSI 1999b). Therefore, each property will be evaluated on an individual basis. Conceptually, the classification of a property is achieved by performing exposure and risk calculations in accord with standard approaches and method specified by USEPA. For convenience, this approach may

be simplified by calculating the maximum concentration value that yields an acceptable risk, and identifying this value as the Risk-Based Concentration (RBC). Then, each property can be classified simply by comparing the appropriate site statistic to the RBC. For arsenic, the risk calculation is based on the 95% UCL for the property, so the classification is achieved by comparing the 95% upper confidence limit of the arithmetic mean (UCL) for the property to the RBC for arsenic. Conceptually, three different RBCs are relevant: acute, subchronic and chronic.

However, as demonstrated in Appendix D, any property that fails the comparison for the acute or sub-chronic RBC is also expected to fail the comparison for the chronic RBC. Nevertheless, all properties will be evaluated using a three-step test to identify a property that is of potential concern from arsenic for acute, subchronic or chronic exposure. The property will be determined acceptable only if all three tests are acceptable (see table below). In the case of lead, the forward-going risk calculation is based on the arithmetic mean of lead concentrations within the property, so classification is achieved by comparing the arithmetic mean soil concentration of the three composite samples to an appropriate site-specific Risk-Based Concentration (RBC) for lead.

Chemical	Test Result	Decision
Arsenic	Three-Step Test	
Test I (chronic)	95% UCL $\leq RBC_c$ 95% UCL $> RBC_c$	Acceptable Potentially unacceptable
Test II (subchronic)	$C_{max} \leq MTCV_{sc}$ $C_{max} > MTCV_{sc}$	Acceptable Potentially unacceptable
Test III (acute)	$C_{max} \leq MTCV_a$ $C_{max} > MTCV_a$	Acceptable Potentially unacceptable
Lead	Mean $\leq RBC_{Pb}$ Mean $> RBC_{Pb}$	Acceptable Potentially unacceptable

RBC_c - RBC for chronic exposure
C_{max} - Maximum concentration at a single property in a composite of size 10
$MTCV_{sc}$ - Minimum Theoretical Composite Value for subchronic exposure
$MTCV_a$ - Minimum Theoretical Composite Value for acute exposure
RBC_{Pb} - site-specific RBC for lead

The RBC for both arsenic and lead will be developed during the feasibility study for the site, after finalization of the human health risk assessment. The RBCs will be designed to protect an individual with Reasonable Maximum Exposure (RME), and will be calculated using all of the same exposure and toxicity values developed for use in the risk assessment. This will include use of all reliable site-specific data available, and may include both deterministic risk assessment approaches and/or probabilistic approaches, as needed to adequately characterize the variability

and uncertainty in risk to humans at the site. That is, a range of potential RBCs may be developed, allowing for risk management judgement in selection of an appropriate decision criterion, in accord with the nine criteria described in the National Contingency Plan (40 Code of Federal Regulations [CFR] Part 300).

Acceptable Limits on Decision Errors

In accord with standard risk-based decision-making at Superfund sites, a property will be assumed to be contaminated unless there is at least 95% confidence that the property is actually safe (i.e., alpha = 0.05) (USEPA 1992b).

For arsenic, this is achieved by using the 95% UCL of the mean concentration at the property as the basis for decision making. That is, if the 95% UCL is less than the RBC, there is at least 95% confidence that the true mean value for the property is below the RBC and that risks are within acceptable limits. However, use of the 95% UCL for arsenic means that some properties that are actually safe may be declared to be unacceptable. Generally, the frequency of this type of error should be no more than 20% (USEPA 1992b). For this project, the goal is to ensure that the frequency of this type of decision error is as low as can be achieved with the available sampling and analysis budget. Once properties that are potentially unacceptable are identified, USEPA may choose to collect additional surface soil samples to minimize this type of error.

For lead, 95% confidence that the property is safe is achieved by use of USEPA's Integrated Exposure Uptake Biokinetic (IEUBK) model or other appropriate mathematical model that describes the probability that an individual exposed to a specified set of environmental lead levels will have a blood lead value that is above a level of health concern (10 ug/dL). The RBC is defined as the soil concentration such that the probability of an individual having a value above 10 ug/dL is no more than 5% (USEPA 1994c). It should be noted that the IEUBK model accounts for all sources of lead exposure, not just soil and dust.

2.1.2 Study Design

Based on the data quality objectives outlined above, the key design elements of the soil sampling component of the Phase III project are as summarized below.

Sampling Depth

Available data on COPC levels in residential soils are sufficient to establish that when contamination is present in a yard, it is mainly surficial (0-2 inches), and that concentrations of contaminants in subsurface soil tend to be lower than in the surface soil (ISSI 1999c; see Appendix C). Thus, this project will seek to characterize only surficial soil in residential yards. Once properties that are potentially unacceptable are identified, USEPA may choose to collect

subsurface soil samples to help determine the appropriate depth of remediation, as appropriate.

Calculation of the 95% UCL

Currently, USEPA has established default methods for calculating the 95% UCL for distributions that are either normal or lognormal (USEPA 1992a):

Normal:

$$UCL = m + t_{1-\alpha,n-1} * \frac{s}{\sqrt{n}} \qquad (1)$$

where:

m	=	arithmetic mean of the data
s	=	standard deviation of the data
n	=	number of samples
$t_{1-\alpha,n-1}$	=	t-statistic for the (1-α) percentile of the t distribution with n-1 degrees of freedom

Lognormal:

$$UCL = \exp\left(m_t + 0.5s_t^2 + \frac{s_t H}{\sqrt{n-1}}\right) \qquad (2)$$

where:

m_t = mean of the log-transformed data
s_t = standard deviation of the log-transformed data
n = number of samples
H = H-statistic from table in USEPA (1992a)

Equations for calculating the 95% UCL of the mean for distributions other than the normal and the lognormal are not readily available.

At this site, data from eight residential properties that have been intensively sampled (ISSI 1999b) suggest the distribution of arsenic values within a residential property tends to be right-skewed, at least for properties where concentration values are substantially higher than average (see Figure 2-1). This indicates that a log-normal distribution might be appropriate for characterizing the distributions at such locations. However, tests of the distribution at these impacted properties reveal that the data are not well characterized by a lognormal (or a normal) distribution (Figure 2-2). The distribution of values at properties that are not impacted or minimally impacted (mean concentration = 40-70 mg/kg) appears to be more nearly normal

(Figure 2-3), but are still skewed at the low end by the presence of multiple values below the detection limit. Because the distributions are not well characterized as either normal or lognormal, use of either equation 1 or equation 2 as the basis for calculating the 95% UCL based on a series of grab samples might yield results that are not accurate.

One way to minimize problems associated with calculating the 95% UCL of the mean for non-standard distributions is compositing. This is because, regardless of the shape of the parent distribution, the distribution of the values of composite samples will approach a normal distribution if the number of sub-samples is sufficiently large and the sub-samples are thoroughly mixed, allowing use of equation 1 for calculation of the UCL of the mean at a property. In addition, the variability between composite samples is less than between grab samples, so uncertainty in the mean of composite samples is usually less than for an equal number of grab samples. For these reasons, the Phase III soil sampling study will utilize compositing of grab samples collected within a property.

Number of Grab Samples per Composite

In order to estimate the number of grab samples per composite needed to reduce intra-composite variability and to ensure that distribution of composites is approximately normal, Monte Carlo simulations were performed using site-specific data from properties that had been intensively sampled (140-160 data points per property) (ISSI 1999b). In these simulations, grab samples of size j (j = 5, 10, 15, 25, 30, 50 grabs per composite) were repeatedly drawn, and the composite mean was calculated as the mean of the grab samples. Then the distribution of the composite values was tested for normality. The results are presented in Appendix E. Based on these tests, a set of 10 sub-samples was found to be adequate to ensure that the distribution of the composites drawn from minimally impacted properties (sample mean = 40-70 mg/kg) will be approximately normal.

At the intensively sampled properties that were clearly impacted (sample mean = 390-2370 mg/kg), the number of grab samples per composite needed to ensure that the distribution of composites is approximately normal is about 15-25. Thus, the distribution of the 10-point composite samples from such a property is likely to be somewhat right-skewed. For right skewed distributions, the median is less than the mean and therefore a single 10-point composite sample is more likely to be below the true mean than it is above the true mean. However, some 10-point composite sample values may be raised by very high although infrequent values and the mean of the three 10-point composite samples should, therefore, approach the true mean and use of equation 1 to calculate the 95% UCL could underestimate the true UCL. At such a location, it is expected that the identification of the property as potentially unacceptable can readily be made based on a comparison of the sample mean to the RBC. That is, if the sample mean is above the RBC, the property may be classified as potentially unacceptable without regard to the value of the UCL. Therefore, the possibility of incorrectly identifying the property as acceptable when it

is really not acceptable is very small.

Number of Composites per Property

The number of composites per yard depends on the acceptable probability of making a Type I (false positive) error. This is the case when a property is incorrectly identified as being above a level of concern when it is actually below a level of concern. In general, as the number of composites increases, the chances of making this type of error decreases. However, the exact number depends on the expected difference between the RBC and the typical level in un-impacted properties. That is, the wider the difference between the mean value at un-impacted properties and the RBC, the fewer samples that are needed to establish that the UCL for an un-impacted property is below the RBC. As noted above, EPA guidance (USEPA 1992b) recommends that the value be no more than 20%, and the goal of the study is to reduce the Type I error rate to the maximum extent that available resources will permit.

In order to investigate the relationship between Type I error rate and the number of composites at this site, a Monte Carlo simulation was performed based on an assumed distribution of arsenic levels in un-impacted properties. This distribution was based on available data on arsenic levels in residential surface soil samples collected in the vicinity of the Globe plant (see Figure 2-4). Each data point represents the measured arsenic value in a four-point composite from a residential property. Values higher than 70 mg/kg were assumed to represent potentially impacted properties, and were not considered in the approximation of the background distribution. Even though these data are from outside the study area for the Phase 3 project, the distribution of values is judged to be reasonably predictive for those that are expected to occur within the study area. Based on these data, the distribution of true property means at an un-impacted property was modeled as:

$$\text{Background} = LN(21,13)$$

where:

LN(21, 13) = lognormal distribution with parameters 21 and 13
21 = mean of the (untransformed) data
13 = standard deviation of the (untransformed) data

From this distribution, a series of random "true means" were selected, each representing a randomly selected background property. The inter-grab sample variability at each property with "true mean" m was simulated based on the observed range of inter-grab-sample variability at the eight properties that had been intensively sampled. At these properties, the coefficient of variation (CV = standard deviation/mean) ranged from about 0.8 to 1.2. Because this range was based on only 8 properties, a slightly wider range of variability (CV = 0.7 to 1.3) was assumed.

Based on this, the standard deviation at a simulated property was simulated as:

$$s = m*CV$$
$$CV = TRI(0.7,1.0,1.3)$$

where:

TRI(0.7,1.0,1.3) = triangular distribution with parameters 0.7, 1.0, 1.3
0.7 = minimum value
1.0 = mode (most likely value)
1.3 = maximum value

For each simulated "true mean" and "true standard deviation", a series of grab samples were selected at random, and combined into n composites of j grab samples per composite. From these, the inter-composite means and standard deviation were calculated and used to calculate the 95% UCL using equation 1 (above). The Type I error rate was assessed by counting the number of properties where the "true mean" was less than the RBC but the 95% UCL was above the RBC.

Because a site-specific RBC has not been derived, it was necessary to assume a value for the purposes of planning the design of Phase III. For arsenic, a value of 70 mg/kg was adopted.

Note that the use of this value for planning Phase III is not equivalent to a decision that this value is actually appropriate. The actual level of human health risk at 70 mg/kg has not been determined, and the final RBC for soil will be developed only after performance of the site-specific risk assessment, using all available site-specific data, and the final value may be higher or lower than 70 mg/kg.

Employing an assumed RBC of 70 mg/kg and the estimated background distribution described above, and employing a grab sample size of 10, the simulated Type I error rates are as shown below:

Number of Composites	Estimated Type I Error rate
2	15%
3	4.1%
4	2.6%
6	1.5%

As seen, if only 2 composites were used, there would be a relatively high probability (about 15%) of declaring a property to be potentially unacceptable when it was actually acceptable. Use of three composites reduces the rate to about 4%, and this error rate can be reduced further by going to 4 or 6 composites. Although a Type I error rate of 4% is very good by most standards, because of the large number of properties which must be evaluated at this site, even a rate this low results in a large number of errors (up to 120 residences).

Based on these findings, a phased approach to sampling and reducing Type I errors was developed. That is, samples collected at each property tested in Phase III will include three composites of 10 grab samples each. All properties whose 95% UCL exceeds the RBC will be considered potentially unacceptable. However, because of the possibility of a Type I error, EPA may consider performing further sampling activities at such locations (especially those where the sample mean is close to or below the RBC) in order to determine whether the property actually does exceed an acceptable level.

Sampling Location

The 30 sub-sampling locations within a yard will be selected in a semi-systematic fashion, as detailed in the Field Sampling Plan (FSP) (Section 3.0).

Sample Preparation

Sub-samples collected at a property will be combined into 3 composite samples in the field, using the standard operating procedures (SOP) provided in Appendix F. These composite samples will be transported to the laboratory, where each will be dried and sieved using a 2 mm screen (#10 sieve). The purpose of this sieving is to remove all large objects and debris such as twigs, clumps of grass, etc. Currently, EPA Region 8 recommends that soil samples used for human health risk assessment purposes be sieved a second time in order to isolate the very fine fraction (less than 250 μm) from the larger soil particles. This is because it is assumed that human exposure is more likely to be to the fine particles than the coarse particles. However, in this case, a previous study at the site (ISSI 1998b) has demonstrated that there is very little difference in contaminant concentration between the fine fraction (< 250 μm) and the bulk fraction (< 2 mm). Therefore, sieving to isolate the fines is not needed for all samples. However, sieving and analysis of the fine fraction will be performed on a selected subset of the soil samples in order to confirm the expectation that concentration values are not higher in fine particles than in bulk soil.

Analyte List

As noted above, data currently available establish that the chemicals of potential concern

(COPCs) at this site are arsenic and lead (ISSI 1999a; see Appendix A). Other chemicals either are not of health concern, or contribute a risk much lower than that contributed by arsenic. Thus, the analyte list for all samples collected during this project is:

Arsenic
Lead

Analytical Method and Detection Limits

Lead and arsenic will be measured in soil samples by fixed-base x-ray fluorescence (XRF). Although health-based criteria have not yet been formally established at this site for either lead or arsenic, experience at other sites has shown that arsenic must be measured with a practical quantitation limit no higher than about 30 mg/kg, and lead should be measured with a practical quanitation limit no higher than about 150 mg/kg. Based on this, acceptable method detection limits at this site will be no higher than:

Arsenic:	MDL 10 mg/kg	PQL 30
Lead:	50 mg/kg	PQL 150

Data Interpretation/Data Use

Surface soil data generated during this part of the Phase III project will form the basis for evaluating the potential human health risks at each property. This will be done following standard methods established by the USEPA for assessing health risks to residents from arsenic and lead. That is, a property will be declared acceptable if the three-step test for arsenic is declared acceptable [(1): 95% UCL is less than the RBC; (2): C_{max} is less than the MTCV for subchronic exposure; and (3): C_{max} is less than the MTCV for acute exposure] AND the arithmetic mean for lead is less than the RBC for lead. If any of the three tests for arsenic are declared potentially unacceptable or the mean concentration for lead exceeds the corresponding RBC, the property will be considered to have potentially unacceptable human health risk. If a property is identified as potentially unacceptable, USEPA may either remediate the property in its entirety, or may perform further sampling to determine with greater confidence a) whether remediation is actually needed, and if so, b) which part or parts of the yard require remediation.

2.2 Indoor Dust Sampling

2.2.1 Data Quality Objectives

State the Problem

Contaminants in outdoor soil are able to enter homes through airborne and direct transport

pathways, and can contribute to contamination of indoor dust on floors, tables, counter tops, etc. Currently, USEPA assumes that about 55% of the total exposure to contaminants in soil occurs indirectly via ingestion of indoor dust (USEPA 1994b). Thus, reliable estimates of the indoor dust concentration are an important part of the risk assessment process.

Collection of indoor dust samples, however, is difficult and costly. Therefore, the problem is to establish a scientifically sound approach for estimating the expected indoor dust concentrations at a residence based on measurements of contaminant levels in yard soil for that residence.

Decisions to Be Made

The decision to be made is the value to be assumed for the concentration of each chemical of potential concern in indoor dust, given only the concentration of that chemical in yard soil.

Types of Input Needed

The basic approach for estimating dust concentrations at locations where they have not been measured is to obtain a robust set of "paired" data on contaminant levels in yard soil and indoor dust (i.e., both measurements are from the same property). These data are fit to an appropriate equation using computer-based regression techniques, and the resultant equation is used to impute dust concentrations from measured soil concentrations. At other sites, a simple linear model has generally proved to be adequate:

$$C_{dust} = D_0 + k * C_{soil}$$

Thus, the inputs needed to establish the parameters of this relationship are an adequate set of paired measurements of COPC levels in indoor dust and outdoor yard soil at multiple residences within the site boundaries.

Bounds of the Study

Any residence for which a reliable soil sample is available is a candidate for collection of a paired indoor dust sample. As discussed below, locations for collection of indoor dust will be stratified to achieve spatial representativeness (across neighborhoods), and will also be stratified to ensure a wide range in soil sample concentrations.

Decision Rule

The concentration of a COPC in indoor dust at a residence will be estimated from the measured value in soil using the best fit equation through the paired soil-dust data.

Acceptable Limits on Decision Errors

If the value of the concentration of a COPC is not known with certainty in either the soil sample or the dust sample, linear regression analysis of the paired samples will tend to underestimate the true slope of the correlation. Thus, the goal is to ensure that the measured values of the concentration in soil and the concentration in dust are sufficiently accurate that the slope of the regression line is within 30% of the true slope.

2.2.2 Study Design

Based on the data quality objectives outlined above, the key design elements of the indoor dust sampling component of the Phase III project are as summarized below.

Sample Number

Data obtained from previous sampling programs at VBI70 were used to estimate the total number of samples required for the study. Based on a soil sample that is a composite of 10 sub-samples, Monte Carlo simulation indicated that reliable results could be obtained if the number of paired soil-dust samples is approximately 50-100. Thus, this part of the Phase III project will collect an indoor dust sample from no fewer than 60 and no more than 90 residences where composite soil samples have been collected.

Sample Locations

Indoor dust sampling locations will be selected to ensure a representative spatial coverage of the site, as well as a suitable range of lead and arsenic concentrations in soil. That is, approximately 10-15 sampling locations will be selected from each of the six neighborhoods which comprise the study area, and locations will be selected to include approximately equal numbers of samples from properties with soil arsenic concentrations in each of the following ranges: low (less than 100 mg/kg), medium (100-300 mg/kg), and high (greater than 300 mg/kg). Special effort will be made to include properties with the highest contamination levels (e.g., greater than 500 mg/kg), since these locations are especially helpful in defining the relationship between soil and dust.

Sample Collection

One composite dust sample consisting of 8-14 sub-samples will be collected at each residence selected for sampling. This composite will be collected using a high-volume vacuum collection device. The sub-samples will be collected in rooms or other living areas ("living spaces") where the residents are most likely exposed including: bedrooms, family and/or television rooms, kitchens, hallways and entryways. In order to standardize the collection process, dust samples will be collected using a template to define the area to be vacuumed. In most cases, 2 templates

will be collected per living space. Thus, the total number of templates collected within a residence will be dependent upon the number of living spaces available. For example, if there are 2 bedrooms, a family room, a kitchen and a hallway, and if two sub-samples are collected in each living space, there would be a total of 10 sub-samples in the composite for that residence. In the case where a residence has more than 10 living spaces, only 1 template per living space will be collected. This approach is recommended so that 20-30 sub-samples are not collected for a large residence. Details on the locations within each living space where dust will be collected are provided in the FSP (Section 3.0).

The total mass of dust collected in the composite sample must be at least one gram. If a 1-gram sample is not collected using the protocol above, additional templates should be collected from appropriate living areas until sufficient mass is collected.

Sample Preparation

Each dust sample will be sieved as detailed in SOP ISSI-VBI70-04 in order to remove non-dust components.

Sample Analysis

The analyte list for indoor dust is the same as selected for soil (arsenic, lead).

Because the mass of dust collected from a residence is often too low to support reliable quantification by XRF techniques, samples will be sieved to removed lint and/or hair, prepared using a nitric acid digestion, and analyzed using standard USEPA protocols via either graphite furnace atomic absorption (GFAA) or Inductively Coupled Plasma/Mass Spectrometry (ICP/MS). Practical quantitation limits for this method are approximately:

As = 5.0 mg/kg
Pb = 1.0 mg/kg

Data Interpretation/Data Use

Data collected from this study will be used to quantify the average (site-wide) relationship between outdoor yard soil contamination and indoor dust contamination. This will be done by preparing a graph of the paired soil-dust concentrations for each analyte, and finding the best-fit regression equation through the data. At other sites, a simple linear model has proved to be

appropriate:

$$C_{dust} = D_0 + k*C_{soil}$$

The value of D_0 indicates the average "background" level of analyte expected in indoor dust, and k is the average increment in indoor dust concentration per unit concentration in outdoor soil. This equation can be used to help increase the accuracy of the human health risk assessment at the site, as well as increase the accuracy of the site-specific RBC for soil.

In the event that one or more dust samples are determined to have interior contaminant levels which are substantially higher (more than 5-fold) that the mean concentration in outdoor yard soil, and are in a range of potential health concern, USEPA may re-visit that property and collect additional samples in order to a) confirm that the original data are accurate, and if so, b) identify likely non-yard sources of dust contamination. If non-yard sources of interior dust contamination are identified at one or more residences, and if the levels are in a range of potential health concern, these locations will be referred to appropriate agencies for investigation and follow-up.

2.3 Alley Soil Pilot Study

2.3.1 Data Quality Objectives

State the Problem

Unpaved alleyways (e.g., dirt or gravel roads) exist at a number of locations in the study area, and vehicular traffic on the alleyways often raises substantial amounts of dust. If these alleyways are contaminated with arsenic and/or lead, this airborne transport of dust could be a source of concern for nearby residents, for several reasons:

1) Direct inhalation of the dust
2) Contamination of otherwise uncontaminated yard soils
3) Contamination of indoor dust

Of these three pathways, contamination of indoor dust is likely to be the greatest reason for concern.

Decisions to Be Made

The decision to be made with the data collected during this pilot study is:

Is there evidence that alleyways contain levels of contaminants that are of potential human health concern?

If so, further studies will be planned to define the nature and extent of alleyway contamination. If not, exposure from alleyways will not be addressed further.

Types of Input Needed

The input needed to make this decision is data on the concentrations of chemicals of concern in alleyway soils at multiple locations within the site.

Bounds of the Study

Any unpaved alley within the boundary of the site is a candidate location for collecting alley soil samples during the pilot project.

Decision Rule

There is no standard risk-based decision rule established by USEPA for evaluation of contamination levels in alleyways, since the magnitude of human exposure from soil in such locations is not known. Based on the assumption that exposure in an alleyway is likely to be substantially less than at a person's house, any alley where the 95% UCL for arsenic and the mean concentration for lead are less than or equal to the corresponding RBCs for a residential yard will be considered to be clearly acceptable.

If any alleyway is located where the 95% UCL for arsenic or the mean for lead exceeds the RBC for residential yards, USEPA will perform a more detailed study to characterize the nature and extent of the contamination, and to estimate the risk to area residents.

Acceptable Limits on Decision Errors

Because the ally sampling plan is a pilot study and is not intended to make final risk-based decisions, no formal quantitative limits on decision errors are required. However, because the screening-level assessment will be based on a comparison of the 95% UCL to the residential soil RBC, it is important that the 95% UCL not be unnecessarily elevated, since this could lead to a high frequency of declaring an alleyway to be potentially unsafe when it really is safe. Therefore, the goal of this phase of the study is that the 95% UCL be within 40% of the sample mean.

2.3.2 Study Design

Based on the data quality objectives outlined above, the key design elements of the alley soil pilot study component of the Phase III project are as summarized below.

Sample Number

Calculation of the number of samples needed to ensure that the 95% UCL is within 40% of the sample mean requires knowledge of the expected variability between samples from alleyways. Since no such samples exist at present, the value of n cannot be calculated with confidence. However, based on experience at other sites, it is expected that a data set of 20-30 samples from an alley will be sufficient to achieve this goal.

Sample Locations

Alleys to be sampled will be selected based on the results of the residential soil sampling project. Preference will be given to alleys that are adjoined by multiple properties that have been sampled, and where at least one of the properties is clearly impacted by arsenic (e.g., mean value is greater than 200 mg/kg). A total of 4-6 such alleys will be sought, each consisting of one city block.

The location of samples within each alley will be defined by a systematic grid laid out over the surface of the alley, as detailed in the FSP (Section 3.0).

Sample Collection

Soil samples from each sampling location will be collected using a procedure similar to that for yard soil, except that compositing of samples will not be performed. This is so that if there are isolated areas of contamination in the alley, the presence of these locations can be observed.

Sample Preparation

Soil samples from alleyways will be dried and sieved through a 2 mm screen (#10 sieve).

Sample Analysis

All alley soil samples will be analyzed using the same method as used for yard soil samples.

Data Interpretation/Data Use

The data from this pilot study will be used to judge if there is a basis to be concerned over chemical contamination of soils in alleyways. This will be done by comparing the 95% UCL of the mean for arsenic and the mean for lead to RBCs based on residential exposures. If the values are below the RBCs, it will be concluded that alley soils are not of concern. If one or both chemicals exceeds its RBC, further studies will be performed to characterize the nature and extent of alleyway contamination and the magnitude of the human health risk, as needed.

2.4 Characterization of Schools and Parks

2.4.1 Data Quality Objectives

State the Problem

Area residents (especially children) may be exposed to contaminants not only at their residence, but also at neighborhood schools and parks. Available data collected to date suggest that neither schools nor parks are a source of concern (UOS 1998a, 1998b), but some locations have not yet been sampled.

Decisions to Be Made

Each school yard and park within the study area will be evaluated to determine whether the concentrations of contaminants are either a) acceptable, or b) potentially unacceptable. These risk-based decisions will, in turn, form an important input to risk management decision-making at the site.

Types of Input Needed

Data required to evaluate each school yard and park are reliable and accurate measurements of the concentration of each chemical of potential concern in representative surface soil samples from each location.

Bounds of the Study

Table 2-1 lists all schools and parks within the study area. Those that have been studied previously will not be re-investigated during Phase III. Locations that have not been studied to date and which will be sampled during Phase III are indicated in the Table.

Decision Rule

Each schoolyard and park will be evaluated using a decision rule analogous to that for residential properties:

Chemical	Test Result	Decision
Arsenic	Three-Step Test	
Test I (chronic)	95% UCL ≤ RBC_c 95% UCL > RBC_c	Acceptable Potentially unacceptable
Test II (subchronic)	$C_{max} \leq MTCV_{sc}$ $C_{max} > MTCV_{sc}$	Acceptable Potentially unacceptable
Test III (acute)	$C_{max} \leq MTCV_a$ $C_{max} > MTCV_a$	Acceptable Potentially unacceptable
Lead	Mean ≤ RBC_{Pb} Mean > RBC_{Pb}	Acceptable Potentially unacceptable

RBC_c - RBC for chronic exposure
C_{max} - Maximum concentration at a single property in a composite of size 10
$MTCV_{sc}$ - Minimum Theoretical Composite Value for subchronic exposure
$MTCV_a$ - Minimum Theoretical Composite Value for acute exposure
RBC_{Pb} - site-specific RBC for lead

Note that, because of differences in duration and frequency of exposure, the RBC for arsenic and/or lead may not be identical at schools, parks and residences. Each type of RBC will be developed during the feasibility study for the site, after finalization of the human health risk assessment. The final RBCs will be calculated using all of the same exposure and toxicity values developed for use in the risk assessment. This will include use of all reliable site-specific data available, and may include both deterministic risk assessment approaches and/or probabilistic approaches, as needed to adequately characterize the variability and uncertainty in risk to humans at the site. That is, a range of potential RBCs may be developed, allowing for risk management judgement in selection of an appropriate decision criterion.

Acceptable Limits on Decision Errors

The maximum acceptable probability that a school yard or park will be declared acceptable when it really is not acceptable is 5%. As above, the probability of declaring the property potentially unacceptable when it really is acceptable will be reduced to the lowest level possible with the available sampling and analysis budget.

2.4.2 Study Design

Based on the data quality objectives outlined above, the key design elements of the school/park sampling component of the Phase III project are as summarized below.

Sampling Depth

All samples will be collected from the 0-2 inch depth interval.

Number and Location of sample Collection

The number and location of sample collection at each school and park included in Phase III will be detailed in an addendum to the FSP (Section 3.0), after survey of each target property.

Sample Preparation and Analysis

All samples will be prepared and analyzed in the same way employed for residential soil samples.

Data Interpretation/Data Use

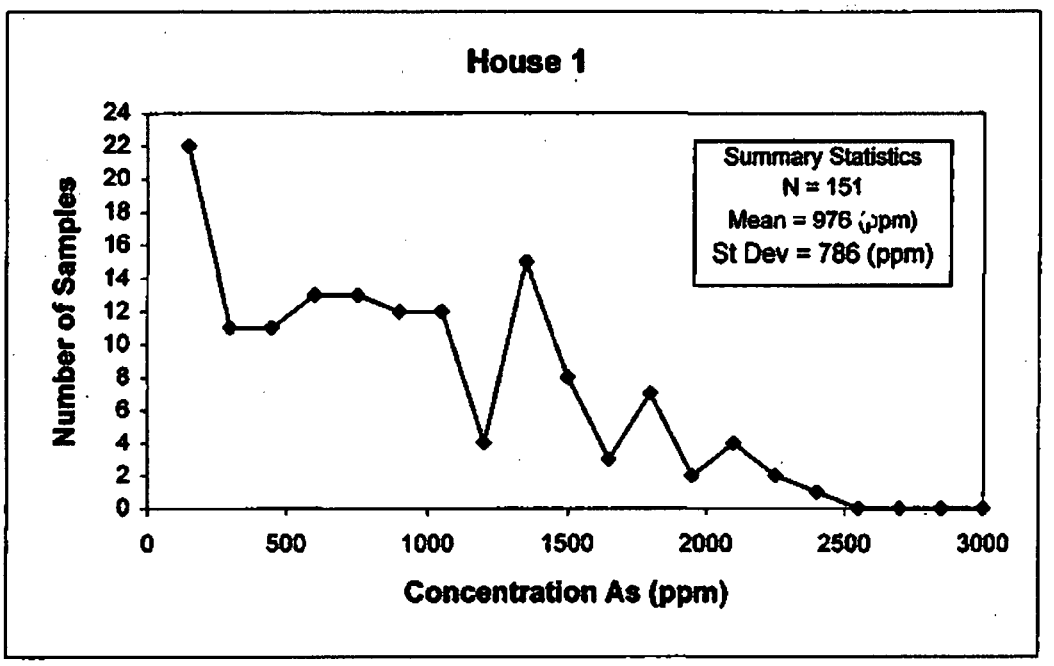
A schoolyard or park will be declared acceptable if the three-step test for arsenic is declared acceptable [(1): 95% UCL is less than the RBC; (2): C_{max} is less than the MTCV for subchronic exposure; and (3): C_{max} is less than the MTCV for acute exposure] AND the arithmetic mean for lead is less than the RBC for lead. If any of the three tests for arsenic are declared potentially unacceptable or the mean concentration for lead exceeds the corresponding RBC, the property will be considered to have potentially unacceptable human health risk. If a property is identified as potentially unacceptable, USEPA may either remediate the property in its entirety, or may perform further sampling to determine with greater confidence a) whether remediation is actually needed, and if so, b) which part or parts of the yard require remediation.

Table 2-1 List of Schools and Parks

Category	Name	Sampling Status	
		Completed	Phase III
School	Garden Place[a]	X	
	Mitchell	X	
	Annunciation		X
	Harrington	X	
	Swansea	X	
	Cole Middle School	X	
	Wyatt-Edison		X
	Pioneer		X
	Northeast Montessori		X
	Family Star Montessori		X
	Johnson Headstart		X
	Montessori-Garfield Headstart		X
	Potential new school (44th & Steel)		X
	Clayton Foundation		X
Park	Swansea	X	
	Elyria	X	
	Schafer	X	
	Russel Square	X	
	Nairobi	X	
	Saint Charles Place	X	
	Durham	X	

a - Soils at Garden Place School were sampled and replaced by Denver Public Schools in 1989. This property was re-sampled by Asarco under the Globe Plan Consent Decree Program.

Figure 2-1: Distribution of Arsenic Values at Impacted Properties



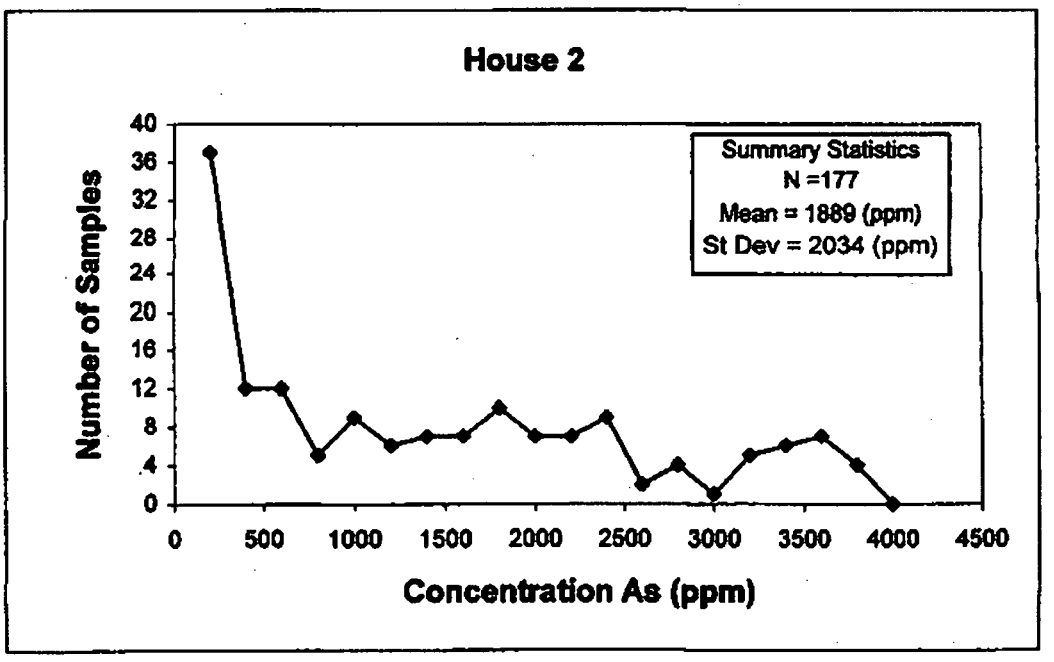
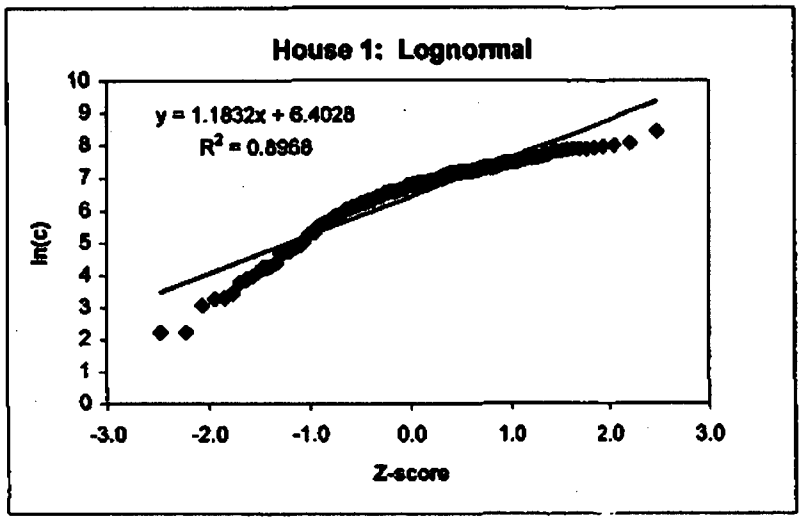
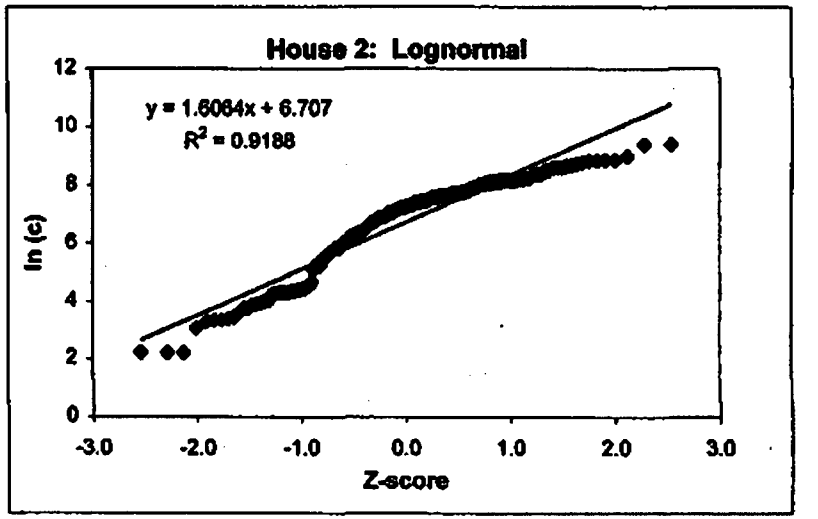
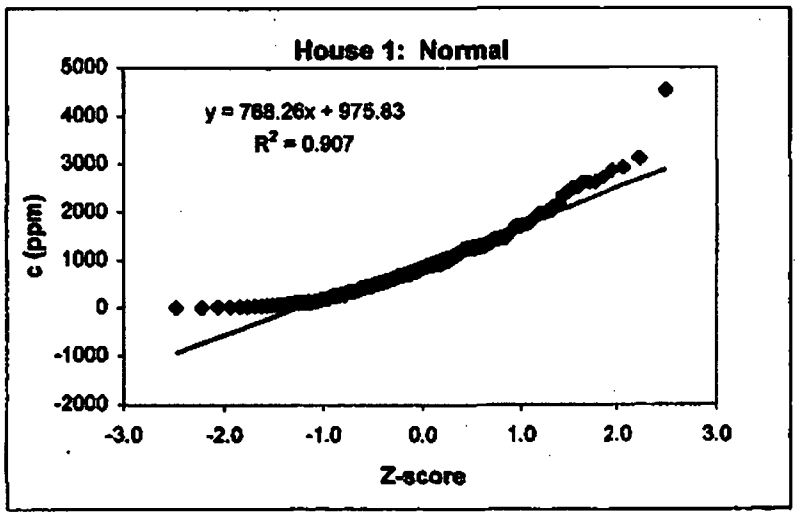


Figure 2-2: Probability Plots of Arsenic Distribution at Impacted Properties







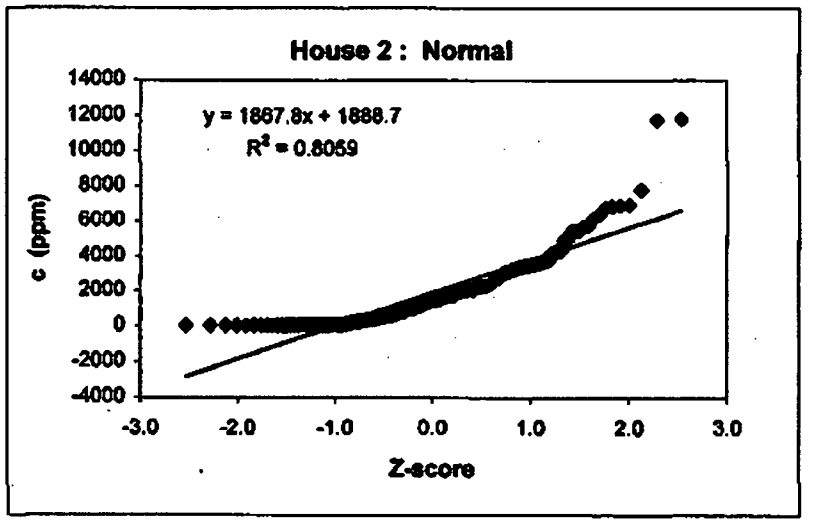
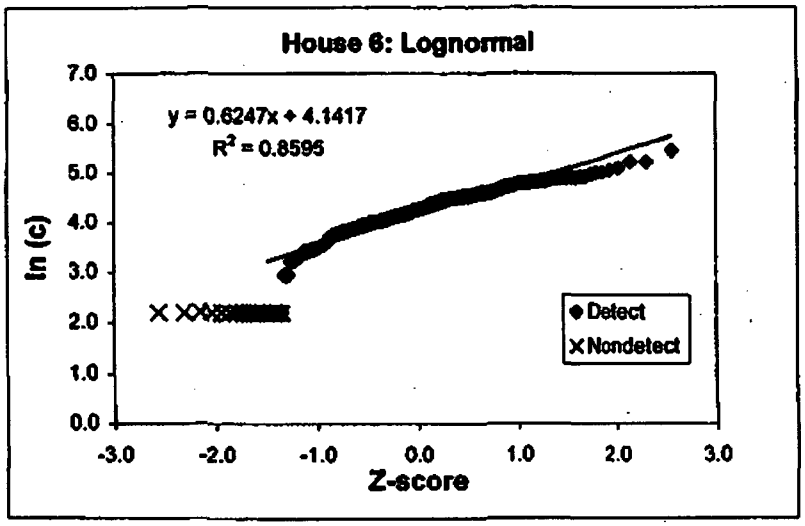
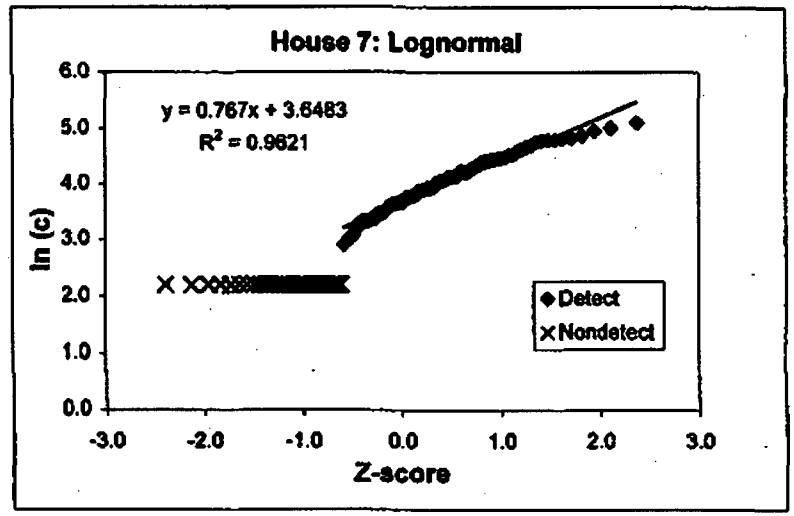
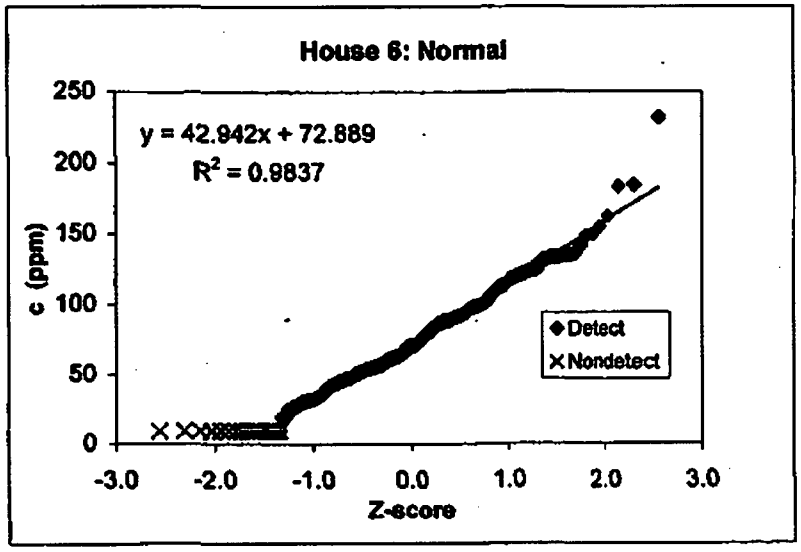


Figure 2-3: Probability Plots of Arsenic Distribution for Minimally Impacted Properties







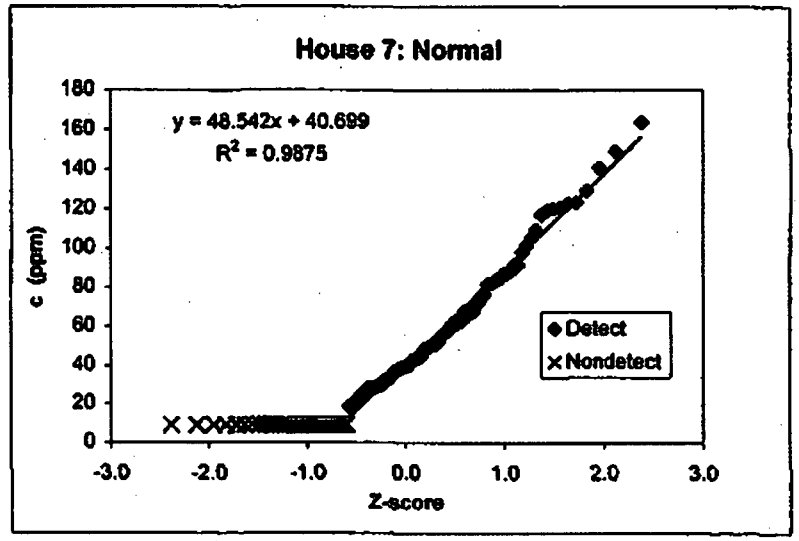
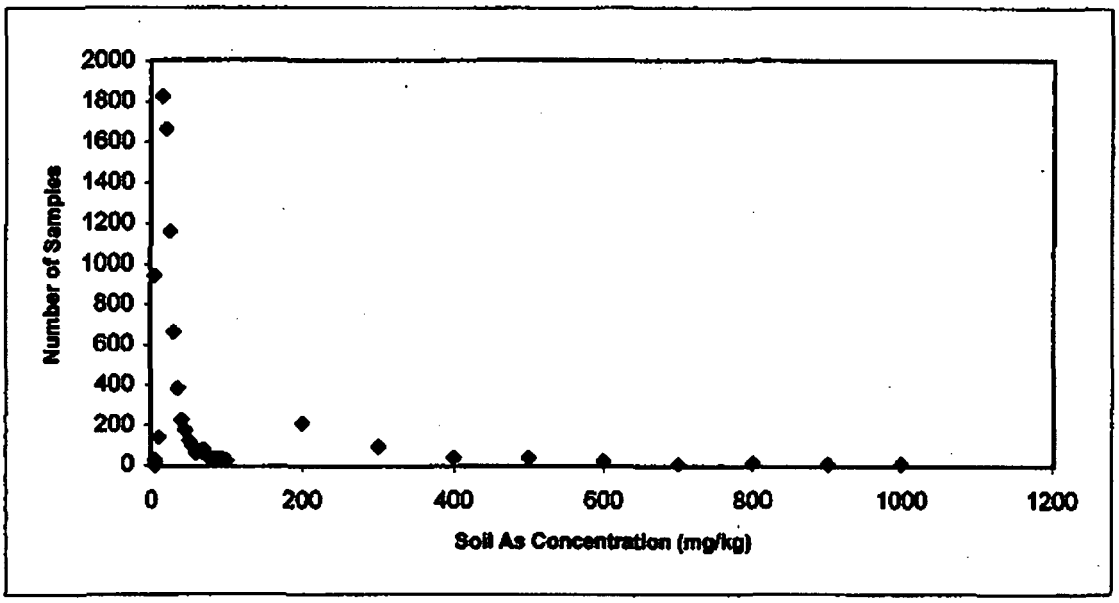
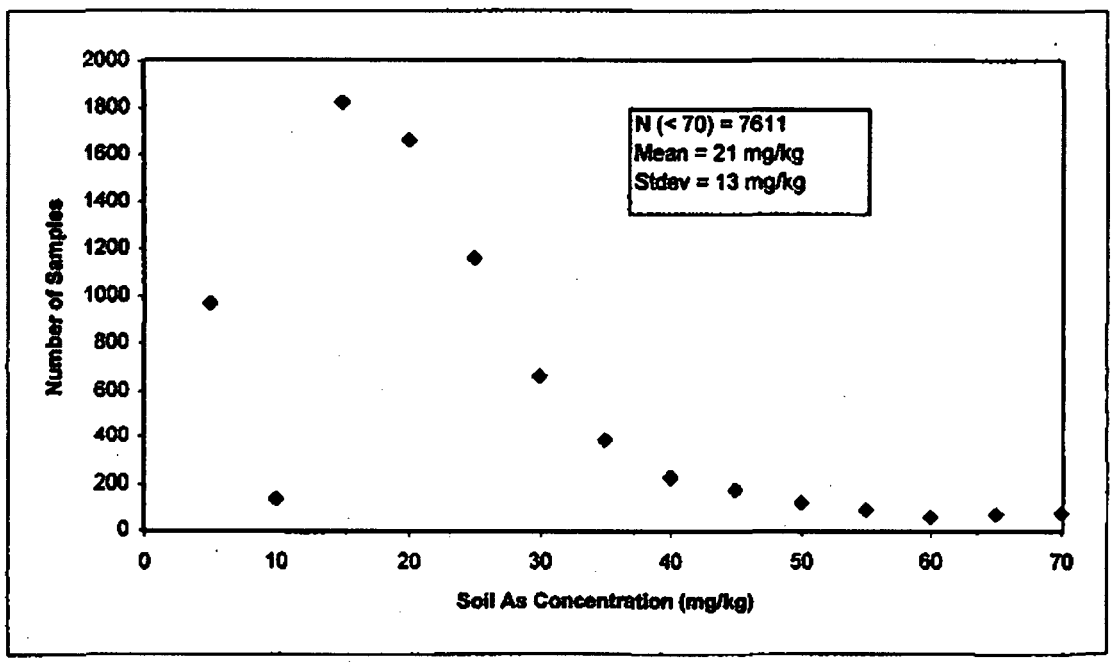


Figure 2-4. Arsenic Levels in Surface Soil at Unimpacted Residences in the Globeville Area





Note: All samples below the detection limit (10 ppm) were assigned a value of 5 mg/kg

Data Source: ASARCO (1999)

Fig. 2-4:Figure 2-4

3.0 FIELD SAMPLING PLAN

This Field Sampling Plan describes the methods and procedures required for implementation of field sampling activities planned as part of the VBI70 Phase III Field Investigation including: descriptions of the sampling locations; number of samples planned for collection; sample matrices; and methods for sample collection, handling and analysis. Additionally, procedures associated with obtaining property access, waste management and disposal and health and safety are also outlined in this section of the Project Plan.

In general, the steps required for successful implementation of this FSP include:

- Obtain a list of eligible properties for Phase III sampling
- Obtain property access authorization
- Collect samples (e.g., residential yard soil, ~~indoor dust~~).
- Submit samples under chain-of-custody for analysis
- Perform sample preparation steps
- Perform sample analysis

At each step where data are collected, data must be incorporated into the project database in an accurate and timely fashion in accord with procedures outlined in the Data Management Plan (DMP) in Section 5.0. A sample flow diagram outlining the overall steps for field data collection activities is presented in Figure 3-1.

3.1 Staff Identification

All USEPA personnel and contractors participating in the field sampling or oversight efforts must wear identification at all times. This important to show residents or observers that field personnel are a part of the Phase III field investigation and belong onsite. Identification (ID) badges should have the name and recent photograph of the person. ID badges must be worn on site and clearly visible at all times.

3.2 Property Access Agreements

As noted previously, approximately 3000 residences are eligible for yard sampling and analysis as part of Phase III. An eligible residential property is any property located within the study boundaries (See Figure 1-2) that has not already had yard soils measured for arsenic and lead as part of Phases I and II (UOS 1998a, 1998b). Written authorization to sample the yard soil must be granted by the property owner prior to sampling. The general process for obtaining and maintaining documentation on property access authorization is summarized in the following subsections. Specific details for obtaining access agreements are provided in the standard operating procedures (SOPs) (Appendix F).

In the event that a residence is selected for supplemental sampling, separate access agreements will be obtained prior to collection of any additional samples. If access inside the residence is necessary (e.g., for collection of indoor dust samples) and the property owner is not the resident, written authorization from the renter/leaser allowing access inside the home must also be obtained and recorded.

3.2.1 Obtaining Access Agreements

Two methods, implemented in a staged fashion, will be employed in an effort to obtain access authorization from as many eligible residential properties as possible. These methods are: a) site-wide mailing; and b) door-to-door interviews.

3.2.1.1 Site-Wide Mailing

List of Addresses

An attempt will be made to contact all property owners and/or residents within the study by U.S. mail to inform each of the plans for the VBI70 Phase III sampling. A current (1998) database containing all tax assessor data for the study area will be purchased. This information will be used to obtain the most current property owner and address data available. After receipt of the database, a copy of the raw database will be stored with data management personnel. The raw database will then be refined as follows:

- Remove any properties that are outside of the study boundaries
- Remove all addresses within the study boundaries for which adequate sampling data are currently available

The revised database (termed the Access Agreement Database) will be forwarded to MK to begin compiling a list of residences to include on the mailing list. After the mailing list is compiled, USEPA will prepare the components of each letter. Because there is a large population of Spanish-speaking residents within the VBI70 site, all documentation prepared for distribution to the public must be available in both Spanish and English versions.

Information to be Distributed

The following information will be distributed to each resident/property owner:

- Cover letter
- Phase III Sampling Fact Sheet
- Access agreement form
- Self-addressed stamped envelope

Examples of the cover letter, the fact sheet, and the access agreement are provided in the SOP (Appendix F). In addition, a letter from community representatives will also be included in the materials distributed to area residents.

Updates/Corrections to Access Agreement Database

In some cases, the database obtained from 1998 tax assessor data may not reflect recent changes in property ownership, and maybe inaccurate or incomplete regarding the type of building (residential, commercial) at specified addresses. Therefore, as field work is undertaken and more accurate information is obtained, updates to the Access Agreement Database will be incorporated.

3.2.1.2 Door-to-Door Recruitment

In cases where no response is received following the site-wide mailing (see above), a team of two people will visit each residence in order to attempt to obtain authorization for soil sampling access. Due to the large number of Spanish-speaking citizens residing in the study area, bilingual personnel will participate in interviews as needed. Each team will have available and will provide to each resident contacted the same set of information and authorization forms that were distributed by mail. The team will describe the goal of the project and clearly state the need for property access. Additionally, the team will explain that authorization onto the property must be given by the property owner. If access is granted, the agreement form will be signed and given to the interviewing team. Authorized members of MK's data entry team will update the Access Agreement Database to indicate whether access was approved or denied as responses are received by the interviewing teams.

3.2.1.3 Follow-up Mailings and Recruitment Activities

Follow-up mailing or door-to-door visits may be implemented at either the soil or indoor dust sampling activities. The RPM will decide whether additional recruitment activities are necessary after receiving the results of the participation rates for each recruitment stage.

3.2.2 Documentation

Recruitment

A cumulative list of all residences that have received mailings and that have been visited will be maintained. This list will document the date when a letter was sent, and the date(s) and time(s) when house visits were performed, along with a record of the outcome (no response, authorization, refusal).

Access Agreements

All signed access agreements will be maintained in a bound logbooks (e.g., three-ring binders). The original signed forms must be placed in a binder and paginated (sequentially numbered) as each new agreement form is received. Data fields that track when access agreement letters are distributed and when access agreement forms are received will be included and updated in the Access Agreement Database in accord with procedures outlined in the DMP (Section 5.0).

3.3 Phase III Field Sampling

After authorization for property access is granted by a sufficient number of property owners to make field implementation effective, the field crew will be assembled. The field crew will be comprised of a Field Project Leader (FPL) who will supervise all field activities, a Field Quality Assurance Coordinator (FQAC) who will ensure that field activities are implemented in accord with project requirements and field samplers (approximately 8 teams of two) who are trained in the sampling methods stipulated for this project. Field sampling activities contained within this project plan for the Phase III investigation have been divided into three major components: residential surface soil, indoor dust sampling and alley sampling. Each of these components are described in the following subsections. Each subsection contains the following information (as applicable). References in parentheses refer to components required by the USEPA guidelines for development of a Quality Assurance Project Plan (QAPP) (USEPA 1998).

- Identification of Sample Locations (B1)
- Measurement of Field Parameters (B1)
- Sampling Method Requirements (B2)
- Sampling Protocols (B2)
- Field Documentation (B3)
- Analytical Method Requirements (B4)
- Sample Preparation (B4)
- Analytical Methods (B4)
- Detection Limit Requirements (B4)

Other key information pertaining to quality assurance/quality control procedures necessary for successful implementation of the investigations are outlined in the QAPP (Section 4.0).

3.4 Residential Yard Soils

Residential yard soils will be collected at each residential property for which access has been granted by the property owner. Because residential yard samples will be collected outside of the home, generally no appointments to schedule sampling events are required. In the event that appointments are necessary, the following general procedure will be implemented.

In general, all scheduled appointments will be tracked using either a bound scheduling logbook or appropriate schedule tracking software.

Missed Appointments

Once an appointment for soil sampling is made, the field team will visit the residence at the appointed time to collect the samples. In the event that no one answers the door, the field team will call the resident using a mobile phone. The team will remain at the residence for at least 15 minutes in case the resident is running late. After 15 minutes has passed without response from the resident, the field team will leave a note on the door reminding about the missed appointment and a phone number to call to reschedule the appointment. Residents will be rescheduled only once. If the resident misses 2 scheduled appointments, this will be interpreted as participant withdrawal.

3.4.1 Residence Identification

The field team will be provided with the street address for each residence to be sampled. The field team will carefully confirm that they have located the specified residence by confirming that the street number and name match. Whenever possible, verbal confirmation of the address will be obtained by speaking to the resident.

3.4.2 Identification and Collection of Yard Soil Samples

All yard soil samples will be collected in accord with the Residential Soil Sampling for Yards and School or Park Soils SOP #ISSI-VBI70-02 (Appendix F). In brief, surface soils (0-2 inches) will be collected at each of 30 sub-locations at each residence, and these 30 sub-samples (grab samples) will be combined in the field into three composite samples. The details for identification and placement of the grab sample locations at each residence is provided in the SOP (Appendix F) and are summarized below. All sampling personnel will be trained in this procedure in order to ensure replicable sample location assignment. There are six major steps in grab sample location identification. They are:

- Measure the property dimensions and draw a field diagram of the property
- Pace off each building or major obstructions and include on the field diagram
- Identify major samplable areas
- Determine the number of sample points in each sub-area
- Record the sample locations
- Mark the sample locations with flags

Measure each yard

The field team leader (TL) will visit a residence at the time of sampling to assign the sampling scheme. The TL will measure the property dimensions with a measuring tape or measuring wheel (± 0.5 feet). A sketch of the property and property dimensions, north orientation, and adjacent streets and alleyways will be prepared on the site diagram.

Pace off each building or obstruction

The TL will then pace off the major permanent structures of the residence (e.g., dimensions of the property boundary, house, garage, driveway, etc.) and prepare a site diagram to approximate scale (± 3 feet on each measurement). The goal is not have a drawing to scale, but instead to have an estimate of the total samplable area in the residential yard. The total samplable area is defined as any area on the property that is free of permanent obstructions. Temporary obstructions such as automobiles or trailers parked on unpaved property locations, picnic tables, plastic or other materials covering the property are not permanent structures and will be considered "samplable". Therefore, areas that could be used in the future if the temporary obstructions were removed, should be identified on the field diagram and must be considered in sample location identification. Figures 3-2 and 3-3 provide examples of a typical residence at the VBI70 site that has been drawn on a grid.

Identify major samplable areas

For each residence, the samplable area will be divided into rectangular subareas, using natural boundaries such as the house, garage, sidewalk or gardens as division markers (See Figure 3-3). A minimum of three and a maximum of eight subareas will be identified to the nearest pace (± 3 ft) Draw the sample areas on the site diagram sheet. The number of squares in each subarea is counted and recorded onto the field data sheet.

Determine the number of sample points in each subarea

Next, the total number of squares contained in all of the subareas will be summed and this number is recorded in the appropriate space on the surface soil data sheet. This number is divided by 30 to determine the relative distance between each sample point and is recorded in the appropriate space on the data sheet (Figure 3-4). To determine the number of sample points in each subarea, the number of squares in each subarea is divided by the relative distance between sample points. Using standard analytical rounding procedures, each number is rounded to the nearest whole number to determine the number of sample points in each subarea. (See Figure 3-3 and 3-4 for example).

Record sample locations

Three composite samples will be collected per residence, each consisting of 10 sub-samples that are identified by marker flags of the same color or number. Although numbers may be used for identification of sample locations, for the purposes of this project plan, all procedural descriptions will be illustrated using colored marker flags (e.g., 10 red, 10 blue, and 10 yellow). Before placing flags into the yard, their planned location will be marked on the site diagram. Marking flag locations on the site diagram before actually placing them will give the TL an opportunity to verify that sample locations are evenly distributed within each subarea, and that 30 sub-sample locations are documented and recorded. In addition, if an error has occurred in the calculation of sub-sample locations, it will be discovered before any flags have been staked. If either permanent or temporary obstructions are present at the intended sampling locations (e.g., sidewalk, shed, garden, etc.), the sample point should be offset so that a surficial yard soil may be collected, then the actual sample location must be correctly documented on the field diagram. If the TL identifies an error in the sample location identification procedures that compromises the readability of the document, a new, revised diagram should be prepared. After recording all of the sample points, the TL should check the site diagram to make sure that sub-sample locations are not clustered in any area (unless clustering is a result of offsetting sample locations due to obstructions), and that they are approximately equidistant throughout the property.

Mark sample locations

Starting at one corner of the property, the field team will stake sub-sample locations using a repeated sequence of three distinct flag types (i.e., Yellow, Blue, Red, Yellow, Blue, Red, etc.) in alternating sequence across subareas. The same flag types must not be placed next to each other, so that an even distribution of flags in each subarea is obtained. As seen in Figure 3-3 the location of each marker flag should be approximately equidistant from the other flags within each subsection. Additionally, each color flag should be alternately placed so that the same color marker flags are not clustered. A sample location or flag color may be reassigned, if clustering is observed.

Surface Soil Collection

The first 10-point composite will be collected by combining the samples at flags of similar color (e.g., red). Grab samples will be collected from the 0-2 inch soil horizon adjacent to each marker flag. Each sample will be collected using a clean coring tool (2-inch diameter). Each grab sample marked by a red flag will be placed into a single zip-lock bag and labeled in accord with the most recent version of the Sample Identification and Tracking SOP (# ISSI-VBI70-01). Because property sizes and obstacles present at each residence may vary significantly, actual sample locations will be identified using a diagram that will be drawn for each individual property sampled. If obstructions are present at the intended sampling locations (e.g., sidewalk,

shed, garden, etc.), the sample point should be offset so that a surficial yard soil may be collected, then the actual sample location must be correctly documented on the field diagram. The second and third 10-point composite samples will be collected in identical fashion but by sampling next to the blue and yellow flags, respectively.

Because of the relatively large number of samples that will be collected at each residential property (thirty 2-inch diameter samples per property), the resulting sample holes or depressions will be backfilled with an USEPA-approved topsoil mixture. Any sod removed temporarily to obtain the soil below will be replaced after backfilling the hole or depression.

If disposable sampling equipment is not used during the sampling event, decontamination procedures must be performed before that equipment may be reused. Decontamination must be performed between collection of composite samples in accord with procedures outlined in the Decontamination SOP #MK-VBI70-07 (Appendix F).

Each field team will carry a three-ring binder that holds the VBI70 Soil Sample Data Sheets (Figure 3-4). These binders will only contain the paperwork necessary to complete a single day of sampling. One data sheet will be completed for each residence, since the data recorded at each property are applicable to each of the three composites collected at that property. Any deviations from standard protocols or notable events (e.g., rainy weather, etc.) should be entered in the section for "Notes". The field team leader will sign the form when sampling is complete and all data are entered onto the form. The field team will not proceed to the next residence until samples are stored in a cooler and paperwork is complete.

At the end of each day of sampling the field teams will return to the Site Office to check-in samples, paperwork and unused sample labels. Samples will be locked and stored under chain-of-custody until they are forwarded for sample preparation and analysis.

3.4.3 Field Documentation

Each sampling team will maintain two forms of field documentation. As discussed above, each team will have a binder containing all field data sheets. Additionally, each team will carry a bound field logbook (not a three-ring binder). Information contained in this log includes the following:

- Sample date
- Sample team ID
- Names of sample team members in attendance
- Weather conditions
- Time sampling begun each day
- Time sampling concluded each day

- Any information that is not limited to a single residence (e.g., deviations to sampling protocols)
- Signature of data logger.

This logbook will be maintained daily during sampling activities. Refer to the Field Documentation SOP # MK-VBI70-05 (Appendix F) for more details.

3.4.4 Sample Preparation

After composite soil samples have been collected, they will be submitted under chain-of-custody for sample preparation. Sample preparation will be performed in accord with the Sample Preparation SOP #MK-VBI70-05 (Appendix F). In brief, the samples will be well-mixed and then oven-dried. Following the drying step, samples will then be sieved and homogenized again. Figure 3-5 provides a flow diagram that summarizes the steps in sample preparation.

Preparation of Bulk Samples

In brief, all composite samples from the field (referred to as "raw" field samples) will be oven-dried and sieved to remove material larger than 2 mm using a #10 stainless steel sieve. The entire mass of each entire raw sample will be sieved in this way. Any material not passing through the 2 mm sieve will be disposed of as IDW. After sieving, the sample passing the sieve (now referred to as the "bulk" sample) is placed into a new zip-lock bag that is labeled with the original sample ID number, except that the suffix is "B" (for bulk) rather than "R" (for raw). From this bag, a 10-g sample is removed, ground and placed in an XRF cup, labeled with the sample ID (suffix = B) and forwarded to the XRF analyst for testing. A record of all drying and sieving procedures must be documented in the Field Sample Preparation Logbook (Figure 3-6). Information such as the sample ID, date of sample preparation, sample mass before and after drying, the duration of drying and the sieve size used will be included in the log.

The effectiveness of mixing will be evaluated by removing ten 10-gram sample aliquots and analyzing the resulting ten samples for arsenic and lead, and evaluating the variability of the analytical results. If the results of this evaluation prove unsatisfactory mixing is occurring preparation of additional investigative samples will cease and corrective actions to improve mixing will be performed and verified prior to preparation of any other investigative samples.

Preparation of Fine Samples

Selected bulk samples will be identified for a second sieving step in order to isolate a fraction of fine particles for analysis. This step will be performed to confirm expectation that arsenic and lead levels are not significantly different in the bulk and fine fractions. This step will be performed for about 60-90 residences. These residences will be selected so that soil

concentrations span the range of reported metals concentrations.

The fine sample is prepared by removing a portion of the bulk sample (about 100 g) and sieving through a #60 stainless steel sieve. After sieving, the material that does not pass through the screen is disposed of as IDW, and the material that does pass through the screen is placed into a new zip-lock bag labeled with the original sample ID number and the suffix "F" (for fine). A 10-g portion of the fine material is removed, ground and placed in an XRF cup, labeled with the sample ID (suffix = F) and forwarded to the XRF analyst for testing.

The effectiveness of mixing will be evaluated by removing ten 10-gram sample aliquots and analyzing the resulting ten samples for arsenic and lead, and evaluating the variability of the analytical results. If the results of this evaluation prove unsatisfactory mixing is occurring preparation of additional investigative samples will cease and corrective actions to improve mixing will be performed and verified prior to preparation of any other investigative samples.

Decontamination

If disposable sieves or other equipment are not used during sample preparation, decontamination procedures must be performed before the tools or equipment may be reused. Decontamination must be performed between samples sieved in accord with procedures outlined in the Decontamination SOP #MK-VBI70-07 (Appendix F).

QA/QC Samples

At the appropriate frequency (See Section 4.0) or as directed by the FQAC, QC samples such as splits or blind standards are inserted into the sample stream. These samples will be logged into the Field QC Sample Logbook (Figures 3-7, 3-8, and 3-9) and assigned a sample ID. This document is a bound (not a three-ring binder) logbook maintained by the FQAC. The appropriate sample ID numbers and labels will be checked-out from the FPL.

Sample preparation must be performed by a technician who will not perform XRF analysis because samples submitted for XRF analysis must be blind. That is, the sample stream will include both investigative samples as well as blind QC samples. Every effort must be made to maintain sample anonymity.

3.4.5 Analytical Method Requirements

Arsenic and lead testing will be performed on all residential soil samples using XRF, providing the chosen XRF methodology can achieve the project-required detection limits (See Section 4.0). A method detection limit study for the chosen instrumentation and proficiency tests for all analysts who will work on the VBI70 Phase III project must be provided to USEPA before

analysis of any field samples may proceed (See Appendix G). XRF analysis will be performed in accordance with the XRF Instrument Operation SOP #MK-VBI70-06.

3.5 Indoor Dust Samples

As discussed in Section 2.0, indoor dust samples will be collected during the Phase III to obtain more information about the site-specific soil:dust ratio at the VBI70 site. This section outlines the details for field collection of indoor dust samples.

3.5.1 Identification of Indoor Dust Samples

A minimum of 60 and a maximum of 90 residences will be identified for indoor dust collection. Locations for collection of indoor dust will be stratified to achieve spatial representativeness and to ensure a wide dynamic range in metals concentrations in yard soil. Stratification will be assigned based on results of residential yard soil measurements and the location of each residence. About 10-15 sampling locations will be selected from each of the five neighborhoods that make up the VBI70 site. Locations will be selected to include approximately equal numbers of samples from properties with soil arsenic concentrations in each of the following ranges: low (<100 mg/kg), medium (100-300 mg/kg) and high (>300 mg/kg). Special priority will be given to properties with the highest contamination levels (e.g., >500 mg/kg), since these locations are especially helpful in defining the relationship between soil and dust.

3.5.2 Scheduling Dust Sampling

After residences are identified for indoor dust sampling based on yard soil levels and proximal location, each resident must be recruited. The owners and residents of homes targeted for indoor dust sampling will be contacted to obtain access. Owners and residents may be contacted by mail or in person to obtain written consent for access. Arrangements will be made to collect the indoor dust samples at a time when the resident will not have vacuumed for at least seven days. In general, all scheduled appointments will be tracked using either a bound scheduling logbook or appropriate schedule tracking software. An example logbook page for Indoor Dust Scheduling is provided in Figure 3-10.

Missed Appointments

Once an appointment for indoor dust sampling is made, the field team will visit the residence at the appointed time to collect the sample. In the event that no one answers the door, the field team will call the resident using a mobile phone. The team will remain at the residence for at least 15 minutes in case the resident is running late. After 15 minutes has passed without response from the resident, the field team will leave a note on the door reminding about the missed appointment and a phone number to call to reschedule the appointment. Residents will

be rescheduled only once. If the resident misses 2 scheduled appointments, this will be interpreted as participant withdrawal and another residence will be selected.

3.5.3 Collection of Indoor Dust Samples

The residences selected for dust sampling will be sampled in accord with the Sampling for Indoor Residential Dust SOP #ISSI-VBI70-04 (Appendix F). In brief, one composite dust samples will be collected at each selected residence using a high-volume vacuum collection device. The composite sample will consist of 8-14 sub-samples (each covering about 4 square feet) taken from living areas (termed living spaces) of the home where the residents are most likely exposed including: bedrooms, family and/or television rooms, kitchens, hallways and entryways. A minimum 1-g dust sample is required before sampling may be considered complete. If a 1-g sample is not collected using the protocols outlined in the SOP, additional templates should be collected from appropriate living areas until sufficient mass is collected. The composite samples will be collected into a bottles that will be covered with a cap and labeled in accord with the Sample Identification and Tracking SOP# ISSI-VBI70-01 (Appendix F).

All reusable indoor dust sampling equipment (e.g., nozzle, etc.) must be decontaminated between residences in accord with procedures outlined in the Decontamination SOP #MK-VBI70-07 (Appendix F).

Each field team will carry a three-ring binder that holds the VBI70 Indoor Dust Sample Data Sheets (Figure 3-11). These binders will only contain the paperwork necessary to complete a single day of sampling. One data sheet will be completed for each residence. Any deviations from standard protocols or notable events should be entered in the section for "Notes". The field team leader will sign the form when sampling is complete and all data are entered onto the form. The field team will not proceed to the next residence until samples are stored in a cooler and paperwork is complete.

At the end of each day of sampling the field teams will return to the Site Office to check-in samples, paperwork and unused sample labels. Samples will be locked and stored under chain-of-custody until they are forwarded to the commercial laboratory for sample preparation and analysis.

3.5.4 Field Documentation

Each sampling team will maintain two forms of field documentation. As discussed above, each team will have a binder containing all field data sheets. Additionally, each team will carry a bound field logbook (not a three-ring binder). Information contained in this log includes the following:

- Sample date
- Sample team ID
- Names of sample team members in attendance
- Time sampling begun each day
- Time sampling concluded each day
- Any information that is not limited to a single residence (e.g., deviations to sampling protocols)
- Signature of data logger

This logbook will be maintained daily during sampling activities. Refer to the Field Documentation SOP # MK-VBI70-07 (Appendix F) for more details.

3.5.5 Sample Preparation

After samples have been collected, they are submitted under chain-of-custody to a commercial laboratory sample preparation and analysis. Samples will be sieved to remove foreign objects such as lint or hair using a 150 µm screen. An acid digestion is then performed on the fines fraction of the dust sample. Sample digestions will be performed in accord with USEPA SW-846 Method 3050B or 3051.

3.5.6 Analytical Method Requirements

Arsenic and lead testing will be performed on all indoor dust samples using either ICP, ICP-MS, or GFAA, providing the chosen methodology can achieve the project-required detection limits (See Section 4.0). A method detection limit study for the chosen instrumentation and proficiency tests for all analysts who will work on the VBI70 Phase III project must be provided to USEPA before analysis of any field samples may proceed (See Section 4.0). ICP, ICP-MS or GFAA analysis will be performed in accordance with USEPA SW-846 Methods 6010B, 6020 or 7060/7421, respectively.

3.6 Alley Samples

A subset of unpaved alleyways that exist within the study area will be characterized for arsenic and lead levels in surficial soils as part of the Phase II field investigation. Details of the field activities are summarized in the sections below.

3.6.1 Identification and Collection of Alleyway Soil Samples

Because the Phase III investigation of alley soils is a pilot study, not all alleyways within the Phase III study area will be sampled. Rather, about 4-6 alleyways will be chosen for characterization. Alleys to be sampled will be selected based on results of the residential soil

sampling phase of the field investigation. Preference will be given to alleys that are adjoined by multiple properties that have been sampled, and where at least one of the properties is clearly impacted by arsenic (e.g., mean value is greater than 200 mg/kg). A total of 4-6 alleys will be identified, each consisting of one city block.

Prior to sampling the FQAC or designate will provide maps that identify the chosen alleyways and individual sample locations. The map will be generated using GIS tools and will serve to identify and document sample locations. Grab sample locations will be placed along a center transect of each residential property along the alleyway, three samples will be collected across the alley. Approximately thirty grab samples for the entire block where each transect will be located in the alley at the approximate center of each residential property (see Figure 3-12). The three samples are located at each transect, one in the center and two sides of the alley. The two side locations are about 2 feet from the property line of residences that border the alleyway.

The FPL will identify the actual sampling locations using the map and by placing marker flags at appropriate locations. If obstructions are present at the intended sampling locations, the sample point should be offset so that an alley soil may be collected, then the actual sample location must be correctly documented on the field diagram. All alleyway soil samples will be collected in accord with the Residential Soil Sampling for Alleyway Soils SOP #ISSI-VBI70-03 (Appendix F). In brief, surface soils (0-2 inches) will be collected at all sample locations. Grab samples will be collected from the 0-2 inch soil horizon adjacent to each marker flag. Each sample will be collected using a clean coring tool (2-inch diameter) (Appendix F). The grab samples will be collected into a zip-lock bag and labeled in accord with the Sample Identification and Tracking SOP# ISSI-VBI70-01 (Appendix F).

Because of the relatively large number of samples that will be collected at each alley, the resulting sample holes or depressions will be backfilled with an USEPA-approved topsoil mixture. Any sod removed temporarily to obtain the soil below will be replaced after backfilling the hole or depression.

If disposable sampling equipment is not used during the sampling event, decontamination procedures must be performed before that equipment may be reused. Decontamination must be performed between collection of composite samples in accord with procedures outlined in the Decontamination SOP #MK-VBI70-07 (Appendix F).

Each field team will carry a three-ring binder that holds the VBI70 Alleyway Soil Sample Data Sheets (Figure 3-13). These binders will only contain the paperwork necessary to complete a single day of sampling. One data sheet will be completed for each alley. Any deviations from standard protocols or notable events (e.g., rainy weather, etc.) should be entered in the section for "Notes". The field team leader will sign the form when sampling is complete and all data are entered onto the form. The field team will not proceed to the next alley until samples are stored

in a cooler and paperwork is complete.

At the end of each day of sampling the field teams will return to the Site Office to check-in samples, paperwork and unused sample labels. Samples will be locked and stored under chain-of-custody until they are forwarded for sample preparation and analysis.

3.6.2 Field Documentation

Each sampling team will maintain two forms of field documentation. As discussed above, each team will have a binder containing all field data sheets. Additionally, each team will carry a bound field logbook (not three-ring binder). Information contained in this log includes the following:

- Sample date
- Sample team ID
- Names of sample team members in attendance
- Weather conditions
- Time sampling begun each day
- Time sampling concluded each day
- Any information that is not limited to a single residence (e.g., deviations to sampling protocols)
- Signature of data logger

This logbook will be maintained daily during sampling activities. Refer to the Field Documentation SOP #MK-VBI70-07 (Appendix F) for more details.

3.6.3 Sample Preparation

After grab soil samples have been collected, they will be submitted under chain-of-custody for sample preparation. Sample preparation will be performed in accord with the Sample Preparation SOP #MK-VBI70-05 (Appendix F). In brief, the samples will be well-mixed and then oven-dried. Figure 3-5 provides a flow diagram that summarizes the steps in sample preparation.

Sample preparation must be performed by a technician who will not perform XRF analysis because samples submitted for XRF analysis must be blind. That is, the sample stream will include both investigative samples as well as blind QC samples. Every effort must be made to maintain sample anonymity.

Preparation of Bulk Samples

In brief, all grab samples from the field (referred to as "raw" field samples) will be oven-dried and sieved to remove material larger than 2 mm using a #10 stainless steel sieve. The entire mass of each entire raw sample will be sieved in this way. Any material not passing through the 2 mm sieve will be disposed of as IDW. After sieving, the sample passing the sieve (now referred to as the "bulk" sample) is placed into a new zip-lock bag that is labeled with the original sample ID number, except that the suffix is "B" (for bulk) rather than "R" (for raw). From this bag, a 10-g sample is removed, ground and placed in an XRF cup, labeled with the sample ID (suffix = B) and forwarded to the XRF analyst for testing. A record of all drying and sieving procedures must be documented in the Field Sample Preparation Logbook (Figure 3-6). Information such as the sample ID, date of sample preparation, sample mass before and after drying, the duration of drying and the sieve size used will be included in the log.

Preparation of Fine Samples

Selected bulk samples will be identified for a second sieving step in order to isolate a fraction of fine particles for analysis. This step will be performed to confirm expectation that arsenic and lead levels are not significantly different in the bulk and fine fractions. This step will be performed for about 10% of alley samples collected.

The fine sample is prepared by removing a portion of the bulk sample (about 100 g) and sieving through a #60 stainless steel sieve. After sieving, the material that does not pass through the screen is disposed of as IDW, and the material that does pass through the screen is placed into a new zip-lock bag labeled with the original sample ID number and the suffix "F" (for fine). A 10-g portion of the fine material is removed, ground and placed in an XRF cup, labeled with the sample ID (suffix = F) and forwarded to the XRF analyst for testing.

Decontamination

If disposable sieves or other equipment are not used during sample preparation, decontamination procedures must be performed before the tools or equipment may be reused. Decontamination must be performed between samples sieved in accord with procedures outlined in the Decontamination SOP #MK-VBI70-07 (Appendix F).

QA/QC Samples

At the appropriate frequency (See Section 4.0) or as directed by the FQAC, QC samples such as splits or blind standards are inserted into the sample stream. These samples will be logged into the Field QC Sample Logbook (Figures 3-7, 3-8, and 3-9) and assigned a sample ID. This document is a bound (not a three-ring binder) logbook maintained by the FQAC. The

appropriate sample ID numbers and labels will be checked-out from the FPL.

3.6.4 Analytical Method Requirements

Arsenic and lead testing will be performed on all alley soil samples using XRF, providing the chosen XRF methodology can achieve the project-required detection limits (See Section 4.0). A method detection limit study for the chosen instrumentation and proficiency tests for all analysts who will work on the VBI70 Phase III project must be provided to USEPA before analysis of any field samples may proceed (See Appendix G). XRF analysis will be performed in accordance with the XRF Instrument Operation SOP #MK-VBI70-06.

3.7 Schools and Parks

Table 2-1 lists all schools and parks within the study area and identifies whether or not they have been sampled yet. As mentioned previously, any schools or parks that have been sampled previously are not planned for re-investigation during the Phase III Field Investigation.

3.7.1 Identification and Collection of Soil Samples at Schools and Parks

The specific number and location of samples planned for collection at each school and park included in Phase III field investigations are not summarized here, but will be detailed in an addendum to the Project Plan at a later date. A specific sampling design for each school or park will be prepared to ensure that the sample locations adequately cover each individual property.

All surface soil samples will be collected at schools and parks in accord with the Residential Soil Sampling for Yard Soils SOP #ISSI-VBI70-02 (Appendix F). In brief, surface soils (0-2 inches) will be collected at the frequency specified for each property. The FPL or designate will assign sampling locations as specified by the addendum and will complete the following activities:

- Draw a field diagram of the property and its major components approximately to scale
- Place marker flags at the property in the approximate specified location

Field Diagram

The FPL will pace off the major attributes of the property (e.g., dimensions of the property boundary, playground, etc.) and prepare a field diagram to approximate scale (± 3 feet on each measurement). The goal is not have a drawing to scale, but instead to have an estimate of the total samplable area at the property.

Flag Placement in Each Subsection

As discussed previously, sample locations will be identified using marker flags. The locations of each marker flag should be approximately equidistant from the other flags at the property as clustering should be avoided.

Soil Sampling

Samples will be collected from the 0-2 inch soil horizon adjacent each marker flag. Each sample will be collected using a clean coring tool (2-inch diameter) (Appendix F). The particular details for soil sample collection will be provided in the addendum to the project plan.

Because of the relatively large number of samples that will be collected at each property, the resulting sample holes or depressions will be backfilled with an USEPA-approved topsoil mixture. Any sod removed temporarily to obtain the soil below will be replaced after backfilling the hole or depression.

If disposable sampling equipment is not used during the sampling event, decontamination procedures must be performed before that equipment may be reused. Decontamination must be performed between collection of composite samples in accord with procedures outlined in the Decontamination SOP #MK-VBI70-07 (Appendix F).

Each field team will carry a three-ring binder that holds the VBI70 Soil Sample Data Sheets (Figure 3-4). These binders will only contain the paperwork necessary to complete a single day of sampling. One data sheet will be completed for each school or park. Any deviations from standard protocols or notable events (e.g., rainy weather, etc.) should be entered in the section for "Notes". The field team leader will sign the form when sampling is complete and all data are entered onto the form. The field team will not proceed to the next property until samples are stored in a cooler and paperwork is complete.

At the end of each day of sampling the field teams will return to the Site Office to check-in samples, paperwork and unused sample labels. Samples will be locked and stored under chain-of-custody until they are forwarded for sample preparation and analysis.

3.7.2 Field Documentation

Each sampling team will maintain two forms of field documentation. As discussed above, each team will have a binder containing all field data sheets. Additionally, each team will carry a bound field logbook (not a three-ring binder). Information contained in this log includes the following:

- Sample date
- Sample team ID
- Names of sample team members in attendance
- Weather conditions
- Time sampling begun each day
- Time sampling concluded each day
- Any information that is not limited to a single property (e.g., deviations to sampling protocols)
- Signature of data logger

This logbook will be maintained daily during sampling activities. Refer to the Field Documentation SOP # MK-VBI70-05 (Appendix E) for more details.

3.7.3 Sample Preparation

After composite soil samples have been collected, they will be submitted under chain-of-custody for sample preparation. Sample preparation will be performed in accord with the Sample Preparation SOP #MK-VBI70-05 (Appendix F).

Sample preparation must be performed by a technician who will not perform XRF analysis because samples submitted for XRF analysis must be blind. That is, the sample stream will include both investigative samples as well as blind QC samples. Every effort must be made to maintain sample anonymity.

Preparation of Bulk Samples

In brief, all composite samples from the field (referred to as "raw" field samples) will be oven-dried and sieved to remove material larger than 2 mm using a #10 stainless steel sieve. The entire mass of each entire raw sample will be sieved in this way. Any material not passing through the 2 mm sieve will be disposed of as IDW. After sieving, the sample passing the sieve (now referred to as the "bulk" sample) is placed into a new zip-lock bag that is labeled with the original sample ID number, except that the suffix is "B" (for bulk) rather than "R" (for raw). From this bag, a 10-g sample is removed, ground and placed in an XRF cup, labeled with the sample ID (suffix = B) and forwarded to the XRF analyst for testing. Information such as the sample ID, date of sample preparation, sieve size and the duration of drying will be included in the log.

The effectiveness of mixing will be evaluated by removing ten 10-gram sample aliquots and analyzing the resulting ten samples for arsenic and lead, and evaluating the variability of the analytical results. If the results of this evaluation prove unsatisfactory mixing is occurring preparation of additional investigative samples will cease and corrective actions to improve

mixing will be performed and verified prior to preparation of any other investigative samples.

Preparation of Fine Samples

Selected bulk samples will be identified for a second sieving step in order to isolate a fraction of fine particles for analysis. This step will be performed to confirm expectation that arsenic and lead levels are not significantly different in the bulk and fine fractions. This step will be performed for about 10% of samples.

The fine sample is prepared by removing a portion of the bulk sample (about 100 g) and sieving through a #60 stainless steel sieve. After sieving, the material that does not pass through the screen is disposed of as IDW, and the material that does pass through the screen is placed into a new zip-lock bag labeled with the original sample ID number and the suffix "F" (for fine). A 10-g portion of the fine material is removed, ground and placed in an XRF cup, labeled with the sample ID (suffix = F) and forwarded to the XRF analyst for testing.

The effectiveness of mixing will be evaluated by removing ten 10-gram sample aliquots and analyzing the resulting ten samples for arsenic and lead, and evaluating the variability of the analytical results. If the results of this evaluation prove unsatisfactory mixing is occurring preparation of additional investigative samples will cease and corrective actions to improve mixing will be performed and verified prior to preparation of any other investigative samples.

Decontamination

If disposable sieves or other equipment are not used during sample preparation, decontamination procedures must be performed before the tools or equipment may be reused. Decontamination must be performed between samples sieved in accord with procedures outlined in Decontamination SOP #MK-VBI70-07 (Appendix F).

QA/QC Samples

At the appropriate frequency (See Section 4.0) or as directed by the FQAC, QC samples such as splits or blind standards are inserted into the sample stream. These samples will be logged into the Field QC Sample Logbook (Figure 3-7, 3-8, and 3-9) and assigned a sample ID. This document is a bound (not a three-ring binder) logbook maintained by the FQAC. The appropriate sample ID numbers and labels will be checked-out from the FPL.

3.7.4 Analytical Method Requirements

Arsenic and lead testing will be performed on all soil samples using XRF, providing the chosen XRF methodology can achieve the project-required method detection limits (See Section 4.0). A

method detection limit study for the chosen instrumentation and proficiency tests for all analysts who will work on the VBI70 Phase III project must be provided to USEPA before analysis of any field samples may proceed (See Appendix G). XRF analysis will be performed in accordance with the XRF INSTRUMENT OPERATION SOP #MK-VBI70-06.

3.8 Sample Identification

Every field and QC sample collected during this investigation will be identified with a unique sample identification number (sample ID). The sample ID consists of 3 elements as described below. Complete details about the sample ID are provided in the Sample Identification and Tracking SOP ISSI-VBI70-01 (Appendix F).

PHASE. All labels will begin with the number "3" to indicate that the sample is derived from the Phase III Field Investigation.

NUMBER. Each label will include a unique identification number. This number will be a 5-digit sequential number starting with "00001" and progressively increasing until the final sample has been collected or tag number "99999" has been reached.

SAMPLE PREPARATION. Samples will be categorized based upon the sample preparation performed. Categories include, but are not limited to the following. The sample preparation nomenclature may be expanded as needed in the future providing they are approved by the Project Database Manager or designate.

- R — Raw sample. Original sample collected during Phase III that is unprocessed.
- A — Archived bulk fraction. This sample is prepared by sieving the raw sample and then archiving for future use. This sample is not subjected to heating.
- B — Bulk fraction. This sample has been prepared by sieving the sample to < 2 mm and then heating above environmental temperatures (> 50 °C).
- F — Fine fraction. This sample has been dried at environmental temperatures (< 50 °C) and then sieved to < 250 µm.

Thus, "3-00001-R" and "3-12846-F" represent possible sample numbers collected during Phase III. This type of sample ID is not "self-reading" (the sample location or QC type cannot be interpreted by reading the sample ID) and has been designed so that sample anonymity may be

maintained through laboratory analysis.

3.9 Sample Handling and Custody Requirements (B3)

At the end of each day, the field team returns the samples and the data sheets to the FPL who reviews the forms for completeness and accuracy. If problems are noted, these must be resolved and corrected before the team leaves the site. If corrections are made to the field notes or data sheets, the field team member will draw a single line through the mistake and initial and date the correction. When the forms are complete and accurate, the FPL signs and dates the forms. All forms are placed in a three-ring binder (the Master Field Logbook) in numerical order by sample ID. One placed into the Master Field Logbook, the forms are immediately paginated (sequentially numbered). Data from the data collection forms are entered into the project database in accord with procedures outlined in the DMP (Section 5.0).

Samples must be kept under strict chain-of-custody at all times. Refer to chain-of-custody (COC) procedures outlined in the Chain-of-Custody and Sample Handling SOP #MK-VBI70-02 (Appendix F). An example COC form is provided as Figure 3-14.

COC forms will be prepared for every sample (residential, alley, school or park soils or indoor dust) collected in the field immediately following collection of each sample. This same COC form will ultimately be used to transfer of the archive (3-#####-A) sample to the storage unit. An example of this is provided in Figure 3-15. Additionally, a second set of COC forms will be prepared for samples submitted to the contract laboratory for confirmation analysis of soils, equipment blanks or indoor dust samples. An example COC form is provided as Figure 3-16.

3.10 Decontamination Procedures

Decontamination is defined as physically removing inorganic contaminants and foreign material (e.g., dust, oil, detergent) or altering their chemical character to nonreactive/inert substances. All sampling devices and equipment (e.g. tubing, nozzles, coring tools) that are planned for use to collect samples at more that one location must be decontaminated prior to reuse. Therefore, decontamination (decon) procedures must be rigorously followed to minimize the potential for cross-contamination of samples.

All decon procedures shall be performed at a designated decontamination area. This area should be chosen such that environmental factors (e.g., cross-winds, drafts, dust) are minimized. Decon procedures will be performed in accord with the Decontamination Procedures SOP #MK-VBI70-07 (Appendix F).

3.11 Sample Archives

All surface soil (bulk and fine fractions) and dust samples collected during the Phase III Field Investigation must be retained in a dry and secure (locked with limited access) storage facility for at least 6 months after the last sample has been collected from the study area. A portion of samples may be identified for further characterization; therefore samples must be stored in an organized manner such that quick retrieval is possible. All investigative samples will be held in storage, under chain-of-custody until the Remedial Project Manager (RPM) indicates that these samples may be disposed according to proper waste disposal methods.

3.12 Health and Safety

The contractor implementing this project plan (MK) will be responsible for providing and instituting an approved Health and Safety Plan (HASP) for this site. The HASP must contain a discussion of safety procedures for topics including but not limited to reduction in slips, trips and falls and personal protective equipment (PPE) that is appropriate for all aspects of the investigation; training and certifications required for each activity; and measures for how to deal with contamination of known and unknown composition, if encountered.

3.13 Waste Generation and Management

Any waste is generated as a result of this investigation must be disposed in accord with Federal, State and local regulations. The contractor generating the waste is responsible for proper management and disposal. See Appendix F for the Investigation Derived Waste (IDW) Management SOP #MK-VBI70-04.

Figure 3-1 Phase III Sample Flow Chart

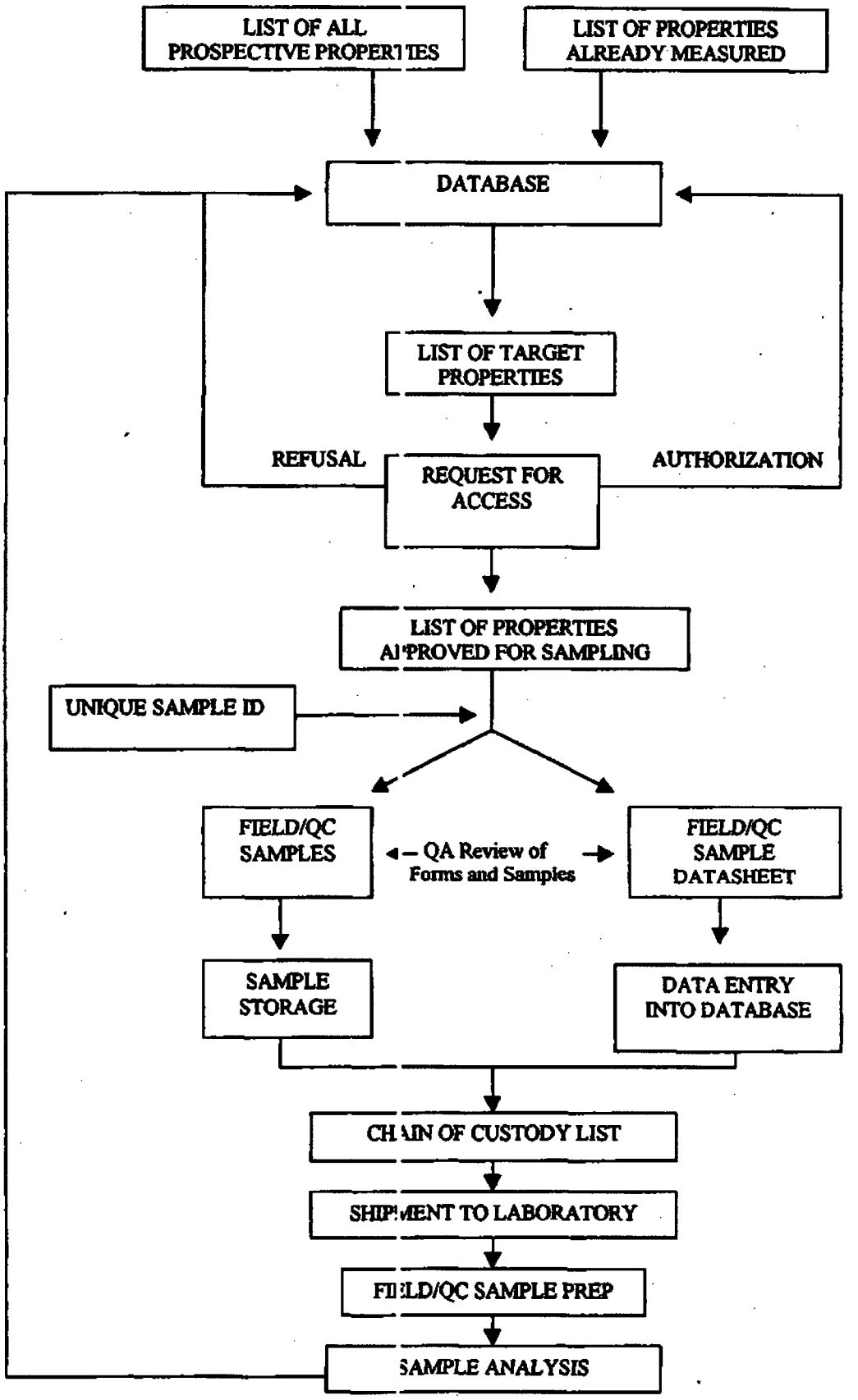
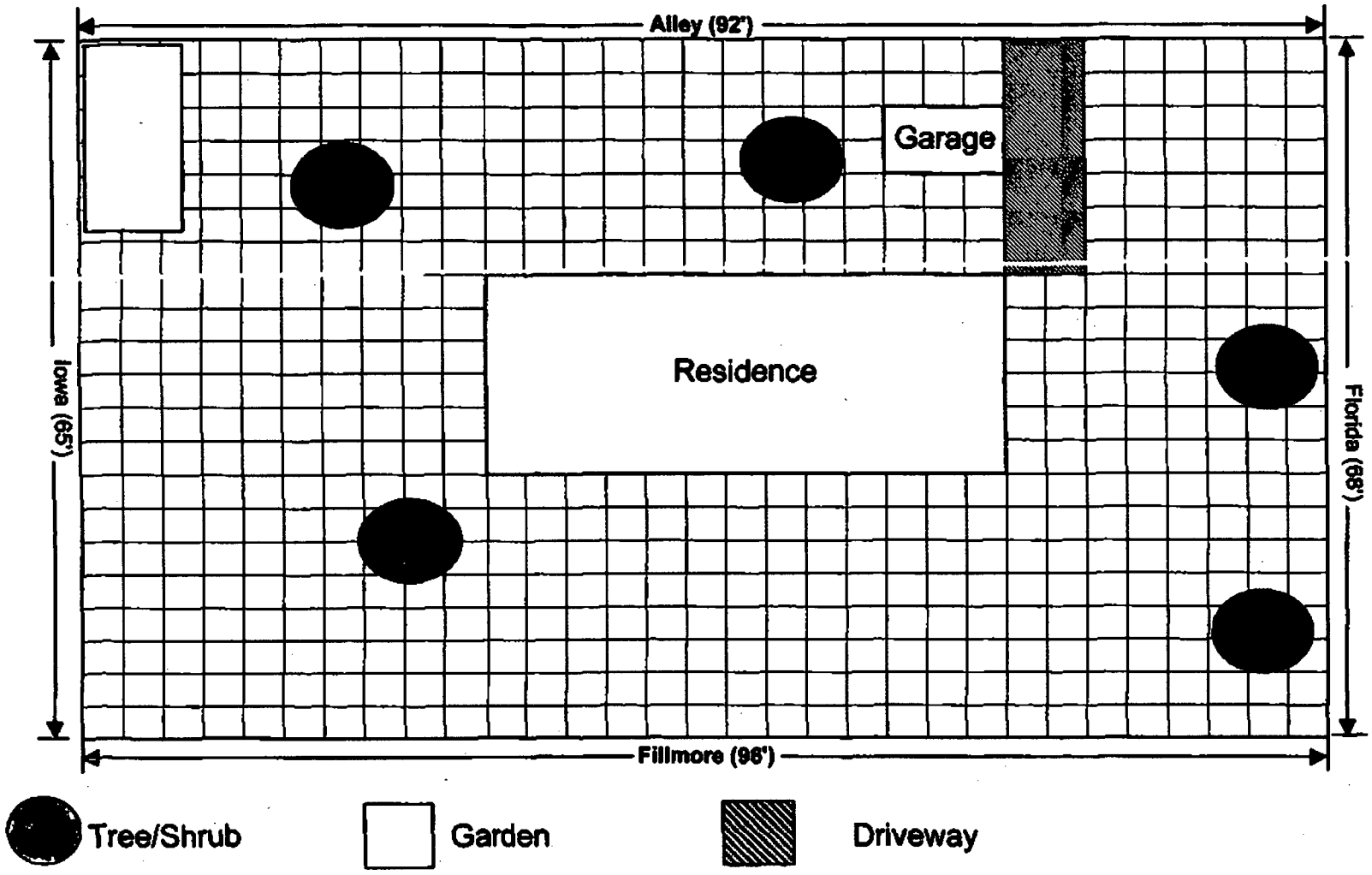


Figure 3-2 Proposed Grid Sampling Design for Residential Surface Soil

Step 1:



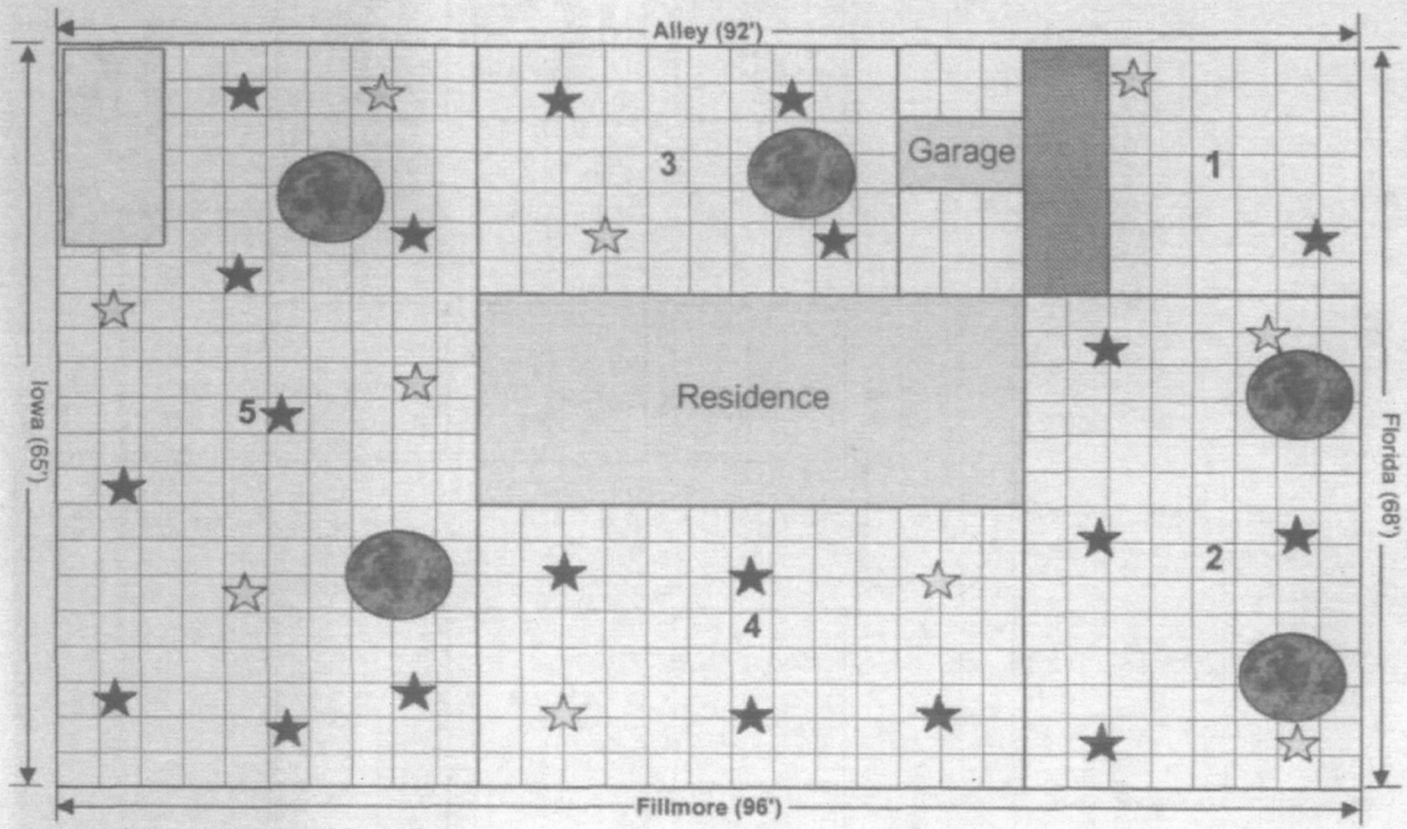
Color Chart(s)

The following pages contain color that does not appear in the scanned images.

To view the actual images, please contact the Superfund Records Center at (303) 312-6473.

Figure 3-3 Proposed Grid Sampling Design for Residential Surface Soil

Step 2:



Tree/Shrub

Garden

Driveway

Sampling Locations

Sub Area	No. of Grids	No. of Flags
1	42	2
2	112	6
3	70	4
4	104	6
5	210	12
Total:	538	Total: 30

Divide by 30: 17.93

Logbook DCN _____

ATTACHMENT 1
SURFACE SOILDATA SHEET

PHASE: 3

MEDIUM: SURFACE SOIL

SAMPLE COLLECTION METHOD: ISSI-VBI70-02 Revision 0

DEPTH: 0-2"

DATE: _____

SAMPLE TEAM ID: _____

ADDRESS: _____
House# *Street Name*

BUILDING TYPE: Residential – Single
Multifamily
Apartment

School (Name) – _____

Park (Name) – _____

CLASS: FS (Field Sample)

	SAMPLE NO.:	SAMPLE TIME:	SAMPLE TYPE: (circle one)	
First Sample		_____	COMP	GRAB
Second Sample		_____	COMP	GRAB
Third Sample		_____	COMP	GRAB

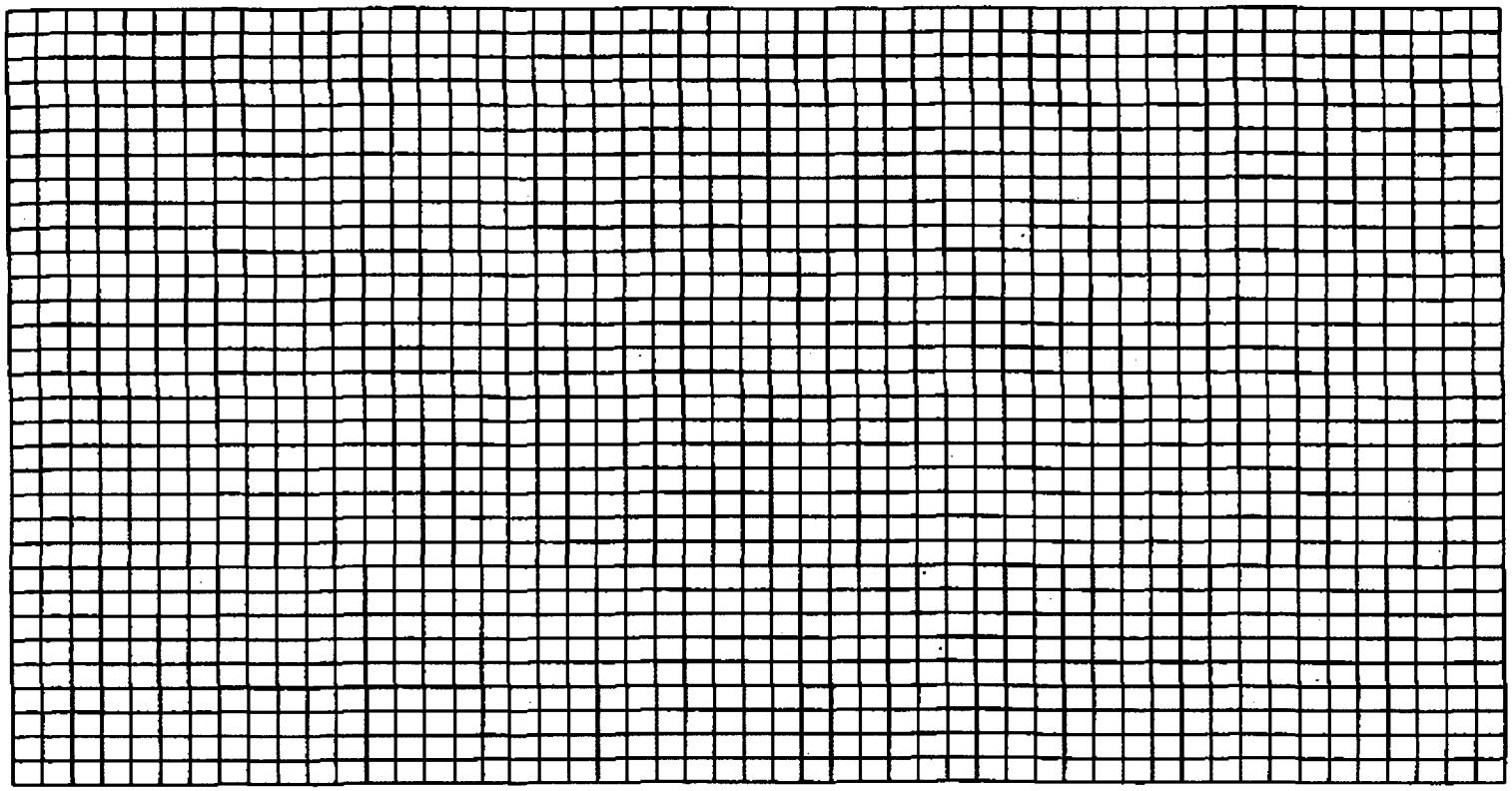
NOTES:

GARDEN PRESENT? _____	Yes	No
IN USE? _____	Yes	No
ADDRESS CONFIRMED BY RESIDENT? _____	Yes	No
WILLING TO ALLOW FURTHER SAMPLING? _____	Yes	No

Field Diagram:

N

DIRECTIONAL ARROW



scale: 1 grid = 1 pace (~ 3 ft)

Sub Area	No. of Grids	Relative Dist. Between Samples (RDBS)	No. of Flags in Sub Area No. of Grids divided by the RDBS	No. of Each Flag (10 of each)
1	_____		_____	Red _____
2	_____		_____	
3	_____	Total Grids divided by 30 =	_____	Blue _____
4	_____		_____	
5	_____	_____	_____	Yellow _____
6	_____		_____	
7	_____		_____	
8	_____		_____	
Total Grids:			Total Flags:	Equal to 30? Y N

Samples Collected by: _____ (Signature) _____ (Date)

Logbook Page Reviewed by: _____ (Signature) _____ (Date)

Figure 3-5 Soil Preparation Flow Chart

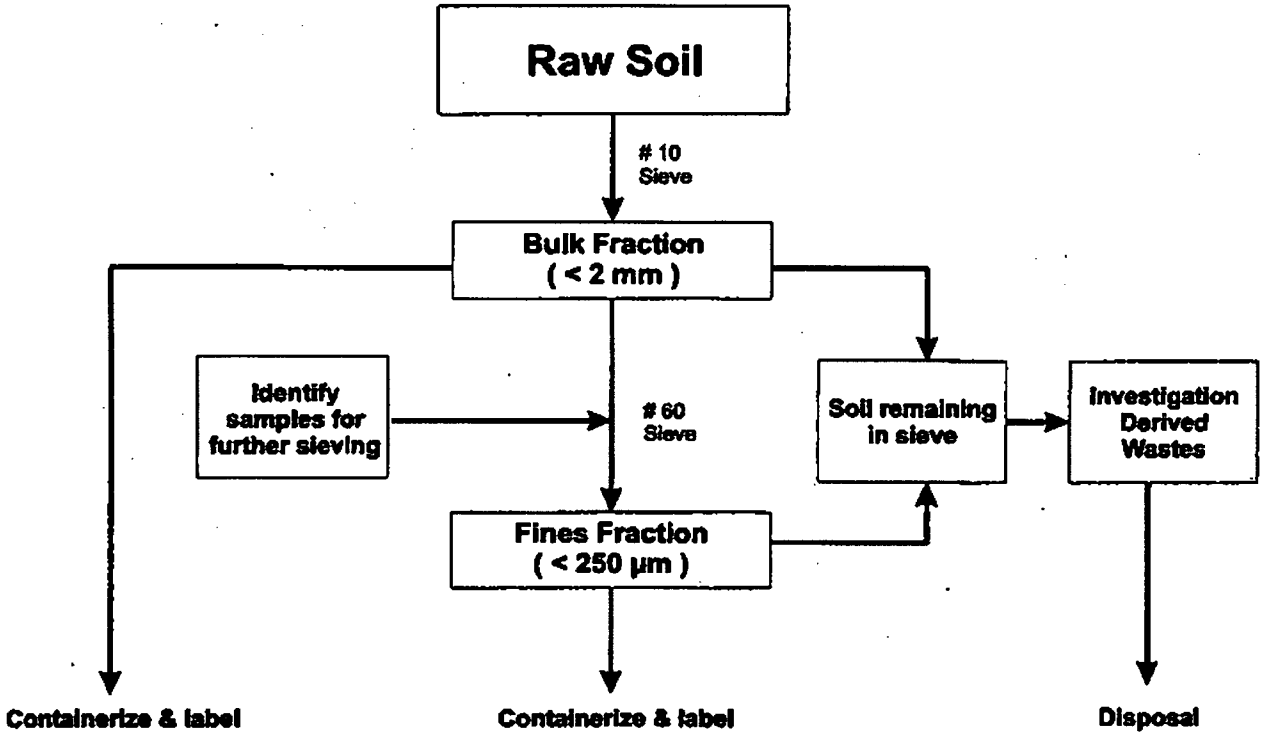


Figure 3-6

VBI70 Field Sample Preparation Logbook Sheet

Sample ID	Prep Batch Number	Confirmation Sample[a]	Sample Drying							Sieving				Notes
			Date/Time Drying Begun[b]	Date/Time Drying Completed[b]	Oven Temp (°C)	Sample Mass[c] (grams)				Date Sieved	Particle Size Fraction[d]			
						Before	After 1	After 2	After 3		Raw Soil	Bulk (<2 mm)	Fine (<250 µm)	

a: Mark an "X" if a confirmation sample is prepared.

b: Enter Date in the following format: mm/dd/yy; Enter Time as 24-hour time (eg. 1340).

c: At least 2 measurements will be recorded. The sample is "completely dry" if the mass measurement is stable. A stability study will be performed as outlined in the Phase III Project Plan.

d :Mark an "X" for each sieve fraction collected

dustappt: Sheet1

Figure 3-7

Logbook DCN _____

VBI70 Blind Soil Field Splits Data Sheet

Date Prepared	Sample ID#	Sample Class	Original Sample ID	Prepared By
		BD		
		BD		
		BD		
		BD		
		BD		
		BD		
		BD		
		BD		
		BD		
		BD		
		BD		
		BD		
		BD		
		BD		
		BD		
		BD		
		BD		
		BD		
		BD		
		BD		
		BD		
		BD		
		BD		
		BD		
		BD		
		BD		

Figure 3-8

Logbook DCN_____

VBI70 QC Data Sheet
Soil Performance Evaluation Standards

Date	Sample #	Sample Class	Lot No.	Certified Concentration		Prepared By
				Arsenic (ppm)	Lead (ppm)	
		PE				
		PE				
		PE				
		PE				
		PE				
		PE				
		PE				
		PE				
		PE				
		PE				
		PE				
		PE				
		PE				
		PE				
		PE				
		PE				
		PE				
		PE				
		PE				
		PE				
		PE				
		PE				
		PE				
		PE				
		PE				
		PE				
		PE				
		PE				

Figure 3-9

Logbook DCN_____

VBI70 Equipment Blank Data Sheet

Date Prepared	Field Team ID	Equipment Type[a]	Sample ID#	Sample Class	Prepared By
				EB	
				EB	
				EB	
				EB	
				EB	
				EB	
				EB	
				EB	
				EB	
				EB	
				EB	
				EB	
				EB	
				EB	
				EB	
				EB	
				EB	
				EB	
				EB	
				EB	
				EB	
				EB	
				EB	
				EB	
				EB	

a A= Auger, T=Trowel, P=Drying Pan, S=Spatula

Figure 3-10

Logbook DCN_____

VBI70 Indoor Dust Scheduling Sheet

DATE _____

Time	House Number	Street Name	Comments / Special Instructions	Property Access Authorization [1]	
				Property Owner	Renter/Leaser
8:00 AM					
8:30 AM					
9:00 AM					
9:30 AM					
10:00 AM					
10:30 AM					
11:00 AM					
11:30 AM					
12:00 PM					
12:30 PM					
1:00 PM					
1:30 PM					
2:00 PM					
2:30 PM					
3:00 PM					
3:30 PM					
4:00 PM					
4:30 PM					
5:00 PM					
5:30 PM					
6:00 PM					

Notes:
[1] Refer to the Master Access Agreement Log. Indicate with an "X" if access is granted, "NA" if not applicable, or "NO" if access has not been authorized. Do not schedule for dust sampling if "NO" is indicated.

Logbook DCN _____

FIGURE 3-11
INDOOR DUST
DATA SHEET

PHASE: 3

MEDIUM: INDOOR DUST

COLLECTION METHOD: ISSI-VB170-04 Revision 0

DATE: _____

SAMPLE TEAM ID: _____

ADDRESS: _____
House# Street Name

CLASS: FS (Field Sample)
EB (Equipment Blank)

SAMPLE TYPE: COMP
GRAB

TEMPLATE SIZE: 4 ft^2

SAMPLE NO.:

TEMPLATE COLLECTION LOCATIONS:

Number	Living Area (a)	Surface Type (b)	Notes
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			

(a) Living Area Codes:
BR = bedroom
FR = family room / living room
K = kitchen
D = dining / eating area
H = hall way
E = entry way
O = other (note which)_____

(b) Surface Types:
H = hard (linoleum, stone, wood, etc.)
S = soft (carpet, rug, etc.)
O = other (note which)_____

Master Logbook Page _____

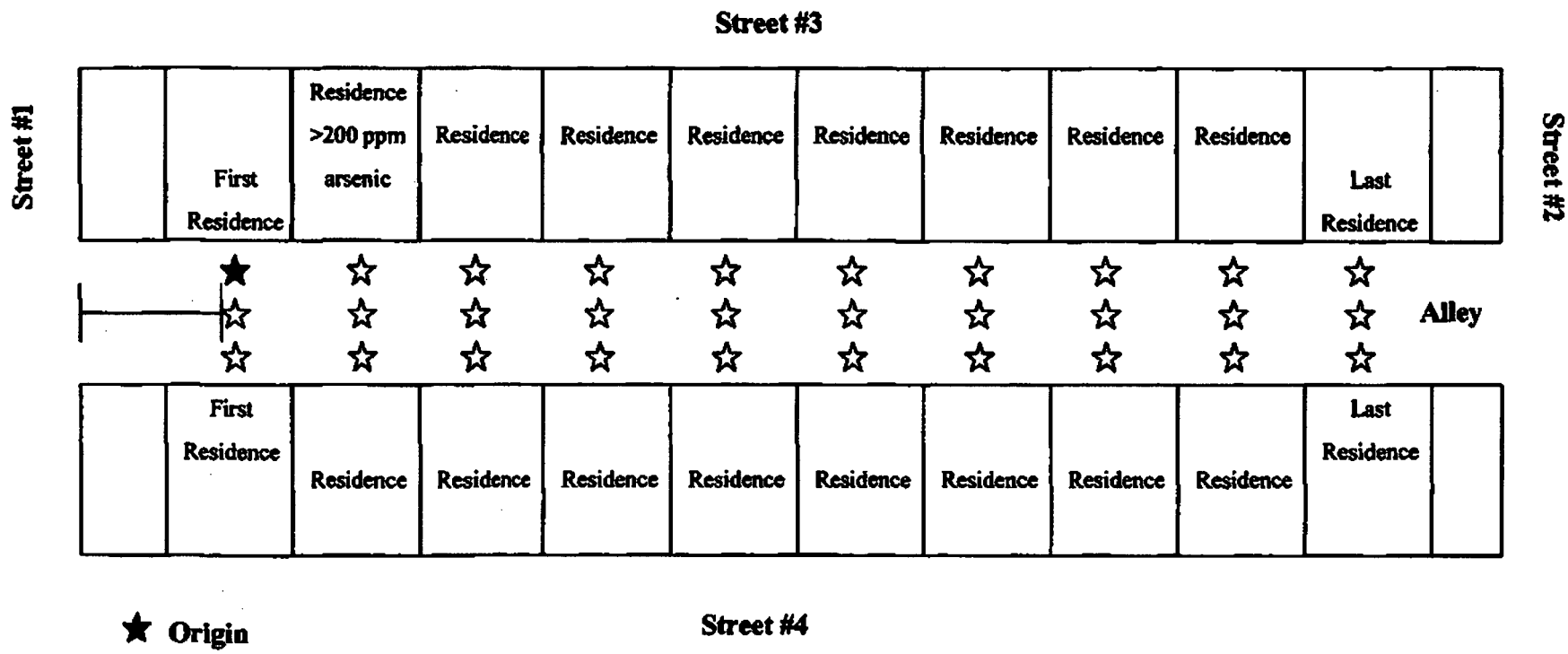
Figure 3-11 (cont.)

Field Diagram:

Samples Collected by: _____ _____
Signature *Date*

Logbook Page Reviewed by: _____ _____
Signature *Date*

Figure 3-12 Typical Sampling Plan at an Alleyway



Logbook DCN _____

FIGURE 3-13
ALLEYWAY SOILDATA SHEET

PHASE: 3 MEDIUM: Alley Soil

DATE: _____ DEPTH: 0-2"

ALLEYWAY ID: _____ SAMPLE COLLECTION METHOD: ISSI-VBI70-03 Revision 0

SAMPLE TEAM ID: _____

INDEX	MAP POSITION	SAMPLE NO.	CLASS FS = Field Sample FD = Field Duplicate	SAMPLE TYPE (circle one)
1			FS FD	COMP GRAB
2			FS FD	COMP GRAB
3			FS FD	COMP GRAB
4			FS FD	COMP GRAB
5			FS FD	COMP GRAB
6			FS FD	COMP GRAB
7			FS FD	COMP GRAB

ALLEY ID: _____

INDEX	MAP POSITION	SAMPLE NO.	CLASS FS = Field Sample FD = Field Duplicate	SAMPLE TYPE (circle one)
8			FS FD	COMP GRAB
9			FS FD	COMP GRAB
10			FS FD	COMP GRAB
11			FS FD	COMP GRAB
12			FS FD	COMP GRAB
13			FS FD	COMP GRAB
14			FS FD	COMP GRAB
15			FS FD	COMP GRAB

ALLEY ID: _____

INDEX	MAP POSITION	SAMPLE NO.	CLASS FS = Field Sample FD = Field Duplicate	SAMPLE TYPE *(circle one)*
16			FS FD	COMP GRAB
17			FS FD	COMP GRAB
18			FS FD	COMP GRAB
19			FS FD	COMP GRAB
20			FS FD	COMP GRAB
21			FS FD	COMP GRAB
22			FS FD	COMP GRAB
23			FS FD	COMP GRAB

ALLEY ID: _____

INDEX	MAP POSITION	SAMPLE NO.	CLASS FS = Field Sample FD = Field Duplicate	SAMPLE TYPE (circle one)
24			FS FD	COMP GRAB
25			FS FD	COMP GRAB
26			FS FD	COMP GRAB
27			FS FD	COMP GRAB
28			FS FD	COMP GRAB
29			FS FD	COMP GRAB
30			FS FD	COMP GRAB

ALLEY ID: _____

INDEX	MAP POSITION	SAMPLE NO.	CLASS FS = Field Sample FD = Field Duplicate	SAMPLE TYPE *(circle one)*	ORIGINAL SAMPLE NO.
31			FS FD	COMP GRAB	
32			FS FD	COMP GRAB	
33			FS FD	COMP GRAB	

Samples Collected by: _____ Signature _____ Date

Logbook Page Reviewed by: _____ Signature _____ Date

MORRISON KNUDSEN CORPORATION

CHAIN OF CUSTODY RECORD

720 Park Blvd., P.O. Box 73
Boise, Idaho 83729
(208) 386-5000

Project No.:

Project Name:

Samplers: (Signature)

Sampler: (Print)

Sample Type	Sampling Point Description	Sample Date	Time	Sample I.D. Number	Split Samples Yes	Split Samples No	Analysis Required																										Remarks

Relinquished By: (Signature) Company:	Date/Time	Received By: (Signature) Company:	Relinquished By: (Signature) Company:	Date/Time	Received By: (Signature) Company:
Relinquished By: (Signature) Company:	Date/Time	Received By: (Signature) Company:	Relinquished By: (Signature) Company:	Date/Time	Received By: (Signature) Company:
Relinquished By: (Signature) Company:	Date/Time	Received By: (Signature) Company:	Received for Laboratory By: (Signature) Company:	Date/Time	Total No. Samples This Shipping Container: Company:
Relinquished By: (Signature) Company:	Date/Time	Received By: (Signature) Company:	Relinquished By: (Signature) Company:	Date/Time	Received By: (Signature) Company:

Figure 3-14

MORRISON KNUDSEN CORPORATION

CHAIN OF CUSTODY RECORD

720 Park Blvd., P.O. Box 73
Boise, Idaho 83729
(208) 380-5000

Project No.: —

Project Name: VB170 Phase III

Samplers: (Signature) John Doe

Sampler: (Print) John Doe

Sample Type	Sampling Point Description	Sample Date	Time	Sample I.D. Number	Split Samples Yes	Split Samples No	Analysis Required: AS & Pb by 20XRF	Remarks
SS	House No & Street Name	8.7.99	1345	3-12345-R		X	X	At archiving
SS	House No & Street Name	8.7.99	1402	3-67890-R		X	X	all samples
								became
								3-XXXXX-A

JDoe 8.7.99

Relinquished By: (Signature) Company: John Doe/MK	Date/Time 8.7.99 1750	Received By: (Signature) Company: Jane Doe/MK	Relinquished By: (Signature) Company: Jane Doe/MK	Date/Time 8.8.99 1700	Received By: (Signature) Company: Joe Doe/MK
Relinquished By: (Signature) Company:	Date/Time	Received By: (Signature) Company:	Relinquished By: (Signature) Company:	Date/Time	Received By: (Signature) Company:
Relinquished By: (Signature) Company:	Date/Time	Received By: (Signature) Company:	Received for Laboratory By: (Signature) Company:	Date/Time	Total No. Samples This Shipping Container: Company:
Relinquished By: (Signature) Company:	Date/Time	Received By: (Signature) Company:	Relinquished By: (Signature) Company:	Date/Time	Received By: (Signature) Company:

Figure 3-15

MORRISON KNUDSEN CORPORATION

CHAIN OF CUSTODY RECORD

720 Park Blvd., P.O. Box 73
Boise, Idaho 83729
(208) 386-5000

Project No.: —

Project Name: VB170 Phase III

Samplers: (Signature) John Doe

Sampler: (Print) John Doe

Analysis Required: As & Pb by TCP-Trace

Sample Type	Sampling Point Description	Sample Date	Time	Sample I.D. Number	Split Samples Yes	Split Samples No	As & Pb by TCP-Trace	Remarks
SS	House # & Street Name	8.8.99	1200	3-12345-B	X		X	
SS	House # & Street Name	8.8.99	1200	3-12345-F	X		X	
SS	House # & Street Name	8.8.99	1200	3-67890-B	X		X	

J. Doe 8.8.99

Relinquished By: (Signature) / Company	Date/Time	Received By: (Signature) / Company	Relinquished By: (Signature) / Company	Date/Time	Received By: (Signature) / Company
John Doe / MK	8.8.99 / 1700	Jenny Nance / Lab			
Relinquished By: (Signature) / Company	Date/Time	Received By: (Signature) / Company	Relinquished By: (Signature) / Company	Date/Time	Received By: (Signature) / Company
Relinquished By: (Signature) / Company	Date/Time	Received By: (Signature) / Company	Received for Laboratory By: (Signature) / Company	Date/Time	Total No. Samples This Shipping Container: / Company
Relinquished By: (Signature) / Company	Date/Time	Received By: (Signature) / Company	Relinquished By: (Signature) / Company	Date/Time	Received By: (Signature) / Company

Figure 3-16

4.0 QUALITY ASSURANCE PROJECT PLAN

This Quality Assurance Project Plan has been prepared in accordance with USEPA guidance documents and presents a specific quality assurance and quality control (QA/QC) program required to ensure that the results of the field investigation satisfy project requirements (USEPA 1994a, 1996, 1998a). This section summarizes activities required to ensure that all technical, operational, monitoring and reporting activities are of the highest achievable quality. Sections that are recommended for inclusion (by USEPA guidance) in this portion of the project plan, but that have been presented in previous sections of the document are cross-referenced in this section for clarity and convenience.

4.1 Project Task And Organization (A4)

4.1.1 Project Task (A4)

Project background, study objectives and tasks are summarized in Section 1.0.

4.1.2 Project Organization (A4)

Key USEPA personnel and the contractors who will participate in operations planned for development, implementation, oversight and interpretation of data generated from the Phase III field investigation are presented in Section 1.0.

4.2 Problem Definition and Background (A5)

Project background and problem definitions are presented Sections 1.0 and 2.0, respectively.

4.3 Project Task Description and Schedule (A6)

Project task description including study goals are presented in Sections 1.0 and 2.0. A schedule of planned activities is included in the final project plan.

4.4 Data Quality Objectives (A7)

The DQO process for the overall study objectives for each of the three components presented in this Project Plan is outlined in Section 2.0. DQO requirements that ensure data of sufficient quality are obtained during this investigation are presented in the following section.

4.4.1 Criteria for Measurement Data (A7)

The performance criteria for measurement data generated as part of this project will be evaluated in terms of precision, accuracy, representativeness, completeness and comparability (PARCC). The following sections describe PARCC criteria.

Precision: Precision is defined as the agreement between a set of replicate measurements without assumption or knowledge of the true value. It is a measure of agreement among individual measurements of the same attributes under prescribed similar conditions (e.g., split samples of a residential composite soil). Agreement is expressed as the relative percent difference (RPD) for duplicate measurements if the reported values are sufficiently above the method detection limit (MDL) (> 5 x MDL) or the absolute difference of two values near the MDL (≤5 x MDL). Where:

$$RPD = \frac{|2(A - B)|}{A + B} \times 100\%$$

$$\text{Absolute difference} = |A - B|$$

Where:

A = original concentration value of an analyte
B = duplicate concentration value of an analyte

Accuracy: Accuracy is a measure of the closeness of individual measurements to the "true" value. Accuracy usually is expressed as a percentage of that value. For a variety of analytical procedures, standard reference materials traceable to or available from National Institute of Standards and Technology (NIST) or other sources can be used to determine accuracy of measurements. Specific accuracy guidelines for other accuracy measurements such as calibration verification standards are summarized in Table 4-2. Additionally, criteria are detailed in the individual SOPs or methodologies provided in Appendix F. Accuracy will be measured as the percent recovery (%R) of an analyte.

$$\%R = \frac{A}{B} \times 100\%$$

Where:

A = measured concentration value of an analyte
B = true (known) concentration value of an analyte

Representativeness: Representativeness is defined as the degree to which data accurately and precisely describe the general characteristics of a population or the parameter variations at a

sampling point. It is important to determine whether samples collected for this investigation are representative at both levels and are presented in Section 2.0. At the level of analytical data, representativeness will be measured through evaluation of blanks, accuracy and precision data.

Comparability: Data are comparable if collection techniques and measurement procedures are equivalent for the samples within a sample set. Comparable data will be obtained by specifying standard units for physical and chemical measurements and standard procedures for sample collection, processing, and analysis. Comparability will be documented through analysis of the confirmation samples. See the attached SOPs (Appendix F) for sampling and for analytical procedures.

Completeness: Data are considered complete when a prescribed percentage of the total measurements and samples that are planned are actually obtained.

Collection of Soil data: The overall goal of the study is to obtain soil data from all residential properties in the study area that have not previously been sampled. However, it is expected that not all property owners will grant authorization to sample at their property. Because the participation rate cannot be predicted, a pre-determined completeness goal for this aspect of the project can not be prescribed. All attempts to acquire access (participation) must be carefully documented and data gaps encountered and the potential impact of the gaps will be discussed in the report that details the findings (Section 4.14). However, properties for which authorization to sample is granted, the completeness goal is 100% (i.e., samples will be collected at all properties granting authorization). Within each property that grants authorization, completeness is defined as collection of the specified set of soil samples (3 composites of 10 each) or indoor dust samples.

Analytical Data Produced by Laboratories: Analytical data must be valid for at least 90% of analyzed samples. This means that fewer than 10% of all analytical data generated for each analytical method may incur a qualification of unusable (R qualification). If this completeness goal is not met due to laboratory error (e.g., lab fails to follow prescribed methodology or project-required corrective action), the analytical laboratory responsible for generating the poor quality data must reanalyze samples without additional cost and reanalyses must adhere to method requirements to generate valid data.

4.5 Special Training Requirements and Certification (A8)

Personnel responsible for completing this project include, but are not limited to: toxicologists, chemists, geologists, statisticians, field samplers, data managers and GIS specialists. These technically-trained personnel have been chosen to participate in the investigation because they are experienced in conducting sampling programs, chemical measurements on a variety of

analytical instrumentation and performing interpretation of data generated from the sampling program. Each person working on this project is responsible for attaining and maintaining appropriate training commensurate with their area of expertise.

All sampling personnel as well as all supervisory personnel retained for field sampling activities must be OSHA HAZWOPER (Occupational Safety and Health Administration Hazardous Waste Operations and Emergency Responder) certified. Additionally, site or field supervisors should have the OSHA 8-hour site supervisor training. Field sampling personnel must also be familiar with the information contained in the project plan and must ensure that all project requirements for sampling are met. Likewise, all analysts must be familiar with the project plan and must ensure that all project requirements for sample preparation and analysis are met. Prior to collection and/or analysis of any samples, each team member participating in the field investigations must attend a "readiness review" and must show auditors that he or she is familiar with and has a clear understanding of all procedures and protocols for which that person is responsible.

Each member of the sampling team must sign that he has received a copy, read and understood the Health and Safety Plan (HASP) prior to initiation of field activities. The Health and Safety Officer (HSO) must keep all signatures on file.

4.6 Documentation and Records (A9)

Maintenance of pertinent documentation is critical for evaluating the success of the investigation. This section describes the laboratory requirements for preparing data packages for this project. In addition, procedures for storing and maintaining laboratory data are described in this section. Documentation describing sample handling and custody requirements are discussed in the FSP (Section 3.0) of the Project Plan.

4.6.1 Field Data (A9)

Field documentation procedures are outlined in Section 3.0, the FSP.

4.6.2 Laboratory Data (A9)

Contract Laboratory Program (CLP)-like data packages will be required for all laboratory analytical data. These CLP-like data packages will include a case narrative, copies of all associated raw data, sample results and all associated QC summaries. A summary of the data package requirements is shown on the next page (as appropriate for the individual cited methods).

Section I **Case Narrative**

A. Case narrative
B. Copies of nonconformance/corrective action forms
C. Copies of sample receipt notices
D. Internal tracking documents, as applicable
E. Copies of all chain-of-custody forms

Section II **Analytical Results** - All results will be reported on a dry weight basis.

A. Results for each parameter including dilutions and reanalysis (dry-weight basis)
B. Units of measure
C. Method Detection Limit
D. Practical Quantitation Limit
E. Date of sample analysis
F. Date of sample receipt
G. Date of sampling
H. Dilution factor

Section III **QA/QC Summaries**

A. Method blanks, continuing calibration blanks, preparation blanks, instrument blanks
B. Initial and continuing calibration verifications
C. ICP/ICP-MS interference check samples
D. Matrix spikes and post-digestion spikes
E. Method duplicate samples
F. Laboratory control samples
G. Method of standard additions
H. ICP/ICP-MS serial dilution
I. Laboratory Duplicates
J. Instrument detection limits

Section IV **Instrument Raw Data** – Sequential measurement readout records for XRF, ICP, ICP-MS, GFAA, which will include the following information (as applicable):

A. Environmental samples, including dilutions and reanalyses
B. Initial calibration (including reporting whether $r^2 \geq 0.995$)
C. Initial and continuing calibration verifications
D. Method blanks, continuing calibration blanks and preparation blanks
E. ICP/ICP-MS interference check samples
F. Matrix spike and post-digestion spikes
G. Matrix duplicate samples
H. Laboratory control samples

I. Method of standard additions
J. ICP/ICP-MS serial dilution

Section V **Other Raw Data**
A. Sample digestion and preparation logs
B. Instrument analysis logs for each instrument used
C. Standard preparation logs, including initial and final concentrations for each standard used

Section VI **Electronic Data** – All analytical data will be supplied in electronic form as well as hardcopy form. All data will be provided as outlined in the DMP (Section 5.0).

4.6.3 Data Management (A9)

A complete discussion of data management procedures is provided in the DMP (Section 5.0).

4.7 Measurement And Data Acquisition (B)

This section describes the site investigation design and implementation, including method for sample collection, handling and analysis. In addition, field and laboratory QC procedures and instrument testing, inspection, maintenance and calibration requirements are described. The information for Sections B1 through B4 has been outlined in the FSP (Section 3.0).

4.8 Quality Control Requirements (B5)

The principal objectives of any sampling and analysis program are to obtain accurate and representative environmental samples and to provide valid analytical data. The quality of data will be assessed through the use of QC samples analyzed on a regular basis. Laboratory QC samples will be analyzed as per analytical method protocols to evaluate whether laboratory procedures and analyses have been completed properly. For this project, the types of QC samples to be analyzed are defined and their role in the production of QC data are discussed in the following sections. In addition to the particular QC requirements identified in the subsequent sections, all analyses must be performed within holding times and must adhere to all procedures as outlined in the appropriate SOPs (Appendix F).

4.8.1 Field Quality Control Samples (B5)

Field QC samples are samples that have been either collected or prepared in the field that must be blind to the analyst at the field laboratory or fixed-based (contract) laboratory.

Blind Field Split: Blind field split samples are two aliquots of the same sample that has been prepared blind to the analyst only after the original sample has been properly prepared (oven-dried, sieved and homogenized). These samples are submitted blind by the field sample preparation technician to the field or contract laboratory to measure the precision of laboratory preparation and analysis. Blind field splits are required to be collected at a frequency of 5% of all surface soil samples collected (1 field split per 20 investigative samples). The RPD for blind field splits should not exceed 25% or, alternatively, the absolute difference should not exceed 1 x MDL. However, these acceptance limits may be arbitrary; therefore, a graphical comparison of the original and field split samples should also be prepared. This comparison will include a linear regression and will report the calculated correlation coefficient (r). Additionally, control charting will be performed in accord with standard USEPA protocols and will be used to establish site-specific performance criteria for field split samples. Blind field splits will be prepared for surficial soil samples at residential properties, schools and parks and will be analyzed in the field laboratory. A subset of these samples may be submitted to the contract laboratory for analysis as well.

Field Duplicate: Field duplicate samples are co-located samples that are collected at the site by field sampling personnel. These samples are submitted blind to the field preparation technician and the field or contract laboratory to test both the precision of the analysis and the precision of sample collection. Field duplicates are required to be collected at a frequency of 5% of all surface soil samples collected (1 field duplicate per 20 investigation samples collected). The RPD for field duplicates should not exceed 25% or, alternatively, the absolute difference should not exceed 1 x MDL. However, these acceptance limits may be arbitrary; therefore, a graphical comparison of the original and field duplicate samples should also be prepared. This comparison will include a linear regression and will report the calculated correlation coefficient (r). Additionally, control charting will be performed in accord with standard USEPA protocols and will be used to establish site-specific performance criteria for field split samples. Field duplicate samples will be collected for alley surface soil samples only and will be analyzed in the field laboratory. A subset of these samples may be submitted to the contract laboratory for analysis as well.

Equipment Blank: An equipment blank is a collection of the rinsate produced from rinsing equipment that has been decontaminated after use with 100-120 mLs of analyte-free deionized water. Equipment blanks must be performed at a frequency of 5% of all decontaminations performed on each type of equipment. Concentrations of target analytes greater than 1 x MDL for most analytes and 5-10 x MDL for laboratory-induced contaminants may suggest that field sampling-induced contamination may have occurred. This sample will only be collected by field sampling personnel if decontamination is required. If all field sampling and preparation equipment is disposable (one-use only), then equipment blanks are not collected. This sample will be analyzed by a contract laboratory.

Blind Standard: The accuracy of an analytical method is evaluated by analyzing a sample medium fortified with a known concentration of target analytes that has been certified using the preparation and analysis method for that particular sample medium. This sample is submitted to the field or contract laboratory blind at a frequency of about 0.1% (about 30 samples) for each level. About 3 concentrations levels of blind standards should be available. The accuracy requirements will be provided by the certifying laboratory. Recoveries will also be monitored using control charting. Control charting will be performed in accord with standard USEPA protocols and will be used to establish site-specific performance criteria. These samples will be analyzed in both the field laboratory and contract laboratory.

Confirmation Sample: In accord with USEPA guidelines (SW-846 Method 6200), the analytical results measured by the XRF must be confirmed using another methodology (ICP, ICP-MS or GFAA) and performed by an independent contract laboratory. Confirmation analyses will be performed on at least 10% of surface soils collected during the Phase III Investigation. That is, a split will be submitted for confirmation analysis at a frequency of at least 10% of each type of surface soil (residential, alley and schools or parks). However, a greater frequency of confirmation samples will be required at the outset of the project. At initiation of field analyses, confirmation samples will be submitted to a contract laboratory at a frequency of 33% until confidence in accuracy of results between XRF and another contract laboratory method is obtained. That is, 1 split will be submitted for confirmation analysis for every 3 surface soil samples collected. A graphical comparison of the XRF analysis and the corresponding ICP, ICP-MS or GFAA metals analysis should also be prepared. This comparison will include a linear regression and will report the calculated correlation coefficient (r). Control charting will be performed in accord with standard USEPA protocols and will be used to establish site-specific performance criteria.

4.8.2 Laboratory Quality Control Samples (B5)

Laboratory QC samples are samples that are prepared at the laboratory and are analyzed along with field samples to monitor the accuracy and precision of analysis.

Matrix Spike: A matrix spike sample is an investigative sample having a matrix that is representative of all investigative samples to which a known concentration of target analytes is added. This quality control sample measures the extent that the sample matrix affects the accuracy of reported target analytes and must be performed at a frequency of 5% of all investigative samples prepared for ICP, ICP-MS or GFAA analysis (1 matrix spike for every 20 investigative samples) or 1 per preparation batch, whichever is more frequent. Specific accuracy and method requirements are summarized in Table 4-2.

Laboratory Control Sample (LCS): A LCS originates in the laboratory or is provided as a standard reference material (SRM) by a manufacturer (eg. NIST) and contains target analytes of

known concentration. Because LCSs are independent of the calibration standards, they are analyzed to verify the accuracy of the standards used to calibrate the instrument. A LCS must be performed at a frequency of 5% of all investigative samples prepared for analysis (1 LCS for every 20 investigative samples) or 1 per preparation batch, whichever is more frequent. The LCS must fall within manufacturer's certified acceptance limits. Specific accuracy and method requirements are summarized in Table 4-2.

Laboratory Duplicates: Laboratory duplicates are splits that are prepared by the field or contract laboratory. Because the laboratory is aware that the samples are duplicates, these samples serve to test the precision of the laboratory's sample preparation and analysis. A laboratory duplicate must be performed at a frequency of 5% of all investigative samples prepared for analysis (1 laboratory duplicate for every 20 investigative samples) or 1 per preparation batch, whichever is more frequent. The RPD for laboratory duplicates should not exceed 25% or, alternatively, the absolute difference should not exceed 1 x MDL.

Instrument Blanks: An instrument blank is composed of the reagents, solvents or matrix of investigative sample following sample preparation and are used to discern if laboratory-induced contamination is present. These samples must be inserted in the analysis stream at a frequency of 5% of samples at minimum. Concentrations of target analytes greater than 1 x MDL for most analytes and 5-10 x MDL for laboratory-induced contaminants may suggest that laboratory-induced contamination may have occurred. Corrective actions must take place prior to analysis of investigative samples. Specific accuracy and method requirements are summarized in Table 4-2.

4.9 Detection Limits (B5)

MDLs are defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the true value is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte. A MDL study must be performed for each method utilized in the study in accord with guidance outlined in the 40 CFR Part 136, Appendix B.

The PQL is defined as 10 times the standard deviation determined from the MDL study (or often described as 3 times the MDL). The project-required detection limits (MDLs and PQLs) required for each analytical methodology planned for this investigation are summarized below.

Table 4-1 Project-Required Detection Limits for Phase III Investigations

Instrument	Method	Method Detection Limits				Practical Quantitation Limits			
		Arsenic		Lead		Arsenic		Lead	
		mg/L	mg/kg	mg/L	mg/kg	mg/L	mg/kg	mg/L	mg/kg
XRF	SOP #MK-VBI70-06	–	10	–	50	–	30	–	150
ICP	USEPA SW-846 6010B	0.001	0.5	0.001	0.5	0.010	5	0.010	5
ICP-MS	USEPA SW-846 6020	0.005	0.01	0.01	0.5	0.5	1.0	1	5
GFAA	USEPA SW-846 7060 (Arsenic) and 7421 (Lead)	0.005	0.01	0.01	0.005	0.5	1.0	1	5

– Not applicable
XRF - X-ray fluorescence
ICP - Inductively Coupled Plasma
ICP-MS - Inductively Coupled Plasma-Mass Spectrometry
GFAA - Graphite Furnace Atomic Absorption

XRF Detection Limits

A MDL study will be performed on the instrument that will be used at the site to measure arsenic and lead levels in soil prior to initiation of the field investigation. Additionally, further MDL studies will be requested over the life of the project. These studies will be requested at least 3 times during the project, but may be requested more frequently. The additional MDL studies will be designed such that all analysts performing XRF analysis are evaluated. That is, a single analyst may not perform every MDL study. Further, the MDL studies will be designed so that analysis times and days of the week are varied. When a member of the USEPA or designate visits the field laboratory and requests a MDL study be performed, the analyst will complete

analysis of the current sample batch and immediately perform the study using the soil samples provided. At the end of the project, an average MDL will be determined for each target analyte using data from all MDL studies performed over the course of the project. These calculated values will be utilized and reported as the site-specific MDLs for the Phase III Investigation. The site-specific MDLs determined using the XRF will be used to determine the site-specific PQLs.

Laboratory MDLs

Results of a current (performed within a year of when analysis is completed) MDL study must be provided by the analytical laboratory that perform all soil confirmation and indoor dust analyses. Therefore, if more than one analytical laboratory is contracted to provided analytical support, MDL studies must be provided by each for the analyses performed. These studies must be provided prior to analysis of any investigative samples.

4.10 Instrument/Equipment Testing, Inspection and Maintenance Requirements (B6)

Field equipment planned for use during this investigation are a fixed-based XRF. This instrument will be inspected daily to ensure it remains in good working condition. Specific details about instrument inspection and maintenance is provided in the XRF SOP. All information relating to the daily instrument inspection, calibration and maintenance will be documented in a field logbook.

Laboratory equipment planned for chemical analysis during this investigation must be inspected daily to ensure it remains in good working condition. Any maintenance that is performed on the instruments must be documented in the respective instrument maintenance logbooks. The logbooks must remain on file accessible at the analytical laboratory for 5 years after analysis of Phase III samples.

4.11 Instrument Calibration and Frequency (B7)

Instrument calibration of field equipment will be performed daily (prior to initiation of analyses) in accord with procedures outlined in the respective SOPs. Calibration of the XRF will include measurement of at least 3 different levels of NIST-certified soil standards that span the range of the expected concentrations. Measurements of calibration standards must be within specifications outlined in the SOP for XRF analysis (Appendix F). Analysis of investigative samples may not begin until measurements of certified standards are within performance limits.

Laboratory instrumentation, used for sample analyses, will be calibrated in accordance with the SOPs or recommended USEPA methodologies. Calibrations must be acceptable before any measurements on investigative samples may be made. Traceable calibration standards will be

obtained by the analytical laboratories. All documentation relating to receipt, preparation and use of standards will be recorded in the appropriate laboratory logbooks. This information will be forwarded as part of the raw analytical data package as described in Section 4.6.2.

4.12 Assessment and Oversight (C)

The following sections describe activities for assessing the effectiveness of the implementation of the project and associated QA/QC. The purpose of the assessment is to ensure that the project plan is implemented as prescribed. The elements include assessments and response actions and reports to management as described in the following sections.

4.12.1 Assessment and Response Actions (C1)

4.12.1.1 Audits (C1)

Assessment of field activities and laboratory analyses will be conducted through oversight of analytical procedures through field and laboratory audits. The purpose of the oversight (audit) activities will be to document field sampling and analysis procedures, to determine if activities are proceeding in accord with project requirements and to document any changes, additions or deletions that have occurred during field sampling and analysis and to identify and immediately implement any corrective actions.

Field audits will evaluate field procedures to ensure that activities are proceeding in accord with the project plan. If conflicts are noted, these must be addressed so that project requirements are met.

Laboratory audits will evaluate laboratory procedures to ensure that they follow Good Laboratory Practices (GLP) Guidelines and to ensure that they do not conflict with project requirements. If conflicts are noted, these must be addressed so that project requirements are met. Additionally, laboratory analyses may also be assessed through submittal of performance evaluation (PE) samples. PE samples may be used as a tool for evaluating the accuracy of laboratory analyses. PE samples are standards submitted blind to the laboratory and are typically submitted prior to submittal of investigative samples. The concentration is unknown to the laboratory analyzing the sample, but known to the submitter. The laboratory reported results for the PE samples will be evaluated by comparison to the certified values provided by the contractor providing field and laboratory oversight (ISSI).

Other audits that will be carried out over the course of the project include:

- Review and verification of procedures followed as part of real-time control charting of QC samples analyzed via field and contract laboratory procedures
- Evaluate the flow of electronic data
- Review and verification of hardcopy data

Audits will review the data flow, verify data entry procedures and evaluate whether data management QC protocols are being observed. If audits resulting from review of any of the procedures reveal that project requirements are not met, then corrective action for the deviation must be requested, reviewed and reported. Results for all audits must be documented and submitted to the USEPA Remedial Project Manager. Information in the report includes:

- Type of System Audit (Field, Laboratory, Data Management, etc.)
- Date of audit
- Summary of procedures reviewed
- Results of the review/audit including any non-conformances noted
- Corrective Action Request(s) [CAR], if non-conformance noted
- Date by which CAR must be received with response

If a CAR is required, a follow-up audit must be performed withing 5 working days upon receipt of the CAR to ensure that corrective actions were implemented. A Follow-up audit report describing the new findings must be submitted to the USEPA RPM. More detailed information regarding corrective action procedures is provided in the next section.

4.12.1.2 Corrective Action Procedures (C1)

Two types of corrective actions may result from audits and/or oversight: immediate and long-term. Immediate corrective actions include correcting deficiencies or errors or correcting inadequate procedures. Long-term corrective actions are designed to eliminate the sources of deficiencies or errors. If either type of corrective action is deemed necessary following an audit, each step in the following procedures must be documented:

- Identify the deviation
- Request a corrective action
- Report the problem the USEPA RPM
- Review the corrective action response
- Perform a follow-up audit to ensure the deviation is not recurring

Appropriate corrective action procedures for specific laboratory or field quality control samples are outlined in the subsequent paragraphs. Refer to Table 4-2 for recommended corrective

action.

4.13 Data Validation And Useability (D)

The following sections describe the requirements and methods for data review, validation and verification. In addition, the process for reconciling the data generated with the requirements of the data user is also defined.

4.13.1 Data Review Validation and Verification (D1)

The process of data review, validation and verification is intended to provide consistent and defensible analytical results. Analytical data generated as part of this project will be reviewed and verified before they are incorporated into the project database. Full data validation will be completed on approximately 10% of the data generated for this project. Abbreviated validation will be completed on all other analytical data. Abbreviated and full data validation criteria are described in Section 4.13.2. Full data validation will be performed in accordance with *USEPA National Functional Guidelines for Inorganic Data Review* (USEPA 1994a), the requirements of this project plan and the requirements in SW-846. Note that the project plan supercedes any discrepancies in accuracy and precision requirements among the three cited documents. Abbreviated validation will utilize these guidelines as they pertain to the components outlined in Section 4.13.2.

4.13.2 Validation and Verification Methods (D1)

Full Validation: Full validation will be conducted on data packages for 10% of the samples submitted for chemical analysis. This will be performed to ensure that data were produced in accord with procedures outlined in this project plan. The following elements will be reviewed for compliance as part of the full data validation:

- Methodology
- Holding Times
- Calibration
- Blanks
- Spikes
- Duplicates
- LCSs
- Practical Quantitation Limits
- Analyte Identification
- Analyte Quantification

Abbreviated Validation/Verification: Abbreviated validation will be completed on 100% of the

analytical results for which full validation was not performed (the remaining 90% of analytical results). This will be performed to ensure that data were produced in accord with procedures outlined in this project plan. The following elements will be reviewed for compliance as part of the abbreviated data validation:

- Methodology
- Holding Times
- Calibration
- Blanks
- Spikes
- Duplicates

4.14 Final Reporting

Data reporting consists of communicating summarized data in a final form. QA for reporting consists of measures intended to avoid or detect human error and to correct identified errors. Such methods include specification of standard reporting formats and contents of measures to reduce data transcription errors.

Laboratory Reports: All raw data and analytical results will be provided by the commercial laboratory. This information will be incorporated into a final report which will be provided in both hardcopy and electronic forms. Copies (hardcopy and electronic) of the raw analytical data packages will be submitted to USEPA for archival. More information regarding data management is provided in Section 5.0.

Study Report: A draft report of all the summary study design characteristics, sample analyses, data quality, correlation results and resulting field and analytical data shall be presented by the prime contractor in both hardcopy and electronic forms. Additionally, the electronic database will also be provided to the USEPA. Simple statistical tests of group treatment differences will be performed and presented as discussed in Section 2.0. This report will undergo technical review by USEPA. If necessary, comments to the draft report will be provided to the prime contractor and a final report will be issued (hardcopy and electronic).

4.15 Reconciliation with Data Quality Objectives (D3)

Information obtained from the VBI70 Phase III Field Investigation will be evaluated through the Data Quality Assessment (DQA) process to determine if the data obtained are of the correct quality and quantity to support their intended use. The DQA process consists of five steps as summarized below (USEPA 1996, 1998b).

Review the DQOs and Sampling Design: DQO outputs will be reviewed to ensure that they are still applicable. The sampling analysis and data collection documentation will also be reviewed for completeness and consistency with DQOs.

Conduct a Preliminary Data Review: Data validation reports will be reviewed to identify any limitations associated with the analytical data. Basic statistics will be utilized where applicable and meaningful graphs of the data will prepared. This information will be used to learn about the structure of the data and to identify patterns, relationships or potential anomalies/outliers.

Select the Statistical Test: The most appropriate statistical procedure for summarizing and analyzing the data will be selected based on the review of the DQOs, the sampling design and the preliminary data review. Key underlying assumptions will be identified that must hold true for the statistical procedures to be valid.

Verify the Assumptions of the Statistical Test: The statistical test will be evaluated to determine whether the underlying assumption holds or whether departures from the assumptions are acceptable given the actual data or other information about the study.

Draw Conclusions from the Data: Calculations required for the statistical test will be completed and inferences drawn as a result of these calculations will be documented.

Table 4-2: Required Quality Control and Recommended Corrective Action for Phase III Investigations

QC Performed	Sample Matrix	Minimum Frequency	Acceptance Criteria: General Requirements (GR)*	Acceptance Criteria: GFAA Method 7060 & 7421	Acceptance Criteria: ICP Method 6010 B	Acceptance Criteria: ICP/MS Method 6020	Acceptance Criteria: XRF SOP #MK-VB170-06	Recommended Corrective Action: General Requirements (GR)	Recommended Corrective Action: GFAA Method 7060 & 7421	Recommended Corrective Action: ICP Method 6010 B	Recommended Corrective Action: ICP/MS Method 6020	Recommended Corrective Action: XRF SOP #MK-VB170-06
Blind Standard	Residential, Alley, School and Park Soils and Indoor Dust	90 samples (30 samples for each spike level) About 3 concentration levels of blind standards will be available.	Accuracy requirements will be provided by the certifying laboratory Recoveries will also be monitored using control charting Control charting will be performed in accord with standard USEPA protocols and will be used to establish site-specific performance criteria	See GR	See GR	See GR	See GR	Verify the percent recovery calculations. If calculations are correct, the FQAC will request the analyst to reanalyze the sample. If reanalysis results are still outside of acceptance limits, submit another blind standard immediately into the sample stream to determine if the analysis shows a trend or an isolated event. *Analysis of site samples may be discontinued until the problem is resolved*	See GR	See GR	See GR	See GR
Confirmation Samples	Residential, Alley, School and Park Soils	33% of surface soils until notified by the USEPA RPM, then at least 10% of surface soils	A graphical comparison of the XRF analysis and the corresponding ICP, ICP-MS or GFAA metals analysis should also be prepared. This comparison should include a linear regression with the calculated correlation coefficient (r). R should be >0.9.	N/A	N/A	N/A	N/A	Validate and/or verify the data Determine if outliers are affecting the correlation. If so, remove the outliers and recalculate r If no source of error can be identified, report the r value as is.	See GR	See GR	See GR	See GR
Continuing Calibration Blank (CCB)	Residential, Alley, School and Park Soils and Indoor Dust	every 10 samples in the analytical batch (before the CCV), *or once every 2 hrs. during the analytical run, whichever is more frequent. A CCB must be run after the last CCV after the last sample.*	N/A	≤ 1 x MDL	within 3 x IDL for each analyte	< 3 x IDL for each analyte.	N/A	Evaluate instrument or system, locate source of contamination, and perform a system blank to determine if the system blank meets acceptance criteria Continue to perform system blanks until acceptance criteria are met. *Reanalyze the blank and associated investigative samples. If the absolute value of the blank exceeds the PQL, correct the problem, recalibrate instrument, verify the calibration, and reanalyze the preceding 10 analytical samples or all of the analytical samples analyzed since the last good calibration blank.*	All samples following the last acceptable CCB must be reanalyzed.	If the average recoveries are not within 3 standard deviations of the background mean, terminate analysis, correct the problem, recalibrate the instrument. Re-analyze the previous 10 investigative samples.	Cause of the problem must be determined, corrected, and all samples analyzed since the last acceptable CCB must be re-analyzed. If a lab consistently has concentration values > 3 x IDL, the IDL may be indicative of an estimated IDL, and must be re-evaluated.	N/A
Energy calibration check		1) Beginning and end of each working day 2) After batteries are changed 3) After instrument has been shut off. 4) Any other time when operator believes that drift is occurring.	N/A	N/A	N/A	N/A	Manufacturer's recommended count time should be used for the check: pure elements (Fe, Mn, Cu, Pb) are usually used for this check	N/A	N/A	N/A	N/A	Reposition pure element sample and reanalyze If criteria are still not met, energy calibration must be performed as described in the manufacturer's manual. Do not analyze investigative samples until criteria are met.

QC Performed	Sample Matrix	Minimum Frequency	Acceptance Criteria					Recommended Corrective Action				
			General Requirements (GR)*	GFAA Method 7060 & 7421	ICP Method 6010 B	ICP/MS Method 6020	XRF SOP #MK-VB170-06	General Requirements (GR)	GFAA Method 7060 & 7421	ICP Method 6010 B	ICP/MS Method 6020	XRF SOP #MK-VB170-06
Continuing Calibration Verification (CCV)	Residential, Alley, School and Park Soils and Indoor Dust	every 10 samples in the analytical batch (after the CCB) For XRF analysis, once per batch of investigative samples	N/A	90-110% recovery of known value	90-110% recovery of known value	90-110% recovery of known value	80-120% recovery of known value	Verify the percent recovery calculations. If calculations are correct, evaluate the standard to determine if it is faulty. If it is, prepare a new standard and reanalyze the CCV and all associated investigative samples. If necessary, recalibrate the instrument. *Do not continue analysis until the problem is solved. If and > control limits, stop analysis, correct problem, recalibrate instrument, verify calibration, and reanalyze all samples analyzed since the last good CCV.*	Discontinue sample analysis, determine cause of the problem, correct the problem, and recalibrate the instrument.	See GR	See GR	reanalyze check sample, if still not acceptable, recalibrate instrument; all samples analyzed since the last acceptable CCV must be reanalyzed.
Equipment Blank	Residential, Alley, School and Park Soils and Indoor Dust	5% of all decontamination is performed on each type of equipment	target analytes <1 x MDL; 10 x MDL for laboratory-induced contaminants	See GR	See GR	See GR	N/A	Suggests that field sampling-induced contamination may have occurred. Evaluate all associated QC samples. If all other QC samples are within prescribed acceptance limits, but the equipment blank is not (e.g., positive identifications of target analytes are observed), *contact the USEPA immediately to determine whether resampling and/or reanalysis is required.*	See GR	See GR	See GR	N/A
Field Duplicate (FD)	Alley Soils	5% of all surface soil samples. (1 field duplicate per 20)	RPD < 25% or the absolute difference should not exceed 1 x MDL. A graphical comparison of the original and field duplicate samples should also be prepared. Recoveries will also be monitored using control charting. Control charting will be performed in accord with standard USEPA protocols and will be used to establish site-specific performance criteria. This comparison will include a linear regression and will report the calculated correlation coefficient. R should be >0.9.	See GR	See GR	See GR	See GR	Verify the RPD calculation. If this is correct, determine if matrix interference or heterogeneous samples are factors in the poor RPD. If matrix effects or heterogeneous samples are not observed, reanalyze the method duplicate and associated investigative samples. *If appropriate, re-extract or redigest and reanalyze the method duplicate and associated investigative samples*	See GR	See GR	See GR	See GR
Blind Field Split (BS)	Residential, School and Park Soils	5% of all surface soil samples. (1 field duplicate per 20)	RPD < 25% or the absolute difference should not exceed 1 x MDL. A graphical comparison of the original and field duplicate samples should also be prepared. Recoveries will also be monitored using control charting. This comparison will include a linear regression and will report the calculated correlation coefficient. R should be >0.9. Additionally, control charting will be performed in accord with standard USEPA protocols and will be used to establish site-specific performance criteria.	See GR	See GR	See GR	See GR	Verify the RPD calculation. If this is correct, determine if matrix interferences or heterogeneous samples are factors in the poor RPD. If matrix effects or heterogeneous samples are not observed, reanalyze the method duplicate and associated investigative samples. *If appropriate, re-extract or redigest and reanalyze the method duplicate and associated investigative samples.*	See GR	See GR	See GR	See GR

QC Performed	Sample Matrix	Minimum Frequency	Acceptance Criteria					Recommended Corrective Action				
			General Requirements (GR)[a]	GFAA Method 7060 & 7421	ICP Method 6010 B	ICP/MS Method 6020	XRF SOP #MK-VB170-06	General Requirements (GR)	GFAA Method 7060 & 7421	ICP Method 6010 B	ICP/MS Method 6020	XRF SOP #MK-VB170-06
Initial Calibration Blank (ICB)	Residential, Alley, School and Park Soils and Indoor Dust	beginning of each run or beginning of every new shift (whichever is more frequent)(before the ICV)	N/A	≤ 1 x MDL	< 1 x MDL	< 3 x IDL for each analyte.	N/A	Evaluate system, locate source of contamination, and perform a system blank to determine if the system blank meets acceptance criteria. Perform instrument maintenance until analysis of system blanks meets acceptance criteria. *Do not begin analysis of investigative samples until criteria are met*	Determine the cause, correct the problem, and recalibrate the instrument before any samples are analyzed	See GR	See GR	N/A
Initial Calibration Verification (ICV)	Residential, Alley, School and Park Soils and Indoor Dust	beginning of each run *and after the last analytical sample*, or beginning of every new shift (whichever is more frequent)(after the ICB)	N/A	90-110% recovery of known value	90-110% recovery of known value	90-110% recovery of known value	Follow procedures outlined in operator's manual. 80-120% recovery of known value, regardless of which calibration procedure is used	Verify the percent recovery calculations. If calculations are correct, evaluate the standard to determine if it is faulty. If it is, prepare a new standard and reanalyze the ICV and all associated investigative samples. If necessary, recalibrate the instrument. *Do not continue analysis until the problem is solved.*	Calibration curves must cover the appropriate concentration range, as determined by Project specifications. Blanks and standards should produce an absorbance of 0.0 - 0.7	Terminate analysis, correct the problem, and recalibrate the instrument. Any sample analyzed under an out-of-control calibration must be re-analyzed	Terminate analysis, correct the problem, and recalibrate the instrument. Any sample analyzed under an out-of-control calibration must be re-analyzed.	Follow corrective procedures as outlined in operator's manual.
Laboratory Control Sample (LCS) or Standard Reference Material (SRM)	Residential, Alley, School and Park Soils and Indoor Dust	5% or 1 per batch (whichever is more frequent)	must be within manufacturer's established acceptance limits	80-120% of known value	See GR	See GR	Follow procedures outlined in operator's manual. 80-120% recovery of known value, regardless of which calibration procedure is used.	Verify the percent recovery calculations. Evaluate the standard to determine if it is faulty. If it is, prepare a new standard and reanalyze the LCS and associated investigative samples. If necessary, recalibrate the instrument. *Do not continue analysis until the problem is solved*	Re-run the LCS or SRM one time. If still not acceptable, all samples analyzed after the last acceptable LCS must be re-prepped and re-analyzed	See GR	See GR	See GR
Matrix Spike (MS)	Residential, Alley, School and Park Soils and Indoor Dust	5% or 1 per batch (whichever is more frequent)	N/A	80-120% recovery of known value	75-125% spiked sample recovery (spiking level plus original sample level)	75-125% recovery of known value	N/A	Verify the matrix spike percent recovery calculations and evaluate the LCS percent recoveries. If the calculations are correct and the LCS recoveries are acceptable, determine if matrix interference is a factor in the poor recoveries. If matrix effects are not observed, reanalyze the matrix spike and associated investigative samples. *If appropriate, re-extract or redigest and reanalyze the matrix spike and associated investigative samples*	Interference test must be conducted (see SW 846 Method 7060 and 7421 for description of interference tests).	Locate source of the problem, correct it, and re-analyze any samples that were run during the out-of-control condition.	Locate source of the problem, correct it, and re-analyze any samples that were run during the out-of-control condition.	N/A

QC Performed	Sample Matrix	Minimum Frequency	Acceptance Criteria					Recommended Corrective Action				
			General Requirements (GR)*	GFAA Method 7060 & 7421	ICP Method 6010 B	ICP/MS Method 6020	XRF SOP #MK-VB170-06	General Requirements (GR)	GFAA Method 7060 & 7421	ICP Method 6010 B	ICP/MS Method 6020	XRF SOP #MK-VB170-06
Method Blank (MB)	Residential, Alley, School and Park Soils and Indoor Dust	5% or 1 per batch (whichever is more frequent) For XRF: each working day before and after analytical run, 1 per 20 investigative samples during run, when contamination is suspected by the operator. Manufacturer's recommended count times per source should be used	Absolute value < PQL	< 1 x MDL; or 10% of lowest concentration for each analyte.	< 1 x MDL except for common laboratory contaminants which may be 5-10 x MDL. *If any analyte concentration is > PQL the lowest conc of that analyte in the associated samples must be 10x more than the conc. found in the blank.*	< 1 x MDL except for common laboratory contaminants which may be 5-10 x MDL. *If any analyte concentration is > PQL the lowest conc. of that analyte in the associated samples must be 10x more than the conc. found in the blank.*	< MDL for each analyte.	Evaluate instrument, locate source of contamination, perform system blanks to confirm that the system blank meets performance criteria. Re-analyze method blank and associated samples *If method blank is still above the acceptance criteria, re-extract or redigest the method blank and all associated samples.*	See GR	See GR	See GR	check probe window, blank sample should be checked for contamination. If not contamination present, instrument must be zeroed following manufacturer's instructions Re-analyze all samples since the last acceptable MB.
Method Duplicate (MD)	Residential, Alley, School and Park Soils and Indoor Dust	5% or 1 per batch (whichever is more frequent)	RPD < 25% (if 5 x MDL), absolute difference 1 x MDL	See GR	RPD < 25% (if 5 x MDL), absolute difference 1 x MDL	RPD < 25% (if 5 x MDL), absolute difference 1 x MDL	See GR	Verify the RPD calculation If this is correct, determine if matrix interference or heterogeneous samples is a factor in the poor RPD. If matrix effects or heterogeneous samples are not observed, reanalyze the method duplicate and associated investigative samples. *If appropriate, re-extract or redigest and reanalyze the method duplicate and associated investigative samples.*	See GR	See GR	See GR	See GR
Post-digestion Spike (PDS)	Residential, Alley, School and Park Soils and Indoor Dust	as required, if matrix spike does not meet acceptance criteria	N/A	85-115% of known value	85-115% recovery of post-spiked sample	75-125% of known value.	N/A	Verify the percent recovery calculations. If these are acceptable and the spike addition produces a minimum level of 10 times to a maximum of 100 times the instrument detection limit (IDL), matrix effects should be suspected. No further action is required.	If recovery <40%, dilute sample by factor of 5-10 and rerun. If after dilution recovery still <40%, report problem to USEPA	Sample must be diluted and re-analyzed to compensate for possible matrix effects. Results must agree to within 10% of the original determination	Sample must be diluted and re-analyzed to compensate for possible matrix effects. Results must agree to within 10% of the original determination	N/A
System Blank	Residential, Alley, School and Park Soils and Indoor Dust	as required; if other blank samples are not meeting acceptance criteria	< 1 x MDL	See GR	See GR	See GR	N/A	Evaluate system, locate source of contamination, and perform a system blank to determine if the system blank meets acceptance criteria. Perform instrument maintenance until analysis of system blanks meet acceptance criteria. *Do not begin analysis of investigative samples until criteria are met.*	See GR	See GR	See GR	N/A

QC Performed	Sample Matrix	Minimum Frequency	Acceptance Criteria					Recommended Corrective Action				
			General Requirements (GR)*	GFAA Method 7060 & 7421	ICP Method 6010 B	ICPMS Method 6020	XRF SOP #MK-VB170-06	General Requirements (GR)	GFAA Method 7060 & 7421	ICP Method 6010 B	ICPMS Method 6020	XRF SOP #MK VB170-06
Instrument Blank (IB)	Residential, Alley, School and Park Soils	5% or 1 per batch (whichever is more frequent)	N/A	N/A	N/A	N/A	Follow procedures outlined in operator's manual. 80-120% recovery of known value, regardless of which calibration procedure is used.	Evaluate system, locate source of contamination, and perform a system blank to determine if the system blank meets acceptance criteria. Perform instrument maintenance until analysis of system blanks meet acceptance criteria. *Do not begin analysis of investigative samples until criteria are met.*	N/A	N/A	N/A	check probe window; blank sample should be checked for contamination. If not contamination present, instrument must be zeroed following manufacturer's instructions. Re-analyze all samples since the last acceptable IB.

*General Requirements should be followed in all cases, except where the requirements of the method are specified. In those cases, follow general requirements as stated and then refer to specific requirements for each method.

MDL - Method Detection Limit
RPD - Relative Percent Difference
PQL - Practical Quantitation Limit
IDL - Instrument Detection Limit
SRM - Standard Reference Material
N/A - Not Applicable

5.0 DATA MANAGEMENT PLAN

This Data Management Plan (DMP) describes the data management practices to be implemented during the performance of the VBI70 Site Phase III Sampling Program. This DMP defines data flow paths, identifies and assigns organizational and individual responsibilities, and describes the procedures and protocols by which the data management processes function.

5.1 DMP Objectives

This DMP is designed to ensure that VBI70 Site data are collected in a consistent manner and transferred to a central repository in an orderly and timely manner. This DMP provides the structure required to incorporate and disseminate data collected during the Phase III Field Investigation.

In summary, the objectives of the DMP are to:

- Identify and assign organizational and individual responsibilities;
- Describe the flow of information through the data management process;
- Describe the checks and controls necessary to insure data accuracy and validity;
- Identify and address key data elements and process dependencies; and
- Provide an organized and controlled system for the handling of data that will allow future users to make informed decisions regarding the comparability of historical data sets.

5.2 Organizational Relationships

Key project personnel and organizational relationships are described in Section 1.0.

5.3 Organizational Responsibilities for the Database

The Project Data Manager (ISSI) is ultimately responsible for the overall data management process of the project database. This process includes the development, implementation, and maintenance of procedures and protocols to ensure that the data are properly documented, stored, retrieved, analyzed. and archived.

MK is responsible for maintaining project files of all data generated during the Phase III field investigation until these files are transferred to the final repository (the Project Database) at ISSI and then ultimately to the files at USEPA. MK and subcontracted analytical laboratories are responsible for collecting data according to project requirements; reviewing data for accuracy, completeness, and technical adequacy under approved quality control procedures; completing, reviewing, and signing appropriate data processing forms; and transferring original data and data forms to the USEPA RPM for cataloging and storage. It is the responsibility of the MK Site

Manager to forward copies of all field and laboratory generated data to the RPM in a timely manner. Validated electronic updates of the database must be submitted by MK on a biweekly basis at a minimum.

5.4 Data Management Team Responsibilities

The key personnel and primary responsibilities of the Data Management Team (DMT) are summarized below. Some of the functional responsibilities described can be held by a single person or delegated to other individuals as appropriate. However, it is the responsibility of the person identified to ensure that tasks are completed.

Data Services Manager (ISSI) - Develops and revises standard operating procedures and protocols for the DMT to achieve data management guidelines. These procedures and protocols are subject to the approval of the USEPA Technical Contact for Data Management/GIS.

Project Database Manager (ISSI) – The Project Database Manager is responsible for overseeing the development, implementation, and maintenance of the computerized database used to electronically store and process project data. The Database Manager is also responsible for the identification and acquisition of hardware and software necessary for the efficient, effective storage, retrieval, and manipulation of computer-based data files. The Database Manager works with project management and technical personnel during initial project planning to identify those key data parameters to be included in the computerized project database and estimates the scope of required data programming, entry, database error-checking, and electronic file maintenance services. The Project Database Manager is also responsible for database security.

Field Activities Database Manager (MK) – The Field Activities Database Manager is responsible for overseeing the accurate and complete population and maintenance of the computerized database used to electronically store and process data obtained during field collection activities. The Field Activities Database Manager is responsible for verification of electronic data entry and maintenance of hard copy forms and logbooks. The Field Activities Database Manager is also responsible for electronic database and document security.

Project Records Manager (USEPA) - The Project Records Manager is responsible for coordinating the receipt, cataloging and filing of all hard copy documents and electronic data deliverables. Upon receipt of a document, the Project Records Manager assigns it a Document Control Number (DCN) and enters this number in the Superfund Document Management System (SDMS). Electronic data are routed to the Project Database Manager for electronic data entry and processing. Hard copy data documents are stored in appropriate project files.

Field Activities Records Manager (MK and ISSI) - The Field Activities Records Manager is responsible for coordinating the receipt, cataloging and filing of all hard copy documents and

electronic data deliverables. Upon receipt of a document, the Field Activities Records Manager assigns it a MK Document Control Number (DCN). The Field Activities Records Manager reviews the document for legibility and completeness. Illegible or incomplete documents are returned to their source for correction/amendment and re-submittal. Hard copy data are forwarded to the Data Entry Clerk for manual data entry and independent data entry verification. Additionally, the Field Activities Records Manager is responsible for coordinating analytical laboratory services, communicating data deliverable requirements, receiving and routing completed laboratory data packages to qualified chemical data validation/verification personnel and ultimately submitting the validated/verified data to the Field Activities Database Manager for incorporation into the database.

Systems Programmer/Analyst (ISSI) - Systems Programmers/Analysts are responsible for assisting the Project Database Manager with developing, implementing, and maintaining computerized databases used to store project data.

Data Entry Clerk (ISSI and MK) - Data Entry Clerks are responsible for the manual entry of selected project data into the electronic database under the direct supervision of the USEPA Work Assignment Manager (WAM). Data Entry Clerks also perform independent error-checks on the data files and make corrections as needed.

5.5 Forms of Data

A variety of data forms are anticipated to be collected during the Phase III Field Activities. These include, but are not limited to:

- Field Data Sheets
- Field observations and measurements
- Maps
- Photographs
- Laboratory analysis results and quality control data
- Information on Requesting and Receiving Property Access

Access Agreements - These data include the property street address and house number, the name and signature of the property owner, the signature date, the owner's phone number and any comments provided by the property owner at the time of access authorization.
Field Data Sheets - These data include identification of sampling locations, the spatial layout and design of existing buildings and structures, sample collection and preparation measurements, and sample identification numbers. The procedures by which these forms are completed are summarized in the FSP (Section 3.0).

Field Observations - These data include descriptions of weather conditions encountered during

sampling, names of the sampling crew, deviations from the FSP or SOP, and any anomalies observed while collecting the sample (e.g., visible staining, strong odor, etc.). The procedures by which these observation are made are summarized in the FSP (Section 3.0).

Maps - Maps may be developed in the field during sample collection efforts (field diagrams) or may be prepared after sampling is complete using GIS tools.

Photographs - Photographs may be taken during implementation of field activities when visual records of the activities are required. Additionally, aerial photographs of the site may be used as a GIS tool for development of a base map of the site.

Laboratory Analyses - The results of physical and chemical laboratory analyses of field samples are another form of data that will be incorporated into the database. Typically, these data are acquired from laboratories in hard copy and/or electronic format.

Differing levels of reliability may be placed on data with respect to their accuracy and precision. Within the context of data management, two distinct types of data will be stored in the Project Database: primary and secondary.

5.5.1 Primary Data

Primary data derive principally from two sources: on-site field observations and laboratory analyses of physical samples taken as a part of on-site investigations. Because these data are collected and tested using procedures and protocols outlined in the Project Plan, they are of quantifiable accuracy and precision. Examples of primary data include field data sheets, field observations, field maps (site diagrams) and analytical laboratory data packages.

5.5.2 Secondary Data

Secondary data include all data generated by private and public entities outside of the scope of the Project Plan. These data typically include such documents as:

- Site-specific and regional vicinity maps
- Historical land use and property ownership records
- Regional geologic, and hydrologic survey data collected by outside firms and public agencies
- Site-specific physical and chemical data generated by outside firms and agencies not directly involved in this study
- Published accounts of investigations undertaken at other sites that may assist in the analysis and interpretation of site-specific primary data collected

If not carefully documented, secondary data can be of variable and indeterminate accuracy and precision. Whenever data obtained from secondary sources are of uncertain merit, they must be used with caution in any decision-making process.

5.6 Data Flow

A conceptual diagram of data flow for the Phase III sampling is presented in Figure 3-1 of the FSP (Section 3.0). The following sections describe the sources of information and the processes identified for the collection, transfer and organization of primary and secondary data sources.

5.6.1 Reference Data Sources

Two principle sources of secondary data are utilized in the collection and management of information for the Phase III investigation, the 1998 City and County of Denver Tax Assessment data and the historical VBI70 Phase I and Phase II site investigation data. These data are used for the purpose of generating key derivative reference tables (Access Agreement Database). As stated in the FSP (Section 3.0), the Access Agreement Database are updated as new data are received during implementation of the Phase III investigation.

1998 City and County of Denver Tax Assessor Data - The initial source of data for property and ownership information is the 1998 City and County of Denver Tax Assessor data purchased from Property Data Center, Inc. (PDC). These data consist of approximately 11,000 property and ownership records bounded to the North by East 52nd Avenue, to the South by East 26th Avenue, to the East by Colorado Boulevard, and to the West by Inca Street. Some of the data points included are: property addresses, coordinates, land use classifications, living area square footage, and ownership information.

Historical Phase I and Phase II Sampling Data – Roughly 1500 properties were sampled for metals in 1998 by Superfund Technical Assessment and Response Team (START) and Response Engineering and Analytical Contract (REAC) personnel. This information is used initially to simply exclude previously sampled properties from the Phase III field sampling event.

The reference tables and data points derived from the reference data are summarized below.

Reference Table	Data Points
List of Prospective Properties	Property address Geographic coordinates Land use classifications Total living area
Ownership Information	Owner name Owner address
Access Agreements	Date of mailing Authorization status Contact information and language preference

The list of all prospective properties is processed, using study area boundary and historical sampling information, to form a list of target properties. Letters requesting from USEPA requesting authorization for access are then generated for owners of target properties and tracked as described in Section 3.0.

5.6.2 Data Acquisition

This section summarizes the collection, transfer and organization of primary field observations and laboratory analyses with regard to the data management process. Details regarding specific data collection procedures can be found in the FSP (Section 3.0).

5.6.2.1 Field Sampling

Prior to field sampling, a list of properties approved for sampling is generated by the Site Manager. Each sampling team is then given blank copies of media specific data collection forms and a set of pre-printed sample identification numbers printed on self-adhesive labels. The data form is filled out at the time of sample collection by the sample collection team according to procedures detailed in the FSP (Section 3.0).

Upon completion of daily sampling activities, the sampling team returns to the field office location with samples and corresponding data sheets. The FPL maintains a log of sample identification numbers that have been used, noting any missing or destroyed labels. Data sheets are forwarded to the FPL for review. Verified forms are then forwarded for entry into the Field

Activities Database for data entry. Refer to the Data Entry SOP No. ISSI-VBI70-05 for more details.

5.6.2.2 Laboratory Data Entry

During sample analysis at the laboratory, analytical results are either entered into the laboratory information management system or directly downloaded from the analytical instrument. The data are reviewed in the laboratory for errors or omissions to assure that the data are reported in the correct format. Upon completion of these efforts, the laboratory submits the data electronically accompanied by the hardcopy raw data to the appropriate Field Activities Records Manager (e.g., ISSI or MK). All data transfer activities follow only after appropriate data screening, verification and validation procedures.

5.7 Database Organization

A database consists of conceptual and physical design components. The conceptual design integrates the intended function, contents, and products of the project database; the procedures for data entry and electronic data incorporation; the needs of data users; and compatibility requirements (within database software limitations). The physical design implements the conceptual design through programming, data incorporation, and built-in software functions.

In addition to meeting the needs of data users, the database management system will incorporate the following capabilities:

- Store tabular data (such as analytical results, qualifier codes, sample locations) in a relational database management system.
- Allow the user to query multidisciplinary data.
- Provide an audit trail for sample tracking, including a QA program to minimize erroneous data entry.
- Allow integration of new data.
- Document the database structure, code definitions, and means of accessing information.

A client-server database system is utilized for the management of Phase III data. The project database is stored and maintained on a Microsoft SQL Server database system (server) located in the ISSI Denver office. Wide area network access to the project database is provided via TCP/IP communications (Internet). Data entry and reporting are performed using a custom MS Access interface (client) developed by ISSI and tailored specifically for the Phase III Field Investigation. The Access tables store the data in a structure consisting of rows and columns. Relationships define how data in one table relate to data in another table. Queries store the framework for selecting subsets of data from tables. The database is constructed of data tables and reference, or "look-up" tables. A detailed description of the Project Database structure is presented in

Appendix H.

The following outlines present a generalized structure of the data tables and field attributes for the project database.

For Properties Approved for Sampling:

Property Location Information
- House Number
- Street Name
- Neighborhood

Property Surface Soil Sample Information
- Building Type (Residential, School, Park, Alleyway)
- Depth of Sample
- Sample Type (Composite, Grab)

Property Indoor Dust Sample Information
- Number of Templates Collected
- Number of Templates Taken

All Media
- Chain-of-Custody Information
- Analytical Results
- Analysis and Sample Preparation Methods
- Laboratory and Validation Qualifiers

Access Agreement Tables

Owner Information Table
- Owner Contact Information
- Owner Language Preference

Access Agreement Letter Table
- Target Property Address
- Date Letter was Sent
- Status of Access Authorization (approved or denied)

5.8 Data Screening, Verification, and Validation

All documents received and catalogued by the DMT are subject to review. Two separate and distinct levels of document review are performed:

- Data Verification
- Data Validation

The following paragraphs describe the performance of these two levels of data review.

5.8.1 Data Verification

The term 'verification' refers to a review process in which data are checked for accuracy and completeness. The Project Database Manager and Field Activities Database Manager are responsible for overseeing this effort. Data verification will be performed on all original data (e.g., sample data collection sheets) to ensure that all information is correct. Any hardcopy or electronic data requiring modification as a result of the verification effort are returned to the source for amendment or correction. After the correction or amendment is complete, the data are then returned to the Project Database Manager or Field Activities Database Manager (as appropriate) and are re-verified to ensure that the appropriate corrections and/or amendments were performed correctly.

5.8.2 Data Validation

Data validation, as it pertains to database management, refers to a point-by-point comparison of the database with the primary data source (e.g., data collection sheets, COC forms, etc.). Database validation will be performed on all data transfers, however, the extent of that validation effort is dependent on how the data were compiled into the database.

Manual Data Entry

One hundred percent of all data entered onto a database table will be verified for accuracy. If corrections or amendments are required as a result of the review, this will be performed in accord with the details outlined in Section 5.9. After the correction or amendment is complete, the data are returned and points where corrections were requested are re-validated to ensure that the appropriate corrections and/or amendments were performed correctly.

Electronic Data Transfer

Twenty percent of all data that are transferred in electronic form will be verified for accuracy against the original hardcopy data. If corrections or amendments are required as a result of the

review, this will be performed in accord with the details outlined in Section 5.8.3. After the correction or amendment is complete, the data are returned and points where corrections were requested are re-validated to ensure that the appropriate corrections and/or amendments were performed correctly.

When errors in the data are observed, further verification of the electronic data is necessary. One hundred percent of the electronic data transfers that require correction will be verified for accuracy. If corrections or amendments are required as a result of the review, this will be performed in accord with the details outlined in Section 5.9. After the correction or amendment is complete, the data are returned and points where corrections were requested are re-validated to ensure that the appropriate corrections and/or amendments were performed correctly.

5.8.3 Data Amendment/Correction

The Data Amendment/Correction form (Figure 5-1) provides the mechanism to request changes to a document or electronic data record and provides an audit trail for subsequent data processing. Only data that have been transferred to the DMT may be submitted for amendment/correction. Changes to data requested as a result of data screening are routed to the Project Database Manager along with a Data Amendment/Correction form and a copy of the document requiring revision. The Project Database Manager assigns a request number to the form and logs it into the Document Control Database before forwarding the change order to the appropriate party.

Figure 5-1 – Data Amendment/Correction Form

ISSI Consulting Group, Inc. 999 18th Street, Suite 1450 Denver, CO 80202 Phone: (303) 292-4142 Fax: (303) 292-4926	Data Amendment/ Correction	DCN: _____ File #: _____
Project Number:	Project Name:	Request Number:
Document Number:	Document Title/Description:	Due/Date:

Description of Amendments/Corrections (Attach supporting documentation showing changes)

Requested By: _____ Initials _____ Date _____
Approved By: _____ Initials _____ Date _____
Processed By: _____ Initials _____ Date _____

5.9 Records Management

Data storage and security are critical aspects of data management. During the life of a project, all data developed as a consequence of field, laboratory, archival, and analytic investigations are under the direct control of the DMT. In the paragraphs that follow, descriptions are provided of the controls that the DMT uses for the storage, access, maintenance and security of project data.

5.9.1 Short-Term Records Management

Short-term records management is defined as the controlled storage of data in either hard copy or electronic formats during the active life of a project. Records management also includes the procedures and protocols that are used to control access and maintain physical security of project technical data. The following paragraphs describe the storage and security requirements for both hard copy and electronically formatted data files.

5.9.1.1 Hard copy Data Files

Two separate categories of hard copy files are identified for the management of project documents: Master Files and Project Files.

Master Files - The master files are the repository for original and amended copies of all project primary data, which include field forms, notebooks, maps, and laboratory data packages. These files also include any secondary and interpretive data that are considered important to the project decision-making process. These master files are stored in secure locations. These files as well as other administrative records are eventually transferred to, or are currently under the formal custody of the USEPA Records Center.

Project Files - The project files are in-house duplicate copies of the master files. Master files include all documents related to the project. In addition, they may contain copies of secondary and interpretive data documents. The project files are stored in locked file cabinets. These files are stamped "copy".

5.9.1.2 Electronic Data Files

In addition to hard copy versions of project technical data, the DMT is responsible for the electronic storage and maintenance of field and laboratory data. Because of the importance of these files to the overall decision-making process, considerable care is exercised by the DMT in the creation, maintenance, and security of the project's computerized database. The paragraphs that follow describe the procedures and protocols for electronic data entry, verification, maintenance and access/security.

Data Entry - Data entry includes both manual transfer of information from hard copy records and automated transfer from electronic files. Typically, manual data entry is used for field data and electronic transfer is used for laboratory data. Most data parameters are identified during project planning and therefore are systematically entered into the project database.

Data Verification - Typically, data entry makes use of only screened, verified, and validated records and, once data are entered, they are verified against those records for accuracy and completeness. The method used to verify the electronic record varies according to the means by which data are entered. The details of data verification are summarized in Section 5.8.1).

Database Maintenance - To ensure the integrity of the project database, the Systems Programmer/Analyst performs regular, periodic file maintenance activities. These include making daily backup copies of all database files to provide the means to restore them in the event of system failure or file corruption. A backup tape of the database files will also be stored off-site. Modifications to database structures are only performed at the direction or approval of the various investigators and data users. Changes to database structures are accommodated and documented by filing a Request for Data Services form with the DMT.

Database Access and Security - In order to minimize the potential for data corruption, access to the project database is password-protected. For example, as system administrator, only the Project Database Manager (or designee) is allowed to alter the structure of the database or its underlying programming. Project managers and technical personnel have read-only access to the database. They may perform on-line query or analyses of the data without restriction; however, they cannot alter the structure or content of the database. They may also request that the DMT provide hard copy summary reports or diskette copies of particular data sets. Files downloaded to project personnel are treated as derivative primary data and are not recorded in the Document Control Database. They also are not incorporated into the Master Document Files or the Project Files because they can be re-created from the project database.

5.9.2 Long Term Records Management

Data and records of data generated as a result of USEPA work assignments are the property of the USEPA. Long-term management of data files is outside of the responsibility of the DMT. Upon completion of the work assignment, Master Document Files as well as electronic copies of the Project Database and Document Control Database will be transferred to the custody of the USEPA Records Center.

6.0 REFERENCES

ISSI. 1998a. Draft Final Project Plan for the Vasquez Boulevard And I-70 Residential Soils Supplemental Investigation: Physico-chemical Characterization of Soils. August 1998.

ISSI. 1998b. Draft Data Report for the Vasquez Boulevard & I-70 Residential Soils Supplemental Investigation: Physico-Chemical Characterization of Soils. November 12, 1998.

ISSI. 1999a. Selection of Chemicals of Potential Human Health Concern at the Vasquez Boulevard and I-70 Site. Memorandum to USEPA. June 18, 1999.

ISSI. 1999b. Draft Report for the Vasquez Boulevard and I-70 Site Residential Risk-Based Sampling Stage I Investigation. Prepared by ISSI Consulting Group, Inc. April 1999.

ISSI. 1999c. Phase III Investigation - Rationale for Collecting Surface Soil Samples Only. Memorandum to USEPA. June 18, 1999.

ISSI. 1999d. Draft Project Plan for the Vasquez Boulevard & I-70 Site: Pilot-Scale Soil Characterization Study. June 1, 1999.

UOS. 1998a. Final Sampling Activities Report for North Denver Residential Soils – Phase I. June 1998.

UOS. 1998b. Sampling Analysis Report – Phase II Sampling for Removal Site Assessment. Vasquez Boulevard/Interstate 70 Site. September 21, 1998.

USEPA. 1986. SW-846. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods. September 1986 and all revisions.

USEPA. 1992a. Supplemental Guidance to RAGS: Calculating the Concentration Term. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response. Publication 9285.7-081. May, 1992.

USEPA. 1992b. Guidance for Data Usability in Risk Assessment. US Environmental Protection Agency, Office of Emergency and Remedial Response. Publication 9285.7-09A. April, 1992.

USEPA. 1994a. Guidance for the Data Quality Objectives Process. Final. U.S. Environmental Protection Agency, Quality Assurance Management Staff. USEPA QA/G-4.

USEPA. 1994b. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response. Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children. EPA Publication No. 9285.7-15-1.

USEPA. 1994c. Revised Interim Soil Lead Guidance for CERCLA and RCRA Corrective Action Facilities. Memorandum from Elliot P. Laws, Assistant Administrator, to Regional Administrators. OSWER Directive 9355.4-12. July 14, 1994.

USEPA. 1996. Quality Management Plan for the U.S. Environmental Protection Agency, Region 8. Version 1.0. Denver, CO.

USEPA. 1998a. USEPA Requirements for Quality Assurance Project Plans for Environmental Data Operations. Draft Interim Final. U.S. Environmental Protection Agency, Quality Assurance Management Staff. USEPA QA/R-5.

USEPA. 1998b. EPA QA/G-9 Guidance for the Data Quality Assessment Process: Practical Methods for Data Analysis. EPA/600/R-96/084. January 1998.

APPENDICES

for the

VASQUEZ BOULEVARD & I-70 SITE
DENVER, CO

PHASE III FIELD INVESTIGATION

August 4, 1999

Prepared For:
U.S. Environmental Protection Agency, Region 8
999 18th Street, Suite 500
Denver, CO 80202

Prepared By:
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Basic Contract No.: SBAHQ-98-D-0002
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Appendix A:

Selection of Chemicals of Potential Human Health Concern at the Vasquez Boulevard & I-70 Site

SELECTION OF CHEMICALS OF POTENTIAL HUMAN HEALTH CONCERN AT THE VASQUEZ BOULEVARD AND I-70 SITE

1.0 INTRODUCTION

Chemicals of potential concern (COPCs) are chemicals which a) are present at a site, b) occur at concentrations which are or might be of health concern to exposed humans, and c) are or might be due to releases from a Superfund site. USEPA has derived a standard method for selecting COPCs at a site, as detailed in *Risk Assessment Guidance for Superfund: Human Health Evaluation Manual (Part A)* (USEPA 1989). In brief, USEPA assumes that any chemical detected at a site is a candidate for selection as a COPC, but identifies a number of alternative methods that may be used for determining when a chemical is not of concern and may be eliminated from further consideration. Each risk assessment may choose to apply some or all of the methods identified by USEPA to select COPCs, as appropriate.

2.0 DATA BASE USED TO SELECT COPCs

Most soil samples collected from the Vasquez Boulevard and I-70 (VBI70) site have been analyzed by X-ray fluorescence (XRF) for only a few contaminants (arsenic, lead, cadmium and zinc), and only the data for arsenic and lead are considered to be reliable (UOS 1998). However, a sub-set of samples have been analyzed for the full suite of 23 metals on USEPA's Target Analyte List (TAL), and these data are the basis of the COPC selection procedure. The data consist of two sub-sets:

- Analyses performed during Phase I, using the bulk fraction (particle size <2 mm) of 44 samples selected at random to confirm the accuracy of the XRF measurements for arsenic and lead and to quantify the levels of TAL metals. Because these samples were selected *a priori* and without regard to the level of contamination, there are only 9 of these samples that contain concentrations of arsenic above 100 ppm, with the maximum value being 1,200 ppm. Thus, these samples are helpful in the COPC selection procedure, but may not necessarily characterize the chemicals that may be of concern at the most contaminated properties.

- Subsequent to Phase I and Phase II, USEPA performed a study on 8 residential properties in the study area specifically intended to support the COPC selection procedure. Five (5) properties were chosen because arsenic levels exceed the established removal action level. Three (3) properties had arsenic below this action level. The data set used to support the COPC selection procedure consists of the fines fraction (particle size <250 μm) of 10 soil samples selected (based on the results of Phase I) to contain high levels of arsenic (6,000 to 12,000 ppm). Two (2) samples from each of the 5 most contaminated properties were chosen because these samples are likely to reflect the contaminants most likely to be of concern.

These data are presented in Appendix 1, and summary statistics are presented in Table 1.

In the case of copper, there is one sample whose analytical value (14,000 ppm) appears to be clearly inconsistent with all of the other 53 values (average = 37 ppm, max = 71 ppm). On this basis, the one extreme value for copper is excluded as an outlier, and screening is based on the remaining samples. All other data values were used. Non-detects were evaluated using the reported detection limit.

3.0 COPC SELECTION METHOD AT THE VBI70 SITE

Step 1: Eliminate chemicals whose maximum value is below a level of concern

This step involves comparing the maximum detected value in a medium to an appropriate Risk-Based Concentration (RBC). If the maximum value is less than the RBC, the chemical does not pose a risk and can be eliminated.

The RBCs used in this evaluation were taken from USEPA's Region III Risk-Based Concentration (RBC) table for residential soil. The value of each RBC depends on the specified Target Risk level. In accord with the goal that the COPC selection process should be conservative, the Target Risk levels used in this evaluation are 1E-06 for carcinogenic chemicals and a hazard quotient (HQ) of 1.0 for noncarcinogenic chemicals.

Table 2 lists the Region III RBCs for each chemical and identifies those which can and cannot be eliminated at this step. Based on this screening step, the following chemicals are eliminated:

- Aluminum
- Barium
- Beryllium
- Cadmium
- Chromium
- Cobalt
- Copper
- Manganese
- Mercury
- Nickel
- Selenium
- Silver
- Vanadium
- Zinc

Step 2. Eliminate Beneficial Minerals

In accord with USEPA (1989), chemicals that are normal constituents of the body and the diet and are required for good health may be eliminated unless there is evidence that site-specific releases have elevated concentrations into a range where intakes would be potentially toxic. At this site, there is no reason to suspect this is the case, so the following chemicals are eliminated on this basis:

- Calcium
- Magnesium
- Potassium
- Sodium

Iron is also eliminated on this basis, since the average concentration of iron (13,400 ppm) is well below the screening level of 23,000 ppm. Additionally, only 1 of 54 samples exceeds the RBC for iron, and this only by a small amount (26,000 vs. 23,000 ppm).

Step 3. Eliminate Chemicals Whose Contribution is Minor Compared to Others

Following Steps 1 and 2, the list of chemicals remaining is:

- Arsenic
- Antimony
- Lead
- Thallium

Antimony may be eliminated because the magnitude of the risk which it poses is very small compared to that posed by arsenic. For example, in the 10 samples most contaminated with arsenic, the average concentration of antimony is about 1% that of arsenic. Because the chronic oral RfD for antimony (4E-04) is slightly larger that the RfD for arsenic (3E-04), it is clear that the average non-cancer risk contributed by antimony is less than 1% of that contributed by arsenic. That is, if antimony was retained and the non-cancer risk were quantified, the risk would be less than 1% larger than if antimony were not included. Because an increment of 1% is well within the uncertainty range of the risk assessment procedure, inclusion of antimony would not change any risk interpretations and therefore is judged to be unnecessary.

Step 4. Special Investigation for Thallium

Data on thallium available from the existing TAL analyses are internally inconsistent, as shown below:

Parameter	Data Set 1	Data Set 2
Mean (ppm)	13.5	0.45
Max (ppm)	19	0.68
Detection Limit (ppm)	10	0.1

The basis for this internal inconsistency is not clear. One possibility is that differences in analytical methods are responsible. Data in Set 1 (collected during Phase I) utilized an analytical method (ICP-Trace, USEPA Method 6010B) that had a relatively high detection limit, and most of the reported values were near that detection limit. In the second data set (specifically targeting samples high in arsenic), thallium was analyzed by USEPA Method 6020 (ICP-MS) which has a much lower detection limit for thallium. In general, the results of the second analysis are thought to be more reliable, and are in accord with expected thallium levels in background soils. However, because it is not certain that the results from the second analysis are actually more reliable than from the first, a special study was performed in which thallium levels were measured in six samples from each of data Set 1 and data Set 2. The details of this study are presented in Attachment 1 to this Appendix.

A comparison of the results of the thallium study with data obtained from past investigations is provided in Table 3. As seen, the results of this study indicate that thallium levels in site soils measured via Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) and graphite furnace atomic absorption (GFAA) are below 1 ppm. In addition, reanalysis of samples that were reported to be slightly above the detection limit for ICP-trace indicate no positive detection of thallium. These data are adequate to conclude that because levels of thallium in site soils are sufficiently below the screening level of health concern (5 ppm), thallium may be dropped as a COPC.

SUMMARY: CHEMICALS SELECTED AS COPCs AT VBI70

Based on the methods and data detailed above, the COPCs selected for quantitative evaluation at the VBI70 site are:

ARSENIC
LEAD

Reference:

URS Operating Services [UOS]. 1998. Final Sampling Activities Report for North Denver Residential Soils – Phase I. June 1998.

USEPA. 1989. Risk Assessment Guidance for Superfund. Volume I. Human health Evaluation Manual (Part A). U.S Environmental Protection Agency, Office of Emergency and Remedial Response. EPA/540/1-89/002.

USEPA. 1999. U.S. Environmental Protection Agency. Region III Risk-Based Concentration Table. Philadelphia, PA. April 12.

TABLE 1 SUMMARY STATISTICS FOR SOIL SAMPLES

Analyte	N	Detection Frequency	Summary Statistics		
			Min	Max	Mean
ALUMINUM	54	100%	4900	15000	8761
ANTIMONY	54	22%	2.2	54	6.8
ARSENIC	54	93%	5	9940	543
BARIUM	54	100%	91	1000	251
BERYLLIUM	54	98%	0.3	1.1	0.7
CADMIUM	54	100%	0.9	19	5.9
CHROMIUM	54	100%	7.2	99	22
COBALT	54	98%	1.0	7.0	4.6
COPPER (a)	53	100%	12	71	37
LEAD	54	100%	36	3550	712
MANGANESE	54	100%	160	560	323
MERCURY	54	93%	0.1	11	1.0
NICKEL	54	100%	5.9	96	11
SELENIUM	54	19%	0.3	10	9
SILVER	54	69%	0.3	3	0.7
THALLIUM	54	89%	0.2	19	11
VANADIUM	54	100%	13	42	21
ZINC	54	100%	84	3680	499
CALCIUM	54	100%	1900	41000	6757
IRON	54	100%	7900	26000	13405
MAGNESIUM	54	100%	1400	4100	2400
POTASSIUM	54	100%	1400	4100	2350
SODIUM	54	5%	300	440	304

a. Excludes one value (14,000 ppm) that is considered anomalous

TABLE 2 COMPARISON OF MAXIMUM VALUES TO RBCs

Analyte	Maximum Conc (ppm)	Region III RBC (ppm)	Retain as COPC?
ALUMINUM	15000	78400	no
ANTIMONY	54	31	yes
ARSENIC	3940	0.43	yes
BARIUM	1000	5500	no
BERYLLIUM	1.1	160	no
CADMIUM	19	78	no
CHROMIUM	99	230	no
COBALT	7.0	4700	no
COPPER (a)	71	3100	no
LEAD	3550	400	yes
MANGANESE	560	1600	no
MERCURY	11	23	no
NICKEL	96	1600	no
SELENIUM	10	390	no
SILVER	3	390	no
THALLIUM	19	5.5	yes
VANADIUM	42	550	no
ZINC	3680	23000	no
CALCIUM	41000	--	no
IRON	26000	23000	yes
MAGNESIUM	4100	--	no
POTASSIUM	4100	--	no
SODIUM	440	--	no

Lab TAL

TABLE 3 COMPARISON OF PAST AND PRESENT RESULTS

	Thallium (mg/kg)								
	Past Results			Present Study					
Sample name	Q	Past Results	Method	Q	ICP-T	Q	ICP-MS	Q	GFAA
C4690CYB-064		0.63	1	U	10		0.70	U	0.50
C4690CYB-046E		0.2	1	U	10		0.10	U	0.50
C4711THF-001		0.33	1	U	10		0.30	U	0.50
C4771VIN-001		0.33	1	U	10		0.30	U	0.50
D4145FIB10		12	2	U	10	U	0.20	U	0.50
D4715GYF10		17	2	U	10		0.30	U	0.50
D4050FIB10		11	2	U	10		0.20	U	0.50
D4701JOS10	U	10	2	U	10	U	0.10	U	0.50
D4780CBB10		16	2	U	10		0.50		0.80
D4785CLF10		15	2	U	10		0.20	U	0.50

Method: (1) ICP-MS [6020] and (2) ICP-trace [6010B]

U - Target analyte not detected

ATTACHMENT 1

SPECIAL STUDY ON THALLIUM IN SITE SOILS

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MEMORANDUM

To: Bonnie Lavelle, Chris Weis
From: Bill Brattin, Mary Goldade
Date: 6/15/99
Subj: Special Evaluation of Thallium in VBI70 Soils

As we discussed, available data are internally inconsistent on the level of thallium (Tl) in site soils at VBI70. We suspect, but cannot demonstrate unambiguously, that levels are low (< 1 ppm), and are not of health concern. In order to resolve this issue, we recommend proceeding with a small study, as described below.

DATA QUALITY OBJECTIVES

State the Problem

Available data are not internally consistent regarding the level of thallium. One data set (measured by ICP-trace) suggests thallium levels are 10-20 ppm (above a level of concern). Another data set (measured by ICP-MS) suggests thallium exists at levels less than 1 ppm (below a level of concern). The problem is to determine which data set is correct.

Decisions to Be Made

The decision to be made is whether or not the Phase 3 soil sampling project will identify thallium as a contaminant of potential concern (COPC), and therefore, included on the target analyte list.

Types of Input Needed

Data required to resolve this issue are accurate and reliable measurements of thallium in site soil. This includes adequate quality assurance/quality control (QA/QC) data to establish that the measurements are reliable.

Decision Rule

If site soils contain thallium at levels largely or entirely below the Region III risk-based soil screening level (5 ppm), thallium may be dropped as a COPC. If site levels are largely or entirely above 5 ppm, thallium will be retained as a COPC.

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STUDY DESIGN

Number of samples

A total of 10 site soil samples will be analyzed for thallium. The 10 site soils will be comprised of 6 samples from the set of soils previously analyzed by ICP-trace (yielding Tl levels of 10-20 ppm) plus 4 samples from the set of soils previously analyzed by ICP-MS (yielding Tl levels below 1 ppm). It should be noted that different fractions of soils were analyzed for each method. During the past investigations (Phase I [UOS 1998a] and RBS [ISSI 1999a]), samples that were analyzed by ICP-trace were sieved to <2 mm prior to analysis, while samples analyzed by ICP-MS were sieved to <250 μm. Due to limited availability of archived samples, bulk samples (sieved to <2 mm) will be analyzed by ICP-trace, while raw samples (not sieved) will be analyzed by ICP-MS for this thallium study. Fine samples (sieved to <250 μm) were not available for analyses.

The list of specific samples selected and the analytical results for thallium available prior to this study are summarized in Table 1.

QA/QC

Four blind QC samples (certified reference materials) will be included in random order with the 10 site samples. These four samples will consist of two samples each of two commercial standards, including 1) a certified clean soil (low thallium, about 0.49 ppm), and 2) a certified thallium standard of approximately 5.0 ppm.

Analytical methods

Each sample will be analyzed for thallium by three analytical methods:

- ICP-trace (EPA SW-846 Method 6010B)
- ICP-MS (EPA SW-846 Method 6020)
- Graphite furnace (EPA SW-846 Method 7841)

Validation of Recovery

In order to assess the recovery of thallium from each sample, every sample will be analyzed in its original form along with a matrix spike (MS). The MS will be spiked so that the increment in thallium concentration is about 5 ppm.

TABLE 1. SAMPLE ID AND PREVIOUS THALLIUM RESULTS

Field Sample ID	CLP Lab Sample ID	XRF Lab Sample ID	Original Method [a]	Original Value Thallium (ppm)
C4690CYB-064	D9D100118-002	ND-98-782	ICP-MS	0.63
C4690CYB-046E	D9D100118-004	ND-98-640	ICP-MS	0.20
C4711THF-001	D9D100118-006	ND-98-549	ICP-MS	0.33
C4771VIN-001	D9D100118-0010	ND-98-245	ICP-MS	0.33
D4701JOS10	9804190-35	ND-98-016	ICP-T	<10
D4145FIB10	9804190-19	ND-98-022	ICP-T	12
D4715GYF10	9804190-36	ND-98-027	ICP-T	17
D4050FIB10	9804190-41	ND-98-058	ICP-T	11
D4785CLF10	9804190-43	ND-98-064	ICP-T	15
D4780CBB10	9804190-26	ND-98-069	ICP-T	16

[a] Samples analyzed by ICP-MS were sieved to <250 μm.
Samples analyzed by ICP-T were sieved to <2 mm.

TABLE 2 LIST OF SAMPLES AND SAMPLE NUMBERS

Index	Field ID	Sample Number
1	Certified 0.49 ppm (RM 8604)	Tl-15
2	Certified 0.49 ppm (RM 8604)	Tl-3
3	Certified 5.0 ppm (RM 8607)	Tl-12
4	Certified 5.0 ppm (RM 8607)	Tl-4
5	ND-98-016	Tl-8
6	ND-98-022	Tl-2
7	ND-98-027	Tl-6
8	ND-98-058	Tl-7
9	ND-98-064	Tl-11
10	ND-98-069	Tl-9
11	ND-98-245	Tl-16
12	ND-98-782	Tl-1
13	ND-98-640	Tl-5
14	ND-98-549	Tl-10

MEMORANDUM

To:	Bonnie Lavelle, Chris Weis
From:	Mary Goldade
Date:	8/3/99
Project:	Vasquez Boulevard & I-70 Site
RE:	Results for the Special Evaluation of Thallium in VBI70 Soils

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ISSI Consulting Group, Inc. (ISSI) has received the results of the Thallium Study. The details of the study design were provided in a memorandum dated June 15, 1999. In brief, data obtained from past investigations were not internally consistent regarding the level of thallium in site soils. One data set (measured by ICP-trace) suggested that thallium levels in site soils are 10-20 mg/kg, which is above the level of concern. Another data set (measured by ICP-MS) suggested that thallium exists at levels less than 1 mg/kg, which is below a level of concern. In order to determine whether thallium should be included on the list of contaminants of potential concern (COPCs), ISSI submitted site soils for additional testing.

A total of 10 site soil samples were analyzed for thallium. The 10 site soils were comprised of 6 samples from the set of soils previously analyzed by ICP-trace (yielding thallium levels of 10-20 ppm) plus 4 samples from the set of soils previously analyzed by ICP-MS (yielding thallium levels below 1 ppm). These samples were drawn from archived site soils collected from both the Phase I/II Investigations and the Risk-Based Sampling (RBS) program. Samples were generally selected so that about half were obtained from the Physico-Chemical Soil Characterization Study (ISSI 1998a) and the remaining half from the RBS program (ISSI 1998b).

It should be noted that dissimilar fractions of soils were obtained and analyzed in this study. During the past investigations, samples that were analyzed by ICP-trace were sieved to <2 mm prior to analysis, while samples analyzed by ICP-MS were sieved to <250 μm. Due to limited availability of archived samples, bulk samples (sieved to <2 mm) were analyzed by ICP-trace, while raw samples (not sieved) were analyzed by ICP-MS for this thallium study. Fine samples (sieved to <250 μm) were not available for analyses.

The list of specific samples selected and a comparison of analytical results for thallium for both the past and present studies are summarized in Table 1.

Analytical methods

Each sample was analyzed for thallium by three analytical methods:

- Inductively Coupled Plasma [ICP-trace] (EPA SW-846 Method 6010B)
- Inductively Coupled Plasma-Mass Spectrometry [ICP-MS] (EPA SW-846 Method 6020)
- Graphite Furnace Atomic Absorption [GFAA] (EPA SW-846 Method 7841)

The raw results of these analyses are provided as an attachment (Table A-1).

Blind Standards

Four blind quality control (QC) samples (certified reference materials) were included in random order with the 10 site samples. These four samples consisted of two samples each of two commercial standards, including: 1) a certified clean soil (low thallium, about 0.49 ppm), and 2) a certified thallium standard of approximately 5.0 ppm.

The results of this analysis are provided in Table 2. As seen, thallium was not detected above the reporting limit in the certified clean soil for any of the three analytical methods. As expected, thallium was not detected in the 5.0 ppm standard via ICP-trace because the reporting limit of 10 is above the certified value. Positive thallium detection via the ICP-MS was not possible due to matrix effects (e.g., the pre-purchased standard contained many other metals in the sample necessitating dilution analyses). Thallium was detected in the 5.0 ppm standard via GFAA within the manufacturer's limits of 2.5-7.5 ppm at 2.5 for one of the two standards. The second standard, measured using GFAA was recovered just below the acceptance criteria at 2.4 ppm. This implies a slight low bias in thallium measurements, but accuracy is generally still within acceptable limits.

Validation of Recovery

In order to assess the recovery of thallium from each sample, every sample was analyzed in its original form along with a matrix spike (MS). The results of the matrix spike analyses are provided in Table 3. As seen, the results of the MS analyses were acceptable and displayed matrix interferences for only one investigative sample. If matrix effects were noted during the analysis, a post-digestion spike (PDS) was immediately performed. The results of the PDS analyses for all samples were acceptable.

Conclusions

A comparison of thallium levels in site soils as reported in past and present studies indicate that results contained in the Phase I Investigation report (UOS 1998) are biased high and are not reliable. Reanalysis of both the Phase I samples and the RBS samples contain thallium below 1

ppm. Results of the supporting QC samples, submitted with the investigative samples, are acceptable. Therefore, the reanalysis results should be utilized in the evaluation of COPCs.

References:

ISSI. 1998a. Draft Final Project Plan for the Vasquez Boulevard and I-70 Residential Soils Supplemental Investigation: Physico-chemical Characterization of Soils. August 1998.

ISSI. 1998b. Project Plan for the Vasquez Boulevard and I-70 Residential Risk-Based Sampling Stage I Investigation. August 1998.

UOS. 1998. Final Sampling Activities Report for North Denver Residential Soils - Phase I. June 1998.

TABLE 1 COMPARISON OF PAST AND PRESENT RESULTS

Sample name	Thallium (mg/kg)								
	Past Results			Present Study					
	Q	Past Results	Method	Q	ICP-T	Q	ICP-MS	Q	GFAA
C4690CYB-064		0.63	1	U	10		0.70	U	0.50
C4690CYB-046E		0.2	1	U	10		0.10	U	0.50
C4711THF-001		0.33	1	U	10		0.30	U	0.50
C4771VIN-001		0.33	1	U	10		0.30	U	0.50
D4145FIB10		12	2	U	10	U	0.20	U	0.50
D4715GYF10		17	2	U	10		0.30	U	0.50
D4050FIB10		11	2	U	10		0.20	U	0.50
D4701JOS10	U	10	2	U	10	U	0.10	U	0.50
D4780CBB10		16	2	U	10		0.50		0.80
D4785CLF10		15	2	U	10		0.20	U	0.50

Method: (1) ICP-MS [6020] and (2) ICP-trace [6010B]

U - Target analyte not detected

Table 2: Blind Standard Results for Thallium (mg/kg)

Client Des.	ALR Des.	Field Sample ID	Spike value	Acceptance Range (mg/kg)	Q ICP Trace	ICP-trace	% recovery	Spike value	Q ICP-MS	ICP-MS	% recovery	Spike value	Q GFAA	GFAA	% recovery
TL-03	99-A12096	RM 8604(0.49ppm)	0.49	0.27-0.72	U	10	NC	0.49	U	2	NC	0.49	U	1.00	NC
TL-04	99-A12098	RM 8607(5.0ppm)	5.00	2.5-7.5	U	10	NC	5.00	U	10	NC	5.00		2.40	48%
TL-12	99-A12114	RM 8607(5.0ppm)	5.00	2.5-7.5	U	10	NC	5.00	U	10	NC	5.00		2.50	50%
TL-15	99-A12116	RM 8604(0.49ppm)	0.49	0.27-0.71	U	10	NC	0.49	U	10	NC	0.49	U	1.00	NC

NC - Not Calculable
U - Target analyte not detected.

Higher detection limit due to matrix interference

TABLE 3: Matrix Spike Analyses Results in Solution Phase

Sample ID	Thallium														
	Q ICP-Trace	ICP-trace (6010B)	AMOUNT SPIKED (mg/L)	Spike Class	%R	Q ICP MS	ICP-MS (6020)	AMOUNT SPIKED (ug/L)	Spike Class	%R	Q GFAA	GFAA (7841)	AMOUNT SPIKED (mg/L)	Spike Class	%R
TL-01	U	1.00	1.00		86%		3.3407				U	0.0047			74%
							6.1155								
							42.5935	50	MS	73%					
		0.86		MS			55.9691	50	PDS	105%		0.0371	0.05	MS	
TL-02	U	1.00	1.00		82%	U	0.9838				U	0.0025			98%
							1.6793								
		0.82		MS			58.943	50	PDS	118%		0.0488	0.05	MS	
TL-05	U	1.00	1.00		84%		1.4442			97%	U	0.0031			96%
		0.84		MS			49.8085	50	MS			0.0482	0.05	MS	
TL-06	U	1.00	1.00		82%		2.8628			91%	U	0.0037			96%
		0.82		MS			48.599	50	MS			0.0482	0.05	MS	
TL-07	U	1.00	1.00		87%		1.9849			96%	U	0.0019			103%
		0.87		MS			49.9113	50	MS			0.0514	0.05	MS	
TL-08	U	1.00	1.00		76%	U	0.3337			96%	U	0.003			90%
		0.76		MS			48.9379	50	MS			0.0452	0.05	MS	
TL-09	U	1.00	1.00		78%		5.2056			89%		0.0075			71%
		0.78		MS			49.622	50	MS			0.043	0.05	MS	
TL-10	U	1.00	1.00		86%		2.9523			82%	U	0.0036			93%
		0.86		MS			44.1989	50	MS			0.0464	0.05	MS	
TL-11	U	1.00	1.00		77%		2.4937			79%	U	0.0046			91%
		0.77		MS			42.1284	50	MS			0.0455	0.05	MS	
TL-16	U	1.00	1.00		80%		3.2709			98%	U	0.0042			103%
		0.80		MS			52.2359	50	MS			0.0516	0.05	MS	
TL-03	U	1.00	1.00		82%	U	-0.1872				U	0.0047			
							-0.1032					0.0005			
							4.8224		MS	10%		0.0223		MS	44%
		0.82		MS			38.4146	50	PDS	77%		0.0383	0.05	PDS	73%
TL-04	U	1.00	1.00		78%	U	0.0664			103%		0.012			
							2.1852					0.0207			
												0.0476		MS	54%
		0.78		MS			51.5295	50	PDS			0.0468	0.05	PDS	70%
TL-12	U	1.00	1.00		82%	U	0.0403					0.0126			
							2.2535					0.0213			
												0.0458		MS	49%
		0.82		MS			46.9832	50	PDS	94%		0.0494	0.05	PDS	74%
TL-15	U	1.00	1.00		81%	U	-0.2415				U	-0.0003			
							-0.1018					0.0019			
												0.0207		MS	38%
		0.81		MS			50.10	50	PDS	100%		0.0516	0.05	PDS	104%

U: Target analyte not detected

MS: Matrix Spike; added prior to digestion

PDS: Post Digestion Spike; added after digestion

low recovery due to matrix interference

Samples diluted due to matrix interference

Attachment

TABLE A-1 RAW ANALYTICAL RESULTS

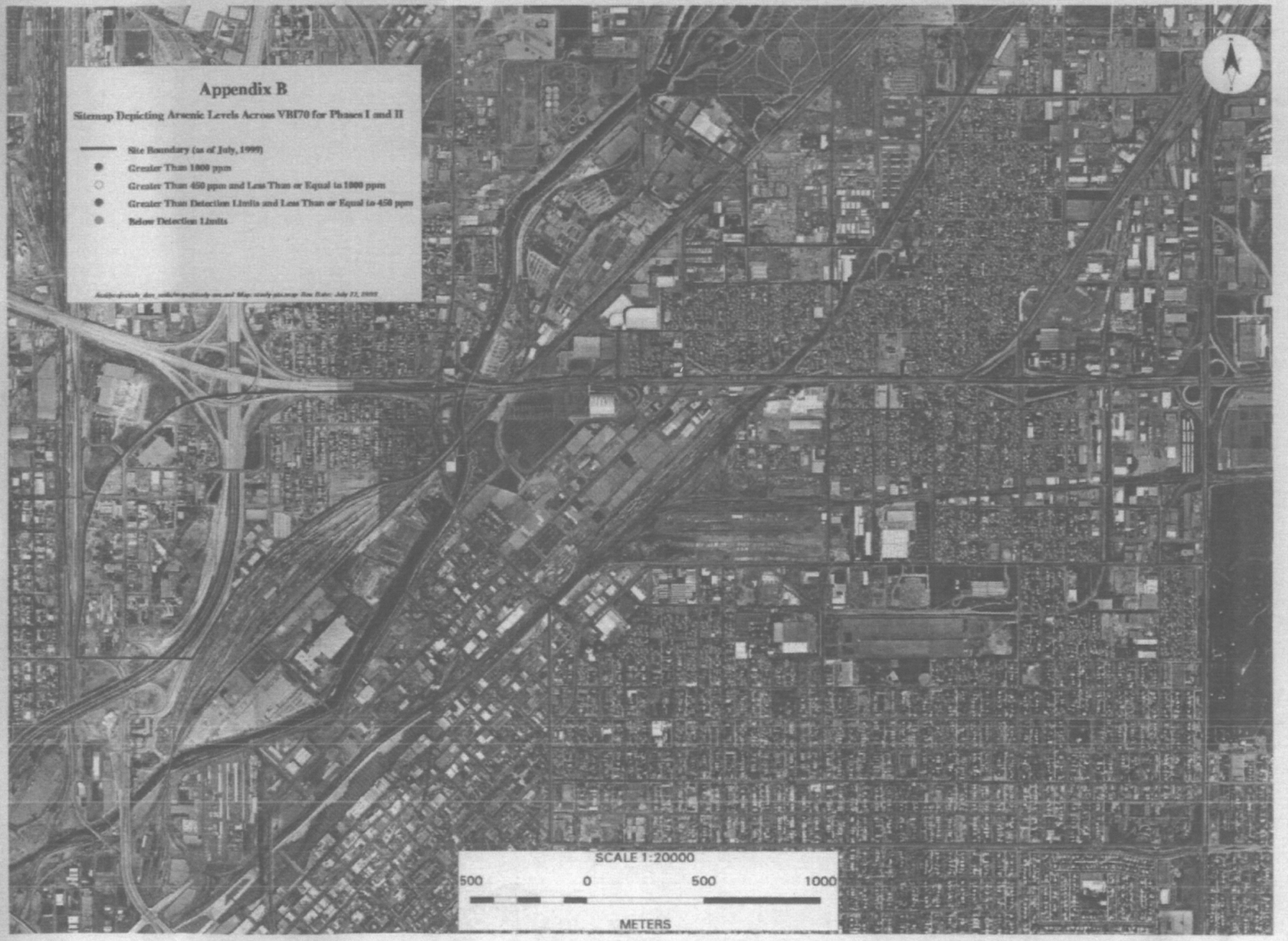
Field Sample ID	Blind Sample ID	Lab ID	Sample Type	Date Collected	Thallium (ppm)					
					Q ICP-Trace	ICP-trace (6010B)	Q ICP-MS	ICP-MS (6020)	Q GFAA	GFAA (7841)
C4690CYB-064	TL-01	99-A12092	FIELD	6/21/99	U	10		0.70	U	0.50
D4145FIB10	TL-02	99-A12094	FIELD	6/21/99	U	10	U	0.20	U	0.50
C4690CYB-046E	TL-05	99-A12100	FIELD	6/21/99	U	10		0.10	U	0.50
D4715GYF10	TL-06	99-A12102	FIELD	6/21/99	U	10		0.30	U	0.50
D4050FIB10	TL-07	99-A12104	FIELD	6/21/99	U	10		0.20	U	0.50
D4701JOS10	TL-08	99-A12106	FIELD	6/21/99	U	10	U	0.10	U	0.50
D4780CBB10	TL-09	99-A12108	FIELD	6/21/99	U	10		0.50		0.80
C4711THF-001	TL-10	99-A12110	FIELD	6/21/99	U	10		0.30	U	0.50
D4785CLF10	TL-11	99-A12112	FIELD	6/21/99	U	10		0.20	U	0.50
C4711VIN-001	TL-16	99-A12118	FIELD	6/21/99	U	10		0.30	U	0.50
RM 8604(0.49ppm)	TL-03	99-A12096	QC	6/21/99	U	10	U	2.00	U	1.00
RM 8607(5.0ppm)	TL-04	99-A12098	QC	6/21/99	U	10	U	10.00		2.40
RM 8607(5.0ppm)	TL-12	99-A12114	QC	6/21/99	U	10	U	10.00		2.50
RM 8604(0.49ppm)	TL-15	99-A12116	QC	6/21/99	U	10	U	10.00	U	1.00

U - Target analyte not detected

Elevated detection limit due to matrix interference

Appendix B:

Site Map Depicting Arsenic Levels across VBI70 for Phases I & II


Appendix B
Sitemap Depicting Arsenic Levels Across VBI70 for Phases I and II
Site Boundary (as of July, 1999)
Greater Than 1000 ppm
Greater Than 450 ppm and Less Than or Equal to 1000 ppm
Greater Than Detection Limits and Less Than or Equal to 450 ppm
Below Detection Limits
SCALE 1:20000
500
0
500
1000
METERS

Appendix C:

Phase III Investigation- Rationale for Collecting Surface Soil Samples Only

ISSI Consulting Group
999 18th Street, Suite 1450
Denver, CO 80202
ph 303.292.4142 • fax 303.292.4926

U.S. SBA 8(a) certified
postmaster@issiinc.com
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MEMORANDUM

To:	Chris Weis & Bonnie Lavelle
From:	Mary Goldade
Date:	June 18, 1999
Project Name:	Vasquez Boulevard & I-70
RE:	Phase 3 Investigation - Rationale for Collecting Surface Soil Samples Only
cc:	Project Files

Purpose
Using soil data gathered from the Vasquez Boulevard and Interstate 70 (VBI70) site to date, determine whether the levels of arsenic and lead found in the surface soils (0-2 inches) are generally higher or lower than that of soils at depths of 6-10 inches. The conclusions reached in this memorandum will be the scientific basis for deciding whether soils at depth must included in the VBI70 Phase 3 study design.

Historical Data
Paired surface soil and depth samples were collected in three previous sampling programs: Phase I/II (UOS 1998a, 1998b); and Risk-Based Sampling (ISSI 1999a). The primary objective for each of these investigations was to determine the nature and extent of arsenic and lead levels in soils at the VBI70 site. Therefore, this investigation included collection of both surficial and depth samples.

Depth samples were collected for the Phase I/II sampling program at approximately 6-10 inches from the soil horizon at most residences from which surface soils were also collected. All soils were tested for both lead and arsenic. In general, the levels of lead and arsenic found in the surficial soils were at least as high and usually higher than those found in the corresponding depth sample.

As part of the Risk-Based Sampling (RBS) Program, the concentration profile for arsenic, lead, cadmium and zinc in residential soils were measured. This was done by collecting soil cores in the 0-12 inch horizon and measuring target metals (arsenic, lead, cadmium and zinc) in each 2 inch interval. These data are presented in the Draft Report for the VBI70 Residential Risk-Based Sampling Stage I Investigation (ISSI Consulting Group [ISSI] 1999a). As seen, although the absolute concentration of each metal varies considerably, concentrations of all target metals (arsenic, lead cadmium and zinc) tend to decrease with increasing depth.

Summary of Results
The historical data obtained for Phase I/II and the RBS were further evaluated and the results of these evaluations are provided in Table 1. In brief, the ratio of the metals levels present in surface soils to those found in the corresponding depth samples were calculated for each surface soil and depth sample pair. Finally, the mean surface to depth ratios were calculated for each of 5 metals concentration intervals for both the Phase I/II and RBS investigations. If the value of the ratios are equal to one, then the metals levels in surface soils are approximately equal those in the depth samples. If the ratios are greater than one, then the metals levels in the surficial soils are greater than those found at depth. Alternatively, if the ratios are less than one, then the metals levels in the depth samples are greater than those found in surface soils.

As seen in Table 1, arsenic and lead levels measured during Phase I/II have at minimum a 1:1 relationship for

corresponding surface and depth samples and the arsenic and lead levels in surface soils increase as the surface:depth ratio increases. Therefore, the highest metals levels tend to occur at the surface. This general trend is also observed for the RBS data.

Conclusion

When contamination is present in soils below the 0-2 inch depth, contamination is generally also present in the corresponding surficial soils at equal or greater concentrations. Therefore, a study that is designed to identify residences with elevated levels of contaminants of potential concern (COPCs) in the surface soils will be sufficient in identifying the impacted locations. Phase 3 soil investigations at VBI70 will be restricted to collection of surface soils only. If levels of COPCs are determined to be present in the residential surface soils above a level of concern, the residence may be investigated further to determine if and to what depth remediation of yard soils is necessary.

Table 1 - Descriptive Statistics for Surface:Depth Ratios of Metals Levels Measured for the Phase I & II and Risk-Based Sampling Events (Intensive Grid Samples)

	Phase I & II		Risk-Based Sampling Event (Intensive Grid Sampling)	
Mean Conc. at Surface (mg/kg)	N	Mean Surface: Depth Ratio	N	Mean Surface: Depth Ratio
Arsenic				
<70	1043	1.0	4	0.4
71-150	142	1.4	3	0.9
151-450	60	3.0	4	1.9
451-1000	18	5.9	2	4.0
>1000	0	9.0	3	5.2
Lead				
<400	1176	1.4	6	1.4
401-1000	85	2.0	5	2.9
1001-1500	4	3.0	1	2.5
1500-2000	1	6.6	3	5.4
>2000	0	--	1	3.9
Cadmium				
<78	NT	NT	16	1.7
78-156	NT	NT	0	--
157-234	NT	NT	0	--
235-312	NT	NT	0	--
>312	NT	NT	0	--
Zinc				
<23,000	NT	NT	16	1.8
23,001-46,000	NT	NT	0	--
46,001-69,000	NT	NT	0	--
69,001-92,000	NT	NT	0	--
>92,000	NT	NT	0	--

-- Not Applicable

a -Surface soil (0-2" depth); Depth soils (~6-10" depth)

b - Intensive residences include focal and adjacent properties

NT - Not Tested

Appendix D:

Screening Level Evaluation of Risks from Acute and Subchronic Exposure to Arsenic in Soil

SCREENING LEVEL EVALUATION OF RISKS FROM ACUTE AND SUBCHRONIC EXPOSURE TO ARSENIC IN SOIL

Basic Equations

In most cases, risk to humans due to arsenic contamination of soil are driven by the estimated risk of cancer following long-term (e.g., 30-year) exposure. Based on standard USEPA default exposure assumptions and a target excess cancer risk level of 1E-04, the screening level Risk-Based Concentration for arsenic in soil is 43 ppm (EPA Region III table). Incorporating the Region VIII default value of 80% for the Relative Bioavailability (RBA) of arsenic in soil yields a default value of 53.2 ppm. It is important to note that this is a default value that does not include any actual site-specific information, and that the final chronic RBC for soil at the VBI70 site will be developed only after the risk assessment is complete, and that all reliable site-specific information will be included.

In some cases (where levels of arsenic in soil are especially high), risks of noncancer effects from subchronic and/or acute exposures to arsenic in soil might also be of concern. The basic equations for assessing non-cancer and cancer risks from acute, subchronic, and chronic exposure are shown below:

$$HQ(a) = C(a) * HIF(a) / RfD(a)$$

$$HQ(sc) = C(sc) * HIF(sc) / RfD(sc)$$

where:

HQ = Hazard Quotient, either for acute (a) or subchronic (sc) exposure
C = Exposure point concentration, either for acute (a) or subchronic (sc) exposure
HIF = Human Intake factor, either for acute (a) or subchronic (sc) exposure
RfD = Reference Dose, either for acute (a) or subchronic (sc) exposure

Residential Exposure Parameters

There are no standard default exposure parameters for calculating subchronic and acute exposures of residents to soil, so the following factors were selected based on professional judgement. All are based on an assumed exposure of a residential child to soil in the yard of the home.

Parameter	Units	Acute	Subchronic
Soil Intake	mg/event	2,000	500
Body weight	kg	10	10
Exposure frequency	days	1	30
Exposure duration	days	1	120
HIF	kg/kg-d	2.0E-04	1.25E-05

Toxicity factors

Acute and sub-chronic oral toxicity factors for arsenic are summarized below:

Duration	RfD (mg/kg-d)	Source
Acute	1E-01	ATSDR 1993, 1998
Sub-chronic	6E-03	USEPA 1995

Screening Level RBCs for Acute and Subchronic Exposures

Based on these inputs, screening-level RBCs for acute and subchronic exposure are:

RBC(acute) = 625 mg/kg
RBC(subchronic) = 600 mg/kg

As noted above, it is important to stress that these screening level RBCs do not incorporate any actual site-specific information, and that these values may not be equal to the final RBCs developed for the site after all reliable site-specific data have been incorporated.

Application of Acute and Subchronic RBCs

An important attribute of the RBCs for subchronic and acute exposure is that they apply to exposure areas that are smaller than for chronic exposure. For example, subchronic exposure might occur in a preferential play area, perhaps 1/5 to 1/10 of the size of the yard, while acute exposure might occur at any location within the yard.

If a yard were sampled by collection of multiple grab samples of soil, the approach for applying the subchronic and acute RBCs would be as follows:

Duration	Test	Interpretation
Acute	Compare acute RBC to maximum value	Max ≤ RBC = acceptable Max > RBC = potentially unacceptable
Subchronic	Divide yard into fifths, identify that which is most contaminated. Compare subchronic RBC to mean concentration	Highest mean ≤ RBC = acceptable Highest mean > RBC = potentially unacceptable

At the VBI70 site, a total of 30 grab samples will be collected from each yard. However, these will not be analyzed individually, but will be composited into 3 sets of 10. Thus, direct application of the evaluation procedure above is not possible. However, it is possible to calculate the Minimum Theoretical Composite Value (MTCV) that an individual composite value might have if it contained a grab sample that exceeded the RBC for acute or subchronic exposure, as follows:

MTCV(acute) = (9*bkg + 1*RBCacute) / 10
MTCV(subchronic) = (9*bkg + 1*RBCsubchronic) / 10

Assuming that background is about 20 ppm, and using the acute and subchronic RBC values above yields the following values:

MTCV(acute) = 81 ppm
MTCV(subchronic) = 78 ppm

Thus, in order for any property to be considered safe, it must pass three tests:

Test 1: 95% UCL of 3 composites ≤ RBCchronic
Test 2: Maximum composite value ≤ MTCVacute
Test 3: Maximum composite value ≤ MTCVsubchronic

<u>Example 1: A property with an Area of Acute Concern</u>

Consider a yard in which 29 of the 30 total samples collected at a property were at background levels (about 20 ppm), and one sample was slightly higher than the level of acute health concern (e.g., 700 ppm). Then, the expected values for each of the three 10-point composites and the grand mean across the 3 composites would be:

Composite 1: (9*20 ppm + 1*700 ppm) / 10 = 88 ppm
Composite 2: (10*20 ppm) / 10 = 20 ppm
Composite 3: (10*20 ppm) / 10 = 20 ppm

Grand mean = (88 ppm + 20 ppm + 20 ppm) / 3 = 43 ppm

Because the grand mean (43 ppm) is close to the RBC for chronic exposure (53 ppm), it is likely that this property will fail the chronic test, since the 95% UCL of the mean is likely to be higher than the chronic RBC. However, even if this property were to pass test the chronic test (95% UCL < 53 ppm), it would fail Test 2, in which the highest composite sample (88 ppm) is compared to the MTCV for acute exposure (81 ppm). Thus, this property will always fail the three-tier test for acceptability and will be placed in the category of "potentially unacceptable".

Example 2: Property with an Area of Subchronic Concern

Consider a yard in which 1/5 of the area was just above the level of subchronic concern (e.g., 650 ppm), while the remainder was un-impacted (20 ppm). Then, the expected values for each of the three 10-point composites and the grand mean across the 3 composites would be:

Composites (all): (24*20 ppm + 6*700 ppm) / 30 = 156 ppm

Thus, the lowest value that the mean of the three composites could have if one fifth of the yard exceeded the subchronic RBC is 156 ppm. This value is substantially higher than the default chronic RBC (53 ppm), so any property which passes the test for chronic risk will also pass the test for subchronic risk.

Even if subchronic exposures were assumed to occur over 1/10th of the yard (rather than 1/5th), the grand mean of the 3 composites would still be higher than the chronic RBC:

(27*20 + 3*700) / 30 = 88 ppm

Note that this conclusion holds regardless of whether the 3 "hot" grab samples are placed in one composite or in different composites. Thus, any property that fails the test for subchronic concern will also fail the test for chronic concern (even before application of the 95% UCL to the chronic test).

Validation of Test Method by Monte Carlo Simulation

As a test of the appropriateness of the three-tiered test outlined above, Monte Carlo simulations were run using both assumed data and actual site data (adjusted using arbitrary scaling factors to achieve a range of different conditions). The results are summarized in Tables 1 and 2. Inspection of these tables reveals that there is a very low false negative rate in all cases examined, strongly supporting the conclusion that the three-tiered test method will be protective for properties that have areas of concern for acute, subchronic and/or chronic exposure.

Conclusion

Available data support the view that properties which have been contaminated with arsenic are not uniformly contaminated, and that some sub-locations within a yard may be substantially more contaminated than the yard-wide average. In such cases, preferential exposure at these "hot-spots" could conceivably be of acute or subchronic health concern. However, any property that has a sub-area at least 1/10th the size of the yard that exceeds the subchronic RBC for arsenic will automatically fail the test for chronic concern. Similarly, any property that has a small sublocation that exceeds the RBC for acute concern will very likely fail the test for chronic concern, and even if it does pass, this property will be identified by application of Test 2 (maximum composite ≤ MTCVacute). Thus, application of the three-tiered test method will identify all properties that are of concern for acute, subchronic and/or chronic health concern.

References

ATSDR. 1993. Toxicological Profile for Arsenic. April 1993.
ATSDR. 1998. Toxicological Profile for Arsenic-Draft Update. August 1998.
USEPA. 1995. Subchronic Reference Dose for Arsenic. Prepared by Robert Benson, Ph.D. September 12, 1995.

TABLE 1 SIMULATED DATA

Condition				Results-Overlaping Grids		Results-Segregated Grids	
Grids	m,s	Mean	"Truth"	Pass	Fail	Pass	Fail
30=	20,20	20	pass	98.7%	1.3%	68%	32%
	40,30	40	pass	54%	46%	33%	67%
	60,40	60	fail	1%	99%	1%	99%
	80,60	80	fail	--	100%	--	100%
29=	20,20						
1=	200,50	26	pass	79%	21%	13%	87%
	400,100	33	pass	11%	89%	0.3%	99.7%
	600,150	39	pass	0.3%	99.7%	--	100%
	800,200	46	fail	0.01%	99.99%	--	100%
27=	20,20						
3= (A,B,C)	200,50	38	pass	70%	30%	--	100%
	400,100	58	fail	2%	98%	--	100%
	600,150	78	fail	--	100%	--	100%
	800,200	98	fail	--	100%	--	100%
27=	20,20						
3= (A,A,A)	200,50	38	pass	0.02%	99.98%	--	100%
	400,100	58	fail	--	100%	--	100%
	600,150	78	fail	--	100%	--	100%
	800,200	98	fail	--	100%	--	100%

A, B, C = each "hot" grab sample goes into different composite
A, A, A = each "hot" grab sample goes into same composite

TABLE 2 SITE DATA

Property	Scaling Factor	Mean	Max	"Truth"	Results-Overlaping Grids		Results-Segregated Grids	
					Pass	Fail	Pass	Fail
1	1	970	4514	fail	--	100%	--	100%
	0.1	97	451	fail	--	100%	--	100%
	0.05	48	226	pass	13%	87%	1%	99%
	0.02	19	90	pass	100%	--	35%	65%
	0.01	10	45	pass	100%	--	63%	37%
	0.005	5	23	pass	100%	--	77%	23%
	0.002	2	9	pass	100%	--	89%	11%
	0.001	1	5	pass	100%	--	94%	6%
7	1	48	164	pass	15%	85%	9%	91%
	0.5	24	82	pass	99.95%	0.05%	77%	23%
	0.1	5	16	pass	100%	--	89%	11%
	0.05	2	8	pass	100%	--	99.3%	0.7%
	1.5	72	246	fail	0.05%	99.95%	0.02%	99.98%
	3	143	491	fail	--	100%	--	100.0%
6	1	74	231	fail	--	100%	--	100%
	0.5	37	116	pass	90%	10%	51%	49%
	0.1	7	23	pass	100%	--	99.4%	0.6%
	0.05	4	12	pass	100%	--	100%	--
4	1	510	2536	fail	--	100%	--	100%
	0.5	255	1268	fail	--	100%	--	100%
	0.1	51	254	pass	7%	93%	4%	96%
	0.05	26	127	pass	99.9%	0.06%	61%	39%
	0.02	10	51	pass	100%	--	91%	9%
	0.01	5	25	pass	100%	--	96%	4%
	0.005	3	13	pass	100%	--	98%	2%
	0.002	1	5	pass	100%	--	99.4%	0.6%

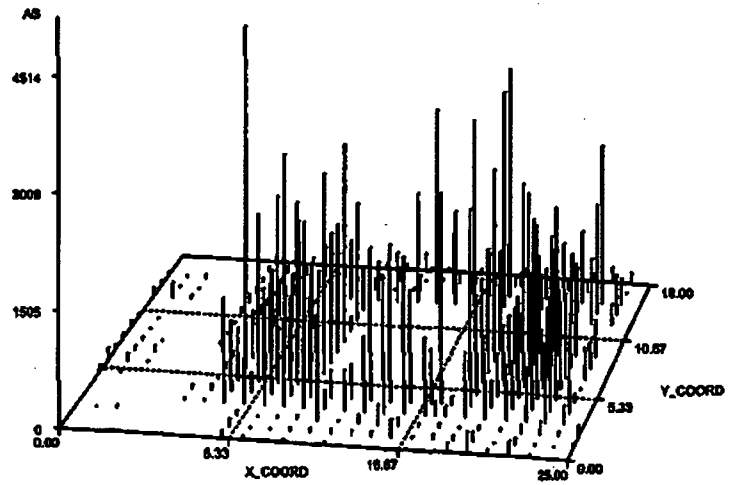
Appendix E:

Monte Carlo Simulations Performed to Support Surface Soil Sampling Strategy

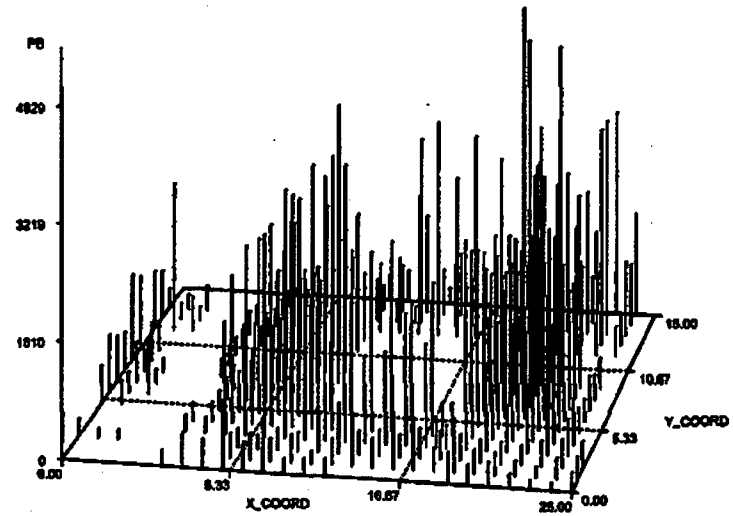
- Simulations performed on risk-based sampling data from locations 3, 4, and 5.
- Simulations to determine the normality of composite samples using the minimum value as the reporting limit.
- Simulations to determine the normality of composite samples using estimated values as the reporting limit.

Spatial Display of Focal Properties

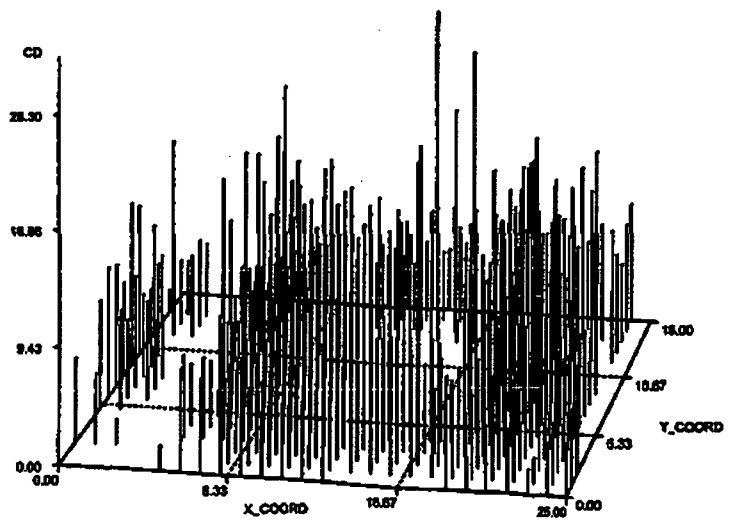
Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 1 LEVEL=Impacted



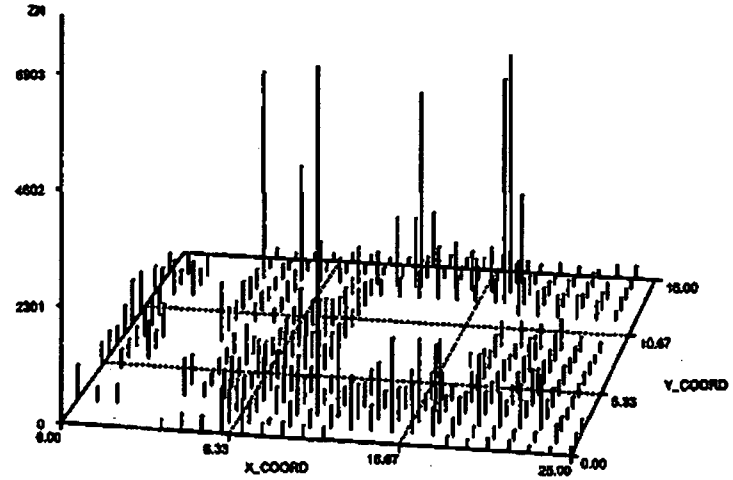
Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 1 LEVEL=Impacted



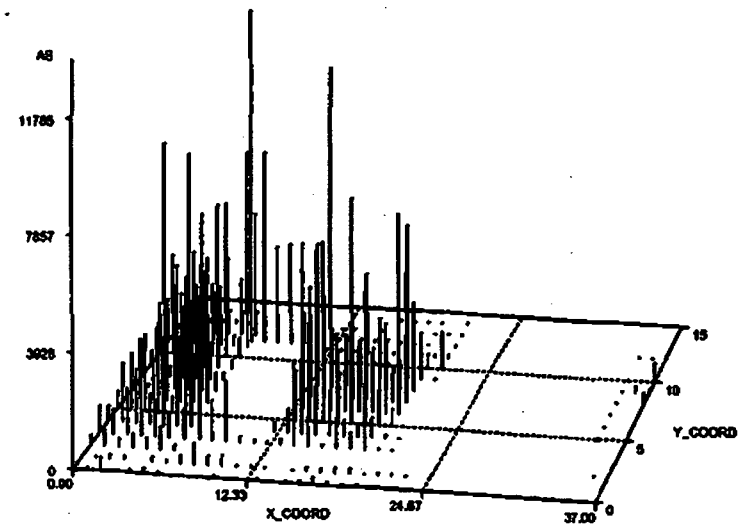
Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 1 LEVEL=Impacted



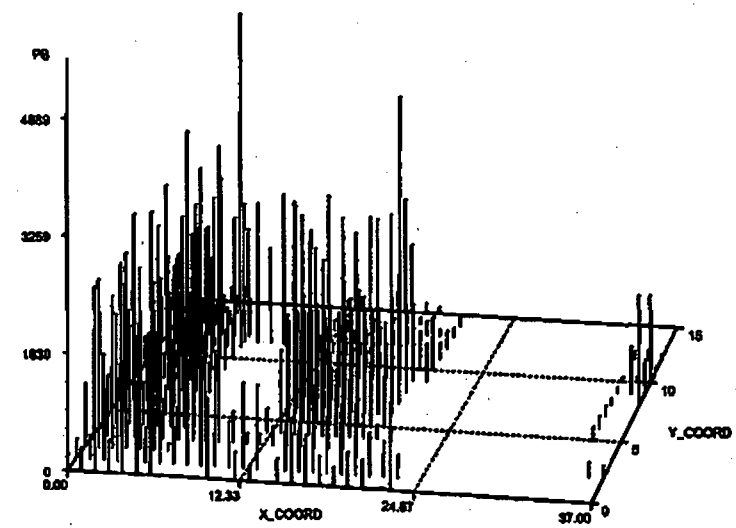
Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 1 LEVEL=Impacted



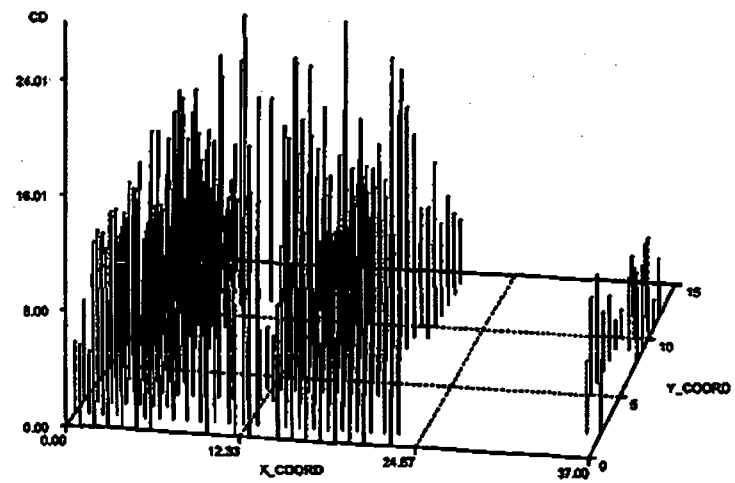
Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 2 LEVEL=Impacted



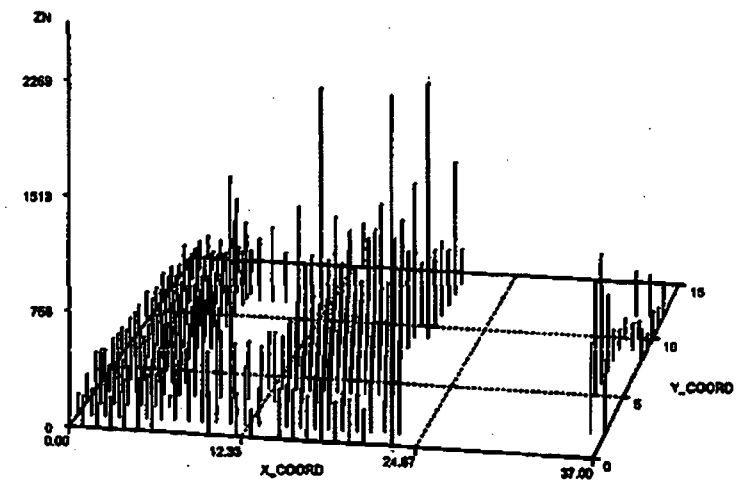
Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 2 LEVEL=Impacted



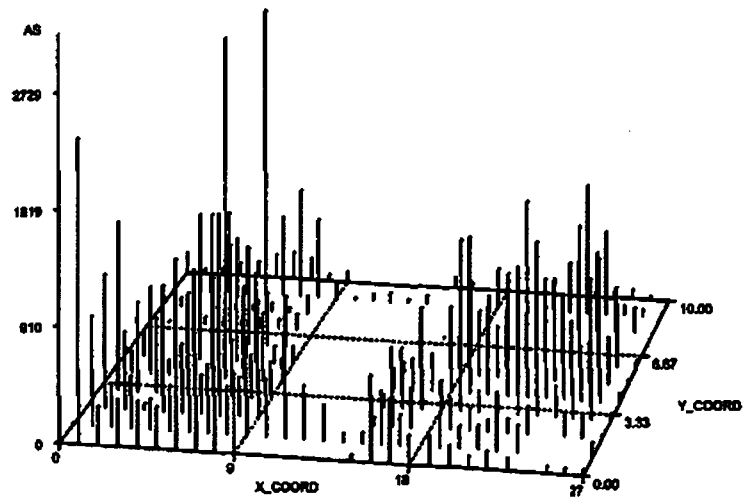
Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 2 LEVEL=Impacted



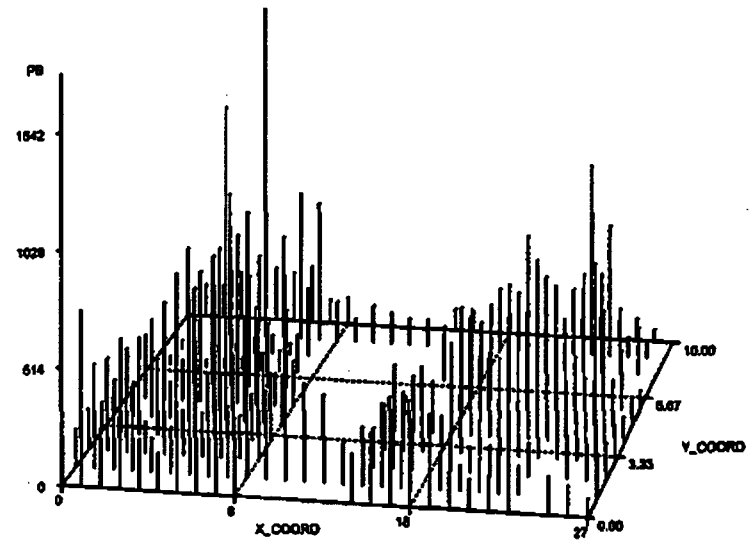
Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 2 LEVEL=Impacted



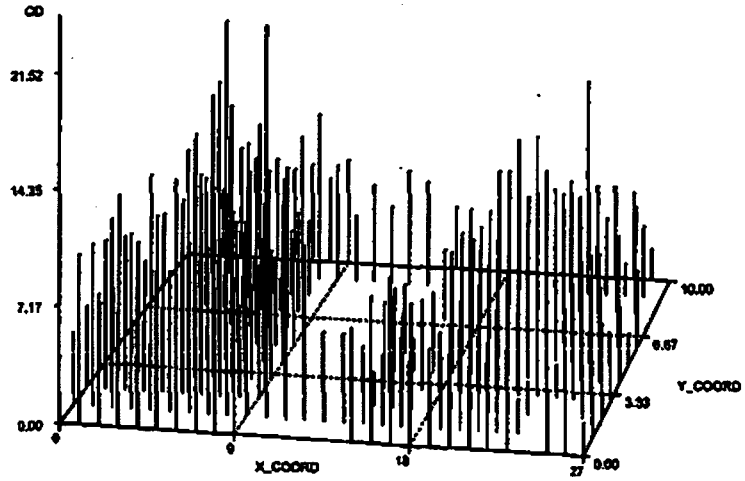
Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 3 LEVEL=Impacted



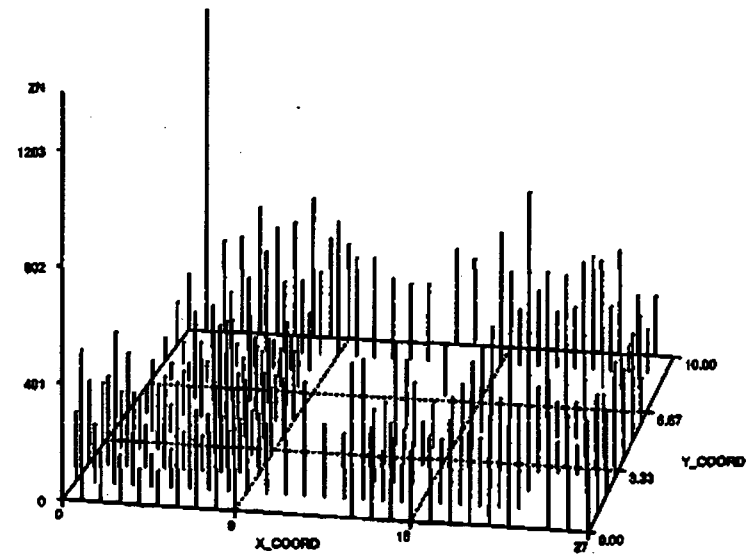
Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 3 LEVEL=Impacted



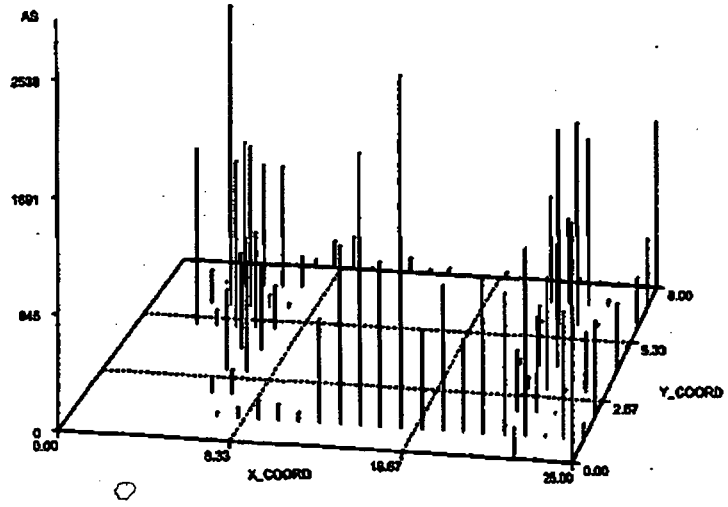
Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 3 LEVEL=Impacted



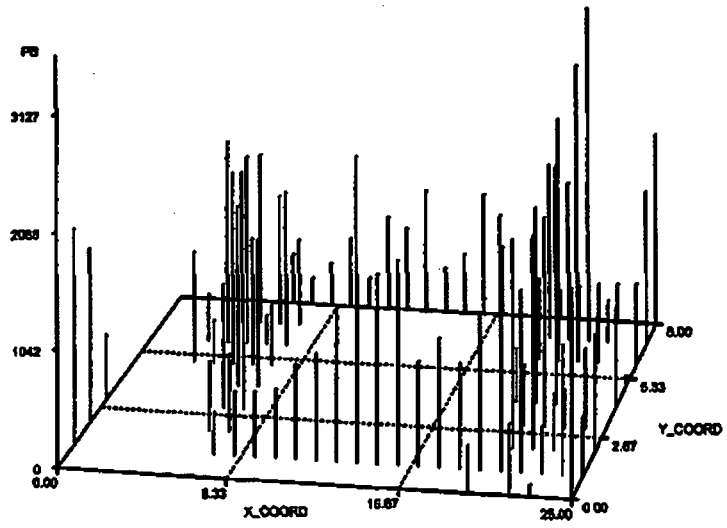
Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 3 LEVEL=Impacted



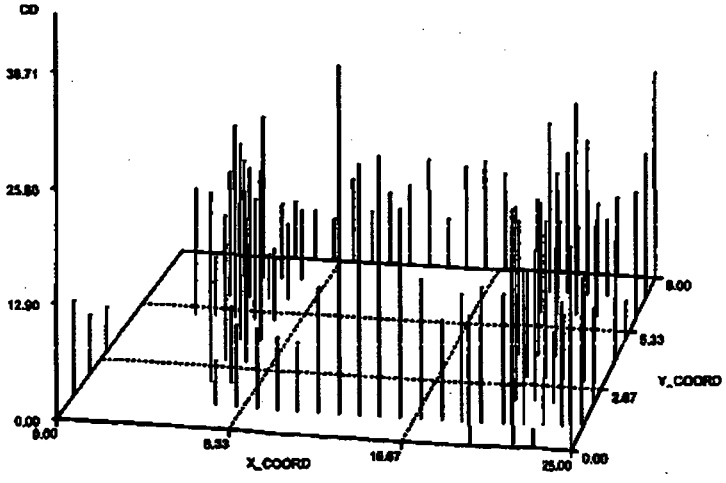
Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 4 LEVEL=Impacted



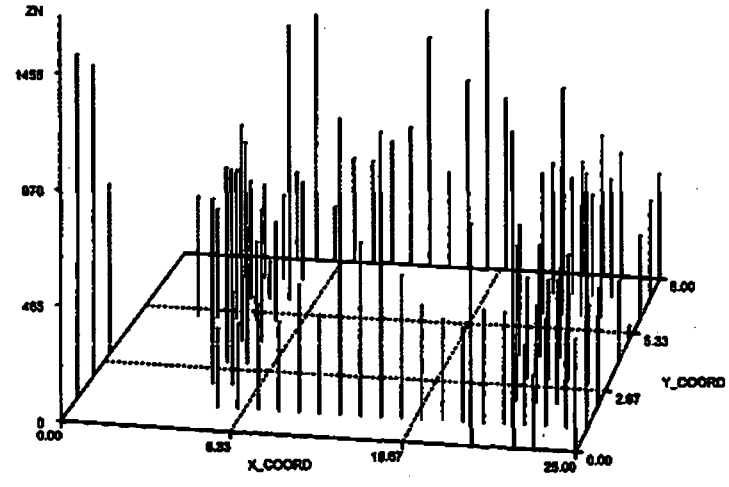
Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 4 LEVEL=Impacted



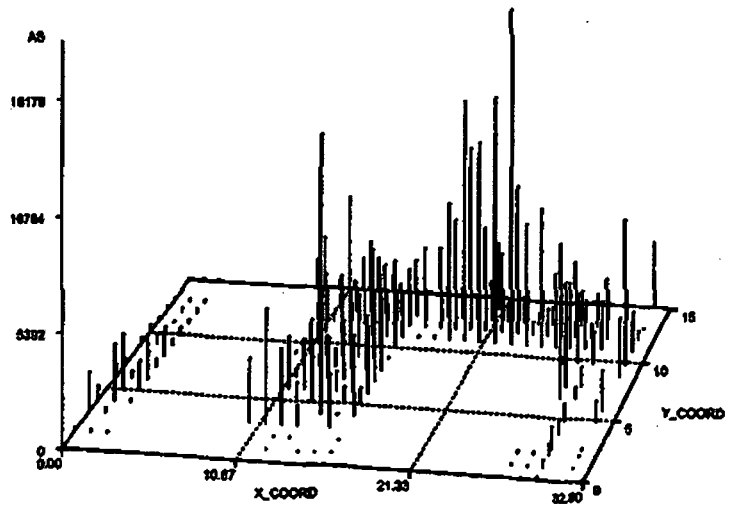
Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 4 LEVEL=Impacted



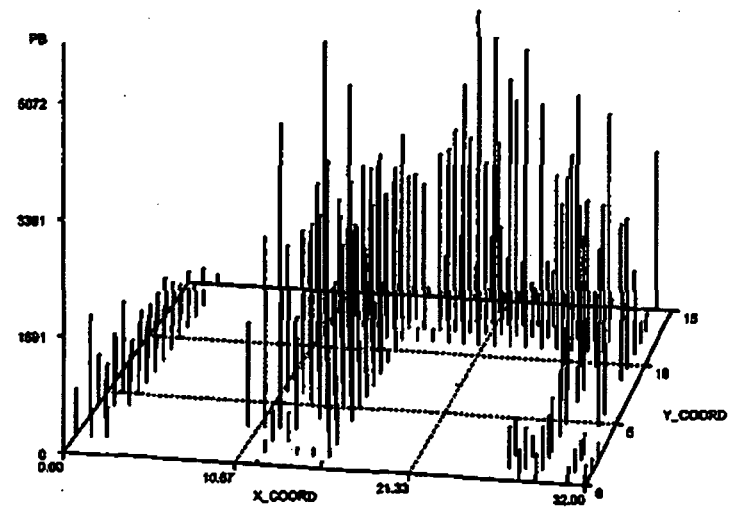
Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 4 LEVEL=Impacted



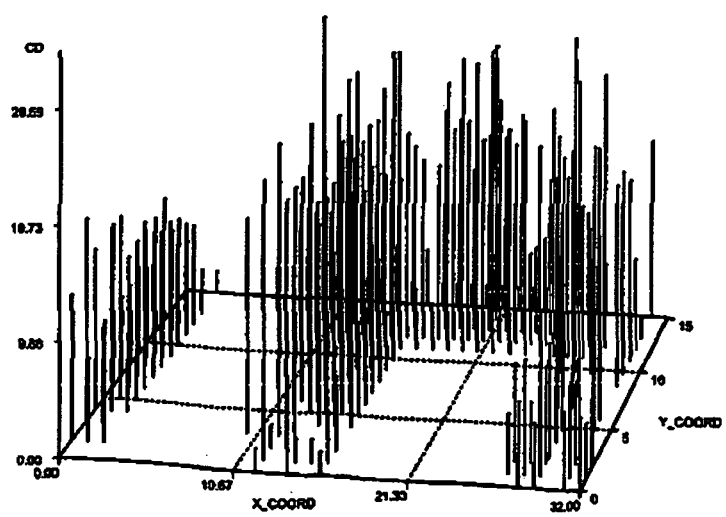
Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 5 LEVEL=Impacted



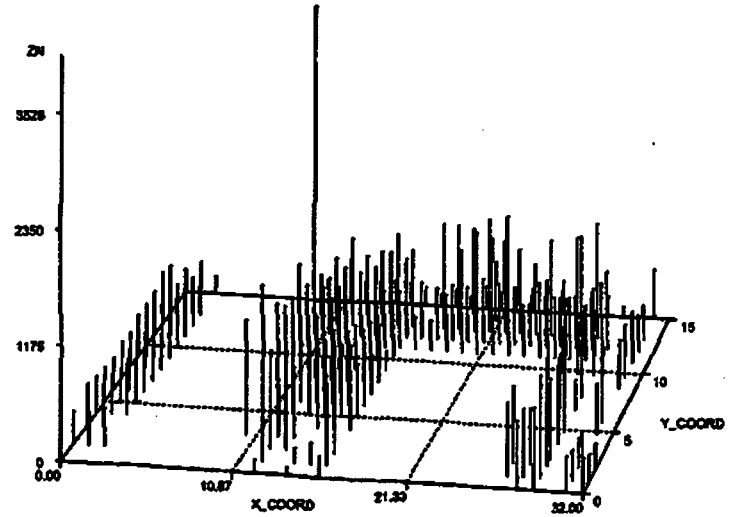
Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 5 LEVEL=Impacted



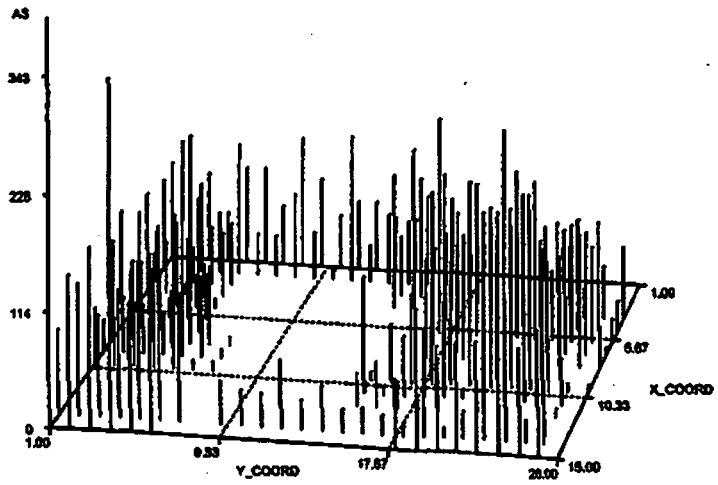
Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 5 LEVEL=Impacted



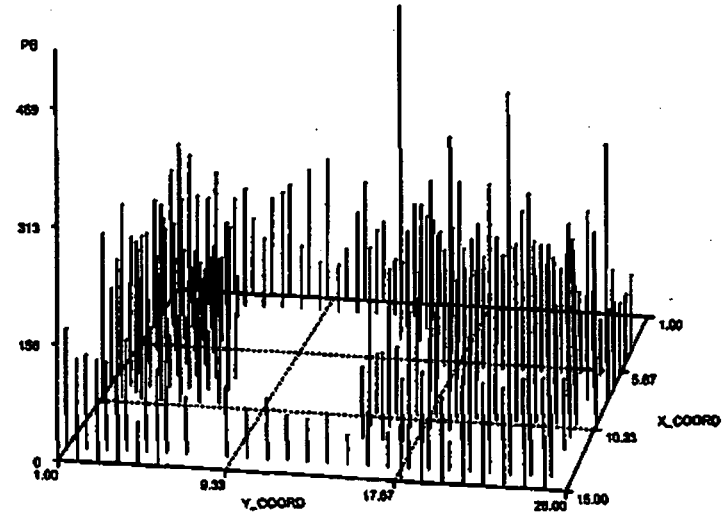
Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 5 LEVEL=Impacted



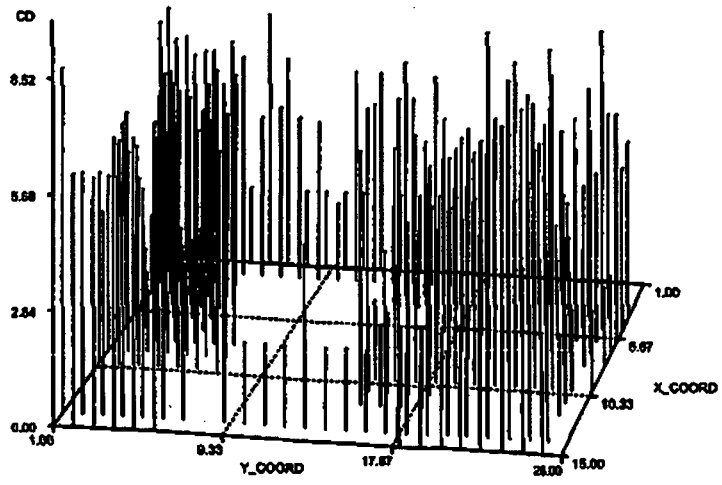
Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 6 LEVEL=Unimpacted



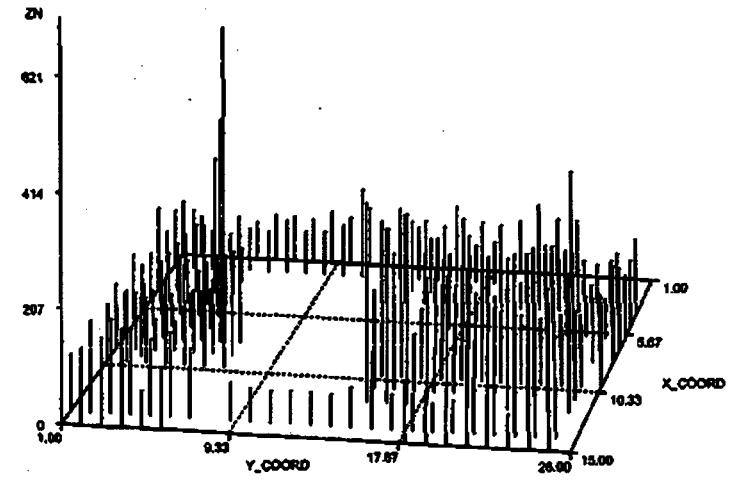
Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 6 LEVEL=Unimpacted



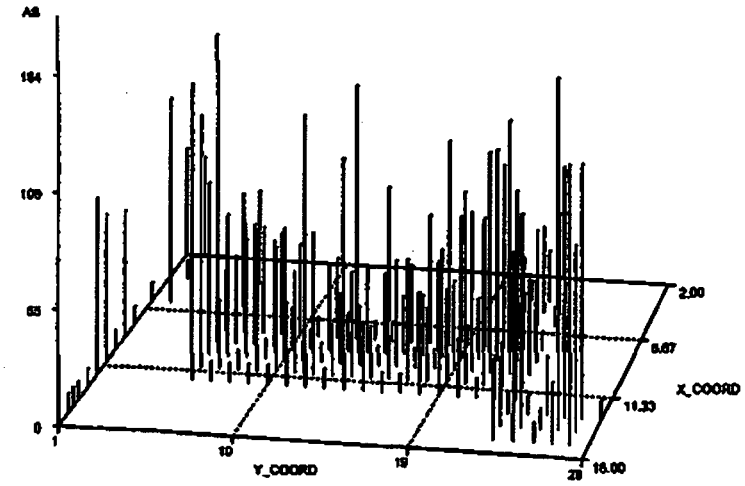
Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 6 LEVEL=Unimpacted



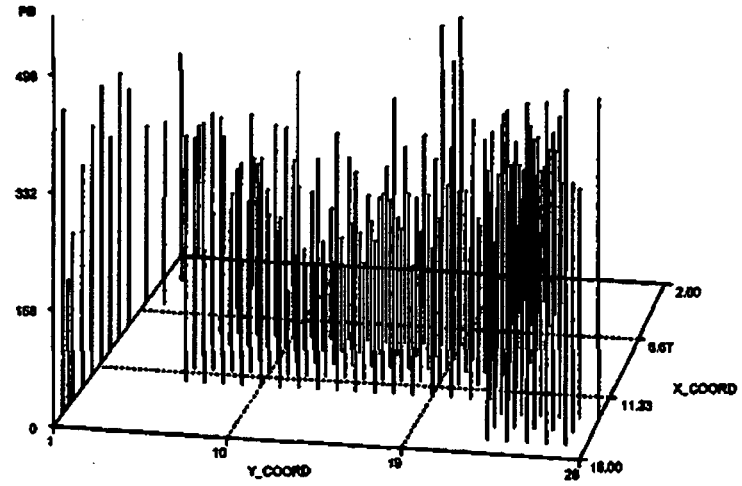
Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 6 LEVEL=Unimpacted



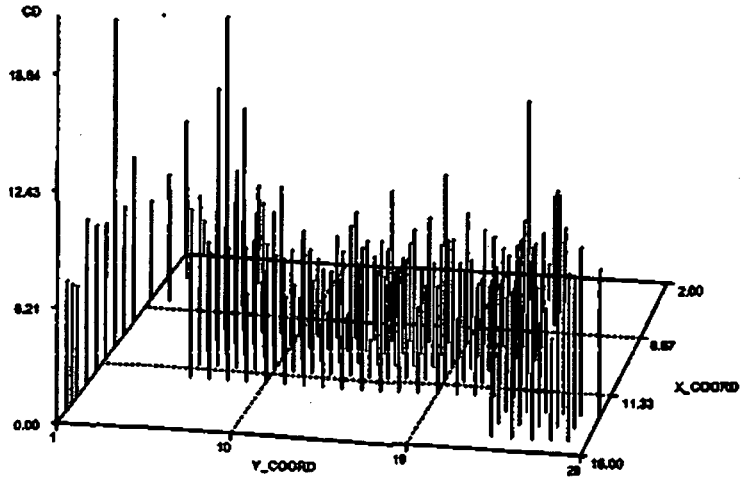
Vasquez Blvd. and I-70 (VB170) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 7 LEVEL=Unimpacted



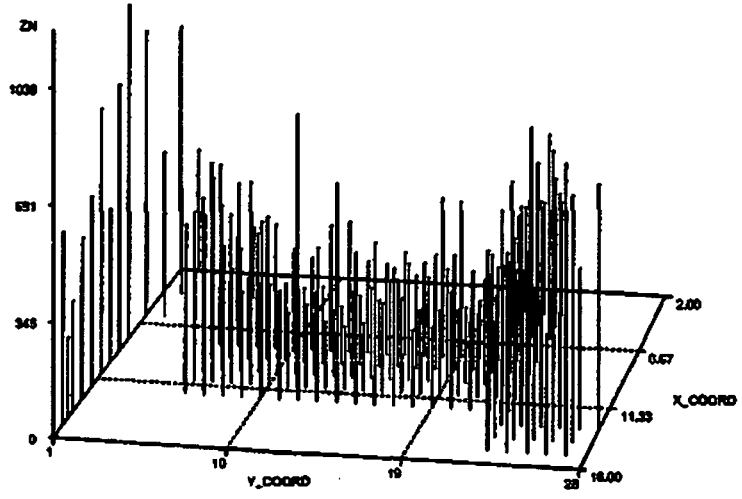
Vasquez Blvd. and I-70 (VB170) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 7 LEVEL=Unimpacted



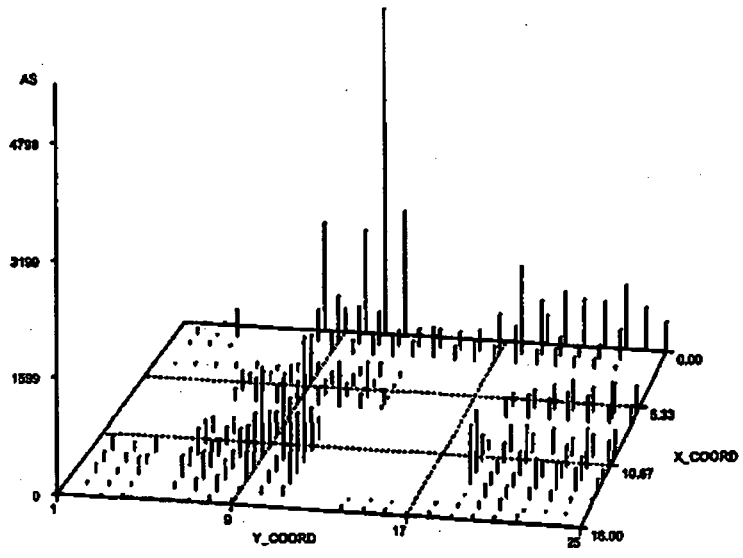
Vasquez Blvd. and I-70 (VB170) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 7 LEVEL=Unimpacted



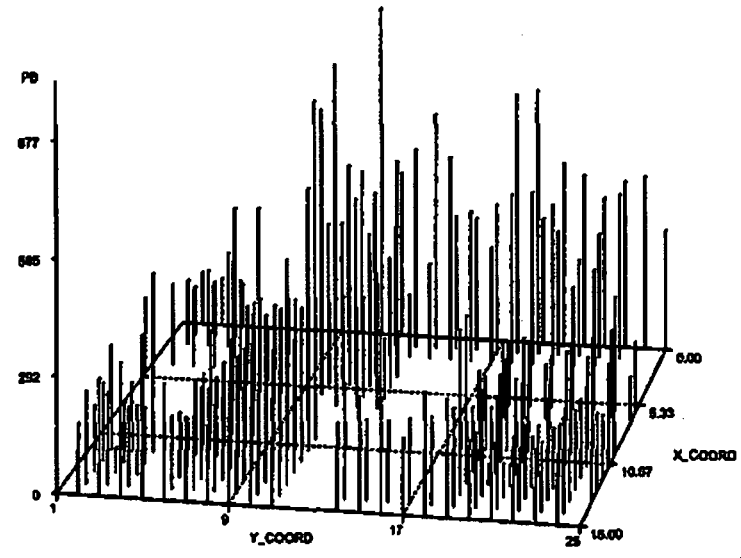
Vasquez Blvd. and I-70 (VB170) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 7 LEVEL=Unimpacted



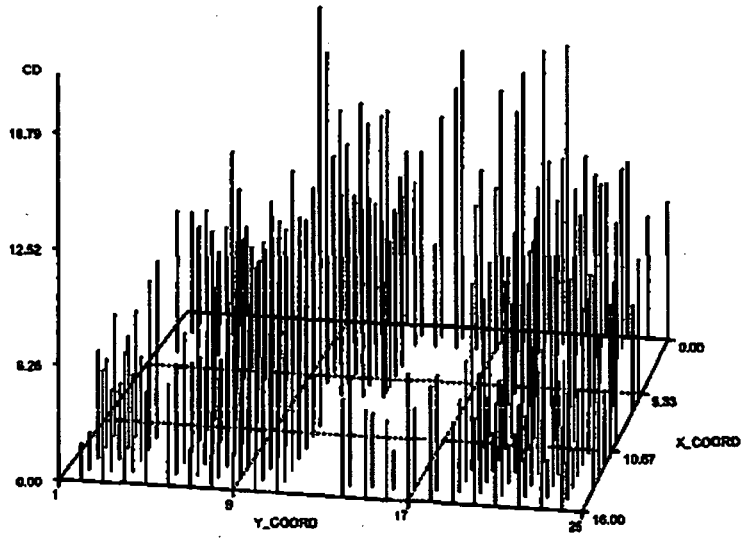
Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 8 LEVEL=Unimpacted



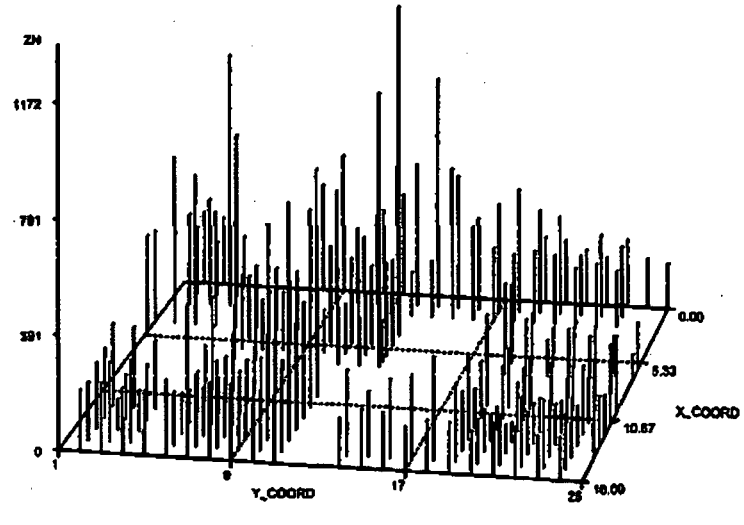
Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 8 LEVEL=Unimpacted



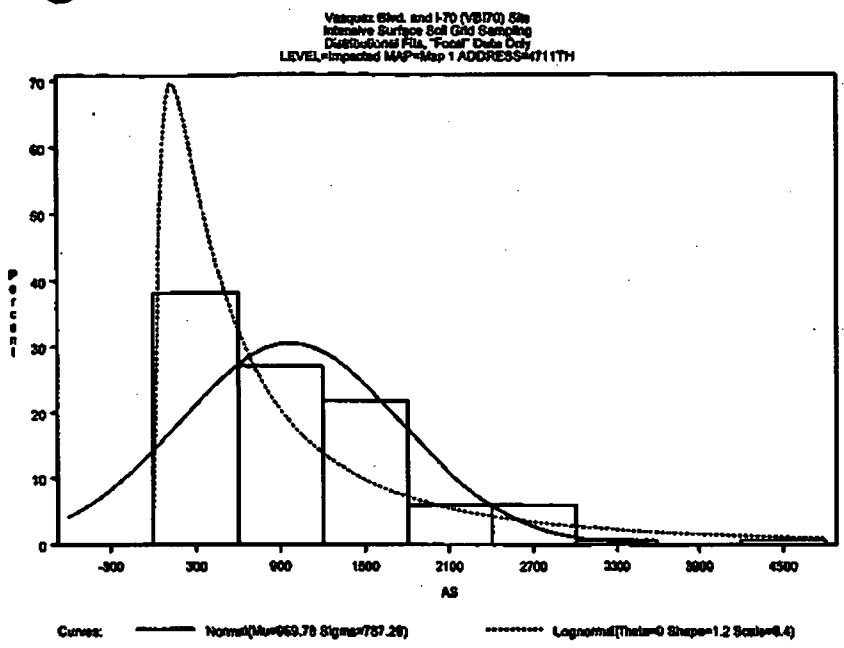
Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 8 LEVEL=Unimpacted

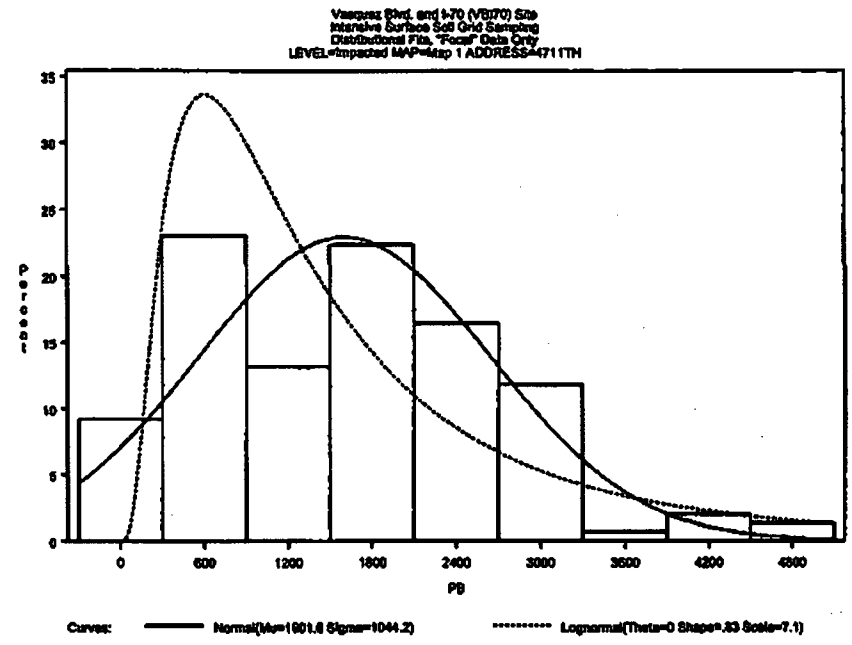


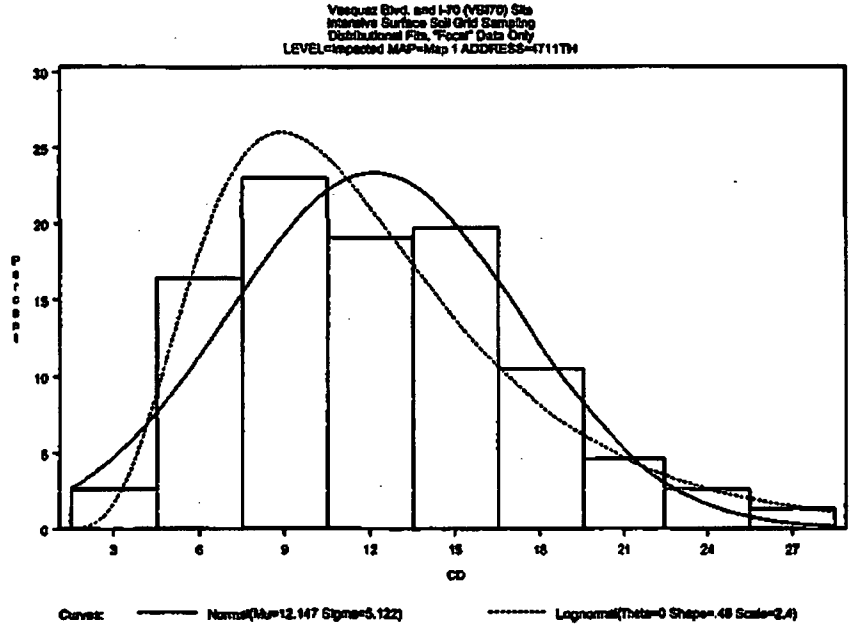
Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Spatial Display
MAP=Map 8 LEVEL=Unimpacted

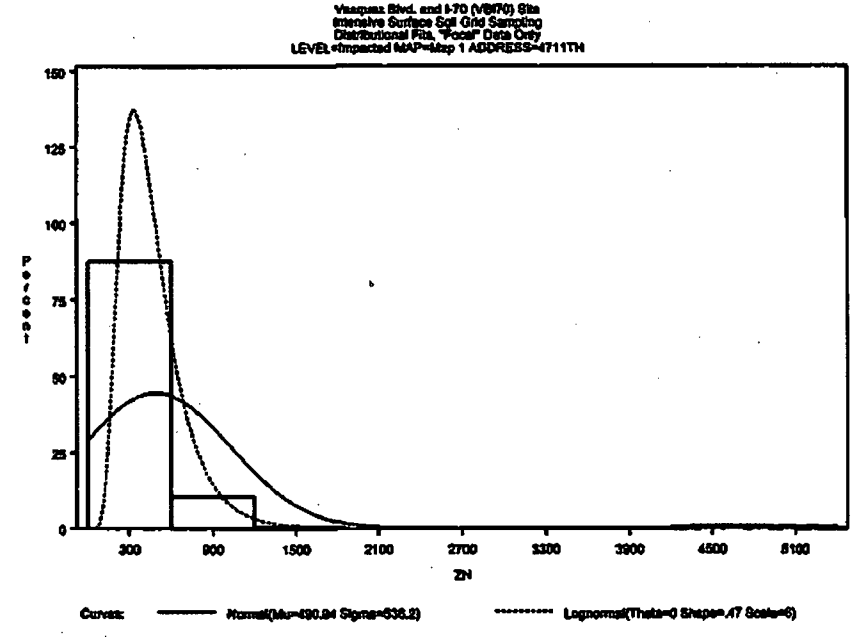


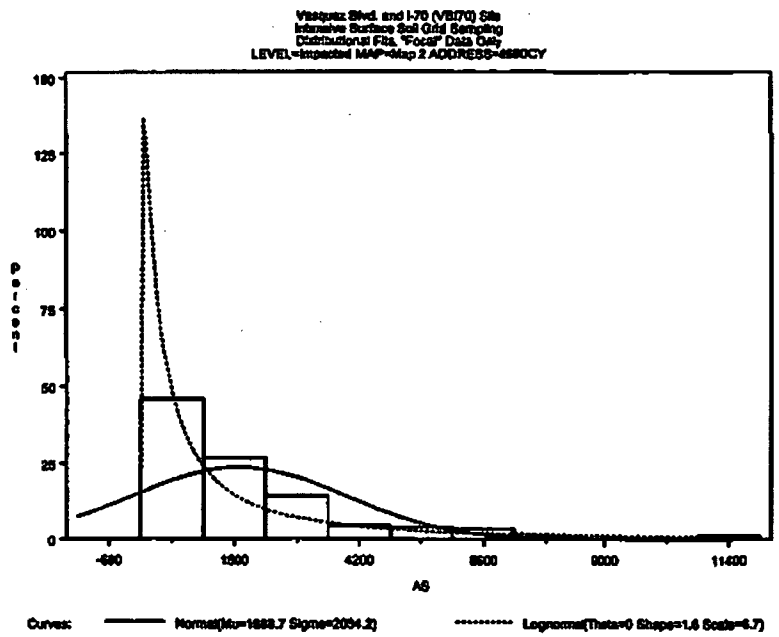
Simulations performed on risk-based sampling data from locations 3,4, and 5

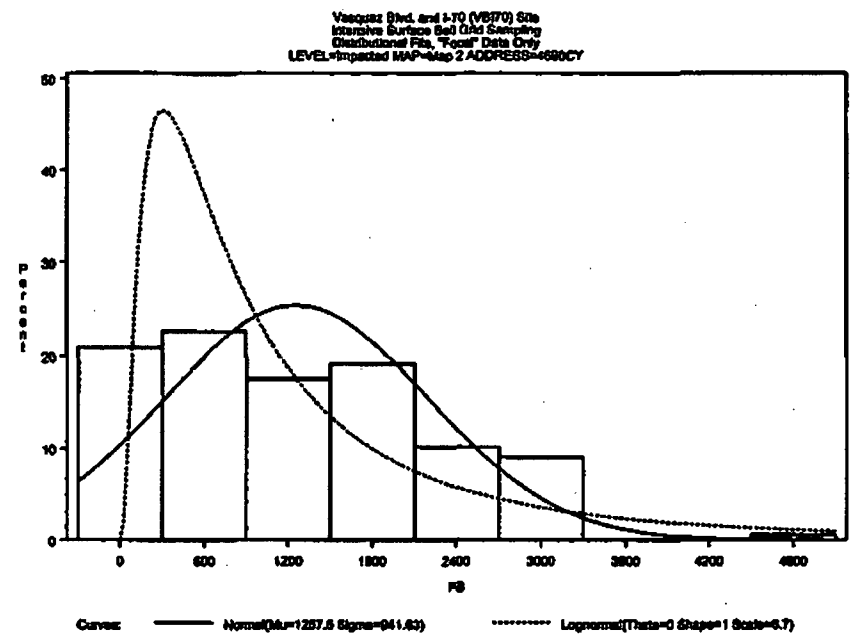

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 1 ADDRESS=4711TH
Percent
AS
Curves: Normal(Mu=669.78 Sigma=757.26) Lognormal(Theta=0 Shape=1.2 Scale=6.4)

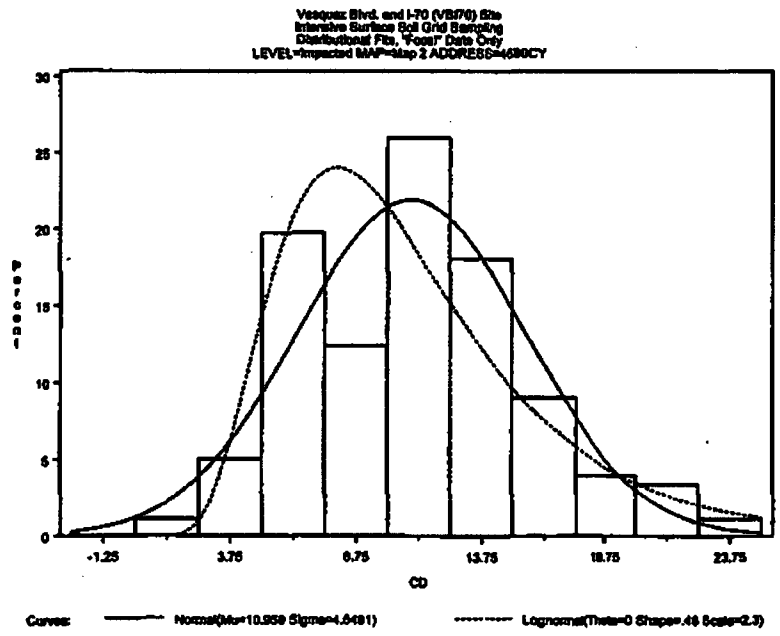

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 1 ADDRESS=4711TH
Percent
PB
Curves: Normal(Mu=1901.6 Sigma=1044.2) Lognormal(Theta=0 Shape=.83 Scale=7.1)

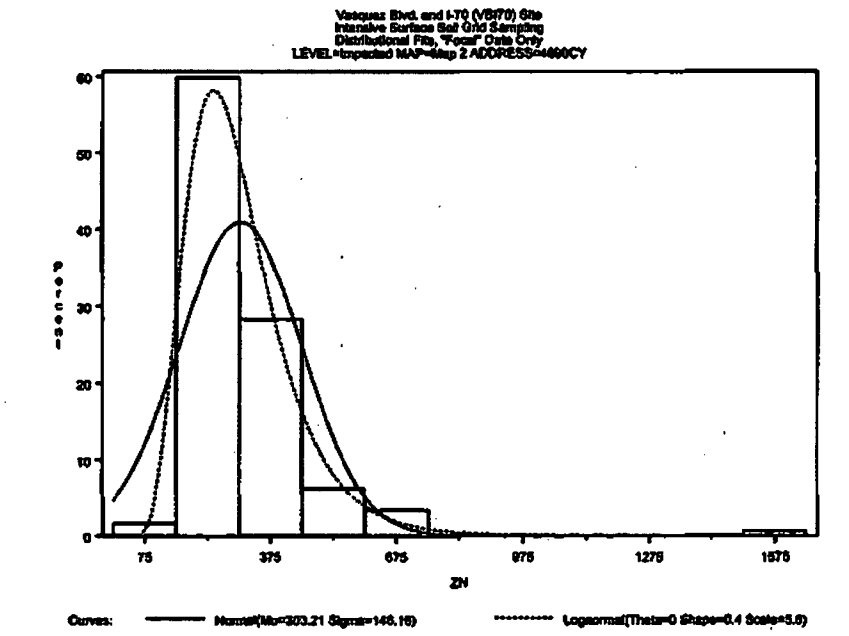

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 1 ADDRESS=4711TH
Percent
CD
Curves: Normal(Mu=12.147 Sigma=5.122) Lognormal(Theta=0 Shape=.48 Scale=2.4)

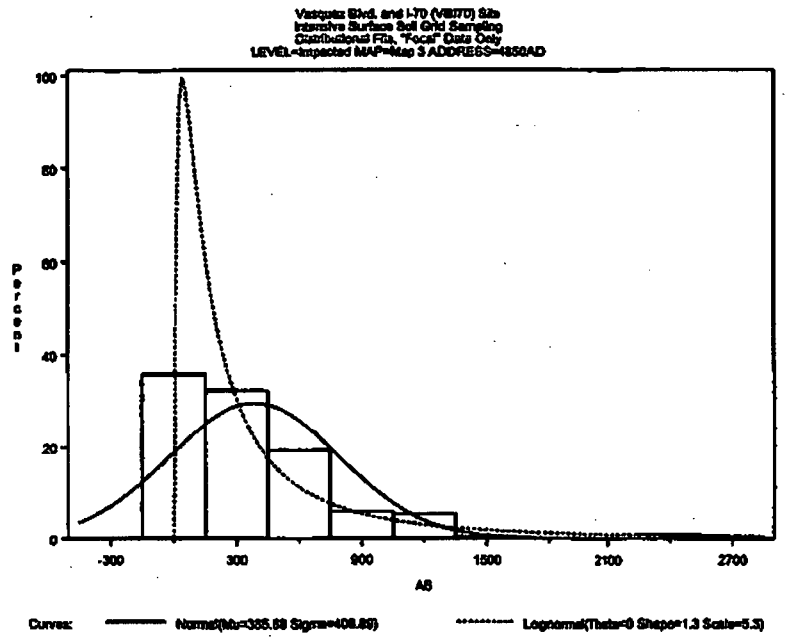

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 1 ADDRESS=4711TH
Percent
ZN
Curves: Normal(Mu=490.94 Sigma=536.2) Lognormal(Theta=0 Shape=.47 Scale=6)

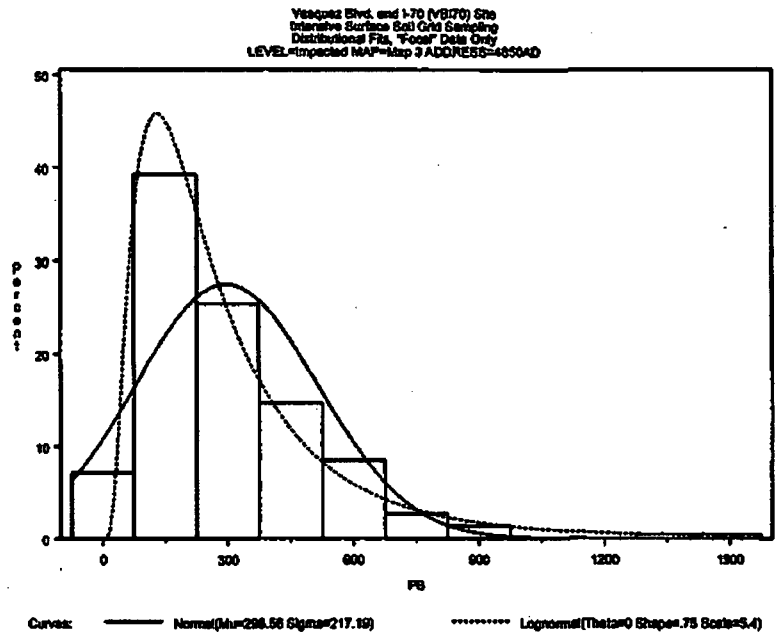

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 2 ADDRESS=4690CY
Percent
AS
Curves:
Normal(Mu=1888.7 Sigma=2094.2)
Lognormal(Theta=0 Shape=1.6 Scale=6.7)

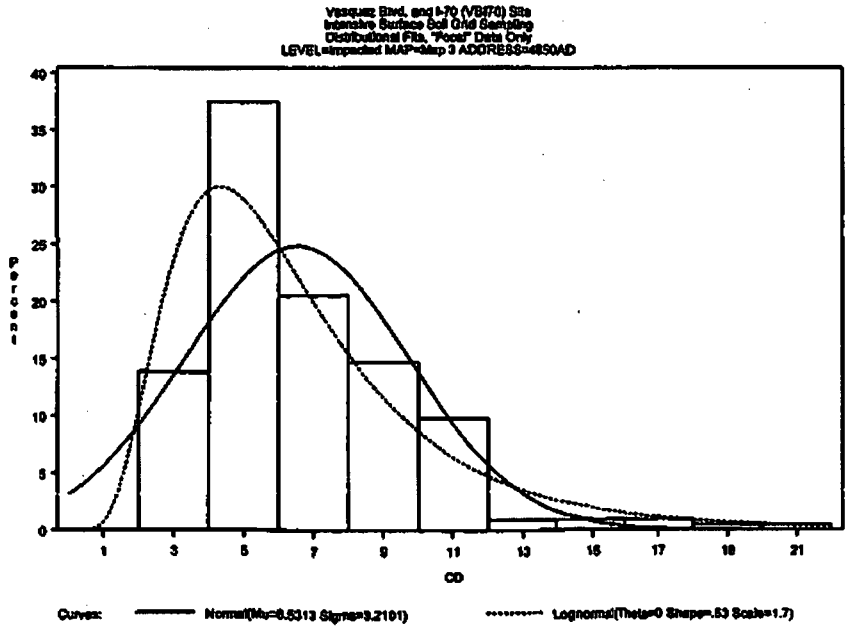

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 2 ADDRESS=4690CY
Percent
PB
Curves:
Normal(Mu=1257.6 Sigma=941.63)
Lognormal(Theta=0 Shape=1 Scale=6.7)

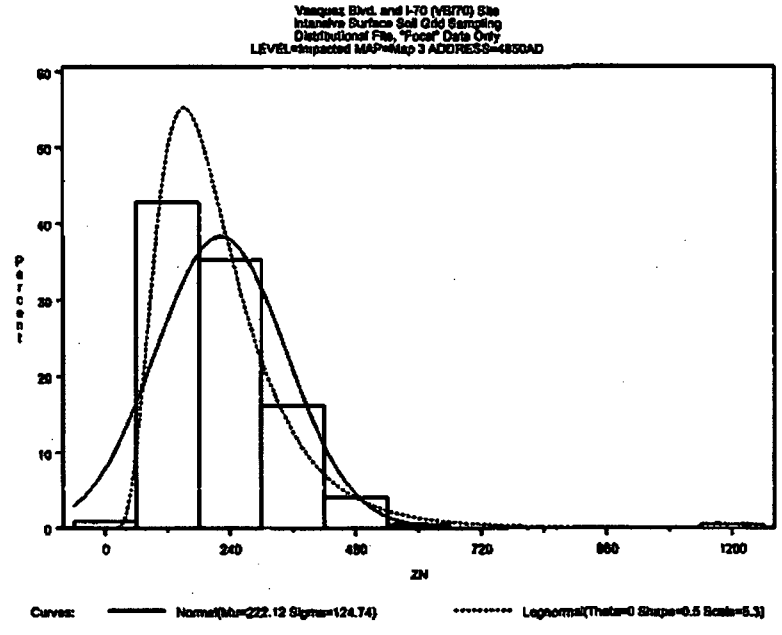

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 2 ADDRESS=4690CY
Percent
CD
Curves:
Normal(Mu=10.959 Sigma=4.6491)
Lognormal(Theta=0 Shape=.46 Scale=2.3)

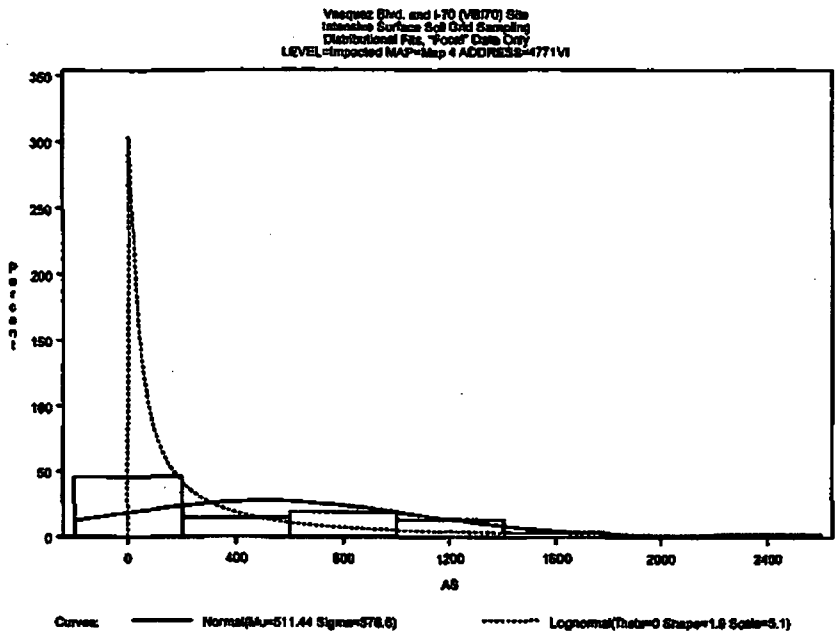

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 2 ADDRESS=4690CY
Percent
ZN
Curves:
Normal(Mu=303.21 Sigma=146.16)
Lognormal(Theta=0 Shape=0.4 Scale=5.6)

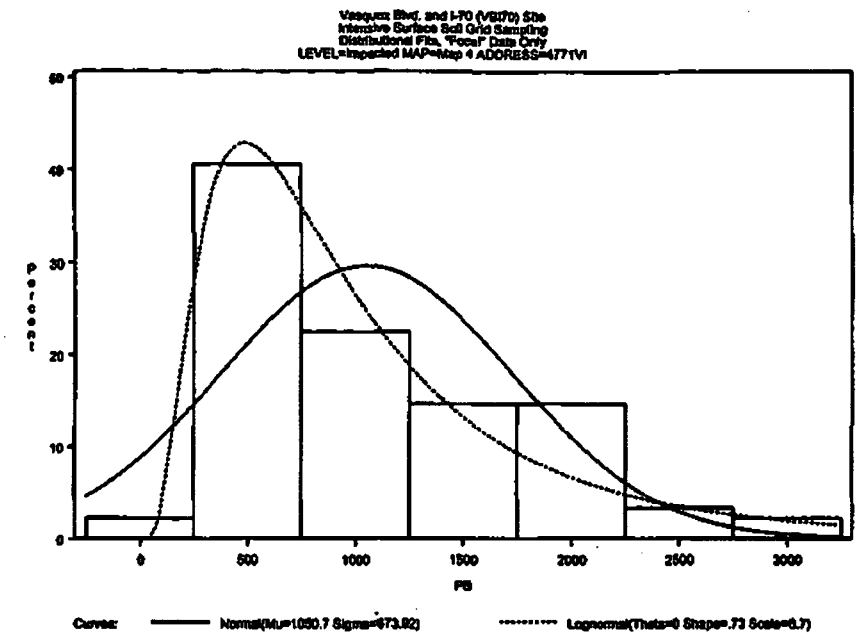

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 3 ADDRESS=4850AD
Percent
AS
Curves: Normal(Mu=355.69 Sigma=408.89) Lognormal(Theta=0 Shape=1.3 Scale=5.3)

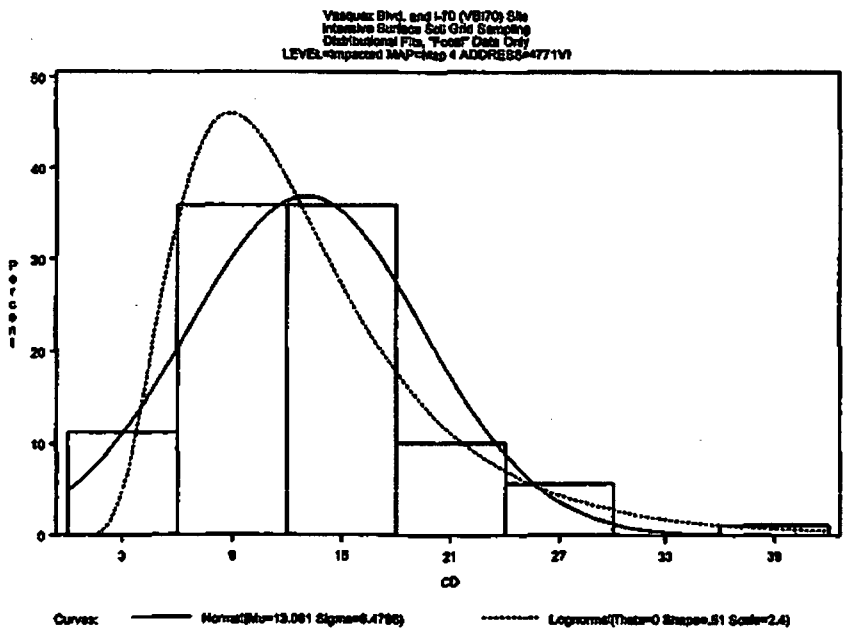

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 3 ADDRESS=4850AD
Percent
PB
Curves: Normal(Mu=298.56 Sigma=217.19) Lognormal(Theta=0 Shape=.75 Scale=5.4)

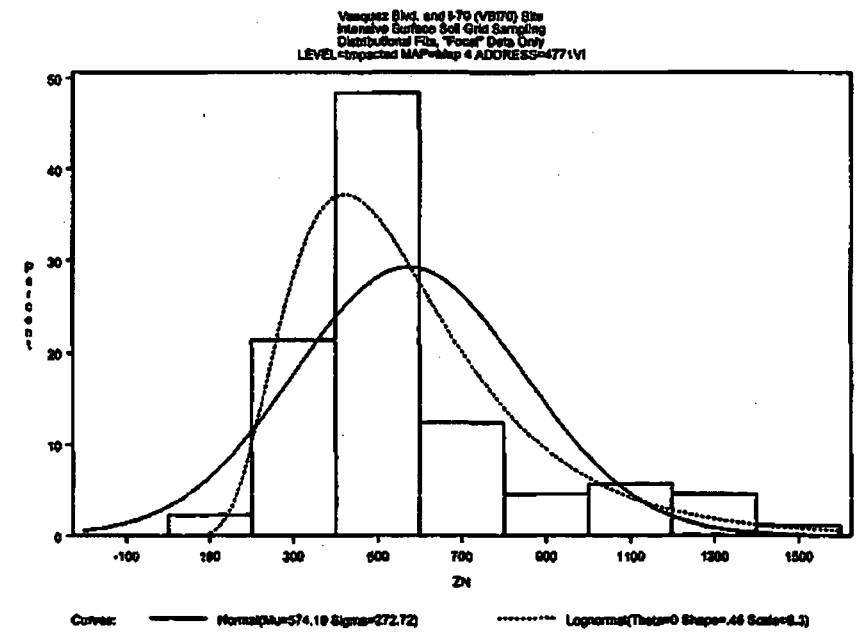

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 3 ADDRESS=4850AD
Percent
CD
Curves: Normal(Mu=6.5313 Sigma=3.2101) Lognormal(Theta=0 Shape=.53 Scale=1.7)

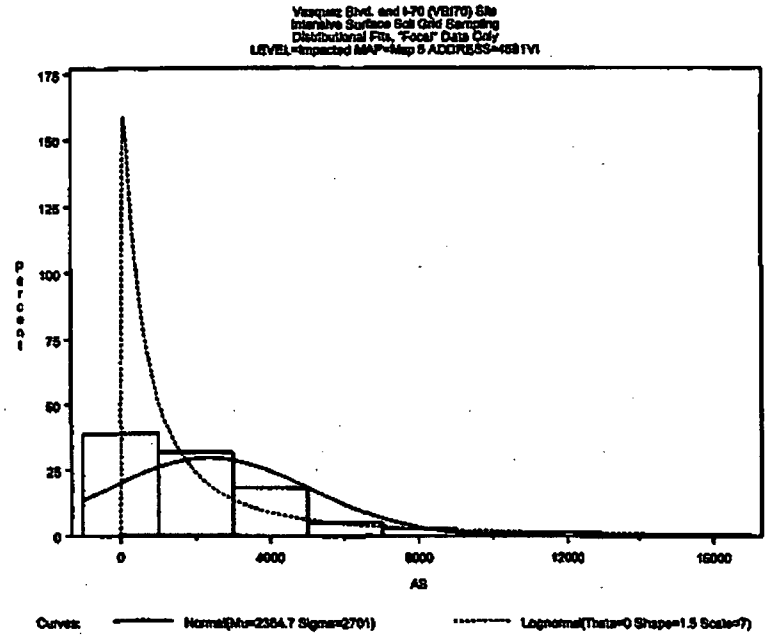

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 3 ADDRESS=4850AD
Percent
ZN
Curves: Normal(Mu=222.12 Sigma=124.74) Lognormal(Theta=0 Shape=0.5 Scale=5.3)

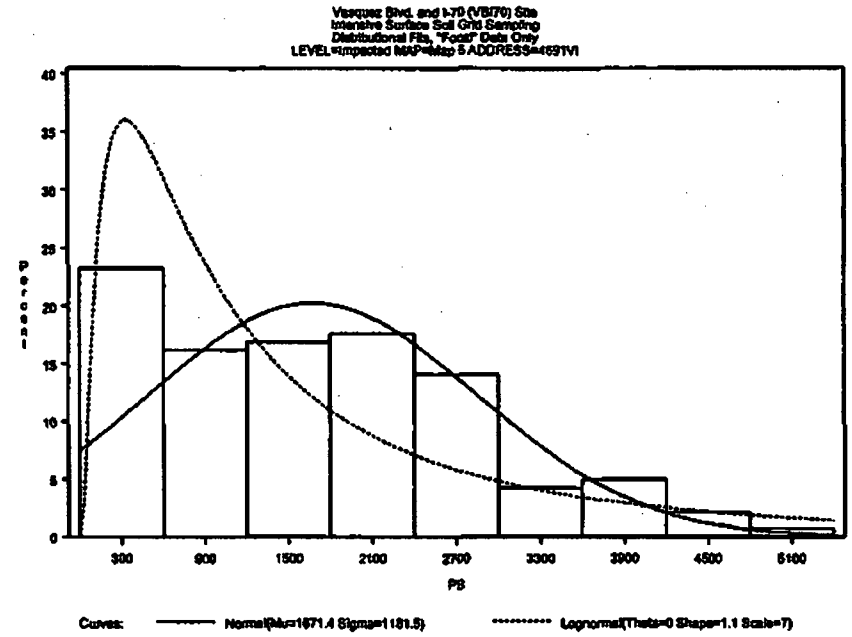

Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 4 ADDRESS=4771VI
Percent
AS
Curves: Normal(Mu=511.44 Sigma=576.6) Lognormal(Theta=0 Shape=1.8 Scale=5.1)

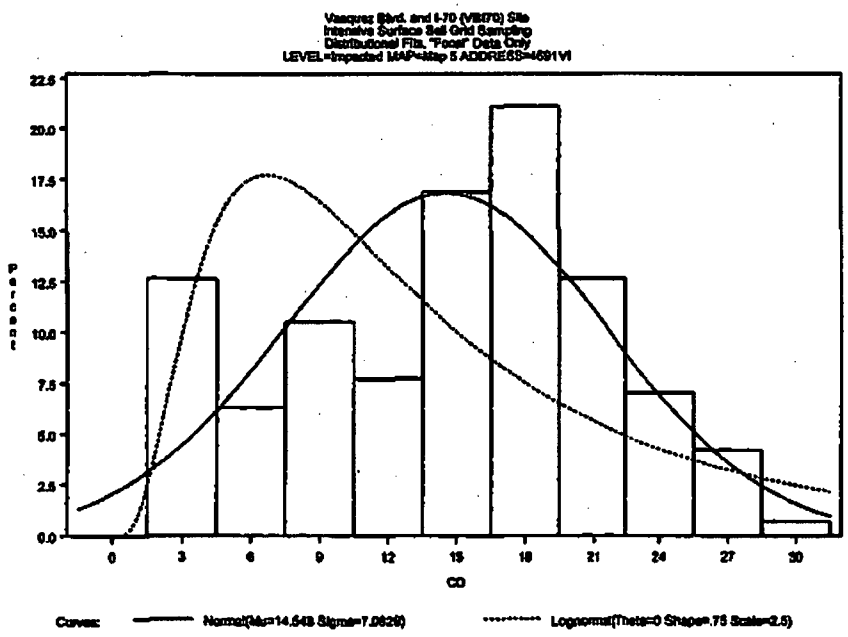

Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 4 ADDRESS=4771VI
Percent
PB
Curves: Normal(Mu=1050.7 Sigma=473.92) Lognormal(Theta=0 Shape=.73 Scale=6.7)

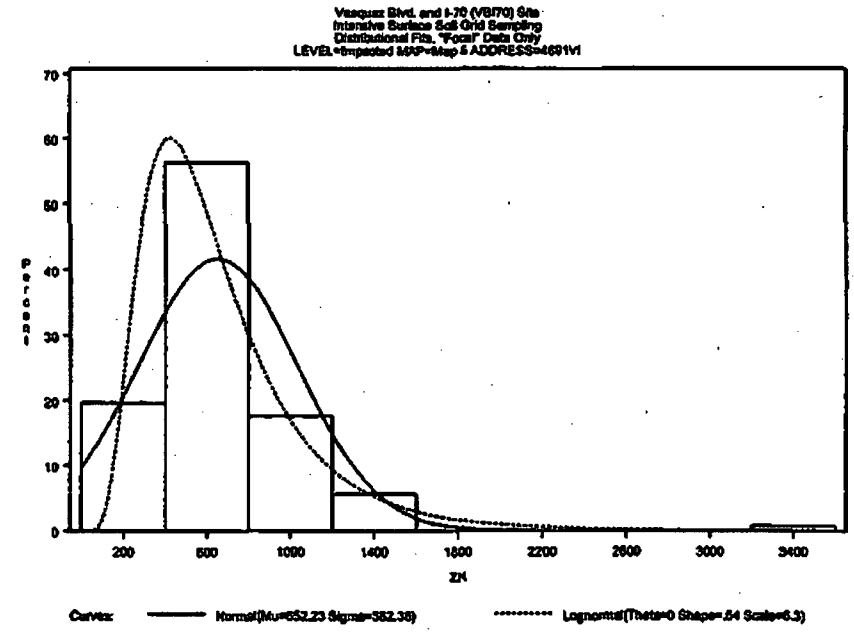

Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 4 ADDRESS=4771VI
Percent
CD
Curves: Normal(Mu=13.061 Sigma=6.4796) Lognormal(Theta=0 Shape=.51 Scale=2.4)

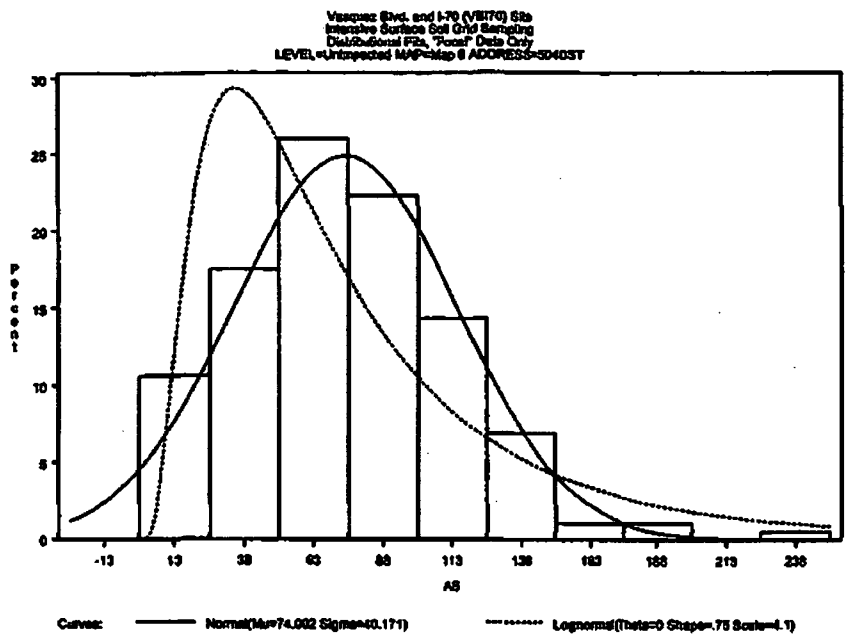

Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 4 ADDRESS=4771VI
Percent
ZN
Curves: Normal(Mu=574.19 Sigma=272.72) Lognormal(Theta=0 Shape=.46 Scale=6.3)

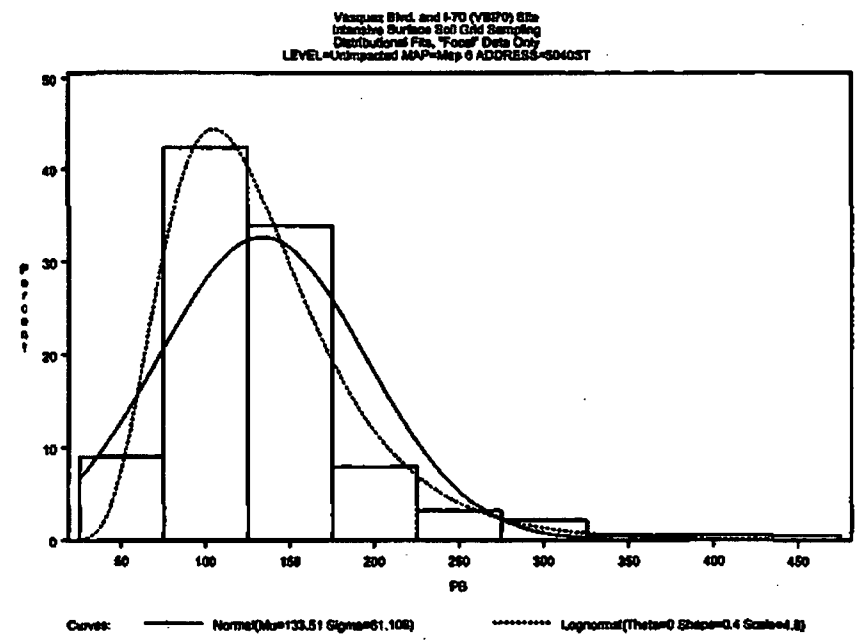

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 5 ADDRESS=4691VI
Percent
AS
Curves: Normal(Mu=2364.7 Sigma=2701) Lognormal(Theta=0 Shape=1.5 Scale=7)

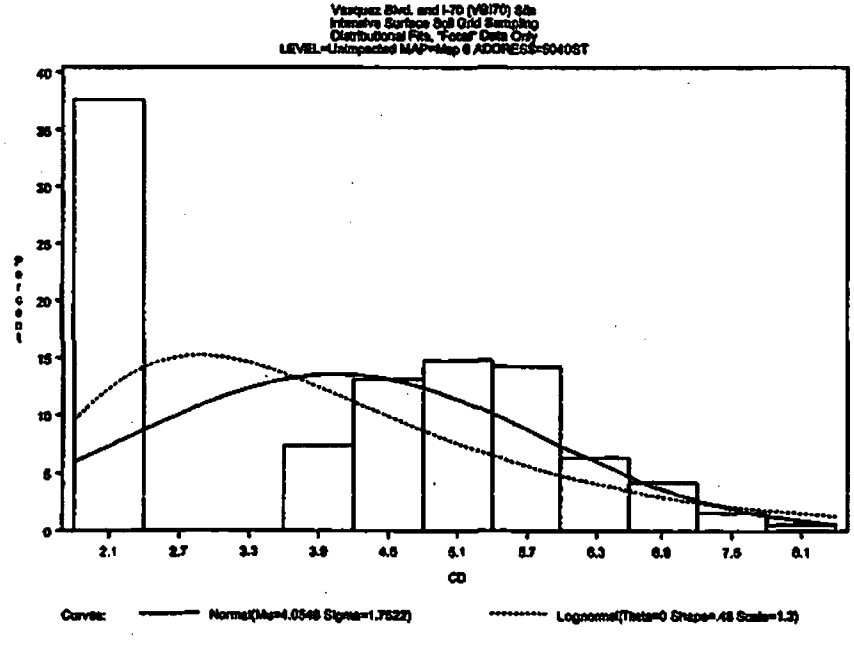

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 5 ADDRESS=4691VI
Percent
PB
Curves: Normal(Mu=1671.4 Sigma=1181.5) Lognormal(Theta=0 Shape=1.1 Scale=7)

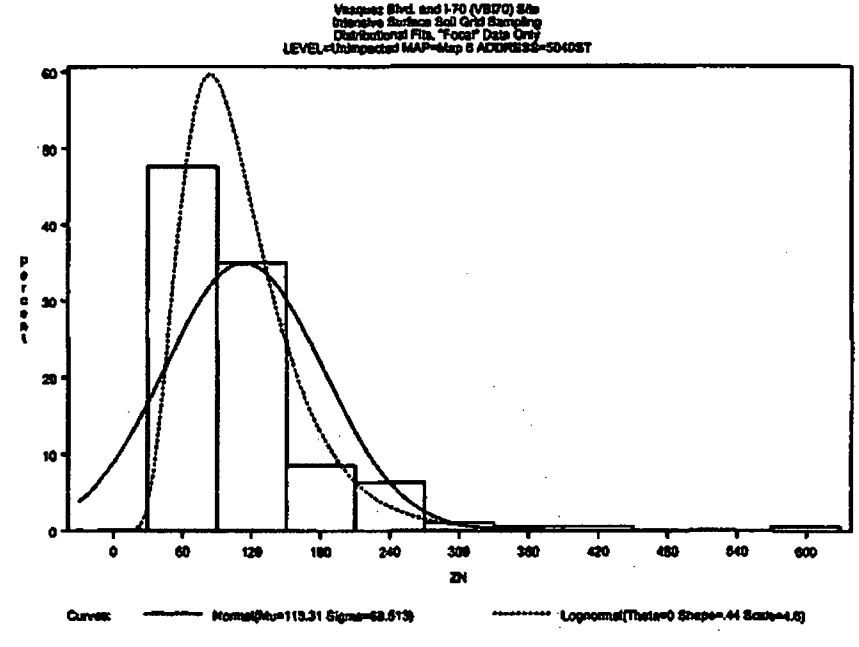

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 5 ADDRESS=4691VI
Percent
CD
Curves: Normal(Mu=14.548 Sigma=7.0629) Lognormal(Theta=0 Shape=.75 Scale=2.5)


Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 5 ADDRESS=4691VI
Percent
ZN
Curves: Normal(Mu=652.23 Sigma=352.38) Lognormal(Theta=0 Shape=.54 Scale=6.3)

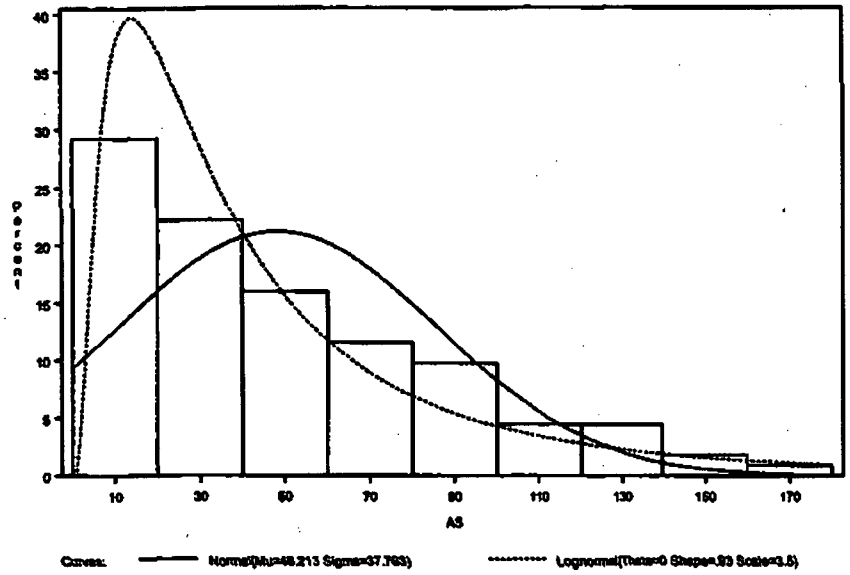

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Unimpacted MAP=Map 6 ADDRESS=5040ST
Percent
AS
Curves: Normal(Mu=74.002 Sigma=40.171) Lognormal(Theta=0 Shape=.75 Scale=4.1)


Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Unimpacted MAP=Map 6 ADDRESS=5040ST
Percent
PB
Curves: Normal(Mu=133.51 Sigma=61.108) Lognormal(Theta=0 Shape=0.4 Scale=4.8)

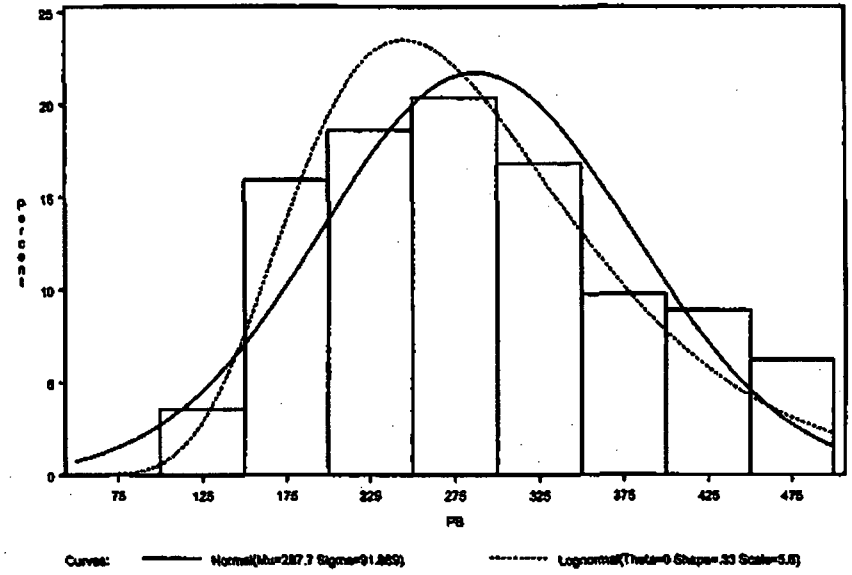

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Unimpacted MAP=Map 6 ADDRESS=5040ST
Percent
CD
Curves: Normal(Mu=4.0548 Sigma=1.7522) Lognormal(Theta=0 Shape=.48 Scale=1.3)


Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Unimpacted MAP=Map 6 ADDRESS=5040ST
Percent
ZN
Curves: Normal(Mu=113.31 Sigma=68.513) Lognormal(Theta=0 Shape=.44 Scale=4.6)

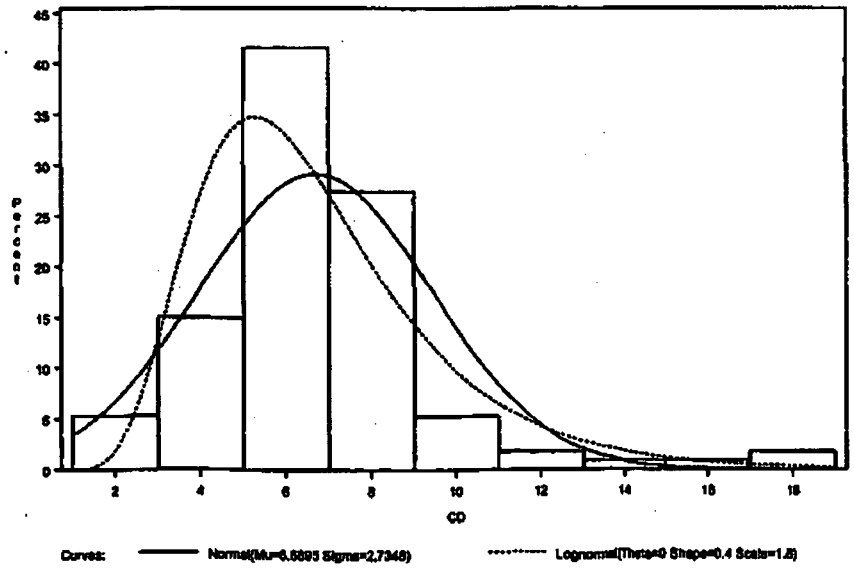
Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Unimpacted MAP=Map 7 ADDRESS=4712JO



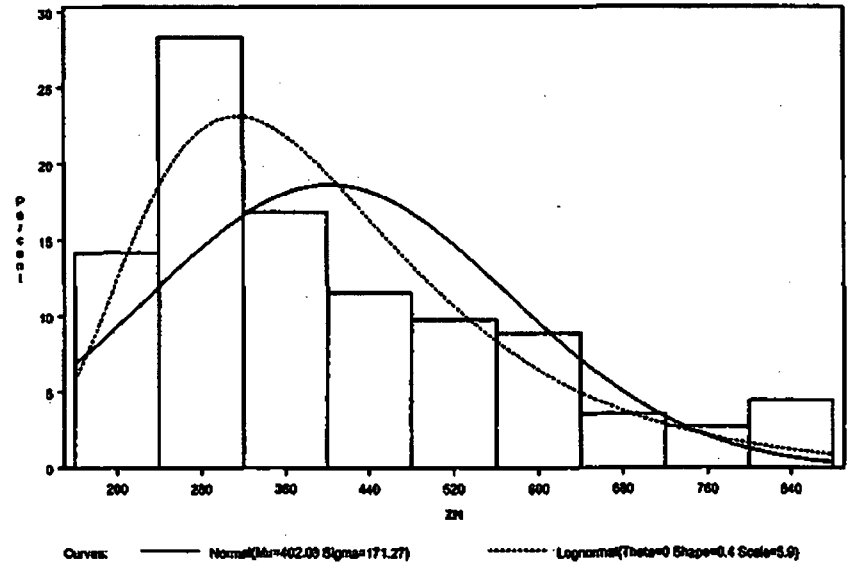
Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Unimpacted MAP=Map 7 ADDRESS=4712JO

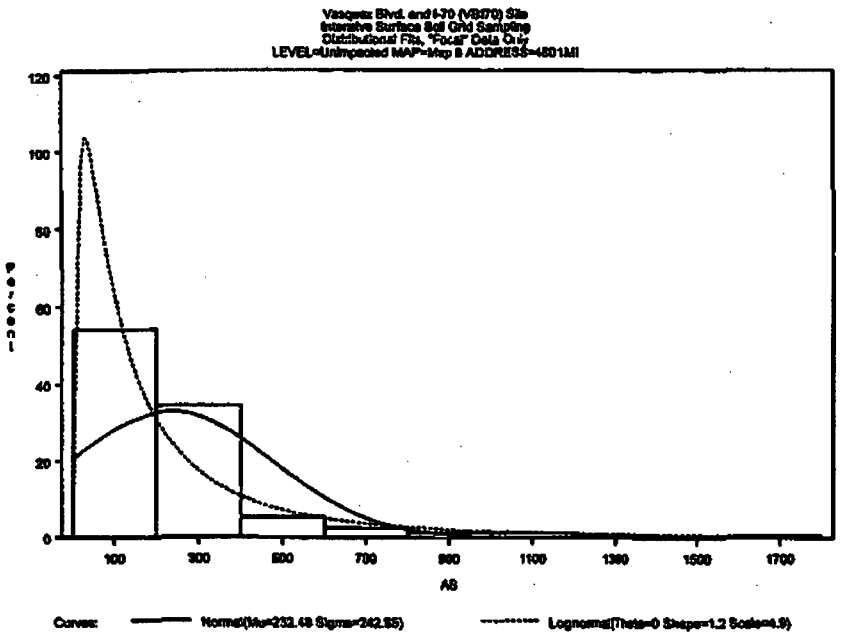


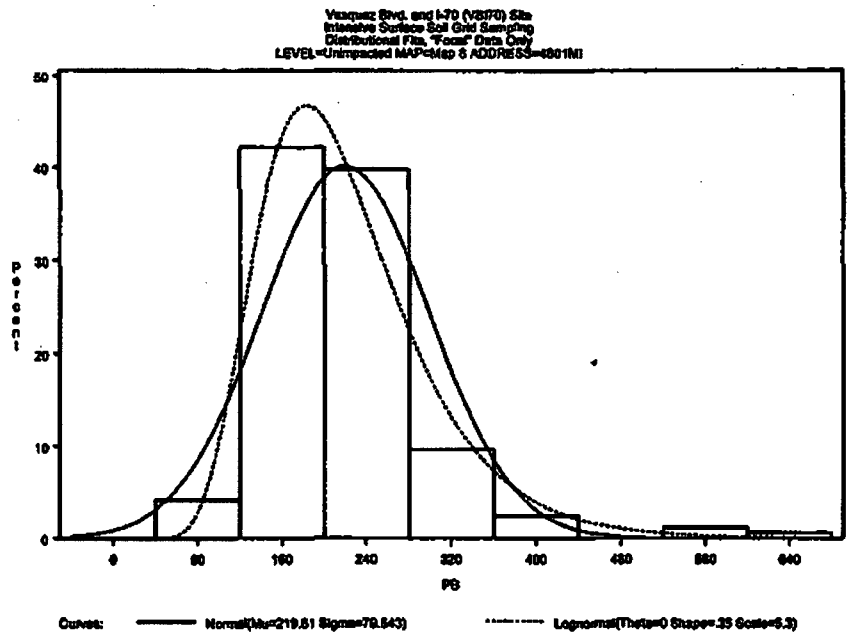
Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Unimpacted MAP=Map 7 ADDRESS=4712JO

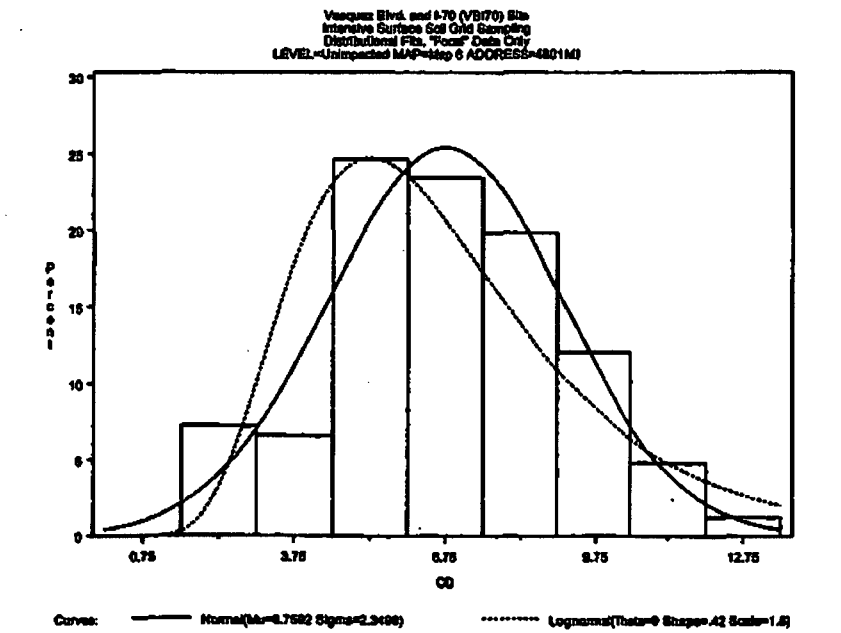


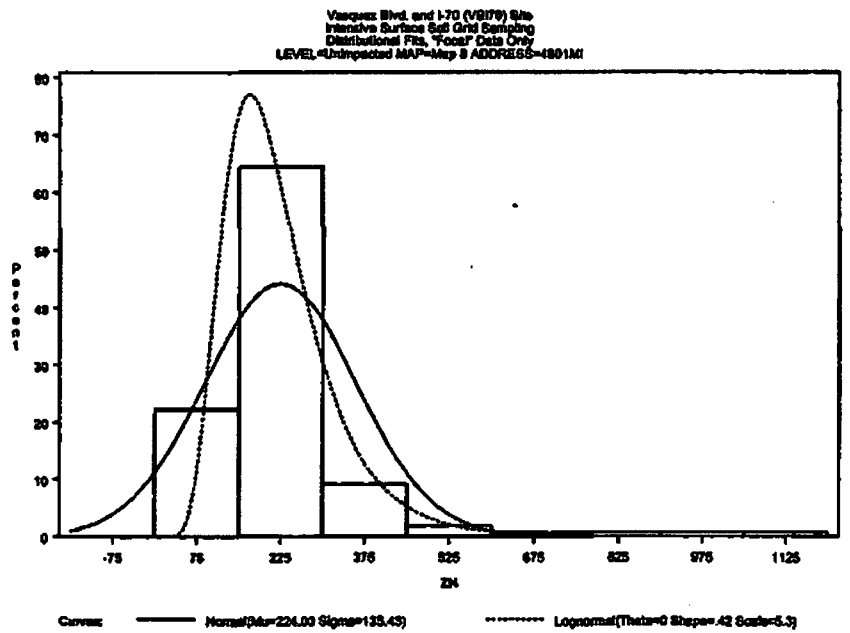
Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Unimpacted MAP=Map 7 ADDRESS=4712JO



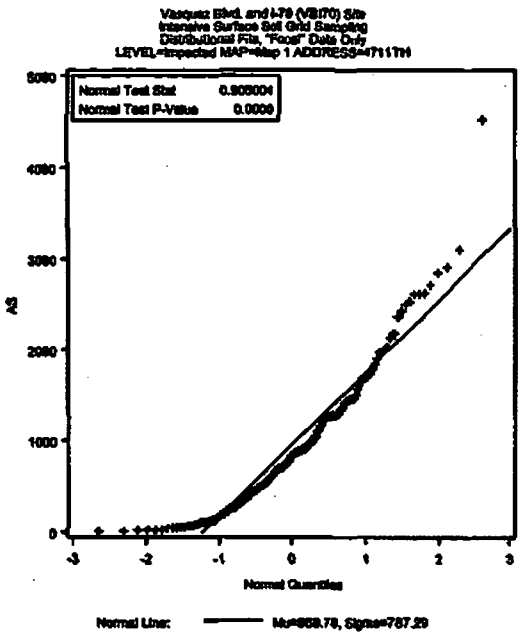

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Unimpacted MAP=Map 8 ADDRESS=4801MI
Percent
AS
Curves: Normal(Mu=232.48 Sigma=242.55) Lognormal(Theta=0 Shape=1.2 Scale=4.9)

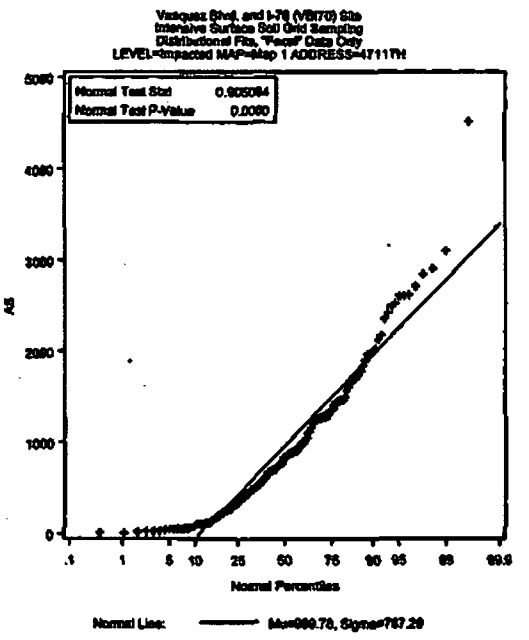

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Unimpacted MAP=Map 6 ADDRESS=4801MI
Percent
PB
Curves: Normal(Mu=219.51 Sigma=79.543) Lognormal(Theta=0 Shape=.35 Scale=5.3)

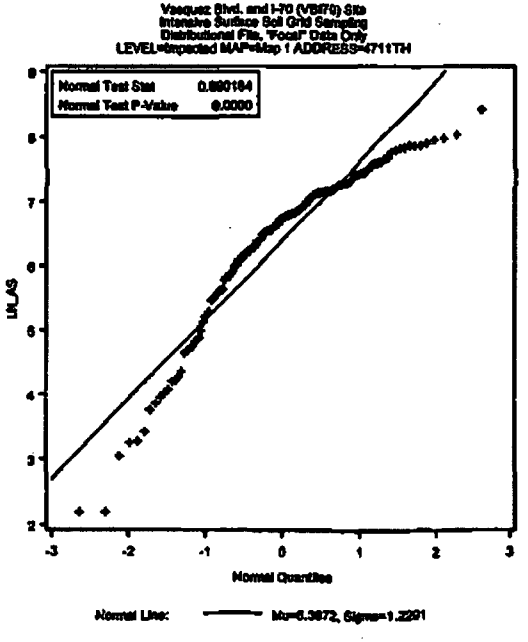

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Unimpacted MAP=Map 6 ADDRESS=4801MI
Percent
CD
Curves: Normal(Mu=6.7582 Sigma=2.3406) Lognormal(Theta=0 Shape=.42 Scale=1.8)

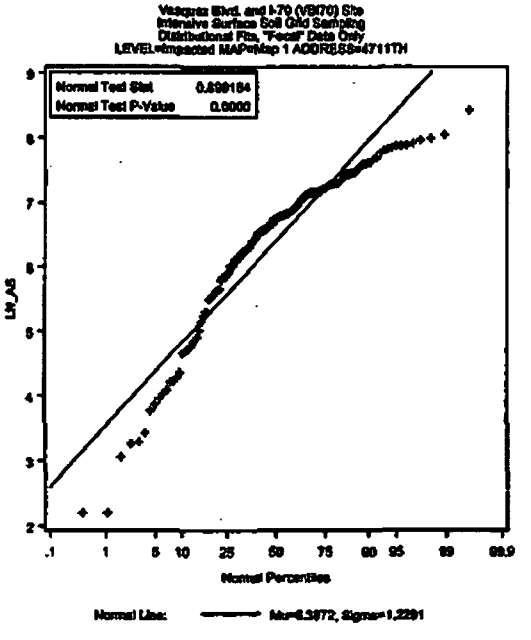

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Unimpacted MAP=Map 8 ADDRESS=4801MI
Percent
ZN
Curves: Normal(Mu=224.00 Sigma=133.43) Lognormal(Theta=0 Shape=.42 Scale=5.3)

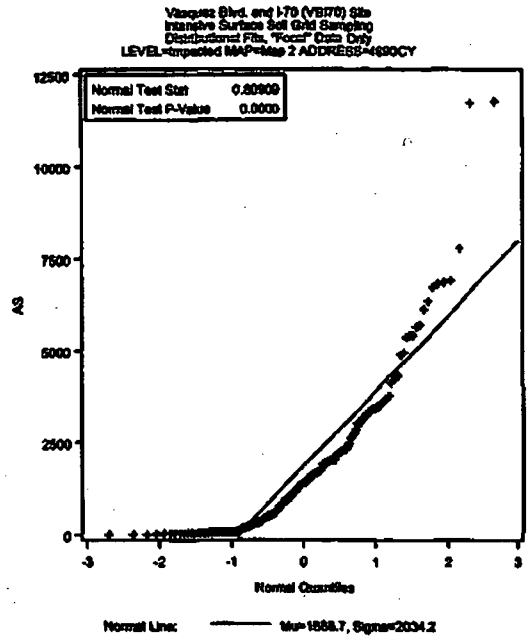
Simulations to determine the normality of composite samples using the minimum value as the reporting limit

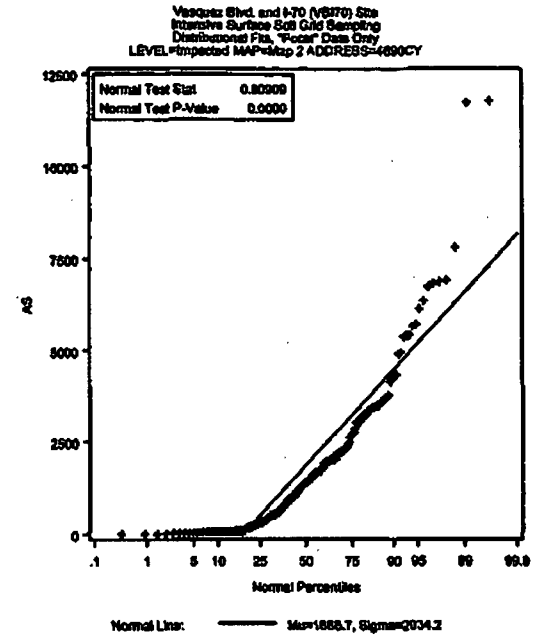

Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 1 ADDRESS=4711TH
Normal Test Stat 0.905004
Normal Test P-Value 0.0000
AS
Normal Quantiles
Normal Line: Mu=669.78, Sigma=787.29

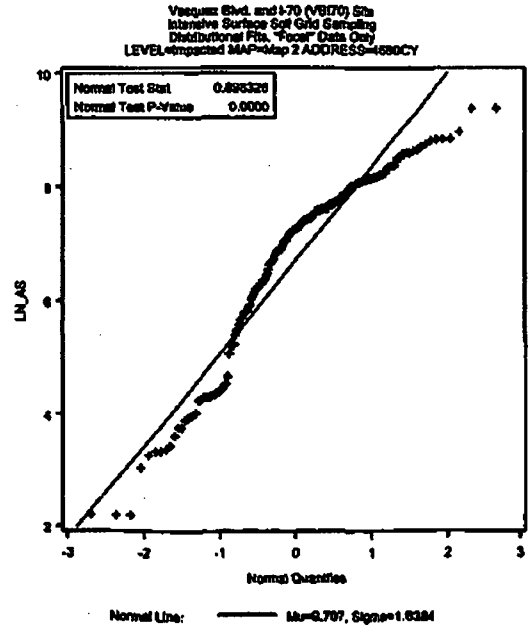

Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 1 ADDRESS=4711TH
Normal Test Stat 0.905004
Normal Test P-Value 0.0000
AS
Normal Percentiles
Normal Line: Mu=669.78, Sigma=787.29

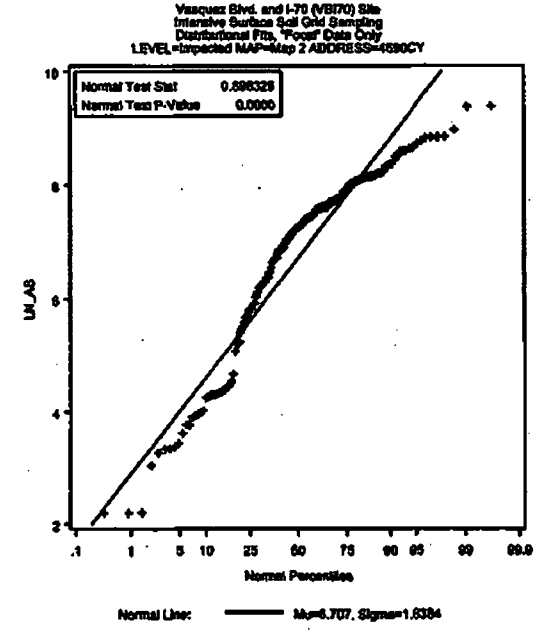

Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 1 ADDRESS=4711TH
Normal Test Stat 0.890164
Normal Test P-Value 0.0000
LN_AS
Normal Quantiles
Normal Line: Mu=6.3872, Sigma=1.2291

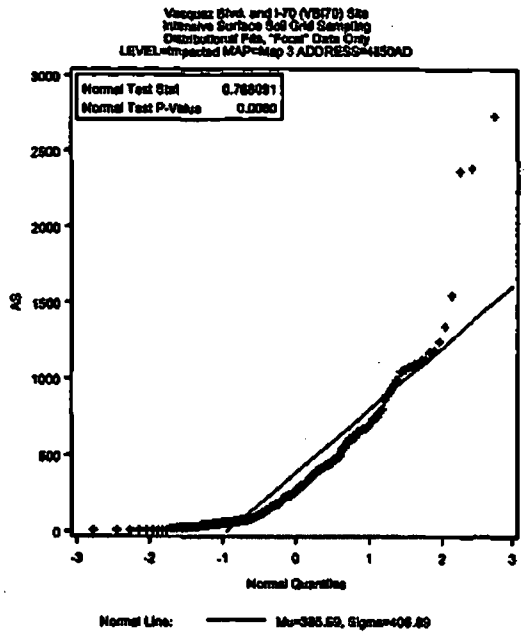

Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 1 ADDRESS=4711TH
Normal Test Stat 0.890164
Normal Test P-Value 0.0000
LN_AS
Normal Percentiles
Normal Line: Mu=6.3872, Sigma=1.2291

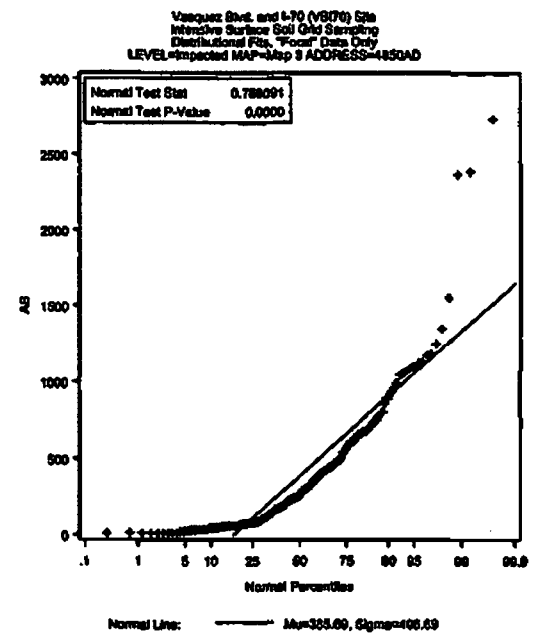

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 2 ADDRESS=4690CY
Normal Test Stat 0.80909
Normal Test P-Value 0.0000
AS
Normal Quantiles
Normal Line: Mu=1888.7, Sigma=2034.2

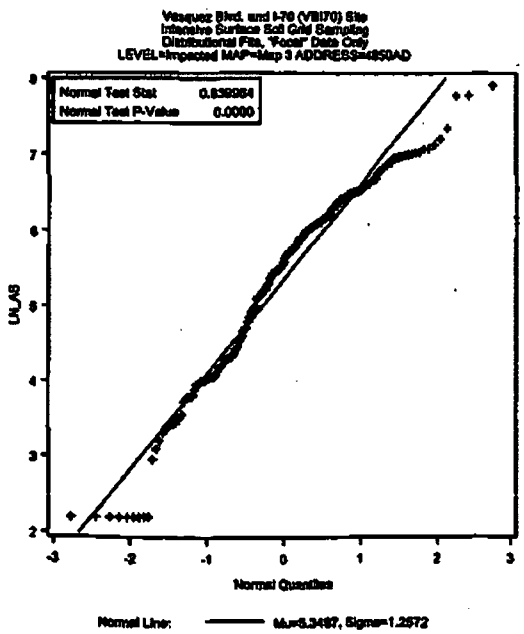

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 2 ADDRESS=4690CY
Normal Test Stat 0.80909
Normal Test P-Value 0.0000
AS
Normal Percentiles
Normal Line: Mu=1888.7, Sigma=2034.2

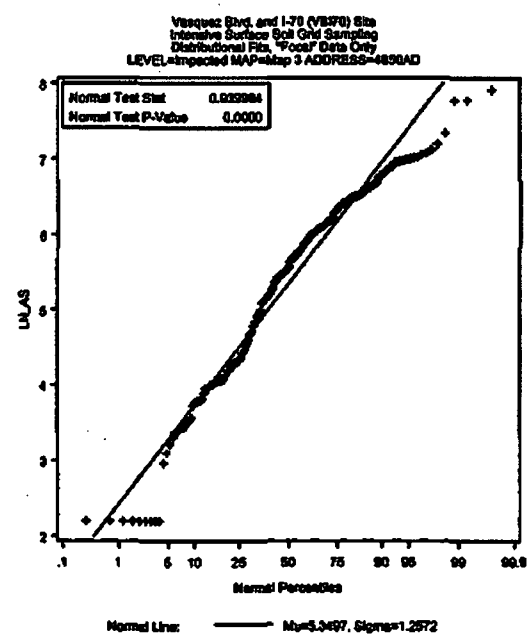

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 2 ADDRESS=4690CY
Normal Test Stat 0.896326
Normal Test P-Value 0.0000
LN_AS
Normal Quantiles
Normal Line: Mu=6.707, Sigma=1.6384

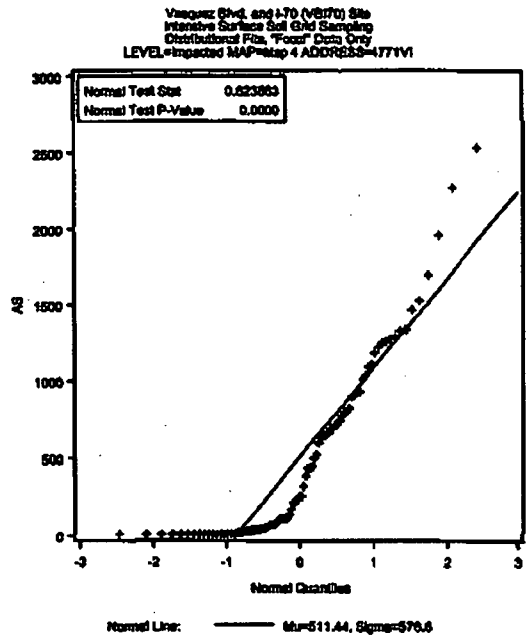

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 2 ADDRESS=4690CY
Normal Test Stat 0.896326
Normal Test P-Value 0.0000
LN_AS
Normal Percentiles
Normal Line: Mu=6.707, Sigma=1.6384

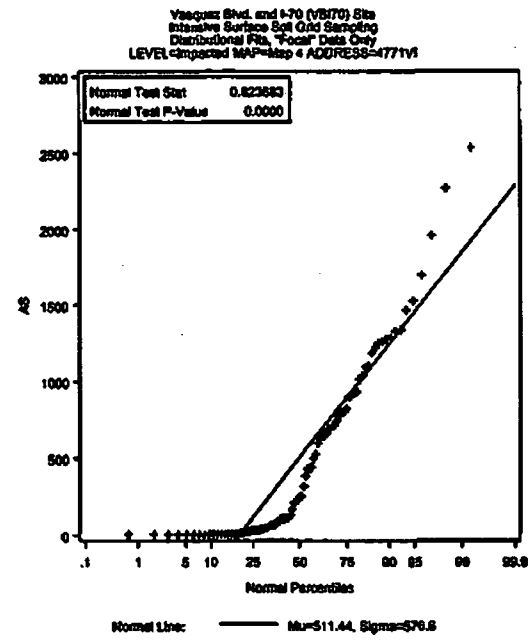

Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 3 ADDRESS=4850AD
Normal Test Stat 0.788091
Normal Test P-Value 0.0000
AS
Normal Quantiles
Normal Line: Mu=385.69, Sigma=406.69

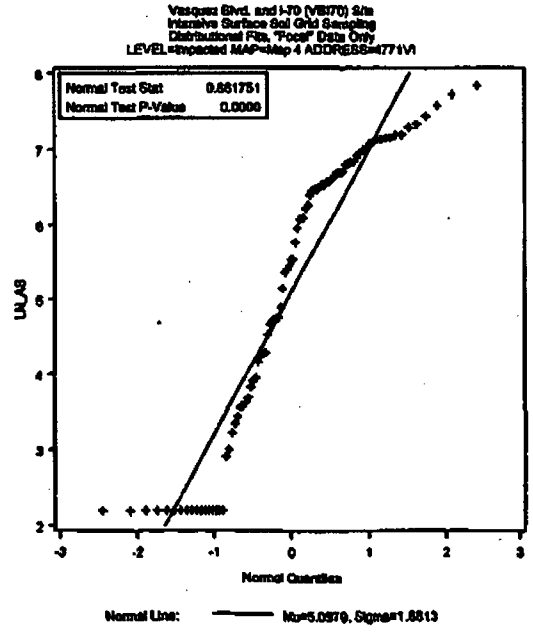

Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 3 ADDRESS=4850AD
Normal Test Stat 0.788091
Normal Test P-Value 0.0000
AS
Normal Percentiles
Normal Line: Mu=385.69, Sigma=406.69

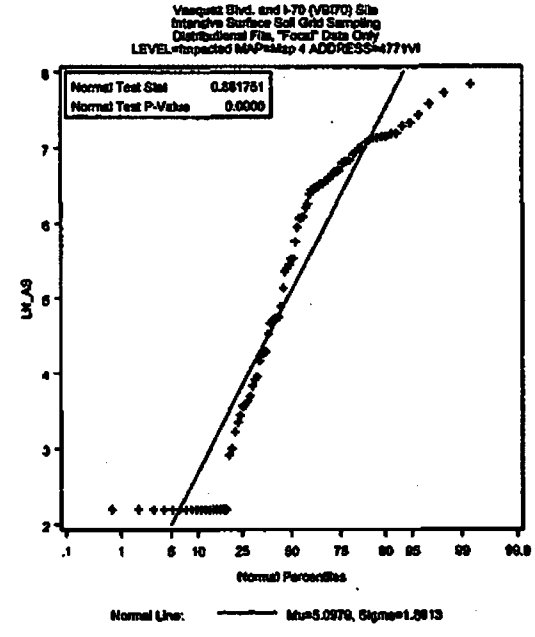

Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 3 ADDRESS=4850AD
Normal Test Stat 0.939984
Normal Test P-Value 0.0000
LN_AS
Normal Quantiles
Normal Line: Mu=5.3497, Sigma=1.2572

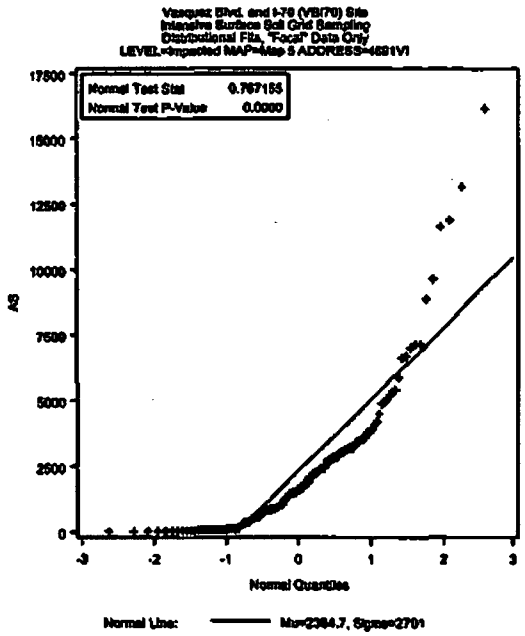

Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 3 ADDRESS=4850AD
Normal Test Stat 0.939984
Normal Test P-Value 0.0000
LN_AS
Normal Percentiles
Normal Line: Mu=5.3497, Sigma=1.2572

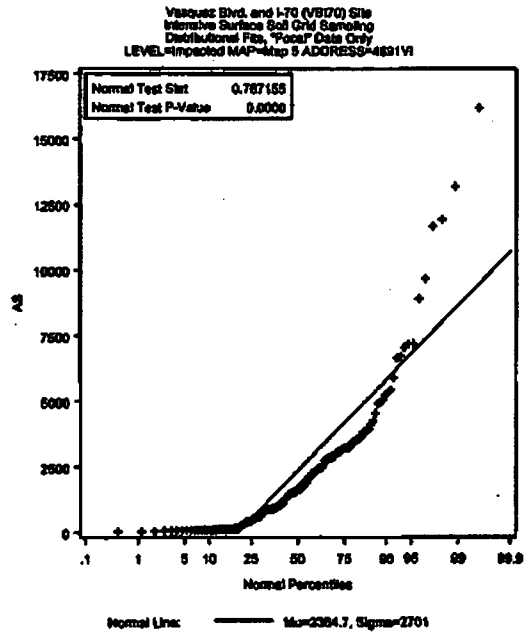

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 4 ADDRESS=4771VI
Normal Test Stat 0.823683
Normal Test P-Value 0.0000
AS
Normal Quantiles
Normal Line: Mu=511.44, Sigma=576.6

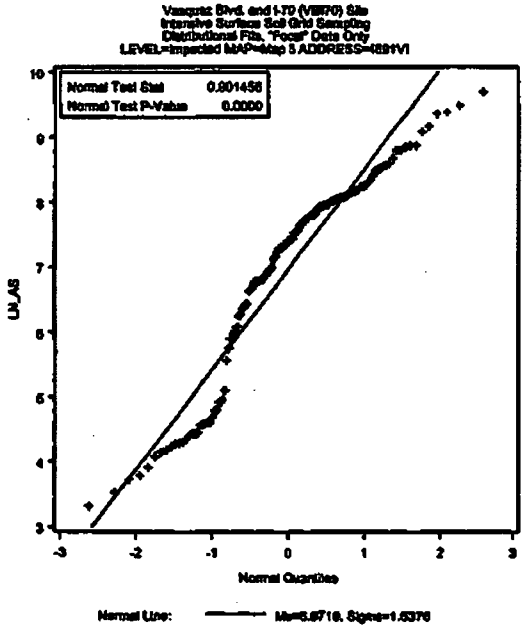

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 4 ADDRESS=4771VI
Normal Test Stat 0.823683
Normal Test P-Value 0.0000
AS
Normal Percentiles
Normal Line: Mu=511.44, Sigma=576.6

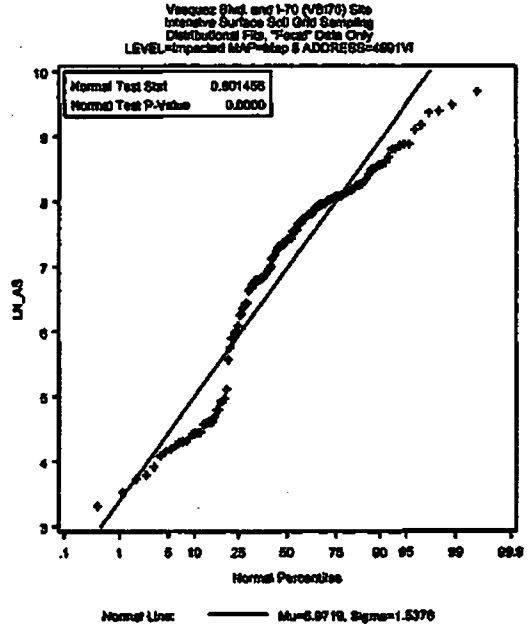

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 4 ADDRESS=4771VI
Normal Test Stat 0.861751
Normal Test P-Value 0.0000
LN_AS
Normal Quantiles
Normal Line: Mu=5.0979, Sigma=1.6813

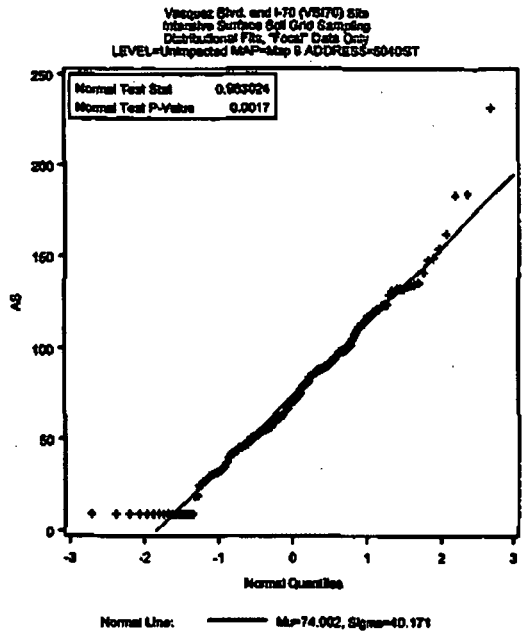

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 4 ADDRESS=4771VI
Normal Test Stat 0.861751
Normal Test P-Value 0.0000
LN_AS
Normal Percentiles
Normal Line: Mu=5.0979, Sigma=1.6813

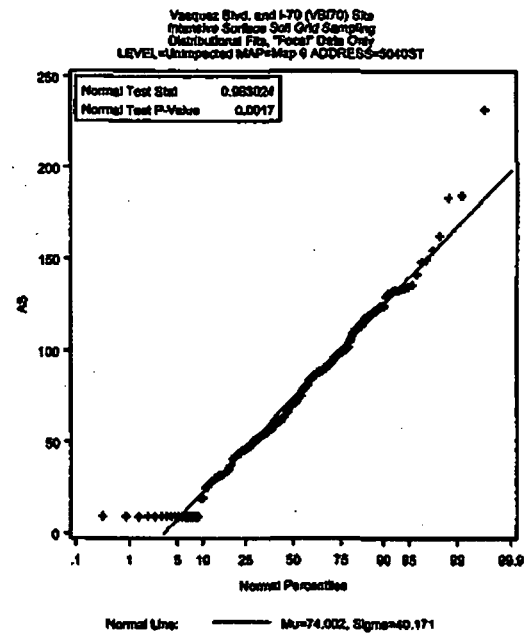

Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 5 ADDRESS=4691VI
Normal Test Stat 0.767155
Normal Test P-Value 0.0000
AS
17500
15000
12500
10000
7500
5000
2500
0
-3
-2
-1
0
1
2
3
Normal Quantiles
Normal Line: Mu=2384.7, Sigma=2701

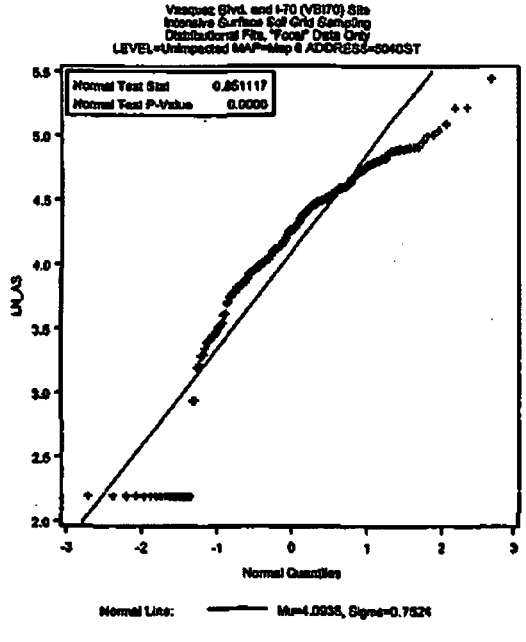

Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 5 ADDRESS=4691VI
Normal Test Stat 0.767155
Normal Test P-Value 0.0000
AS
17500
15000
12500
10000
7500
5000
2500
0
.1
1
5
10
25
50
75
90
95
99
99.9
Normal Percentiles
Normal Line: Mu=2384.7, Sigma=2701

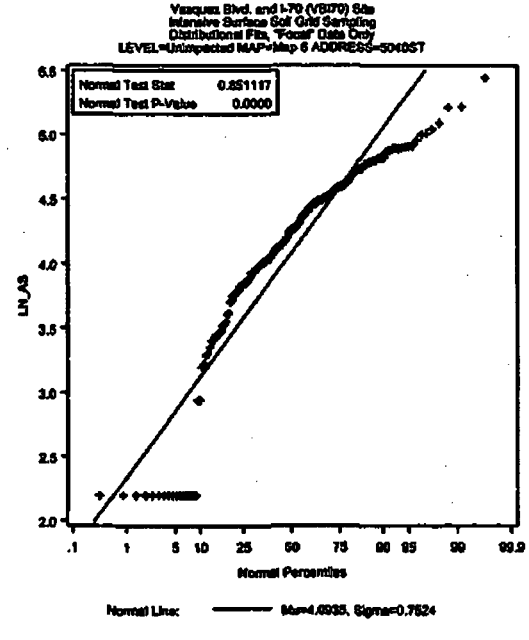

Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 5 ADDRESS=4691VI
Normal Test Stat 0.901456
Normal Test P-Value 0.0000
LN_AS
10
9
8
7
6
5
4
3
-3
-2
-1
0
1
2
3
Normal Quantiles
Normal Line: Mu=6.8719, Sigma=1.5376

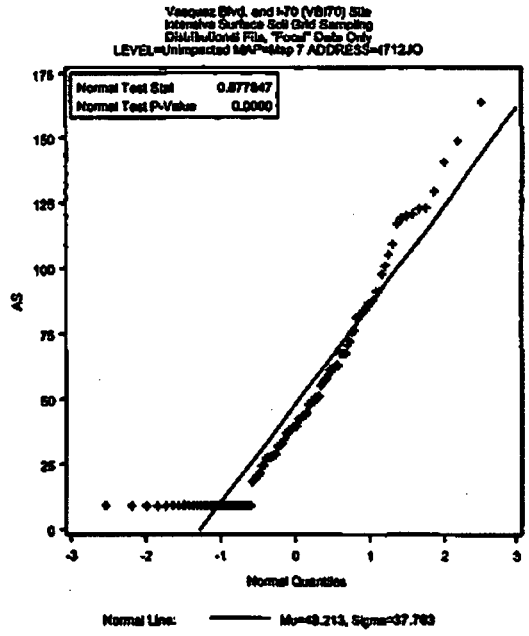

Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Impacted MAP=Map 5 ADDRESS=4691VI
Normal Test Stat 0.901456
Normal Test P-Value 0.0000
LN_AS
10
9
8
7
6
5
4
3
.1
1
5
10
25
50
75
90
95
99
99.9
Normal Percentiles
Normal Line: Mu=6.8719, Sigma=1.5376

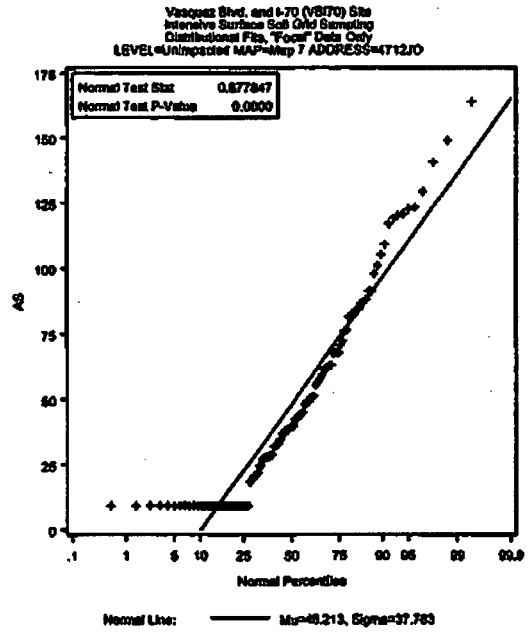

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Unimpacted MAP=Map 6 ADDRESS=5040ST
Normal Test Stat 0.983024
Normal Test P-Value 0.0017
AS
Normal Quantiles
Normal Line: Mu=74.002, Sigma=40.171

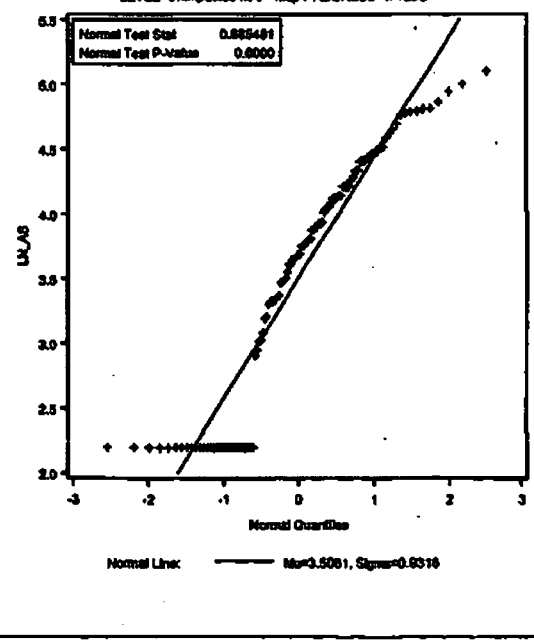

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Unimpacted MAP=Map 6 ADDRESS=5040ST
Normal Test Stat 0.983024
Normal Test P-Value 0.0017
AS
Normal Percentiles
Normal Line: Mu=74.002, Sigma=40.171

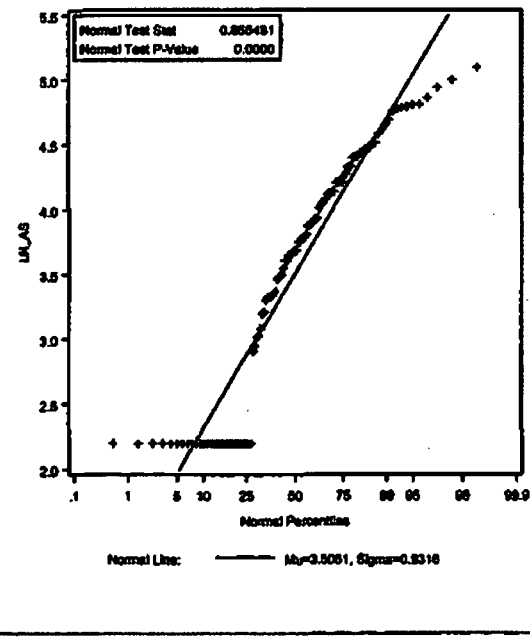

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Unimpacted MAP=Map 6 ADDRESS=5040ST
Normal Test Stat 0.851117
Normal Test P-Value 0.0000
LN_AS
Normal Quantiles
Normal Line: Mu=4.0935, Sigma=0.7524

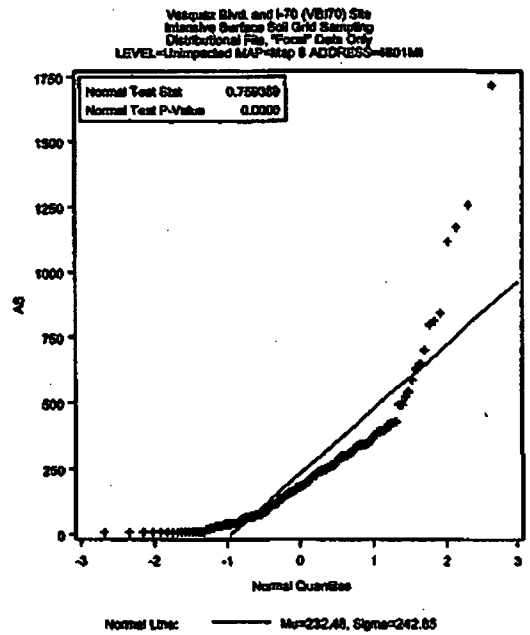

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Unimpacted MAP=Map 6 ADDRESS=5040ST
Normal Test Stat 0.851117
Normal Test P-Value 0.0000
LN_AS
Normal Percentiles
Normal Line: Mu=4.0935, Sigma=0.7524

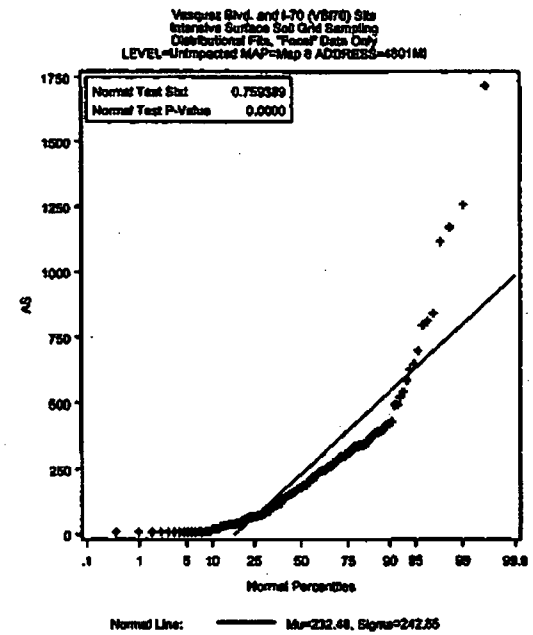

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Unimpacted MAP=Map 7 ADDRESS=4712JO
Normal Test Stat 0.877847
Normal Test P-Value 0.0000
AS
Normal Quantiles
Normal Line: Mu=48.213, Sigma=37.783

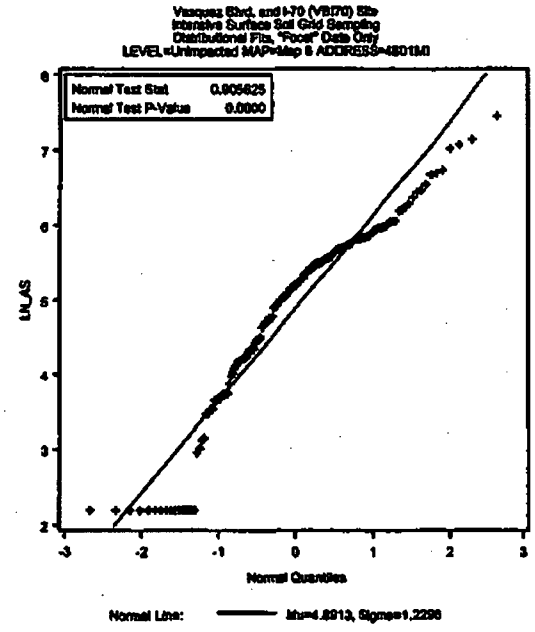

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Unimpacted MAP=Map 7 ADDRESS=4712JO
Normal Test Stat 0.877847
Normal Test P-Value 0.0000
AS
Normal Percentiles
Normal Line: Mu=48.213, Sigma=37.783

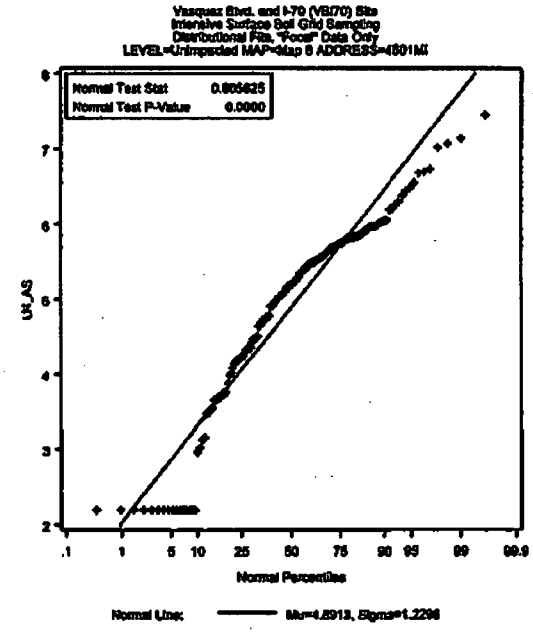

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Unimpacted MAP=Map 7 ADDRESS=4712JO
Normal Test Stat 0.855481
Normal Test P-Value 0.0000
LN_AS
Normal Quantiles
Normal Line: Mu=3.5061, Sigma=0.9316


Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Unimpacted MAP=Map 7 ADDRESS=4712JO
Normal Test Stat 0.855481
Normal Test P-Value 0.0000
LN_AS
Normal Percentiles
Normal Line: Mu=3.5061, Sigma=0.9316


Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Unimpacted MAP=Map 6 ADDRESS=4601MI
Normal Test Stat 0.759389
Normal Test P-Value 0.0000
AS
Normal Quantiles
Normal Line: Mu=232.48, Sigma=242.85

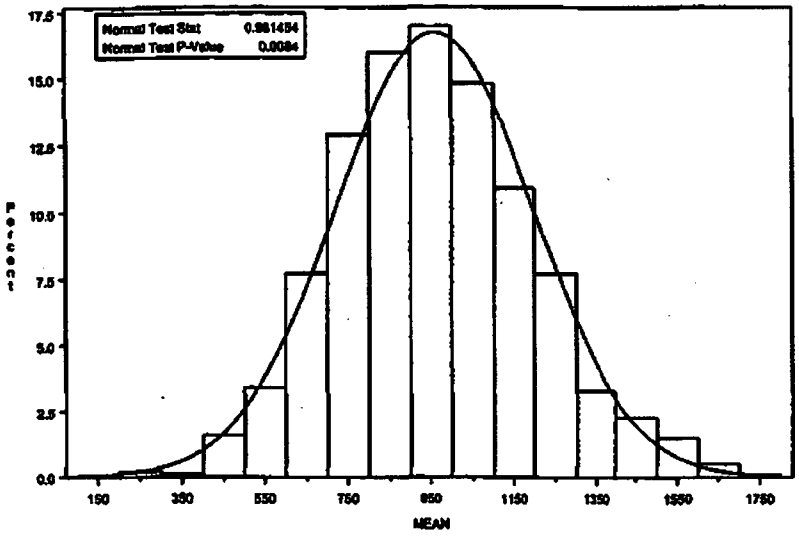

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Unimpacted MAP=Map 6 ADDRESS=4601MI
Normal Test Stat 0.759389
Normal Test P-Value 0.0000
AS
Normal Percentiles
Normal Line: Mu=232.48, Sigma=242.85


Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Unimpacted MAP=Map 6 ADDRESS=4601MI
Normal Test Stat 0.905625
Normal Test P-Value 0.0000
LN_AS
Normal Quantiles
Normal Line: Mu=4.8913, Sigma=1.2298

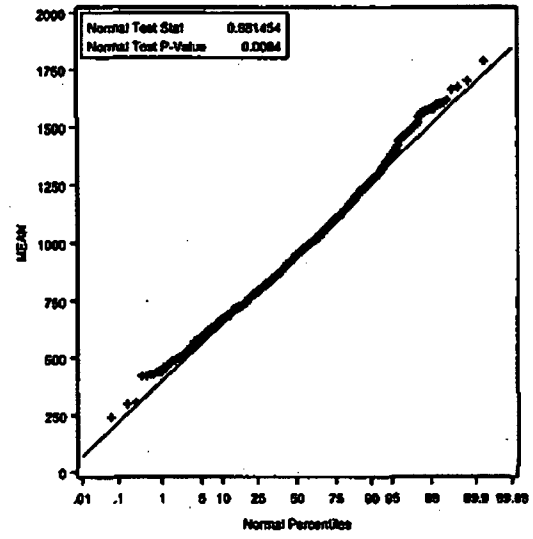

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Distributional Fits, "Focal" Data Only
LEVEL=Unimpacted MAP=Map 6 ADDRESS=4601MI
Normal Test Stat 0.905625
Normal Test P-Value 0.0000
LN_AS
Normal Percentiles
Normal Line: Mu=4.8913, Sigma=1.2298

Simulations to determine the normality of composite samples using estimated values below the reporting limit

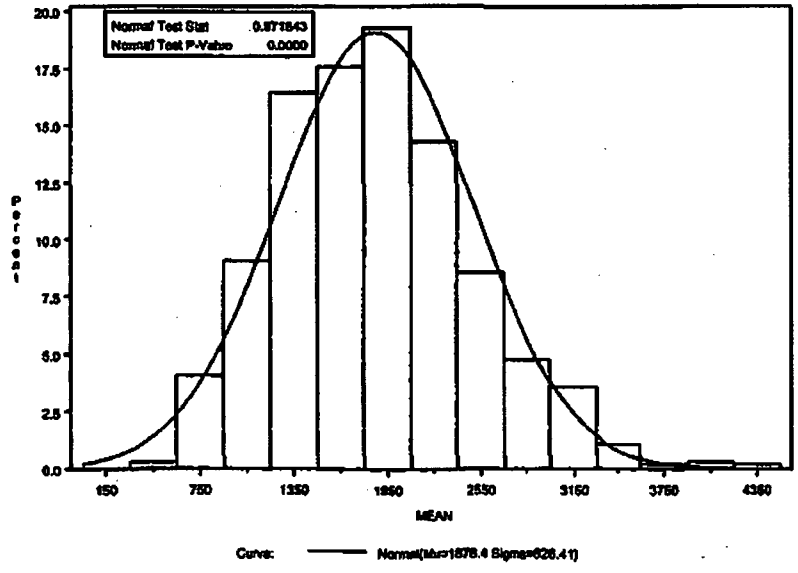
Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 10 Grabs
MAP=Map 1



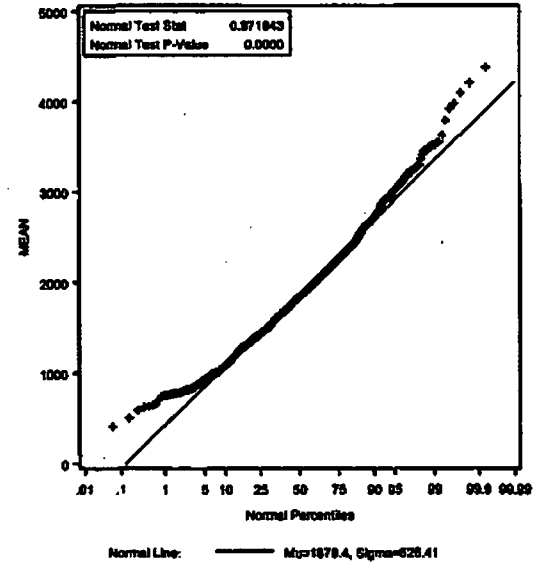
Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 10 Grabs
MAP=Map 1



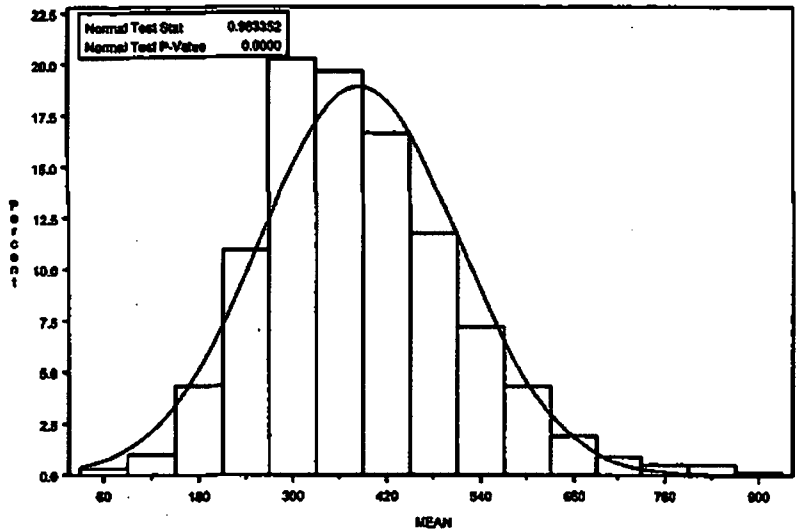
Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 10 Grabs
MAP=Map 2



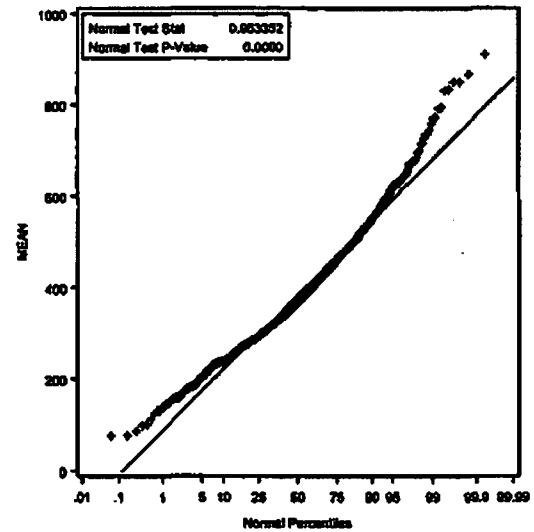
Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 10 Grabs
MAP=Map 2



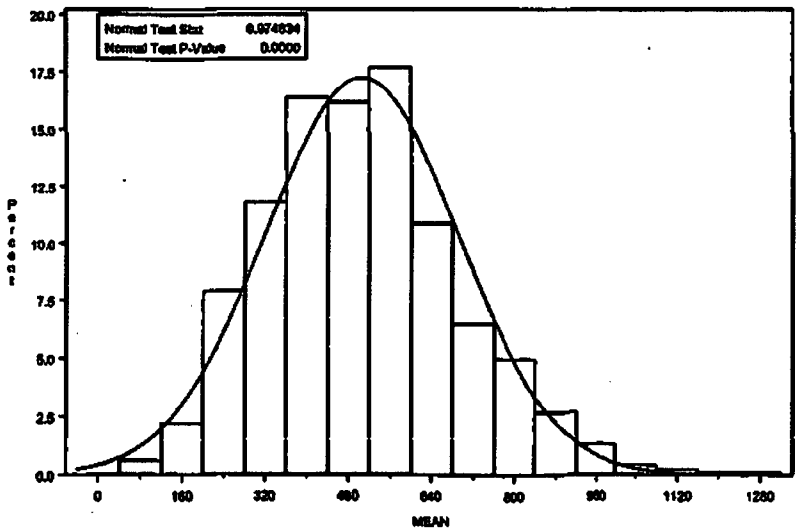
Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 10 Grabs
MAP=Map 3



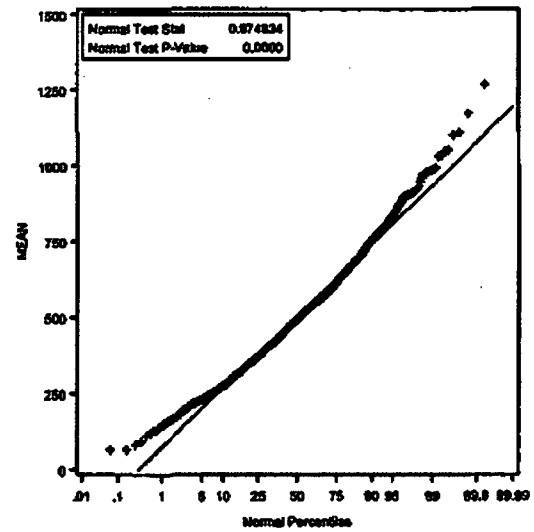
Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 10 Grabs
MAP=Map 3



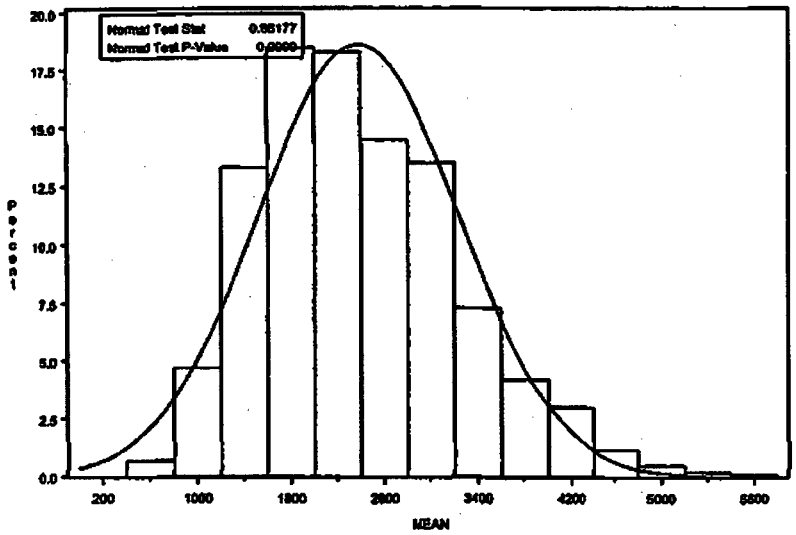
Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 10 Grabs
MAP=Map 4



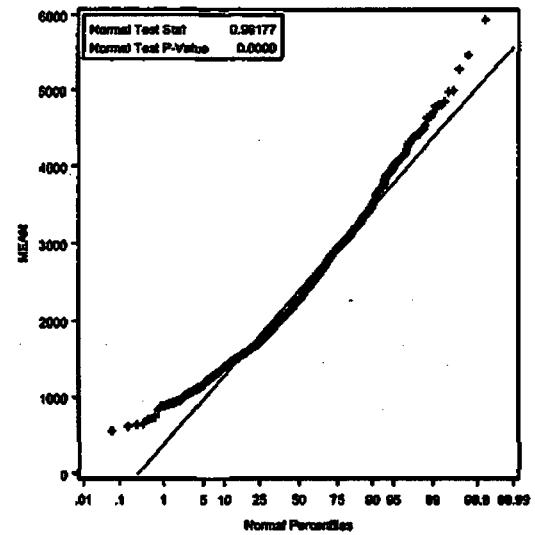
Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 10 Grabs
MAP=Map 4



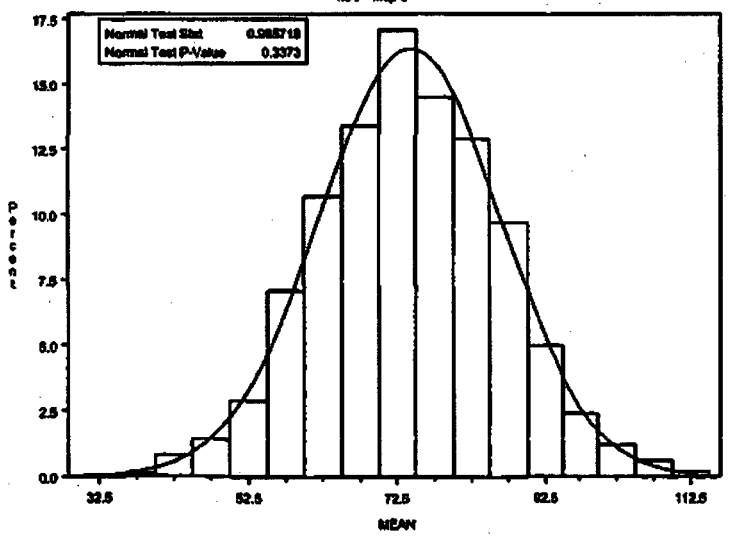
Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 10 Grabs
MAP=Map 6



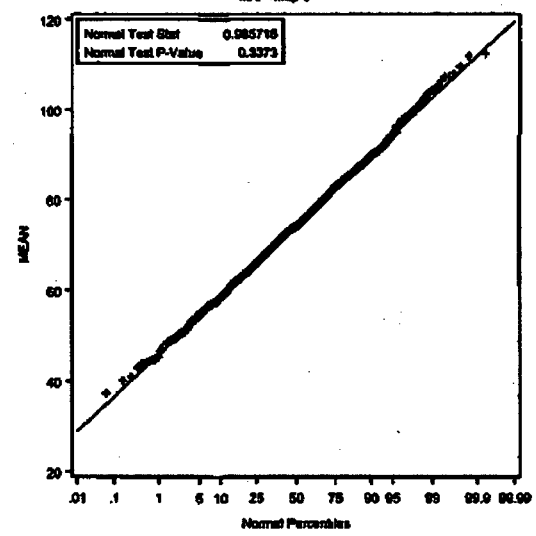
Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 10 Grabs
MAP=Map 6



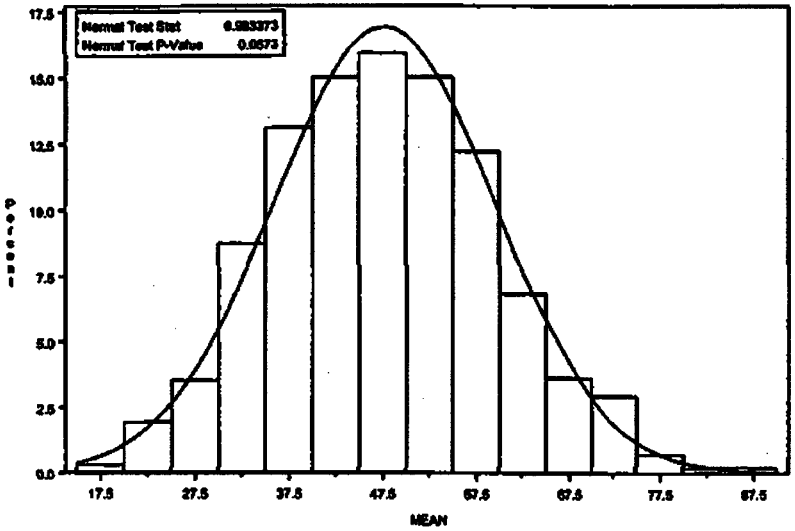
Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 10 Grabs
MAP=Map 6



Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 10 Grabs
MAP=Map 6

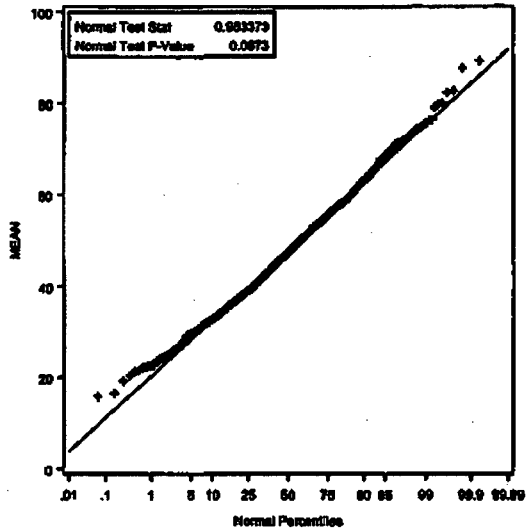


Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 10 Grabs
MAP=Map 7



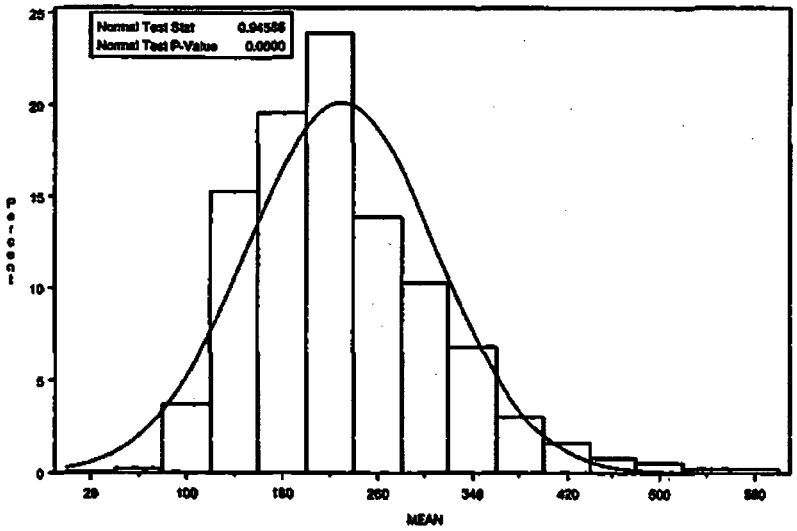
Curve: Normal(Mu=47.732 Sigma=11.604)

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 10 Grabs
MAP=Map 7



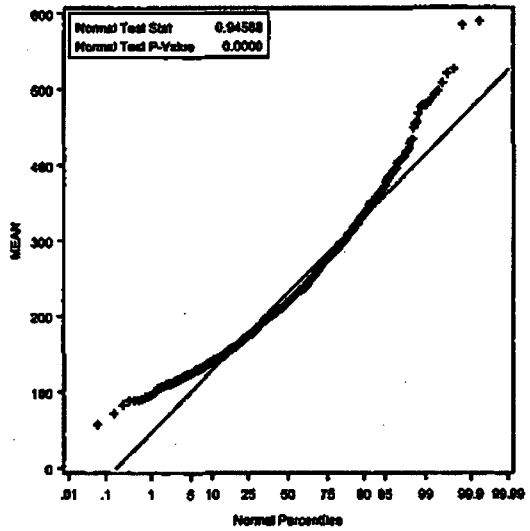
Normal Line: Mu=47.732, Sigma=11.604

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 10 Grabs
MAP=Map 8

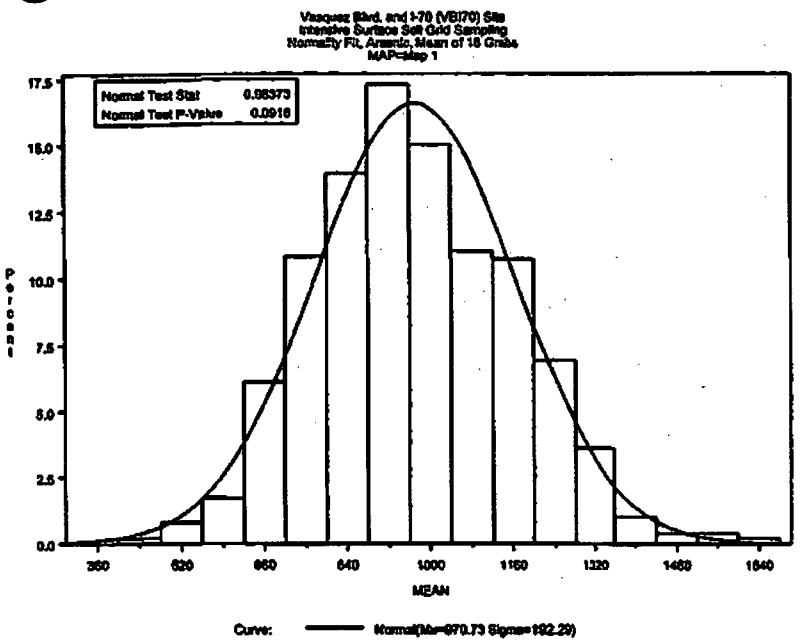


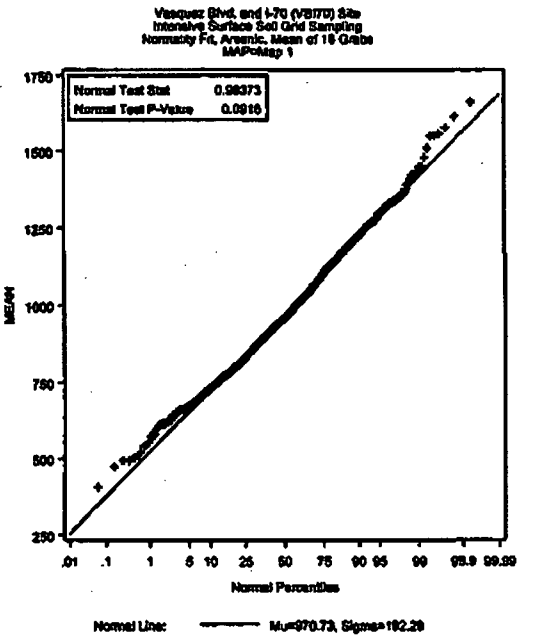
Curve: Normal(Mu=230.23 Sigma=79.159)

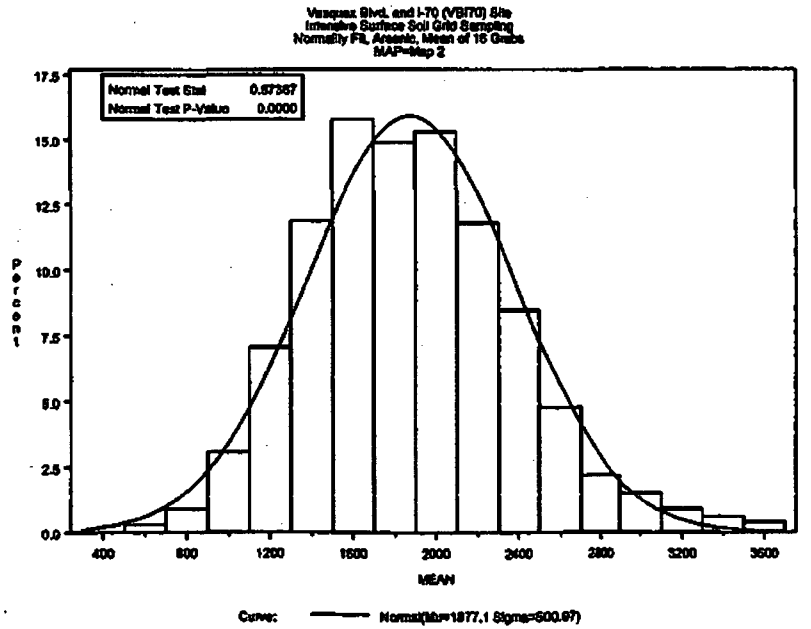
Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 10 Grabs
MAP=Map 8

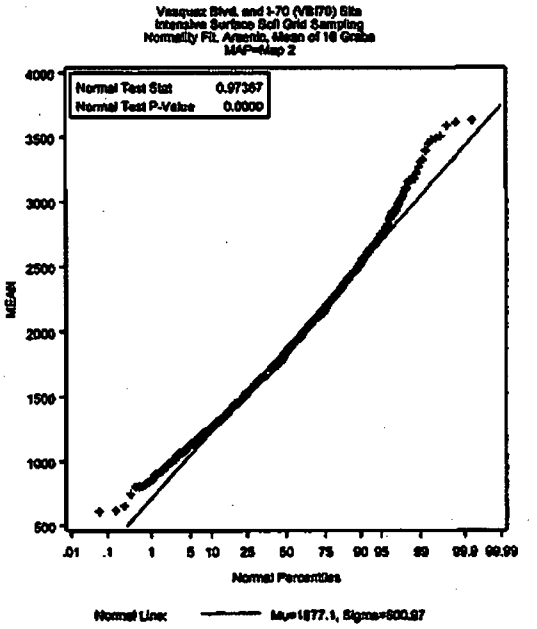


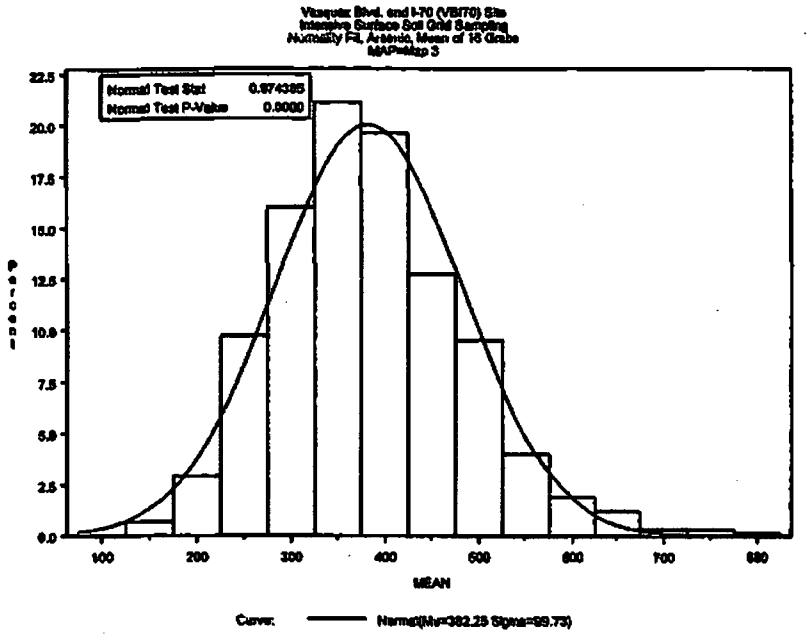
Normal Line: Mu=230.23, Sigma=79.159

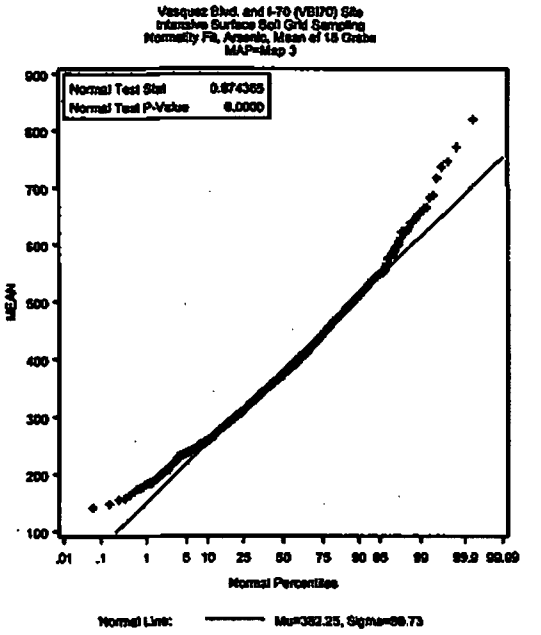

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Normally Fit, Arsenic, Mean of 16 Grabs
MAP=Map 1
Normal Test Stat 0.98373
Normal Test P-Value 0.0916
Percent
MEAN
Curve: Normal(Mu=970.73 Sigma=192.29)

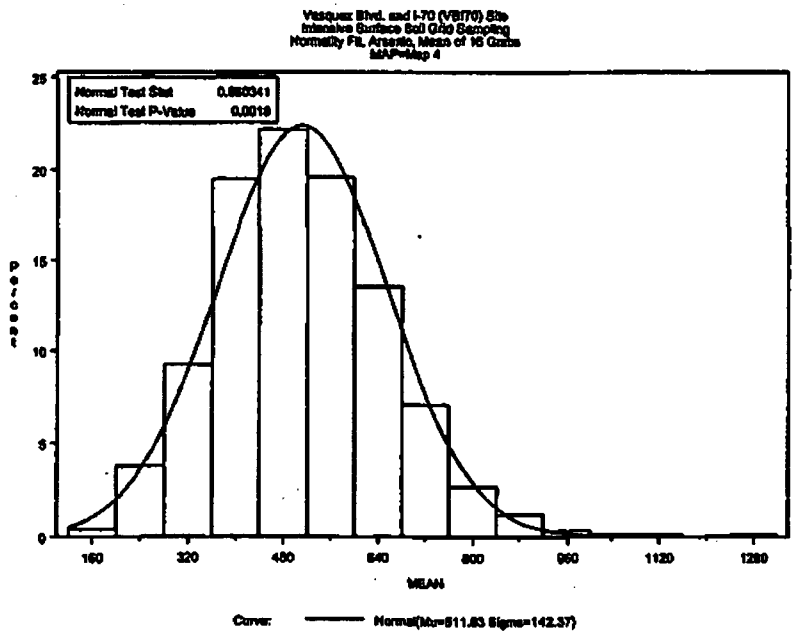

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Normally Fit, Arsenic, Mean of 16 Grabs
MAP=Map 1
Normal Test Stat 0.98373
Normal Test P-Value 0.0916
MEAN
Normal Percentiles
Normal Line: Mu=970.73, Sigma=192.29

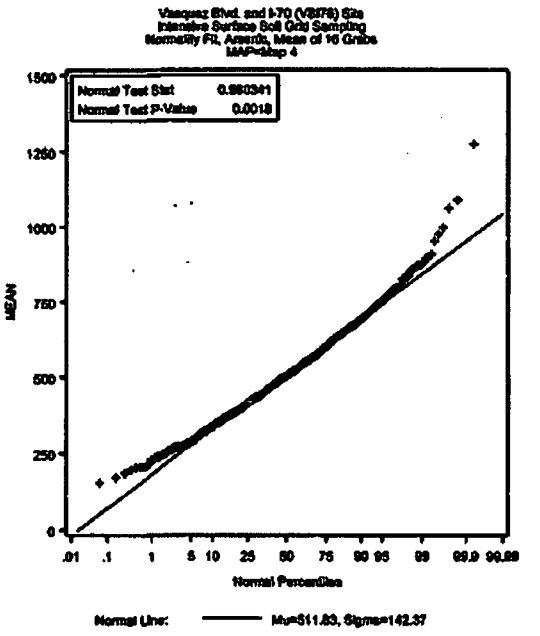

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Normally Fit, Arsenic, Mean of 16 Grabs
MAP=Map 2
Normal Test Stat 0.97367
Normal Test P-Value 0.0000
Percent
MEAN
Curve: Normal(Mu=1877.1 Sigma=600.97)

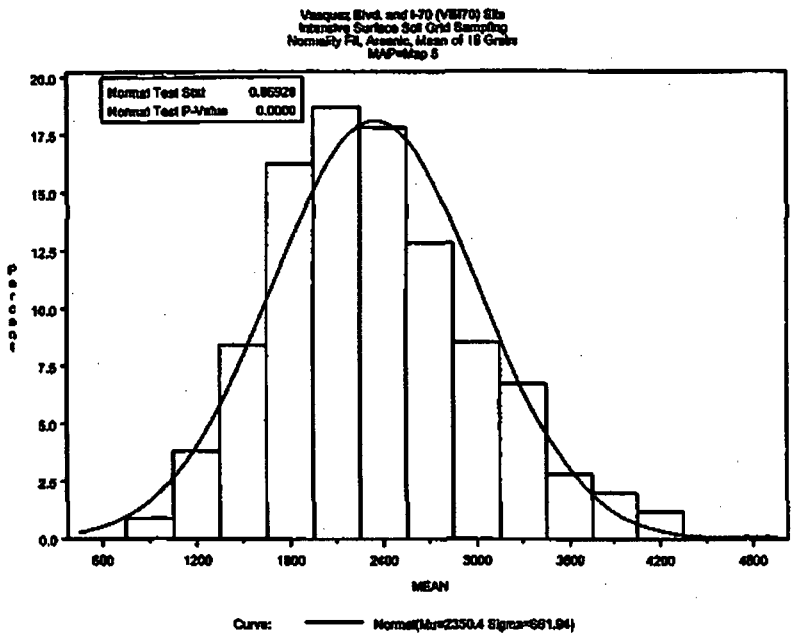

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Normally Fit, Arsenic, Mean of 16 Grabs
MAP=Map 2
Normal Test Stat 0.97367
Normal Test P-Value 0.0000
MEAN
Normal Percentiles
Normal Line: Mu=1877.1, Sigma=600.97

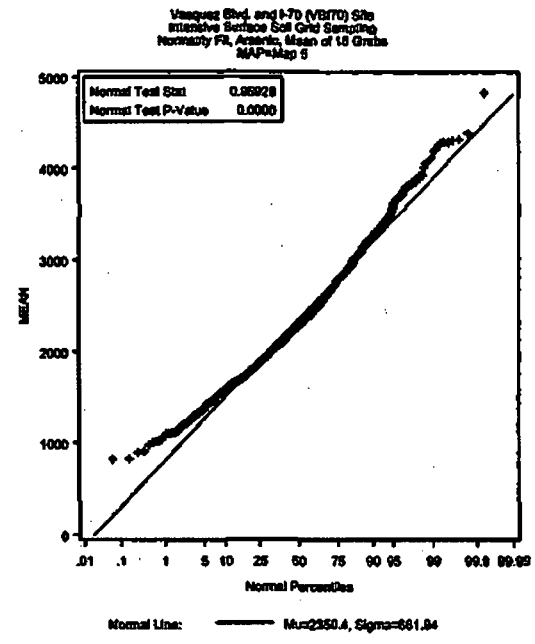

Vasquez Blvd. and I-70 (VB170) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 16 Grabs
MAP=Map 3
Normal Test Stat 0.974385
Normal Test P-Value 0.0000
MEAN
Curve: Normal(Mu=382.25 Sigma=99.73)

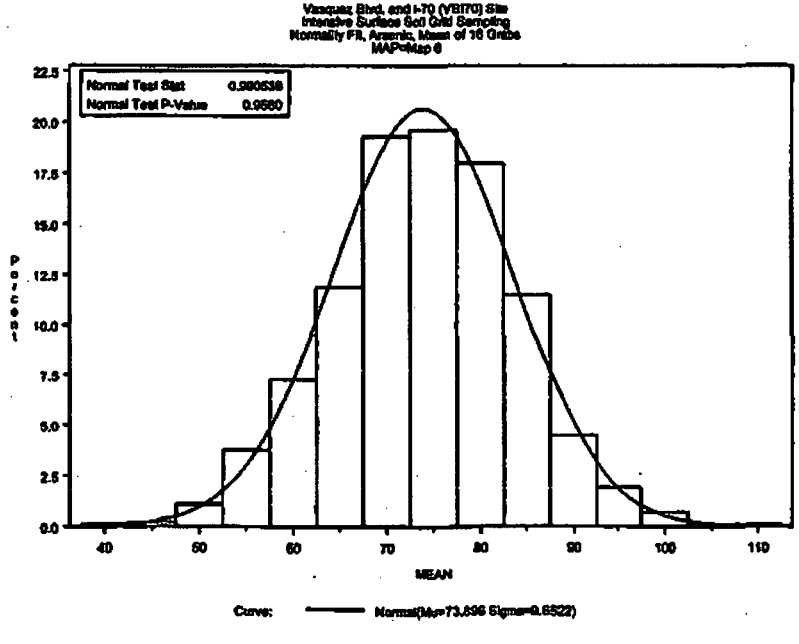

Vasquez Blvd. and I-70 (VB170) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 16 Grabs
MAP=Map 3
Normal Test Stat 0.974385
Normal Test P-Value 0.0000
MEAN
Normal Percentiles
Normal Line: Mu=382.25, Sigma=99.73

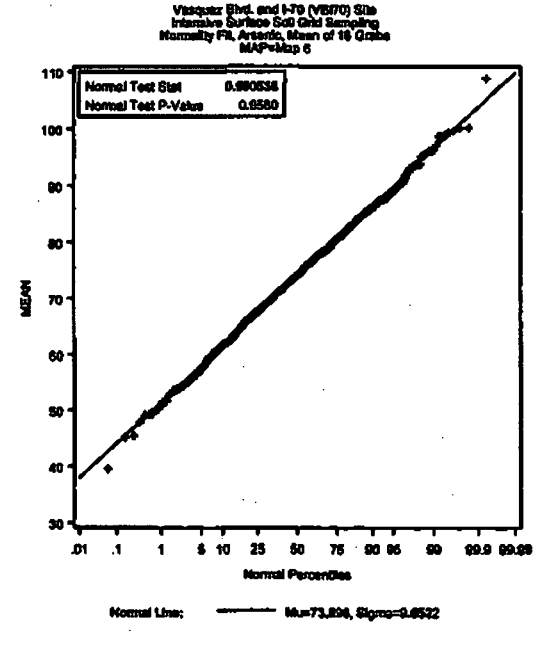

Vasquez Blvd. and I-70 (VB170) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 16 Grabs
MAP=Map 4
Normal Test Stat 0.980341
Normal Test P-Value 0.0018
MEAN
Curve: Normal(Mu=511.83 Sigma=142.37)

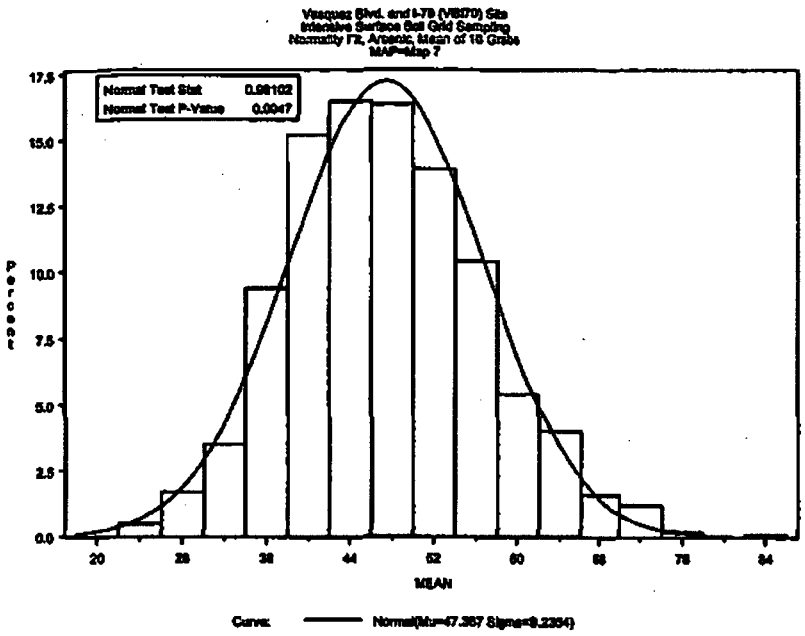

Vasquez Blvd. and I-70 (VB170) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 16 Grabs
MAP=Map 4
Normal Test Stat 0.980341
Normal Test P-Value 0.0018
MEAN
Normal Percentiles
Normal Line: Mu=511.83, Sigma=142.37

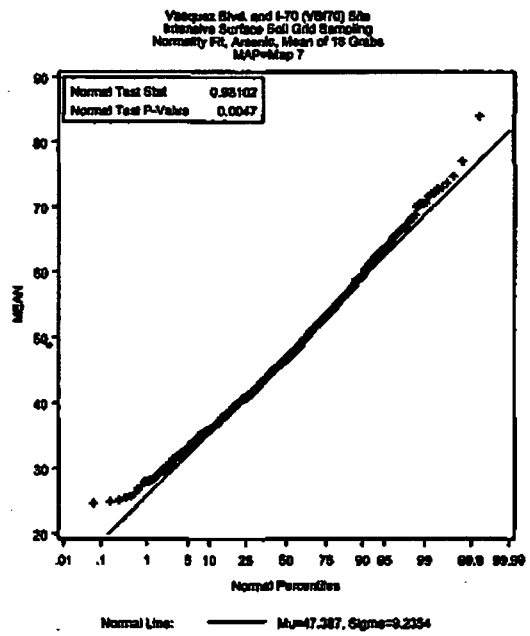

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 16 Grabs
MAP=Map 5
Normal Test Stat 0.86928
Normal Test P-Value 0.0000
Percent
MEAN
Curve: Normal(Mu=2350.4 Sigma=661.94)

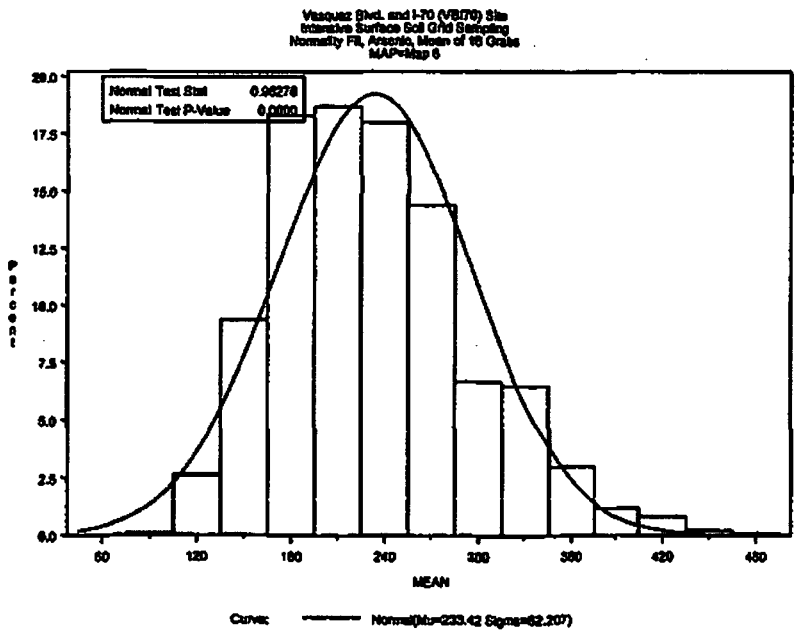

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 16 Grabs
MAP=Map 5
Normal Test Stat 0.86928
Normal Test P-Value 0.0000
MEAN
Normal Percentiles
Normal Line: Mu=2350.4, Sigma=661.94

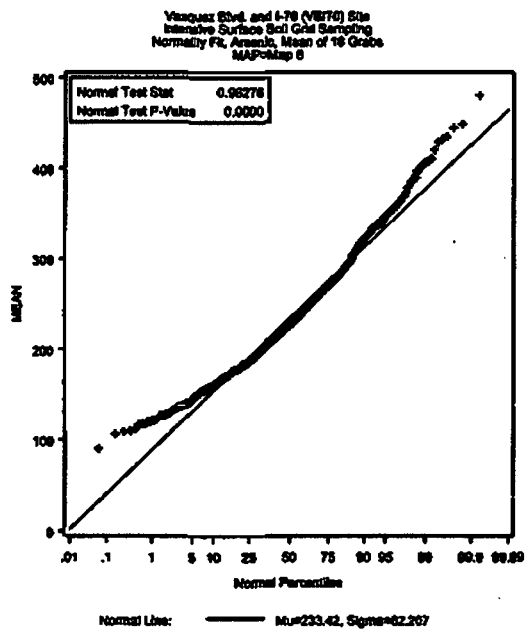

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 16 Grabs
MAP=Map 6
Normal Test Stat 0.990538
Normal Test P-Value 0.9580
Percent
MEAN
Curve: Normal(Mu=73.896 Sigma=9.6522)


Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 16 Grabs
MAP=Map 6
Normal Test Stat 0.990538
Normal Test P-Value 0.9580
MEAN
Normal Percentiles
Normal Line: Mu=73.896, Sigma=9.6522

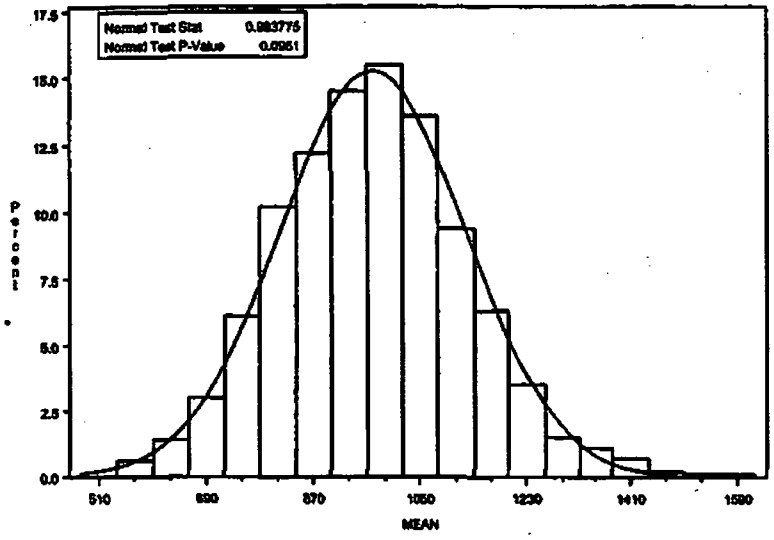

Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 16 Grabs
MAP=Map 7
Normal Test Stat 0.98102
Normal Test P-Value 0.0047
Percent
MEAN
Curve: Normal(Mu=47.387 Sigma=9.2354)


Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 16 Grabs
MAP=Map 7
Normal Test Stat 0.98102
Normal Test P-Value 0.0047
MEAN
Normal Percentiles
Normal Line: Mu=47.387, Sigma=9.2354

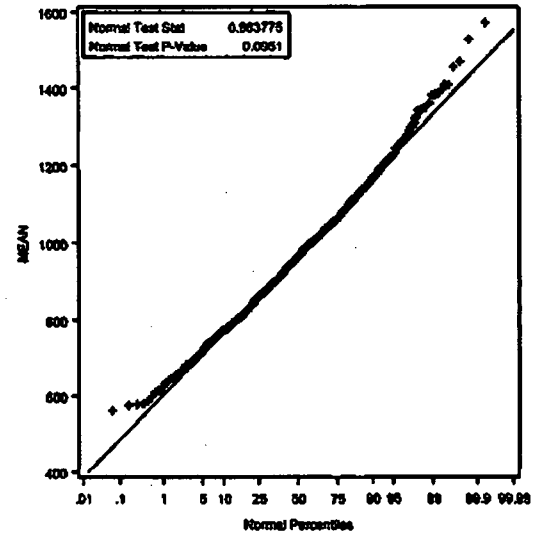

Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 16 Grabs
MAP=Map 6
Normal Test Stat 0.96278
Normal Test P-Value 0.0000
Percent
MEAN
Curve: Normal(Mu=233.42 Sigma=62.207)


Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 16 Grabs
MAP=Map 6
Normal Test Stat 0.96278
Normal Test P-Value 0.0000
MEAN
Normal Percentiles
Normal Line: Mu=233.42, Sigma=62.207

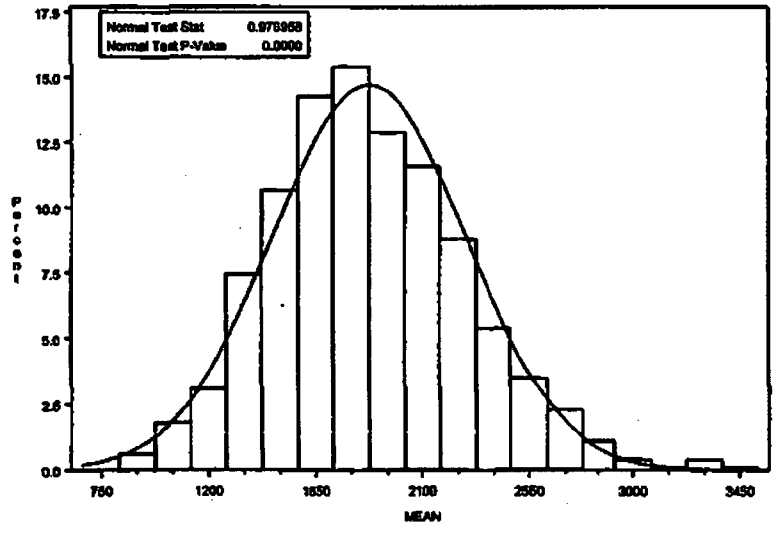
Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 25 Grabs
MAP=Map 1



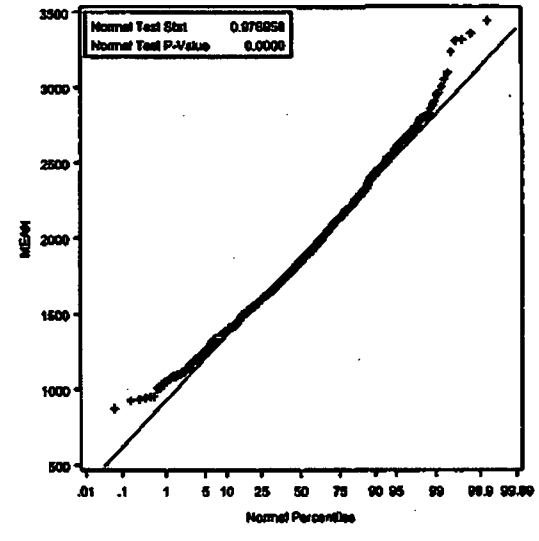
Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 25 Grabs
MAP=Map 1

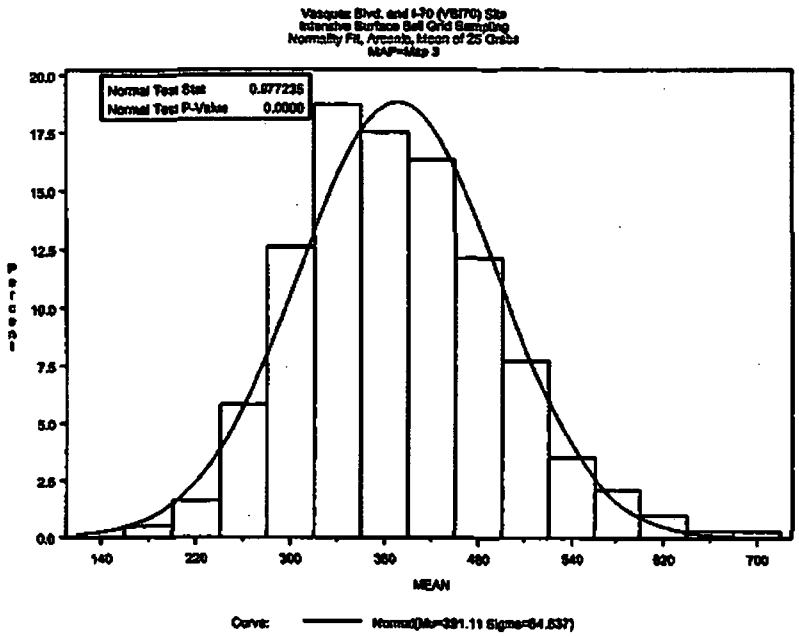


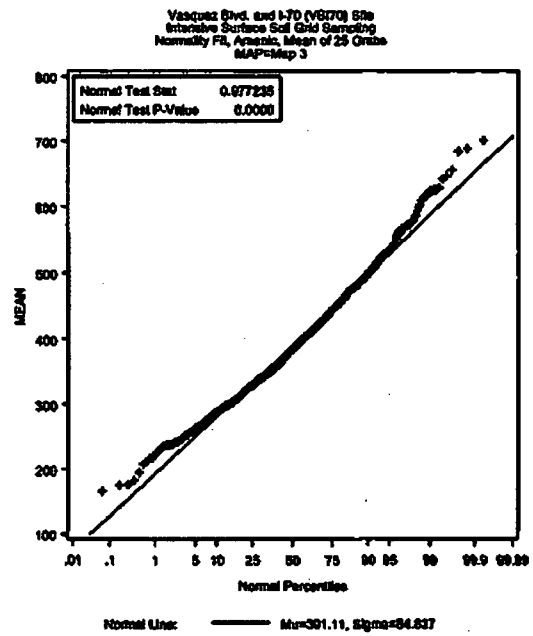
Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 25 Grabs
MAP=Map 2

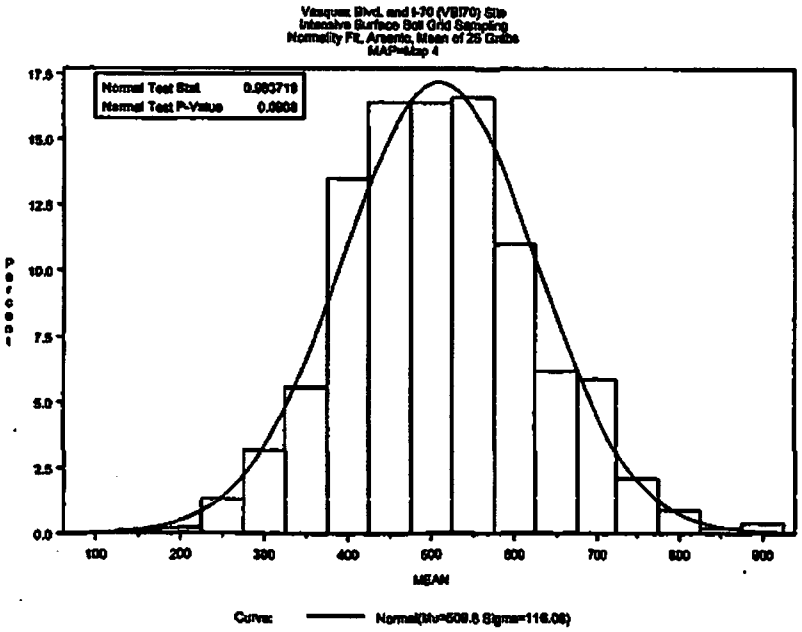


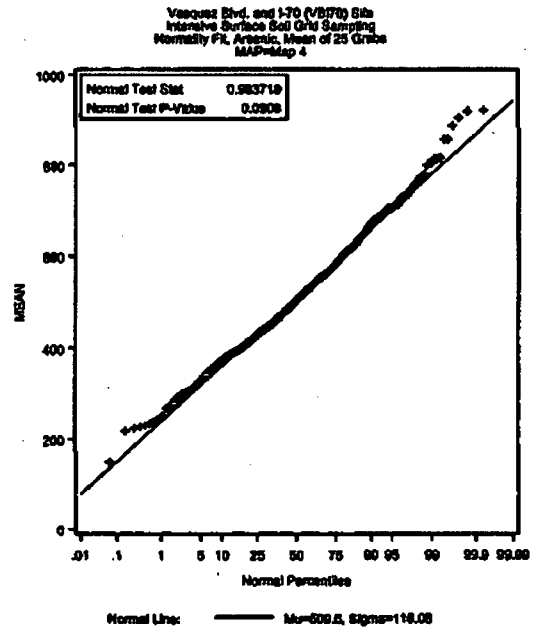
Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 25 Grabs
MAP=Map 2

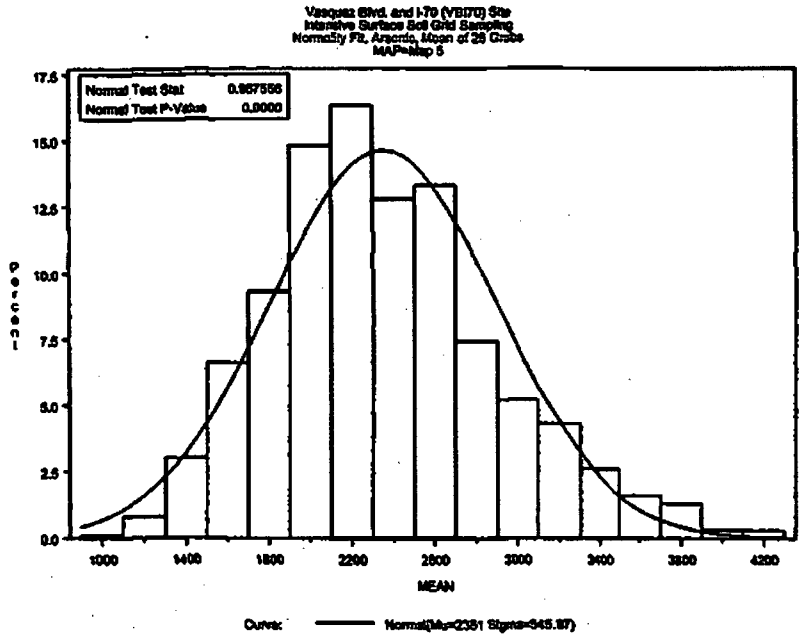


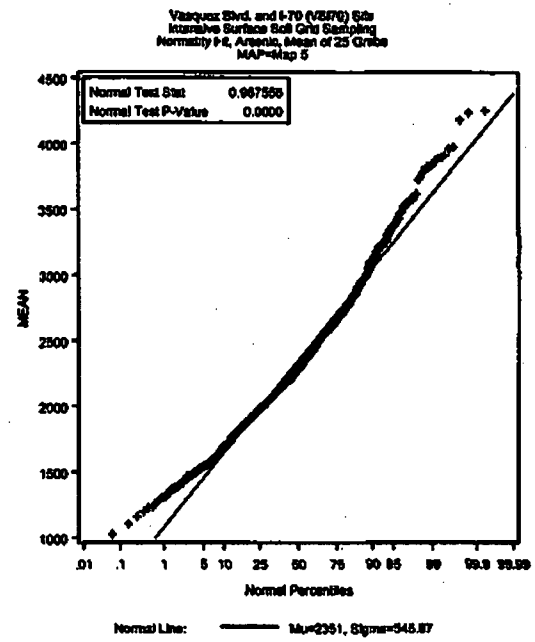

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 25 Grabs
MAP=Map 3
Normal Test Stat 0.977235
Normal Test P-Value 0.0000
Percent
MEAN
Curve: Normal(Mu=391.11 Sigma=64.637)

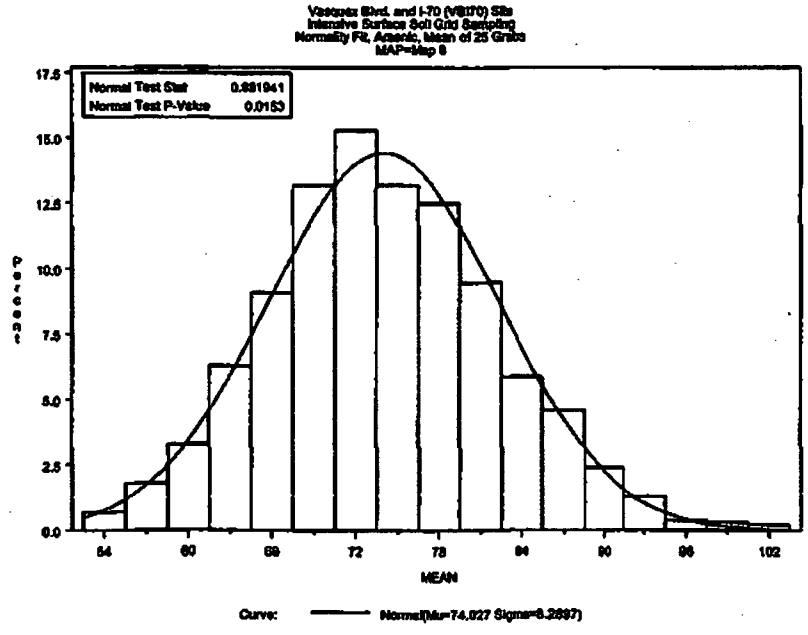

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 25 Grabs
MAP=Map 3
Normal Test Stat 0.977235
Normal Test P-Value 0.0000
MEAN
Normal Percentiles
Normal Line: Mu=391.11, Sigma=64.637

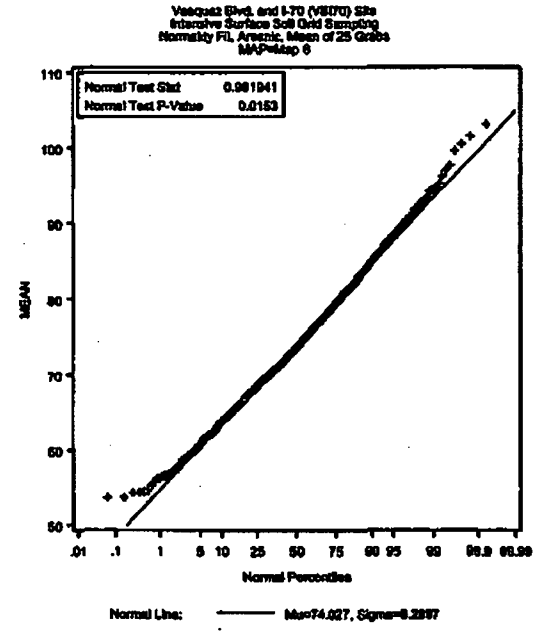

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 25 Grabs
MAP=Map 4
Normal Test Stat 0.983719
Normal Test P-Value 0.0908
Percent
MEAN
Curve: Normal(Mu=608.8 Sigma=116.08)

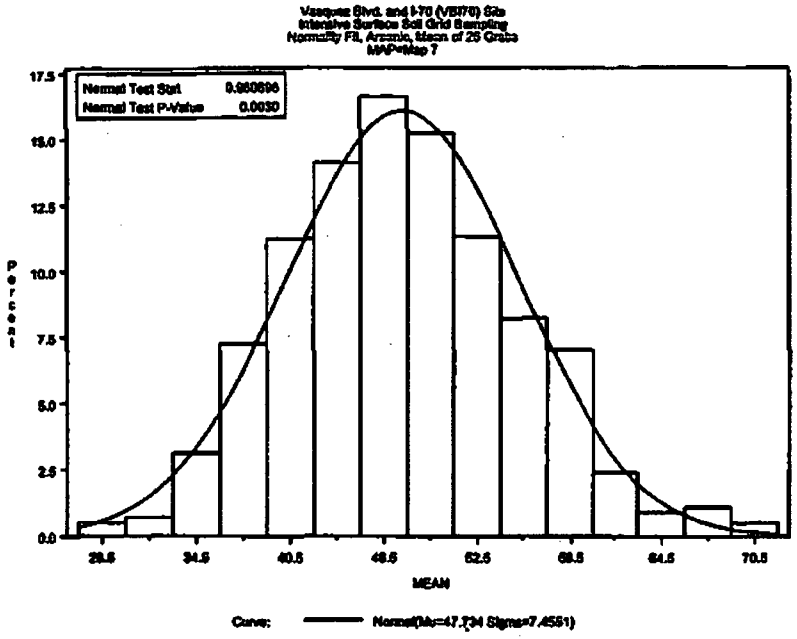

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 25 Grabs
MAP=Map 4
Normal Test Stat 0.983719
Normal Test P-Value 0.0908
MEAN
Normal Percentiles
Normal Line: Mu=608.8, Sigma=116.08

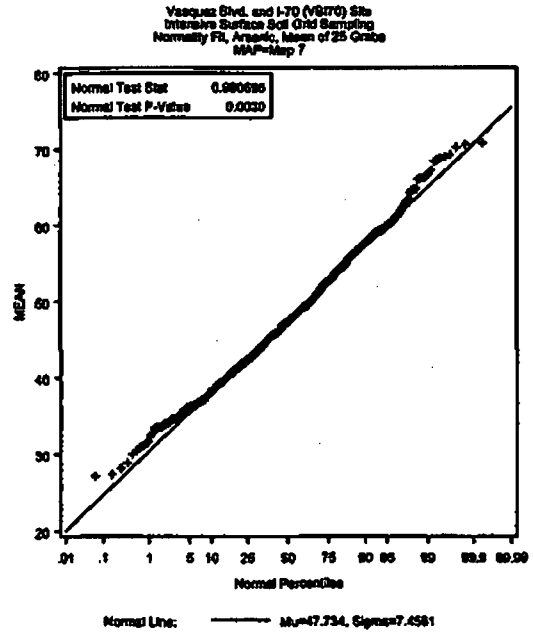

Vasquez Blvd. and I-70 (VB170) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 28 Grabs
MAP=Map 5
Normal Test Stat 0.967556
Normal Test P-Value 0.0000
MEAN
Curve: Normal(Mu=2351 Sigma=545.87)

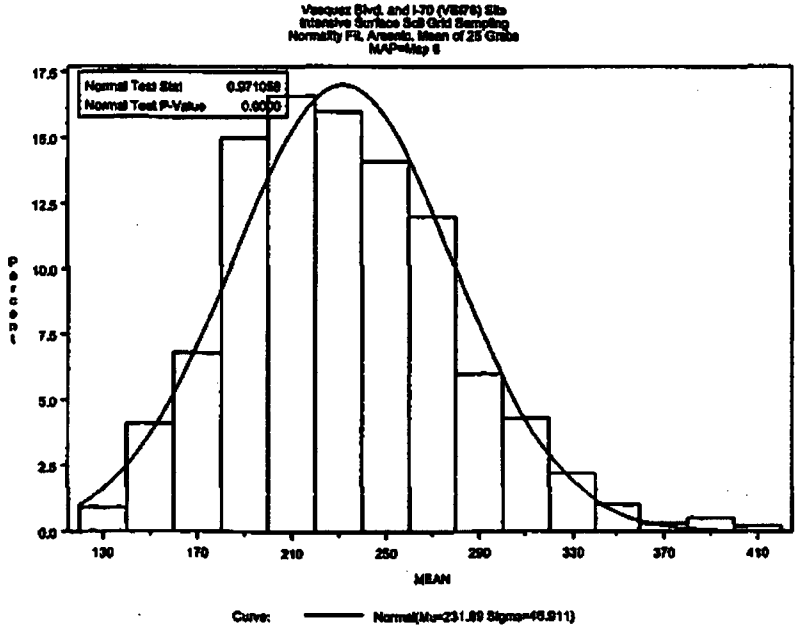

Vasquez Blvd. and I-70 (VB170) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 25 Grabs
MAP=Map 5
Normal Test Stat 0.967556
Normal Test P-Value 0.0000
MEAN
Normal Percentiles
Normal Line: Mu=2351, Sigma=545.87

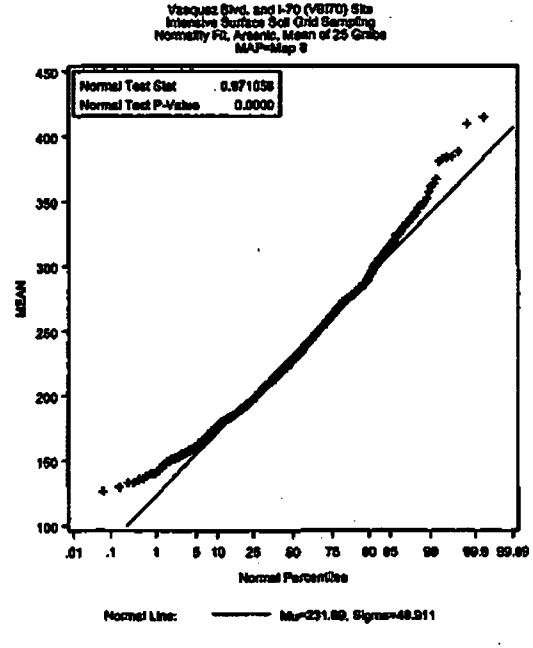

Vasquez Blvd. and I-70 (VB170) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 25 Grabs
MAP=Map 6
Normal Test Stat 0.981941
Normal Test P-Value 0.0153
MEAN
Curve: Normal(Mu=74.027 Sigma=8.2897)


Vasquez Blvd. and I-70 (VB170) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 25 Grabs
MAP=Map 6
Normal Test Stat 0.981941
Normal Test P-Value 0.0153
MEAN
Normal Percentiles
Normal Line: Mu=74.027, Sigma=8.2897

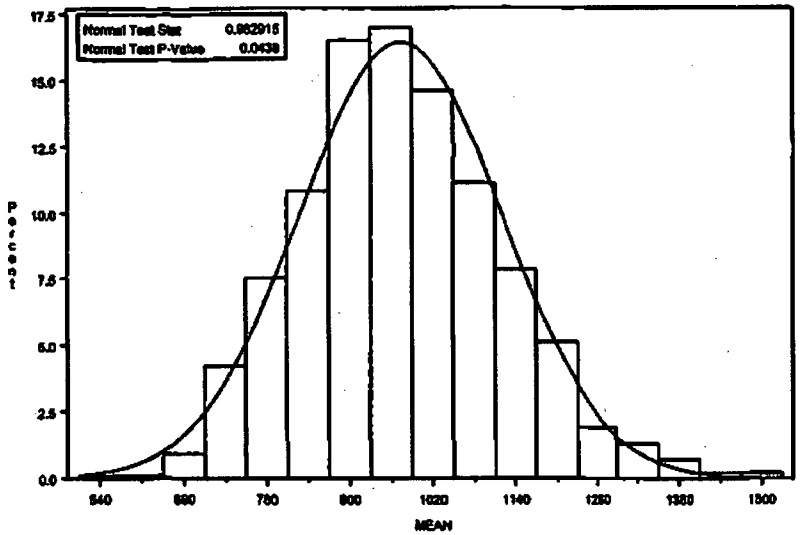

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 25 Grabs
MAP=Map 7
Normal Test Stat 0.980696
Normal Test P-Value 0.0030
Percent
MEAN
Curve: Normal(Mu=47.734 Sigma=7.4581)


Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 25 Grabs
MAP=Map 7
Normal Test Stat 0.980696
Normal Test P-Value 0.0030
MEAN
Normal Percentiles
Normal Line: Mu=47.734, Sigma=7.4581

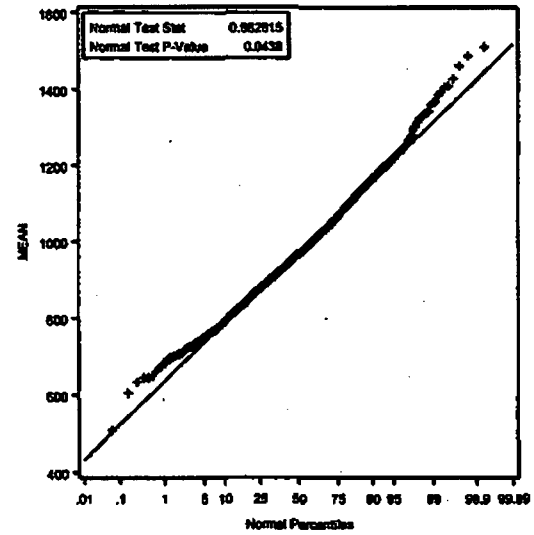

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 25 Grabs
MAP=Map 8
Normal Test Stat 0.971058
Normal Test P-Value 0.0000
Percent
MEAN
Curve: Normal(Mu=231.89 Sigma=46.911)


Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 25 Grabs
MAP=Map 8
Normal Test Stat 0.971058
Normal Test P-Value 0.0000
MEAN
Normal Percentiles
Normal Line: Mu=231.89, Sigma=46.911

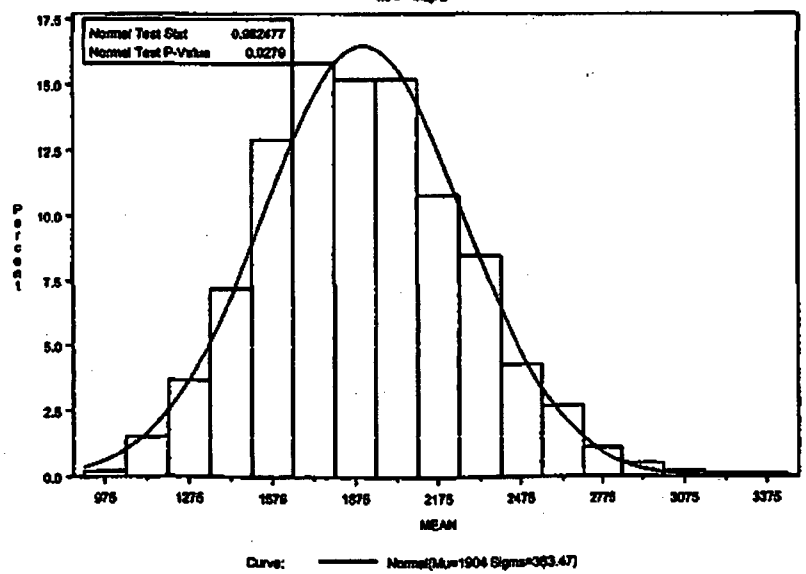
Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 30 Grabs
MAP=Map 1



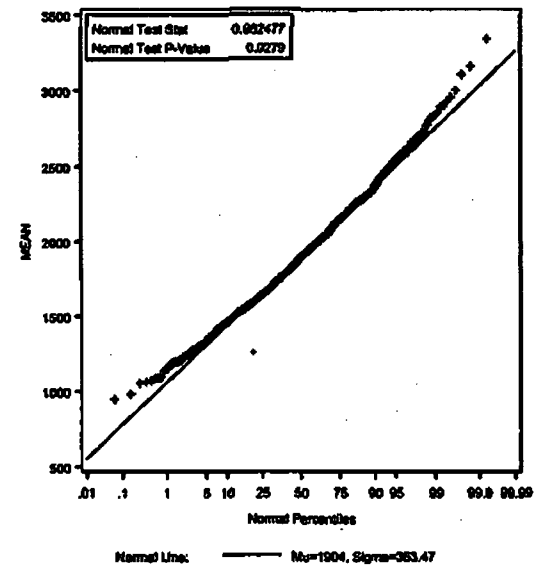
Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 30 Grabs
MAP=Map 1



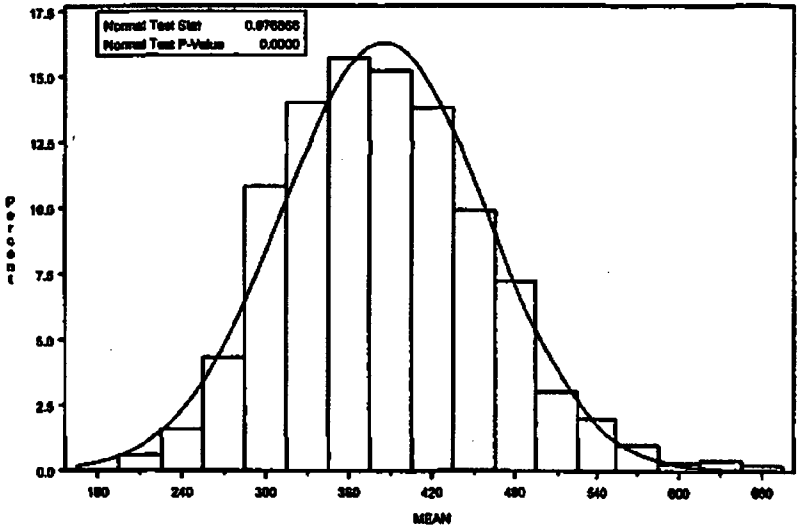
Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 30 Grabs
MAP=Map 2



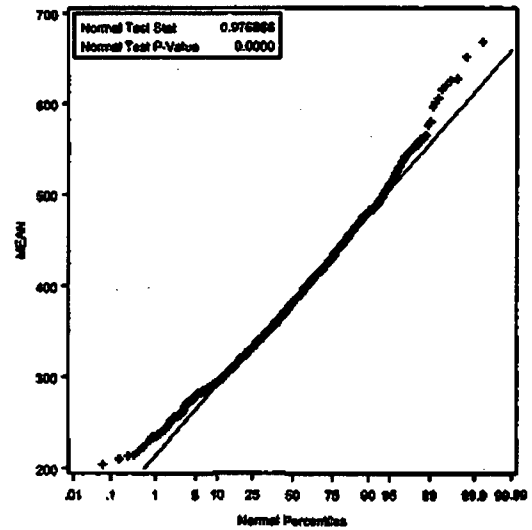
Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 30 Grabs
MAP=Map 2



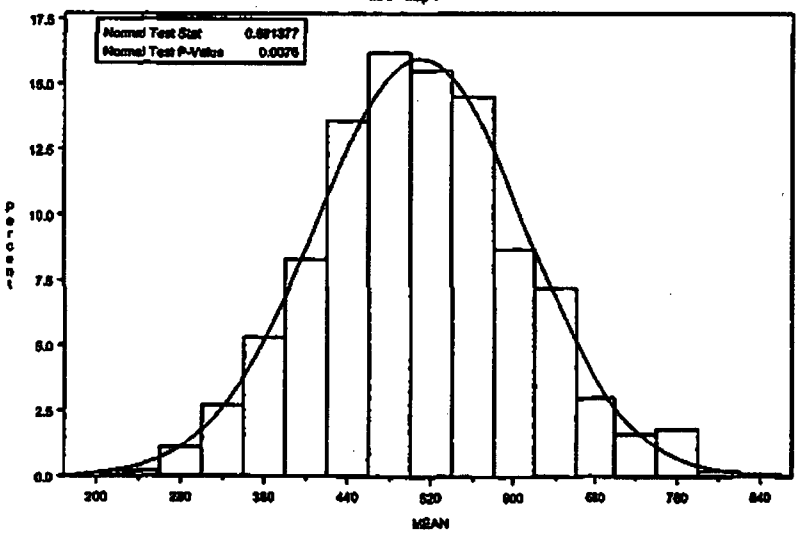
Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 30 Grabs
MAP=Map 3



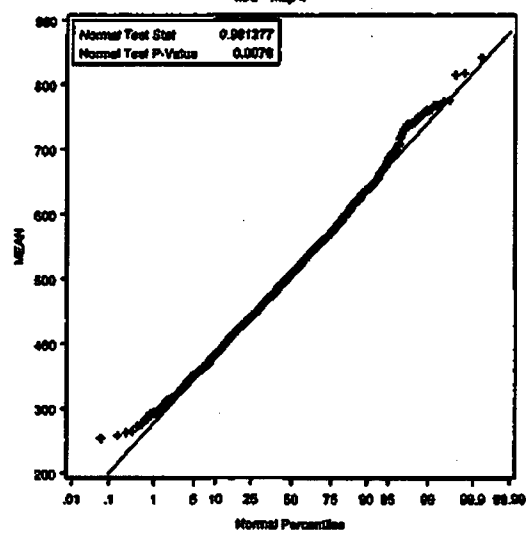
Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 30 Grabs
MAP=Map 3



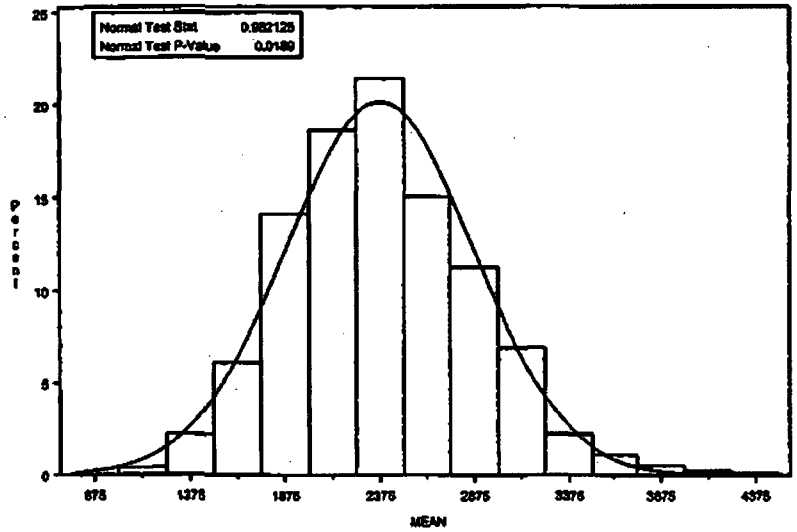
Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 30 Grabs
MAP=Map 4



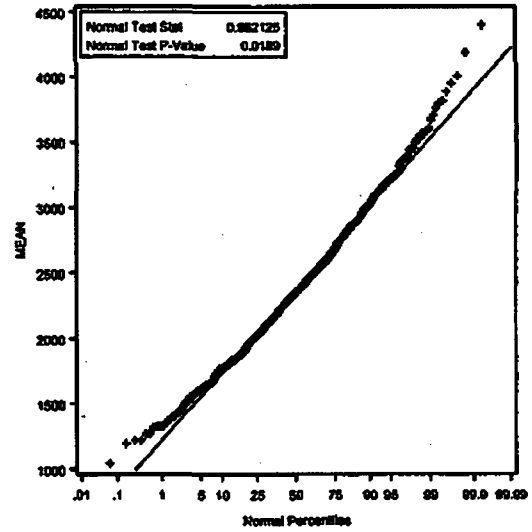
Vasquez Blvd. and I-70 (VB70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 30 Grabs
MAP=Map 4



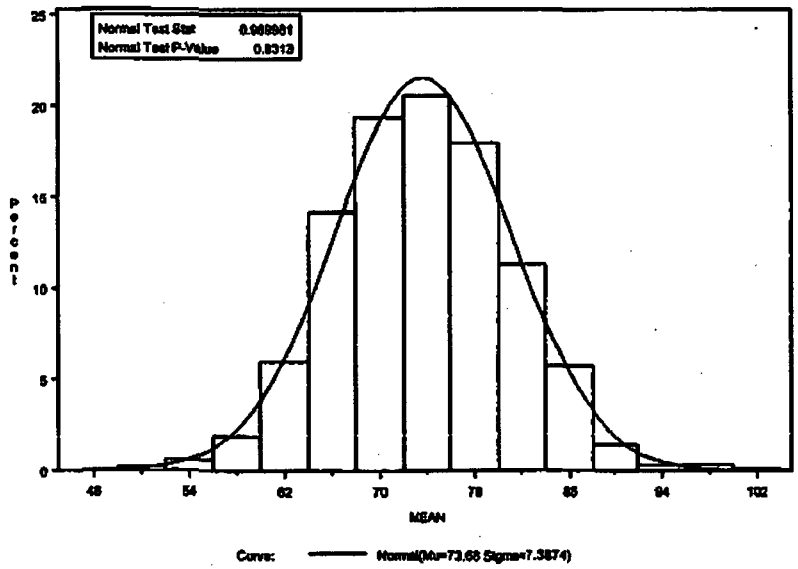
Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 30 Grabs
MAP=Map 6



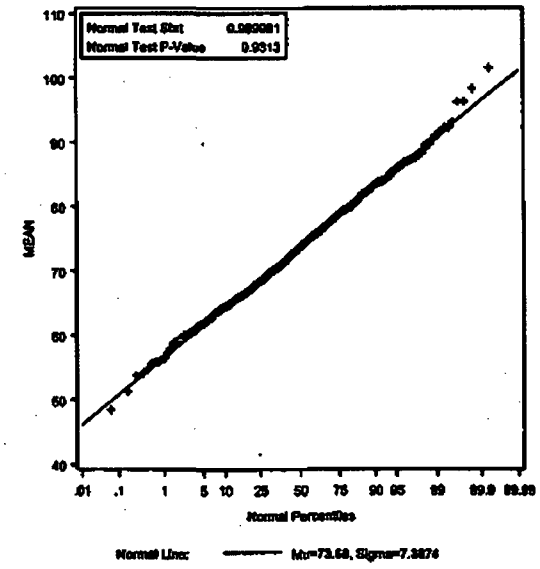
Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 30 Grabs
MAP=Map 6



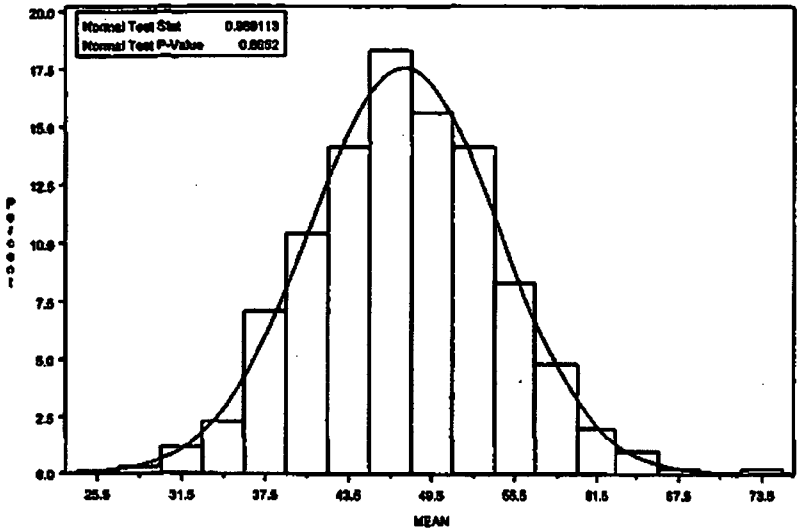
Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 30 Grabs
MAP=Map 6



Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 30 Grabs
MAP=Map 6

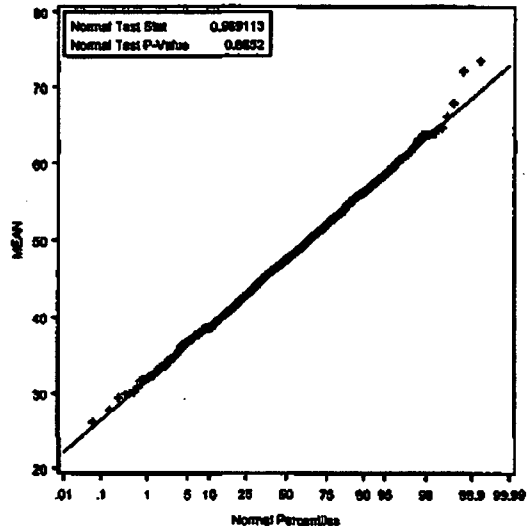


Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 30 Grabs
MAP=Map 7



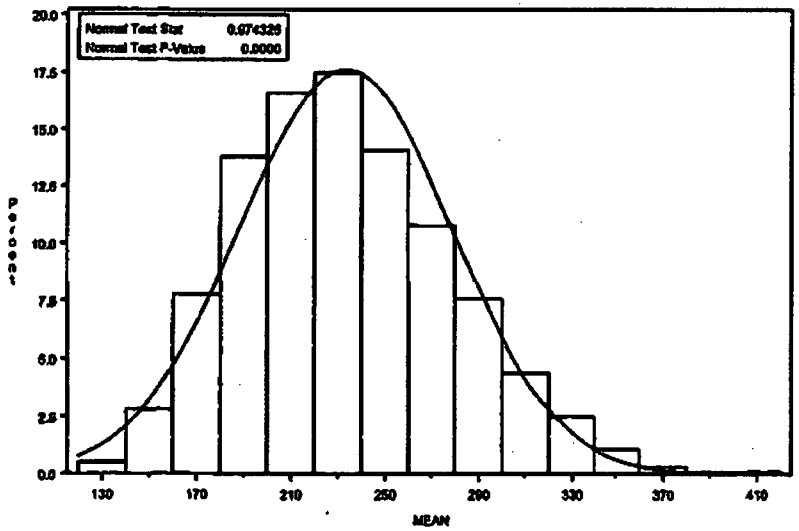
Curve: Normal(Mu=47.504 Sigma=6.8181)

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 30 Grabs
MAP=Map 7



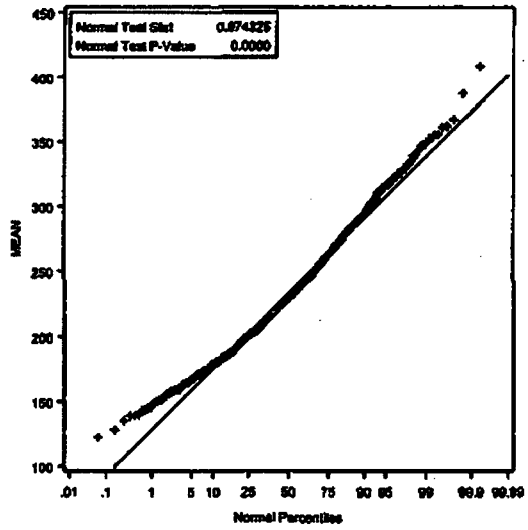
Normal Line: Mu=47.504, Sigma=6.8181

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 30 Grabs
MAP=Map 8



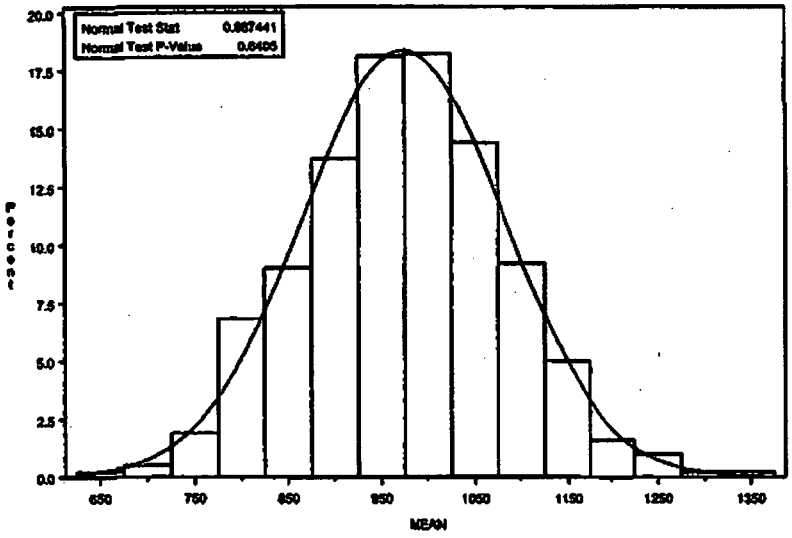
Curve: Normal(Mu=233.34 Sigma=45.258)

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 30 Grabs
MAP=Map 8



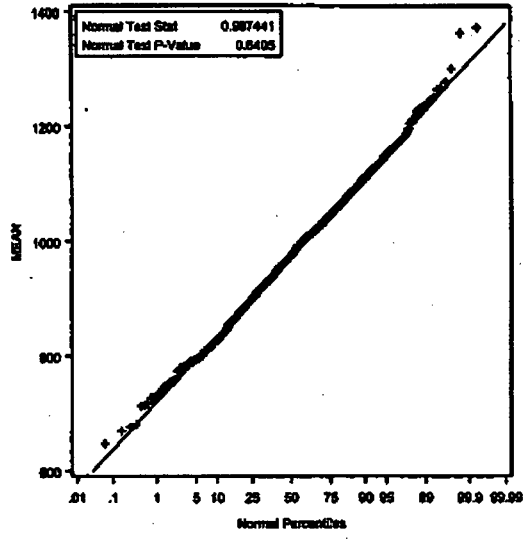
Normal Line: Mu=233.34, Sigma=45.258

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 50 Grabs
MAP=Map 1



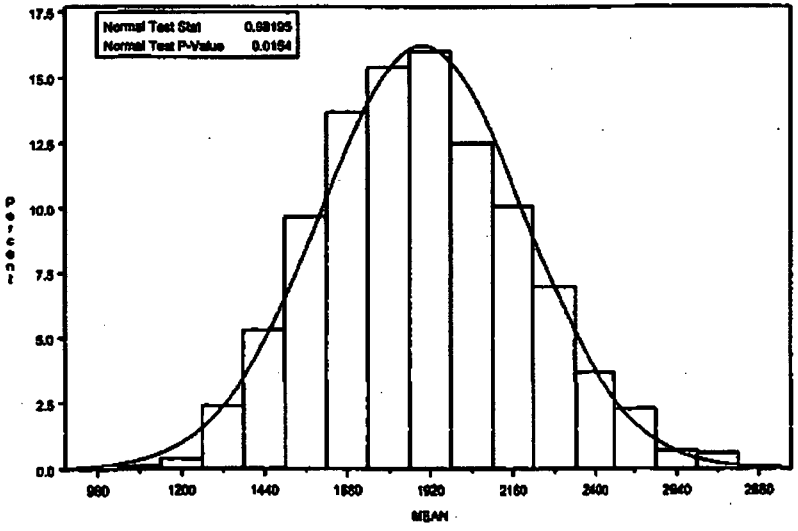
Curve: Normal(Mu=974.11 Sigma=108.68)

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 50 Grabs
MAP=Map 1



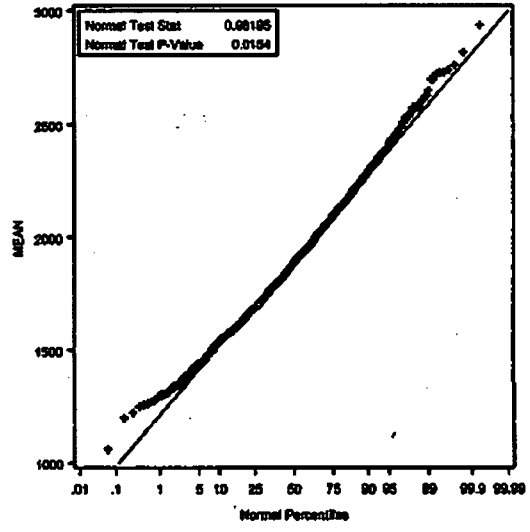
Normal Line: Mu=974.11, Sigma=108.68

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 50 Grabs
MAP=Map 2

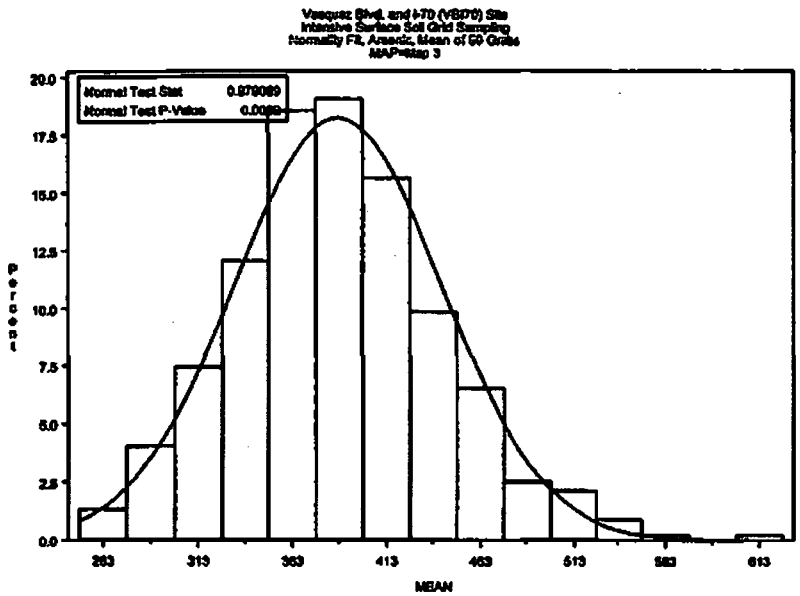


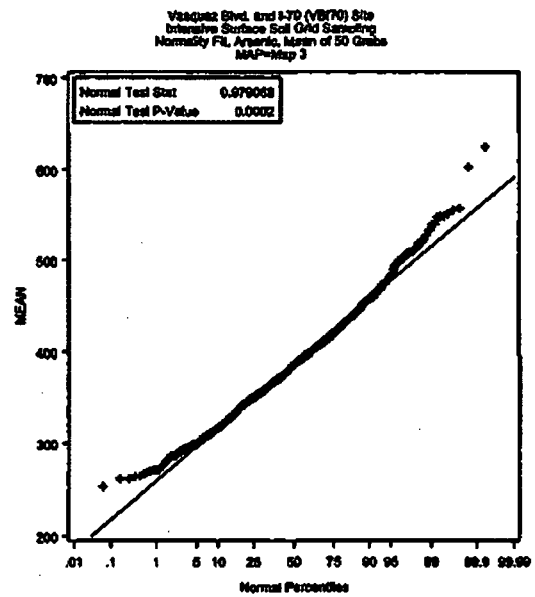
Curve: Normal(Mu=1897.7 Sigma=295.39)

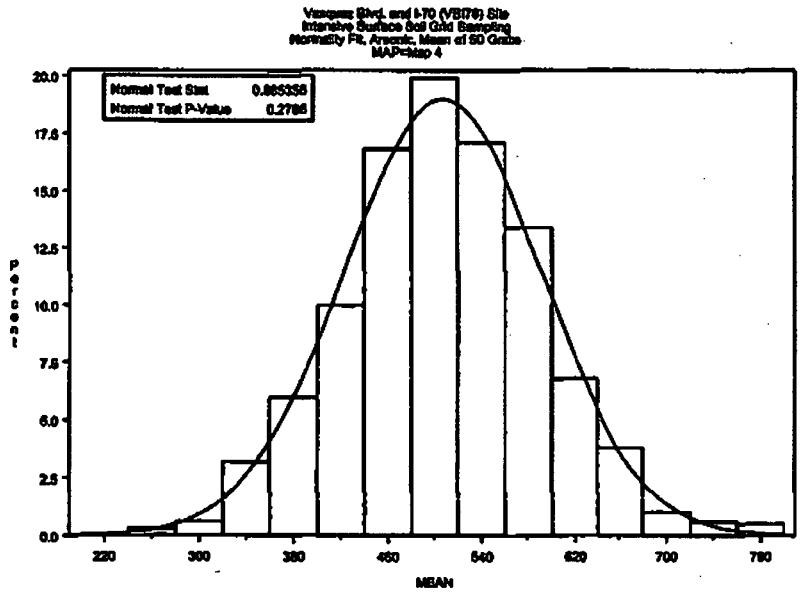
Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 50 Grabs
MAP=Map 2

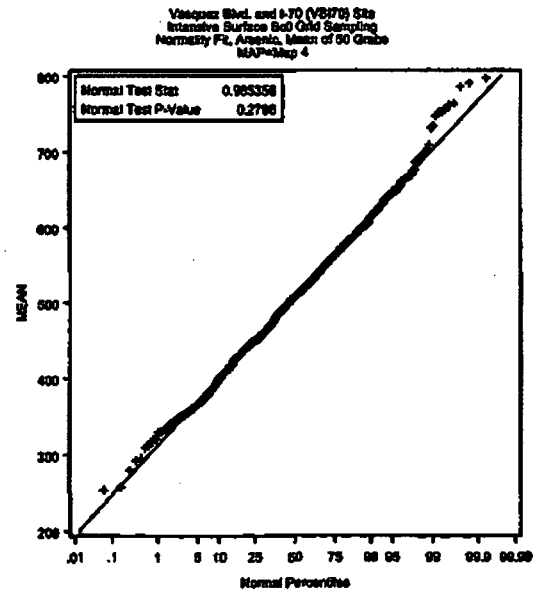


Normal Line: Mu=1897.7, Sigma=295.39

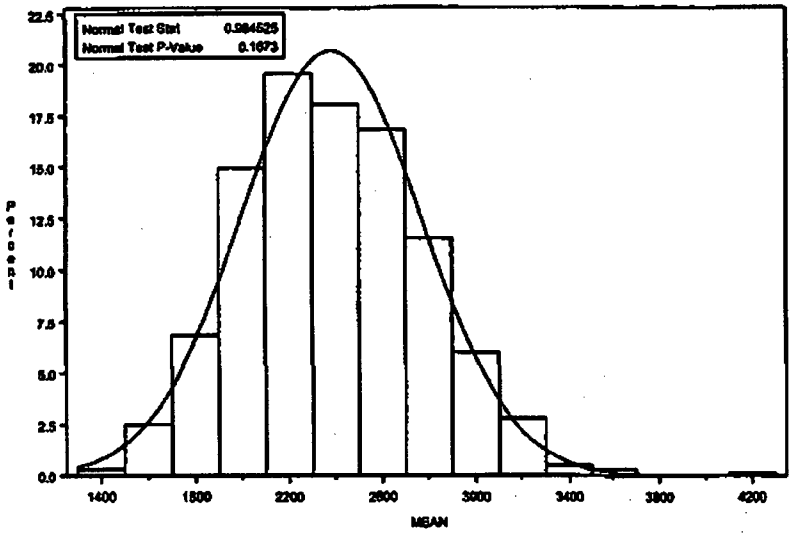

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 50 Grabs
MAP=Map 3
Normal Test Stat 0.979069
Normal Test P-Value 0.0002
PERCENT
MEAN
Curve: Normal(Mu=388.96 Sigma=54.833)


Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 50 Grabs
MAP=Map 3
Normal Test Stat 0.979069
Normal Test P-Value 0.0002
MEAN
Normal Percentiles
Normal Line: Mu=388.96, Sigma=54.833


Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 50 Grabs
MAP=Map 4
Normal Test Stat 0.985358
Normal Test P-Value 0.2786
PERCENT
MEAN
Curve: Normal(Mu=507.3 Sigma=84.123)

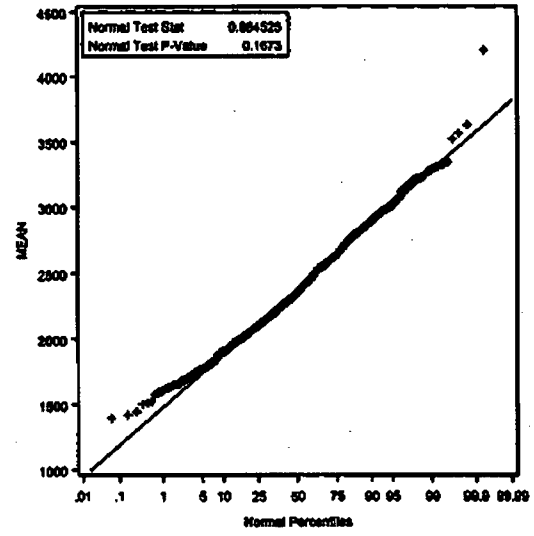

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 50 Grabs
MAP=Map 4
Normal Test Stat 0.985358
Normal Test P-Value 0.2786
MEAN
Normal Percentiles
Normal Line: Mu=507.3, Sigma=84.123

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 50 Grabs
MAP=Map 5



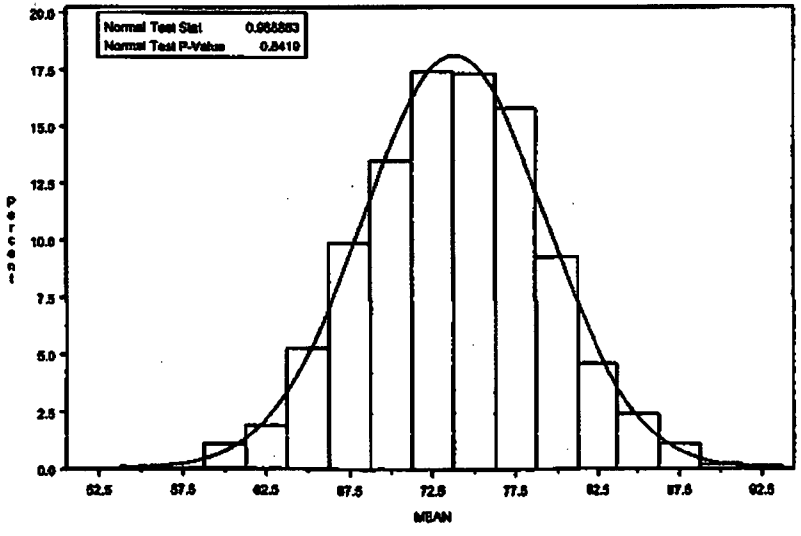
Curve: Normal(Mu=2383.2 Sigma=368.26)

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 50 Grabs
MAP=Map 5



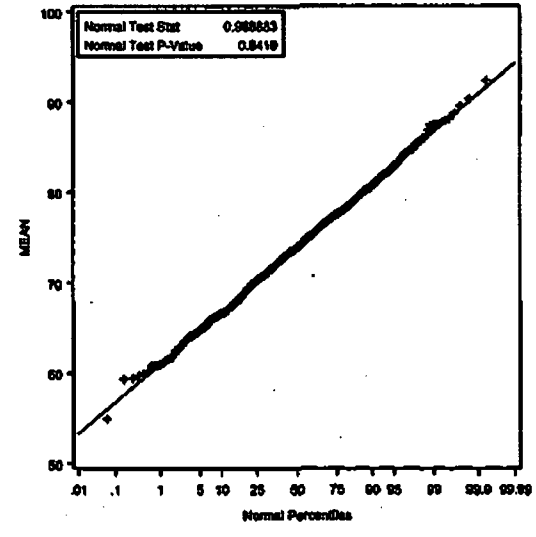
Normal Line: Mu=2383.2, Sigma=368.26

Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 50 Grabs
MAP=Map 6

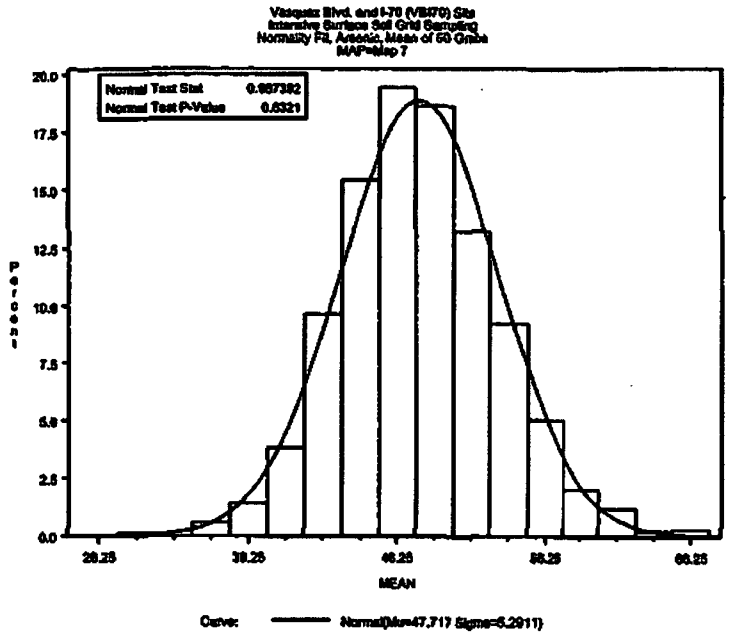


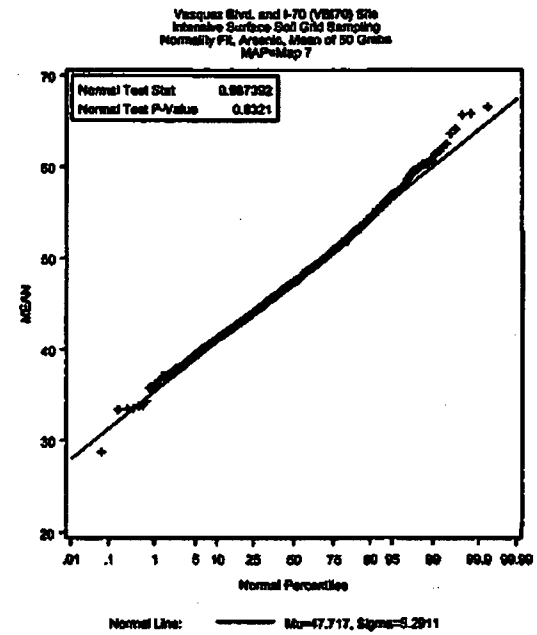
Curve: Normal(Mu=73.829 Sigma=5.5081)

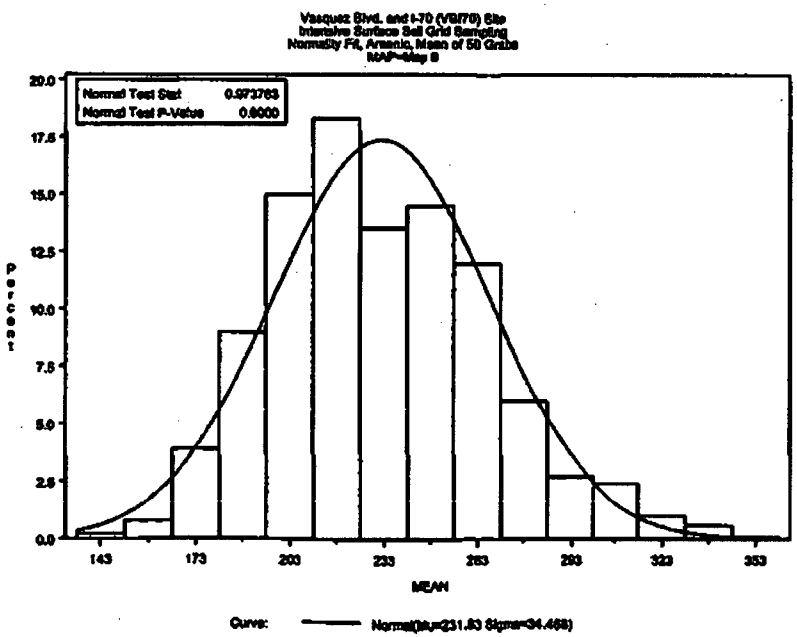
Vasquez Blvd. and I-70 (VBI70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 50 Grabs
MAP=Map 6

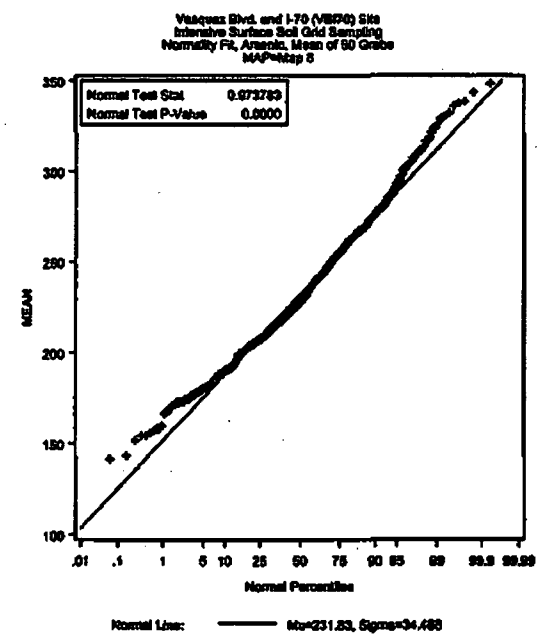


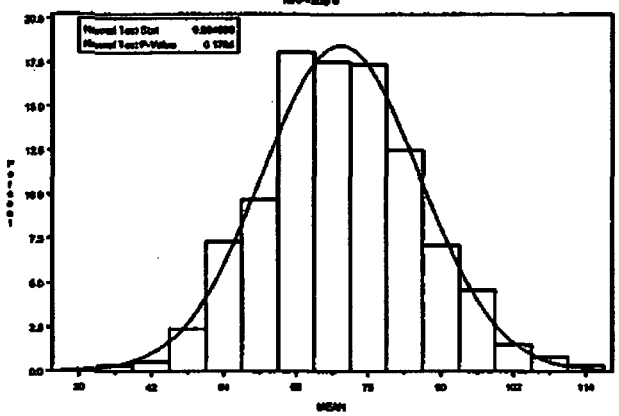
Normal Line: Mu=73.829, Sigma=5.5081

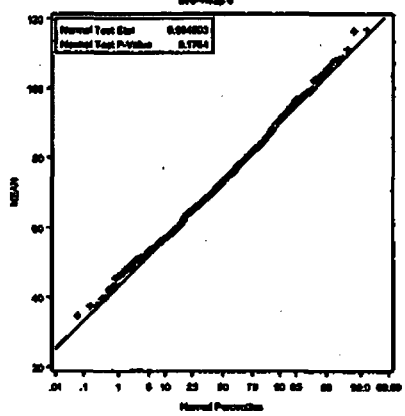

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 50 Grabs
MAP=Map 7
Normal Test Stat 0.987392
Normal Test P-Value 0.0321
Percent
MEAN
Curve: Normal(Mu=47.717 Sigma=5.2911)

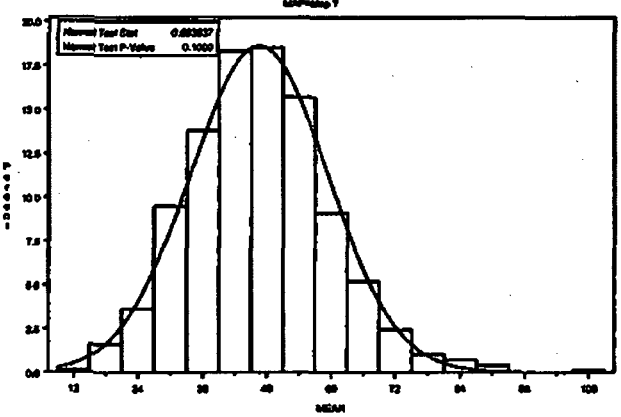

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 50 Grabs
MAP=Map 7
Normal Test Stat 0.987392
Normal Test P-Value 0.0321
MEAN
Normal Percentiles
Normal Line: Mu=47.717, Sigma=5.2911

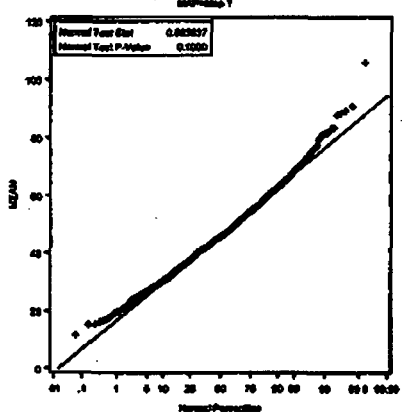

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 50 Grabs
MAP=Map 8
Normal Test Stat 0.973763
Normal Test P-Value 0.0000
Percent
MEAN
Curve: Normal(Mu=231.83 Sigma=34.468)

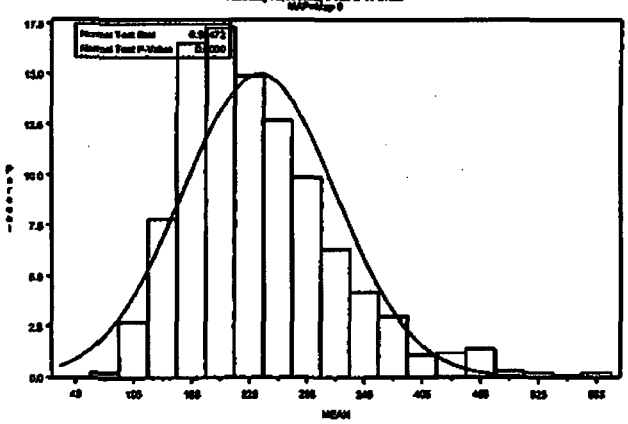

Vasquez Blvd. and I-70 (VB/70) Site
Intensive Surface Soil Grid Sampling
Normality Fit, Arsenic, Mean of 50 Grabs
MAP=Map 8
Normal Test Stat 0.973763
Normal Test P-Value 0.0000
MEAN
Normal Percentiles
Normal Line: Mu=231.83, Sigma=34.468

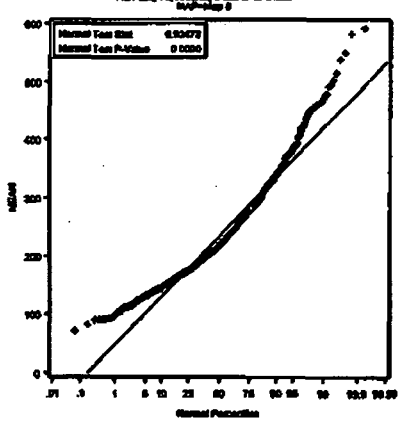

MEAN

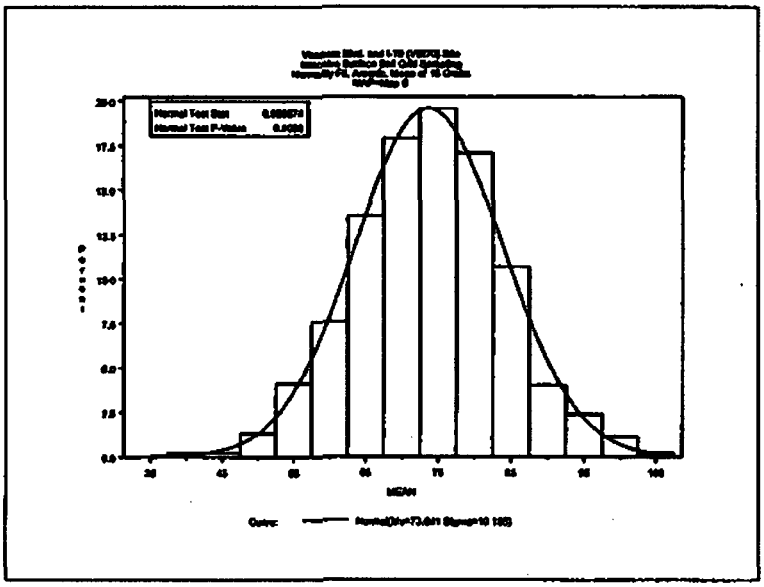

MEAN

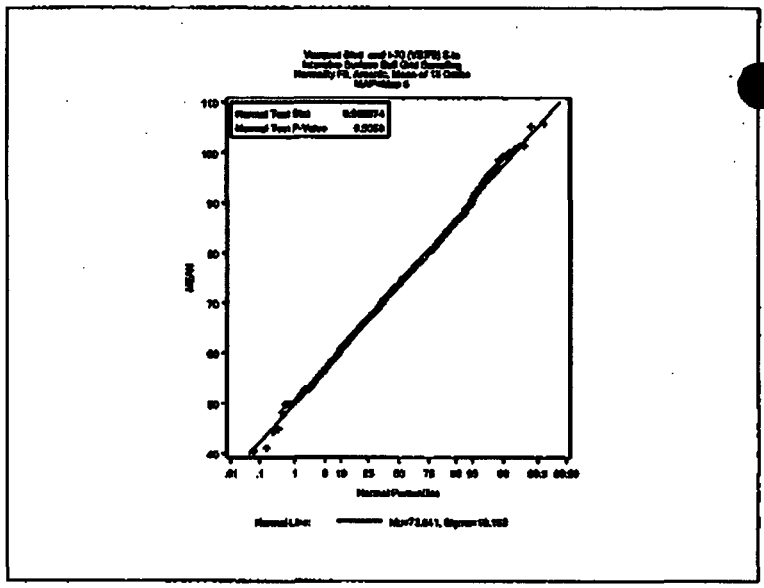

MEAN

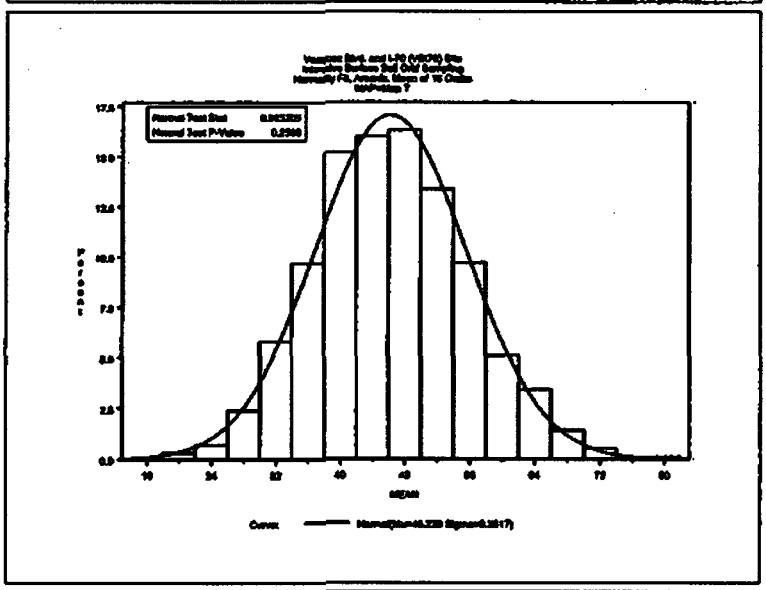

MEAN

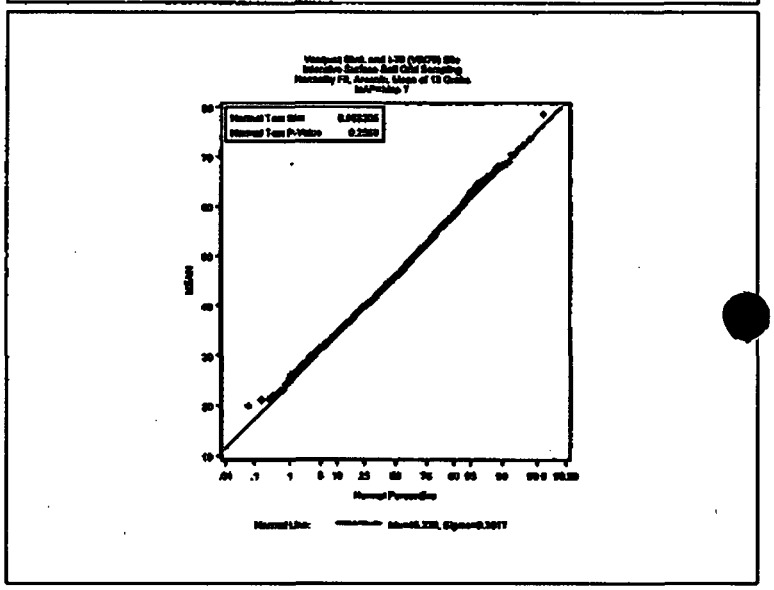

MEAN

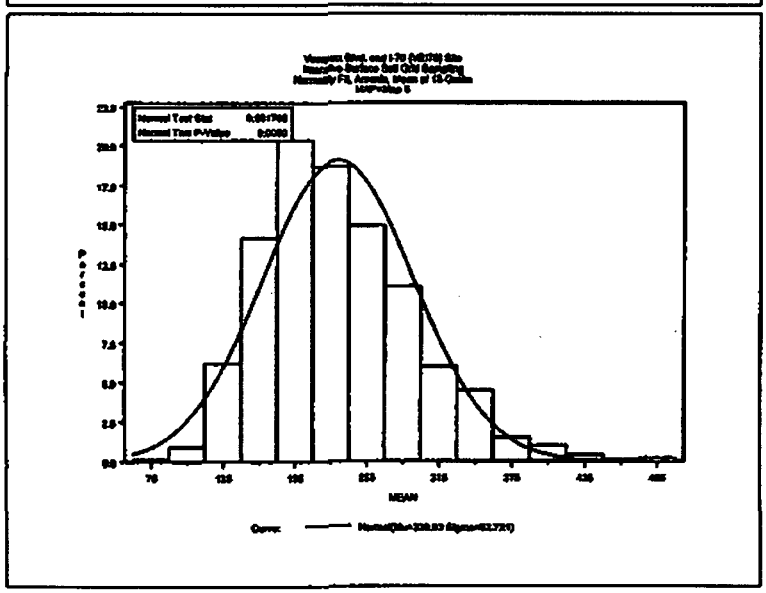

MEAN

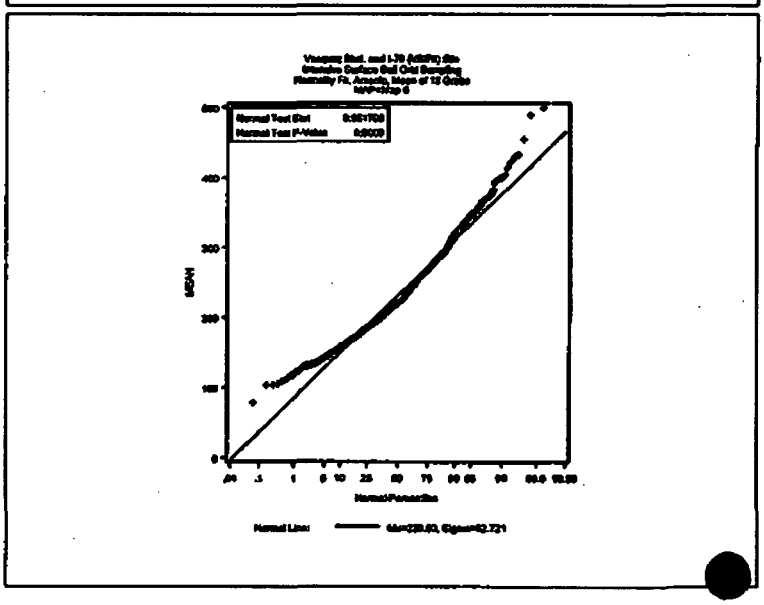

MEAN

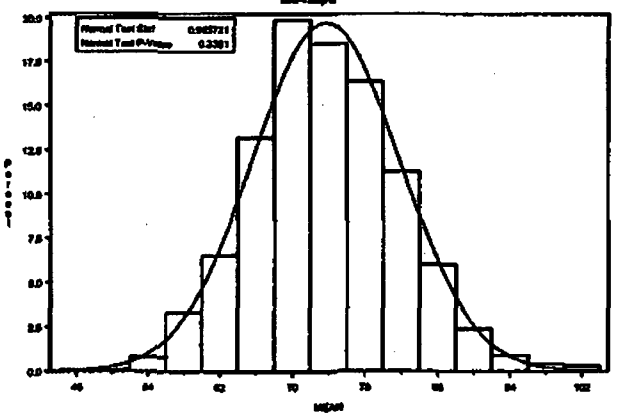

MEAN

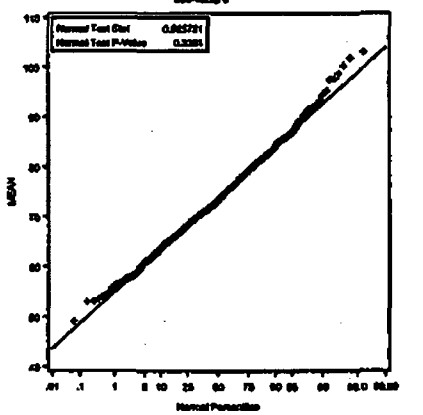

MEAN

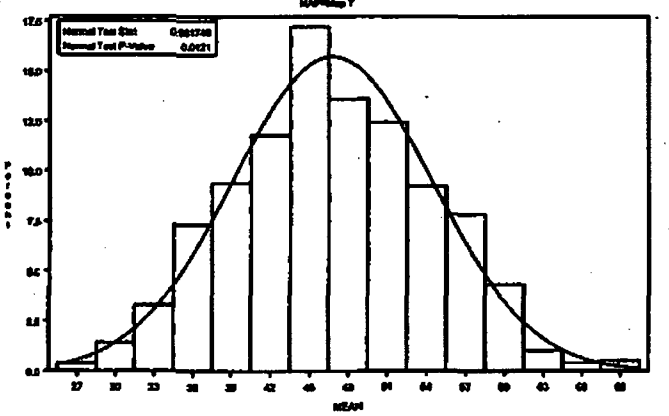

MEAN

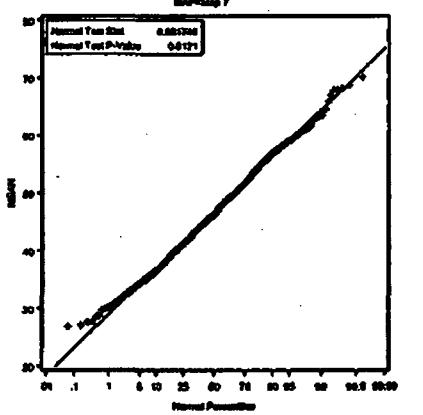

MEAN

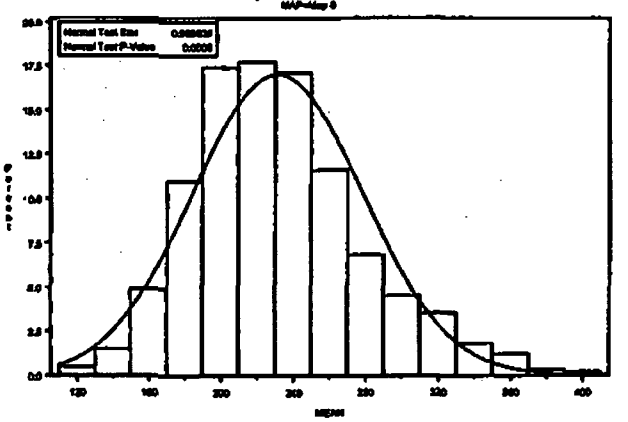

MEAN

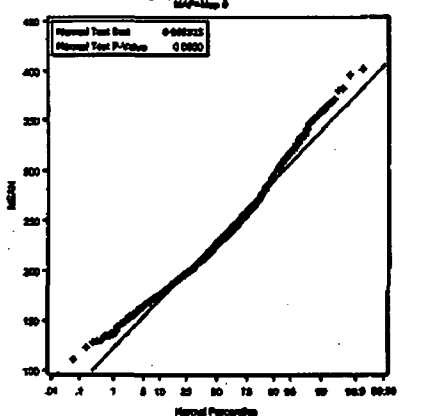

MEAN

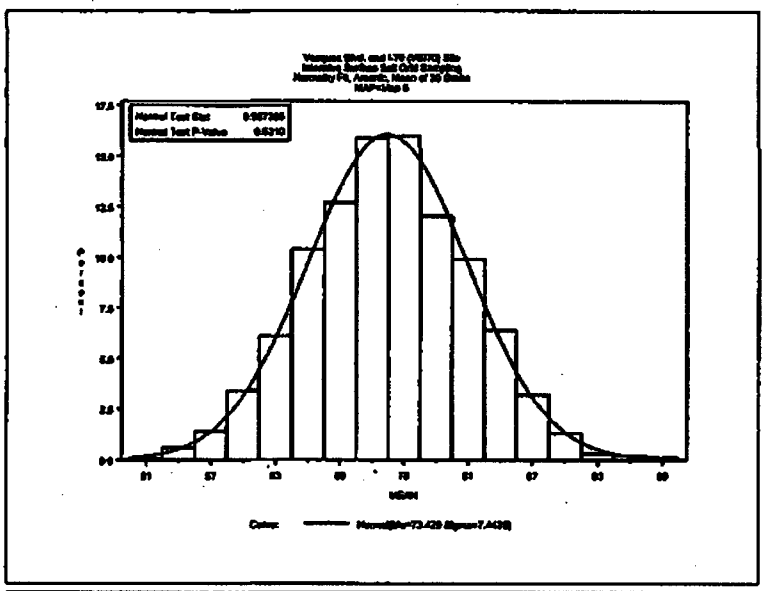

MEAN
Normal Percentiles

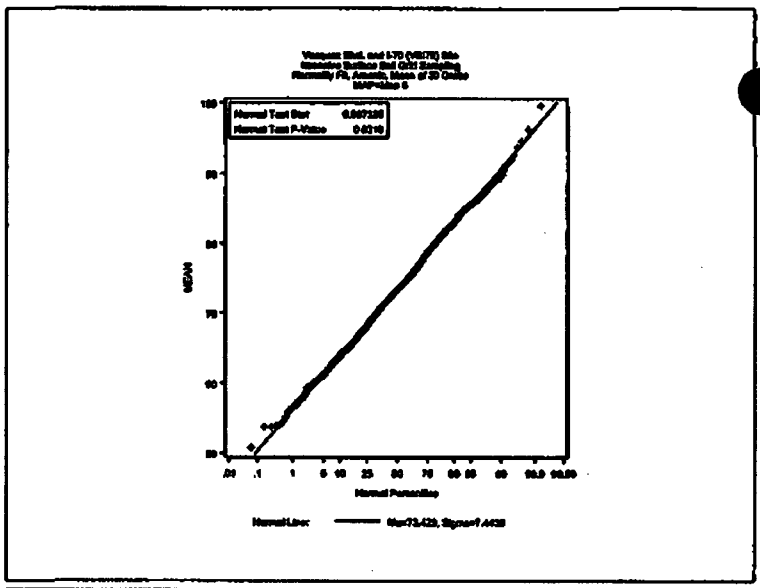

MEAN

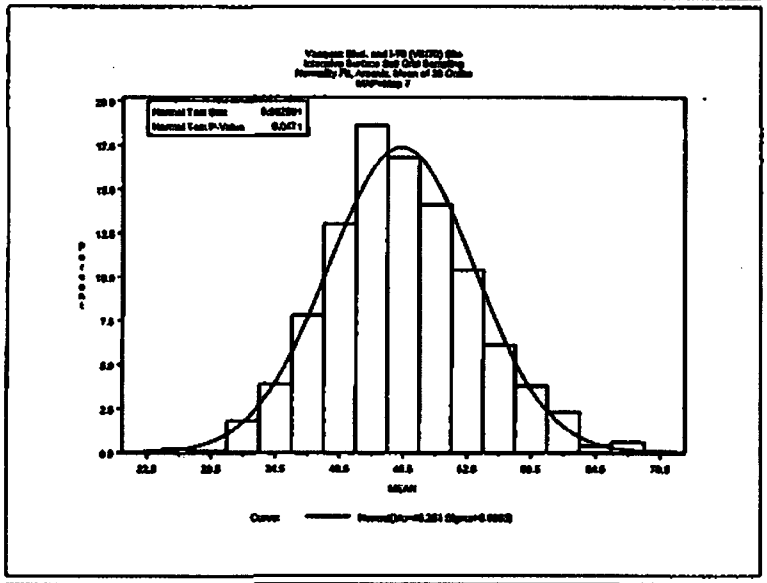

MEAN
Normal Percentiles

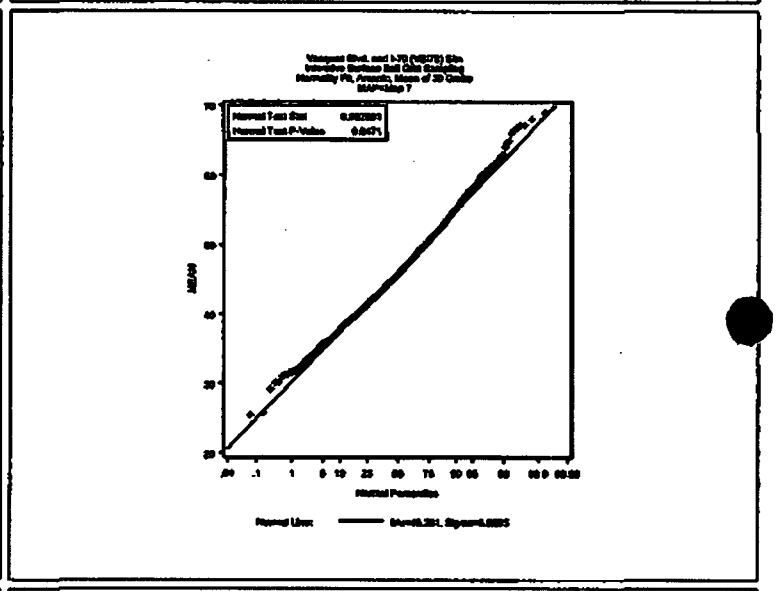

MEAN

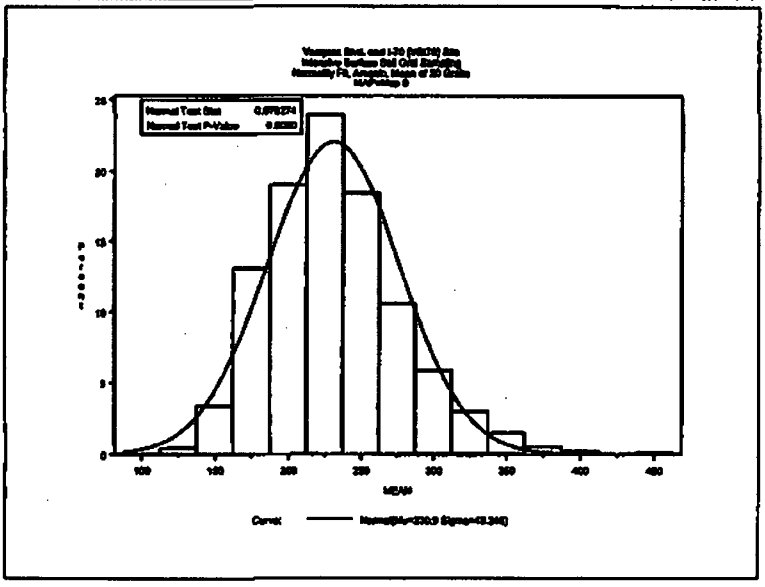

MEAN
Normal Percentiles


MEAN


MEAN


MEAN


MEAN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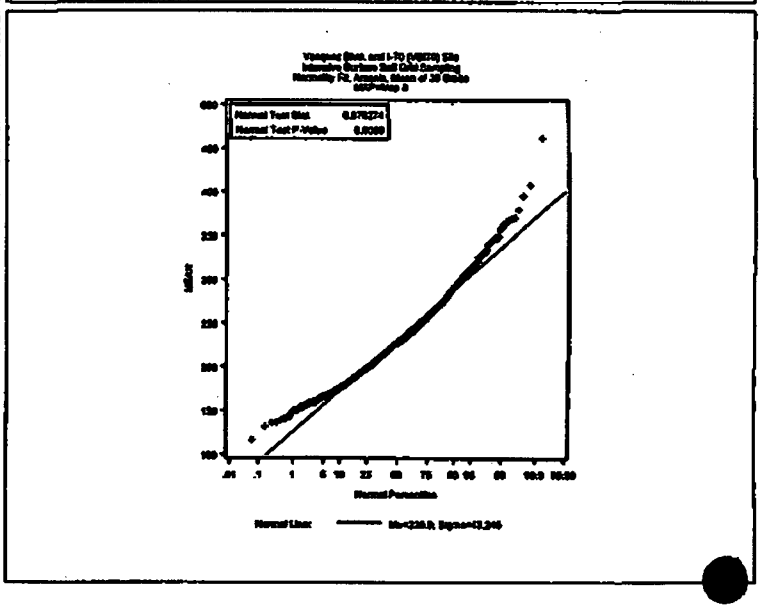

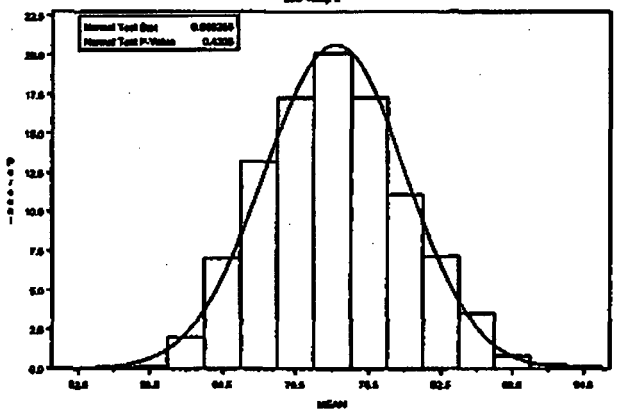
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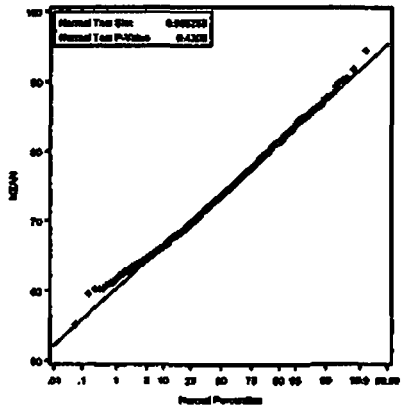
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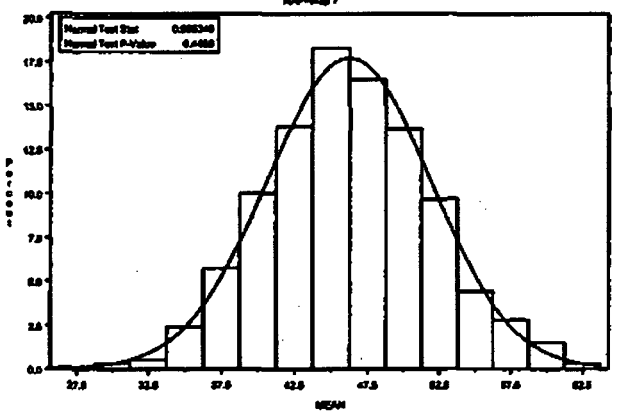
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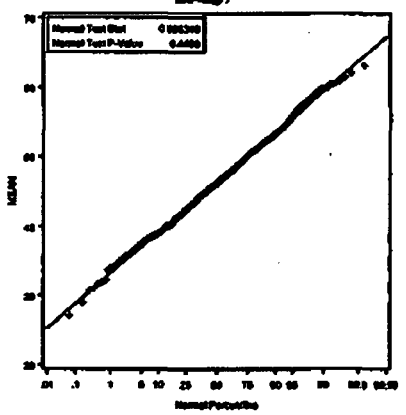
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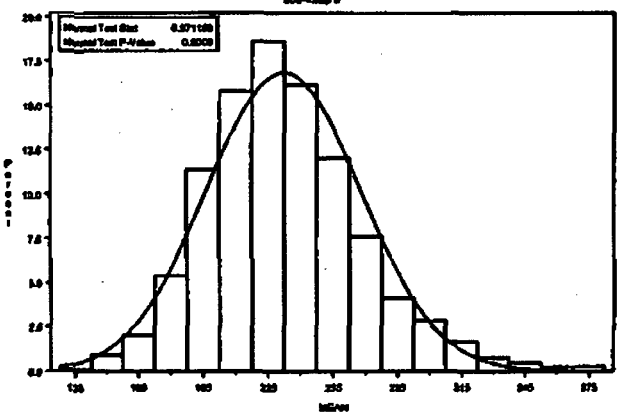
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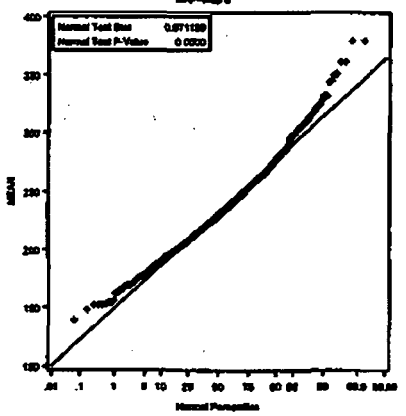
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Appendix F:

Standard Operating Procedures

TECHNICAL STANDARD OPERATING PROCEDURE

Date: July 30, 1999 (Rev. # 1) SOP No. ISSI-VBI70-01

Title: SAMPLE IDENTIFICATION AND TRACKING PROCEDURES

APPROVALS:

Author ISSI Consulting Group, Inc. June 10, 1999
Original Date

SYNOPSIS: A standardized method for sample identification and tracking for the Phase III Surface Soil Investigation is provided.

Received by QA Unit:

REVIEWS:

TEAM MEMBER	SIGNATURE/TITLE	DATE
EPA Region 8	Bonnie Lake / RPM	8/4/99
ISSI Consulting Group, Inc.	J. Goldada / FQAC	7.30.99

Revision Date	Reason for Revision
July 30, 1999	Included another sample identifier for archived bulk fraction soils.

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide a standardized method for uniquely identifying and tracking samples collected during the Phase III Surface Soil Investigation at the VBI70 site. This SOP is to be used by employees of USEPA Region 8 contractors/subcontractors supporting USEPA Region 8 projects and tasks. This SOP describes both the nomenclature which will be used to identify samples and outlines the measures by which samples will be tracked throughout the collection process. Site-specific deviations from the procedures outlined in this document must be approved by the USEPA Region 8 Remedial Project Manager or the Regional Toxicologist prior to initiation of the sampling activity.

2.0 RESPONSIBILITIES

Successful execution of the Project Plan requires a clear hierarchy of assigned roles with different sets of responsibilities associated with each role.

The Field Project Leader (FPL) may be an USEPA employee or contractor who is responsible for overseeing the sampling activities. The FPL is also responsible for checking all work performed and verifying that the work satisfies the specific tasks outlined by this SOP and the Project Plan. It is the responsibility of the FPL to communicate with the Field Personnel specific collection objectives and anticipate situations that require any deviation from the Project Plan. It is also the responsibility of the FPL to communicate the need for any deviations from the Project Plan with the appropriate USEPA Region 8 personnel (Remedial Project Manager or Regional Toxicologist).

Field personnel performing sampling are responsible for adhering to the guidelines established within this SOP.

3. 0 SAMPLE NOMENCLATURE

All samples collected during this study will be assigned a unique label ("tag number").

Each sample label will consist of three elements, as follows:

PHASE. All labels will begin with the number "3" to indicate that the sample is derived from Phase III of the study.

NUMBER. Each label will include a unique identification number. This number will be a 5-digit sequential number starting with "00001" and progressively increasing until the final sample has been collected or tag number "99999" has been reached.

SAMPLE PREPARATION. Samples will be categorized based upon the sample preparation performed. Categories include, but are not limited to:

- R — Raw sample. Original sample collected during Phase III that is unprocessed.
- A — Archived bulk fraction. This sample is prepared by sieving the raw sample and then archiving for future use. This sample is not subjected to heating.
- B — Bulk fraction. This sample has been prepared by sieving the sample to < 2 mm and then heating above environmental temperatures (> 50 °C).
- F — Fine fraction. This sample has been dried at environmental temperatures (< 50 °C) and then sieved to < 250 µm.

Thus, "3-00001-R" and "3-12846-F" represent possible sample numbers collected during Phase III.

Note: The sample preparation nomenclature may be expanded as needed in the future providing they are approved by the Project Database Manager or designate.

4.0 SAMPLE TRACKING

Prior to sample collection, each team will be given blank copies of media-specific data sheets and a set of pre-printed sample identification numbers on self-adhesive labels.

There will be two labels for each sample number. The set of labels that are checked out by a team will be documented by the FPL or designate prior to sampling each day using the VBI70 Surface Soil Labels-Master Sheet (Attachment 1).

When a sample of site medium is collected (e.g., yard soil, indoor dust, alleyway soil), a self-adhesive label will be transferred from the pre-printed sheet to the sample container. At the same time (before collection of any other sample), the second copy of the sample number will be transferred to the appropriate location on the data sheet. The sample data sheet will be filled out at the time of sample collection by the sample collection team. This sheet will contain all relevant information necessary to properly identify the sample. An example data sheet is provided in Attachment 2. All data sheets will be maintained in three-ring binder logbooks. Each sampling team will have a separate logbook.

Because the sample identification number is not a self-reading or immediately decipherable, it is critical that the supporting sample data sheet be filled out legibly, accurately and completely. Notes should be as descriptive and as inclusive as possible such that a person reading the entries, who is independent of the sampling effort, should be able to reconstruct the sampling situation from the recorded information. Language should be objective, factual, and free of personal feelings and inappropriate terminology. Data sheets must be signed by the person recording the information. Any errors or mistakes in field recording must be initialed and dated by the recorder, along with a note explaining the change.

If self-adhesive labels are destroyed and/or voided during sampling activities, this information should be immediately documented in the general logbook for the field team.

5.0 DAILY CLOSE-OUT

Upon completion of daily sampling activities, the sampling team will return to the field office location with samples and corresponding data sheets and any unused labels. It is mandatory that each sample be submitted with its corresponding data sheet. The Field Project Leader or designated sample custodian will verify that the identification numbers on each sample correspond to the data sheet, and that each data sheet is legible and filled out in its entirety. Each data sheet will be copied and the originals will be transferred from the team logbook into a three-ring binder master logbook organized by sample identification number. Once inserted into the master logbook, each data sheet will be numbered sequentially in the space provided in the lower right corner. Additionally, the sample custodian will maintain a log of the sample identification numbers which have been used, noting any missing or destroyed labels (see Attachment 1). The sample labels

and numbers for each team must be rectified at the end of each day. After verification, the samples will be locked and stored according to media. The copies of the sample data sheets will be submitted to the Field Database Manager for entry into the Field Activities Database. Data entry will be performed according to the Data Management Plan established for this project. A flowchart that illustrates the general flow of events is presented in Figure 1.

Attachment 1:

VBI70 Surface Soil Labels – Master Sheet

Logbook DCN_____

VBI70 Surface Soil Labels - Master Sheet

Label #	Check-Out			Check-In			Voided?	Reason
	Sample Team ID	Date	Initials	Sample Team ID	Date	Initials		
3-00001								
3-00002								
3-00003								
3-00004								
3-00005								
3-00006								
3-00007								
3-00008								
3-00009								
3-00010								
3-00011								
3-00012								
3-00013								
3-00014								
3-00015								
3-00016								
3-00017								
3-00018								
3-00019								
3-00020								
3-00021								
3-00022								
3-00023								
3-00024								
3-00025								
3-00026								
3-00027								

Attachment 2:

VBI70 Surface Soil Data Sheet

Logbook DCN _____

ATTACHMENT 1
SURFACE SOILDATA SHEET

PHASE: 3
MEDIUM: SURFACE SOIL
SAMPLE COLLECTION METHOD: ISSI-VBI70-02 Revision 1
DEPTH: 0-2"

DATE: _____

SAMPLE TEAM ID: _____
ADDRESS: _____
House# *Street Name*

BUILDING TYPE: Residential – Single
Multifamily
Apartment

School (Name) – _____

Park (Name) – _____

CLASS: FS (Field Sample)

	SAMPLE NO.:	SAMPLE TIME:	SAMPLE TYPE: (circle one)
First Sample		_____	COMP GRAB
Second Sample		_____	COMP GRAB
Third Sample		_____	COMP GRAB

NOTES:

GARDEN PRESENT? _____	Yes	No
IN USE? _____	Yes	No
ADDRESS CONFIRMED BY RESIDENT? _____	Yes	No
WILLING TO ALLOW FURTHER SAMPLING? _____	Yes	No

Field Diagram:

N

DIRECTIONAL ARROW

scale: 1 grid = 1 pace (~ 3 ft)

Sub Area	No. of Grids	Relative Dist. Between Samples (RDBS)	No. of Flags in Sub Area No. of Grids divided by the RDBS	No. of Each Flag (10 of each)
1	_____		_____	Red _____
2	_____		_____	
3	_____	Total Grids divided by 30 =	_____	Blue _____
4	_____		_____	
5	_____	_____	_____	Yellow _____
6	_____		_____	
7	_____		_____	
8	_____		_____	
Total Grids:			Total Flags:	Equal to 30? Y N

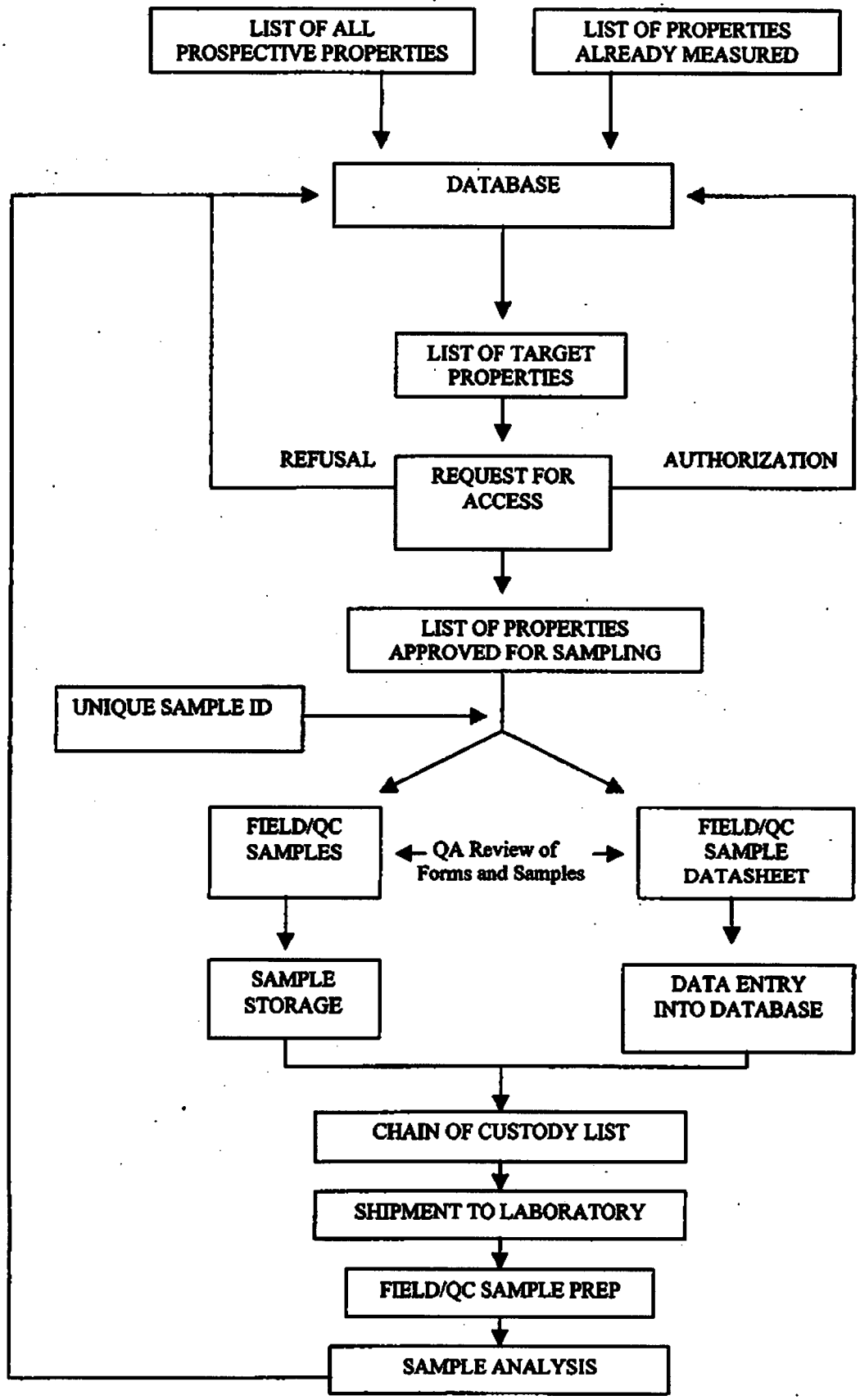
Samples Collected by: _____ _____
Signature *Date*

Logbook Page Reviewed by: _____ _____
Signature *Date*

Figure 1:

Phase III Sample Flow Chart

PHASE 3 SAMPLE FLOW CHART



Date: July 29, 1999 (Rev. # 1) SOP No. ISSI-VBI70-02

Title: RESIDENTIAL SOIL SAMPLING FOR YARDS, AND SCHOOL OR PARK SOILS

APPROVALS:

Author _____ISSI Consulting Group, Inc._____ Original Date: June 14, 1999

SYNOPSIS: A standardized method for exposure-based residential yard, school or park surface soil sampling is described. Protocols for sample collection, compositing, and handling are provided.

Received by QA Unit:

REVIEWS:

TEAM MEMBER	SIGNATURE/TITLE	DATE
EPA Region 8	[illegible] / RPM	7/29/99
ISSI Consulting Group, Inc.	J. Goldade / FQAC	7-29-99

Revision Date	Reason for Revision
July 29, 1999	Modified the definition of "samplable" areas to include regions where temporary obstructions are present. This will assure that both current and future land use is evaluated.

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide a standardized method for residential yard, school, or park surface soil sampling, to be used by employees of USEPA Region 8, or contractors and subcontractors supporting USEPA Region 8 projects and tasks. This SOP describes the equipment and operations used for sampling residential yards, and school or park surface soils in areas which will produce data that can be used to support risk evaluations. Deviations from the procedures outlined in this document must be approved by the USEPA Region 8 Remedial Project Manager or Regional Toxicologist prior to initiation of the sampling activity.

2.0 RESPONSIBILITIES

The Field Project Leader (FPL) may be an USEPA employee or contractor who is responsible for overseeing the residential surface soil sampling activities. The FPL is also responsible for checking all work performed and verifying that the work satisfies the specific tasks outlined by this SOP and the Project Plan. It is the responsibility of the FPL to communicate with the Field Personnel regarding specific collection objectives and anticipated situations that require any deviation from the Project Plan. It is also the responsibility of the FPL to communicate the need for any deviations from the Project Plan with the appropriate USEPA Region 8 personnel (Remedial Project Manager or Regional Toxicologist).

Field personnel performing residential yard, and school or park soil sampling are responsible for adhering to the applicable tasks outlined in this procedure while collecting samples. The field personnel should have limited discretion with regard to collection procedures, but should exercise judgment regarding the exact location of the Sample Point, within the boundaries outlined by the FPL.

3.0 EQUIPMENT

- Soil augers - Various models of soil augers are acceptable and selection of the specific brand and make of tool will be recommended by the contractor implementing the field work (Morrison Knudsen Corporation). Augers are usually made of stainless steel, and should be capable of retrieving a cylindrical plug of soil 2 inches in diameter and 2 inches long. In all cases the procedures recommended by the manufacturers should be followed with regard to use of the auger. Augers with disposable plastic sleeves may be employed to minimize the decontamination effort.

- Collection containers - plastic zip-lock bags.
- Trowels - for extruding the soil from the auger. May be plastic or stainless steel.
- Compositing Bowl - for collecting the grab samples for compositing. Samples will be coarsely mixed in this bowl. May be plastic or stainless steel.
- Gloves - for personal protection and to prevent cross-contamination of samples. May be plastic or latex. Disposable, powderless.
- Field clothing and Personal Protective Equipment - as specified in the Health and Safety Plan.
- Sampling flags - three different colors or numbers (e.g., red, blue, and yellow). Used for identifying yard soil sampling locations. Each color or number represents a different composite sample.
- Wipes - disposable, paper or baby wipes. Used to clean and decontaminate marker flags.
- Field notebook -a bound book used to record progress of sampling effort and record any problems and field observations during sampling.
- Three-ring binder book- to store necessary forms used to record and track samples collected at the VBI70 site. Binders will contain the Surface Soil Data Sheet, Site Diagram, and sample labels for each day. Example forms are provided in Attachment 1.
- Permanent marking pen - used as needed during sampling and for documentation of field logbooks and data sheets.
- Measuring tape or wheel - used to measure each property.
- Measuring tape or pocket ruler - used to measure the length of soil core in the soil coring device.
- Trash Bag - used to dispose of gloves and wipes.

4.0 SAMPLING PATTERN

Sampling patterns for residential yard, school or park soils are designed to identify and collect

samples to support human health risk assessment. Idealized sampling patterns for residential soils are presented in the attached figures, but possible deviations from these sampling patterns could occur based on buildings or other obstructions found at each property. However, sample locations will be identified on a property-by-property basis. Proposed sampling patterns for the individual schools and parks will be provided as an attachment to the Phase III Field Investigation Project Plan at a later date.

4.1 RESIDENTIAL YARD SOIL

Residential yard soil samples will be composited, which requires soil collection from multiple (sub-sample) points. These soils are then mixed and used as a measure of the concentration averaged over the entire area (property). Surficial yard soil samples (0-2 inch depth) will be collected.

Soil Sample Location Identification

The surficial sampling locations within a yard will be based on a 30-point sampling grid. Because of the large number of properties that require sampling during this project, an independent chemical analysis will not be performed for each of the sub-samples collected from each property. Rather, three composite samples will be collected per residence, each consisting of 10 sub-samples that are identified by marker flags of the same color or number. Although numbers may be used for identification of sample locations, for the purposes of this SOP, all procedural descriptions will be illustrated using colored marker flags (e.g., 10 red, 10 blue, and 10 yellow). Identification of individual grab sample locations will be performed using the following general steps.

The team leader (TL) for each sampling team will be trained in this procedure in order to ensure replicable sample location assignment. The following steps will be followed (in order) prior to any sample collection:

a. Measure each yard

b. Pace off each building or permanent obstruction

c. Identify major samplable areas

d. Determine the number of sample points in each subarea

e. Record sample locations

f. Mark sample locations

g. Collect the sample

4.1.1 Measure each yard

The TL will visit a residence at the time of sampling to assign the sampling scheme. The TL will measure the property dimensions with a measuring tape, measuring wheel or laser measuring device (± 0.5 feet). Draw a sketch of the property and record property dimensions, north orientation, and adjacent streets and alleyways on the site diagram.

4.1.2 Pace off each building or permanent obstruction

The TL will then pace off the major permanent structures of the residence (e.g., dimensions of the property boundary, house, garage, driveway, etc.) and prepare a site diagram to approximate scale (± 3 feet on each measurement). The goal is not have a drawing to scale, but instead to have an estimate of the total samplable area in the residential yard. The total samplable area is defined as any area on the property that is free of permanent obstructions. Temporary obstructions such as automobiles or trailers parked on unpaved property locations, picnic tables, plastic or other materials covering the property are not permanent structures and will be considered "samplable". Therefore, areas that could be used in the future if the temporary obstructions were removed, should be identified on the field diagram and must be considered in sample location identification. Figure 2 and Figure 3 provide examples of a typical residence at the VBI70 site that has been drawn on a grid.

4.1.3 Identify major samplable areas

For each residence, the samplable area will be divided into rectangular subareas, using natural boundaries such as the house, garage, sidewalk or gardens as division markers (See Figure 3). A minimum of three and a maximum of eight subareas will be identified to the nearest pace (± 3 ft). For convenience, it is recommended that the number of subareas identified is minimized. Draw the subareas on the site diagram sheet. Count the number of squares in each subarea and record this information on the field data sheet.

4.1.4 Determine the number of sample points in each subarea

Add the total number of squares contained in each of the subareas, and record in the appropriate space on the surface soil data sheet. Divide this number by 30 to determine the relative distance between each sample point, and record in the appropriate space on the data sheet (Attachment 1). To determine the number of sample points in each subarea, divide the number of squares in each subarea by the relative distance between sample points. Using standard analytical rounding procedures, round each number to the nearest whole number to determine the number of sample points in each subarea. (See Figure 3 for example).

4.1.5 Record sample locations

Before placing flags into the yard, mark their planned location on the site diagram. Marking flag locations on the site diagram before actually placing them will give the TL a chance to check that sample locations are evenly distributed within each subarea, and that 30 sub-sample locations are documented and recorded. In addition, if an error has occurred in the calculation of sub-sample locations, it will be discovered before any flags have been staked. Because property sizes and obstacles present at each residence may vary significantly, actual sample locations will be identified using a diagram that will be drawn for each individual property sampled. If either permanent or temporary obstructions are present at the intended sampling locations (e.g., sidewalk, shed, garden, etc.), the sample point should be offset so that a surficial yard soil may be collected, then the actual sample location must be correctly documented on the field diagram. If the TL identifies an error in the sample location identification procedures that compromise the readability of the document, a new, revised diagram may be necessary. After recording all of the sample points, the TL should check the site diagram to make sure that sub-sample locations are not clustered in any area (unless clustering is a result of offsetting sample locations due to obstructions). The TL should also verify that sample points are approximately equidistant throughout the property.

4.1.6 Mark sample locations

Starting at one corner of the property, stake sub-sample locations using a repeated sequence of three distinct flag types (i.e., Yellow, Blue, Red, Yellow, Blue, Red, etc.) in alternating sequence across subareas. Do not place the same flag types next to each other, so that there is an even distribution of flags in each subarea (Figure 3). As seen in Figure 3, the location of each marker flag should be approximately equidistant from the other flags within each subsection. Additionally, each color flag should be alternately placed so that the same color marker flags are not clustered. A sample location or flag may be reassigned if clustering is observed.

4.1.7 Surface Soil Collection

The first 10-point composite will be collected by combining the samples at flags of similar color (e.g., red). Grab samples will be collected from the 0-2 inch soil horizon adjacent to each marker flag. Each sample will be collected using a clean coring tool (2-inch diameter). Each grab sample marked by a red flag will be placed into a single zip-lock bag and labeled in accord with the most recent version of the Sample Identification and Tracking SOP (# ISSI-VBI70-01). The second and third 10-point composite samples will be collected in identical fashion but by sampling next to the blue and yellow flags, respectively.

4.2 SCHOOLS AND PARKS SOIL

Surface soil samples at schools and parks will be collected using the same sampling strategy as discussed for the residential soil sampling (Section 4.1). The number of grab samples collected

at an individual school or park may vary, but 3 composite samples will be collected at minimum. Each individual grab sample will be identified using marker flags of any three different colors (e.g., red, blue and yellow). The exact sampling pattern will be unique to the individual school or park and will be submitted as an attachment to the Project Plan at a later date. At minimum, each marker flag will be approximately equidistant from the other flags and each color flag should be alternately placed so that the same color marker flags are not clustered.

Decontaminate equipment as described in Section 9.0

5.0 COLLECTION OF COMPOSITE SAMPLES USING A CORING TOOL

A new pair of plastic gloves are to be worn in each Sampling Zone.

Locate the Sub-sample Point as specified by the TL and clean the area free of twigs, leaves, and other vegetative material that can be easily be removed by hand. If the specified sub-sample point is occupied by a rock, cobble or other hard object of sufficient size to be incapable of easy removal by hand, move the sub-sample point to a location closest to the original point.

Place the soil coring tool on the ground and position it vertically. Holding the tool handle with both hands, apply pressure sufficient to drive the tool approximately 2 inches into the ground while applying a slight twisting force to the coring tool. Remove the tool by pulling up on the handle while simultaneously applying a twisting force. If the sample was retrieved successfully, a plug of soil approximately two inches long should have been removed with the coring tool. If turf-like vegetation (lawn), is present at the sample location, the coring tool should be advanced through the sod and the root mass to the measured 2 inch interval as marked on the outside of the auger.

Hold the soil coring tool horizontally or place it on the ground. Using a clean spatula or knife, remove the soil collected at depth greater than two inches from the end of the sampling tool. Allow this soil to fall into the plastic bucket designated for excess soil material. Use a trowel to extrude the soil from the auger, pushing the two-inch soil plug from the coring tool so that it falls directly into the sample container. Repeat the steps outlined above until all of the sub-samples for each composite have been collected in the three sample containers.

Sample preparation homogenization will be performed in accord with the Sample Preparation SOP #MK-VBI70-05.

If sampling equipment is to be re-used, follow the decon procedures outlined in Section 9.0 before collecting the next composite sample.

6.0 SAMPLE CONTAINERS AND LABELING

Following the procedures outlined in Section 5.0, grab samples will be composited and then placed into sample containers (quart-sized plastic ziplock bags or larger). For each composite

sample, three sample identification labels are required. One label is placed on the Soil Collection Data Sheet (Attachment 1), one label is affixed to the quart-size bag containing the sample, and one label remains loose in the gallon-sized (or larger) ziplock bag which are reserved for sample preparation.

Sample labeling will occur as prescribed below:

1) Place the red pre-printed label ending with the "-R" onto the composite sample (See Sample Identification and Tracking SOP# ISSI-VBI70-01).
2) Place the blue pre-printed label ending with the "-R" onto the Soil Data Collection Sheet.
3) Place the third (green) pre-printed sample label ending with the "-B" designation onto another quart-sized zip-lock bag. There will be no sample in this bag, but it will be brought back to the field office unfilled and will serve as the sample container for the prepared sample sieved to <2 mm (bulk fraction).
4) This procedure will be repeated for the second and third composite samples collected at a property using clean zip-lock bags and unique sample ID numbers.
5) Place the 3 samples into a larger (gallon size) zip-lock bag that has been marked on the outside of the bag with the property address with permanent marker.

A percentage of samples will be selected for fine fraction (<250 um) analysis, as described in the Project Plan. Selected samples will be prepared in accord with the sample preparation SOP (No. MK-VBI70-05), and labeled with an "-F" designation written in permanent marker on the sample identification label.

7.0 SITE CLEAN-UP

Each hole made in the yard using the auger must be backfilled with clean topsoil and tamped down lightly. If sod was removed to obtain the soil sample, the hole should first be backfilled and then the grass plug be replaced by the field personnel.

If any rinse water used for sample decontamination is generated in the course of sample collection, it must be disposed of as specified in the SOP for Investigation Derived Waste Management (MK-VBI70-04). Wherever possible, sod and soil (not collected and retained as part of the composite sample) should be replaced in the same hole.

All 30 flags (if reused) should be decontaminated by wiping off with towels and/or baby wipes before re-use.

Throw all used wipes and gloves into the trash bags and take with you to dispose of at the field office.

8.0 RECORD KEEPING AND QUALITY CONTROL

Each field crew will carry a three-ring binder book that contains the surface soil data sheet, site diagram, and sample labels. In addition, a field notebook should be maintained by each individual or team that is collecting samples, as described in the Project Plan. At the end of each day, the field crews will submit the site sketches and data sheets to the FPL. Each sampled property must have site sketches with sub areas and grab sample locations needed for 30 sub-samples, as described in Section 4.1. Deviations from this sampling plan should be noted in the field notebook, as necessary.

For each property, the notebook information must include:

a. date
b. time
c. personnel
d. weather conditions
e. sample identification numbers that were used
f. locations of any samples and sub-samples that could not be collected
g. descriptions of any deviations to the Project Plan and the reason for the deviation.

Samples taken from soils with visible staining or other indications of non-homogeneous conditions should also be noted.
Field personnel will collect the proper type and quantity of quality control samples as prescribed in the Project Plan.

9.0 DECONTAMINATION

Because decontamination procedures are time consuming, having a quantity of sampling tools sufficient to require decontamination at a maximum of once per day is recommended. All sampling equipment must be decontaminated prior to reuse as prescribed in the Decontamination SOP (#MK-VBI70-07).

10.0 GLOSSARY

Project Plan - A written document that spells out the detailed site-specific procedures to be followed by the FPL and the field personnel.

Sample Point - The actual location at which the sample is taken. The dimensions of a sample Point are 2" in diameter and 2" deep (core technique) or 2" across by 2" deep (spoon/scoop technique).

Composite Sampling - A sample program in which multiple sub-sample points are compiled together and submitted for analysis as a single sample.

Sample zone - A unit of surface area subjected to a given sample program. A given zone usually is thought to contain similar metals concentrations or to be defined by a single set of exposure parameters.

11.0 REFERENCES

USEPA, 1995. Residential Sampling for Lead: Protocols for Dust and Soil Sampling, Final Report, EPA 747-R-95-001, USEPA, March 1995, 38 p.

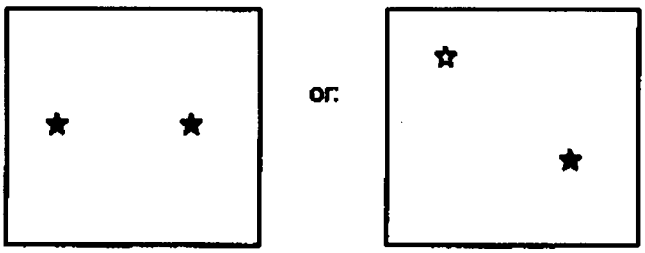
American Society for Testing and Materials, 1995. Standard Practice for Field Collection of Soil Samples for Lead Determination by Atomic Spectrometery Techniques, ASTM Designation: E 1727 - 95, October 1995, 3 p.

Figures and Attachment

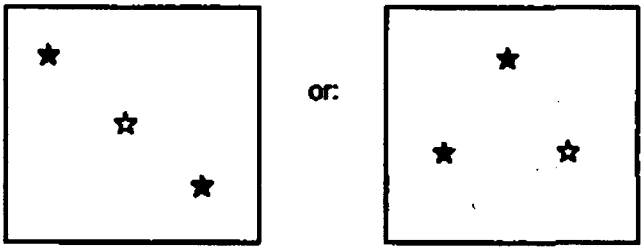
Figure 1

Idealized Sample Point Locations for Different-Sized Sample Areas

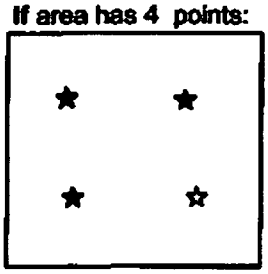
If area has 2 points:



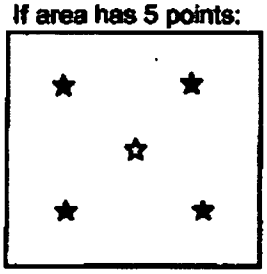
If area has 3 points:



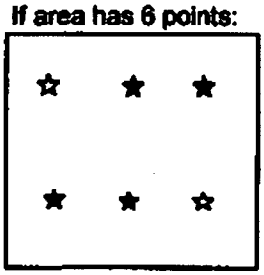
If area has 4 points:



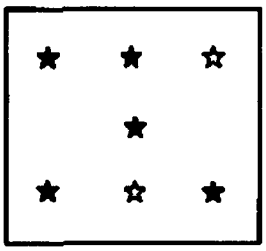
If area has 5 points:



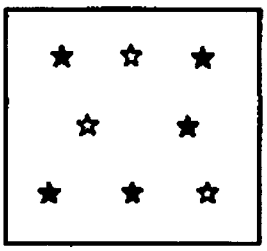
If area has 6 points:



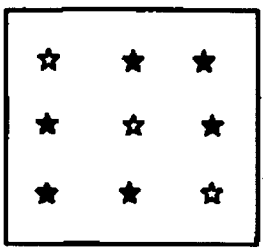
If area has 7 points:



If area has 8 points:



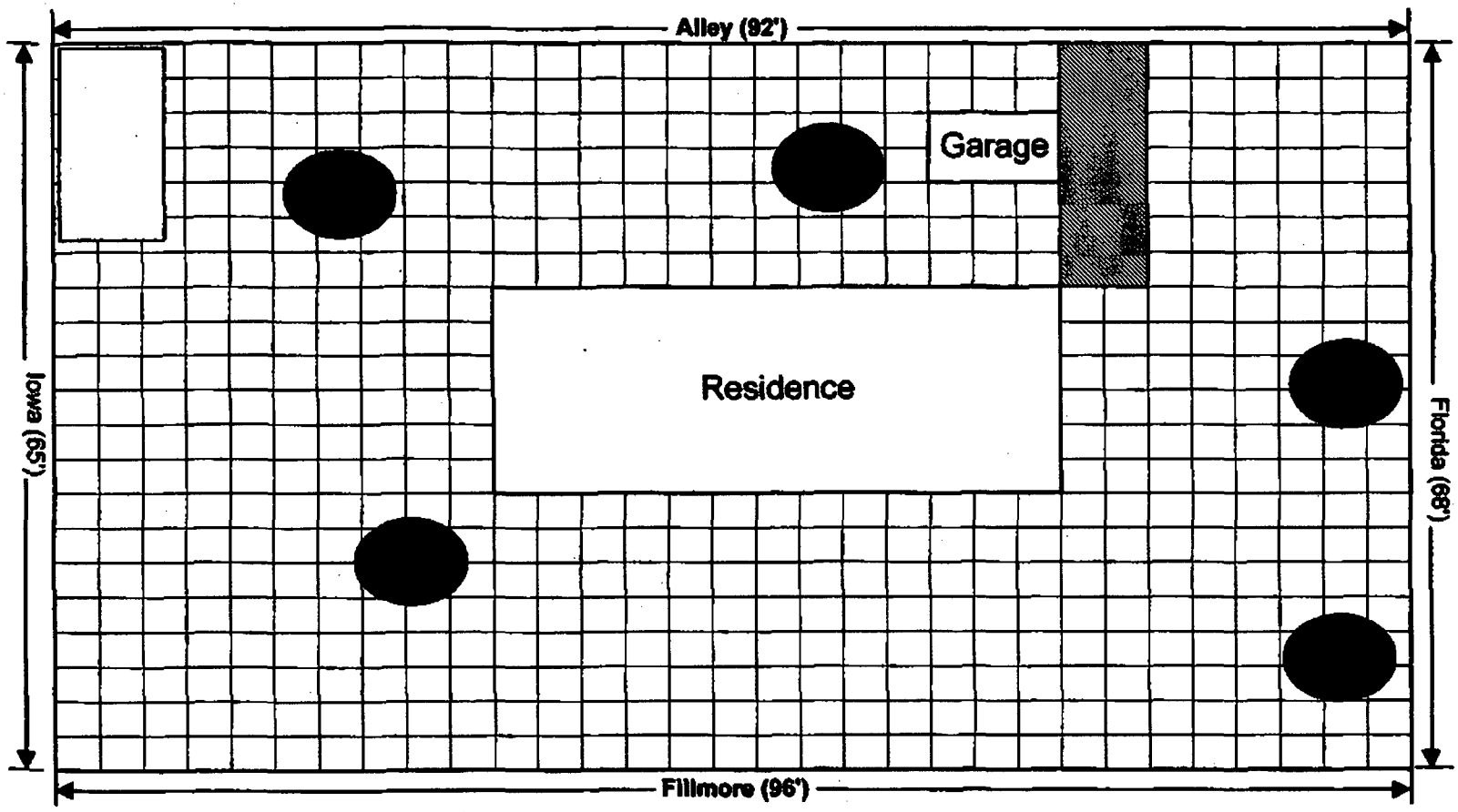
If area has 9 points:



idealpoints

Figure 2 Proposed Grid Sampling Design for Residential Surface Soil

Step 1:



Tree/Shrub

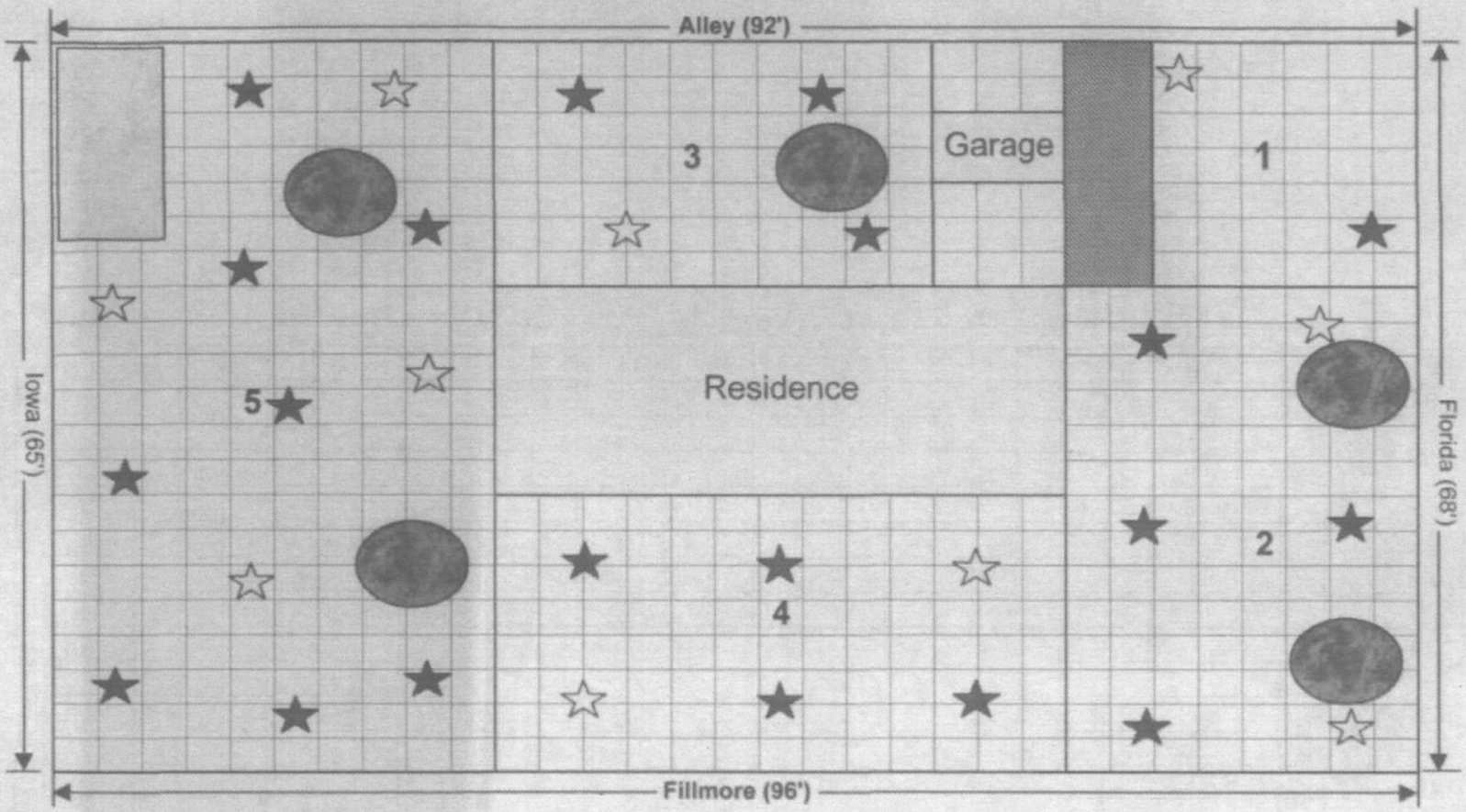
Garden

Driveway

smlgridyard

Figure 3 Proposed Grid Sampling Design for Residential Surface Soil

Step 2:



Tree/Shrub

Garden

Driveway

Sampling Locations

Sub Area	No. of Grids	No. of Flags
1	42	2
2	112	6
3	70	4
4	104	6
5	210	12
Total:	538	Total: 30

Divide by 30: 17.93

s[illegible]ridyard

Logbook DCN _____

ATTACHMENT 1
SURFACE SOILDATA SHEET

PHASE: 3

MEDIUM: SURFACE SOIL

SAMPLE COLLECTION METHOD: ISSI-VBI70-02 Revision 1

DEPTH: 0-2"

DATE: _____

SAMPLE TEAM ID: _____

ADDRESS: _____
House# *Street Name*

BUILDING TYPE: Residential – Single
Multifamily
Apartment

School (Name) – _____

Park (Name) – _____

CLASS: FS (Field Sample)

	SAMPLE NO.:	SAMPLE TIME:	SAMPLE TYPE: (circle one)	
First Sample		_____	COMP	GRAB
Second Sample		_____	COMP	GRAB
Third Sample		_____	COMP	GRAB

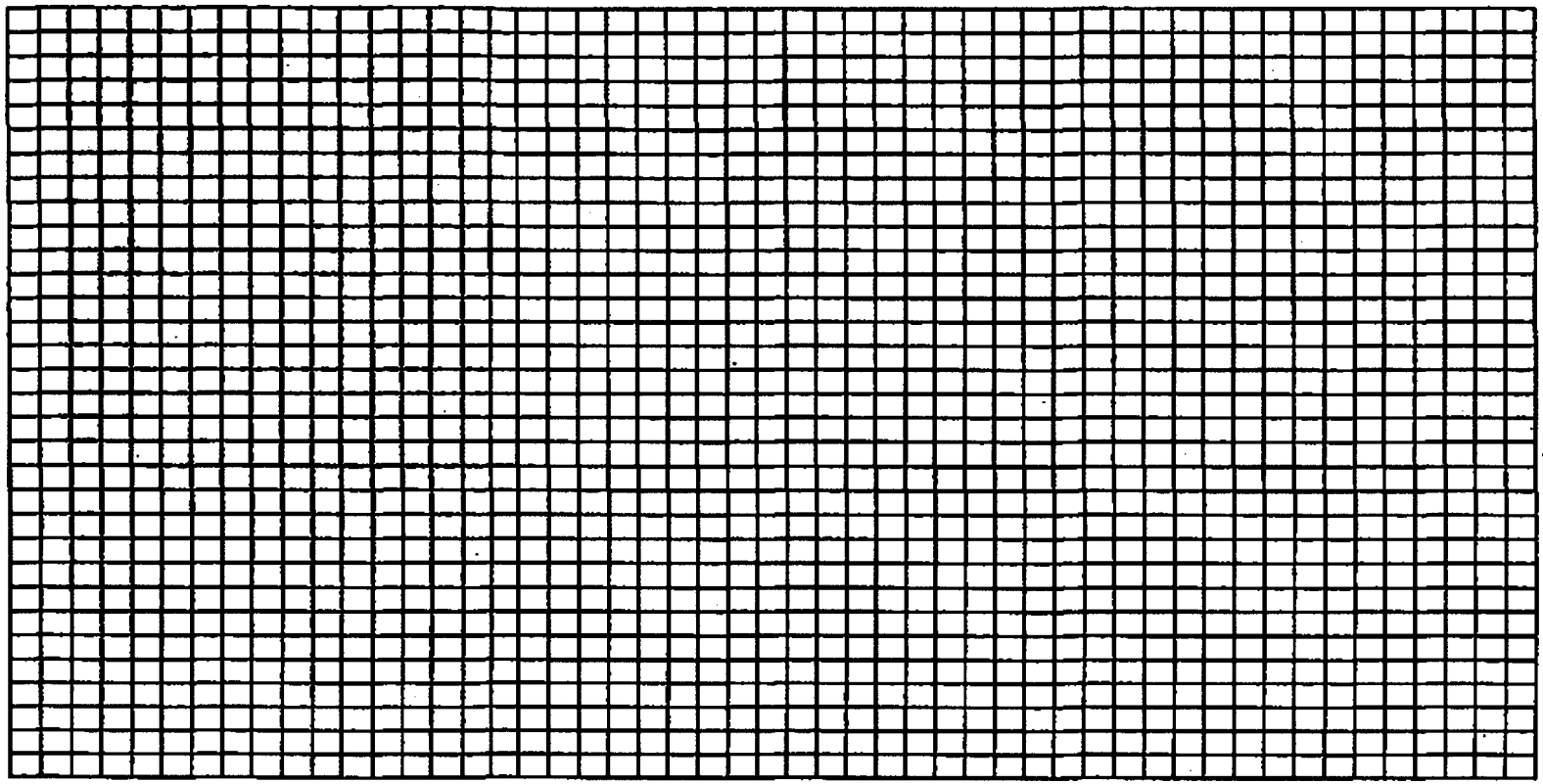
NOTES:

GARDEN PRESENT? _____	Yes	No
IN USE? _____	Yes	No
ADDRESS CONFIRMED BY RESIDENT? _____	Yes	No
WILLING TO ALLOW FURTHER SAMPLING? _____	Yes	No

Field Diagram:

N

DIRECTIONAL ARROW



scale: 1 grid = 1 pace (~ 3 ft)

Sub Area	No. of Grids	Relative Dist. Between Samples (RDBS)	No. of Flags in Sub Area No. of Grids divided by the RDBS	No. of Each Flag (10 of each)
1	_____		_____	Red _____
2	_____		_____	
3	_____	Total Grids divided by 30 =	_____	Blue _____
4	_____		_____	
5	_____	_____	_____	Yellow _____
6	_____		_____	
7	_____		_____	
8	_____		_____	
Total Grids:			Total Flags:	Equal to 30? Y N

Samples Collected by: _____ _____
Signature *Date*

Logbook Page Reviewed by: _____ _____
Signature *Date*

TECHNICAL STANDARD OPERATING PROCEDURE

Date: June 14, 1999 (Rev. # 0) SOP No. ISSI-VBI70-03

Title: RESIDENTIAL SOIL SAMPLING FOR ALLEYWAY SOILS

APPROVALS:

Author _____ISSI Consulting Group, Inc._____ Date: June 14, 1999

SYNOPSIS: A standardized method for residential alleyway surface soil sampling is described. Protocols for sample collection, and sample handling are provided.

Received by QA Unit:

REVIEWS:

TEAM MEMBER	SIGNATURE/TITLE	DATE
EPA Region 8	[illegible]	7/20/99
ISSI Consulting Group, Inc.	[illegible] for Bill Bratlin	7/21/99

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide a standardized method for residential alleyway surface soil sampling to be used by employees of USEPA Region 8 contractors/subcontractors supporting USEPA Region 8 projects and tasks. This SOP describes the equipment and operations used for sampling alleyway surface soils in residential areas which will produce data that can be used to support risk evaluations. Site-specific deviations from the procedures outlined in this document must be approved by the USEPA Region 8 Remedial Project Manager, or Regional Toxicologist prior to initiation of the sampling activity.

2.0 RESPONSIBILITIES

The Field Project Leader (FPL) may be an USEPA employee or contractor who is responsible for overseeing the residential yard and alleyway surface soil sampling activities. The FPL is also responsible for checking all work performed and verifying that the work satisfies the specific tasks outlined by this SOP and the Project Plan. It is the responsibility of the FPL to communicate with the Field Personnel regarding specific collection objectives and anticipated situations that require any deviation from the Project Plan. It is also the responsibility of the FPL to communicate the need for any deviations from the Project Plan with the appropriate USEPA Region 8 personnel (Remedial Project Manager, or Regional Toxicologist).

Field personnel performing residential alleyway soil sampling are responsible for adhering to the applicable tasks outlined in this procedure while collecting samples at residences.

3.0 EQUIPMENT

- Soil augers - Various models of soil augers are acceptable and selection of the specific brand and make of tool will be recommended by the contractor implementing the field work (Morrison Knudsen Corporation). Augers are usually made of stainless steel, and should be capable of retrieving a cylindrical plug of soil 2 inches in diameter and 2 inches long. In all cases the procedures recommended by the manufacturers should be followed with regard to use of the auger. Augers with disposable plastic sleeves may be employed to minimize the decontamination effort.

- Collection containers - plastic ziplock bags

- Trowels - for extruding the soil sample from the auger. May be plastic or stainless steel.

- Gloves - for personal protection and to prevent cross-contamination of samples. May be plastic or latex. Disposable, powderless.

- Field clothing and Personal Protective Equipment - as specified in the Health and Safety Plan.
- Field notebook -used to record progress of sampling effort and record any problems and field observations.
- Permanent marking pen - used to label sample containers.
- Three-ring binder book - to store necessary forms used to record and track samples collected at the VBI70 site. Binders will contain the Alleyway Data Collection Sheet, Site Diagram, and sample labels for each day.
- Measuring tape or pocket ruler -used to measure the length of soil core in the soil coring device.
- Trash Bag - used to dispose gloves and wipes.

4.0 SAMPLING PATTERN - ALLEYWAY SOIL

Currently, the relationship between a residence with elevated (>200 ppm) arsenic concentrations in yard soil and possible adjacent alleyways is not understood. For the purposes of this pilot investigation, a minimum of four and a maximum of six alleyway units located adjacent to a residence with elevated (>200 ppm) arsenic concentration will be identified and sampled. Priority will be given to locations where a composite has been collected for all or most of the properties in the study location, and where indoor dust samples have been collected. Grab samples will be collected in a pattern similar to that shown in Figure 1.

Prior to sampling the FPL will provide maps that identify the alleyways and individual sample locations. The map will be generated using GIS tool used to identify and document sample locations as well as provide the approximate dimensions of the alleyway and other landmarks. In the event that sample locations must be offset due to the presence of obstructions, the new location must be clearly marked on the map. Grab sample locations will be placed along a center transect of the selected alleyway and three samples will be collected across the alley (see Figure 1). Approximately 30 grab samples will be collected from the entire block. The three samples are located in the center and two sides of the alley where the two sides are about 2 feet from the property line of residences that border the alleyway.

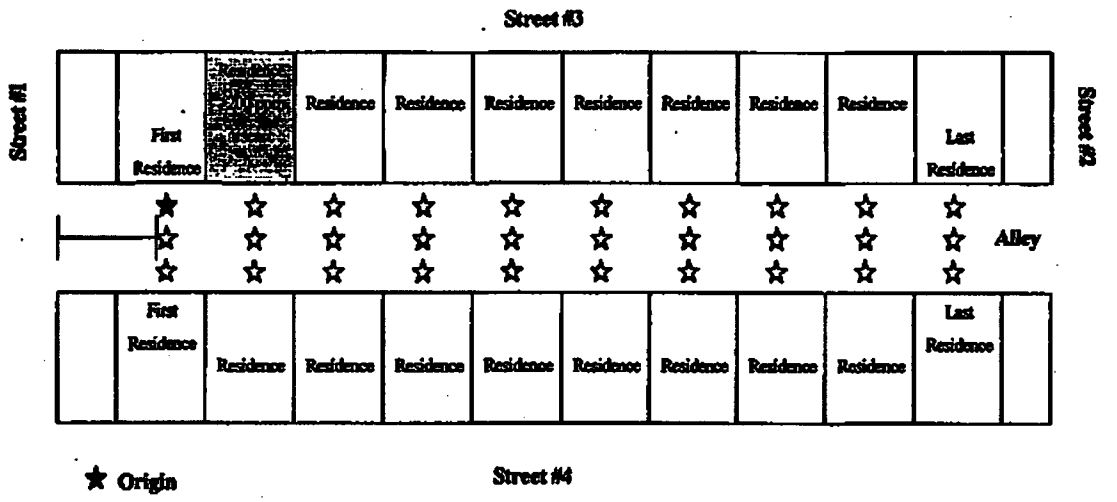


Figure 1 Idealized Alleyway Sampling Strategy

Grab samples will be collected from the 0-2 inch soil horizon and placed into a separate plastic ziplock bag. Each sample will be collected using a clean auger and trowel, and identified with a unique number ending with "-R" provided on the sample labels. One label is placed on the Alleyway Soil Collection Data Sheet (Attachment 1) and the other label is affixed to the zip-lock bag containing the sample. Sample labeling will occur as prescribed below:

- Place the red pre-printed label ending with the "-R" onto the zip-lock bag (See Sample Identification and Tracking SOP# ISSI-VBI70-01).
- Place the blue pre-printed label ending with the "-R" onto the Alleyway Soil Data Collection Sheet.
- Place the 30 grab samples into a larger (gallon size or larger) zip-lock bag that has been marked on the outside of the bag with the alleyway identification number with permanent marker.

5.0 COLLECTION OF SOIL SAMPLES USING A SOIL AUGER

A new pair of plastic gloves are to be worn at each sample point.

Place the soil coring tool on the ground and position it vertically. Holding the tool handle with both hands, apply pressure sufficient to drive the tool approximately 2 inches into the ground while applying a slight twisting force to the coring tool. Remove the tool by pulling up on the handle while simultaneously applying a twisting force. If the sample was retrieved successfully, a plug of soil approximately two inches long should have been removed with the coring tool.

Hold the soil coring tool horizontally or place it on the ground. Using a clean spatula or knife, remove the soil collected at depth greater than two inches from the end of the sampling tool. Allow this soil to fall into the plastic bucket designated for excess soil material. Use a trowel to extrude the soil from the auger, pushing the two-inch soil plug from the coring tool so that it falls directly into the zip-lock bag.

Care should be taken to avoid tracking soil from one area to another. As samples are taken sequentially, care should also be taken not to contaminate an area yet to be sampled with the residue of the sample that is currently being taken. In general one should move in a single direction through the sampling area. If an area is known or suspected of having a higher concentration of metals, all other considerations being equal, it should be sampled last to prevent cross contamination.

Decontaminate equipment as described in Section 9.0.

6.0 SAMPLE CONTAINERS AND LABELING

Following the procedures outlined in Section 5.0, grab samples will be collected directly into zip lock bags and labeled in accord with the most recent version of the Sample Identification and Tracking SOP (# ISSI-VBI70-01). Each sample must have a sample identification number affixed to the zip-lock bag, and also attached to the Alleyway Soil Data Sheet.

7.0 SITE CLEAN-UP

Each hole made in the yard using the auger must be backfilled with clean topsoil and tamped down lightly. If sod was removed to obtain the soil sample, the hole should first be backfilled and then the grass plug be replaced by the field personnel.

Rinse water used for sample decontamination that is generated in the course of sample collection must be disposed of as specified in the SOP for Investigation Derived Waste Management (MK-VBI70-04). Wherever possible, sod and soil (not collected and retained as part of the composite sample) should be replaced in the same hole.

All 30 flags (if reused) should be decontaminated by wiping off with towels and/or baby wipes before re-use.

Throw all used wipes and gloves into the trash bags and take with you to dispose of at the field office.

8.0 FIELD QUALITY ASSURANCE/QUALITY CONTROL

Adherence to quality assurance/quality control (QA/QC) procedures is an important part of field sample collection. Field QA/QC procedures include documentation requirements and

preparation of field QC samples.

8.1 Field Quality Control Samples

The following QC sample will be collected during alleyway soil sampling.

Field Duplicate: Field duplicate samples are co-located samples at a single grab sample location. These samples are submitted blind to the laboratory to test both the precision of the laboratory analysis and the precision of sample collection. Field duplicates are required to be collected at a frequency of 5% of all surface soil samples collected (1 field duplicate per 20 investigation samples collected).

8.2 Field documentation

A field notebook should be maintained by each individual or team that is collecting samples as described in the Project Plan. For each alleyway, the following information should be collected.

- date
- time
- personnel
- weather conditions
- a sketch of the sampling pattern that is filled in with sample identification numbers as the samples are collected
- locations of any samples that could not be acquired
- descriptions of any deviations to the Project Plan and the reason for the deviation

Samples taken from soils with visible staining or other indications of non-homogeneous conditions should be noted. Use the maps provided by the FPL or draw a diagram that details each alleyway. Sample locations and sample numbers should be identified on the diagram.

In addition, each field crew will maintain a three-ring binder book that has Alleyway Soil Data Sheets and sample labels needed for each day. At the end of the day, the field crew will submit these forms and check them in with the FPL at the time that the samples are checked in.

Field personnel will collect the proper type and quantity of quality control samples as prescribed in the Project Plan.

9.0 DECONTAMINATION

Because decontamination procedures are time consuming, having a quantity of sampling tools sufficient to require decontamination at a maximum of once per day is recommended. All sampling equipment must be decontaminated prior to reuse. Follow the procedures outlined in SOP No. MK-VBI70-07.

10.0 GLOSSARY

Project Plan - The written document that spells out the detailed site-specific procedures to be followed by the Project Leader and the Field Personnel.

Sample Point - The actual location at which the sample is taken. The dimensions of a sample Point are 2" in diameter and 2" deep.

11.0 REFERENCES

USEPA, 1995. Residential Sampling for Lead: Protocols for Dust and Soil Sampling, Final Report, EPA 747-R-95-001, USEPA, March 1995, 38 p.

American Society for Testing and Materials, 1995. Standard Practice for Field Collection of Soil Samples for Lead Determination by Atomic Spectrometery Techniques, ASTM Designation: E 1727 - 95, October 1995, 3 p.

ATTACHMENTS

Logbook DCN _____

ATTACHMENT 1
ALLEYWAY SOILDATA SHEET

PHASE: 3 MEDIUM: Alley Soil

DATE: _____ DEPTH: 0-2"

ALLEYWAY ID: _____ SAMPLE COLLECTION METHOD: ISSI-VBI70-03 Revision 0

SAMPLE TEAM ID: _____

INDEX	MAP POSITION	SAMPLE NO.	CLASS FS = Field Sample FD = Field Duplicate	SAMPLE TYPE (circle one)
1			FS FD	COMP GRAB
2			FS FD	COMP GRAB
3			FS FD	COMP GRAB
4			FS FD	COMP GRAB
5			FS FD	COMP GRAB
6			FS FD	COMP GRAB
7			FS FD	COMP GRAB

ALLEY ID: _____

INDEX	MAP POSITION	SAMPLE NO.	CLASS FS = Field Sample FD = Field Duplicate	SAMPLE TYPE *(circle one)*
8			FS FD	COMP GRAB
9			FS FD	COMP GRAB
10			FS FD	COMP GRAB
11			FS FD	COMP GRAB
12			FS FD	COMP GRAB
13			FS FD	COMP GRAB
14			FS FD	COMP GRAB
15			FS FD	COMP GRAB

ALLEY ID: _____

INDEX	MAP POSITION	SAMPLE NO.	CLASS FS = Field Sample FD = Field Duplicate	SAMPLE TYPE *(circle one)*
16			FS FD	COMP GRAB
17			FS FD	COMP GRAB
18			FS FD	COMP GRAB
19			FS FD	COMP GRAB
20			FS FD	COMP GRAB
21			FS FD	COMP GRAB
22			FS FD	COMP GRAB
23			FS FD	COMP GRAB

ALLEY ID: _____

INDEX	MAP POSITION	SAMPLE NO.	CLASS FS = Field Sample FD = Field Duplicate	SAMPLE TYPE *(circle one)*
24			FS FD	COMP GRAB
25			FS FD	COMP GRAB
26			FS FD	COMP GRAB
27			FS FD	COMP GRAB
28			FS FD	COMP GRAB
29			FS FD	COMP GRAB
30			FS FD	COMP GRAB

ALLEY ID: _____

INDEX	MAP POSITION	SAMPLE NO.	CLASS FS = Field Sample FD = Field Duplicate	SAMPLE TYPE *(circle one)*	ORIGINAL SAMPLE NO.
31			FS FD	COMP GRAB	
32			FS FD	COMP GRAB	
33			FS FD	COMP GRAB	

Samples Collected by: _____ Signature _____ Date

Logbook Page Reviewed by: _____ Signature _____ Date

TECHNICAL STANDARD OPERATING PROCEDURE

Date: June 28, 1999 (Rev. # 0) SOP No. ISSI-VBI70-04

Title: HIGH VOLUME INDOOR DUST SAMPLING AT RESIDENCES FOR DETERMINATION OF RISK-BASED EXPOSURE TO METALS

APPROVALS:

Author ISSI Consulting Group, Inc. Date June 28, 1999

SYNOPSIS: A standardized high-volume vacuum method for collection of indoor dust at residences is described. This method is suitable for measurement of either contaminant concentration (mg/kg) or contaminant loading (mg/m^2) in indoor dust.

Received by QA Unit:

REVIEWS:

TEAM MEMBER	SIGNATURE/TITLE	DATE
USEPA Region 8	[illegible]	7/20/99
ISSI Consulting Group, Inc.	W J Brattin	7/21/99

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to provide a standard approach for collection of interior surface dust samples within a residence. The SOP includes a description of the equipment and methods to be used. This protocol will be implemented by employees of USEPA Region 8 or contractors and subcontractors supporting Region 8 projects and tasks.

2.0 RESPONSIBILITIES

The Field Project Leader (FPL) is responsible for ensuring that all dust samples collected are obtained in accord with the procedures specified in this SOP. The FPL may be an USEPA employee or an USEPA contractor. The FPL is responsible for training all Field Personnel in the methods and techniques specified in this SOP and for checking that all work performed satisfies the specific tasks outlined by this SOP and the Project Plan. It is the responsibility of the FPL to identify any deviations from the SOP that may be required and to obtain approval for these deviations from the USEPA Region 8 Remedial Project Manager, Regional Toxicologist, or Field Quality Assurance Coordinator prior to initiation of any sampling activities that are not in accord with this SOP.

3.0 DUST COLLECTION PROTOCOL

3.1 Overview

This protocol is for collection of dust samples from interior surfaces using a high-volume vacuum method. The sampling method is based on the method of Roberts et al. (1989, 1991, 1994) and Stamper et al. (1990), and is presented in ASTM's *Standard Practice for Collection of Dust from Carpeted Floors for Chemical Analysis* (ASTM 1993). The protocol is suitable for the collection of interior dust samples from either hard or smooth and highly textured surfaces, such as brickwork and rough concrete, and soft, fibrous surfaces, such as upholstery and carpeting.

At the VBI70 site, one dust sample will be collected at each residence. This sample will be a composite of dust collected from multiple different sub-locations within the residence. At each sub-sampling location, dust is withdrawn from the surface area by means of a flowing air stream passing through a sampling nozzle at a specific velocity and flow rate. Dust is separated from the air mechanically by a cyclone and is collected in a catch bottle attached to the bottom of the cyclone. The cyclone collects particles approximately 5-µm mean aerodynamic diameter and larger. The collected sample is substantially unmodified by the sampling procedure.

3.2 SAMPLING EQUIPMENT

3.2.1 Sampling Apparatus

The sampling apparatus may be acquired commercially [CS_3 model HVS3] (see Figure 1) or constructed. The dimensions of the sampling apparatus (nozzle size, cyclone diameter, cyclone inlet diameter, etc.) are interdependent. The flow rate must produce a sufficient velocity both at the sampling surface and in the cyclone. The cyclone must have a cut diameter of 5 µm at the same velocity that will provide a horizontal velocity of 40 cm/s at 10 mm from the nozzle in the carpet material. The fundamental principles of this device have been discussed in Roberts et al. (ASTM 1994).

- **Nozzle** – The edges and corners of the sampling nozzle shall be rounded to prevent catching any carpeted material. The nozzle must be constructed to allow for sufficient suction to separate loose particles from the carpet and carry them to the cyclone. It must have an adjustment mechanism to establish the nozzle lip parallel to the surface and to achieve the proper suction velocity and pressure drop across the nozzle. A nozzle 12.4 cm long and 1 cm wide, with a 13-mm flange and tapered to the nozzle tubing at no more than 30°, will yield the appropriate velocities when operated as specified.

- **Gaskets** – Gaskets in joints should be of a material appropriate to avoid sample contamination.

- **Cyclone** – The cyclone shall must be constructed such that air flow allows for separation of particles 5-µm mean aerodynamic diameter and larger. The cyclone must be made of aluminum or stainless steel.

- **Catch Bottle** – The catch bottle must be either a 500-mL amber glass jar (Fisher Scientific Cat. No. 03-320-4C) or 500-mL fluorinated ethylene propylene (FEP) bottle (Fisher Scientific Cat. No. 03-312-22) to avoid contamination and allow the operator to see the sample.

- **Flow Control System** – The flow control system shall allow for substantial volume adjustment. The suction source must be capable of drawing 12 L/s through the system with no restrictions other than the nozzle, cyclone, and flow control system connected. A commercial vacuum cleaner can be used for this purpose.

- **Flow Measuring and Suction Gages** – The use of Magnehelic gages for measurement of the pressure drop at the nozzle and for control of the flow rate for the entire system is considered adequate and applicable for this sampling practice.

3.2.2 Other Equipment

- Stop Watch
- Disposable Gloves
- Trash bag for disposing of wipes, gloves
- 50 cm long x 3 cm diameter brush for decontamination of the apparatus
- 500-mL squeeze bottle with analyte-free deionized water
- 500-mL squeeze bottle with soapy (e.g., Liquinox) analyte-free water
- Wipes
- Masking tape and marking pen
- Sieve – 150 µm mesh; #100 sieve must be either stainless steel or plastic
- Analytical balance – accurate to 0.1 g; weighing range of 0.1 mg to 1000g
- Template (2 ft x 2 ft [4 ft^2])

3.2.3 Reagents and Materials

Any chemicals used for decontamination must be reagent grade or better.

3.3 Preparation and Calibration

Preparation - Clean the wheels and nozzle lip with a clean laboratory tissue immediately before sampling. The sampling train shall be inspected to ensure that it has been cleaned and assembled properly. The sampling train shall be leak-checked prior to sampling. This can be accomplished by placing a mailing envelope or a piece of cardboard beneath the nozzle and switching on the suction source. The flow Magnehelic gage should read 5 Pa (0.02 in. H_2O) or less. If any leakage is detected, the system shall be inspected for the cause and corrected before use.

Calibration-The sampling strategy described in this practice does not have any calibrated flow devices other than the cyclone and the Magnehelic gages. The cyclone used for the separation of the particles must be designed to give proper separation at varying flow rates throughout the sampling range of the system. The pressure gages and any other devices (that is, temperature gage) used for testing purposes should be calibrated against a primary standard. Adjust the flow rate and nozzle pressure drop to values that approximate those given in Section 3.6.

- Pressure Gages – Pressure gages shall be calibrated against an inclined manometer or other primary standard at the beginning of each day. One means of checking a Magnehelic gage is to set a flow rate through the sampling system with a manometer and then switch to the Magnehelic gage. If the difference in the readings is more than 3%, the gage is leaking or is in need of repair or calibration. This should be done at two different flow rates when checking the gage.

3.4 Sample Label and Field Data Sheet

Before beginning the dust collection protocol within a residence, first attach a pre-made site-specific sample identification label to a clean dust collection bottle and attach the bottle to the sampling device. Then attach the corresponding pre-made sample identification number to the field data sheet for that sample (see SOP ISSI-VBI70-01). This field data sheet is presented in Figure 2. On the data sheet, fill in the appropriate information on the sampling team, date, residence address, etc. As sampling progresses, record the location of each template collected on the field data sheet.

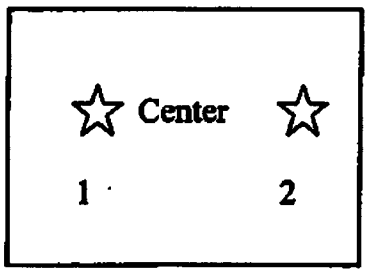
3.5 Sampling Locations within the Residence

A single composite of dust will be collected on the floor at each residence (e.g., dust will not be collected from windowsills, furniture, etc.). This composite will be composed of dust collected from a number of sub-sampling locations, identified as below. All sub-samples will be collected in rooms or other living areas ("living spaces") where the residents are most likely to be exposed. This includes bedrooms, family and/or television rooms, kitchens, hallways and entryways.

In most cases, two templates will be collected per living space. Thus, the total number of sub-samples collected within a residence will be dependent upon the number of living spaces available. In the case where a residence has more than 10 living spaces, only 1 template per living space will be collected. This approach is recommended so that 20-30 sub-samples are not collected for a large residence.

Sub-sample locations within a living space (living space sample points) should focus on areas with the greatest potential for exposure. This is typically along the center axis of the living space. Corners of rooms, areas beneath furniture, etc., are not likely to be high exposure areas (even if especially dusty) and will not be sampled. A typical pattern of template locations within a living space is illustrated below:

Living Space



If obstructions are present at locations described above, the sub-sample location may be off-set accordingly, the new location noted in the field logbook and sample collected in accordance with this SOP.

3.6 Sampling Procedure

At each sub-location within the house to be sampled (see below), place the template on the sampling surface. If needed, use masking tape to temporarily hold the template to the surface so the template does not move during sampling. Turn on the vacuum and place the nozzle in one corner of the sampling area, then adjust the flow rate and pressure drop according to the type of surface. For hard surfaces or level loop carpet, the flow rate should be adjusted to at least 7.8 L/s (18 cfm), and the nozzle drop should be at least 2.2 kPa (9 in. H_2O). For plush or shag carpet, the flow rate must be at least 9.5 L/s (20 cfm), and the nozzle pressure drop must be at least 2.5 kPa (10 in. H_2O). The two factors that affect the efficiency of the sampling system are the flow rate and pressure drop at the nozzle. The pressure drop at the nozzle is a function of the flow rate and distance between the surface and the nozzle flange.

Begin sampling by moving the nozzle along one edge of the sampling area template. Move the nozzle at approximately 0.5 m/s back and forth <u>four times</u> along the edge. Then move the nozzle inward at a distance equal to the sampling width of the nozzle and make four passes parallel to the edge of the template. Repeat this strip-by-strip collection pattern until the entire template area has been covered.

Switch off the vacuum and move to the next sampling sub-location within the residence. Repeat the process at each sub-location. When all sub-locations within the residence have been sampled, the catch bottle can be removed, labeled, and capped for storage and analysis in accord with the Project Plan.

3.7 Decontamination – Sampler Cleaning

After all sub-samples have been collected at a residence, the sampling equipment must be thoroughly decontaminated before beginning sampling at the next residence. With the sample collection bottle removed and safely stored, open the flow control valve to maximum flow, tip the sampler back so that the nozzle is approximately 5 cm (2 in.) off the floor, and switch the vacuum on. Place a hand covered by a rubber glove on the bottom of the cyclone and alternate closing and opening the cyclone for 10 seconds to free any loose material adhering to the walls of the cyclone and tubing. It is not necessary to catch this small amount of dust, as it is usually much less than 1% of the collected sample.

Remove the sampler to a well-ventilated cleaning area free of dust. Remove the cyclone and elbow at the top of the nozzle tubing from the sampler. Use a 50-cm long by 3-cm diameter (20 by 1.25-in.) brush to clean the nozzle, and clean all related items up to and including the cyclone and catch bottle. Cleaning should begin by first rinsing with the soapy water solution and then triple rinsing with deionized water that has been certified lead and arsenic free. Allow all equipment to air dry. The equipment must be completely dry before sampling again. The dry brushing and wet cleaning is performed to prevent contamination from passing from one sample to another. An equipment blank will be collected after every 20 decontaminations. Equipment blank sample collection is described in the QC section (Section 6.2).

3.8 Prevention of Cross-Contamination

The following work practices should be followed to prevent cross-contamination of samples:

- Avoid disturbing and tracking dust from one location to another by identifying and clearly marking all sampling locations upon arrival at the sampling site, avoiding walking through or over any of the marked sampling location areas, and instructing field team members to pull on new disposable shoe covers upon each entry into the building (this is especially significant if field teams have been walking through known exterior contamination sources).
- Use a new pair of powderless gloves at each sampling location.
- Inspect all sampling equipment for cleanliness prior to collection of each sample.
- Do not open sample collection containers until needed to collect each sample.
- Immediately remove and dispose of gloves when sampling is complete.

5.0 SAMPLE STORAGE AND ANALYSIS

5.1 Sample Storage

After collection of the sample in the catch bottle, the bottle should be tightly capped, the security of the sample identification number checked, and the bottle placed in an appropriate storage container. Storage at ambient temperature for up to 180 days is appropriate for samples that will be analyzed only for metals.

5.2 Sample Preparation

Before analysis, each dust sample will be sieved to remove large non-dust material (hair, fibers, objects, etc.). Sieve the samples thorough a #100 mesh screen to isolate particles that are 150 µm or smaller. After sieving, weigh the sieved material to an accuracy of ± 0.1g. This weight will be reported by the laboratory so that loading data may be determined. For field blanks, little or no measurable dust mass is expected to be obtained. To identify any potential systematic contamination that may occur during sample collection, equipment blanks will be collected instead, as described in Section 6.2. After decontamination, deionized water will be collected from the collection bottle, and submitted to the laboratory for analysis. Equipment blank samples should be prepared and analyzed as standard aqueous samples.

5.3 Sample Analysis

The analytes of interest for indoor dust are arsenic and lead. Because the mass of dust collected from a residence is often too low to support reliable quantification by XRF techniques, samples will be digested using nitric acid (SW-846 method 3050 or 3051) and analyzed using standard USEPA protocols via either graphite furnace atomic absorption (GFAA), Inductively Coupled Plasma/Mass Spectrometry (ICP/MS), or ICP-trace instrumentation, providing the following method detection limits are achieved:

Arsenic	1.0 mg/kg
Lead	5.0 mg/kg

6.0 FIELD QUALITY ASSURANCE/QUALITY CONTROL

Adherence to quality assurance/quality control (QA/QC) procedures is an important part of field sample collection. Field QA/QC procedures include documentation requirements, and field QC samples.

6.1 Documentation Requirements

All field documentation requirements are included in the Indoor Dust Data Sheet (see Figure 2). Each sampling team must ensure that all required items are recorded on this field data sheet, that the sample number is firmly affixed, and that any deviations from the SOP are noted on the sheet.

6.2 Field QC Samples

Equipment blanks. Equipment blank samples are used to identify any potential systematic contamination due to improper decontamination during field collection activities. Equipment blanks should be collected after performing the appropriate equipment decontamination procedures (Section 3.7). Equipment blank samples will be collected at a frequency of 5% (1 equipment blank per 20 decontaminations). These samples are collected by drawing 100-120 mL of analyte-free water through the decontaminated high-volume vacuum apparatus and collecting the rinsate into a clean catch bottle.

Blind Standard (Reference Material) Samples. Blind standard will be submitted to the laboratory to determine the accuracy of metals analysis using this sample collection method. These QC samples will be submitted blindly to the laboratory at a frequency of 20% (1 blind standard per 20 field samples).

7.0 REFERENCES

American Society for Testing and Materials (ASTM). 1994. Standard Practice for Collection of Dust from Carpeted Floors for Chemical Analysis. ASTM Designation: D5438-93. September.

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USEPA. 1996. Sampling Manual for IEUBK Model. Prepared by Roy F. Weston. Document control number 4800-045-0019.

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Roberts, JW and MG Ruby. 1989. *Development of a High Volume Surface Sampler for Pesticides*, U.S. Environmental Protection Agency Report No. EPA 600/4-88/036, Research Triangle Park, N.C. January 1989.

Stamper, VR, et. al. 1990. *Development of a High Volume Small Surface Sampler for Pesticides and Toxics in House Dust*, Research Triangle Park, N.C. June 1990. Included in supporting data, which are on file at ASTM Headquarters Request RR:D22-1010.

Figure 1

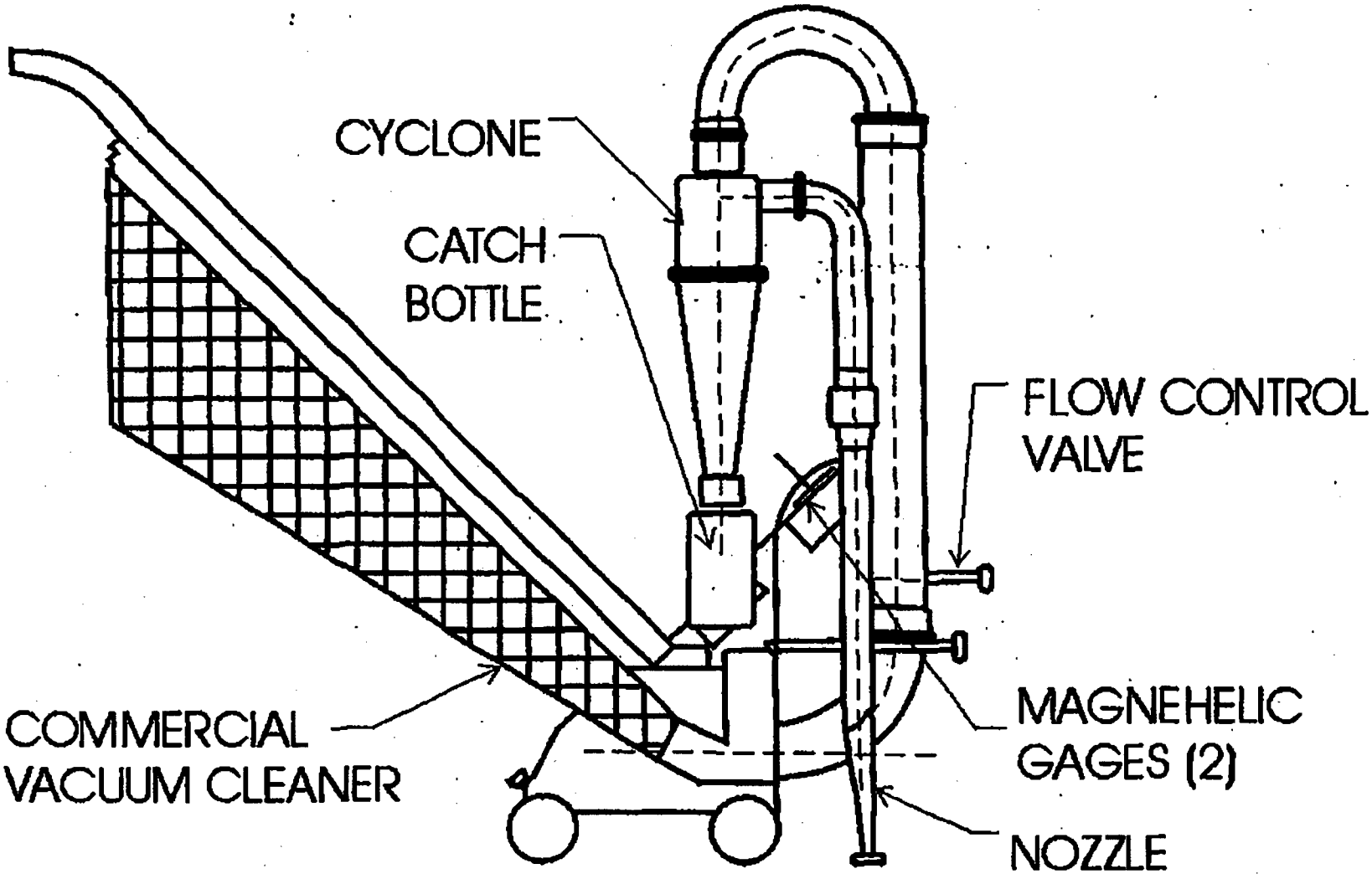


Figure 1: Dust sampler using a commercial vacuum cleaner as the suction source.

Figure 2

Logbook DCN _____

FIGURE 2
INDOOR DUST
DATA SHEET

PHASE: 3

MEDIUM: INDOOR DUST

COLLECTION METHOD: ISSI-VB170-04 Revision 0

DATE: _____

SAMPLE TEAM ID: _____

ADDRESS: _____
House# *Street Name*

CLASS: FS (Field Sample)
EB (Equipment Blank)

SAMPLE TYPE: COMP
GRAB

TEMPLATE SIZE: 4 ft^2

SAMPLE NO.:

TEMPLATE COLLECTION LOCATIONS:

Number	Living Area (a)	Surface Type (b)	Notes
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			

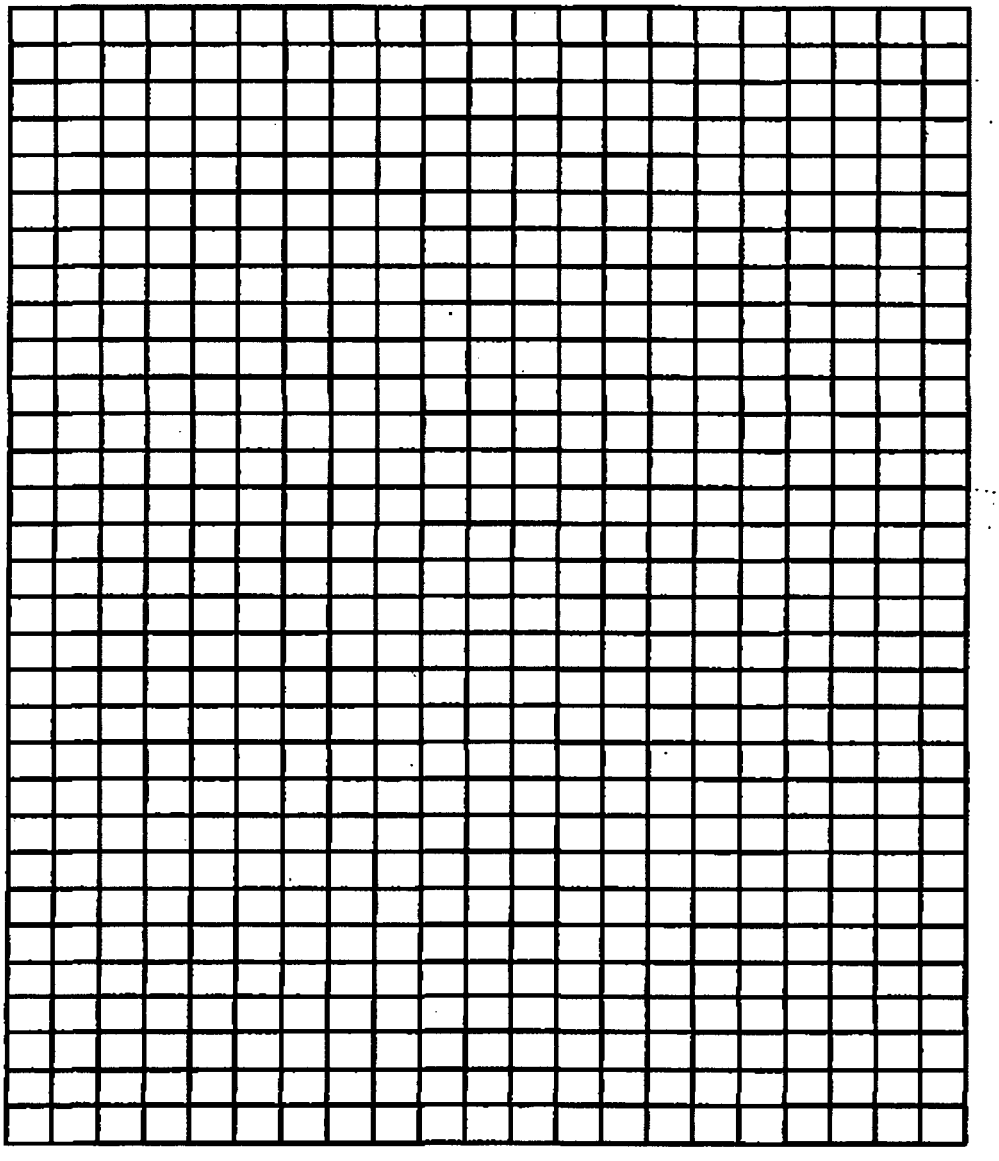
(a) Living Area Codes:
BR = bedroom
FR = family room / living room
K = kitchen
D = dining / eating area
H = hall way
E = entry way
O = other (note which)_____

(b) Surface Types:
H = hard (linoleum, stone, wood, etc.)
S = soft (carpet, rug, etc.)
O = other (note which)_____

Master Logbook Page _____

Figure 2 (cont.)

Field Diagram:



Samples Collected by: _____ _____
Signature *Date*

Logbook Page Reviewed by: _____ _____
Signature *Date*

TECHNICAL STANDARD OPERATING PROCEDURE

Date: July 22, 1999 (Rev. # 0) SOP No. ISSI-VBI70-05

Title: DATA ENTRY

APPROVALS:

Author ISSI Consulting Group, Inc. Date July 22, 1999

SYNOPSIS: Protocol for entering field data sheets, results of laboratory analysis and related field sampling documentation into the project database.

Received by QA Unit:

REVIEWS:

TEAM MEMBER	SIGNATURE/TITLE	DATE
USEPA Region 8	[illegible] / RPM	8/5/99
ISSI Consulting Group, Inc.	[illegible] / FQAC For Doug Weiner	8.5.99

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to provide a standard method for entering field observations and results of laboratory analysis into the project database. Sources of these data include field data sheets, laboratory preparation logsheets, laboratory analytical results, and sample chain-of-custody forms generated during execution of the VBI70 Phase III site investigation. This protocol will be implemented by employees of USEPA Region 8 or contractors and subcontractors supporting Region 8 projects and tasks.

2.0 RESPONSIBILITIES

Individual and organizational responsibilities for data management personnel are described in the Data Management Plan.

The Field Activities Database Manager is responsible for overseeing the accurate and complete population and maintenance of the computerized database used to electronically store and process data obtained during field collection activities. The Field Activities Database Manager is responsible for verification of electronic data entry and maintenance of hard copy forms and logbooks. The Field Activities Database Manager is also responsible for implementation of the electronic database and document security.

Technical difficulties encountered or questions regarding the operation of database applications software are directed to the Project Database Manager. It is also the responsibility of the Project Database Manager or designee to schedule and perform installation and training for the project data entry prior to the initiation of field activities. Subsequent installation, upgrades and training may be necessary to address future project requirements and system enhancements.

It is the responsibility of the Field Activities Database Manager to identify any deviations from the SOP that may be required and to obtain approval for these deviations from the USEPA Region 8 Remedial Project Manger or the USEPA Technical Contact for Data Management/GIS prior to initiation of any data entry activities that are not in accord with this SOP.

3.0 DATABASE MANAGEMENT SYSTEM

3.1 Overview

A client-server database system is utilized for the management of Phase III data. The project database is stored and maintained on an MS SQL Server database system (server) located in the ISSI Denver office. Wide area network access to the project database is provided via TCP/IP communications (Internet). Data entry and reporting are performed using a custom MS Access interface (client) developed by ISSI and tailored specifically for the Phase III investigation. A detailed overview of the project database is presented in the Data Management Plan.

3.2 System Requirements

Software:	MS Access 97 SQL Server Client Software (ISSI Provided)
Operating System(s):	MS Windows 95 / MS Windows 98 / MS Windows NT
Hardware Requirements:	Pentium Grade PC 16MB Random Access Memory (Minimum RAM) Super VGA video resolution (800 x 600) 50MB Hard Disk Space
Internet Communications:	Internet Service Provider (ISP) 56kb or faster communications rate

Table 1 – System Requirements

3.3 Installation

The Project Database Manager will coordinate with the Field Activities Database Manager to schedule installation and remote site testing of the data entry and reporting interface. Installation and testing of the database client interface will be performed by the Project Database Manager or designee prior to initiation of field sampling and data collection activities.

3.4 Training

The Project Database Manager will coordinate with the Field Activities Database Manager to schedule training for data management personnel. Training will be performed prior to initiation of field sampling and data collection activities.

4.0 DATA ENTRY PROTOCOL

4.1 Overview

This protocol is to be used for entering data from field data collection sheets, laboratory preparation logsheets, results of laboratory analysis, and information contained on the chain-of-custody form into the project database. Specifically, this SOP addresses entering data from the following data sources:

- Surface Soil Data Sheets
- Alleyway Soil Data Sheets
- Indoor Dust Data Sheets
- Field Sample Preparation Logbook Sheets

Additional data may be entered from the hardbound notebooks maintained by the field sampling crews.

At the completion of each day's sample collection activities, the field data sheets are screened for legibility and completeness by the Field Project Leader or designate. Following verification the field forms and copies of the associated chain-of-custody forms are forwarded to the appropriate Field Activities Database Manager for entry into the project database. The Data Entry Clerk enters the information contained on the forms into the project database and generates a hard copy report of the newly entered data. The hard copy report is then verified for accuracy in accordance with the protocol described in Section 5.8 of the Data Management Plan. Data entry verification reports are stored as described in Section 5.9 of the Data Management Plan.

Results of laboratory analysis may be imported electronically into the project database, or alternatively, manually entered from hard copy laboratory reports. Analytical results should be transferred or entered as soon as results are available. Electronically imported data records are verified for accuracy in accordance with Section 5.8 of the Data Management Plan.

4.2 SQL Server Login

The database client interface is initiated by double clicking on the VBI70 Database icon. The user is prompted for a SQL Server Login ID and password. Login IDs and passwords for data management personnel will be provided on request by the Project Database Manager.

4.3 Menu Operation

A menu system is provided to assist users in navigating through the data entry and reporting interface (Figure 1). Menu items that reference sub-menus are denoted with a right-arrow symbol (=>).

Data entry screens are accessed by selecting the "Data Maintenance" menu option from the Main Menu. To navigate the menu, use the up and down arrow keys to highlight the menu choice and press the <Enter> key, or position and click the mouse pointer over the menu selection.

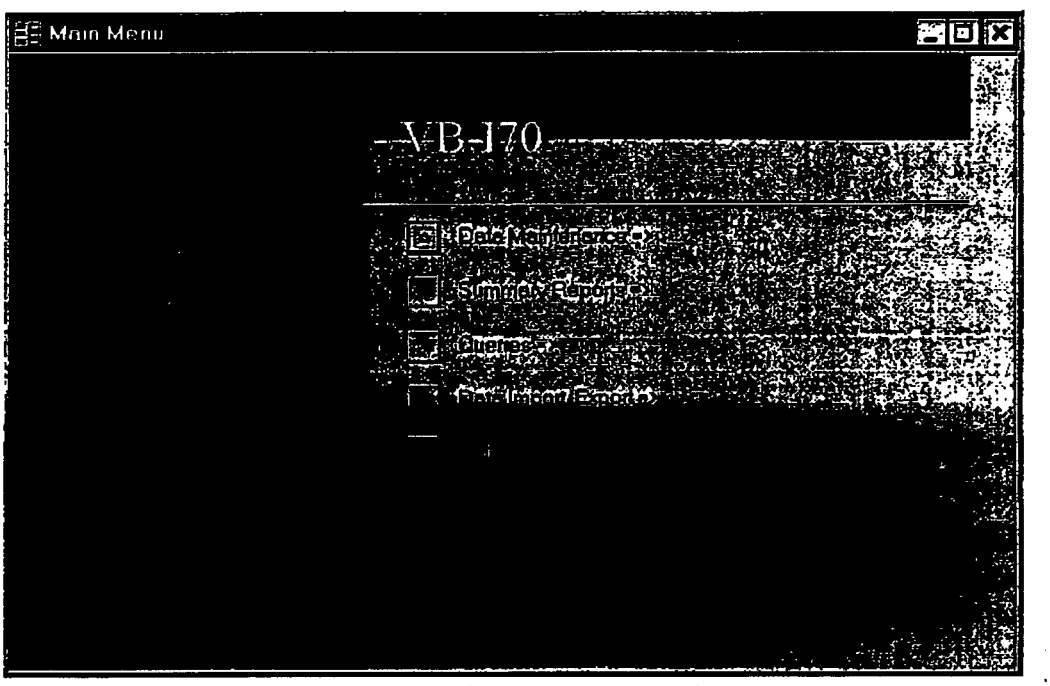


Figure 1 – Main Menu

4.4 Entering Field Data Sheets

The VBI70 database interface utilizes standard MS Access conventions for entering, finding, filtering, and viewing data. Please refer to the MS Access software documentation for a complete reference of keyboard shortcuts and application functionality.

Data entry screens are arranged to prompt for information in the same order as the information is recorded on the field data sheets. A typical data entry screen (Property Surface Soil Samples) is presented in Figure 2.

Drop-down Fields

Certain data entry fields are restricted to a valid list of values. These fields are identified by a small down-arrow located at the right hand side of the data field. To enter a valid value in one of the drop-down fields, enter the appropriate code and then press the <Tab> key to move the cursor to the next field. To display a full list of valid values, mouse click on the small down-arrow located at the right end of the drop-down field.

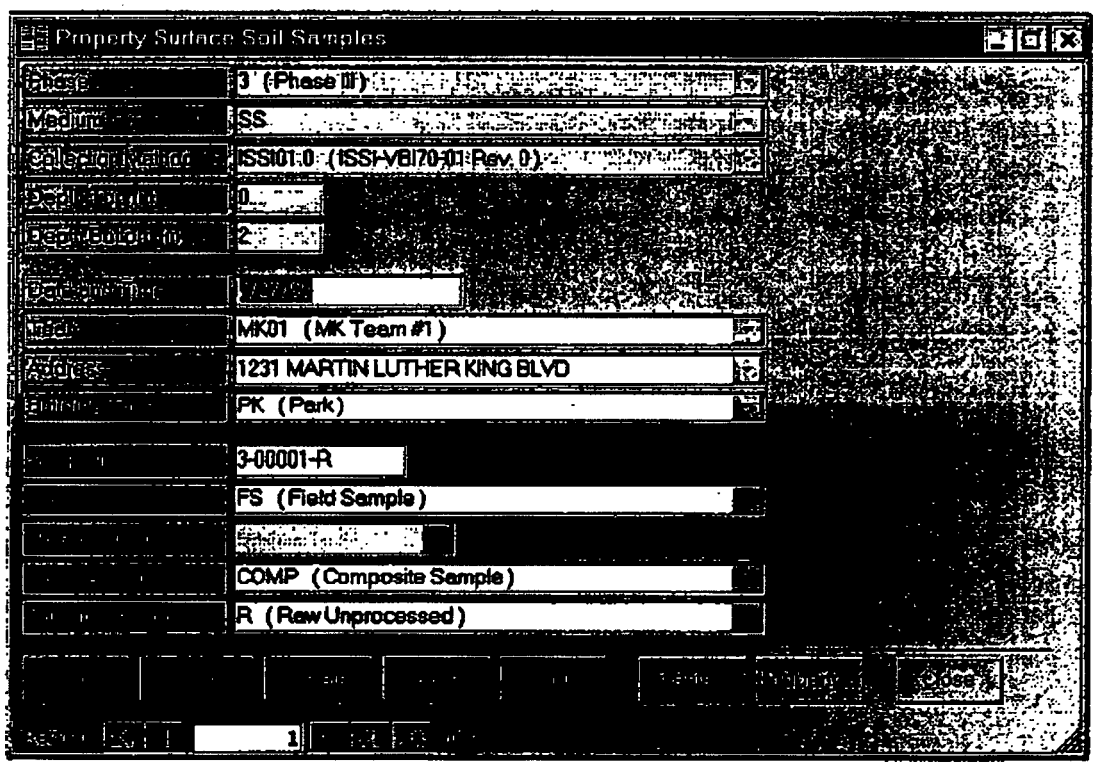


Figure 2 – Surface Soil Data Entry Screen

For example: to enter a "composite" sample type, type the code "CP" in the sample type field and press enter, or select "Composite" from the drop-down list. After entering a valid code, both the code and code description are displayed in the entry field for clarity.

Fields with a light gray background appearance are "Read Only" fields, meaning that the data displayed in the field cannot be changed.

The footer or bottom-most section of the form contains a set of command buttons. The following standard conventions apply to the Surface Soil, Alleyway Soil and Indoor Dust data entry screen command buttons:

[Add] - Appends a new sample.

[Add Next] - The database is organized with one data record for each sample. Surface Soil and Alleyway data sheets are designed to record more than one sample per data sheet. The [Add Next] command button is provided as a convenient way to carry over common sample information to the next data record. The cursor is then positioned on the Sample Number field of the new data record for entering the next sample number of the set.

[Delete] - Deletes the current sample record. Sample records cannot be deleted if Test or Laboratory Results information exists for the sample.

[Save] -Saves changes to the data record. Changes are automatically saved when a new record is added.

[Undo] -If changes haven't been saved, the [Undo] command button will restore the data entry fields to their initial state.

[Tests...] - Launches laboratory data entry screens. Entering laboratory information is described in following sections.

[Close] - Exits the data entry form and returns control to the menu system.

4.5 Valid Value Reference Tables

The valid value reference, or "lookup" tables may be accessed from the Main Menu by selecting "Data Maintenance =>", "Lookup Tables =>" and then either "Field Data Lookup Tables =>" or "Laboratory Data Lookup Tables". Certain lookup tables may only be accessed for **read-only** purposes. Additions or changes to the read-only valid

values may be requested by submitting a Data Amendment/Correction Form to the Data Services Manager as described in Section 5.8 of the Data Management Plan.

4.6 Entry of Surface Soil Data Sheets

From the Main Menu, select "Data Maintenance =>", "Property Sampling =>", "Add/Edit Surface Soil Samples".

The following information is entered from the Surface Soil Data Sheet for each sample collected:

Field Name	Data Entry Instructions
Phase	Defaults to code "3", Phase III Sampling
Medium	Defaults to code "SS", Surface Soil Sampling
Sample Collection Method	Defaults to "ISSI-VBI70-02 Rev. 1"
Depth Top (in)	Defaults to 0"
Depth Bottom (in)	Defaults to 2"
Sample Date and Time	Enter the Sampling Date. Sample Time is optional. Entry Format: MM/DD/YY 24:00
Sample Team ID	Valid value list
Address	Valid value list
Building Type	Valid value list
Sample Number	Enter the Sample Number
Class	Defaults to "FS" for yard soil samples
Parent Sample	Not required for Class "FS". Indicates the sample number associated with a duplicate field QC sample.
Sample Type	Defaults to "COMP" for composite samples
Sample Fraction	Defaults to "R" for raw samples

The Surface Soil Sample data entry screen has an additional command button labeled [Property...]. This button calls up the Property Access Agreement record for the selected property address. The purpose of this button is to record answers to the following questions posed on the Surface Soil Data Sheet:

- Is there a garden present?
- Is the garden currently in use?
- Has the address been confirmed by the resident?
- Is the resident willing to allow further sampling?

After completing the entry of all sample information, select the [Tests...] command button. Enter the requested analyses as described in the following section.

Select the [Add Next] command button to carry over information to the next sample collected at the same address, or select the [Add] command button to enter data for a new property address. Select the [Close] button to return to the menu system.

4.7 Entry of Tests (Required Analysis) Information

Data entry screens for samples of each medium include a command button to access the analytical requests (tests) and analytical results information. Analytical requests are listed for each sample on the sample chain-of-custody form. Select the [Tests...] command button to enter analytical requests. The data entry screen for entering laboratory analyses and results information is presented in Figure 3.

Create one entry for each laboratory analysis required as indicated on the sample chain-of-custody form. For example, enter test "XRF-MK" to select the "As and Pb by XRF" analytical request.

For each laboratory analysis required, enter the chain-of-custody ID and select the appropriate laboratory ID.

All other information will be entered and provided by the laboratory performing the analysis. Select the [Close] button to save the information and return to sample data entry screen.

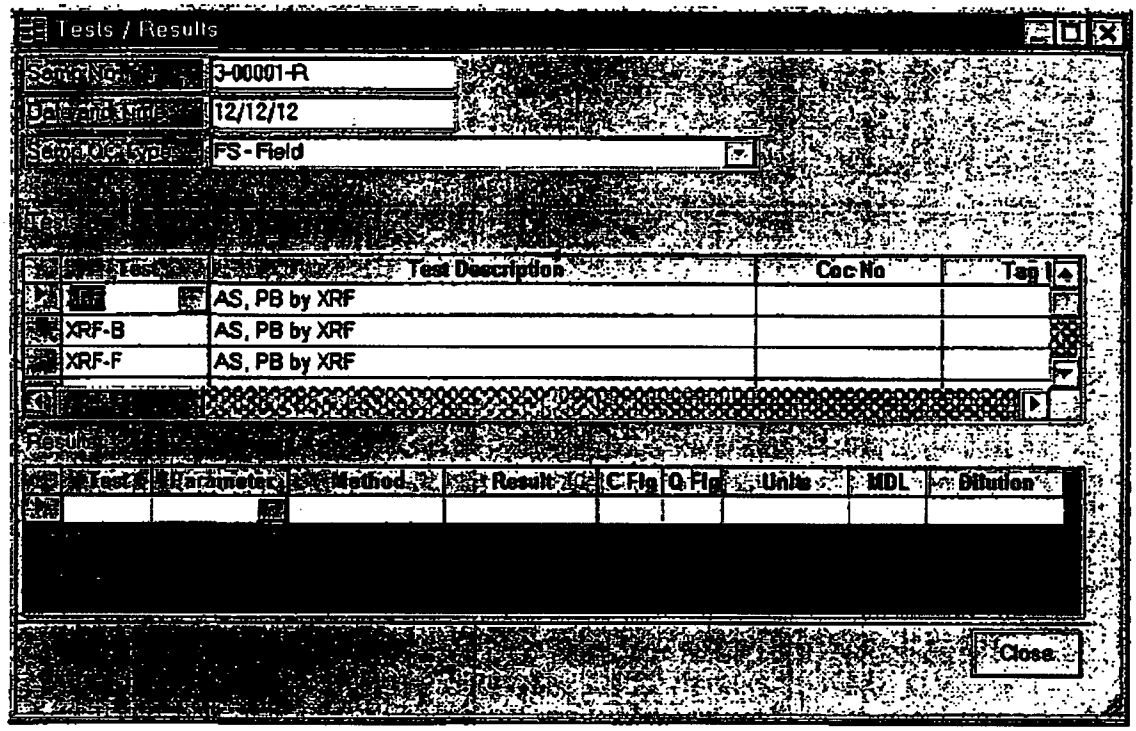


Figure 3 – Laboratory and Results Entry Screen

4.8 Entry of Alleyway Soil Data Sheets

From the Main Menu, select "Data Maintenance =>", "Alleyway Sampling =>", "Add/Edit Alleyway Soil Samples".

The following information is entered from the Alleyway Soil Data Sheet for each sample collected:

Field Name	Data Entry Instructions
Phase	Defaults to code "3", Phase III Sampling
Medium	Defaults to code "AW", Alleyway Soil Sample
Sample Date and Time	Enter the sampling date. Sample time is optional.
Depth Top (in)	Defaults to 0"
Depth Bottom (in)	Defaults to 2"
Alleyway ID	Valid value list. Note: Alleyway IDs and Map Positions will be assigned in the mapping process.
Sample Collection Method	Defaults to "ISSI-VBI70-03 Rev. 0"

Sample Team ID	Valid value list
Map Position	Enter the Map Position as indicated on the data sheet
Sample Number	Enter the Sample Number as indicated
Class	Enter the Sample Class, "FS" for Routine Field Samples or "FD" for Field Duplicates
Parent Sample	Enter the Original Sample Number for Class "FD", or Field Duplicate samples. Not required for Class "FS" samples
Sample Type	Defaults to "GRAB" for grab samples
Sample Fraction	Defaults to "R" for raw samples

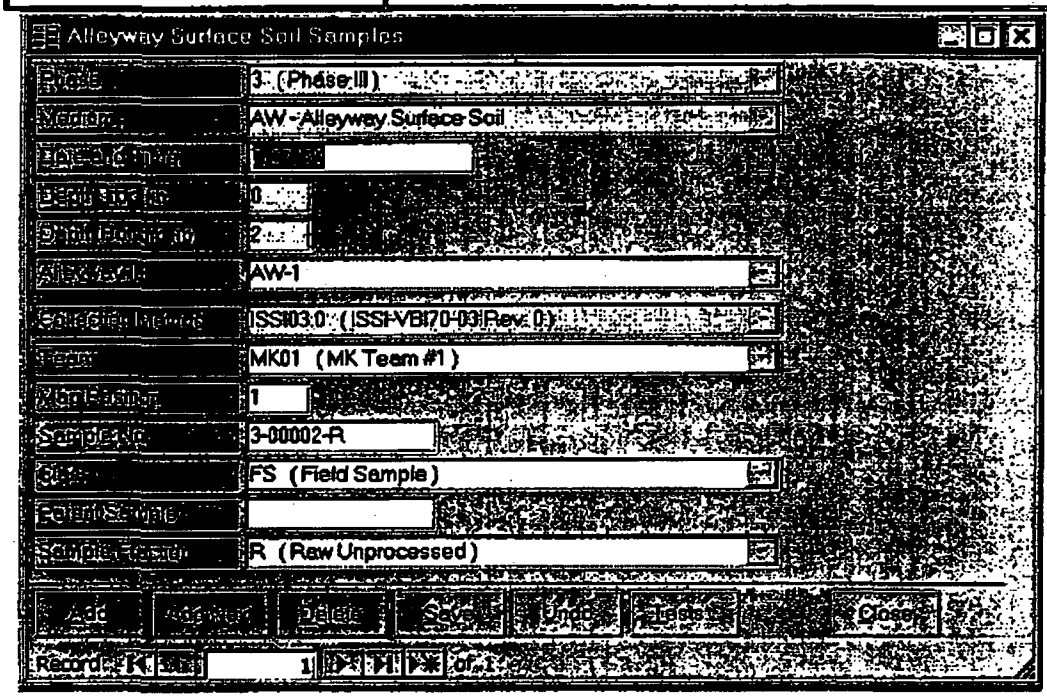


Figure 4 – Alleyway Surface Soil Sampling

Select the [Tests...] command button to enter required analysis information as described in Section 4.7.

Select the [Add Next] command button to carry over information to the next sample collected at the alleyway, or select the [Add] command button to enter data for a new alleyway location. Select the [Close] button to return to the menu system.

4.9 Entry of Indoor Dust Data Sheets

From the Main Menu, select "Data Maintenance =>", "Property Sampling =>", "Add/Edit Indoor Dust Samples". The data entry screen for indoor dust sampling is presented in Figure 5.

The following information is entered from the Indoor Dust Data Sheet for each sample collected:

Field Name	Data Entry Instructions
Phase	Defaults to code "3", Phase III Sampling
Medium	Defaults to code "HD", Household Dust Sampling
Sample Collection Method	Defaults to "ISSI-VBI70-04 Rev. 0"
Sample Date and Time	Enter the Sampling Date. Sample Time is optional. Entry Format: MM/DD/YY 24:00
Sample Team ID	Valid value list
Address	Valid value list
Sample Number	Enter the Sample Number as indicated
Class	"FS" for Field Sample or "EB" for Equipment Blank
Parent Sample	Not required for Class "FS". Indicates the sample number associated with a duplicate field QC sample.
Sample Type	Defaults to "COMP" for composite samples.

For each template location, enter the Living Area Code, Surface Type Code and any notes as indicated on the Indoor Dust field data sheet.

Select the [Tests...] command button to enter required analysis information as described in Section 4.7.

Select the [Close] button to return to the menu system.

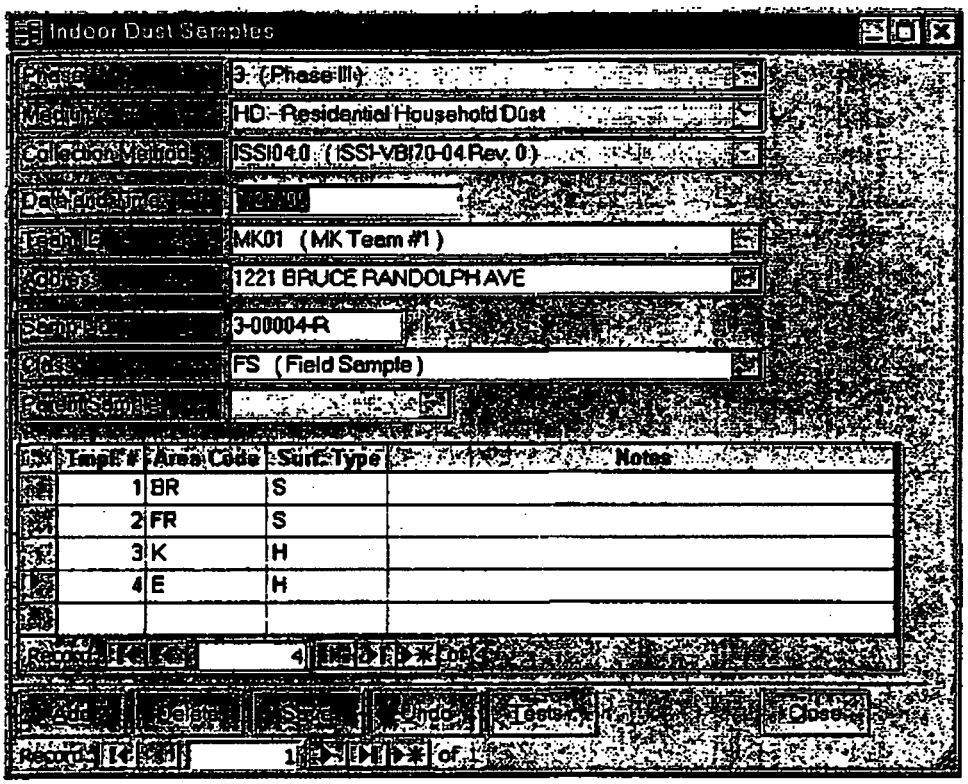


Figure 5 – Indoor Dust Data Entry Screen

4.10 Entry of Field Sample Preparation Logbook Sheets

The procedure for entering surface soil samples listed on the Field Sample Preparation Logbook Sheet is similar to that of the Surface Soil and Alleyway Soil data sheets. The samples listed on this log will all have a sample number suffix of either "-B" or "-F", representing the "Bulk" and "Fine" fraction of the "Raw" or "-R" sample. This procedure requires that the raw (-R) sample information be entered from either the Surface Soil or Alleyway Soil field data sheets **before** the Bulk or Fine fraction samples are entered from the Field Sample Preparation Logbook sheet.

The data entry process begins by finding the associated "-R" sample in the database. Enter the Surface Soil Samples data entry screen by selecting "Data Maintenance =>", "Property Sampling =>", "Add/Edit Surface Soil Samples" from the Main Menu.

To find the raw sample in the database, position the cursor in the "Sample No." field and press <Ctrl-F>, or click on the binoculars icon on the tool bar at the top of the screen.

Check that the find options are set to search all records, to match any part of the field and to search only the current field (Figure 6). Enter the raw sample number in the Find What field; i.e.: 3-00001-R, and then click on the "Find First" command button to retrieve the raw sample information. If the sample is found, select the "Add Next" command button to carry over the raw sample information to the new "Bulk" or "Fine" sample entry. If the sample is not found, look for the sample using the Alleyway Soil Sample data entry screen.

Click on the "Tests..." command button to enter the requested analysis information from the laboratory prepared chain-of-custody. The procedure for entering requested analysis information is described in Section 4.7.

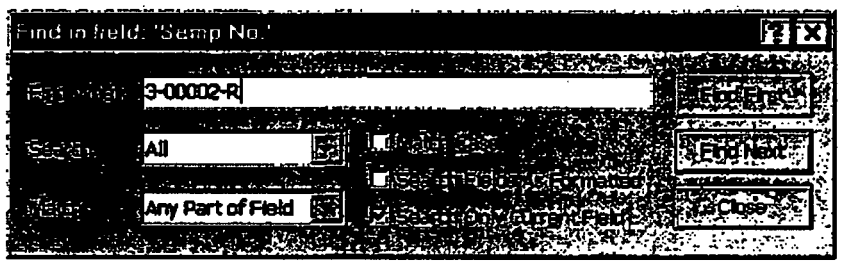


Figure 6

TECHNICAL STANDARD OPERATING PROCEDURE

Date: July 15, 1999 SOP No. MK-VBI70-01

Title: **Property Access**

APPROVALS:

Morrison Knudsen Corporation

Author: _____ Date: July 15, 1999

SYNOPSIS: Provides procedures and guidelines regarding requesting consent for property access, conditions that limit access, and proper conduct when working on private property.

Received by QA Unit

REVIEWS:

TEAM MEMBER	SIGNATURE/TITLE	DATE
EPA Region 8	_____ / RPM	7/24/99
Morrison Knudsen Corp.	_____ / QA Coordinator	7/16/99

REV.	DATE	REVISION DESCRIPTION

TECHNICAL STANDARD OPERATING PROCEDURE
PROPERTY ACCESS

1.0 PURPOSE

The purpose of this SOP is to provide procedures and guidelines to the Morrison Knudsen (MK) personnel assigned to the VB/I-70 project and their subcontractors regarding requesting consent for property access, conditions that limit access, and proper conduct when working on private property.

2.0 SCOPE

This procedure covers activities associated with outdoor and indoor sampling activities on private properties targeted for sampling under this project.

3.0 RESPONSIBILITIES

All **Field Personnel** are responsible for implementing this procedure as specified, recording communications with property owners, ensuring personal safety, and notifying the Field Supervisor of any problems or concerns.

The **Field Supervisor** is responsible for training field personnel to this procedure, emphasizing the need for safe and professional conduct of all field personnel, reviewing communication records, and notifying the Site Manager of any problems or concerns. The Field Supervisor will also provide information to field personnel identifying properties for which access has been received and those for which access is to be requested.

The **Site Manager** is responsible for ensuring that proper resources are provided for training to this procedure and maintenance of safe working conditions, and requesting support from EPA in responding to access problems or concerns.

4.0 REQUIREMENTS

4.1 General

Only those properties for which written consent for property access has been provided by the owner will be sampled. To the extent possible, written consent for access will be obtained in advance of the sampling program. Field personnel will attempt to gain

written consent for access for additional properties in the course of the sample program. Field personnel will work in crews of at least two at all times.

4.2 Conditions Limiting Access

Providing a safe working environment is MK's highest priority. The field personnel must be cognizant of all conditions existing at an individual property, and are required to immediately leave the property if there are any safety concerns, including any of the following conditions:

1. Dog or other potentially dangerous animal is unrestrained or inadequately restrained
2. Resident or owner requests that personnel leave
3. Resident, owner or other individual verbally threatens or harasses any personnel
4. Resident or owner requires samples be collected in a location or manner contrary to the approved procedure
5. Signs of any criminal activity are observed
6. "Keep Out" or equivalent sign is posted and written access has not been received
7. Gates of any height are locked
8. Potential physical, biological or chemical hazards exist

4.3 Request for Property Access

4.3.1 Field personnel will request access from selected properties as directed by the Field Supervisor.

4.3.2 Personnel will possess proper identification and the following information in English and Spanish:

- EPA Notice regarding Phase III sampling
- Cover letter sent to property owners
- Access agreement
- Letter from community representatives

4.3.2 Personnel will knock or ring the door bell at the front door of the home, provided that none of the Conditions Limiting Access listed above exist.

4.3.3 If the resident does not answer, an EPA-approved bilingual notice will be left at the door.

4.3.4 If the resident answers determine if they or anyone at home speaks English. If the resident only speaks Spanish and a Spanish-speaking worker is not present, communicate that someone will return to speak with them.

4.3.5 Personnel should ask to speak to a parent if a minor answers the door, and should communicate the following:

- Name and affiliation
- Purpose of visit
- Inquire as to whether the adult resident is the owner
  - If no, ask whether they would like written information to forward to the owner
  - If yes, explain that sampling is ongoing in their area, provide the written information, provide an opportunity to sign and submit the access agreement at that time, and ask owner how long they have owned the property
- Answer any commonly asked questions and if needed explain that other questions will be forwarded to EPA and that someone will contact them with a response

4.3.6 If the resident represents himself/herself as the property owner and signs the access agreement, the field personnel will proceed to collect samples.

4.3.7 Personnel will record the following information for each property in a field logbook:

- Date and time
- Property address
- Whether adult resident was home
- Whether agreement was signed
- Summary of communications
- Inquiries, complaints and items requiring EPA response

4.4 Personnel Conduct

4.4.1 Field personnel will take all available measures to prevent damage to private property, to restore the property to its previous condition, and to be respectful of residents. All trash,

equipment and materials used by field personnel will be removed from the property upon completion of sampling.

4.4.2 The following activities are not permitted on residential properties:

- Unauthorized parking
- Loitering or spending break time
- Smoking
- Offensive language or behavior
- Trespassing over locked gates
- Unauthorized entry to home or exterior structures
- Disturbing any area or vegetation except as required by the sampling procedures

5.0 ATTACHMENT

Property Access Cover Letter, Agreement, and Letter from Community Representatives

TECHNICAL STANDARD OPERATING PROCEDURE
PROPERTY ACCESS

ATTACHMENT

PROPERTY ACCESS COVER LETTER, AGREEMENT AND LETTER FROM COMMUNITY REPRESENTATIVES

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8
999 18th STREET - SUITE 500
DENVER, CO 80202-2466

Ref: 8EPR-SR

June 11, 1999

Dear Property Owner/Resident:

The Environmental Protection Agency (EPA) is investigating the soils in the Swansea, Elyria, Cole, Clayton, and Globevillle neighborhoods of Denver. You may be aware that in the spring and summer of 1998, we conducted a study in these neighborhoods by collecting soil samples from over 1300 residential yards. Soil was tested for arsenic and lead content. The majority of yards sampled have low levels, but some had levels high enough to warrant replacement of the soil in the yard.

This summer, EPA will be collecting and testing soil from residential yards that were not tested last year. Our study boundaries are 56th Avenue to the north, Martin Luther King Boulevard on the south, the South Platte River on the west, and Colorado Boulevard on the east. We will also include a small area in Globeville that is west of I-25 (to Fox Street) and south of I-70. We'd like to sample every residential yard in the study area. This information will be important for EPA's use in looking at patterns of lead and arsenic levels and for predicting potential health risks associated with contact with soil. We also think this is important information for every homeowner to have to ensure protection of your health and that of your family.

EPA requests your written permission to conduct this work on your property. Your name and signature will not be publicly available. Soil collection and testing is free. If you are willing to volunteer to have your soil sampled and tested, please follow these steps:

(1) PLEASE READ AND SIGN THE ATTACHED "ACCESS AGREEMENT."

(2) PLACE THE SIGNED ACCESS AGREEMENT IN THE ENCLOSED POSTAGE PAID ENVELOPE ADDRESSED TO EPA'S CONTRACTOR , MORRISON KNUDSEN, AND DROP IT IN THE MAIL.

You don't need to be home when the samples are collected but if you would like to be, we will attempt to schedule sampling when you are there. If you are renting the property, please ask the owner to sign the agreement. Soil samples will be sent to a laboratory for testing. This work may take up to three months. When they are available, EPA will mail individual results to each property owner.

If you have questions about this study, please don't hesitate to call Pat Courtney at (303) 312-6631, or Ted Fellman at (303) 312-6119. Thank you very much for your cooperation.

Sincerely,

Bonnie Lavelle
Remedial Project Manager

enclosure

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8
999 18th STREET - SUITE 500
DENVER, COLORADO 80202-2466

ACCESS AGREEMENT

PROPERTY ADDRESS:

_____

Mailing Address (If Different than Property Address):

_____

I will allow Environmental Protection Agency (EPA) staff and EPA's authorized representatives to have access to my property identified above for the purpose of collecting soil samples. I understand that this service is provided at no cost to me.

I understand that this soil testing is part of an investigation of possible metals contamination in soils in the north Denver area. EPA is conducting this investigation as part of its responsibilities under the Comprehensive Environmental Response, Compensation and Liability Act, a law also referred to as "Superfund".

_____ _____
Print Name Date

_____ _____
Signature Phone Number

Please check the following if applicable:

___ I would like EPA to provide me with a portion of the sample, called a "split sample," that I may have analyzed at my own expense.

If you have any questions, please contact Ted Fellman at (303) 312-6119, or Marta Valentine from the Morrison Knudsen Corporation (EPA's contractor) at (303) 948-4693.

Your Comments:

PLEASE SIGN AND RETURN THIS ACCESS AGREEMENT TO OUR CONTRACTOR IN THE ENCLOSED PREPAID ENVELOPE. Soil sampling will take about 1 hour. The owner or resident need not be present. If you would like to be notified when we plan to sample your property, please state so in the Comments section and provide your phone number. Also, pet owners are asked to provide a phone number so that if necessary we may schedule the sampling at a time when the pet will be indoors or restrained. Thank you for participating in this important study of your neighborhood.

NOTE: If you are <u>not</u> the current property owner, and you are not a renter who wishes to forward this request to the owner, please state so in the Comments section and return this agreement unsigned.

C.E.S.C Neighborhood Coalition
Clayton, Elyria, Swansea, & Cole

June 1, 1999

Dear Neighbor:

Greetings. C.E.S.C. Neighborhood Coalition is a group of concerned residents from the Clayton, Elyria, Swansea and Cole who have joined together because of the current serious environmental issues facing our community. After doing some soil testing last summer, the Environmental Protection Agency (EPA) found that many homes contained high amounts of toxic heavy metals in their soils. For the last six months to a year the C.E.S.C Neighborhood Coalition has been working with the EPA to make certain community concerns are heard and are included in decisions that are made.

Enclosed you will find a request from the Environmental Protection Agency (EPA) who will do more soil testing this summer. Many homes did not get tested last summer, in fact, only 15% – 18% of the homes in Clayton and Cole were tested. **We strongly encourage our neighbors to have their soil tested.** This testing is free to property owners and will tell if there is any soil contamination in your lawn or garden. The EPA will provide you with a letter explaining the testing results and public meetings will be held in the community to further explain what results mean. **Please sign the Access Agreement and return it to the EPA as soon as possible.**

Your participation in this soil testing will help give a better picture of how far the toxic metals contamination may have spread and what action can be taken to have it cleaned up. If you have questions you may call your neighborhood representative listed below, or the EPA representative. Also, if you are interested in attending our Coalition meetings or getting involved, please call for our next meeting time and date.

In Peace,

Anthony Thomas
Clayton Resident
303-399-1379

Joan Hooker
Clayton Resident
303-322-0920

Sandy Douglas
Cole Resident
303-297-8653

Michael Maes
Swansea Resident
303-292-3203

Lorraine Granado
Swansea Resident
303-292-3203

TECHNICAL STANDARD OPERATING PROCEDURE

Date: July 15, 1999 SOP No. MK-VBI70-02

Title: **Chain of Custody And Sample Handling**

APPROVALS:

Morrison Knudsen Corporation

Author: Mark Valent Date: July 15, 1999

SYNOPSIS: Provides procedures and instructions on maintaining and documenting chain of custody and on containing, preserving, and packaging samples for shipment to off-site laboratories.

Received by QA Unit

REVIEWS:

TEAM MEMBER	SIGNATURE/TITLE	DATE
EPA Region 8	[illegible] / RPM	7/24/99
Morrison Knudsen Corp.	[illegible] / QA Coordinator	7/16/99

REV.	DATE	REVISION DESCRIPTION

TECHNICAL STANDARD OPERATING PROCEDURE
CHAIN OF CUSTODY AND SAMPLE HANDLING

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide instructions to Morrison Knudsen (MK) personnel assigned to the Vasquez Boulevard/I-70 project, and their subcontractors, on maintaining and documenting chain of custody (COC) and on containing, preserving, and packaging samples for shipment to off-site laboratories.

2.0 SCOPE

This procedure covers activities associated with maintaining and documenting chain of custody and environmental sample handling. This procedure does not cover activities associated with submitting samples for analysis under EPA's Contract Laboratory Program.

3.0 REFERENCES

MK Engineering Standard 3.4, Sampling Handling Requirements

EPA Method 6010B: Inductively Coupled Plasma Atomic Emission Spectroscopy, SW-846

4.0 RESPONSIBILITIES

- The **Sampler** is responsible for collecting samples in appropriate containers, labeling sample containers and maintaining and documenting sample custody until the samples are relinquished.

- The **Field Supervisor** or a designate is responsible for review of sample labeling, chain of custody documentation, and packaging of samples for shipment.

- The **Project Chemist** will be responsible for verifying implementation of this procedure through surveillance and maintaining records.

- The **Site Manager** will be responsible for ensuring that records are properly maintained and that personnel are trained to this procedure.

5.0 REQUIREMENTS

5.1 Chain of Custody Procedures

Chain of custody must be maintained at all times and documented on a COC form. A sample is in an individual's custody if:

- It is in his/her possession
- It is in his/her view, after being in their possession
- It was in his/her possession and he/she either locked it or placed it in a sealed container to prevent tampering
- It is in a designated secure area

5.1.1 Chain of custody forms shall be used for all samples submitted to either the on-site laboratory or an off-site laboratory. An example COC for an MK contract lab is presented as an Attachment.

5.1.2 Each sample shall be entered on the COC at the time of sample collection by the Sampler(s). The following information shall be entered:

- Project identification
- Sample identification number
- Date and time sampled
- Sample media
- Required analyses
- Number of containers collected for the sample

5.1.3 Each person on the sampling team shall sign the COC in the Samplers Signature box. When samples are relinquished, one of the sampling team members will sign the "Relinquished By" signature block at the bottom of the COC and enter the date and time. The person receiving the samples will sign the "Received By" signature block.

5.1.4 One copy of the COC will be retained along with corresponding airbills and provided to the Project Chemist for review and filing.

5.1.5 Custody seals will be placed on all containers used to ship samples to an off-site laboratory, and also will be used whenever the samples are not in view or in a secured area. The seals must be placed so that it would not be possible to tamper with the sample without disturbing the seal.

5.2 Sample Containment, Preservation and Holding Times

5.2.1 Samples will be placed in containers compatible with the analytical request and laboratory requirements. Soil samples collected for metals analysis by XRF will be collected in plastic, sealable bags. Soil samples collected for metals analysis at an off-site laboratory may be collected in plastic, sealable bags or in glass jars. Rinsate blank water samples will be contained in certified clean polyethylene bottles. Sealed plastic bags will be checked to verify complete closure of the seal.

5.2.2 Soil and dust samples will not require any preservation. Rinsate samples will be preserved with nitric acid to pH<2. Samples should be handled and stored to maintain integrity and prevent damage to the container.

5.2.3 Soil and dust samples submitted for analysis by ICP Method 6010B will have a maximum holding time for analysis of 6 months following sample collection.

5.3 Sample Packaging and Shipping Procedures

5.3.1 Samples will be packaged so as to minimize the possibility of container breakage, and to provide containment in the event of container breakage or leaking. Any samples in glass containers for off-site shipment will be packaged using bubble wrap or equivalent packing materials.

5.3.2 All samples shipped to an off-site laboratory will be contained in a plastic cooler with packing material, if necessary, to prevent excessive agitation of the contents.

5.3.3 A notation will be made in the "Received By" block on the COC form that a cooler was sealed for shipment via the carrier. One copy of the COC form will be retain, and the completed form will be verified against the cooler contents, placed in a sealable bag, and taped to the inside top of the cooler.

5.3.4 All coolers will be securely taped closed, sealed with a minimum of two signed custody seals and labeled with a completed air bill prior to shipment.

5.3.5 Samples that are identified as possible dangerous goods will be shipped in accordance with appropriate DOT regulations for hazardous materials.

6.0 ATTACHMENTS

Attachment - Example Chain of Custody Form

TECHNICAL STANDARD OPERATING PROCEDURE
CHAIN OF CUSTODY AND SAMPLE HANDLING

ATTACHMENT

EXAMPLE CHAIN OF CUSTODY FORM

MORRISON KNUDSEN CORPORATION

CHAIN OF CUSTODY RECORD

720 Park Blvd., P.O. Box 73
Boise, Idaho 83729
(208) 386-5000

Project No.:

Project Name:

Samplers: (Signature)
Sampler: (Print)

Sample Type	Sampling Point Description	Sample Date	Time	Sample I.D. Number	Split Samples Yes	Split Samples No	Analysis Required																	Remarks

Relinquished By: (Signature) Company:	Date/Time	Received By: (Signature) Company:	Relinquished By: (Signature) Company:	Date/Time	Received By: (Signature) Company:
Relinquished By: (Signature) Company:	Date/Time	Received By: (Signature) Company:	Relinquished By: (Signature) Company:	Date/Time	Received By: (Signature) Company:
Relinquished By: (Signature) Company:	Date/Time	Received By: (Signature) Company:	Received for Laboratory By: (Signature) Company:	Date/Time	Total No. Samples This Shipping Container: Company:
Relinquished By: (Signature) Company:	Date/Time	Received By: (Signature) Company:	Relinquished By: (Signature) Company:	Date/Time	Received By: (Signature) Company:

TECHNICAL STANDARD OPERATING PROCEDURE

Date: July 15, 1999 SOP No. MK-VBI70-03

Title: **Field Documentation**

APPROVALS:

Morrison Knudsen Corporation

Author: Mai Valent Date: July 15, 1999

SYNOPSIS: Provides procedures and instructions for maintaining field documentation for Vasquez Boulevard/I-70 field investigations.

Received by QA Unit

REVIEWS:

TEAM MEMBER	SIGNATURE/TITLE	DATE
EPA Region 8	RPM	7/24/99
Morrison Knudsen Corp.	QA Coordinator	7/16/99

REV.	DATE	REVISION DESCRIPTION

TECHNICAL STANDARD OPERATING PROCEDURE
FIELD DOCUMENTATION

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide instructions for maintaining field documentation for Vasquez Boulevard/I-70 field investigations.

2.0 SCOPE

This procedure covers logs and data sheets maintained by the sampling personnel.

3.0 RESPONSIBILITIES

The **Sample Lead** will be responsible for maintaining the sample documentation during sampling activities and providing the documentation to the Field Supervisor or designate.

The **Field Supervisor** or designate will be responsible for receiving, reviewing, and maintaining the sample documentation records. He/She also will train the sampling personnel to the requirements of this procedure. The Field Supervisor will forward all original documents to the Site Manager.

The **Site Manager** will ensure that records are maintained and filed properly and that all personnel are trained to this procedure.

4.0 REQUIREMENTS

Field documentation consists of field data sheets, field logbooks, and calibration logs. Data sheets will be maintained by each sample team in a three-ring binder, in accordance with the sampling procedures SOPs. A hard bound logbook will be used by each sample crew. Information recorded in the hard bound logbook will be in accordance with the following procedures:

TECHNICAL STANDARD OPERATING PROCEDURE
FIELD DOCUMENTATION

- Pre-number pages and annotate any unused pages. Make entries as events occur throughout the day's activities. Use black permanent ink pens. Do not use white-out or erase; rather, line out, initial and date any errors.

- Log entries using a 24-hour system.

- Report operational information:
  - Start time, progress, and completion of work at each property
  - Location
  - Site Conditions
  - Weather conditions
  - Site Sketch
  - Sample team ID and Workers in attendance
  - Any unplanned events or deviation from the project procedures
  - Communications with non-MK or subcontractor personnel

- Field documents constitute legal documents. All entries should be factual and objective, and without personal feelings or opinions. Entries related to any concerns, errors made, or omissions are legitimate entries.

- Each page must be numbered, initialed and dated.

- Pages or portions of pages not used should be lined out and initialed/dated.

- In the event that field instrumentation is required, this equipment will be calibrated according to manufacture's instructions. Calibration records and instrument identification will be documented in the field logbooks or calibration logs for each sample team.

- All documentation for the sample preparation and XRF analysis will be maintained as required in the respective SOPs.

TECHNICAL STANDARD OPERATING PROCEDURE

Date: July 15, 1999 SOP No. MK-VBI70-04

Title: **Investigation Derived Waste Management**

APPROVALS:

Morrison Knudsen Corporation

Author: [signature] Date: July 15, 1999

SYNOPSIS: Provides procedures to manage investigation derived wastes.

Received by QA Unit

REVIEWS:

TEAM MEMBER	SIGNATURE/TITLE	DATE
EPA Region 8	[signature] /RPM	7/24/99
Morrison Knudsen Corp.	[signature] /QA Coordinator	7/16/99

REV.	DATE	REVISION DESCRIPTION

TECHNICAL STANDARD OPERATING PROCEDURE
INVESTIGATION DERIVED WASTE MANAGEMENT

1.0 PURPOSE

The purpose of this procedure is to describe the methods that will be used by Morrison Knudsen personnel assigned to the VB/I-70 project and their subcontractors to manage investigation derived wastes (IDW).

2.0 SCOPE

This procedure covers management of all IDW, including trash, soils, water, and personal protective equipment (PPE). Management procedures include waste collection, segregation, characterization, storage, shipping and disposal, as appropriate for each waste stream.

3.0 REFERENCES

Management of Investigation-Derived Wastes During Site Inspections, EPA/540/G-91/009

Code of Federal Regulations, Chapter 50, Parts 262 and 265.

4.0 DEFINITIONS

DOT: Department of Transporation
IDW: Investigation Derived Waste
PPE: Personal Protection Equipment

5.0 RESPONSIBILITIES

All **Field Personnel** will be responsible for managing IDW in accordance with this procedure.

The **Field Supervisor** will be responsible for training field personnel to the requirements of this plan, verifying its implementation, and generating and maintaining required records.

The **Site Manager** will be responsible for ensuring that personnel are properly trained and providing guidance for any special circumstances that may arise.

6.0 EQUIPMENT

- DOT compliant containers as specified in 40 CFR 265 Subpart I.
- Non-hazardous (and if necessary Hazardous) Waste Labels
- Spill Control Materials

7.0 REQUIREMENTS

7.1 General

All IDW will be managed in accordance with federal, state, and local rules and regulations. Personnel responsible for hazardous waste labeling, inspecting, profiling, manifesting, and transportation preparation will be trained per 29 CFR 1910.120 and 49 CFR 172.704.

7.2 Waste Types

Waste streams anticipated to be generated during the work activities include:

- Raw fraction soils and vegetation
- Bulk and fine fraction soil
- Disposable gloves and other personal protection equipment (PPE)
- Decontamination rinsate generated at residential properties
- Decontamination rinsate generated at the field office/laboratory
- Trash

7.2.1 Raw Fraction Soils and Vegetation - The large fraction soils and vegetation will be separated from the fine fraction soils during sample collection, preparation and sieving procedures. Large fraction soils or vegetation, including sod, generated at individual residential properties should be left at the property in the vicinity of the sample location(s). Large fraction soils or vegetation generated during sample preparation at the

field office/laboratory will be contained and stored in drums pending profiling and disposal as described below.

7.2.2 Bulk and Fine Fraction Soil - Bulk and fine fraction soils will be generated at the field office/laboratory by the sample preparation process. Any portion of the prepared soils that are not archived will be contained and stored in drums pending profiling and disposal as described below.

7.2.3 Disposable Gloves and PPE - Disposable PPE including gloves will be double bagged and disposed along with trash at a municipal landfill. Gloves that are grossly impacted by soils will be decontaminated prior to disposal.

7.2.4 Decontamination Rinsate Generated at Residential Properties - Rinsate generated at individual properties from equipment or personnel decontamination will be disposed on the property at which the equipment was used, prior to leaving that property.

7.2.5 Decontamination Rinsate Generated at Field Office/Laboratory - Rinsate generated at the field office/laboratory from equipment or personnel decontamination will be contained and stored in drums pending profiling and disposal as described below.

7.2.6 Trash - All trash generated during the project will be contained in plastic trash bags for pick-up and disposal by a municipal trash management company; unauthorized disposal of trash in trash recepticals that service City of Denver residents and businesses will not be permitted.

7.3 Contained Waste

7.3.1 Containers - Soils and decontamination rinsate waste generated at the field office/laboratory will be contained in DOT-compliant drums in accordance with 40 CFR 265 Part I. Trash and PPE contained outdoors will be placed in a closed plastic trash receptical to prevent disturbance by animals and dispersion by wind.

7.3.2 Labeling - All drummed IDW will be labeled as to its contents, source of material and the date on which waste accumulation begins. Non-hazardous waste labels will be used if appropriate. Additional labeling requirements specified in 40 CFR 262 and 265 Subpart I will be performed for waste that it determined to meet the criteria of a RCRA Hazardous Waste.

7.3.3 Storage - All drummed IDW will be stored in a designated area and in a manner that minimizes the potential for container damage or personnel injury. Non-hazardous waste will be segregated from waste that is determined to meet the criteria of a RCRA Hazardous Waste. As a protective measure, hazardous waste will be stored in a secure (fenced), lined, bermed area, and will be subject to weekly inspections in accordance with 40 CFR 262. Water accumulating in the lined storage area after a precipitation event will be removed and contained with the non-hazardous rinsate waste.

7.3.4 Profiling - All drummed IDW will be profiled using knowledge of the material and/or analytical data. Profile forms will be completed and submitted to the appropriate disposal facility as the basis of waste acceptance.

7.3.5 Transporation and Disposal - Drummed IDW will be transported and disposed by transporters and facilities permitted to manage the profiled waste. All non-hazardous waste will be managed as industrial or special waste, and shipped under a non-hazardous waste bill of lading. Hazardous waste will be shipped to an EPA-approved RCRA Subtitle C facility under a RCRA Uniform Hazardous Waste Manifest, identified with the EPA Generator ID, and in accordance with all DOT requirements for shipping hazardous materials. A DOT Hazardous Material Registration must be provided by the transporter and accompany each hazardous material shipment. Disposal certification will be obtained from the RCRA Subtitle C facility.

7.4 IDW Log

A waste log will be developed and maintained to document the following information:

- Description of waste generated (e.g. soils, water)

- Classification of wastes (non-hazardous, hazardous, etc.) including EPA code as applicable
- Quantities of waste generated
- Type of waste storage container
- Dates of waste generation
- Manifest/Bill of Lading Numbers

8.0 RECORDS

- Waste Log
- Waste Profiles
- Non-Hazardous Waste Manifest/Bill of Lading
- RCRA Uniform Hazardous Waste Manifest, if needed
- Hazardous Waste Disposal Certification, if needed
- DOT Hazardous Material Registration, if needed

TECHNICAL STANDARD OPERATING PROCEDURE

Date: August 4, 1999 SOP No. MK-VBI70-05

Title: **Sample Preparation**

APPROVALS:

Author: Morrison Knudsen Corporation Date: August 4, 1999

SYNOPSIS: Provides procedures and instructions for the preparation of soil samples for on-site XRF and off-site laboratory analysis.

Received by QA Unit

REVIEWS:

TEAM MEMBER	SIGNATURE/TITLE	DATE
EPA Region 8	[illegible] / RPM	8/5/99
Morrison Knudsen Corp.	[illegible] / QA Coordinator	8/4/99

REV.	DATE	REVISION DESCRIPTION
1	8/4/99	Grinding of bulk soil prior to XRF analysis added

TECHNICAL STANDARD OPERATING PROCEDURE
SAMPLE PREPARATION

1.0 PURPOSE

The purpose of this procedure is to provide instructions to Morrison Knudsen personnel assigned to the VB/I-70 Project and their subcontractors for the preparation of soil samples.

2.0 SCOPE

This procedure covers activities associated with preparation of soil samples for subsequent analysis by X-ray fluorescence spectrometry, inductively coupled plasma spectroscopy, and/or bioavailability tests.

3.0 REFERENCES

Method 6200 Field Portable X-Ray Fluorescence Spectrometry For The Determination Of Elemental Concentrations In Soil And Sediment

Spectrace QuanX Laboratory X-Ray Fluorescence Analyzer Standard Operating Procedure

Standard Operating Procedure for Equipment Decontamination

Standard Operating Procedure for Waste Disposal

4.0 DEFINITIONS

None

5.0 RESPONSIBILITIES

The **Sample Preparation Technician** will be responsible for overseeing sample receipt and chain of custody both before and after the preparation process, and implementation of the sample preparation process.

The **Field Supervisor** will be responsible for quality and production of field laboratory operations.

The **Site Health and Safety Officer** will be responsible for verifying implementation of this procedure using safe laboratory practices.

The **Field Quality Assurance Coordinator** will be responsible for overseeing proper implementation of the quality control procedures, including tracking of blind standard performance evaluation samples, tracking of confirmation samples for off-site laboratory analysis, and specification of sample labels to be used for blind split samples.

The **Site Manager** will be responsible for ensuring that personnel are properly trained to this procedure.

6.0 REQUIREMENTS

6.1 General

6.1.1 Sample preparation activities shall be performed only in areas designated for each activity.

6.1.2 Eating and smoking are prohibited in all areas of the sample preparation area.

6.1.3 Samples generally will be prepared in batches consisting of twenty field samples.

6.1.4 All non-dedicated equipment used during sample preparation must be decontaminated prior to use as described in the Decontamination SOP (MK-VBI70-07).

6.2 Equipment

Sample drying trays
Permanent Marking pen
General purpose laboratory oven
#10 mesh stainless steel sieve
#60 mesh stainless steel sieve
Sample bags
XRF cups
Mylar
Spatulas
Analytical balance accurate to 0.1 g, range of 0.1 g to 1000 g
Mortar and pestle, 140 mL or greater (or mill equipped with Burundum cylinders)

6.3 Soil Bulk Sieving

6.3.1 Select samples to be prepared. Prior to opening the sample bag, knead the contents to break up soil clumps and mix approximately two minutes or until the soil appears to be well homogenized. If the kneading process produces cohesive clumps, that observation will be noted in the Preparation Log.

6.3.2 Pour the sample from the bag onto a #10 sieve attached to a catch pan. Shake the sieve to pass the sample through the sieve into the catch pan. Using a gloved hand, break up other clumps that can be easily broken by hand and move soil to aid sieving. Dispose of any sample that did not pass through the sieve into the waste soil receptacle.

6.3.3 Pour approximately 6 ounces of the sieved sample into a pre-labeled (3-XXXXX-B) drying pan and pour the remainder of the sieved soil into a pre-labeled bag for archiving (3-XXXXX-A) under chain of custody documentation.

6.3.4 Document the date sieving was performed for each sample in the Sample Preparation Log Sheet.

6.4 Bulk Soil Drying

6.4.1 Set the oven temperature to 103-105 C (not to exceed 115 C).

6.4.2 Spread the sample on the drying tray in an even layer to promote even drying.

6.4.3 Check the oven temperature to verify proper temperature has been reached. Place the drying trays containing the samples into the oven(s). Leave the samples in the oven until completely dry as defined by a stable sample weight. Establish the drying time initially by recording weights for samples with varying soil moisture: 1) before drying, 2) at estimated completion, and 3) following an additional 15 minute drying time to confirm stable weight. Verify sample dryness for all samples by squeezing a portion of the sample between a gloved thumb and forefinger. Sample dryness is indicated by a lack of cohesiveness in the soil. Document the sample drying time for each sample on the Sample Preparation Log.

6.4.4 When samples are dry, remove from the oven and place in the ventilation area. **Before placing samples at the ventilation area, verify that the blower is turned on.**

6.4.5 Place the sample from the drying pan into a pre-labeled (3-XXXXX-B) sample bag. Completely seal the bag, then mix by turning the bag end over end slowly a minimum of ten times.

6.5 Bulk Soil Grinding and Cupping

6.5.1 Using a spatula, stir the contents of the sample bag thoroughly, then transfer 7 - 10 grams to the mortar.

6.5.2 Grind the soil using the pestle for ten minutes or until all material is evenly ground to a powder. If larger grained vegetation or soil materials remain, sieve the sample through a #60 sieve.

6.5.3 Using a spatula, fill the pre-labeled (3-XXXXX-B) XRF cup with soil from the mortar, filling cup ½ to ¾ full. Secure a piece of Mylar film over the top of the cup to seal.

6.5.4 Prepare XRF quality control samples as described in Section 6.7.2. Dispose of any unused ground soil into the waste soil receptacle.

6.6 Drying and Sieving Fine Fraction Soil

6.6.1 Selected archived bulk soil samples will be dried at a low temperature and sieved to isolate the naturally occurring fine fraction using a #60 mesh sieve.

6.6.2 Set the oven temperature to 45-48 C (not to exceed 50 C).

6.6.3 Pour approximately 8 ounces of soil onto a pre-labeled (3-XXXXX-A) drying tray and spread in an even layer to promote even drying. Return the remaining soil to the archive.

6.6.4 Check the oven temperature to verify proper temperature has been reached. Place the drying trays containing the samples into the oven(s). Leave the samples in the oven until completely dry as defined by a stable sample weight. Establish the drying time initially by recording weights for samples with varying soil moisture: 1) before drying, 2) at estimated completion, and 3) following an additional 15 minute drying time to confirm stable weight. Confirm sample dryness for all samples by squeezing a portion of the

sample between a gloved thumb and forefinger. Sample dryness is indicated by a lack of cohesiveness in the soil. Document the sample drying time for each sample on the Sample Preparation Log.

6.6.5 When samples are dry, remove from the oven and place in the ventilation area. **Before placing samples at the ventilation area, verify that the blower is turned on.**

6.6.6 Pour the dried sample onto a #60 sieve attached to a catch pan. Shake the sieve to pass the sample through the sieve into the catch pan. Dispose of any sample that did not pass through the sieve into the waste soil receptacle. Place the sample in the catch pan into a pre-labeled (3-XXXXX-F) sample bag. Completely seal the bag then mix by turning the bag end over end slowly a minimum of ten times. Using a spatula, stir the soil thoroughly and then fill the pre-labeled (3-XXXXX-F) XRF cup with soil from the sample bag, filling cup ½ to ¾ full. Secure a piece of Mylar film over the top of the cup to seal.

6.7 Quality Control Sample Preparation Procedure

6.7.1 Sample preparation will be performed in an area separate from the XRF operations. The sample preparation technician who prepares sample batches containing blind quality control samples may not perform analysis on those samples. The XRF analyst will not observe the sample preparation and will not view the preparation logs in order to maintain sample anonymity to the analyst.

6.7.2 Prepare each of following quality control samples at rate of one per twenty field samples by filling two XRF cups with soil (following sample drying, sieving, mixing and grinding procedures):

- One laboratory duplicate, labeled 3-XXXXX-B(or -F)D
- One blind field split, labeled with a unique sample ID from the list of sample labels pre-assigned as blind split samples.

6.7.3 Prepare confirmation samples at a rate specified by the EPA Remedial Project Manager (initially one per three field samples) by transferring approximately 4 ounces from the prepared field sample bag (following bulk sieving, drying, fine sieving where applicable, and mixing; grinding of confirmation samples is not necessary) into a second bag and labeling the confirmation sample with the identical sample identification (i.e., 3-XXXXX-B or 3-XXXXX-F). The confirmation sample will be submitted under chain of custody to an off-site laboratory for analysis by Method 6010B (ICP) as described in the Chain of Custody and Sample Handling SOP (MK-VBI70-02).

6.7.4 Document the laboratory duplicate in the "Notes" column of the Field Sample Preparation Log. Document the blind field split Sample ID and original Sample ID on the QC Data Sheet for Blind Soil Field Splits.

6.7.5 Prepare blind standards as directed by the Field Quality Assurance Coordinator by filling a pre-labeled XRF cup with soil from the blind standard sample provided. If the standard is not received pre-dried, sieved and ground, the sample will be prepared in accordance with sieving, drying, and grinding procedures detailed above in Section 6.3, 6.4 and 6.5. Label the cup with a unique sample ID from the list of sample labels pre-assigned as blind standards. Document the blind standard when prepared on the Performance Evaluation Standard (Blind Standard) QC Data Sheet.

6.7.6 Place 18 XRF cups for a single sample run into a staging container for transfer to the XRF Analyst (the analyst will complete the run with addition of a standard reference material and instrument blank).

6.8 Investigation Derived Waste Management

6.8.1 Remove the sample receptacle from under the ventilation hood and dispose of its contents into the waste soil drum when full and at the end of each day.

6.8.2 Place all non-dedicated sample drying trays, sieves, catch pans, and spatulas used during sample preparation in the receptacles for equipment decontamination.

7.0 ATTACHMENTS

Field Sample Preparation Logbook Sheet

QC Data Sheet, Blind Soil Field Splits

QC Data Sheet, Blind Performance Evaluation Samples

TECHNICAL STANDARD OPERATING PROCEDURE
SAMPLE PREPARATION

ATTACHMENTS

FIELD SAMPLE PREPARATION LOGBOOK SHEET

QC DATA SHEET, BLIND SOIL FIELD SPLITS

QC DATA SHEET, BLIND PERFORMANCE EVALUATION SAMPLES

VBI70 Field Sample Preparation Logbook Sheet

Sample ID	Prep Batch Number	Confirmation Sample[a]	Sample Drying							Sieving				Notes
			Date/Time Drying Begun[b]	Date/Time Drying Completed[b]	Oven Temp (°C)	Sample Mass[c] (grams)				Date Sieved	Particle Size Fraction[d]			
						Before	After 1	After 2	After 3		Raw Soil	Bulk (<2 mm)	Fine (<250 µm)	

a: Mark an "X" if a confirmation sample is prepared.

b: Enter Date in the following format: mm/dd/yy; Enter Time as 24-hour time (eg. 1340).

c: At least 2 measurements will be recorded. The sample is "completely dry" if the mass measurement is stable. A stability study will be performed as outlined in the Phase III Project Plan.

d :Mark an "X" for each sieve fraction collected

VBI70 QC Data Sheet
Blind Field Split Samples

Date	Sample ID	Sample Class	Original Sample	Prepared By	Notes
		BD			
		BD			
		BD			
		BD			
		BD			
		BD			
		BD			
		BD			
		BD			
		BD			
		BD			
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		BD			
		BD			
		BD			
		BD			
		BD			
		BD			

VBI70 QC Data Sheet
Soil Performance Evaluation Standards

Date	Sample #	Sample Class	Lot No.	Certified Concentration		Prepared By
				Arsenic (ppm)	Lead (ppm)	
		PE				
		PE				
		PE				
		PE				
		PE				
		PE				
		PE				
		PE				
		PE				
		PE				
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TECHNICAL STANDARD OPERATING PROCEDURE

Date: July 29, 1999 SOP No. MK-VBI70-06

Title: **XRF Instrument Operation**

APPROVALS:

Author: Morrison Knudsen Corporation Date: July 29, 1999

SYNOPSIS: Provides procedures and instructions on the proper XRF operation protocol.

Received by QA Unit

REVIEWS:

TEAM MEMBER	SIGNATURE/TITLE	DATE
EPA Region 8	[illegible]	7/30/99
Morrison Knudsen Corp.	[illegible] / QA Coordinator	7/29/99

REV.	DATE	REVISION DESCRIPTION

TECHNICAL STANDARD OPERATING PROCEDURE
XRF INSTRUMENT OPERATION

1.0 PURPOSE

The purpose of this procedure is to provide instructions to Morrison Knudsen (MK) personnel assigned to the VB/I-70 project and their subcontractors on the proper XRF operation protocol.

2.0 SCOPE

This procedure covers activities associated with intrusive sample analysis by utilizing an energy dispersive X-ray fluorescence spectrometry method (EDXRF). The procedure details operation of the KevexSpectrace QuanX instrument, which is a field portable, but not hand held, XRF.

3.0 REFERENCES

Spectrace, QuanX EDXRF Analysis of Contaminated Soils Standard Operating Procedure

Spectrace, QuanX Operation Manual, Current Revision

Harding, Soil Analysis Application Report, Low Concentration Soil Contaminant Characterization Using EDXRF Analysis

Method 6200: Field Portable X-Ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment

4.0 DEFINITIONS

EDXRF:	Energy Dispersive X-ray Fluorescence Spectrometer/Spectrometry
NIST:	National Institute of Standards and Technology
ppm:	Parts per million
SRM:	Standard Reference Material
QuanX:	Spectrace Brand Name for 6000 Series EDXRF

5.0 RESPONSIBILITIES

The **Field Analyst/XRF Operator** is responsible for operation and maintenance of the QuanX EDXRF and data management in accordance with this procedure.

The **Field Supervisor** is responsible for training the Field Analyst(s) on the requirements of this procedure, and for providing oversight and assistance as necessary to ensure compliance with this procedure.

The **Project Chemist** is responsible for reviewing instrument output and quality control records to confirm proper implementation of the quality control requirements.

The **Site Health and Safety Officer** is responsible for verifying the use of safe laboratory practices throughout implementation of this procedure.

The **Site Manager** is responsible for ensuring that the Field Analyst receives proper training and that proper equipment and resources are available as needed to safely operate the instrument and to generate high quality data.

6.0 EQUIPMENT

- QuanX EDXRF, ECD Model, equipped with spectrometer, control/pulse processing electronics, and data processor with QUANX.EXE software installed
- 20-position sample tray
- CFR 1500 Uninterrupted Power Supply, 100-120/200-240 VAC, 5/2.5 A, 50/60 Hz, single phase, 500 watts (1000 watt total power source to support data processor)
- 3000 LE Series printer

7.0 REQUIREMENTS

7.1 General

A specific area within the field office will be designated as laboratory space for sample preparation and sample analysis using EDXRF. The QuanX must be supplied with power at 115V AC, 14 amps, and equipped with an uninterrupted power source. Power for both the EDXRF instrument and the personal computer should be from the same AC line. The uninterrupted power source will provide protection against power surges and allow continuous operation in the event of a power failure. This will also insure the detector remains cool and electronics stabilized, which is crucial to the EDXRF analysis. The instrument must be placed so that free air flow around the instrument is supplied, with operating temperatures of 50 - 90 degrees Fahrenheit and relative humidity less than 80%.

7.2 Maintenance

Maintenance will be performed as specified in the Operations Manual, including:

- Daily Energy Calibration and Calibration Verification
- Weekly Fast Discriminator Check, Log System Status Values
- Semi-annual Interlock Test and Radiation Survey

Any maintenance performed on the instrumentation will be documented in a maintenance log. Additionally, instrument cleaning will be performed using a hand held canister of compressed air to clear dust from the instrument and data processor, in addition to wiping with a clean cloth.

7.3 Instrument Log

A hardbound instrument log book will be used to record the daily instrument operations. The instrument log will be maintained in accordance with the requirements of the Technical Standard Operating Procedure for Field Documentation. Data to be entered in the logbook includes, but is not limited to, date, indoor temperature and humidity and the beginning and end of each day, time, sample ID (field, calibration or other quality control), arsenic concentration, lead concentration, and quality control sample performance.

7.4 Quality Control Procedures

7.4.1 Date Check - Check the system date each day before use by typing *c:\quanx\confirm>* **DATE**. If the system date displayed in incorrect, type the correct date using the MM-DD-YY format.

7.4.2 Energy Calibration - The energy calibration is a software function that calibrates the spectrometer electronics to assure the accuracy of the energy scale. An energy calibration will be performed daily prior to use in accordance with the manufacturer's procedures (Attachment A). If an error message appears, exit the program by pressing the F10 key.

If the error reads " ACQ Aborted: Stabilizer Lost Zero Peak," upon exiting it will ask whether to "Save Value of Gain DAC." Type N for NO. Within the Procedure Menu, follow these steps:

1. Press the F7 key.again to start the energy calibration, pause for approximately 20 seconds and press the space bar to start the program. Repeat this procedure if no response is received.
2. If the first procedure does not work, exit the program by pressing the F10 key. Type *c:\quanx\confirm>* **cd** and press Enter, repeat to obtain the c: prompt. Turn the unit off, then on and wait approximately one minute. Type **cd quanx** press Enter, then **cd confirm** and press Enter. Type **Quanx** to reach the Procedure Menu. Press the F7 key and pause, then press the space bar to start the program.
3. Re-run the Energy Calibration
4. If the error persists, hit the space bar to return to main menu. Select "Low Z Unknown," pres F2 (set-up), and verify both the Acquisition Parameters and the Spectrum Processing values against the parameters as defined in Section 11 of the Spectrace Software Manual (Chapter 11). Re-set any values that vary from those defined in the Manual. Press F10 to return to the main menu, select "Mid Z Unknown" and repeat this verification for the Mid Z range.
5. Re-run the Energy Calibration

6. If the error persists, contact the Field Supervisor. The Field Supervisor will review and may repeat the troubleshooting procedures with the Analyst, and will contact the KevexSpectrace Representative if Energy Calibration cannot be achieved. If the instrument is out-of operation due to calibration failure or other problems for more than 24 hours, then the Site Manager and EPA Remedial Project Manager will be notified.

7.4.3 Initial Calibration Verification - MK will utilize a Fundamental Parameter method to check the instrument calibration using the following three standard reference materials (SRM), or equivalent:

- SRM 2709 San Joaquin Soil (Baseline Trace Element Concentrations)
- SRM 2710 Montana Soil (Highly Elevated Trace Element Concentrations)
- SRM 2711 Montana Soil (Moderately Elevated Trace Element Concentrations)

Only SRM that have been certified by the National Institute of Standard and Technology shall be utilized, and all certifications shall be reviewed and maintained. The initial calibration verification check will be performed by analyzing the three standards each day, simultaneously, following the energy calibration and prior to analysis of environmental samples. Results will be compared against the NIST acceptable concentration ranges. If one or more concentrations fall outside of the acceptable concentration ranges, the SRM will be re-analyzed. If the results remain outside of the acceptable concentration ranges following three runs, refer to Troubleshooting Procedures, which include a standardization test if necessary, to be performed as specified in the Operations Manual. Prior to proceeding to the standardization test, the following procedures may be performed:

- Turn the sample cup with mylar facing up and tap the container to loosen the soil from the mylar. Shake the sample from side to side and turn back over with mylar facing down, tap on paper towel and place in tray for re-analysis; or
- Replace the mylar.

Environmental samples will not be analyzed without verifying acceptable instrument calibration.

7.4.4 Standardization Test - If the calibration cannot be achieved following the Troubleshooting Procedures, the instrument will be re-standardized. From the Procedure Menu, select "SOIL STANDARDS 6+7". Press the F1 key and the program will prompt you to place each SRM in a designated position. Press the space bar to start the program. The printout from this test will be retained and noted in the instrument log; however, the standardization test results will need to be removed from the downloaded electronic data. If the calibration cannot be achieved following re-standardization, the Field Supervisor will be contacted. The Field Supervisor will review and may repeat the troubleshooting and standardization procedures with the Analyst, and will contact the KevexSpectrace Representative if calibration problems persists. If the instrument is out-of operation due to calibration failure or other problems for more than 24 hours, then the Site Manager and EPA Remedial Project Manager will be notified.

7.4.5 Continuing Calibration Verification - One SRM check standard will be included with the Environmental samples for every sample run. The SRM result will be verified against the NIST acceptable concentration range between each run. If the result is not within the acceptable range, troubleshooting procedures will be performed as described in 7.4.3 and 7.4.4, and the samples analyzed with that standard will need to be re-analyzed.

7.4.6 Blank Samples - Method blanks and instrument blanks will be prepared and analyzed using clean silica sand or other material specified in Method 6200. The instrument blank will be run once per every 20 samples. A method blank will be run at least daily to monitor for contamination that may have been introduced through the sample preparation. The method blank is subject to the same preparation procedures as the environmental samples. Detections in the instrument blank or method blank will require that the problem be identified and corrected prior to running additional field samples. Samples analyzed with a blank containing detected elements must be re-analyzed.

7.4.7 Performance Evaluation Samples - Performance evaluation samples may be analyzed to assess system performance. All performance evaluation samples will be identified and packaged in the same manner as environmental samples and submitted blind to the analyst.

7.4.8 Field Laboratory Duplicates - Duplicates consist of two samples extracted from one source. Laboratory duplicates will be prepared following the sample preparation by placing the prepared soil in two XRF cups and labeling one with the sample ID followed by "DUP". Laboratory duplicates will be analyzed in the same run. Results of the duplicates will be reviewed by the analyst immediately following analysis to evaluate system performance. The RPD will be calculated and entered into the instrument log. The relative percent difference (RPD) should not exceed 20% or, alternatively, the absolute difference should not exceed the MDL. If these limits are exceeded, actions should be taken as described in the Project Plan QAPP, Table 4-2.

7.4.9 Detection Limits - The AR Harding Soil Analysis Application Report (attached) presents the lower levels of detection applicable to the QuanX EDXRF (Spectrace 6000) equal to 12 ppm for arsenic and 7 ppm for lead. A detection limit study will be performed as described in Method 6200 and 40CFR Part 136, Appendix B to confirm instrument-specific sensitivity on site-specific soil. Analysis will be performed on ten aliquots of a homogenized low-concentration site-specific soil sample with arsenic and lead concentration between 2 and 5 times the expected method detection limit (As: 24 - 60 ppm, Pb: 14 - 35 ppm). The method detection limit will be defined as 3 times the standard deviation of the ten measurements. The MDL study will be repeated several times throughout the course of the project and the results will be plotted.

7.5 Sample Analysis Procedures

7.5.1 Inspect prepared samples to verify condition and proper identification. Reference Chain of Custody records to insure the samples are identified correctly.

7.5.2 Enter sample identification into XRF log book (**maximum 18 samples per run, plus one laboratory duplicate and one standard**), and enter the instrument blank and check standard identifications used for that run into log book. NOTE: (alternate check standards for each run.)

7.5.3 Open QuanX cover and load samples into sample tray, matching the log book sequence to the tray numbers. To load samples, tap each sample mylar facing down on a clean paper towel. Place sample in tray with mylar facing down so that the sample sits level. **Re-check that log book sequence number matches tray number for each sample.**

7.5.4 Close QuanX cover.

7.5.5 From the Procedure Menu screen - select "SOIL UNKNOWNS 2+3".

7.5.6 Press the F1 key to prompt "HOW MANY SAMPLES TO RUN?" Type in total number (including check standard and method blank if present) from log book and hit enter. From the sample identification screen, enter identifications from log book and press Enter after each entry. **Prior to pressing Enter following the last sample identification, re-check the sample identification entries against the log book.**

7.5.7 Press the final Enter, and the instrument will automatically start the sample analysis.

7.5.8 If an error is discovered, cancel this program by pressing the F10 key, make the necessary corrections and repeat the procedure.

7.5.9 Upon completion of analysis, the QuanX will automatically begin to print the results. The printout will report the elements analyzed, concentration in ppm, and error for each sample identification. Record the concentration of arsenic and lead results in the instrument log book and review quality control sample results as discussed in Section 7.6.

7.6 Data Export and Conversion

The data will be exported at least daily and converted to the project-required format. A daily backup of all data will be maintained.

7.6.1 Backup will be performed on the instrument-generated SPC and RESULTS data files. The SPC files contain the run date, run time and coded spectrum for each sample identification. The RESULTS file is an ascii text file containing the run date, run time, sample identification, element, results, units, and instrument-calculated error. The backup will performed as follows:

1. Press F10 to exit QuanX program
2. Type **PKZIP SPCmmdd.ZIP mmdd*.***, where mmdd is the month and date of the previous run date.
3. Type **PKZIP RESmmdd.ZIP RESULTS**
4. Place disk labeled VBI70 SPC/RES (start date) in drive a:
5. Type **COPY SPCmmdd.ZIP a:**
6. Type **COPY RESmmdd.ZIP a:**
7. When disk is full (approximately weekly), enter the ending date on the label and archive.

7.6.2 Data Export will be performed as follows:

1. Place disk labeled CONV123 into drive a:
2. Type **CONV123**
3. When prompted "Name of file is RESULTS. Do you have a different filename?" Type **N**
4. When prompted "Name of worksheet file to create is RESULTS. Do you have a different filename? Type **Y**
5. Enter new file name: **a:\mmdd**
6. Type **a:\dir** and verify file copied to disk
7. Remove disk from QuanX data processor and verify that file can be opened by Lotus 1-2-3 (loaded on a separate PC); if not, repeat steps 1-12

8. On QuanX data processor, Type **QUANX\CONFIRM**
9. Type **DEL RESULTS**
10. Type **DEL*.SPD** (make sure the period is typed between the * and the SPC, otherwise the entire program will have to be recreated)
11. Type **DEL*.ZIP** (again, make sure the period is type)
12. Type **QUANX** to execute QuanX program and return to the menu screen.

7.6.3 Data Conversion to MSAccess Template will be performed as follows:

1. Place CONV123 in drive a: and open data file mmdd
2. Delete column B and all columns labeled ERROR and SIO2
3. Select all data (minus header row) and (Edit menu) COPY
4. (File menu) OPEN, directory C:\XLSCNVRT, filetype EXCEL WORKSHEET
5. Select TEMPLATE FOR IMPORTING DATA TO ACCESS
6. Click on Column A Row 2, (Edit menu) PASTE
7. Enter date of analysis as last column
8. (File menu) SAVE AS, **a:\mmdd.xls**
9. Exit out of Lotus 1-2-3, do not save changes to the template file.

8.0 RECORDS

- NIST Certificates of Analysis for Each Standard Reference Material
- Instrument Log Book
- Maintenance Log
- Electronic and Hard Copy Instrument Data

9.0 ATTACHMENTS

A Spectrace QuanX Laboratory X-Ray Fluorescence Analyzer Standard Operating Procedure

B Soil Analysis Application Report: Low Concentration Soil Contaminant Characterization Using EDXRF Analysis

TECHNICAL STANDARD OPERATING PROCEDURE
XRF INSTRUMENT OPERATION

ATTACHMENT A

Spectrace QuanX Laboratory X-Ray Fluorescence Analyzer
Standard Operating Procedure

STANDARD OPERATING PROCEDURE

SPECTRACE QuanX EDXRF ANALYSIS of CONTAMINATED SOILS

TN spectrace

A Thermo Instruments Company

1024 Centre Ave., Suite 100E
Fort Collins, CO 80526

SPECTRACE QUANX LABORATORY X-RAY FLUORESCENCE ANALYZER STANDARD OPERATING PROCEDURE

Table of Contents

	Page Number
1.0 Scope and Application	1
1.1 Principles of Operation	1
1.1.1 Fundamentals of X-ray spectrometric measurements	1
1.1.2 Generation of spectral background	1
2.0 Overview of the method	2
3.0 Sample containers and handling	3
4.0 Interferences	3
4.1 Sample preparation error	3
4.2 Spectral interference	3
4.2.1 Lead [Pb] Lα line and arsenic [As] Kα line overlap	3
4.3 Chemical matrix interferences	3
5.0 Equipment and apparatus	4
5.1 Description of the Spectrace QuanX	4
5.2 Equipment and apparatus list	4
5.2.1 Spectrace QuanX Analyzer System	4
5.2.2 Sample preparation and presentation materials	4
5.2.3 Limits and Precautions	4
5.3 Instrument maintenance	5
5.3.1 Detector cooling	5
5.3.2 Sample chamber cleaning	5
6.0 Reagents	5
6.1 Reagents for the acquisition of peak shape spectra	5

	Page Number
6.2 Interference sample	6
6.2.1 Composition of interference sample	6
6.2.2 Formulation of the interference sample	6
7.0 Procedures	6
7.1 Prerequisites	6
7.1.1 Site location	6
7.1.2 Detector cooling	6
7.1.3 Energy calibration	6
7.1.4 Acquisition of reference peak shape spectra	7
7.2 Standardization of the Method	7
7.2.1 Setting up the standards file	7
7.2.2 Setting up the reference and spectrum processing file	7
7.2.3 Setting up the analysis technique menu in the combination procedure	8
7.2.4 Setting up the acquisition conditions	8
7.2.5 Run the analysis of the standards	8
7.2.6 Evaluation of the standardization	8
7.2.7 Set up three procedures for the analysis of unknowns	8
7.3 General keys and menu software	8
7.4 Pre operational checks	8
7.4.1 Control sample check	8
7.4.2 Resolution and stability check	9
7.5 Analysis of unknown soil samples	9
7.5.1 Prepare samples	9
7.5.2 Select the run unknowns combination procedure	9
7.5.3 Enter the number of samples to analyze	9
7.6 Minimum Detectable Limits (MDL's) of the method	9

	Page Number
7.6.1 Non target elements method MDL's	9
7.6.2 Target elements MDL's	9
7.6.3 Typical MDL's for the Spectrace QuanX for soils	9
8.0 Sample preparation	10
9.0 Calculations	10
9.1 Minimum detectable level (MDL) calculation for non-target elements	10
9.2 MDL calculation for target elements	10
9.3 Minimum quantitation level (MQL)	10
10.0 Quality assurance/quality control	11
10.1 Precision	11
10.2 Accuracy	11
10.2.1 Matrix considerations	11
11.0 References	12
12.0 Bibliography	12

List of Figures

1. Copper calibration disk spectrum	13
2. Standards file data	13
3. Reference file setup for Low Z standards	13
4. Mid Z reference file setup	14
5. High Z reference file setup	14
6. Example of a Low Z acquired spectrum	15
7. Example of a Mid Z acquired spectrum	16
8. Example of a High Z acquired spectrum	17
9. Example of a Spectrace QuanX unknown printout	18
10. Resolution and stability output example	19
Addendum to the Standard Operating Procedure	A-1

SPECTRACE QUANX LABORATORY X-RAY FLUORESCENCE ANALYZER STANDARD OPERATING PROCEDURE

1.0 Scope and Application

This document addresses the application of energy dispersive X-ray fluorescence spectrometry (EDXRF) to the determination of contaminant metals in soil and sediments. The EDXRF technique is capable of both qualitative and quantitative analysis of elements with atomic numbers 11 (sodium) through 92 (uranium). This operating procedure discusses the determination of the elements listed in Table 1.

Table 1. Elements and their atomic symbols analyzed by the EDXRF method.

Arsenic (As)	Manganese (Mn)
Barium (Ba)	Mercury (Hg)
Cadmium (Cd)	Nickel (Ni)
Calcium (Ca)	Potassium (K)
Chromium (Cr)	Silver (Ag)
Copper (Cu)	Titanium (Ti)
Iron (Fe)	Zinc (Zn)
Lead (Pb)	

1.1 Principles of Operation

The Spectrace QuanX is a benchtop mounted, laboratory grade EDXRF instrument. A one, ten or twenty position sample changer is available for sample analyses.

1.1.1 Fundamentals of the X-ray spectrometric measurements

The basis of X-ray fluorescence spectrometry is the interaction of X-rays produced by the Spectrace QuanX X-ray tube with the constituents of the soil or sediment sample.

When atoms in a soil sample absorb the tube x-radiation, the energy causes the ejection of an electron from the atomic cloud. Next, electronic transitions occur to return the excited atom to a ground energy state. These transitions result in emission of a *characteristic* X-ray. The energy of the characteristic X-ray indicates the atomic number of the emitting atom and the specific electronic transition that occurred. (Reference 1,2)

The lithium drifted silicon (Si(Li))detector converts the characteristic X-ray energy into an electronic signal. The electronics in the Spectrace QuanX further processes the signal and displays the X-ray spectrum on a personal computer.

1.1.2 Generation of spectral background

When the X-ray tube shines on the soil sample, some of the X-rays are scattered toward the detector rather than absorbed by the soil. The X-ray spectrum then shows the scattered radiation as background under the elemental emission lines. The magnitude of the background limits the achievable minimum detectable limit for the target contaminant elements.

The peak fitting and deconvolution software of the Spectrace QuanX filters background signal prior to quantitative analysis. Each soil spectrum then can be compared with another without regard to background variations.

2.0 Overview of the method

Three spectra are acquired for each EDXRF measurement. Each spectrum optimizes one or more target elements or matrix constituents of the sample. Standardization of the EDXRF method relies on National Institutes of Standards and Technology (NIST) certified soil standard materials.

Elemental emission peak deconvolution is followed by quantitative analysis with a fundamental parameters method. The fundamental parameters method can accurately determine the composition of a sample even though the standards used do not cover the range of concentrations expected. Additionally, fundamental parameters can address matrix interactions from widely varying soil types.

Calibration by fundamental parameters proceeds by completely defining for the program each standard sample's composition, including the major components (ex. Fe, Ca). Many instances arise when a portion of the matrix may be better estimated by a difference component. For soil, the difference component is defined as SiO_X where X can be 2 - 5. When X = 5, a composition of 24% Si and 45% O results that approximates the concentrations found in most soils types.

The tube output distribution is calculated by the program followed by determination of the matrix independent pure element count rate (PECR) for each analyte. The routine then develops a set of theoretical standards. Next, the routine computes the theoretical X-ray intensity expected for each analyte using the Sherman (Reference 3) formula

$$I_L = \omega_A g_L \frac{r_A - 1}{r_A} \frac{d\Omega}{4\pi} \int_{E_{abs}}^{E_{max}} \frac{I_E C_A \mu_A(E) \csc\phi}{\mu_M(E)\csc\phi + \mu_M(E_A)\csc\psi} \quad \text{Eq. 2.1}$$

where:

I_L - intensity of the analyte emission line;
ω_A - fluorescent yield of analyte A;
g_L - fractional value of the measured analyte line (L) in its series;
r_A - absorption edge jump ratio of analyte A;
$\frac{d\Omega}{4\pi}$ - fractional value of the fluorescent X-ray that is directed toward a detector;
E_{max} - maximum tube output X-ray energy;
E_{abs} - absorption edge energy of analyte A;
I_E - intensity of the primary X-ray beam at energy (E);
C_A - concentration of analyte A;
$\mu_A(E)$ - mass absorption coefficient on analyte A for X-ray energy (E);
ϕ - incident angle of primary beam;
$\mu_M(E)$ - mass absorption coefficient of the matrix for X-ray energy (E);
$\mu_M(E_A)$ - mass absorption coefficient of the matrix for analyte X-ray;
ψ - take off angle of the fluorescent emission.

Combining the theoretical standard and intensity information, alpha influence coefficients are determined by solving simultaneous equations of the form developed by Lachance and Traill (Reference 4) shown in equation 2.2 below. Alpha coefficients describe the quantitative effect of each matrix element on an analyte's measured X-ray intensity.

$$C_i = B_i + K_i I_i \left(1 + \sum_{j=1}^{n} \alpha_{ij} C_j\right) \qquad \text{Eq. 2.2}$$

where:

I_i = X-ray intensity of element i;
α_{ij} = alpha coefficient describing the matrix interaction of element j on analyte i;
C_i = concentration of analyte element i;
K_i = slope term;
B_i = intercept term;
C_j = concentration of matrix element j.

Unknowns are quantified by estimating analyte concentration from the measured intensity and the alpha coefficients. Next, theoretical intensities are calculated from equation 2.1 and compared to the measured intensities. If the intensities are more than 1% different, a new estimate of concentration is made and the theoretical intensity computation is repeated. The iteration continues until the theoretical and measured intensities converge (Reference 5).

3.0 Sample containers and handling

After sample collection by EPA approved protocol, samples should be stored in either metal free glass jars or polyethylene bags. In the lab, only disposable wooden or plastic spatulas and clean glass drying containers should contact the soil samples.

4.0 Interferences

The EDXRF method is a total elemental analysis technique. Errors can arise for the following sources:

4.1 Sample preparation error

The nature of soil samples require an approach to such variables as moisture, particle size, and heterogeneity and representitiveness of the sample to the soil at the site. Sample preparation as outlined in this SOP minimizes or eliminates the effects of many of these variables on the EDXRF result.

4.2 Spectral interference

Emission line overlap can be severe depending on the spectral peak position and relative concentrations of the overlapping elements. The Spectrace software utilizes a multiple linear least squares deconvolution method that provides accurate analyte peak intensities for subsequent quantification.

4.2.1 Lead [Pb] Lα line and arsenic [As] Kα line overlap

Accurate peak deconvolution is obtained at lead concentration to arsenic concentration ratios of 17:1 (Reference 6).

4.3 Chemical matrix interferences

Quantitative X-ray fluorescence analysis is a comparison analytical method; EDXRF spectrometer response for an elemental emission line is evaluated with respect to the known concentration of the element in a standard material. Contaminated soils are complex samples in regard to their overall elemental composition. Matrix effects are defined as the impact that the concentration variations of major soil components (ex. Ca, Fe, Si) has on measured analyte X-ray emission intensity.

The fundamental parameters method mathematically corrects analyte intensities with respect to concentration variations of sample matrix components

5.0 Equipment and apparatus

5.1 Description of the Spectrace QuanX

The Spectrace QuanX is a benchtop mounted, laboratory grade, energy dispersive X-ray fluorescence (EDXRF) spectrometer. It has found wide application in the analysis of soils, sediments, hazardous waste, and waste oil materials.

The instrument utilizes a high flux rhodium [Rh] or tungsten [W] anode X-ray tube which is positioned to direct X-rays onto the sample. Standard equipment includes a liquid nitrogen cooled lithium drifted silicon [Si(Li)] solid state X-ray detector. Optionally, an electronically cooled Si(Li) detector could be substituted.

Pulse processing electronics in the Spectrace QuanX chassis communicate spectral data to a personal computer. The personal computer displays and processes spectral information, and outputs elemental concentration data.

5.2 Equipment and apparatus list

5.2.1 Spectrace QuanX Analyzer System

The complete Spectrace QuanX Analyzer system includes:

- Spectrace QuanX cabinet
- Spectrace QuanX operators manual
- Personal computer (a 486 is recommended) with QUANX.EXE software installed and a printer.
- Spectrace QuanX technical manual

5.2.2 Sample preparation and presentation materials

- Sample communition device - mechanical grinder (tungsten carbide) or manual grinding device - mortar and pestle (tungsten carbide)
- Drying oven - conventional (115 degrees Celsius) or microwave
- 10 mesh brass sieve
- Drying containers (glass or polyethylene)
- Disposable X-ray cups (32 mm outside diameter)
- Polypropylene window film (0.25 mil thickness)

5.2.3 Limits and Precautions

Spectrace QuanX operators are protected from accidental exposure to X-rays by a lid lock and interlocks on all covers. If any problems arise with the X-ray on indicator light on the front panel or with the interlock system contact your Spectrace Instruments service engineer.

Beryllium windows are present on the X-ray tube and detector. Do not allow any sample or debris to fall on the window to avoid puncturing it. If a window should break note the beryllium metal is poisonous. Use extreme caution when collecting broken beryllium pieces. Consult your Spectrace Instruments service engineer for advice on cleanup of broken windows.

Liquid nitrogen detectors require periodic replenishing of the cryogenic liquid. Contact of cryogenic liquids to skin can be dangerous. Wear loose fitting, insulating clothing and avoid spilling the liquid nitrogen.

5.3 Instrument maintenance

5.3.1 Detector cooling

If a liquid nitrogen cooled detector is employed, refill the dewar every 7 days or more frequently if required.

If the Spectrace QuanX is equipped with an electronically cooled detector, ensure the free flow of air around the spectrometer cabinet. Additionally, a supply of uninterruptable 110V AC power is recommended.

5.3.2 Sample chamber cleaning

Keep debris and dust wiped from the chamber. Do not use forced air to dust the chamber because the detector beryllium window is fragile.

6.0 Reagents

A first step in the determination is to acquire a library of reference peak shapes for emission peak deconvolution.

6.1 The following reagents for the acquisition of peak shape spectra:

Potassium carbonate	Tungsten oxide
Calcium carbonate	Mercury oxide
Titanium dioxide	Lead oxide or metal
Vanadium oxide	Arsenic oxide
Chromium oxide	Rubidium carbonate
Manganese oxide	Strontium carbonate
Iron oxide	Zirconium oxide
Copper metal	Silver metal
Cobalt oxide	Cadmium metal
Nickel metal or chloride	Tin metal
Zinc metal or oxide	Antimony oxide
	Barium carbonate

All compounds or metals should be Analyzed Reagent grade or better.

6.2 Interference sample

When lead [Pb] metal or oxide is used to produce the reference lead emission lines the Lα and Lβ ratio does not accurately reflect the ratio found in soil spectra (Reference 6). For this reason, an interference sample is used to generate the lead reference spectrum.

6.2.1 Composition of interference sample

Boric acid [H_2BO_3] - 15.8%
Silicon dioxide [SiO_2] - 50%
Aluminum trioxide [Al_2O_3] - 20%
Calcium oxide [CaO] - 11%
Iron oxide [Fe_2O_3] - 1%
Iron metal [Fe] - 2%
Lead nitrate [$Pb(NO_3)_2$] - 0.2%

6.2.2 Formulation of the interference sample

The materials listed in section 6.2.1, weighed to proper proportions, are introduced into a mechanical grinding vessel and ground for 3 minutes. This material is available from the Spectrace Instruments Applications Department upon request.

7.0 Procedures

7.1 Prerequisites

7.1.1 Site location

The instrument must be placed so that free air flow around the instrument is supplied. Operate at temperatures of 50 -90 degrees Fahrenheit and relative humidity between 20 - 80% only. Power requirements are 115 V AC, 14 amps and a power conditioner/filter is recommended. Power both the Spectrace QuanX instrument and the personal computer from the same AC line.

7.1.2 Detector cooling

Two modes of Si(Li) cooling can be employed. If a liquid nitrogen cooled detector is used, the dewar must be replenished with liquid nitrogen every seven days or as needed.

Electronically cooled detectors require AC power during operation, however, Spectrace Instruments recommends continuous power to the system so that the detector remains cool and electronics stabilized.

7.1.3 Energy calibration

Once every twenty four hours, the gain setting of the instrument must be checked using the copper calibration disk supplied by the manufacturer. Execute the automated "ENRGY CALIB" function from the procedure menu. The computer automatically adjusts electronics gain to ensure proper calibration. This function normally takes between 8 and 10 minutes. Figure 1 shows the copper emission spectrum displayed during energy calibration.

7.1.4 Acquisition of reference peak shape spectra

The acquisition of reference spectra is only required once. As long as no pulse processing modules have changed, these peak shape references remain valid. Often, this procedure can be done at the manufacturers site.

Place the materials listed in section 6.1 and the interference sample described in section 6.2 in individual X-ray cups with polymer window film seals. Then acquire the following spectra in a subdirectory labeled \REFS with the conditions listed below. Reference is made to DOS file naming structure below. Consult Chapter 4 of the Operators Manual or a DOS manual.

- 10 kV, aluminum filter. - for the elements potassium, calcium, titanium, vanadium, chromium, and iron. Save the spectra individually in the \REFS subdirectory with the spectrum number equal to the atomic number (i.e. potassium [K] - SPECTRUM.19). Place the cursor on the Kα peak of each element emission and allow at least 30,000 counts to acquire in the channel.

- 35 kV, thick palladium filter - for the elements cobalt [Co], nickel [Ni], zinc [Zn], bromine [Br], arsenic [As], rubidium [Rb], strontium [Sr], and zirconium [Zr]. Save the spectra individually in the \REFS subdirectory with the spectrum number equal to the atomic number (i.e. cobalt [Co] - SPECTRUM.27). Place the cursor on the Kα peak of each element emission and allow at least 30,000 counts to acquire in the channel. For the L line emission of mercury [Hg], lead [Pb], and tungsten [W] allow at least 10,000 counts to acquire in the Lα channel. Save the spectrum as 100 + the atomic number (mercury [Hg] - SPECTRUM.180). For the interference sample, use the same conditions as above but allow the spectrum to acquire for 1000 seconds livetime and save the spectrum as SPECTRUM.199.

- 48 kV, thin copper filter - for the elements silver [Ag], cadmium [Cd], tin [Sn], antimony [Sb], and barium [Ba]. Save the spectra individually in the \REFS subdirectory with the spectrum number equal to the atomic number (i.e. silver [Ag] - SPECTRUM.47). Place the cursor on the Kα peak of each element's emission line and allow at least 30,000 counts to acquire in the channel.

7.2 Standardization of the Method

Standardization of the Spectrace QuanX uses a set of NIST certified reference materials and/or site specific calibration standards. By using these materials, the EDXRF standardization then can be referenced to NIST certificates or an independent analysis referee method. Standardization adjustment can be affected by including or omitting a particular analyte element in a standard or addition or removal of a standard sample altogether.

7.2.1 Setting up the standards file

For the standards NIST 2709, 2710, 2711, 2704, 8407, 8408 type in the standards file as shown in Figure 2. Parentheses indicate that the concentration is to be used to define the matrix of the standard but <u>not</u> to be used for estimation of analyte sensitivity. Generally, those concentrations in the standard less than 50 ppm are defined in parentheses. A blank indicates that the component is either not present or is at a concentration near the minimum detectable limit of the method. Consult the Spectrace Instruments Fundamental Parameters software manual for further details.

7.2.2 Setting up the reference and spectrum processing file.

Enter the reference file following the instructions in Chapter 4 of the Spectrace Instruments QuanX users manual.

7.2.3 Set up the analysis technique menu in the combination procedure, see setup of multiple procedures in Chapter 4 of the Spectrace QuanX operators manual.

7.2.4 Set up the acquisition conditions as follows:

Low Z procedure: 10 kV tube voltage, 0.70 mA tube current, aluminum (0.13 mm) filter, and 100 seconds analysis livetime. Figure 6 is an example of a Low Z acquired spectrum.

Mid Z procedure: 35 kV tube voltage, 0.12 mA tube current, thick palladium [Pd] filter (0.13 mm), 200 seconds analysis livetime. Figure 7 is an example of a Mid Z acquired spectrum.

High Z procedure: 48 kV tube voltage, 0.10 mA tube current, thin copper filter (0.37 mm), 200 seconds analysis livetime. Figure 8 is an example of a High Z acquired spectrum.

7.2.5 Run the analysis of the standards.

7.2.6 Evaluation of the standardization:

Table 2 lists the pure element count rates for the standardization. The pure element count rates should be within 20% relative of these values.

Table 2. Pure element count rates for the elements analyzed.

Element	Pure Element Count Rate	Element	Pure Element Count Rate
Arsenic	55255	Manganese	33990
Barium	12071	Mercury	6115
Cadmium	27123	Nickel	26386
Calcium	10665	Potassium	6795
Chromium	30341	Silver	27115
Copper	25583	Titanium	18365
Iron	34186	Zinc	28131
Lead	9450		

7.2.7 Set up three procedures for the analysis of unknowns, identical to steps 7.2.2 to 7.2.4 except indicate a combination procedure in the mode "Run unknowns" in the analysis technique menu. Figure 9 is an example of a Spectrace QuanX soil sample unknown printout.

7.3 General keys and menu software

The Spectrace Instruments Operators manual and Fundamental Parameters software manual should be consulted for operation and flow of analysis of the Spectrace software.

7.4 Pre operational checks

7.4.1 Control sample check

One of the six NIST soil standards or a well characterized sample from the site is analyzed as an unknown. Plot the concentration response for at least one element (preferably a target analyte) from each of the three acquisition conditions on a control chart. For those analytes with greater than 100 ppm concentration, the result should be within 20% of the known

elemental concentration. If a result exceeds the 20% limit, restandardize the method as described in section 7.2.

If more than one measurement of an element in a set of five exceeds the Upper or Lower control limit (± 3 x standard deviation of the charted data) perform a resolution and stability check.

7.4.2 Resolution and stability check

A resolution and stability check should be performed if the test outlined in section 7.4.1 fails. See the sample output in Figure 10 or consult the Spectrace Instruments Model QuanX Technical manual for details. Contact a Spectrace service engineer if the instrument fails this test.

7.5 Analysis of unknown soil samples

7.5.1 Prepare samples as indicated in Section 8.0.

7.5.2 On the procedure menu, select the run unknowns combination procedure setup in Section 7.2.7.

7.5.3 Hit the F1 "RUN" key and enter the number of samples to analyze and the identifying label for the first soil sample. Repeat for all individual samples in the set to be analyzed. Figure 9 is an example of a Spectrace QuanX soil sample unknown printout.

7.6 Minimum Detectable Limits (MDL's) of the method for the Spectrace QuanX

7.6.1 Non target elements method MDL's

Determination of the non-target elements' MDL's proceeds by averaging the counting statistic error from the "CONCENTRATION ERROR" printout header for the element in each of the six standards. This average, multiplied by 3 is the MDL reported for that element.

7.6.2 Target elements MDL's

For the target elements, select the NIST standard which comes closest to the action level concentration for the target. Then using the "PEAK BACKGROUND" printout format use equation found in section 8.1 to determine MDL's.

7.6.3 Typical MDL's for the Spectrace QuanX for soils are listed below in Table 3.

Table 3. Minimum detectable levels of EDXRF analyzed elements.

Element	MDL (mg/kg)	Element	MDL (mg/kg)
Arsenic	8	Manganese	12
Barium	35	Mercury	8
Cadmium	2	Nickel	7
Calcium	90	Potassium	120
Chromium	16	Silver	2
Copper	4	Titanium	18
Iron	11	Zinc	4
Lead	4		

8.0 Sample preparation

8.1 First agitate the sample in its glass or bag container to mix the soil material.

8.2 Using a wooden spatula, transfer approximately 15 grams of sample material onto the glass drying container.

8.3 Place in the drying oven and drive off moisture.

8.4 Sieve dried material through 10 mesh screen and discard the fraction held in the screen.

8.5 Transfer the material passing through the screen to the grinding vessel and grind for a preset period of time to assure -250 mesh material.

8.6 Transfer approximately 8 grams of the dried material into a labeled disposable X-ray cup and seal with one sheet of polypropylene window film.

9.0 Calculations

9.1 MDL calculation for non-target elements

Calculation of the MDL for the non-target elements is three times the average counting statistics error. Use the "CONCENTRATION ERROR" report format to obtain the data.

9.2 MDL calculation for target elements

Calculation of the MDL for the target elements uses Equation 9.1 below and requires peak and background counting data from an NIST certified soil standard reference material containing a concentration of the target element closest to the predetermined action level. Use the report format "PEAK BACKGROUND" to obtain the data for this calculation.

$$MDL = \frac{3 \times \sqrt{B}}{P} \times conc. \quad \text{Eq. 9.1.}$$

Where the variables are defined as:

MDL - minimum detection level;
B - background counts under fitted analyte peak;
P - fitted peak counts of analyte peak;
conc. - concentration of analyte from standard reference material certificate provided by NIST.

9.3 Minimum Quantitation Level (MQL)

The minimum quantitation level (MQL) is the concentration of analyte required to ensure a measurement precision of 10% relative standard deviation. Equation 9.2 illustrates the calculation of MQL.

$$MQL = 3 \times MDL \quad \text{Eq. 9.2.}$$

10.0 Quality assurance/quality control

10.1 Precision

Precision data is accumulated in the pre-operational check listed section 7.4. Figure 7 lists typical analytical precision for NIST 2710. Keep in mind that precision is a function of counting time and the number of peak counts and background counts collected for the analyte. Precision in EDXRF measurements is predicted by counting statistics as shown in the following equation:

$$Rel.\ \sigma_{theo} = \frac{\sqrt{P + 2 \times B}}{P} \times 100\% \qquad \text{Eq. 10.1}$$

The Spectrace Instruments model QuanX typically provides measurement precision (indicated by the control chart plotted in section 7.4) 1.2 - 1.8 times the σ theoretical. Several acquisitions of the control sample are required prior to making this determination.

10.2 Accuracy

The accuracy of an EDXRF measurement can be verified in two ways. First, certified soil reference materials (procured from the NIST or other standard generating entity) not utilized in the Spectrace QuanX standardization are analyzed as soil unknowns as outlined in Section 7.5. Verify that results for target elements near the predetermined action concentration level are within 20% of the certified concentration for the standard.

Second, a subset of samples (10% at the minimum), preferably near the action concentration level, are submitted to a laboratory for acid digestion and ion-coupled plasma emission or atomic absorption spectrometric (ICP/AA) analysis. The split submitted should be taken of the prepared soil material subsequent to Section 8.5. Target elements exhibiting a regression analysis (EDXRF data versus ICP/AA data) r^2 value greater than 0.95 have been considered QA3 level data. Regression analysis producing r^2 values of 0.7 or above can be considered QA1 level (field screening) data. To improve the r^2 value, ICP/AA analyzed soil materials maybe added to the standards file setup in 7.2.1. The utmost discretion should be used to alter the standardization method of section 7.2. Laboratory data should be provided for all the elements listed in the standards file (Figure 2). Short of that potassium, calcium and iron along with the target elements must be determined in the potential site specific standard samples.

10.2.1 Matrix considerations

Complimentary QA/QC verification include analysis of soils with varying matrix composition. Of interest is the effect on EDXRF results when analyzing samples with high siliceous or calcareous soils or soils with high iron composition.

Additionally, acid digestion and ICP/AA analyzed site specific standards can introduce error due to variable recoveries, caused by soil matrix differences, of target elements. When site specific standards are used, errors are propagated into the EDXRF standardization. For a discussion of site specific standardization see Reference 7 and the addendum to this SOP.

11.0 References

(1) E.P. Bertin, "Principles and Practice of X-ray Spectrometric Analysis", 2nd ed., Chap. 2, Plenum Press, New York (1975).

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(6) J. Ashe, Presented at NIST Workshop "Accuracy of Lead Measurements of Paint, Soil and Dust Samples by Laboratory-Based XRF", Peter Pella chairman, Boulder, CO, 1993.

(7) Addendum to NIST Montana Soils Standard Reference Materials (2709, 2710, 2711) Analysis Certificate, 1993

12.0 Bibliography

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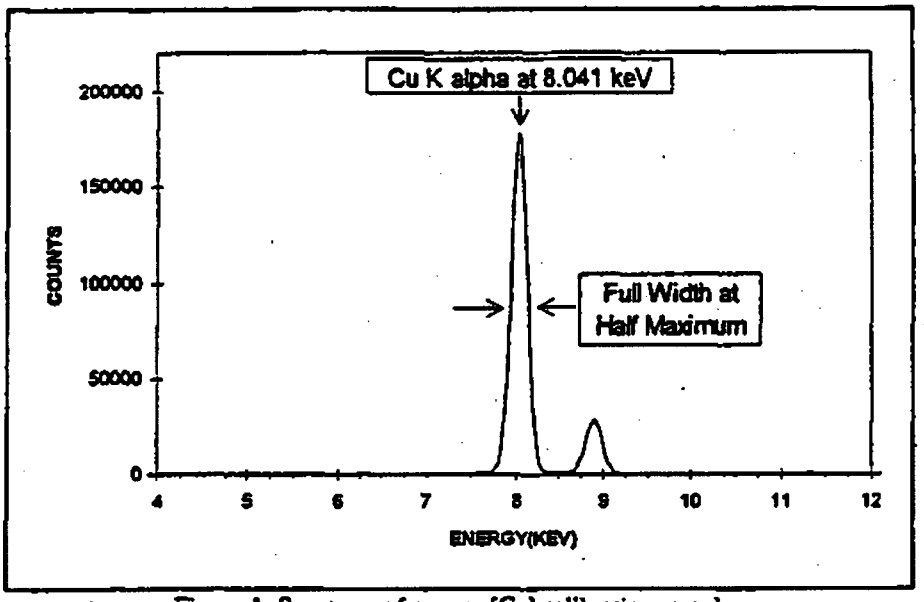

Figure 1. Spectrum of copper [Cu] calibration sample.

Sample ID	K %	CA %	TI %	CR PPM	MN PPM	FE %	NI PPM	CU PPM	ZN PPM	AS PPM	PB PPM	HG PPM	AG PPM	CD PPM	BA PPM	SIO5 DIFF
2710	2.11	1.25	0.283	(39)	10110	3.38		2950	6952	626	5532	(32)	35	(22)	707	
2711	2.45	2.88	0.306	(47)	638	2.89		114	350	105	1162			42	726	
2704	2	2.6	0.457	135	555	4.11		99	438	(23)	161				414	
2709	2.03	1.89	0.342	130	538	3.5	88	35	106						968	
8408	(1.5)		(0.56)	(88)	(1400)	(2.6)			(160)		(80)	107			(360)	
8407	(1.7)		(0.44)	(98)	(970)	(2.42)			(230)		(96)	50			(400)	

Figure 2. Standards file data.

SPECTRUM PROCESSING- PROCEDURE 2- LOW Z STANDARDS

1.	*AR K	- XML-FITTING	< 2280 - 3660 EV >
2.	K KA	- XML-FITTING	< 2640 - 4060 EV >
3.	CA KA	- XML-FITTING	< 3000 - 4480 EV >
4.	TI KA	- XML-FITTING	< 3820 - 5420 EV >
5.	*V KA	- XML-FITTING	< 4240 - 5920 EV >
6.	CR KA	- XML-FITTING	< 4700 - 6440 EV >
7.	MN KA	- XML-FITTING	< 5180 - 7000 EV >
8.	FE KA	- XML-FITTING	< 5680 - 7560 EV >
9.	*BA L	- XML-FITTING	< 3480 - 6360 EV >

Figure 3. Reference file setup for Low Z standards.

SPECTRUM PROCESSING - PROCEDURE 3 MID Z STANDARDS

1.	*MN	- XML-FITTING	< 5300 - 6940 EV >
2.	*FE	- XML-FITTING	< 5880 - 7580 EV >
3.	*CO	- XML-FITTING	< 6260 - 8060 EV >
4.	NI KA	- XML-FITTING	< 6740 - 8780 EV >
5.	CU KA	- XML-FITTING	< 7300 - 9440 EV >
6.	ZN KA	- XML-FITTING	< 7880 - 10100 EV >
7.	AS KA	- XML-FITTING	< 9760 - 12420 EV >
Φ8.	PB LB	- XML-FITTING	< 9900 - 13480 EV >
Φ9.	*PBLL	- XML-FITTING	< 8680 - 9660 EV >
Φ10.	*PBLG	- XML-FITTING	< 13840 - 16280 EV >
11.	*RB	- XML-FITTING	< 12560 - 15820 EV >
12.	*SR	- XML-FITTING	< 12980 - 16740 EV >
13.	*ZR	- XML-FITTING	< 14900 - 18580 EV >
14.	*BR	- XML-FITTING	< 11060 - 13960 EV >
15.	HG LB	- XML-FITTING	< 9300 - 13000 EV >
16.	*W LA	- XML-FITTING	< 7780 - 106600 EV >

Φ- Region No. 8 is defined using the interference sample spectrum C:\REFS\SPECTRUM.199.

Φ- Regions Nos. 9 and 10 are defined using a pure Pb sample spectrum C:\REFS\SPECTRUM.182.

Figure 4. Mid Z reference file setup.

SPECTRUM PROCESSING- PROCEDURE 4 HIGH Z STANDARDS

1.	AG KA	- XML-FITTING	< 21120 - 26120 EV >
2.	CD KA	- XML-FITTING	< 22120 - 27300 EV >
3.	SN KA	- XML-FITTING	< 24160 - 29840 EV >
4.	SB KA	- XML-FITTING	< 25220 - 31080 EV >
5.	BA KA	- XML-FITTING	< 30880 - 37980 EV >

Figure 5. High Z reference file setup.

SPECTRACE INSTRUMENTS

SPECTRUM : NIST 2711

TUBE VOLTAGE : 10 KV
TUBE CURRENT : 0.70 mA
ATMOSPHERE : AIR

FILTER USED : ALUMINUM
LIVETIME : 100 SEC

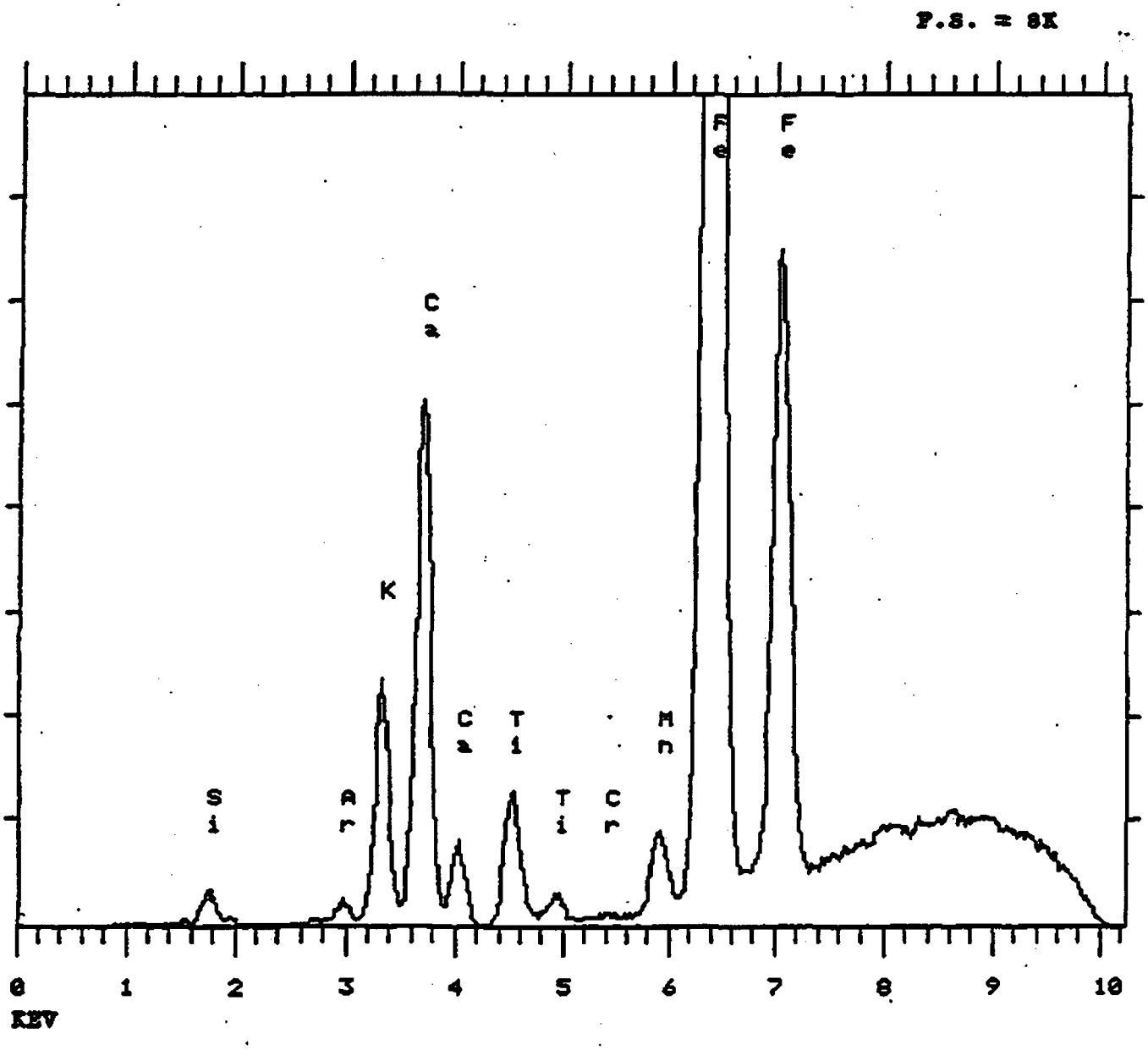

Figure 6. Example of a Low Z acquired spectrum.

SPECTRACE INSTRUMENTS

SPECTRUM : 2711

TUBE VOLTAGE : 35 KV
TUBE CURRENT : 0.10 mA
ATMOSPHERE : AIR

FILTER USED : PD THICK
LIVETIME : 200 SEC

F.S. = 2K

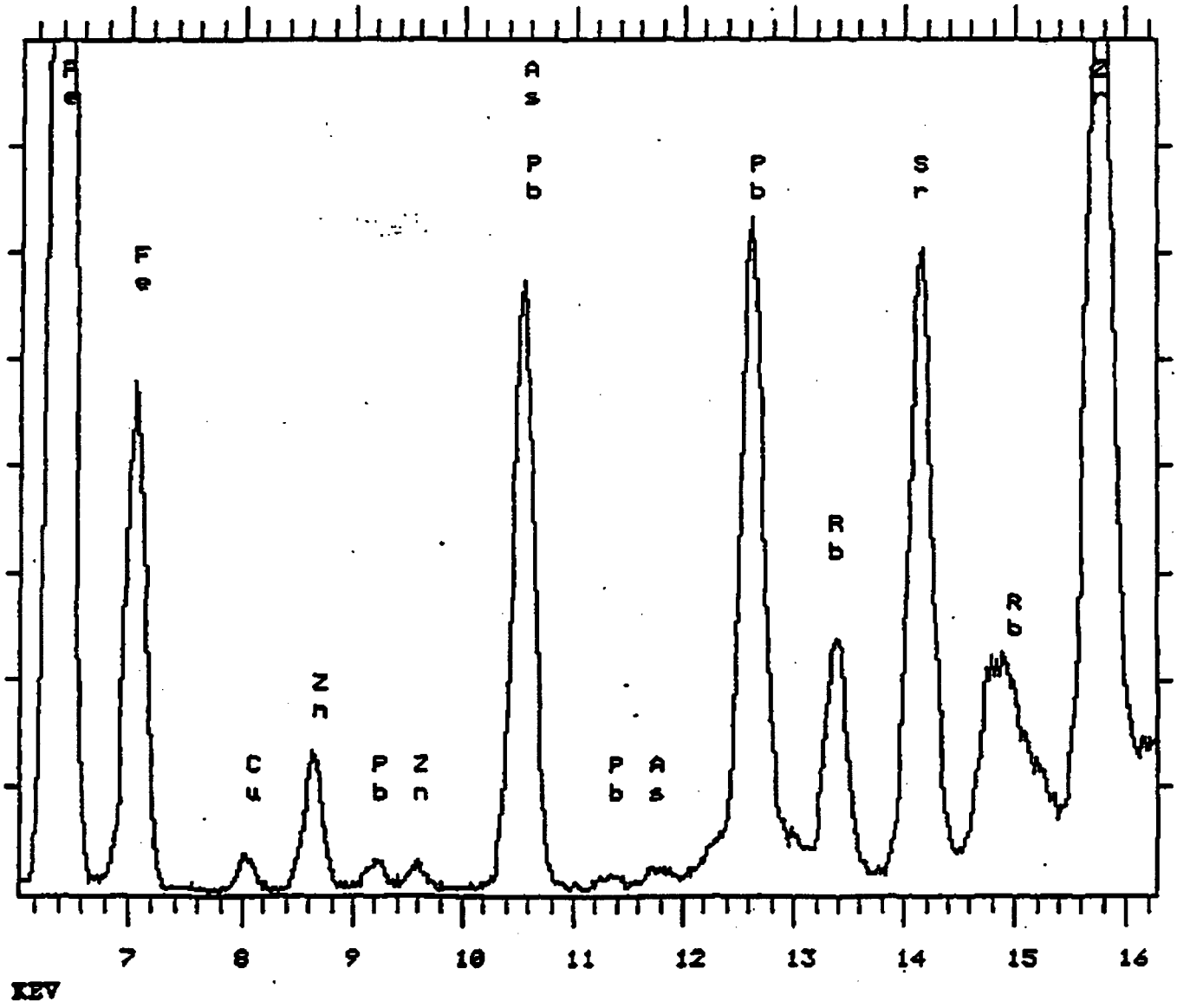

Figure 7. Example of a Mid Z acquired spectrum.

SPECTRACE INSTRUMENTS

SPECTRUM : NIST 2711

TUBE VOLTAGE : 48 KV
TUBE CURRENT : 0.10 mA
ATMOSPHERE : AIR

FILTER USED : CU THIN
LIVETIME : 200 SEC

F.S. = 4K

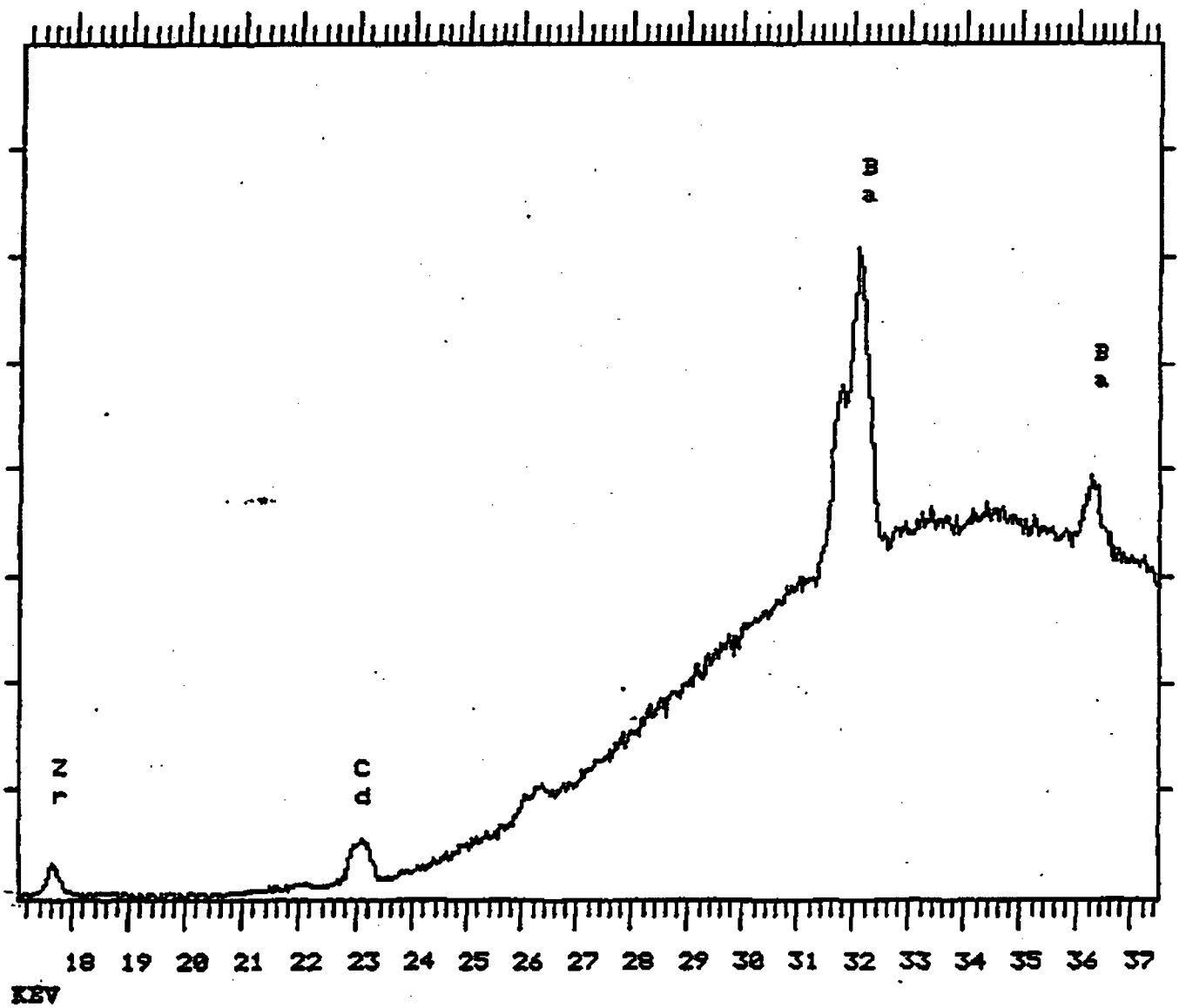

Figure 8. Example of a High Z acquired spectrum.

EDXRF ANALYSIS
SPECTRACE INSTRUMENTS

PROCEDURE : LOW Z UNKNOWNS
FILTER USED : ALUMINUM
ATMOSPHERE : AIR
COUNT RATE RANGE : MED
ANALYSIS METHOD : NO ANALYSIS

TUBE VOLTAGE : 10 KV
TUBE CURRENT : 0.70 MA
LIVETIME : 100 SEC
PRESET COUNT : 0 K

TIME : 3:03 pm

DATE : 5/16/96

EDXRF ANALYSIS
SPECTRACE INSTRUMENTS

PROCEDURE : MID Z UNKNOWNS
FILTER USED : PD THICK
ATMOSPHERE : AIR
COUNT RATE RANGE : MED
ANALYSIS METHOD : NO ANALYSIS

TUBE VOLTAGE : 35 KV
TUBE CURRENT : 0.12 MA
LIVETIME : 200 SEC
PRESET COUNT : 0 K

TIME : 3:03 pm

DATE : 5/16/96

EDXRF ANALYSIS
SPECTRACE INSTRUMENTS

PROCEDURE : HIGH Z UNKNOWNS
FILTER USED : CU THIN
ATMOSPHERE : AIR
COUNT RATE RANGE : MED
ANALYSIS METHOD : PEAK RATIOS

TUBE VOLTAGE : 48 KV
TUBE CURRENT : 0.10 MA
LIVETIME : 200 SEC
PRESET COUNT : 0 K

TIME : 3:03 pm

DATE : 5/16/96

EDXRF ANALYSIS
SPECTRACE INSTRUMENTS

PROCEDURE : COMBINATION 2+3+4
FILTER USED : PD MEDIUM
ATMOSPHERE : AIR
COUNT RATE RANGE : MED
ANALYSIS METHOD : FUN. PARAMS.

TUBE VOLTAGE : 30 KV
TUBE CURRENT : 0.02 MA
LIVETIME : 100 SEC
PRESET COUNT : 0 K

TIME : 3:04 pm

DATE : 5/16/96

SAMPLE	ELEMENT	CONCENTRATION			ERROR
335					
	K	2.528	%	+/-	0.0203
	CA	1.031	%	+/-	0.0103
	TI	0.177	%	+/-	0.0032
	CR	31.347	PPM	+/-	8.7141
	MN	1047.719	PPM	+/-	12.9442
	FE	6.713	%	+/-	0.0078
	NI	33.321	PPM	+/-	3.5587
	CU	2268.150	PPM	-/-	17.4265
	ZN	2157.262	PPM	+/-	15.0266
	AS	192.295	PPM	+/-	3.9042
	PB	271.172	PPM	+/-	4.3691
	HG	N D			
	AG	9.647	PPM	+/-	0.8334
	CD	6.495	PPM	+/-	0.9373
	BA	675.437	PPM	+/-	10.6193
	SIOS	88.882	DIFF		

Figure 9. Example of a Spectrace QuanX sample printout.

RUN #	FWHM*	PEAK CENTROID	TOTAL COUNTS	PEAK COUNTS	TIME
1	180.1	8041	2187969 ± 0.00%	1345906 ± 0.00%	12:30:28
2	179.5	8042	2189712 ± 0.04%	1346270 ± 0.01%	12:38:01
3	179.7	8042	2188745 ± 0.03%	1344938 ± 0.04%	12:45:28
4	179.6	8042	2187722 ± 0.04%	1344136 ± 0.06%	12:52:55
5	179.3	8042	2189506 ± 0.04%	1347528 ± 0.09%	13:00:22
6	179.0	8042	2189264 ± 0.03%	1345296 ± 0.08%	13:07:50
7	179.8	8042	2186424 ± 0.05%	1343684 ± 0.09%	13:15:16
8	179.3	8042	2194782 ± 0.11%	1350504 ± 0.15%	13:22:44
9	179.4	8042	2191210 ± 0.10%	1347079 ± 0.14%	13:30:12
10	179.1	8042	2191683 ± 0.10%	1347479 ± 0.14%	13:37:39

*- FWHM - full width at half maximum of the Cu K alpha peak. See Figure 1.

Figure 10. Example of resolution and stability test procedure printout.

Government agencies as well as private industry are actively investigating and remediating soils at sites contaminated by heavy metals. Energy dispersive X-ray fluorescence analysis (EDXRF) is well suited to the determination of heavy metals in contaminated soils because it is a non-destructive and accurate elemental analysis technique. Energy dispersive X-ray fluorescence spectrometers are field portable or transportable in a van or trailer. Transportable EDXRF systems can provide minimum detectable levels (MDL) below 10 ppm for most metals. Field portable EDXRF instruments provide MDLs below 50 ppm for most metals. EDXRF results correlate well with other metal analysis methods (AA or ICP).

Quantitative X-ray fluorescence analysis is a comparison analytical method; EDXRF spectrometer response for an elemental emission line is evaluated with respect to the known concentration of the element in a standard material. Simple sample matrix types such as polymers or hydrocarbons, exhibit linear X-ray intensity response over limited metal concentration ranges. Contaminated soils, by comparison, are complex samples in regard to their overall elemental composition. Matrix effects are defined as the impact that the concentration variations of major soil components (ex. Ca, Fe, Si) has on measured analyte X-ray emission intensity.

Matrix effects produce a non-linear measured X-ray intensity versus metal concentration response when analyzing soils. A classical method that addresses matrix effects, called site specific standardization, relies on a suite of standards and regression mathematics. When this aspect of EDXRF is applied to contaminated soils analysis several concerns arise as listed in Table A-1. The standard materials selected for EDXRF calibration must contain metal analyte concentrations that bracket the range found at the contaminated site. In addition, the concentrations of iron, calcium, and silicon in the standard materials must bracket those found in the soil types at the site.

Table A-1. Comparison of two standardization methods.

FP Standardization	Site Specific Standardization
☐ No site sampling required prior to project initiation;	○ Soil samples to be used as standards must be collected well in advance of project initiation date;
☐ Pure elements and/or readily available certified reference materials are used as standards (see Appendix B);	○ High costs associated with lab analysis of soils and significant time required to receive data back;
☐ Concentration levels of matrix and metals in the standards need not bracket the levels found at the site.	○ A large number of standards are required so that the matrix and metal concentrations bracket the entire range found at the site.

Figure A-1 is an example of a site specific standardization for lead in soil. The samples earmarked to be used as standards were collected during an expeditionary sampling trip to the site followed by independent analysis of the collected samples. Soil samples selected as standards (usually significantly fewer than were collected) are designated "site specific" and hopefully bracket the concentration ranges required. Some reasons for omitting a soil sample from the suite of standards may include: (1) Having several other samples possessing the same general concentrations of metals and matrix, or (2) questionable independent analysis data for a metal or matrix component.

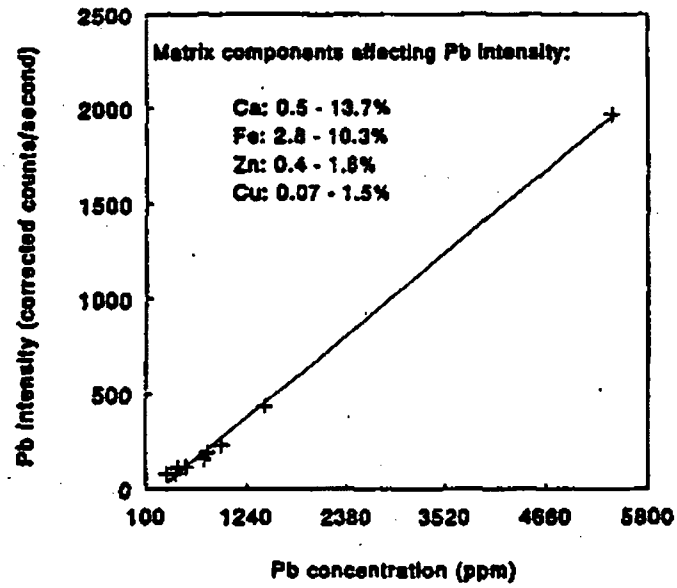

Figure A-1. Lead calibration obtained using site specific standards.

Generating site specific standards may be prohibitive for two reasons: (1) Cost considerations concerning expeditionary sampling and sufficient independent analysis to have confidence in the soil metal and matrix compositions, or (2) time constraints involving sampling and waiting for independent analysis results.

The Pb calibration curve shown in Figure A-1 is only valid if unknown soil compositions fall between 400 and 5200 ppm Pb and possess a matrix makeup in the ranges listed on the figure. While at some sites this requirement may be met, other sites may provide samples that routinely fall outside the required concentration ranges.

As a result of the constraints imposed by site specific standardization, a mathematical treatment of matrix effects designated "Fundamental Parameters" (FP) has been developed (see Table A-1). The FP routines discussed in this report provide accurate metal concentration determinations in contaminated soil samples that have wide ranges of metal and matrix concentrations. Calibration of an FP method requires only a limited set of certified generic soil standards or pure elements.

The Spectrace models 6000 and 5000 use X-ray tube excitation and the FP routine is classified as a tube modeling routine.

TUBE MODELING FP ROUTINES

Fundamental parameter routines based on tube modeling use equations describing X-ray tube intensity output distributions. Mathematical derivation of these algorithms occurred sometime ago; they have only recently been executed on personal computers.

Tube modeling routines can use pure elements or oxides of the pure elements as standards. Unfortunately, however, X-ray excitation conditions appropriate for analysis of a pure metal sample do not result in optimum sensitivities and minimum detectable metal levels in a soil matrix.

To achieve optimum X-ray analysis conditions for metals in soils, a limited set (typically six) of soil standard materials is selected. The National Institute of Standards and Technology (NIST) provides several certified reference materials satisfactory for standardization of the tube modeling FP routines.

Prior to FP standardization X-ray spectra of the standards are collected and analyzed for analyte and matrix element emission intensities. Calibration proceeds by completely defining for the program each standard sample's composition, including the major components (ex. Fe, Ca). Many instances arise when a portion of the matrix may be better estimated by a difference component. For soil, the difference component is defined as SiO_X where X can be 2 - 5. When X = 5, a composition of 24% Si and 45% O results that approximates the concentrations found in most soils types.

The tube output distribution is calculated by the program followed by determination of the matrix independent pure element count rate (PECR) for each analyte. The routine then develops a set of theoretical standards. Next, the routine computes the theoretical X-ray intensity expected for each analyte using equation 2.1 in the Spectrace 5000/6000 Standard Operating Procedure (SOP). Combining the theoretical standard and intensity information, alpha influence coefficients are determined by solving simultaneous equations of the form in equation 2.2 in the SOP. Alpha coefficients describe the quantitative effect of each matrix element on an analyte's measured X-ray intensity.

Unknowns are quantitated by estimating analyte concentration from the measured intensity and the alpha coefficients. Next, theoretical intensities are calculated from equation 2.1 and then the computed intensities are compared with the measured intensities. If the intensities are more than 1% different, a new estimate of concentration is made and the theoretical intensity computation is repeated. The iteration continues until the theoretical and measured intensities converge. Figure A-2 illustrates correlation between a tube modeling FP routine for 150 soil samples analyzed by EDXRF for Pb and Cd and inductively coupled plasma analysis (ICP) data.

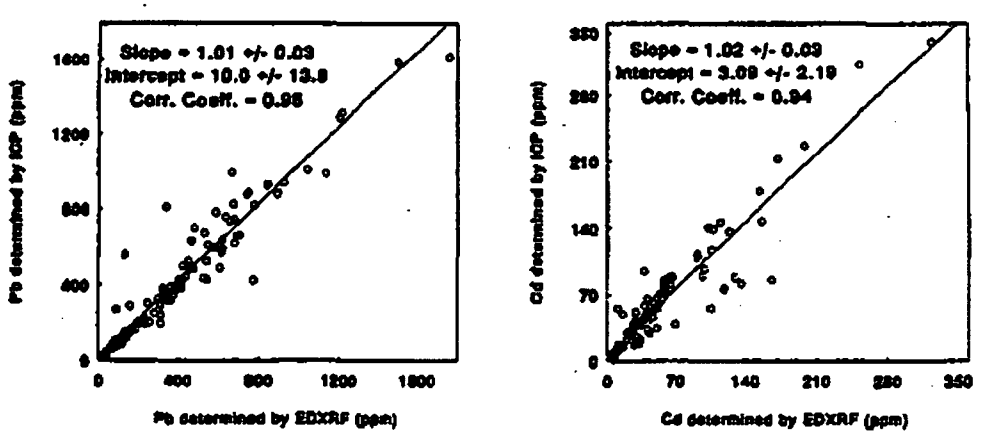

Figure A-2. Correlation plots for Pb and Cd analyzed in 150 soil samples by both EDXRF and ICP.

CONCLUSION

The incorporation of fundamental parameter routines for EDXRF analysis of soils provides accurate estimates of metal contaminant concentration with a minimum number of standard materials. FP standardization offers several advantages when compared with site specific standardization. Fundamental parameters standardization relies on pure element standards or certified standard reference soil materials. These materials are readily available, unlike site specific standards. Universal application to all soil matrix types is another merit of FP standardization. When analyzing soil samples collected from a site EDXRF results correlate well with AA and ICP methods. Fundamental parameters analysis methods provide rapid and cost effective EDXRF measurement data in contrast to site specific standardization that requires an initial sampling trip and the time interim waiting for laboratory results.

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TECHNICAL STANDARD OPERATING PROCEDURE
XRF INSTRUMENT OPERATION

ATTACHMENT B

Soil Analysis Application Report

Low Concentration Soil Contaminant Characterization Using EDXRF Analysis

LOW CONCENTRATION SOIL CONTAMINANT CHARACTERIZATION USING EDXRF ANALYSIS

AR. Harding

INTRODUCTION

Effective assessment and remediation of hazardous waste sites dictates that analytical methodologies be developed which assist in the evaluation of site contamination and simultaneously make efficient use of sampling time and resources (1). Optimally, a technique would provide on-site personnel with immediate and accurate information concerning the identity and concentration of inorganic soil contaminants (2).

Inorganic pollutants can be readily determined in contaminated soils with energy dispersive X-ray fluorescence spectrometry (EDXRF) using a thermoelectrically cooled Si(Li) detector (3). A field mobile laboratory van or trailer can accommodate the EDXRF system because the electrically cooled detector, which provides high resolution EDXRF spectra, does not require cryogenic cooling. Soil sample preparation for EDXRF analysis is minimal, therefore, short turnaround times are realized between sampling and reporting results.

This report will describe an EDXRF method developed to determine four inorganic soil contaminants: lead, arsenic, zinc, and cadmium at four sampling depths. The EDXRF results for approximately one hundred eighty soil samples will be compared to results obtained for sample splits submitted for analysis at an independent laboratory. Evaluation of low concentration arsenic detectability with elevated lead concentrations in these samples will be discussed. Accuracy and precision of the EDXRF method will also be compared to the independent methods using a standard reference material and soil samples submitted in triplicate to both laboratories.

EXPERIMENTAL

The field mobile EDXRF spectrometer used in this work was a Spectrace 6000 (Spectrace Instruments, Inc., Mountain View, CA). The EDXRF system consists of three modules: the spectrometer, the control/pulse processing electronics, and the data analysis computer. The compact size and weight (90 lbs.) of the modules permits installation of the system in a laboratory trailer or van.

The bench top spectrometer module, which can accommodate a single soil sample, is powered by 110 V line or generator feed. The excitation source used is a low powered Rh anode X-ray tube (50 KV, 0.35 mA (17 W) maximum output) positioned at a 45° incident angle to the sample. Three primary radiation filters permit optimum spectral acquisition conditions to be computer selected.

The thermoelectrically cooled Si(Li) X-ray detector is mounted at a 45° take-off angle in an inverted geometry with respect to the sample. The 20 mm2 Si(Li) crystal, which is protected by a 0.5 mil Be window, is cooled to -90°C for operation using a multi-stage thermoelectric (Peltier effect) cooler. The 300 watts produced at the detector heat sink are dissipated by forced ambient air. Thermoelectrically cooled detectors provide typical resolutions of 185 eV (Mn Ka).

A card cage module is interfaced between the spectrometer and a personal computer. The card cage components include the detector high voltage supply, the pulse processing electronics, and the control circuit board for the EDXRF spectrometer. The data analysis software executed on the PC is capable of either a fundamental parameters or empirical data treatment scheme using a combination of standard reference materials and/or site specific standards.

Sampling of the suspected waste site was performed using EPA approved protocols in a 9500' x 3500' rectangular area. Forty-three (43) cores were collected and partitioned into four depth levels: surface to 2"; 2" to 6"; 6" to 12"; and 12" to 18", and designated levels 1 through 4, respectively. At the site, samples were first homogenized and then split into two fractions. One was submitted for EDXRF analysis and the other sent to an independent lab for analysis.

The independent laboratory used EPA SW 846 (methods 3050 and 6010) methodology to determine Cd, Pb, and Zn concentrations in the soil sample splits. Arsenic was determined in those splits using SW 846 method 3050 and EPA method 206.4 (spectrophotometric).

Sample preparation for EDXRF analysis consisted of drying the sample for 4 minutes in a microwave oven followed by sieving the dried sample. Material passing through the 2 mm sieve was collected as sample and was free of large foreign objects such as pebbles and sticks. Drying the sample was required due to the variable moisture content in the submitted soils; some surface samples had the consistency of mud. The sieved soil was then ground in a Spex shatterbox grinder (Spex Ind., Edison, NJ) using tungsten carbide cups for 2 minutes. Grinding cups were subsequently cleaned using soap and tap water. The cleaned cups were rinsed with distilled/deionized water followed by isopropanol. Approximately 5 grams of prepared sample were poured into a disposable 32 mm X-ray sample cup and covered with a 6.3 um polypropylene film. Five grams of dried sample gave the equivalent of a 15 mm sample depth in the cup. Approximately twenty-five samples were prepared and analyzed per day.

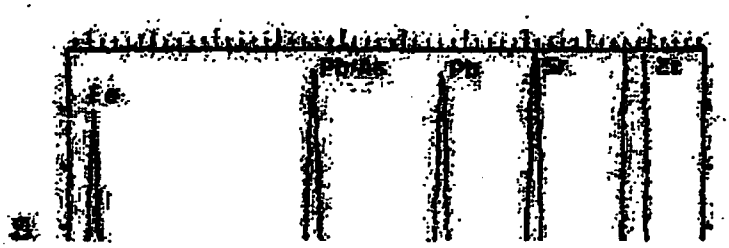
STANDARDIZATION METHOD

Two sets of excitation conditions were employed to determine seven elements in the soil samples, four of which are of specific environmental concern: Zn, As, Pb, and Cd. Table 1 lists the two sets of spectral acquisition conditions and which conditions were used to determine each analyte.

SPECTRAL REGION	CONDITIONS	ANALYTES
MID Z	35 KV, 0.35 mA, 0.13m Rh filter, 200 s livetime	Mn, Fe, Cu Zn, Pb, As
HIGH Z	50 KV, 0.35 mA, 0.63mm Cu filter, 200 s livetime	Cd

Table 1. Spectral acquisition conditions for the EDXRF analysis of soils.

Figure 1 is a mid Z spectrum of a soil sample that was found to contain 125 ppm As, 1100 ppm Pb, and 729 ppm Zn. A multiple linear least squares peak fitting routine was used for deconvolution of overlapped peaks.



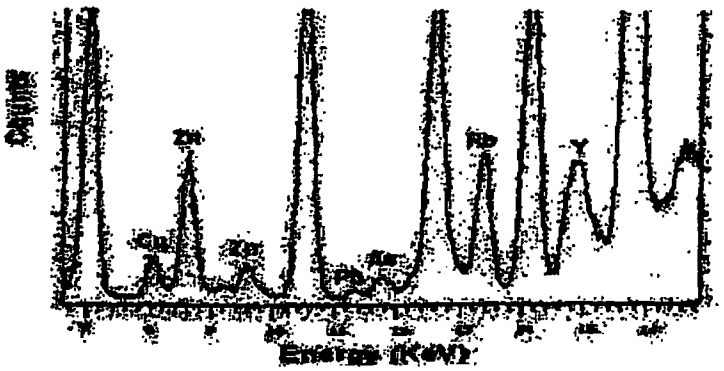


Figure 1. Mid Z spectrum of a soil sample containing 1100 ppm Pb, 729 ppm Zn, and 125 ppm As. Full scale on the y-axis is 2,000 counts.

The soil characterization method was standardized using four standard reference materials (SRM): NBS 1648 (urban particulate); NBS 2704 (river sediment); SO- 1 and SO-3, two soil standards available from the Canada Centre for Mineral and Energy Technology. Standards labeled NBS are available from the National Institute for Standards and Technology (NIST). These SRMs have certified concentrations of Fe, Mn, Cu, Zn, Pb, and Cd.

A fundamental parameters (FP) method (5) was employed as the data treatment scheme and used certified concentrations of Fe, Mn, Cu, Zn, Pb, and Cd in the four standard materials. To compute instrumental sensitivity (emission peak counts per second per ppm), the balance of the standard was assumed to be comprised of SiO2 to account for the contribution of the matrix on the measured analyte X-ray intensity. The balance component Si05 was selected to mimic the concentration of Si and 0 in typical soils, approximately 24% Si and 45% 0. Since none of the selected SRMs contain arsenic, As sensitivity (cps/ppm) was determined using a fundamental parameters theoretical calculation based on the computed Zn sensitivity. Table 2 lists the analyte sensitivities computed by the FP method.

ANALYTE	SENSITIVITY (cps/ppm)	LLD (ppm)
Mn	0.010	21
Fe	0.015	19
Cu	0.046	26
Zn	0.067	19
Pb	0.084	7
As	0.132	12
Cd	0.107	4

Table 2. Sensitivity and lower limits of detection for the analytes of interest.

There are some advantages to using an FP method for standardization compared to site specific soil standards. The FP method can use readily available, well-characterized SRMs to measure analyte sensitivities. Site specific soil standards, by contrast, are usually collected with a separate sampling mobilization. The FP method standardized with SRMs can provide accurate analyte concentrations to be determined in samples with fairly wide matrix variations without restandardization, unlike methods incorporating site specific standards.

RESULTS

Table 2 lists the lower limits of detection determined using the two sets of spectral acquisition conditions (Table 1). The pertinent equation is: LLD (ppm) = 3*sqrt(Ib)/m*sqrt(T), where Ib is the background intensity (cps), m is the analyte sensitivity (cps/ppm), and T is the acquisition livetime in seconds (6). Calculated LLD values are dependent upon spectrum acquisition times, sample matrix, and excitation conditions. The conditions in Table 1 were selected to optimize the Pb and Cd spectral regions. Improved LLDs are possible with EDXRF using longer spectrum acquisition livetimes and optimized excitation conditions for selected spectral regions.

Results for the determination of four analytes by EDXRF in 180 samples (43 cores at 4 levels, two SRMs, three samples in triplicate) were compared to independent analysis results in order to evaluate the level of agreement between the two methods. Table 3 lists the correlation plot data for the analytes in terms of actual slope, intercept, errors, and the correlation coefficient of the fit. Each analyte correlation plot included approximately 150 data points.

ANALYTE	SLOPE	INTERCEPT	CORRELATION COEFFICIENT
Pb	1.01 ± 0.03	10.0 ± 13.8	0.96
As	1.08 ± 0.05	0.98 ± 3.54	0.92
Cd	1.02 ± 0.03	3.09 ± 2.19	0.94
Zn	1.02 ± 0.02	63.0 ± 13.6	0.98

Table 3. Correlation plot data for the four analytes of environmental interest.

As shown in Table 3, slopes of the plots for Pb, Cd, Zn, and As are within 8% of 1.00 and all correlation coefficients are greater than 0.92. The calculated slope near 1.00 and correlation coefficients greater than 0.90 indicates agreement between the two analytical techniques. Figure 2 is a plot of 94 data points in the range of 0 to 300 ppm Pb. Figure 3 is a plot of 110 EDXRF and ICP analyzed samples in the range of 0 to 100 ppm Cd and also indicates agreement between the results of the two methods.

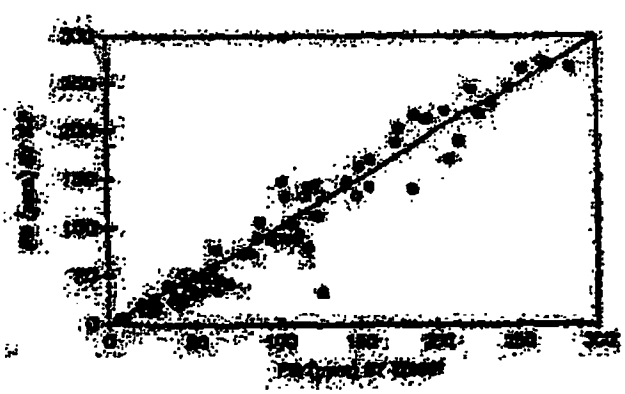
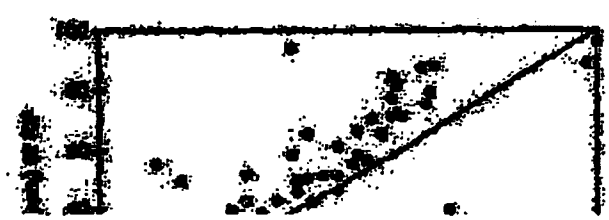


Figure 2. Pb correlation plot for 94 samples.



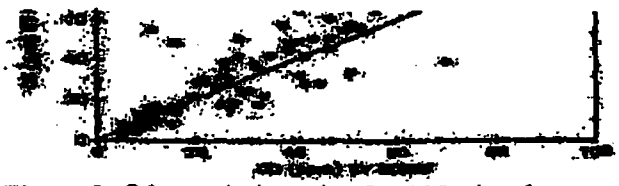


Figure 3. Cd correlation plot for 110 samples.

ACCURACY AND PRECISION

To evaluate the accuracy provided by the EDXRF method two SRMs were submitted as unknowns for EDXRF analysis as well as being submitted to the independent lab for analysis. Table 4 lists the results for SRM SO-2. EDXRF analysis of SO-2 provides results that are in good agreement with certified values. The independent ICP analysis of zinc in SO-2, however, is biased low by a factor of one-half.

Sample	Analyte	ICP	EDXRF	Certified
SO-2	Pb	19	17	21
	Zn	55	123	124

Table 4. Results of the analysis of SRM SO-2 by ICP and EDXRF methods. All values in ppm.

Precision was evaluated by submitting three samples a total of three times for independent and EDXRF analysis. Table 5 shows the results for the two methods along with the calculated standard deviation (in ppm) of the three replicate analyses. Note that Cd in sample C was only reported by EDXRF to the nearest 1 ppm and three values of 9 ppm Cd were determined, hence the zero standard deviation for the three replicates. EDXRF precision is better than 10% relative standard deviation in all but one case (As in sample C) and compares well with that provided by the independent lab.

Sample	Element	Ind. Lab	EDXRF
A	As	45 ± 4	41 ± 3
	Cd	20 ± 2	31 ± 3
	Pb	286 ± 28	312 ± 12
	Zn	185 ± 15	134 ± 10
B	As	17 ± 3	14 ± 1
	Cd	80 ± 6	58 ± 4
	Pb	141 ± 15	158 ± 3
	Zn	556 ± 39	529 ± 46
C	As	17 ± 1	19 ± 4
	Cd	10.0 ± 0.9	9 ± 0
	Pb	117 ± 8	142 ± 14
	Zn	173 ± 26	128 ± 3

Table 6. EDXRF and independent lab results for three soil samples each analyzed in triplicate. All values in ppm

CONCLUSION

Field mobile EDXRF analysis of soils suspected of being contaminated provides information concerning the nature, extent, and magnitude of the contamination. Due to the minimal sample preparation necessary for EDXRF analysis, sampling to result turnaround time is relatively short so

preparation necessary for EDXRF analysis, sampling to result turnaround time is relatively short so the most effective use of sampling resources is realized. EDXRF detection limits below 20 ppm were obtained for the elements of environmental concern. The effect of increasing lead concentration on arsenic detectability was quantified. Using the EDXRF method described here, reliable As results were found for those samples containing As/Pb concentration ratios above 0.083. Accuracy and precision for the analytes of interest using the EDXRF method was shown to be comparable to results obtained by independent analysis. Comparable results for Cd, As, Pb, and Zn between independent and EDXRF methods validates the use of EDXRF analysis for hazardous waste site investigation and remediation.

ACKNOWLEDGMENT

The author would like to acknowledge James P. Walsh and Associates for site sampling and providing the independent analysis data.

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TECHNICAL STANDARD OPERATING PROCEDURE

Date: July 15, 1999 SOP No. MK-VBI70-07

Title: **Decontamination**

APPROVALS:

Morrison Knudsen Corporation

Author: Mark Valent Date: July 15, 1999

SYNOPSIS: Provides procedures and instructions for decontamination of sampling equipment and field personnel.

Received by QA Unit

REVIEWS:

TEAM MEMBER	SIGNATURE/TITLE	DATE
EPA Region 8	Bonita Lake / RPM	7/24/99
Morrison Knudsen Corp.	Ellen McEt / Field QA Coordinator	7/16/99

REV.	DATE	REVISION DESCRIPTION

TECHNICAL STANDARD OPERATING PROCEDURE
DECONTAMINATION

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide instructions for decontamination of sampling equipment and field personnel. Decontamination is necessary to protect personnel and to minimize the potential for cross-contamination of samples. This procedure is to be used by MK employees assigned to the Vasquez Boulevard/I-70 project and their subcontractors.

2.0 SCOPE

This procedure covers activities associated with decontamination of sample equipment and personnel. Additional requirements for personnel decontamination may be specified in the Site Health and Safety Plan.

3.0 RESPONSIBILITIES

All Field Personnel will be responsible for performing personal and equipment decontamination after sampling at each location and at the end of the day in accordance with these procedures.

The **Field Supervisor** will be responsible for training field personnel in appropriate decontamination procedures as well as verifying implementation of this procedure through surveillance.

The **Site Manager** will be responsible for ensuring that all personnel are trained to this procedure.

4.0 DECONTAMINATION

4.1 Personnel will remove disposable gloves following collection of each sample. Gloves will contained in a plastic bag and disposed as municipal waste. All personnel and clothing will be inspected following sample collection at each property and, if necessary, decontaminated to remove any potential harmful substances that may have adhered to

them. Disposable, pre-moistened wipes will be available for personnel to wash their face and hands.

4.2 The equipment used for sample collection, including hand augers, bowls and trowels, will be decontaminated between samples collected for separate composites, between samples collected for discrete sampling and analysis, and following the last sample collection daily. Sampling equipment and tools will be decontaminated immediately following sample collection at the location/property from which the sample was collected by the following procedure:

- Wash with a low- or non-phosphate detergent and tap water using a brush as necessary
- Triple rinsed with deionized water
- After decontamination, equipment and tools will be protected by placing them in clean containers and taking care not to allow contact with surface soils

4.3 Sample preparation tools, including drying pans, sieves, and spatulas, will be decontaminated between samples by the following procedure:

- Wash with a low- or non-phosphate detergent and tap water
- Triple rinse with deionized water
- After decontamination, equipment and tools will be protected by placing them in clean containers and taking care not to allow contact with surface soils

4.4 Rinsate blanks will be collected at a rate of 5% (one in twenty decontaminations). The rinsate blank will be collected by pouring deionized water over decontaminated equipment and collecting the rinsate in a 500-mL certified clean polyethylene bottle. The sample will be preserved using nitric acid to pH<2, and submitted to an off-site laboratory for total arsenic and lead analyses.

4.5 Decontamination rinsate will be disposed in accordance with the Technical Standard Operating Procedure for Investigation Derived Waste Management.

Appendix G:

Method Detection Limit Study and Proficiency Demonstration

ISSI Consulting Group
999 18th Street, Suite 1450
Denver, CO 80202
ph 303.292.4142 • fax 303.292.4926

U.S. SBA 8(a) certified
postmaster@isslinc.com
www.isslinc.com

MEMORANDUM

To:	Chris Weis & Bonnie Lavelle
From:	Mary Goldade, Adrian Bradley
Date:	June 17, 1999
Project Name:	Vasquez Boulevard & I-70
RE:	Method Detection Limit Study and Proficiency Demonstration
cc:	Project Files

Introduction

In accord with quality assurance/quality control (QA/QC) requirements outlined in the Phase 3 Project Plan, a method detection limit (MDL) study must be performed for the X-ray fluorescence (XRF) methodology prior to implementation of the Phase 3 Project Plan. That is, a determination of the MDL must be performed for the selected analytes (lead and arsenic) using site soils. In addition, an initial demonstration of method proficiency must be performed by each technician performing XRF analysis to confirm their accurate and precise performance of the method for this particular matrix. This memorandum identifies the process by which a MDL study will be performed and outlines the procedures required to demonstrate proficiency. If you have any questions about this memorandum, please contact me at (303) 292-4142 extension 235.

Site Soil Collection and Preparation

ISSI Consulting Group, Inc. (ISSI) will obtain approximately 20 kg of surficial site soils that will have low (approximately background) levels of arsenic and lead. Following collection, the soil will be air-dried and sieved to <2 mm. The arsenic and lead levels in the "clean" site soils will be quantified and certified using XRF analysis. Certification of metals levels will be performed by a laboratory independent from that planned for the Phase 3 measurements.

Method Detection Limit Study

The MDL is defined as the minimum concentration that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte. A MDL study will be performed on the XRF in accordance with the Code of Federal Regulations [CFR] (40 CFR Part 136, Appendix B) which is summarized below. A copy of this complete procedure is provided (Attachment 1).

Site soils to be used in the MDL study will be provided by ISSI. After careful mixing to homogenize the sample (do not grind or crush), the soil will be split into seven replicates. Each replicate will be prepared and measured for arsenic and lead using the same instrument that will be used for the larger Phase 3 investigation. Make all computations according to the defined MDL study methodology, with final results to be reported in mg/kg. Calculate the mean and standard deviation of the replicate samples. Please refer to 40 CFR Part 136, Appendix B for specific details pertaining to calculation of MDLs for arsenic and lead.

MEMORANDUM

To:	Chris Weis & Bonnie Lavelle
From:	Mary Goldade, Adrian Bradley
Date:	June 17, 1999
Project Name:	Vasquez Boulevard & I-70
RE:	Method Detection Limit Study and Proficiency Demonstration
cc:	Project Files

Introduction

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A report summarizing the MDLs for arsenic and lead via XRF should include the following information:

- Measured concentrations for each of the individual (seven) measurements for arsenic and lead
- Mean
- Standard deviation

Initial Demonstration of Proficiency

Each laboratory must demonstrate initial proficiency with each combination of sample preparation and determinative methods that it utilizes by generating data of acceptable accuracy and precision for a reference sample containing the target analytes in a blank matrix. The laboratory must also repeat this demonstration whenever new staff are trained or significant changes in instrumentation are made.

To evaluate the performance of the total analytical process, the reference samples must be handled in exactly the same manner as actual samples (approved standard operating procedures). The following steps must be performed for each technician who performs analyses for the VBI70 Phase 3 investigation. ISSI will provide the reference standards for this effort.

Analyze at least 4 replicate aliquots of each well-mixed reference sample for arsenic and lead by the same procedures and using the same instrumentation used to analyze actual samples. Calculate the average recovery and the standard deviation of the recoveries for each analyte of interest using the 4 results. Results will be reported to USEPA and compared with the certified arsenic and lead values for the samples.

A report summarizing the proficiency test should include the following information:

- Measured arsenic and lead levels for each of the individual samples
- Units of measure
- Sample Number
- Mean and standard deviation for each set of replicate analyses (for each reference standard)

If any individual measured metal value falls outside the range for accuracy, then the system performance is unacceptable for that analyte(s). Analyses of investigative samples may only proceed after proficiency is demonstrated.

ATTACHMENT 1

APPENDIX B TO PART 136—DEFINITION AND PROCEDURE FOR THE DETERMINATION OF THE METHOD DETECTION LIMIT—REVISION 1.11

Definition

The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.

Scope and Application

This procedure is designed for applicability to a wide variety of sample types ranging from reagent (blank) water containing analyte to wastewater containing analyte. The MDL for an analytical procedure may vary as a function of sample type. The procedure requires a complete, specific, and well defined analytical method. It is essential that all sample processing steps of the analytical method be included in the determination of the method detection limit.

The MDL obtained by this procedure is used to judge the significance of a single measurement of a future sample.

The MDL procedure was designed for applicability to a broad variety of physical and chemical methods. To accomplish this, the procedure was made device- or instrument-independent.

Procedure

1. Make an estimate of the detection limit using one of the following:

(a) The concentration value that corresponds to an instrument signal/noise in the range of 2.5 to 5.

(b) The concentration equivalent of three times the standard deviation of replicate instrumental measurements of the analyte in reagent water.

(c) That region of the standard curve where there is a significant change in sensitivity, i.e., a break in the slope of the standard curve.

(d) Instrumental limitations.

It is recognized that the experience of the analyst is important to this process. However, the analyst must include the above considerations in the initial estimate of the detection limit.

2. Prepare reagent (blank) water that is as free of analyte as possible. Reagent or interference free water is defined as a water sample in which analyte and interferent concentrations are not detected at the method detection limit of each analyte of interest. Interferences are defined as systematic errors in the measured analytical signal of an established procedure caused by the presence of interfering species (interferent). The interferent concentration is presupposed to be normally distributed in representative samples of a given matrix.

3. (a) If the MDL is to be determined in reagent (blank) water, prepare a laboratory standard (analyte in reagent water) at a concentration which is at least equal to or in the same concentration range as the estimated method detection limit. (Recommend between 1 and 5 times the estimated method detection limit.) Proceed to Step 4.

(b) If the MDL is to be determined in another sample matrix, analyze the sample. If the measured level of the analyte is in the recommended range of one to five times the estimated detection limit, proceed to Step 4.

If the measured level of analyte is less than the estimated detection limit, add a known amount of analyte to bring the level of analyte between one and five times the estimated detection limit.

If the measured level of analyte is greater than five times the estimated detection limit, there are two options.

(1) Obtain another sample with a lower level of analyte in the same matrix if possible.

(2) The sample may be used as is for determining the method detection limit if the analyte level does not exceed 10 times the MDL of the analyte in reagent water. The variance of the analytical method changes as the analyte concentration increases from the MDL, hence the MDL determined under these circumstances may not truly reflect method variance at lower analyte concentrations.

4. (a) Take a minimum of seven aliquots of the sample to be used to calculate the method detection limit and process each through the entire analytical method. Make all computations according to the defined method with final results in the method reporting units. If a blank measurement is required to calculate the measured level of analyte, obtain a separate blank measurement for each sample aliquot analyzed. The average blank measurement is subtracted from the respective sample measurements.

(b) It may be economically and technically desirable to evaluate the estimated method detection limit before proceeding with 4a. This will: (1) Prevent repeating this entire procedure when the costs of analyses are high and (2) insure that the procedure is being conducted at the correct concentration. It is quite possible that an inflated MDL will be calculated from data obtained at many times the real MDL even though the level of analyte is less than five times the calculated method detection limit. To insure that the estimate of the method detection limit is a good estimate, it is necessary to determine that a lower concentration of analyte will not result in a significantly lower method detection limit. Take two aliquots of the sample to be used to calculate the method detection limit and process each

through the entire method, including blank measurements as described above in 4a. Evaluate these data:

(1) If these measurements indicate the sample is in desirable range for determination of the MDL, take five additional aliquots and proceed. Use all seven measurements for calculation of the MDL.

(2) If these measurements indicate the sample is not in correct range, reestimate the MDL, obtain new sample as in 3 and repeat either 4a or 4b.

5. Calculate the variance (S^2) and standard deviation (S) of the replicate measurements, as follows:

$$S^2 = \frac{1}{n-1}\left[\sum_{i=1}^{n} x_i^2 - \frac{\left(\sum_{i=1}^{n} X_i\right)^2}{n}\right] \quad S = \left(S^2\right)^{\frac{1}{2}}$$

where:

X_i; i=1 to n, are the analytical results in the final method reporting units obtained from the n sample aliquots and Σ refers to the sum of the X values from i=1 to n.

6. (a) Compute the MDL as follows:

$$MDL = t_{(n-1,1-\alpha=0.99)}\ (S)$$

where:

MDL = the method detection limit

$t_{(n-1,1-\alpha=0.99)}$ = the students' t value appropriate for a 99% confidence level and a standard deviation estimate with n-1 degrees of freedom. See Table.

S = standard deviation of the replicate analyses.

(b) The 95% confidence interval estimates for the MDL derived in 6a are computed according to the following equations derived from percentiles of the chi square over degrees of freedom distribution ($_n\chi^2/df$).

LCL = 0.64 MDL

UCL = 2.20 MDL

where: LCL and UCL are the lower and upper 95% confidence limits respectively based on seven aliquots.

7. Optional iterative procedure to verify the reasonableness of the estimate of the MDL and subsequent MDL determinations.

(a) If this is the initial attempt to compute MDL based on the estimate of MDL formulated in Step 1, take the MDL as calculated in Step 6, spike the matrix at this calculated MDL and proceed through the procedure starting with Step 4.

(b) If this is the second or later iteration of the MDL calculation, use S^2 from the current MDL calculation and S^2 from the previous MDL calculation to compute the F-ratio. The F-ratio is calculated by substituting the larger S^2 into the numerator S^2_A and the other into the denominator S^2_B. The computed F-ratio is then compared with the F-ratio found in the table which is 3.05 as follows: if $S^2_A/S^2_B<3.05$, then compute the pooled standard deviation by the following equation:

$$S_{pooled} = \left[\frac{6S_A^2 + 6S_B^2}{12}\right]^{\frac{1}{2}}$$

if $S^2_A/S^2_B>3.05$, respike at the most recent calculated MDL and process the samples through the procedure starting with Step 4. If the most recent calculated MDL does not permit qualitative identification when samples are spiked at that level, report the MDL as a concentration between the current and previous MDL which permits qualitative identification.

(c) Use the S_{pooled} as calculated in 7b to compute The final MDL according to the following equation:

$$MDL = 2.681\ (S_{pooled})$$

where 2.681 is equal to $t_{(12,1-\alpha=0.99)}$.

(d) The 95% confidence limits for MDL derived in 7c are computed according to the following equations derived from percentiles

(3) If these measurements indicate the sample is not in correct range, reestimate the MDL, obtain new sample as in 3 and repeat either 4a or 4b.

5. Calculate the variance (S^2) and standard deviation (S) of the replicate measurements, as follows:

$$\left[\frac{\sum_{i=1}^{n} X_i^2 - \frac{\left(\sum_{i=1}^{n} X_i\right)^2}{n}}{n-1}\right]^{\frac{1}{2}} = S = \left(S^2\right)^{\frac{1}{2}}$$

where: LCL and UCL are the lower and upper 95% confidence limits respectively based on seven aliquots.

7. Optional iterative procedure to verify the reasonableness of the estimate of MDL and subsequent MDL determination.

(a) If this is the initial attempt to compute MDL based on the estimate of MDL formulated in Step 1, take the MDL as calculated in Step 6, spike the matrix at this calculated MDL and proceed through the procedure starting with Step 4.

(b) If this is the second or later iteration of the MDL calculation, use S^2 from the current MDL calculation and S^2 from the previous MDL calculation to compute the F-ratio. The F-ratio is calculated by putting the larger S^2 into the numerator and the other into the denominator S^2_B. The computed F-ratio is then compared with the F-ratio found in the table which is 3.05. If follows: If $S^2_A/S^2_B<3.05$, then compute the standard deviation by the following equation:

$$= \left[\frac{6S_A^2 + 6S_B^2}{12}\right]^{\frac{1}{2}}$$

(c) Use the S_{pooled} as calculated to compute The final MDL according to the following equation:

$$MDL = 2.681\ (S_{pooled})$$

where 2.681 is equal to $t_{(n-1,1-\alpha=.99)}$.

(d) The 95% confidence limits for MDL are computed according to the following equations derived from the chi squared over degrees of freedom distribution.

LCL=0.72 MDL

UCL=1.65 MDL

where LCL and UCL are the lower and upper 95% confidence limits respectively based on seven aliquots.

TABLES OF STUDENTS' t VALUES AT THE 99 PERCENT CONFIDENCE LEVEL

Number of replicates	Degrees of freedom (n-1)	$t_{(n-1,.99)}$
7	6	3.143
8	7	2.998
9	8	2.896
10	9	2.821
11	10	2.764
16	15	2.602
21	20	2.528
26	25	2.485
31	30	2.457
61	60	2.390
121	120	2.326

Reporting

The analytical method used must be specifically identified by number or title and the MDL for each analyte expressed in the appropriate method reporting units. If the analytical method permits options which affect the method detection limit, these conditions must be specified with the MDL value. The spike matrix used to determine the MDL must also be identified with MDL value. Report the mean analyte level with the MDL to indicate if the MDL procedure was valid. If a laboratory standard or a sample matrix contained a known amount analyte spiked for this determination, also report the percent recovery.

If the level of analyte in the sample was below the determined MDL or exceeds 10 times the MDL of the analyte in reagent water, do not report a value for the MDL.

[49 FR 43430, Oct. 29, 1984; 50 FR 694, 696, Jan. 4, 1985, as amended at 51 FR 23703, June 30, 1986.]

APPENDIX C TO PART 136—INDUCTIVELY COUPLED PLASMA—ATOMIC EMISSION SPECTROMETRIC METHOD FOR TRACE ELEMENT ANALYSIS OF WATER AND WASTES METHOD 200.7

1. Scope and Application

1.1 This method may be used for the determination of dissolved, suspended, or total elements in drinking water, surface water, domestic and industrial wastewaters.

1.2 Dissolved elements are determined in filtered, acidified samples. Appropriate steps must be taken in all analyses to ensure that potential interferences are taken into account. This is especially true when dissolved solids exceed 1500 mg/L. (See Section 5.)

1.3 Total elements are determined after appropriate digestion procedures are performed. Since digestion techniques increase the dissolved solids content of the samples, appropriate steps must be taken to correct for potential interference effects. (See Section 5.)

1.4 Table 1 lists elements for which this method applies along with recommended wavelengths and typical estimated instrumental detection limits using conventional pneumatic nebulization. Actual working detection limits are sample dependent and as the sample matrix varies, these concentrations may also vary. In time, other elements may be added as more information becomes available and as required.

1.5 Because of the differences between various makes and models of satisfactory instruments, no detailed instrumental operating instructions can be provided. Instead, the analyst is referred to the instruction provided by the manufacturer of the particular instrument.

2. Summary of Method

2.1 The method describes a technique for the simultaneous or sequential multielement determination of trace elements in solution. The basis of the method is the measurement of atomic emission by an optical spectroscopic technique. Samples are nebulized and the aerosol that is produced is transported to the plasma torch where excitation occurs. Characteristic atomic-line emission spectra are produced by a radio-frequency inductively coupled plasma (ICP). The spectra are dispersed by a grating spectrometer and the intensities of the lines are monitored by photomultiplier tubes. The photocurrents from the photomultiplier tubes are processed and controlled by a computer system. A background correction technique is required to compensate for variable background contribution to the determination of trace elements. Background must be measured adjacent to analyte lines on samples during analysis. The position selected for the background intensity measurement, on either or both sides of the analytical line, will be determined by the complexity of the spectrum adjacent to the analyte line. The position used must be free of spectral interference and reflect the same change in background intensity as occurs at the analyte wavelength measured. Background correction is not required in cases of line broadening where a background correction measurement would actually degrade the analytical result. The possibility of additional interferences named in 5.1 (and tests for their presence as described in 5.2) should also be recognized and appropriate corrections made.

Appendix H:

Data Management Plan Additions

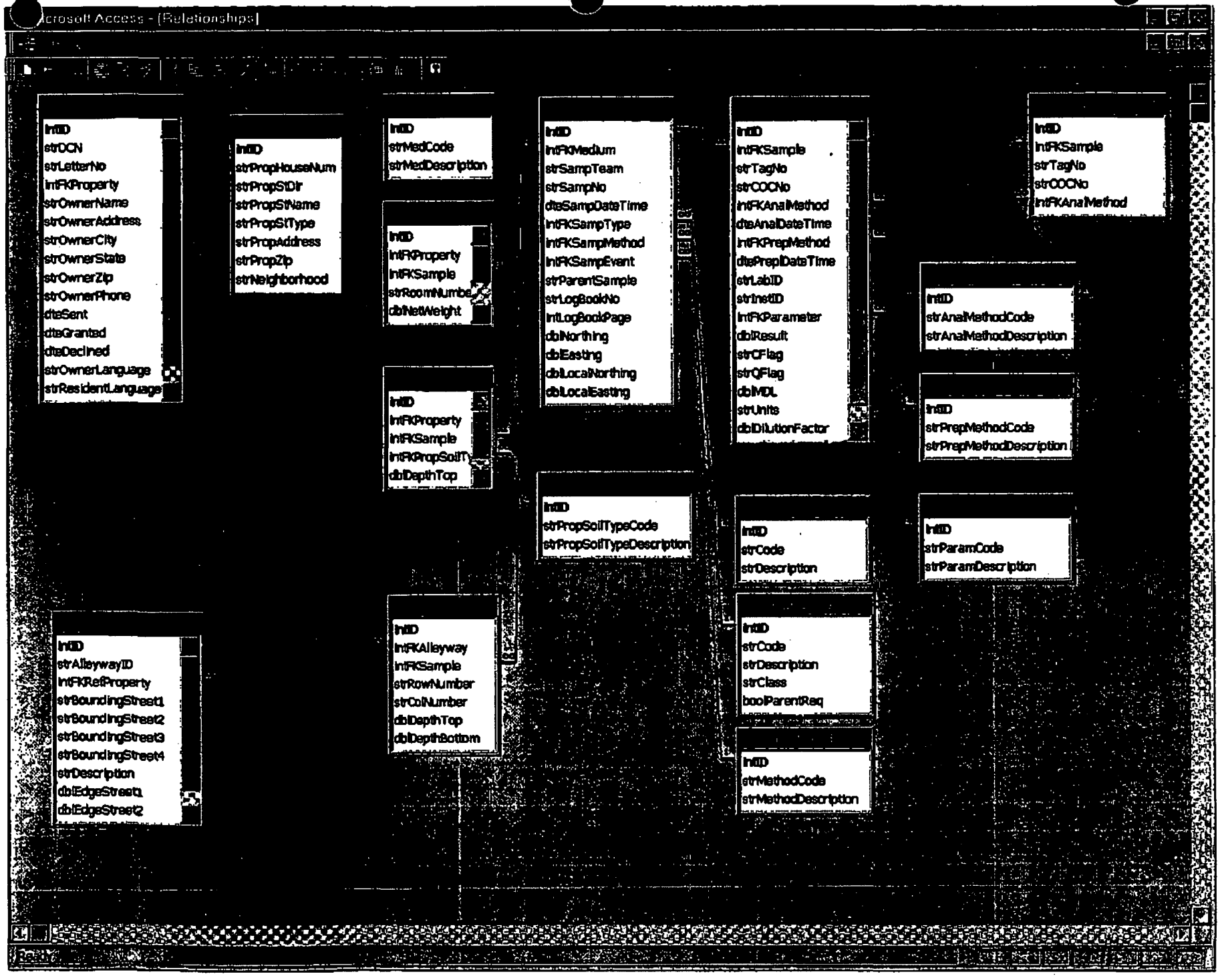
Microsoft Access - [Relationships]
intID
strOCN
strLetterNo
intFKProperty
strOwnerName
strOwnerAddress
strOwnerCity
strOwnerState
strOwnerZip
strOwnerPhone
dteSent
dteGranted
dteDeclined
strOwnerLanguage
strResidentLanguage
intID
strPropHouseNum
strPropStDir
strPropStName
strPropStType
strPropAddress
strPropZip
strNeighborhood
intID
strMedCode
strMedDescription
intID
intFKProperty
intFKSample
strRoomNumbe
dblNetWeight
intID
intFKProperty
intFKSample
intFKPropSoilT
dblDepthTop
intID
intFKMedium
strSampTeam
strSampNo
dteSampDateTime
intFKSampType
intFKSampMethod
intFKSampEvent
strParentSample
strLogBookNo
intLogBookPage
dblNorthing
dblEasting
dblLocalNorthing
dblLocalEasting
intID
intFKSample
strTagNo
strCOCNo
intFKAnalMethod
dteAnalDateTime
intFKPrepMethod
dtePrepDateTime
strLabID
strInstID
intFKParameter
dblResult
strCFlag
strQFlag
dblMDL
strUnits
dblDilutionFactor
intID
intFKSample
strTagNo
strCOCNo
intFKAnalMethod
intID
strAnalMethodCode
strAnalMethodDescription
intID
strPrepMethodCode
strPrepMethodDescription
intID
strPropSoilTypeCode
strPropSoilTypeDescription
intID
strCode
strDescription
intID
strParamCode
strParamDescription
intID
strAlleywayID
intFKRefProperty
strBoundingStreet1
strBoundingStreet2
strBoundingStreet3
strBoundingStreet4
strDescription
dblEdgeStreet1
dblEdgeStreet2
intID
intFKAlleyway
intFKSample
strRowNumber
strColNumber
dblDepthTop
dblDepthBottom
intID
strCode
strDescription
strClass
boolParentReq
intID
strMethodCode
strMethodDescription

Table: refAnalMethod

Columns

Name	Type	Size
intID	Number (Long)	4
strAnalMethodCode	Text	10
strAnalMethodDescription	Text	50

Table: refEvent

Columns

Name	Type	Size
intID	Number (Long)	4
strCode	Text	10
strDescription	Text	50

Table: refMedium

Columns

Name	Type	Size
intID	Number (Long)	4
strMedCode	Text	2
strMedDescription	Text	50

Table: refParameter

Columns

Name	Type	Size
intID	Number (Long)	4
strParamCode	Text	10
strParamDescription	Text	50

Table: tblAccess

Columns

Name	Type	Size
intID	Number (Long)	4
strDCN	Text	10
strLetterNo	Text	10
intFKProperty	Number (Long)	4
strOwnerName	Text	50
strOwnerAddress	Text	50
strOwnerCity	Text	50
strOwnerState	Text	2
strOwnerZip	Text	10
strOwnerPhone	Text	12
dteSent	Date/Time	8
dteGranted	Date/Time	8
dteDeclined	Date/Time	8
strOwnerLanguage	Text	50
strResidentLanguage	Text	50
strComments	Text	200

Table: tblAlleyway

Columns

Name	Type	Size
intID	Number (Long)	4
strAlleywayID	Text	10
intFKRefProperty	Number (Long)	4
strBoundingStreet1	Text	50
strBoundingStreet2	Text	50
strBoundingStreet3	Text	50
strBoundingStreet4	Text	50
strDescription	Text	50
dblEdgeStreet1	Number (Double)	8
dblEdgeStreet2	Number (Double)	8
dblInterval	Number (Double)	8

Table: refPrepMethod

Columns

Name	Type	Size
intID	Number (Long)	4
strPrepMethodCode	Text	10
strPrepMethodDescription	Text	50

Table: refPropSoilType

Columns

Name	Type	Size
intID	Number (Long)	4
strPropSoilTypeCode	Text	2
strPropSoilTypeDescription	Text	50

Table: refSampMethod

Columns

Name	Type	Size
intID	Number (Long)	4
strMethodCode	Text	3
strMethodDescription	Text	35

Table: refSampQCType

Columns

Name	Type	Size
intID	Number (Long)	4
strCode	Text	255
strDescription	Text	255
strClass	Text	255
boolParentReq	Yes/No	1

Table: tblAlleywaySoil

Columns

Name	Type	Size
intID	Number (Long)	4
intFKAlleyway	Number (Long)	4
intFKSample	Number (Long)	4
strRowNumber	Text	50
strColNumber	Text	50
dblDepthTop	Number (Double)	8
dblDepthBottom	Number (Double)	8

Table: tblAnalysis

Columns

Name	Type	Size
intID	Number (Long)	4
intFKSample	Number (Long)	4
strTagNo	Text	15
strCOCNo	Text	15
intFKAnalMethod	Number (Long)	4
dteAnalDateTime	Date/Time	8
intFKPrepMethod	Number (Long)	4
dtePreptDateTime	Date/Time	8
strLabID	Text	15
strInstID	Text	15
intFKParameter	Number (Long)	4
dblResult	Number (Double)	8
strCFlag	Text	1
strQFlag	Text	3
dblMDL	Number (Double)	8
strUnits	Text	10
dblDilutionFactor	Number (Double)	8
strBatchNo	Text	15

Table: tblProperty

Columns

Name	Type	Size
intID	Number (Long)	4
strPropHouseNum	Text	5
strPropStDir	Text	1
strPropStName	Text	35
strPropStType	Text	5
strPropAddress	Text	50
strPropZip	Text	5
strNeighborhood	Text	30

Table: tblPropertyDust

Columns

Name	Type	Size
intID	Number (Long)	4
intFKProperty	Number (Long)	4
intFKSample	Number (Long)	4
strRoomNumber	Text	5
dblNetWeight	Number (Double)	8
dblTotalArea	Number (Double)	8
dblRoomTemp	Number (Double)	8
dblRoomHumidity	Number (Double)	8

Table: tblPropertySoil

Columns

Name	Type	Size
intID	Number (Long)	4
intFKProperty	Number (Long)	4
intFKSample	Number (Long)	4
intFKPropSoilType	Number (Long)	4
dblDepthTop	Number (Double)	8
dblDepthBottom	Number (Double)	8

Table: tblRequest

Columns

Name	Type	Size
intID	Number (Long)	4
intFKSample	Number (Long)	4
strTagNo	Text	15
strCOCNo	Text	15
intFKAnalMethod	Number (Long)	4

Table: tblSample

Columns

Name	Type	Size
intID	Number (Long)	4
intFKMedium	Number (Long)	4
strSampTeam	Text	10
strSampNo	Text	15
dteSampDateTime	Date/Time	8
intFKSampType	Number (Long)	4
intFKSampMethod	Number (Long)	4
intFKSampEvent	Number (Long)	4
strParentSample	Text	15
strLogBookNo	Text	8
intLogBookPage	Number (Long)	4
dblNorthing	Number (Double)	8
dblEasting	Number (Double)	8
dblLocalNorthing	Number (Double)	8
dblLocalEasting	Number (Double)	8

Table: tblProperty
Description: Property Information Table

Order	Field Name	Caption	Field Description	Format	Valid Values
1	intPropID	AutoNumber	Unique Property ID	LongInteger	
2	strPropHouseNum	House Number	House number for subject property	C5	
3	strPropStDir	Street Direction	Street direction for subject property	C1	"S","W"," "
4	strPropName	Street Name	Street name for subject property	C35	
5	strPropStType	Street Type	Street type for subject property	C5	
6	strPropZip	Zip Code	Zip code for subject property	C5	
7	strNeighborhood	Neighborhood	Neighborhood	C20	Neighborhoods

Table: tblSample
Description: Master Sample Log

Order	Field Name	Caption	Field Description	Format	Valid Values
1	intID	AutoNumber	System Generated Unique Record Identifier	AutoNumber	
2	intFKMedium	Media Code	Foreign Key to Media Code	LongInteger	refMedium
3	strSampTeam	Team ID	Sampling Team	C10	
4	strSampNo	Sample Number	Field / Lab Sample Number	C15	Specified in Field Sampling Plan
5	dteSampDateTime	Sample Date	Date sampled in the field	Date/Time	MM/DD/YY 24:00
6	intFKSampType	Sample Type	Foreign Key to Sample Types	C2	refSampType
7	intFKSampMethod	Sample Method Code	Foreign Key to Sample Methods	C2	refSampMethod
8	intFKSampEvent	Sampling Event	Sampling Event	C20	"PHASE III"
9	strParentSample	Parent Sample Number	Parent Sample Number	C15	
10	strLogBookNo	Log Book	Log Book Number	C10	
11	dblNorthing	Northing	For each sample, using the following GPS coordinate parameters: UTM, Zon 13, NAD 27. Note - Units = meters.	Double	
12	dblEasting	Easting	For each sample, using the following GPS coordinate parameters: UTM, Zon 13, NAD 27. Note - Units = meters.	Double	
13	dblLocalNorthing	Local Northing	Local Northing Coordinate (ft.)	Double	
14	dblLocalEasting	Local Easting	Local Easting Coordinate (ft.)	Double	

Table: tblAccess
Description: Access Agreement Letter Tracking

Order	Field Name	Caption	Field Description	Format	Valid Values
1	intID	AutoNumber	System Generated Unique Record Identifier	AutoNumber	
2	strDCN	DCN	Document Control Number	C10	
3	strLetterNo	Letter Number	Letter Number	C10	
4	intFKProperty	Property Address	Foreign Key to Property Address	LongInteger	tblProperty
5	strOwnerName	Owner Name	Owner Name	C50	
6	strOwnerAddress	Owner Address	Owner Address	C50	
7	strOwnerState	Owner State	Owner State	C50	
8	strOwnerPhone	Owner Phone	Owner Phone	C2	
9	dteSent	Date Sent	Date Access Agreement Letter Sent	Date/Time	
10	dteGranted	Date Granted	Date Access Granted	Date/Time	
11	dteDeclined	Date Declined	Date Access Declined	Date/Time	
12	strOwnerLanguage	Owner Language	Owner Language Preference	C10	English, Spanish, Other
13	strResidentLanguage	Resident Language	Resident Language Preference	C10	English, Spanish, Other
14	strComments	Comments	Explanation or comments regarding authorization of sampling	C200	

Table: tblRequest
Description: Requested Laboratory Analysis - Used to generate Chain-of-Custody Report

Order	Field Name	Caption	Field Description	Format	Valid Values
1	intID	AutoNumber	System Generated Unique Record Number	AutoNumber	
2	intFKSample	Sample Number	Foreign Key to Sample Table	LongInteger	tblSample
3	strTagNo	Tag Number	Tag Number	C15	
4	strCOCNo	COC Number	COC Number	C15	
5	intFKAnalMethod	Method Requested	Foreign Key to Analytical Method Table	LongInteger	refAnalMethod

Table: tblPropertySoil
Description: Property Surface Soil Sample Attributes

Order	Field Name	Caption	Field Description	Format	Valid Values
1	intID	AutoNumber	System Generated Unique Record Identifier	AutoNumber	
2	intFKProperty	Property Address	Foreign Key to Property Table	Long Integer	tblProperty
3	intFKSample	Sample Number	Foreign Key to Sample Table	Long Integer	tblSample
4	intFKPropSoilType	Property Soil Type	Location Type (Yard, Garden, Park, etc.)	Long Integer	refPropertySoil
5	dblDepthTop	Top of Soil Depth	Top of Soil Depth (in)	Double	0"
6	dblDepthBottom	Bottom of Soil Depth	Bottom of Soil Depth (in)	Double	2"

Sample Type Code	Sample Type Description	Sample Type Class
AB	Ambient Conditions Blank	FQ
BD	Blank Spike Duplicate	LQ
BS	Blank Spike	LQ
BSD	Blank Spike and Duplicate considered as one sample	LQ
EB	Equipment Blank	FQ
FD	Field Duplicate	FQ
FR	Field Replicate	FQ
FS	Field Spike	FQ
KD	Known (External Reference Material) Duplicate	LQ
LB	Lab Blank	LQ
LR	Lab Replicate	LQ
MB	Material Blank	LQ
MS	Lab Matrix Spike	LQ
MSD	Lab Matrix Spike and Spike Duplicate pair considered as one sample	LQ
N	Normal Environmental Sample	NF
RB	Material Rinse Blank	FQ
RD	Regulatory Duplicate	FQ
RM	Known (External Reference Material)	LQ
SD	Lab Matrix Spike Duplicate	LQ
TB	Trip Blank	FQ

Parent Sample Required	System or User Defined
0	S
1	S
0	S
0	S
0	S
1	S
1	S
1	S
1	S
0	S
1	S
0	S
1	S
1	S
0	S
0	S
1	S
0	S
1	S
0	S

Media Code	Media Description
DA	Attic Dust
DI	Interior Dust
SA	Alleyway Soil
SG	Garden Soil
SY	Yard Soil
VG	Vegetables

Sample Method Code	Sample Method Description
SG	Surface Soil Grab Sample
SC	Surface Soil Composite Sample

Language Type Description
English
Spanish
Other

VB/I-70 Superfund Site

Communication Strategy

Outstanding Property Outreach 2012

Last updated: May 31, 2012

Prepared by: Jennifer Chergo, EPA OCPI, x6601

Issue: Beginning in summer 2012, EPA will begin contacting property owners at properties where EPA was denied access to either sample or cleanup yard soils during the VB/I-70 OU1 Superfund Site residential soils cleanup. The VB/I-70 Superfund Site OU1 included more than 4,000 properties in all or part of five neighborhoods in northeast Denver. Of those, approximately 160 properties remain outstanding, either needing to be sampled or cleaned up. The VB/I-70 Superfund Site OU1 residential soils cleanup effort concluded in 2006. The ROD did not discuss the issue of outstanding properties. After a five-year review in 2009, EPA determined that the remedy would not be protective until those outstanding properties were sampled and cleaned up, if necessary, or some kind of IC was put in place to protect current and future residents. EPA estimates that as many as 50 percent of the outstanding properties now have new owners who purchased the property likely unaware that it had not been sampled or that it needed a cleanup. As a result, EPA decided that one last opportunity should be afforded to the owners of the outstanding properties to have their properties sampled and/or cleaned up by EPA. The property owners who decline this final opportunity will be subject to institutional controls on their property. These institutional controls will be in the form of a deed notice alerting prospective buyers about the existence or potential for elevated levels of lead and/or arsenic in the yard soils at that property.

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Considerations:

- EPA held a ceremony to announce the completion of residential cleanups at VB/I-70 in 2006. It has been six years and there has been significant turnover at the outstanding properties (~50%). In other words, many people at the outstanding properties and in the

area-at-large have likely never heard of this project. Therefore, this action may generate a great deal of public interest.

- Some of the residents who will be refusing EPA may be elderly and the area itself is considered an environmental justice area. The optics of imposing institutional controls on these properties needs to be considered.

Visibility: Moderate this year, as EPA will be only sending out sampling crews. However, it will be high next year as EPA conducts removals using big equipment and digging up yards. The site is a densely populated, urban area.

Controversy: Moderate to high. EPA may have to impose institutional controls on private properties (low-income elderly residents, for instance). Also, there is the potential that people may ask why EPA waited six years to act.

Spokespeople: Jennifer Chergo, EPA CIC x6601, 303-246-9552 cell, Paula Schmittdiel, EPA RPM, x6861, 720-951-0795 cell

Main Messages:

- EPA is offering one last chance for property owners at these outstanding properties to have their soil sampled and/or cleaned up at no cost to them.

- At any properties where EPA continues to be denied access, EPA will require that some type of notice is included in the property record so that potential future buyers will be alerted to known or potential soil contamination.

- This is not a newly-identified issue. From 2003 to 2006, EPA sampled more than 4,000 properties in the area, 98 percent of the total, and cleaned up close to 800. EPA is simply attempting to finish up the project by gaining access to the remaining 2 percent of properties either not sampled or cleaned up in the earlier effort.

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Potential Questions and Suggested Answers:

1. **What is the problem?**
   EPA investigations showed that there were many properties within the VB/I-70 Superfund site boundaries with levels of lead and/or arsenic that could pose a risk to residents. EPA was able to gain access to sample and/or cleanup approximately 98 percent of the more than 4,000 residential properties in the five affected neighborhoods. There remain around 130 properties that EPA is attempting once again to get access from the owner to sample and/or cleanup.

2. **Why is EPA coming back to these properties only now, knowing for the past six years that these properties were out there?**

   EPA reviews most Superfund site remedies every five years as standard practice. So, in 2009, EPA reviewed the VB/I-70 remedy and the decision not to pursue the outstanding properties. EPA determined that this approach was not protective of current and future residents and that more action should be taken at these properties.

3. **Can the EPA really impose restrictions on a private property?**

If a property owner continues to refuse EPA access to sample and/or cleanup the property, EPA may issue a notice on the property title. However, that notice is strictly informational and does not restrict use of the property in any way.

4. **If my yard requires a cleanup, how can I keep my family from being exposed until EPA cleans it up next year?**

The main risk is by breathing in dust from contaminated soils. This can be reduced by removing shoes and dirty clothing when you enter the home, washing hands frequently and damp-dusting inside surfaces. Children sometimes ingest contaminated dirt when playing, so it's important to watch that they do not play in bare dirt areas and put dirty toys and hands in their mouths. EPA has much more information about this that we will provide to you.

5. **Can EPA re-sample a property that was sampled in the earlier effort?**

No. EPA has only limited resources. In addition EPA does not think it necessary to resample because we are confident in the initial sampling that was conducted at your property.

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6. **I was very unhappy with the cleanup action EPA conducted at my property during the initial remedial action. Can EPA re-do the cleanup at my property?**

No. EPA has only limited resources. If you were unhappy with the cleanup conducted at your property, the issue needed to be addressed at that time.

Background

The Vasquez Boulevard and Interstate 70 (VB/I-70) Superfund site is an area of approximately four square miles located in north-central Denver. Historically, this area was a major smelting center for the Rocky Mountain West. Three smelting plants: Omaha & Grant, Argo, and Globe, operated in the area for varying lengths of time, beginning as early as 1870, refining gold, silver, copper, lead and zinc.

VB/I-70 was divided into three Operable Units (OUs) for the purposes of better managing the project. OU1 focuses on residential soils and includes the following north Denver neighborhoods: Cole, Clayton, Swansea, Elyria, Globeville and a small section of Curtis Park. EPA and the Colorado Department of Public Health and the Environment (CDPHE) began investigating these residential yards in 1998 to determine if arsenic, lead, cadmium, or zinc residues from past smelting operations posed a potential threat to the health of residents. The investigation showed that lead and arsenic were the heavy metals of concern and sampling results showed elevated lead and arsenic concentrations in some yards. A large-scale residential soils investigation and cleanup ensued with considerable community involvement throughout. This effort was completed in August 2006.

OU2 of the VB/I-70 site is the area where the Omaha Grant Smelter was located. EPA is concerned that wastes generated from the historic smelter operation may still exist and may impact the groundwater or be a health concern. EPA is investigating to evaluate these concerns.

OU3 of the VB/I-70 site is the area where the Argo Smelter operated. The historic smelter buildings have been demolished and the area has been redeveloped. EPA is investigating to evaluate if smelter generated wastes were buried on the site and whether they pose a health risk to future construction workers or groundwater.

Outreach Activities

WHAT	WHEN	WHO	HOW
Meet with city of Denver representatives about project	DONE	Paula and and Fonda with Alice Nightengale, Gene Hook, and Lisa Ferrell	
Draft Fact Sheet	Final by June 8	Jennifer with team review	
Update Website	Live by June 8	Jennifer with team review	
Meet with City Council representatives	Meet sometime the week of June 11	Paula and Jennifer and Marilyn and Fonda and city rep?	Jennifer will send email invitation on June 4 and follow-up with a phone call that week
Meet with congressional representatives	Meet sometime the week of June 11	Paula and Jennifer and Marilyn and Fonda and city rep?	Sandy Fells will send invite the week of June 4 and set up meetings with staffers for sometime the week of June 11
Meet with state representatives	Meet sometime the week of June 11	Paula and Jennifer and Marilyn and Fonda and city rep?	Jennifer will email invitations to meet with them on June 4 and follow up with a phone call
Meet with community leaders and any other identified stakeholders	Meet sometime the week of June 11	Paula and Jennifer and Marilyn and Fonda and city rep.?	Jennifer will identify them and contact them the week of June 4 and set up meetings
Email update to local media	Week of June 11	Jennifer with team review	Jennifer will send an update email to reporters
Send out letters with access agreements (in Spanish and English) to property owners explaining action and invite them to an informational session	Monday June 18	Jennifer w/team review	
Go door-to-door with access agreements	Week of June 25	?	
Host informational session in neutral location	June 28	EPA, State, City	

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Mail follow-up letter with access agreements	Week of July 9	Jennifer w/team review	
Go door-to-door with access agreements	Week of July 16	?	

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Congresswoman Diana DeGette

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Denver City Councilperson Albus Brooks, District 8 (Cole/Clayton), 2713 Welton St., 80205, 720-337-8888, albus.brooks@denvergov.org

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Cole Neighborhood

Sandy Douglass 303-866-0648

Clayton Neighborhood

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