ENGINEERING EVALUATION/COST ANALYSIS

JEWETT WHITE LEAD SITE
2000-2012 RICHMOND TERRACE
STATEN ISLAND, NEW YORK

United States Environmental Protection Agency
Region II

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TABLE OF CONTENTS

APPENDICES

E.0 EXECUTIVE SUMMARY

The United States Environmental Protection Agency (EPA) has evaluated whether to take a response action at the Jewett White Lead Superfund Site (Site) located in Port Richmond, Borough of Staten Island, Richmond County, New York. Through this evaluation, EPA has determined that a response action is appropriate and hereby proposes that a removal action should be first taken at the 2000-2012 Richmond Terrace portion of the Site. Such action shall be performed under the removal authority pursuant to Section 104(a) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (CERCLA), 42 U.S.C. Section 9604(a), and Section 300.415 of the National Contingency Plan (NCP*)*, 40 Code of Federal Regulations (CFR) Part 300.

EPA has determined that a sufficient planning period exists before Site activities for this action must be initiated, and accordingly, this response will be conducted as a Non-Time-Critical Removal Action. This Engineering Evaluation/Cost Analysis (EE/CA) was prepared by EPA, Region 2 in support of the Non-Time-Critical Removal Action for the 2000-2012 Richmond Terrace portion of the Jewett White Lead Site.

While environmental investigations of the 2015 Richmond Terrace portion of the Site (which is not the subject of this EE/CA) have been conducted by EPA in October 2010, additional investigations will be necessary to delineate the lead contamination, to analyze removal action alternatives, and to select the most appropriate removal action for this portion of the Jewett White Lead Site. These additional investigations at the 2015 Richmond Terrace property will be conducted in the spring of 2011, and a separate EE/CA may be developed discussing the removal alternatives for the 2015 Richmond Terrace portion of the Jewett Site.

Removal Action Objectives

The goal of this Non-Time-Critical Removal Action is to eliminate or mitigate existing threats to public health and the environment, posed by hazardous substances present at the Site. To accomplish this goal and to mitigate the risk to human and ecological receptors, the objectives of the removal action are as follows:

- Prevent or minimize the migration of hazardous substances released at the Site to the area's soils, sediment, surface water and groundwater;
- Abate, minimize, stabilize, mitigate, or remove the contaminants from the soil such that unacceptable risks to human and ecological receptors are eliminated; and
- Restore the property to its current use.

Site Characteristics

The Site consists of the historic footprint of the former Jewett White Lead Company facility and the extent of contamination which includes the 1.07-acre parcel of land at 2000-2012 Richmond Terrace and the approximately 4.41-acre parcel of land at 2015 Richmond Terrace (of which, approximately 2.25-acres is not covered by the surface waters of the Kill Van Kull) (Mazella, 2011). The Site is situated within an urban mixed use residential neighborhood with concentrations of industrial and manufacturing facilities situated along the waterfront, within the Port Richmond section of the Borough of Staten Island, New York.

Historically, John Jewett & Sons White Lead Company operated a white lead manufacturing facility at the 2015 Richmond Terrace property from 1839 until April 3, 1890 when National Lead & Oil Company of New York (National Lead) acquired the Site property. National Lead continued the manufacture of white lead at the Site, and extended the operations across the street to include the 2000 Richmond Terrace property. National Lead owned and operated at both properties until approximately 1943.

The 2000-2012 Richmond Terrace property portion of the Site, which is the subject of this EE/CA, is presently owned by Perfetto Realty Corporation (PRC). The property is currently an unpaved vacant lot that is being utilized as a staging/storage area for construction-related materials. The 2015 Richmond Terrace property portion of the Site is presently owned by the Moran Towing Corporation, an active tug boat facility. Buildings, concrete, or asphalt cover most of the Moran Towing Corp. property, although there are several areas where the asphalt or concrete is in disrepair exposing bare soil.

On June 3, 2008, the Council of the City of New York submitted a written request to EPA to evaluate the portion of the Site located at 2000-2012 Richmond Terrace for potential environmental contamination. A Removal Site Evaluation to evaluate the property for a removal action under the authority of CERCLA found elevated levels of lead throughout most of the 2000-2012 Richmond Terrace property, both laterally and with depth. The average surface lead concentration was 5,081 mg/kg.

Rationale for Non-Time-Critical Removal Action

Based upon conditions identified through the investigation described above, a CERCLA Removal Action is warranted to mitigate the threats to the public health or welfare and the environment.

The Jewett White Lead Site is considered a facility as defined by Section 101(9) of CERCLA, as amended, 42 U.S.C. Section §9601 (a). Samples taken from soils at the Site contain “hazardous substances” as defined in Section 101(14) of CERCLA, 42 U.S.C. §9601(14). A release of hazardous substances has occurred on the Site in a quantity and concentration that has resulted in a substantial threat to the public health or welfare, or the environment.

There are potential exposure pathways, via incidental ingestion of soil and inhalation of fugitive dusts that may present an imminent and substantial endangerment to humans and the environment, and no other party, government or otherwise, is currently taking a timely response action to mitigate the threat. There is a threat of further releases at and from the Site. Without a response action, contaminants at the Site could migrate to area soils, sediment, surface water, and groundwater.

EE/CA

This EE/CA only addresses the 2000-2012 Richmond Terrace portion of the Site. Based upon the environmental investigations conducted at the 2000-2012 Richmond Terrace property, the extent of lead contaminated soils has been delineated. Removal alternatives can be analyzed and a removal action can be selected based upon current knowledge of the nature and extent of contamination at this property.

The data collected by EPA and EPA contractor representatives were used to develop this EE/CA Report. These environmental investigations have substantially characterized the nature and extent of the contamination in soils, sediment, surface water and groundwater at the 2000-2012 Richmond Terrace portion of the Site. EPA has prepared this EE/CA to analyze removal action alternatives and to select the most appropriate alternative to disassociate/restrict human exposure to the contaminated areas and to prevent or minimize the migration of hazardous constituents to area soils and groundwater. The EE/CA follows the guidelines in Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA (EPA/540-R-93-057, August 1993).

Individual and Comparative Analysis of Alternatives

Five removal action alternatives are identified and evaluated in this EE/CA to address the contaminated soils and shallow groundwater at the 2000-2012 Richmond Terrace portion of the Jewett White Lead Site.

Alternative 1, No Action: The no-action alternative does not include any removal measures that address the contaminated media. This alternative would, however, include the implementation of a public awareness program so that nearby residents are advised about the threats posed by the contamination located on the Site. It is considered as a baseline for comparison with the other alternatives.

Alternative 2, Excavation and Off-Site Disposal: Under this alternative, the contaminated soils and waste materials would be excavated and transported off-Site for treatment/disposal. The excavated areas would be backfilled with clean fill and re-vegetated.

Alternative 3, Capping: This alternative would involve the placement of an engineered, multi-layered soil cap over the contaminated soils, including a grading layer, a barrier protection layer, a Geosynthetic drainage layer, a common fill layer, and a vegetative soil layer.

Alternative 4, Paving: This alternative would involve the consolidation of contaminated soils under an asphalt cover. The removal of the upper 6 inches of soil at the site would be required to maintain existing grade and accommodate the pavement.

Alternative 5, Immobilization: This alternative would involve the immobilization of contaminants in the top 2 ft of contaminated soil via in-situ treatment with a concrete additive which would immobilize the lead in the soil, preventing leaching to surface water and groundwater, as well as preventing contact with deeper, untreated, lead-impacted soils.

The removal action alternatives were evaluated against the following three criteria:

Effectiveness:	The ability of the alternative to meet the objectives within the scope of the removal action in terms of overall protection of public health and the environment, compliance with ARARs and other guidance, long-term effectiveness and permanence, short-term effectiveness, and reduction of toxicity, mobility or volume;
Implementability:	The technical and administrative feasibility of implementing an alternative and the various services and materials required during the implementation;
Cost:	The projected cost of each alternative.

The comparative analysis of the removal action alternatives, based upon the three evaluation criteria noted above, is summarized as follows:

- *Effectiveness:* Alternatives 2, 3, 4, and 5 have demonstrated effectiveness and will provide overall protection of public health and the environment and control the soil and waste migration.

- *Implementability:* Alternatives 2, 3, 4, and 5 involve conventional technology with proven reliability that can be implemented. Alternative 2 is administratively feasible, while alternatives 3, 4 and 5 require both engineering and institutional controls to be implemented. There are no implementability issues for the No Action Alternative 1.

- *Cost:* The estimated capital cost, based upon an estimated waste volume of 4,242-cubic yards, the annual operation and maintenance (O&M), and present-worth costs for each of the alternatives are:

Alternatives	Capital Cost	Transportation & Disposal Costs	Operation & Maintenance Costs[1]	Present-Worth Cost
Alternative 1 No Action	$0	$0	$0	$10,050
Alternative 2 Excavation	$171,146	$626,787	$14,509	$924,153
Alternative 3 Capping	$119,450	$354,618	$112,860	$644,076
Alternative 4 Paving	$139,500	$73,879	$112,860	$354,711
Alternative 5 Immobilization	$145,455	$0	$112,860	$279,315

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[1] O&M costs include the present value of groundwater monitoring and cap maintenance for 30 years.

Alternative 2 has the highest present worth cost ($924,153) of the alternatives considered, but no operation and maintenance costs. Alternative 5 has low capital cost, no transportation and disposal costs, but is not a permanent solution and has on-going operation and maintenance costs.

RECOMMENDED RESPONSE ACTION ALTERNATIVE

EPA proposes Alternative 2, Excavation and Disposal**,** as the removal action alternative for the 2000-2012 Richmond Terrace portion of the Jewett White Lead Site. This determination is based on the proven effectiveness of the action, the ease of implementation, and the relative cost.

The preferred alternative would involve the excavation and removal of approximately 4,242-cubic yards of lead contaminated soil from the 2000-2012 Richmond Terrace property. While Alternative 2 has a substantially higher cost ($924,153) than the other removal alternatives, it compares favorably to the remaining alternatives and provides a proportionately higher level of protection of human health and the environment. In addition, the excavation and disposal of the lead contaminated soils would result in a permanent action that requires no additional long-term oversight and/or maintenance.

The proposed removal action is the preferred response action for the Site. Changes to the preferred removal action or a change from the preferred removal action to another removal action may be made if public comments or additional data indicate that such a change will result in a more appropriate action.

The final decision regarding the removal action will be made after EPA has taken into consideration all public comments. The decision will be documented in an Action Memorandum, which will also address public comments received on this proposed removal action. The Administrative Record will include a responsiveness summary which will address all public comments.

1.0 INTRODUCTION

This report presents the EE/CA for a non-time-critical removal action at the 2000-2012 Richmond Terrace portion of the Jewett White Lead Site, the location of a former white lead manufacturing facility located in the Port Richmond section in the Borough of Staten Island, Richmond County, New York. The response action will be conducted pursuant to Section 104(a) of CERCLA, 42 U.S.C. §9601 *et seq.* and Section 300.415 of the NCP, 40 CFR Part 300. The goal of the non-time-critical response action is to eliminate or mitigate existing threats to public health and the environment by (a) preventing the migration of hazardous substances released at the Site to the area soils, sediment, surface water and groundwater; (b) eliminating unacceptable risks to human and ecological receptors; and (c) restoring the property to its current use after the removal action is complete. The EE/CA which analyzes alternatives to meet the goal of the removal action was prepared by EPA, Region 2.

Various prior investigations including those conducted by EPA have identified the presence of contaminated media containing hazardous substances at the Site. Therefore, EPA has determined that a removal action is warranted to mitigate the threats to the public health, welfare and/or the environment posed by the contaminated Site conditions. The removal action is considered a non-time-critical removal action because earlier interim actions have been implemented that temporarily prevent the migrations of high concentrations of lead from the Site and have allowed sufficient time to plan the removal action prior to initiating on-Site activities.

The Site is a facility as defined by Section 101(9) of CERCLA. A release of hazardous substances has occurred on the Site in a quantity and concentration that has resulted in a substantial threat to the public health, welfare, or the environment. The levels of contaminants detected in soil samples on the Site exceed the EPA Soil Screening Level (SSL) (EPA Document Number: EPA540/R-96/018) and the NYSDEC SCOs (Final Restricted Use SCOs NYCRR Part 375-6.8(b)) soil clean up objectives. There is a current exposure pathway that may present an imminent and substantial endangerment to humans and the environment, and no other party, government or otherwise, is currently taking a timely response action to mitigate the threat. There is a threat of further releases at and from the Site. Site conditions that support a removal action under Section 300.415 (b)(2) of the NCP include:

40 CFR 300.415 (b)(2)(i):	actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants;
40 CFR 300.415 (b)(2)(iv):	high levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface, that may migrate;
40 CFR 300.415 (b)(2)(v):	weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released; and
40 CFR 300.415(b)(2)(vii):	there are no other appropriate federal or state response mechanisms currently available to respond to the situation at the Site.

1.1 PURPOSE AND ORGANIZATION OF EE/CA

The purpose of this EE/CA is to identify and evaluate removal action alternatives, and to recommend the preferred removal action to eliminate or mitigate threats to public health, welfare and the environment. The data collected and presented by EPA and the Site Investigation Summary Report prepared by Creative Habitat Corp., under contract to the current property owner, were all used to develop this EE/CA Report. The EE/CA was prepared in accordance with the requirements of CERCLA, the NCP, *Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA* (EPA/540-R-93-057, August 1993); and other documents which are cited therein.

The organization of this EE/CA report is as follows:

This section, 1.0, presents an introduction, the purpose of the EE/CA, organization, Site background and historical information, and summaries of previous reports.

Section 2.0 discusses the non-time-critical removal action objectives, the statutory limits on removal action, and the scope and schedule of the removal action.

Section 3.0 identifies removal action alternatives, describes the evaluation criteria and regulatory considerations, and screens the removal action alternatives individually based on the evaluation criteria.

Section 4.0 compares the response action alternatives against the evaluation criteria relative to each other, and recommends a response action alternative.

1.2 SITE CHARACTERIZATION

This section presents the characteristic of the Site, including a Site description, Site history, Site geology and hydrogeology, summary of previous investigations and a summary of risk assessment.

1.2.1 Site Description

The Site consists of the historic footprint of the former Jewett White Lead Company facility and the extent of contamination which includes a 1.07-acre parcel of land at 2000-2012 Richmond Terrace, which is designated as Block 1006 and Lot 32 on the Richmond County Tax Map, as well as the approximately 4.41-acre parcel of land at 2015 Richmond Terrace (of which approximately 2.25-acres is not covered by the surface waters of the Kill Van Kull) designated as Block 185, and Lot 548 on the Richmond County Tax Map.

The Site is located on the North Shore of Staten Island in the Port Richmond section. The area around the Site is a mix of residential, light industrial, and commercial. A residential neighborhood commences just south of the elevated railroad line. The nearest residence is located approximately 100 feet south of the Site. Bus stops are present on both sides of Richmond Terrace in front of the Site and on Park Avenue across the street from the entrance to the 2000-2012 Richmond Terrace property.

The 2000-2012 Richmond Terrace portion of the Site (which is the sole focus of this EE/CA) is bordered to the south by an abandoned railroad line, to the west by Park Avenue, and to the north and east by Richmond Terrace. The 2015 Richmond Terrace portion of the Site is bordered to the east by a shipyard facility, to the west by Cable Queen, a New York submarine contracting company, to the north by the Kill Van Kull (a body of water which is a tributary of the New York Harbor), and to the south by Richmond Terrace. The two properties are separated by Richmond Terrace, the main roadway running east-west parallel to the Kill Van Kull. Richmond Terrace has been an active roadway since the early nineteenth century, and many of Staten Island's first industries were established on what is now called Richmond Terrace, but was originally named Shore Road.

In 2009, EPA selected Port Richmond, and the adjoining neighborhoods along the north shore of Staten Island, as a nationally-designated Environmental Justice Showcase Community. The Environmental Justice Showcase Communities effort seeks to bring together governmental and non-governmental organizations and pools their collective resources and expertise on the best ways to achieve real results in communities. EPA recognizes there are communities across the country that experience environmental justice concerns including: multiple, disproportionate environmental health burdens; population vulnerability; limits to effective participation in decisions with environmental and health consequences; and opportunities for multiple federal, state and local agency collaboration, with a focus on green development. For the North Shore of Staten Island, EPA will continue to work with all stakeholders, including local organizations, government agencies (federal, State, City) as well as the business sector to improve collaboration in the delivery of services to support this community while addressing its environmental justice issues.

1.2.2 Site History

John Jewett & Sons White Lead Company operations originated at 2015 Richmond Terrace where they owned and operated the Site from 1839 until April 3, 1890 when National Lead acquired the Site property. When National Lead purchased the business, they extended the white lead operations across the street to include the property at 2000 Richmond Terrace. National Lead owned and operated at both properties until approximately 1943.

On December 31, 1943, Moran Towing Corporation acquired the 2015 Richmond Terrace portion of the Site from National Lead. The 2015 Richmond Terrace property portion of the Site is presently owned by the Moran Towing Corporation, an active tug boat facility.

On May 31, 1946 National Lead sold the portion of the Site located at 2000 Richmond Terrace. Between 1949 and 1990, various businesses operated at the 2000-2012 Richmond Terrace property including Sedutto's Ice Cream factory. The buildings on this portion of the Site were eventually razed and cleared after several fires occurred at the Sedutto's Ice Cream factory.
The property was sold at auction on January 26, 2007 to Leewood Park Avenue LLC. PRC purchased the property from Leewood Park Avenue LLC on October 18, 2007, and currently owns the 2000-2012 Richmond Terrace portion of the Jewett White Lead Site. The property was

utilized by PRC to store equipment and materials from local construction projects.

The 2000-2012 Richmond Terrace property portion of the Site is currently an unpaved vacant lot. The ground surface at this portion of the Site consists of mostly grassy soils with some stone near the entrance. The soils have been disturbed in the past due to the presence of heavy machinery and vehicular movement.

1.2.3 Summary of Previous Site Investigations

On June 3, 2008, the Council of the City of New York submitted a written request to EPA to evaluate the 2000-2012 Richmond Terrace property for potential environmental contamination. Initially, EPA's Pre-Remedial Section evaluated the Site. Subsequently, the Site was referred to EPA's Removal Action Branch to conduct a Removal Site Evaluation that would evaluate the property for a removal action under the authority of CERCLA.

On October 3, 2008, Creative Habitat Corp. under contract PRC, the current property owner of 2000-2012 Richmond Terrace, conducted a subsurface investigation of the property. Four test pits were excavated to a 5' depth, and a total of 12 soil samples were collected from three intervals: 0-15", 15-30", and 30-48". Elevated levels of lead were found in the top 30" of soil within the test pits (Hoeger, 2009).

In December 2008, EPA and contractor representatives from the Removal Support Team collected soil samples from 16 test pits at the 2000-2012 Richmond Terrace property that were excavated to a depth of approximately four feet below grade. Many of the test pits were found to contain either blackened soil, concrete in the form of slabs and/or footings, asphalt, bricks, or wood. The analyses of the soil samples collected from the test pits included target analyte list (TAL) metals and Polychlorinated Biphenyls (PCBs). Off-property samples were collected from four locations along Richmond Terrace in order to determine if contamination had migrated from the property.

The analytical results from the sampling event in December 2008 at the property revealed the presence of elevated levels of lead throughout most of that property, both laterally and with depth. The average surface lead concentration was 5,081 milligrams/kilogram (mg/kg). The highest lead concentration detected at the surface was 37,100 mg/kg, near the gate on Park Avenue. The average lead concentration in the soil samples collected at depths of 1-foot, 2-foot, and 3-foot below grade were 28,245 mg/kg, 61,201 mg/kg, and 53,398 mg/kg, respectively. The highest lead concentration detected in the subsurface was 240,000 mg/kg. In addition, the four off-property sample locations were found to contain lead concentrations ranging from 383 mg/kg to 2,760 mg/kg.

Analytical data collected at the 2000-2012 Richmond Terrace property indicated that elevated levels of lead are present, and activities at the property could potentially cause the soils to become airborne or to migrate beyond the property boundary during dry weather conditions. In addition there is physical evidence that soil had migrated beyond the property boundary onto a portion of Richmond Terrace via runoff during rainfall events and onto Park Avenue via vehicular traffic leaving the property.

At EPA's request, the New York State Department of Health (NYSDOH), under cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR), prepared a Letter of Technical Assistance dated March 25, 2009 (Doroski, 2009). NYSDOH concluded that the apparent migration of lead-contaminated dust warranted immediate mitigation measures to limit the use of the property to prevent additional migration of lead-containing fugitive dust. It concluded that the concentrations of lead detected in the surface soil at the 2000-2012 Richmond Terrace property and the off-property road dust represent a significant public health concern if people, especially children, are exposed to them. The RSE prepared by EPA for the 2000-2012 Richmond Terrace property dated April 24, 2009 concluded that a CERCLA removal action is warranted to address the potential threats posed by the contaminated soil at the 2000-2012 Richmond Terrace portion of the Site (Magriples, 2009).

On April 6, 2009, at EPA's request and oversight, the property owner of 2000-2012 Richmond Terrace initiated an interim removal action to stabilize conditions at the property. The interim removal action consisted of establishing storm water management controls, improving the condition of the existing fencing and windscreen, spreading grass seed and mulch, posting "lead-hazard" warning signs, and wet-sweeping sediment/dirt along the sidewalk and curb adjacent to the Site along Richmond Terrace and Park Avenue. The work was completed on April 20, 2009.

The interim removal action completed on April 20, 2009 established a grass cover on the lead-contaminated soils to limit the migration of wind-blown lead dusts from the property onto neighboring residential properties. In addition, a silt fence was installed along the property lines to prevent surface water runoff containing lead-contaminated soils/sediments from being transported off the property onto the adjacent sidewalks. While these measures temporarily limit the exposure threat, as stated in the Letter of Health Consult provided by NYSDOH dated February 11, 2010, permanent measures are needed to eliminate the potential for future human exposures to soils contaminated with high levels of lead on the former Jewett White Lead property (Doroski, 2010).

Based upon the elevated levels of lead in both the surficial soils at the 2000-2012 Richmond Terrace property and additional samples collected along the sidewalk adjacent the 2000-2012 Richmond Terrace property, EPA collected additional off-site soil samples in the surrounding community, including in residential backyards of the properties immediately adjacent to the former Jewett White Lead Company facility property and in a background area located upwind of the Site.

Elevated levels of lead were found in the residential backyards sampled and in the surrounding community with an average lead concentration of 549 mg/kg in the surface soils (0-2" depth) in the backyards, and an average concentration of lead in the surface soils in the background area of 788 mg/kg. (Staiger, 2010)

Attribution analysis indicates that environmental sources of lead other than from the Site are the primary contributors to lead contamination in this community. Other potential sources of lead include leaded gasoline emissions, exterior lead-based paint, elevated steel structures, and former industrial processes. The RSE for the Off-Site soil sampling dated March 18, 2010 concluded that the Jewett White Lead Site is not a significant contribution source to the lead found in the community. The lead in the community appears to be consistent with urban lead contamination typically seen in the industrialized Northeast United States.

On June 15, 2009, EPA collected 14 surficial soil samples from the 2015 Richmond Terrace property portion of the Jewett White Lead Site. The soil samples were collected from portions of the property where exposed soil was present or where the concrete and asphalt appeared to be in disrepair. Elevated levels of lead were found to be in the samples collected at concentrations that ranged from 145 mg/kg to 2,730 mg/kg, with the highest lead concentrations present in the surface soils adjacent the Richmond Terrace sidewalk. (Staiger, 2010)

Additional investigations to determine the extent of contamination were conducted in October 2010 at the Site. From October 4 to October 28, 2010, EPA and its contractor representatives began collecting additional soil samples at both properties that comprise the Site to determine the extent of contamination. Soil samples were collected in one-foot intervals beginning at the surface and extending to the water table or to the vertical extent of the lead contamination, whichever was encountered first. All soil samples were field screened with a field-portable X-ray fluorescence (FP-XRF) calibrated to lead in soil. Ten percent of the samples collected were submitted for confirmatory analysis for total Lead, as well as Toxicity Characteristic Leaching Procedure (TCLP) and Synthetic Precipitation Leaching Procedure (SPLP) for Lead. Monitoring wells were installed to determine the ground water impacts from the lead contaminated soils. In addition sediment and surface water samples were collected from storm sewer outfalls to the Kill Van Kull to determine if the lead contamination from the 2000-2012 Richmond Terrace property had impacted the waterway.

The field screening results from the sampling event in October 2010 at the 2000-2012 Richmond Terrace property indicates that the elevated levels of lead at the property are confined to the upper four feet of soil with the exception of a small well defined area located in the southwest corner of the property adjacent Park Ave. A total of 25 test pits were excavated on the property, with 15 test pits extending to the 5' depth. The average lead concentrations in the field screened soil samples collected at depths of 1-foot, 2-foot, 3-foot, 4-foot, and 5-foot below grade were 7,083 mg/kg, 20,340 mg/kg, 21,070 mg/kg, 14,388 mg/kg, and 5,752 mg/kg, respectively. The highest lead concentration detected in the subsurface was 97,921 mg/kg at the 2- to 3-foot depth interval. The average lead concentration in the 15 test pits extended to the 6' depth is 350 mg/kg. Following sampling on the property, the test pit locations were seeded with grass seed to encourage the growth of a grass cover to reduce the potential for dust generation.

Eleven of the soil samples were submitted for laboratory confirmatory analysis, as well as TCLP and SPLP lead. The TCLP and the SPLP are designed to determine the mobility of both organic and inorganic contaminants contained in wastes. While the TCLP relies on extraction fluids that simulate the organic acids that would form from decomposing wastes in a landfill, the SPLP simulates mid-Atlantic rainfall with a pH of 4.2 (acid rain), and estimates the leaching potential of contaminants that may occur under field conditions. Both TCLP and SPLP results ranged from non-detect to 28 mg/L. The results for both the TCLP and SPLP analysis indicate that the higher levels of lead may leach to the groundwater if not addressed.

Ground water samples were collected from two of the three monitoring wells installed at the 2000-2012 Richmond Terrace property on October 28, 2010. One well, PO-03, was found to be dry at the time of sampling. The samples were collected using EPA's low-flow/low-stress methodology, and water quality parameters were measured at each sampling location prior to collection. Lead was not detected in the ground water samples collected from the two monitoring wells installed at the 2000-2012 Richmond Terrace property.

A total of 23 soil borings were installed to the water table at the 2015 Richmond Terrace property from October 11 to 15, 2010. Soil samples were collected from 1' depth intervals and field screened with an FP-XRF for lead. Elevated levels of lead are present throughout the property beneath the asphalt paving. The average lead concentrations in the field screened soil samples collected at depths of 1-foot, 2-foot, 3-foot, and 4-foot below grade were 3,884 mg/kg, 6,473 mg/kg, 7,591 mg/kg, and 12,541 mg/kg. The highest lead concentration detected in the subsurface was 130,000 mg/kg at the 4- to 5-foot depth interval. The lead levels appear to increase with depth and extend into the water table.

In summary, the levels of contaminants detected in soil samples from the Site exceed the EPA Soil Screening Levels and the NYSDEC Part 375 soil clean up objectives.

1.2.4 Summary of Streamlined Risk Assessment

A streamlined risk assessment was performed for the 2000-2012 Richmond Terrace portion of the Site in the Borough of Staten Island, Richmond County, New York and is included as Appendix D within Attachment III. The objective of the streamlined risk assessment is to provide an evaluation of potential risks to human receptors assuming no removal or cleanup actions are taken at the site.

The current land use is zoned commercial/industrial. The future land use is not expected to change. However, this assessment included screening against the residential screening criteria, as a conservative measure to provide a range of the risks associated with each exposure scenario.

The screening process is a conservative step in the streamlined risk assessment process. To evaluate the potential risks posed to current and future receptors, a conservative screening process was applied to identify Constituents of Potential Concern (COPC) in the surface soil, subsurface soil and groundwater at the site.

The maximum detected concentrations of the constituents detected (lab data) were compared to their respective screening levels. In soil, aluminum, antimony, arsenic, copper, iron, lead, manganese and mercury exceeded their respective residential screening criteria and were identified as COPCs. When compared to their respective screening criteria, a cancer risk or non-cancer hazard was generated for each chemical based upon the maximum detected concentration, whichever was the most sensitive health endpoint. For carcinogens, cancer risks are generally expressed as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the carcinogen. This evaluation was conducted for all constituents which exceeded their respective screening level. These risks are probabilities that usually are expressed in scientific notation. An excess lifetime cancer risk of 1×10^{-6} indicates that an individual experiencing the reasonable maximum exposure estimated has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. The NCP defines the acceptable risk range for site related exposures as one in 10,000 (1×10^{-4}) to one in a million (1×10^{-6}). Non-cancer health endpoints are general expressed as ratios of exposure to toxicity, which is called a hazard quotient (HQ). An HQ<1.0 indicates that a receptor's dose of a single contaminant is less than the reference dose (RfD), and that toxic non-carcinogenic effects from that chemical are highly unlikely.

The maximum detected concentrations of COPCs (individually) are below the HI = 1 or within the cancer risk range, with the exception of lead and manganese. Lead is evaluated differently than other constituents and is discussed later. The maximum detected concentration of manganese corresponds to a hazard index of 1.8, which slightly exceeds the non cancer hazard threshold. Although the HI slightly exceeds the threshold of 1, manganese is not considered a risk driver at the site since it is consistent with eastern USA background.

Three detected chemicals in groundwater samples exceeded their respective tap water screening criteria. The maximum detected concentration for Iron corresponds to 0.9 HI, which is below EPAs threshold of 1. The maximum detected concentration for manganese corresponds to a 5.6 HI, which slightly exceeds EPAs threshold of 1. The maximum detected concentration of arsenic corresponds to a cancer risk of 1.6×10^{-3}, which exceeds EPA cancer risk range. It should be noted that Arsenic was detected only in one of the three monitoring wells sampled at the site.

The risks associated with exposure to lead are not expressed as a probability of developing cancer. But rather compared to a screening value which corresponds to a threshold of no more than 5% of children exposed would have a blood lead level greater than 10 ug/dl. The CDC has identified a blood lead concentration level of 10 µg/dL as the level of concern above which significant health risks occur. For lead, the toxicity assessment is based on exceeding the 10 µg/dL blood lead concentration.

The samples collected and analyzed using the XRF indicate that the maximum detected concentration of lead (97,921 mg/kg) exceed its respective screening criteria for the child (400 mg/kg) and adult receptor (880 mg/kg). The average lead concentration at the surface (0-2ft) is 27,443 mg/kg and is much higher when compared to the total soil (surface and subsurface) lead concentration throughout the Site (11,245 mg/kg).

The residential screening level for lead of 400 mg/kg has been calculated with the Agency's new Integrated Exposure Uptake Biokinetic Model (IEUBK) model (Pub. # 9285.7-15-2, PB93-963511), using default parameters which includes the 10 ug/dl critical blood lead level. The maximum detected concentration of lead in the soils at the site is 97,921 mg/kg, which is over 2 orders of magnitude above the 400 mg/kg screening criteria for lead in a residential setting. At this concentration, lead at the Jewett White Lead site may be considered a principal threat waste. Principal threat wastes are those source materials that generally cannot be reliably contained or would present a significant risk to human health or the environment should an exposure occur. These include materials having high concentrations of toxic compounds.

"Source material" is defined as material that includes or contains hazardous substances, pollutants or contaminants that act as a reservoir for migration of contamination to groundwater, to surface water, to air or acts as a source for direct exposure. At the unpaved 2000-2012 Richmond Terrace Property, soil presents a direct exposure to receptors that may access the property. The soil at the 2000-2012 Richmond Terrace Property is considered a source material.

The lead results indicate that the average concentration on the Site (surface and subsurface) presents an unacceptable risk to the current industrial/commercial receptor and the potential future resident. (McPherson, 2011)

1.2.5 Summary of Screening Level Ecological Risk Assessment

A streamlined Screening Level Ecological Risk Assessment (SLERA) was performed for the 2000-2012 Richmond Terrace portion of the Jewett White Lead Site in the Borough of Staten Island, Richmond County, New York and is included in Attachment III.

There appears to be the potential for risk to ecological receptors at the property. Contaminant concentrations measured at the property exceeded screening benchmarks for many contaminants in soil, in catch basin water and sediments, and in sediment and surface water at the outfalls in the Kill Van Kull. Hazard quotients for surface water and sediment (both freshwater and marine) were generally low, but still exceeded threshold values. Concentrations of contaminants in soil were very high for some contaminants, particularly lead, aluminum, iron, and chromium. In addition, food chain models indicated the potential for risk to all assessment endpoints evaluated (herbivorous birds and mammals, invertivorous birds and mammals, and carnivorous birds and mammals). For all assessment endpoints except carnivorous mammals, lead was the primary contaminant of concern, with hazard quotients (HQs) reaching 18,000 for the American woodcock. For carnivorous mammals, the highest HQ was calculated for aluminum. This is likely due to using the default bioaccumulation factor (BAF) of 1.0, which was applied because soil to small mammal values could not be found in the published literature. This BAF is likely to be overly conservative and may cause aluminum to appear to be a disproportionately important Contaminants of Potential Concern (COPCs).

The SLERA clearly indicates that concentrations of lead and other metals at the 2000-2012 Richmond Terrace portion of the Site are sufficiently high to present risk to ecological receptors. The fact that little viable habitat exists at the property may represent a mitigating factor by reducing the possibility of ecological exposure. (Pensak, 2011)

2.0 REMOVAL ACTION AND OBJECTIVES

This section presents the overall goals and objectives of the proposed non-time-critical removal action, describes the statutory limitations on the removal actions, and describes the anticipated timetable for the implementation of the non-time-critical response action.

2.1 STATUTORY LIMITS ON REMOVAL RESPONSE ACTIONS

Superfund-financed response actions classified as removal actions are limited to a 12-month duration and to $2 million in expenditures by Section 104(c)(1) of CERCLA, 42 U.S.C Section 9604(c) and 40 CFR §300.415(b)(5). Exemptions from the time and funding limitations in the statute can be granted where EPA determines that the proposed removal action is appropriate and consistent with an anticipated long-term remedial action or an emergency condition exists.

2.2 CONDITIONS THAT JUSTIFY A REMOVAL ACTION

Site characterization investigations described in Section 1.0 indicate that the wastes and soils located on the 2000-2012 Richmond Terrace property contain hazardous substances including lead. Lead is present at the property at levels that pose a threat to public health, welfare and the environment. Therefore, EPA has determined that a non-time-critical removal action is appropriate to abate, prevent, minimize, stabilize, mitigate, or eliminate these threats. Specifically, action(s) will be undertaken to restrict or disassociate human exposure to the contaminated areas at the property, and to prevent or minimize the migration of hazardous substances released at the property to the area soils, sediment, surface water and groundwater. The general response actions to evaluate which is appropriate and applicable to accomplish these objectives are considered in the following Sections.

2.3 REMOVAL ACTION SCOPE, OBJECTIVES AND SCHEDULE

Investigations at the 2000-2012 Richmond Terrace property indicate that an unacceptable risk exists to human and ecological receptors. Based upon the investigations conducted at the property, the following metals have been identified as COPCs: aluminum; antimony; arsenic, copper, iron, manganese, lead and mercury. In order to mitigate the risk to human and ecological receptors, the scope of the removal action is to achieve the overall objective of protecting human health and the environment. The objectives identify removal actions that are necessary to adequately address human-health and ecological risks.

With the overall objective of protecting human health and the environment, the specific removal action objectives developed for this property are as follows:

- Prevent or minimize the migration of hazardous substances released at the property to the area's soils, sediment, surface water and groundwater;

- Abate, minimize, stabilize, mitigate, or remove the contaminants from the soils such that unacceptable risks to human and ecological receptors are eliminated. The table below presents the COPCs with corresponding site-specific Risk Based Criteria (RBCs), or Screening Levels; and

- Restore the property to its current use.

EPA, in consultation with NYSDEC, has set the following site-specific RBCs for the contaminant constituents at the 2000-2012 Richmond Terrace property. These RBCs, listed below, based in part on the Regional Screening Levels for Contaminants at Superfund Sites (November, 2010) and the Streamlined Human Health Risk Assessment, will be used to define which contaminants potentially pose a concern. The values in the table provided are not promulgated standards but rather risk based criteria:

Aluminum	99,000 mg/kg
Antimony	41 mg/kg
Arsenic	1.6 mg/kg
Copper	4,100 mg/kg
Iron	72,000 mg/kg
Manganese	2,300 mg/kg
Lead	800 mg/kg
Mercury	3.4 mg/kg

EPA, in consultation with NYSDEC, has set the following site-specific preliminary remediation goal for lead at the 2000-2012 Richmond Terrace property. The PRG, listed below, is based in part on the Regional Screening Levels for Contaminants at Superfund Sites (November, 2010), the Streamlined Human Health Risk Assessment, and the NYSDEC Part 375 and will be used to define which soils and waste materials potentially pose a concern and would require excavation, containment and/or treatment:

- Lead 800 mg/kg

Addressing soils above the PRG of 800 mg/kg of lead will result in a cleanup that is protective for other contaminants of concern as well. Soils that contain less than 800 mg/kg of lead are not expected to fail TCLP.

It is anticipated that any of the alternatives for a removal action could be accomplished in less than a year from the start date. At this point, the start date is not known; however, it is anticipated that the removal action will be initiated in the spring of 2011. A detailed schedule and time line for required tasks to perform the response action will be prepared prior to commencing field activities.

3.0 IDENTIFICATION OF REMOVAL ACTION ALTERNATIVES

3.1 INTRODUCTION

Five removal alternatives are identified as potential actions toward achieving the primary objectives of this non-time-critical removal action to eliminate or mitigate existing and/or potential threats to the public health and the environment by: (a) eliminate unacceptable risks to human and ecological receptors; and (b) preventing or minimizing the migration of hazardous constituents to area soils, sediment, surface water and groundwater. These alternatives are as follows.

3.2 REMOVAL ACTION ALTERNATIVES

3.2.1 Alternative 1: No Action

The Superfund program requires that the "no-action" alternative be considered as a baseline for comparison with the other alternatives. The no-action alternative does not include any removal measures that address the contaminated media. This alternative would, however, include the implementation of public awareness program to ensure that nearby residents are familiar with the threats posed by the contamination located on the Site.

3.2.2 Alternative 2: Excavation and Off-Site Treatment/Disposal

Preparation activities under this alternative would include the construction of a vehicle decontamination pad and material stockpile and staging areas, clearing and grubbing, removal of materials, such as construction equipment stored on the property, and reconstructing the erosion control measures. Following these activities, approximately 4,242-cubic yards of soils exceeding the Site-specific PRG for lead would be excavated. The available soil analytical results will be used to determine initial excavation dimensions. Soil samples would be collected from the walls and base of the initial excavation and analyzed for metals. If analytical results of the post-excavation samples indicate that residual concentrations exceed the minimum action level, additional soil would be excavated, followed by additional confirmatory sampling. The process would be repeated until analytical results reveal that all the soils containing metals concentrations greater than the PRG for lead have been removed, or until a hard surface such as a roadway or sidewalk are encountered.

Once confirmatory sampling results indicate that excavation activities are completed, the excavated areas would be backfilled to restore the property to the existing grade. Backfill would consist of certified clean soil from an approved off-site source. The top 6 inches of backfill would be soil that would meet the needs of the property owner, either organic-rich loam capable of supporting vegetative growth, an inorganic travel layer (i.e., stone dust or crushed stone), or a combination of both. A vegetative cover would be planted immediately following placement of any topsoil layer.

Excavated soil will be sampled at the rate required by the proposed treatment, storage and disposal facility (TSDF), using TCLP analytical methods. As the final phase of this action, excavated soils will be transported and disposed of at an appropriate TSDF.

3.2.3 Alternative 3, Capping

Preparation activities under this alternative would include the construction of a vehicle decontamination pad and material stockpile and staging areas, clearing and grubbing, removal of materials, such as construction equipment stored on the property, reconstructing erosion control measures, and decommissioning the existing shallow groundwater monitoring wells (leaving them in place would require sealing them to the barrier protection layer). Soils that do not pass the RCRA characteristic testing would be sent off-Site for treatment/disposal at a RCRA subtitle C facility. The remaining soils will be regraded. Following these activities, an approximately 1-acre multi-layer cap would be constructed over the consolidated contaminated soils. The cap layers, from bottom to top, would consist of the following:

> Grading Layer: Common fill would be placed to create positive surface water run-off. Some on-site materials would be used for common fill.
>
> Barrier Protection Layer: A 40-mil (0.040-inch) thick flexible membrane liner (FML) manufactured from high-density polyethylene (HDPE). The HDPE liner provides a low-permeability layer that would act as the primary liner in retarding infiltration. Common fill layer would be placed at a thickness of 20 inches to provide protection for the HDPE and drainage layer.
>
> Geosynthetic Drainage Layer: The drainage layer would be used to remove surface water that infiltrates through the upper layers of the cap. The drainage layer would tie into a drainage system located within an anchor trench around the perimeter of the cap.
>
> Clean Fill Layer: This layer would provide protection for the barrier and drainage layers, and would comprise approximately 1.5 ft of clean fill.
>
> A Vegetative Soil Layer: A uppermost cover layer that would meet the needs of the property owner, either organic-rich loam capable of supporting vegetative growth, an inorganic travel layer (i.e., stone dust or crushed stone), or a combination of both would be place at a thickness of 6 inches to accommodate the root system of the vegetation selected for the cap

After capping, the property would be landscaped, fenced, and posted. This alternative would also include implementing institutional controls necessary to protect the integrity of the cap. Such an approach may include the imposition of an institutional control in the form of an environmental easement granted to NYSDEC for the property, and a Site Management Plan to assure the institutional and engineering controls remain in place and effective.

Property maintenance activities, including maintaining the fence and signs, removal of trees and shrubs on the cap that can puncture the geomembrane with root growth, monitoring for invasion by burrowing animals, and repair of any erosion, would be necessary to maintain the integrity of the cap system.

Groundwater beneath the Site will be monitored at the three onsite wells semi-annually for a period of up to 30 years, to verify the success of the removal. Site maintenance activities, including maintaining the pavement, fence, and signs, would be necessary to maintain the integrity of the pavement system. Potentially Responsible Parties (PRPs) will perform monitoring of groundwater under New York State oversight.

3.2.4 Alternative 4, Paving

Preparation activities under this alternative would include the construction of a vehicle decontamination pad and material stockpile and staging areas, clearing and grubbing, removal of on-site materials, such as construction equipment stored on the property, and reconstructing erosion control measures. The existing onsite groundwater monitoring wells could be left in place.

In order to maintain the current grade at the Site, the top 6 inches of contaminated soil would be removed, in order to accommodate the pavement. Approximately 500 cubic yards of soil will be removed.

Following these activities, an approximately 1-acre asphalt pavement would be constructed over the graded contaminated soils. After paving, the Site would be fenced and posted. This alternative would also include implementing institutional controls necessary to protect the integrity of the cap. Such an approach may include the imposition of an institutional control in the form of an environmental easement granted to the NYSDEC for the property, and a Site Management Plan to assure the institutional and engineering controls remain in place and effective.

Property maintenance activities, including maintaining the fence and signs, repair of any erosion and/or cracks, would be necessary to maintain the integrity of the cap system.

Groundwater beneath the Site will be monitored at the three onsite wells semi-annually for a period of up to 30 years, to verify the success of the removal. Site maintenance activities, including maintaining the pavement, fence, and signs, would be necessary to maintain the integrity of the pavement system. PRPs will perform monitoring of groundwater under New York State oversight.

3.2.5 Alternative 5, Immobilization

Preparation activities under this alternative would include the construction of a vehicle decontamination pad and material stockpile and staging areas, clearing and grubbing, removal of on-site materials, such as construction equipment stored on the property, reconstructing erosion control measures, and decommissioning the existing onsite groundwater monitoring wells.

Following these activities, the top two feet of lead contaminated soil would be treated in-situ with a concrete additive which would immobilize the lead in the soil, preventing leaching to surface water and groundwater (soils would pass TCLP criteria), as well as preventing contact with deeper, untreated, lead-impacted soils. The treatment would be accomplished by adding the concrete additive and water to the soil via an industrial tilling machine, in two, 1-ft lifts. The additive would not significantly increase the volume of treated soils, such that no soil removal will be required to maintain current grade. Once cured, the treated area will provide a surface that precludes vegetation growth and burrowing animals, and a suitable surface for the current site use, storage of construction equipment. No further cover will be required.

After immobilization, the three onsite monitoring wells would be replaced, and their surface completions would be sealed to the ground surface. Following monitoring well installation and development, the Site would be fenced, and posted. Such an approach may include the imposition of an institutional control in the form of an environmental easement granted to the NYSDEC for the property, and a Site Management Plan to assure the institutional and engineering controls remain in place and effective.

Groundwater beneath the Site will be monitored at the three onsite wells semi-annually for a period of up to 30 years, to verify the success of the removal. Site maintenance activities, including maintaining the fence and signs, would be necessary to maintain the integrity of the cap system. PRPs will perform monitoring of groundwater under New York State oversight.

4.0 ANALYSIS OF ALTERNATIVES

4.1 INTRODUCTION

This Section is intended to present a discussion of the five removal alternatives developed in the previous section. In addition to providing additional information about the nature of each alternative, an analysis of each alternative with respect to its effectiveness, implementability, and cost is included. The removal alternatives represent a range of potential actions which are evaluated to determine which can best meet the removal action objectives of the project in light of their differing levels of protectiveness of human health and the environment and reasonable range of costs.

4.2 OVERVIEW OF EVALUATION CRITERIA

Each alternative would be assessed against the following three evaluation criteria and their components, in conformance with the non-time-critical removal action guidance:

Effectiveness
Overall Protection of Public Health and the Environment
Compliance with ARARs and Other Criteria, Advisories, and Guidance
Long-Term Effectiveness and Permanence
Reduction of Toxicity, Mobility, or Volume through Treatment
Short-Term Effectiveness

Implementability
Technical and Administrative Feasibility
State Acceptance
Community Acceptance

Cost
Direct and Indirect Capital Costs
Operation and Maintenance Costs
Total Costs

Brief descriptions of the three evaluation criteria and their components are presented in the following subsections.

4.2.1 Effectiveness

This refers to each alternative's ability to meet the removal action objectives (RAOs) within the scope of the removal action. Each alternative is evaluated against the scope of the removal action and against each specific objective for final disposition of the wastes (if applicable) and the level of cleanup desired.

4.2.1.1 Overall Protection of Public Health and the Environment

This criterion assesses whether the alternatives are protective of public health and the environment. The evaluation will focus on how each alternative achieves adequate protection and describe how the alternative will reduce, control, or eliminate risks at the property through the use of treatment, engineering, or institutional controls. The evaluation will identify any unacceptable short-term impacts. The overall assessment of protectiveness is based on a composite of factors assessed under the evaluation criteria, including long-term effectiveness and permanence, short-term effectiveness, and compliance with applicable or relevant and appropriate requirements (ARARs.)

4.2.1.2 Compliance with ARARs and Other Criteria, Advisories, and Guidance

This criterion addresses whether or not a removal action would meet all of the ARARs of other federal and state environmental statutes and requirements or provide grounds for invoking a waiver. These requirements are discussed within this section.

Removal actions, such as this non-time-critical removal action, are required to attain ARARs to the extent practicable pursuant to the requirements of Section 300.415(j) of the NCP. Applicable requirements are those substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address either hazardous substances, the type of action to be implemented at the Site, an aspect specific to the location of the Site, or other circumstances relevant to the Site. Relevant and appropriate requirements are those substantive environmental protection requirements, criteria, or limitations which are promulgated under federal or state law which, while not applicable to either the hazardous substances found at the Site, the type of response action itself, the Site location, or other circumstances at the Site, nevertheless address problems or situations sufficiently similar to those encountered at the Site such that they are well-suited to the Site. EPA also will consider “To Be Considered” (TBCs) that include non-binding criteria, advisories, guidance, and proposed standards. TBCs are not potential ARARs; rather they are meant to complement the use of ARARs. It may be necessary to consult TBCs to interpret ARARs, or to determine preliminary remediation goals when ARARs do not exist for particular contaminants.

ARARs are generally divided into three categories: chemical-specific; location-specific; and action-specific. Chemical-specific ARARs provide guidance on acceptable or permissible contaminant concentrations of specific substances in soil, air, and water. Location-specific ARARs govern activities based on their specific location, such as floodplains, wetlands, endangered species habitats, or historically significant areas, while action-specific ARARs are technology or activity-based requirements based on the type of response action which is envisioned.

4.2.1.2.1 Chemical-Specific ARARs

Chemical-specific ARARs for the COPCs at the Site (*e.g.,* metals) are discussed below. These ARARs would be the federal standards or the more stringent state standards.

Appropriate federal requirements include Resource Conservation and Recovery Act (RCRA), 42 U.S.C. § 6901, *et seq*., which regulates the disposal of hazardous wastes.

New York State surface water standards have been promulgated by NYSDEC for the protection of human health and/or aquatic life and are legally enforceable. The surface water standards are dependent on the federally-assigned classification of the surface water body as well as the carbonate hardness of the surface water for inorganic constituents (6 NYCRR Part 701).

4.2.1.2.2 Location-Specific ARARs

Location-specific ARARs that may govern activities in critical environments such as endangered species habitats and historic locations are as follows.

The Endangered Species Act (16 U.S.C. 1531 *et seq*.) and the Endangered and Threatened Species of Fish and Wildlife; Species of Special Concern (6 NYCRR Part 182) address the protection of threatened and endangered species. There may be threatened or endangered species or habitats expected to be present within the area of study as determined by the NYSDEC, based on a review of the Significant Habitat and Natural Heritage Program files for the Site (NYSDEC, 2010).

The National Historic Preservation Act addresses potential impacts to properties that are listed in the National Register of Historic Places, or ones that are eligible for such a listing. No historic places are located on or near the Site. Therefore, the non-time-critical removal action is not expected to have any impact on these potential resources.

4.2.1.2.3 Action-Specific ARARs

RCRA, 42 U.S.C. Sections 6901 *et seq*., and the New York State Hazardous Waste Regulations deal with the treatment and disposal methods of all hazardous wastes. The wastes from the Site, if there are any to be disposed, must be in handled accordance with the federal hazardous waste regulations (40 CFR Parts 260-268 and 761) promulgated under RCRA, as well as portions of the New York State Hazardous Waste Regulations (6 NYCRR Parts 370-376). Determination of the presence and appropriate waste code for any hazardous wastes at the property or residuals from the treatment of such wastes would be made in accordance with these regulations.

Soils or wastes which are deemed hazardous under RCRA would need to be treated/disposed of at a RCRA Subtitle C facility. Soils or wastes which do not have hazardous characteristics could be treated/disposed of at a RCRA Subtitle D facility (*i.e*., municipal landfill). Soils or wastes which are deemed hazardous under RCRA and left in place would need to be capped and maintained in accordance with RCRA landfill closure and post-closure care requirements (40 CFR Part 264.310).

The Occupational Safety and Health Administration has promulgated permissible exposure limits (PELs) for a variety of contaminants in the air (29 CFR 1910, Subpart Z). The PELs are based on time-weighted average (TWA) concentrations to which workers may be exposed over an 8-hr exposure period without adverse health effects. PELs and TWAs are intended for adult workers exposed in an occupational setting, and are not directly applicable to CERCLA Sites. The PELs and TWAs may be used as guidance values to determine whether long-term exposures to contaminants in air may pose a human health risk.

4.2.1.2.4 To Be Considered

Chemical-specific TBCs for the COPCs at the Site are discussed below.

New York State Part 375 soil clean up objectives (SCOs) have been promulgated by NYSDEC for the protection of human health. While the objective of the SCOs is the attainment of these soil cleanup objectives to eliminate all significant threats to human health and/or the environment posed by the inactive hazardous waste Site, as it turns out, the cleanup standard for lead which we've selected is more stringent than the relevant SCO.

EPA Region 3 and Region 9 (respectively) have established RBC for many organic as well as inorganic contaminants found at CERCLA Sites. These RBCs could be used as action or cleanup levels to address the COPCs found at the Site.

The Clean Air Act (CAA) (42 U.S.C. §§ 7401 *et. seq.*), governs air emissions resulting from remedial actions at CERCLA Sites. National Ambient Air Quality Standards [NAAQS (40 CFR Part 50)] have been promulgated under the CAA for six criteria pollutants, including airborne particulates. NAAQS standards for lead have been promulgated at 1.5 micrograms per cubic meter averaged over a calendar quarter. To the extent that response actions undertaken at the Site emit regulated air contaminants, the CAA should be considered.

The National Institute for Occupational Safety and Health (NIOSH) has developed concentrations for contaminants in the air that are immediately dangerous to life or health (IDLH) for individuals in occupational settings. The IDLH is the maximum concentration, in the event of respirator failure, that could be tolerated for 30 min without experiencing any escape-impairing or irreversible health effects. The IDLHs are appropriate only for subchronic exposures to non-carcinogenic compounds or effects of compounds in air. These values are not directly applicable to CERCLA Sites; however, they may provide guidance concerning the upper bound of safe inhalation exposures to contaminants for workers on the Site. NIOSH also has recommended exposure limits (RELs) for each contaminant of concern. An REL is generally a time-weighted average based on the toxicological and industrial hygiene data.

American Conference of Governmental Industrial Hygienists has developed threshold limit values (TLVs) that are updated every year. The TLV is a time-weighted average concentration under which most people can work consistently for eight hours a day, day after day, and experience no harmful effects.

U.S. EPA, Presumptive Remedy Guidance for Metals-in-Soil Sites (OSWER 9355.0-72, September 1999) identifies a presumptive remedy for metals-in-soil sites, and summarizes technical factors that should be considered when selecting a presumptive remedy for these sites.
Action-Specific TBCs for the Site: None identified

Location-Specific TBCs for the Site: None identified

4.2.1.3 Long-Term Effectiveness and Permanence

This criterion involves the evaluation of the extent and effectiveness of the controls that may be required to manage the risk posed by treatment residuals and/or untreated wastes at the property. This criterion also considers the adequacy and reliability of controls and addresses the extent to which there is a need for Post-Removal Site Controls (with the statutory time limits imposed on such actions).

4.2.1.4 Reduction of Toxicity, Mobility, and Volume through Treatment

This criterion includes evaluating the anticipated performance of specific treatment technologies. This evaluation addresses the statutory preference for selecting removal actions that employ treatment technologies to permanently and significantly reduce toxicity, mobility, or volume of wastes. Factors that will be considered, as appropriate, include the following:

- The treatment processes the alternatives employ and the materials they will treat.
- The amount of hazardous materials to be destroyed or treated.
- The degree of reduction expected in toxicity, mobility, or volume.
- The degree to which the treatment would be irreversible.
- The type and quantity of residuals that would remain after treatment.
- Whether the alternative would satisfy the preference for treatment.

4.2.1.5 Short-Term Effectiveness

This criterion examines the effectiveness of alternatives in protecting public health and the environment during the construction and implementation period until the RAOs have been met. The following factors will be considered:

- Potential for short-term risks to the affected community as a result of the response action.
- Potential impacts on workers during the response action, and the effectiveness and reliability of protective measures that would be taken.
- Potential adverse environmental impacts of the response action, and the effectiveness and reliability of protective measures that would be taken.
- Time until protection is achieved.

4.2.2 Implementability

The ease of implementing the removal alternatives will be assessed by considering the following factors.

4.2.2.1 Technical and Administrative Feasibility

Technical feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology, the reliability of the technology, ease of undertaking additional response actions, the ability to monitor the effectiveness of the action, and the extent to which the removal action contributes to the efficient performance of any long-term remedial action.

Administrative feasibility, including activities needed to coordinate with other offices and agencies, the ability to obtain necessary approvals and permits from other agencies (for off-site actions), and statutory limits on removal actions.

Availability of services and materials, including the availability of adequate on or off-site treatment, storage capacity, and disposal capacity and services; the availability of necessary equipment and specialists, and provisions to ensure any necessary additional resources; and the availability of prospective technologies for full-scale application.

4.2.2.2 State Acceptance

The State of New York has been providing input on this EE/CA during its preparation, and their concerns have been considered in determining the recommended removal alternative. Any additional State concerns will be addressed in the final selection of the removal alternative as set forth in an Action Memorandum.

4.2.2.3 Community Acceptance

Community acceptance will be assessed following review of the public comments received on the EE/CA.

4.2.3 Cost

The costs that will be assessed include the following:

- Capital costs, including both indirect and direct costs.
- Post-removal site control costs, which include annual operation and maintenance (O&M), monitoring, and residual disposal costs (notwithstanding the statutory time limits imposed on such actions).
- Present-worth costs, which include the capital costs plus the present value of 30 years of post-removal site control costs (calculated at a 7 percent discount rate).

4.3 ANALYSIS OF ALTERNATIVES

4.3.1 Alternative 1: No Action

EPA considers a "no-action" alternative as a baseline for comparison with the other alternatives. Alternative 1 does not include any removal measures to address the contaminated media. This alternative would, however, include the implementation of a public awareness program to ensure that the nearby residents are familiar with the threats posed by the contamination located on the property.

4.3.1.1 Effectiveness

4.3.1.1.1 Overall Protection of Human Health and the Environment

Alternative 1 would not be protective of human health and the environment, since it would not actively address the potential human health and ecological risks posed by the contaminated soils, and would not minimize the migration of hazardous constituents to area soils, sediment, surface water, and groundwater.

4.3.1.1.2 Compliance with ARARs

Since the contaminated soils would not be addressed under Alternative 1, this alternative would not comply with all pertinent ARARs.

4.3.1.1.3 Long-Term Effectiveness and Permanence

Alternative 1 involves no controls and would not be effective in permanently minimizing the migration of hazardous constituents to area soils, sediment, surface water, and groundwater or eliminating unacceptable risk to human and environmental receptors.

4.3.1.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 1 would not result in the reduction of the toxicity, mobility, and volume of contaminants in Site soils. Alternative 1 does not meet the statutory preference for selecting response actions that employ treatment technologies to permanently and significantly reduce toxicity, mobility, or volume of wastes.

4.3.1.1.5 Short-Term Effectiveness

Since this alternative does not include any physical construction measures in any areas of contamination, it would not present a risk to the community or on-site workers as a result of its implementation.

4.3.1.2 Implementability

There are no construction-related considerations associated with the no action alternative.

4.3.1.3 Cost

There are no capital or transportation and disposal costs associated with the no-action alternative. The estimated indirect costs are presented below. However, a public Site information repository would be established for the local residents and other interested parties in the community.

Capital Cost	Transportation and Disposal Costs	Operation and Maintenance Costs	Indirect Costs	Total Cost
$0	$0	$0	$10,050	$10,050

4.3.2 Alternative 2: Soil Excavation, Off-Site Treatment/Disposal

Under this alternative, the contaminated soils would be excavated and transported off-site for treatment/disposal. The excavated areas would be backfilled with clean fill and revegetated.

4.3.2.1 Effectiveness

4.3.2.1.1 Overall Protection of Human Health and the Environment

The potential for future migration of hazardous substances in soils above the level of concern from the Site would be completely eliminated by permanently removing those contaminated soils under this alternative. The action is protective of human health and the environment because the risk of incidental contact with waste by humans and ecological receptors would be significantly reduced by removing the contaminated soil above the established level of concern.

4.3.2.1.2 Compliance with ARARs

All applicable ARARs will be addressed under this Alternative.

As discussed in Subsection 4.1, EPA in consultation with NYSDEC has set site-specific PRGs for lead. Those soils exceeding site-specific PRGs would be removed from the Site under this alternative.

Soils exceeding the above site-specific Screening Levels would be excavated. Samples would be collected from the walls and base of the excavation and analyzed for metals. If analytical results of post-excavation samples indicate that residual concentrations exceed the action level, additional soil would be excavated, followed by additional confirmatory sampling. The process would be repeated until analytical results reveal that all the soils containing metals concentrations greater than the minimum action level have been removed.

All excavated soils would be subjected to RCRA hazardous waste characteristic testing. Those soils that pass the RCRA characteristic testing would be sent off-site for disposal at a RCRA Subtitle D facility (i.e., a municipal landfill). Those soils that do not pass the RCRA characteristic testing would be sent off-site for treatment/disposal at a RCRA Subtitle C facility. Alternative 2 would be subject to New York State and federal regulations regarding transportation and off-site treatment/disposal of wastes would require compliance with fugitive dust emission regulations.

4.3.2.1.3 Long-Term Effectiveness and Permanence

Excavation and off-site disposal of the contaminated soil would provide long-term protection of human health and the environment and prevent the migration of hazardous constituents to area soils, sediment, surface water, and groundwater.

4.3.2.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Under this alternative, contaminants would be removed from the Site for treatment/disposal, thereby reducing their toxicity, mobility, and volume.

4.3.2.1.5 Short-Term Effectiveness

This alternative would involve excavating, transporting, and depositing waste. While this would present some risk to on-site workers through dermal contact and inhalation, these exposures could be minimized by utilizing proper protective equipment and appropriate engineering controls. The vehicular traffic associated with the off-site transport of contaminated soils could impact the local roadway system and nearby residents through increased noise levels. Under this alternative, there is a potential for increased stormwater runoff and erosion during excavation activities that would have to be properly managed to prevent excessive water and waste material loading. Appropriate measures would have to be taken during excavation activities to prevent the transport of fugitive dust.

4.3.2.2 Implementability

It is estimated that this alternative would require approximately 15 days for soil excavation and 15 days for soil backfilling, and would take 2 months to implement.

The actions under this alternative would use proven earthmoving equipment and techniques and established administrative procedures. In addition, sufficient facilities are available for treatment and disposal of the excavated soils. Therefore, this alternative would be easily implemented.

4.3.2.3 Cost

The estimated capital, transportation and disposal costs, and indirect costs are presented below.

Capital Cost	Transportation and Disposal Costs	Operation and Maintenance Costs	Indirect Costs	Total Cost
$171,146	$626,787	$14,509	$111,711	$924,153

4.3.3 Alternative 3: Capping

This alternative would involve the excavation and consolidation of contaminated soils under a soil cap cover. The removal of the upper 2 ft of soil at the site would be required to maintain existing grade and accommodate the 2-ft cap. An estimated 2,400 cubic yards, will be removed. The Site would then be landscaped, fenced, and posted. This alternative would also include implementing long-term groundwater monitoring activities. The actions under this alternative would require the implementation of institutional controls that may be administratively difficult, since construction of the soil cap would require the imposition of an environmental easement. In addition, the current 2000-2012 Richmond Terrace Property owner may be required to maintain a Site Management Plan to ensure the institutional and engineering controls remain in place and are effective.

4.3.3.1 Effectiveness

4.3.3.1.1 Overall Protection of Public Health and the Environment

Under this alternative, the potential for future migration of contaminants would be reduced by containing the contaminated soils. The action is protective of human health and the environment because the risk of incidental contact with waste by humans and ecological receptors would be significantly reduced by containing the contaminated soil. Capping would also prevent surface contaminant migration from the Site.

4.3.3.1.2 Compliance with ARARs

All applicable ARARs will be addressed; however, this alternative would leave soils in place beneath the cap that exceed NYSDEC Part 375 RUSCOs.

As discussed in Subsection 4.1, EPA in consultation with NYSDEC has set site-specific Screening Levels for the COPCs detected at the Site. Those soils exceeding site-specific Screening Levels would be contained by a cap under this alternative.

This alternative would also require compliance with fugitive dust emission regulations.

The excavated soils or wastes transported off-site under this alternative would be subject to New York State and federal regulations regarding transportation and off-site treatment/disposal of wastes.

This alternative would conform with EPA Guidance on Presumptive Remedy for Metals-in-Soil Sites in that the top two feet of highly contaminated soil which is considered principle threat waste has been removed and replaced with clean fill.

4.3.3.1.3 Long-Term Effectiveness and Permanence

Capping would provide a high degree of long-term protection of human health and the environment. The vegetated soil cover would help protect the cap against erosion and the fencing, signs, and land-use restrictions would ensure the integrity of the containment system. The effectiveness and permanence of this response action would be entirely dependent upon the effective maintenance of the multilayer cap and access controls and the proper enforcement of the land-use controls.

4.3.3.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

With the exception of any excavated contaminated soils that require off-site treatment/disposal, any reduction of toxicity, mobility, or volume would not be through treatment. The mobility of the contaminated soils would be reduced under this alternative through containment, not treatment; there would be no reduction of the toxicity or volume.

4.3.3.1.5 Short-Term Effectiveness

This alternative would involve excavating, moving, placing, and regrading an estimated 2,400 cubic yards of waste. While these actions present some potential risk to on-site workers through dermal contact and inhalation, these exposures can be minimized by utilizing proper protective equipment and engineering controls. The vehicle traffic associated with delivery of clean fill and cap construction could impact the local roadway system and nearby residents through increased noise levels. Under this alternative, there is a potential for increased stormwater runoff and erosion during excavation activities that would have to be properly managed to prevent excessive water and waste material loading. Engineering controls would be taken during excavation activities to prevent transport of fugitive dust. It is estimated that this alternative would require one month to implement.

4.3.3.2 Implementability

It is estimated that this alternative would require approximately 6 days for soil excavation, 6 days for soil backfilling and liner construction and would take 1.5 months to implement. Capping involves processes that can be easily implemented. Labor, equipment, and materials for this alternative are conventional and readily available. Numerous contractors, using conventional techniques and equipment, could install the soil cover. Equipment, services, and materials for this work are readily available. The actions under this alternative would necessitate the implementation of institutional controls such as the imposition of an environmental easement. In addition, the current property owner may be required to maintain a Site Management Plan to ensure the institutional and engineering controls remain in place and are effective.

4.3.3.3 Cost

The estimated capital, transportation and disposal costs, and indirect costs are presented below.

Capital Cost	Transportation and Disposal Costs	Operation and Maintenance Costs	Indirect Costs	Total Cost
$119,450	$354,618	$112,860	$57,147	$644,076

4.3.4 Alternative 4: Paving

This alternative would involve the consolidation of contaminated soils under an asphalt cover. The removal of the upper 6 inches of soil at the Site would be required to maintain existing grade and accommodate the pavement. Approximately 500 cubic yards of soil will be removed from the Site and properly disposed. The property would then be fenced and posted. This alternative would also include implementing long-term groundwater monitoring activities and the implementation of institutional controls to maintain the asphalt cover. The actions under this alternative would require the implementation of institutional controls that may be administratively difficult, since construction of the asphalt cap would require the imposition of an environmental easement. In addition, the current 2000-2012 Richmond Terrace Property owner may be required to maintain a Site Management Plan to ensure the institutional and engineering controls remain in place and are effective.

4.3.4.1 Effectiveness

4.3.4.1.1 Overall Protection of Public Health and the Environment

Under this alternative, the potential for future migration of contaminants would be reduced by containing the contaminated soils. The action is protective of human health and the environment because the risk of incidental contact with waste by humans and ecological receptors would be significantly reduced by containing the contaminated; however, the potential exists for direct contact with the lead-contaminated soils should the cap be disturbed. Paving would prevent surface contaminant migration from the property.

4.3.4.1.2 Compliance with ARARs

All applicable ARARs will be addressed; however, this alternative would leave soils in place beneath the cap that exceed NYSDEC Part 375 RUSCOs.

As discussed in Subsection 4.1, EPA in consultation with NYSDEC has set site-specific Screening Levels for the COPCs detected at the Site. Those soils exceeding site-specific Screening Levels would be contained by a cap under this alternative.

This alternative would also require compliance with fugitive dust emission regulations.

The excavated soils or wastes transported off-site under this alternative would be subject to New York State and federal regulations regarding transportation and off-site treatment/disposal of wastes.

4.3.4.1.3 Long-Term Effectiveness and Permanence

Paving would provide a high degree of long-term protection of human health and the environment. The asphalt pavement cover would be resistant to erosion and the fencing, signs, and institutional controls would ensure the integrity of the containment system. The effectiveness and permanence of this removal action would be entirely dependent upon the effective maintenance of the asphalt pavement cap and access controls and the proper enforcement of the institutional controls.

4.3.4.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

With the exception of any excavated contaminated soils that require off-site treatment/disposal, any reduction of toxicity, mobility, or volume would not be through treatment. The mobility of the contaminated soils would be reduced under this alternative through containment, not treatment; there would be no reduction of the toxicity or volume.

4.3.4.1.5 Short-Term Effectiveness

This alternative would involve excavating, moving, placing, and regrading waste. While these actions present some potential risk to on-site workers through dermal contact and inhalation, these exposures can be minimized by utilizing proper protective equipment and engineering controls. The vehicle traffic associated with paving could impact the local roadway system and nearby residents through increased noise levels. Under this alternative, there is a potential for increased stormwater runoff and erosion during and following excavation activities that would have to be properly managed to prevent excessive water and waste material loading. Engineering controls would be taken during excavation activities to prevent transport of fugitive dust.
It is estimated that this alternative would require one month to implement.

4.3.4.2 Implementability

It is estimated that this alternative would require approximately 5 days for soil excavation and grading, 3 days for paving and would take 1 month to implement.

Paving involves processes that can be easily implemented. Labor, equipment, and materials for this alternative are conventional and readily available. Numerous contractors, using conventional techniques and equipment, could install the pavement. Equipment, services, and materials for this work are readily available. The actions under this alternative would necessitate the implementation of institutional controls such as the imposition of an environmental easement. In addition, the current property owner may be required to maintain a Site Management Plan to ensure the institutional and engineering controls remain in place and are effective.

4.3.4.3 Cost

The estimated capital, transportation and disposal costs, and indirect costs are presented below.

Capital Cost	Transportation and Disposal Costs	Operation and Maintenance Costs	Indirect Costs	Total Cost
$139,500	$73,879	$112,860	$28,472	$354,711

4.3.5 Alternative 5: Immobilization

This alternative would involve the immobilization of contaminants in the top 2 ft of contaminated soil via in-situ treatment with a concrete additive which would immobilize the lead in the soil, preventing leaching to surface water and groundwater, as well as preventing contact with deeper, untreated, lead-impacted soils. No further cover will be required. The Site would then be fenced and posted. This alternative would also include implementing long-term groundwater monitoring activities, and the implementation of institutional controls.

4.3.5.1 Effectiveness

4.3.5.1.1 Overall Protection of Public Health and the Environment

Under this alternative, the potential for future migration of contaminants would be reduced by immobilizing the upper 2 ft of contaminated soils, and providing an impermeable barrier for the remaining contaminated soils. The action is protective of human health and the environment because the risk of incidental contact with waste by humans and ecological receptors would be significantly reduced by immobilizing/containing the contaminated soil. Immobilization would also prevent surface contaminant migration from the Site.

4.3.5.1.2 Compliance with ARARs

All applicable ARARs will be addressed; however, this alternative would leave soils in place beneath the cap that exceed NYSDEC Part 375 RUSCOs.

As discussed in Subsection 4.1, EPA in consultation with NYSDEC has set site-specific Screening Levels for the COPCs detected at the Site. Those soils exceeding site-specific Screening Levels would be contained by a cap under this alternative.

This alternative would also require compliance with fugitive dust emission regulations.

4.3.5.1.3 Long-Term Effectiveness and Permanence

Immobilization would provide a high degree of long-term protection of human health and the environment. The treated soil would be resistant against erosion and the fencing, signs, and land-use restrictions would ensure the integrity of the containment system. The effectiveness and permanence of this action would be dependent upon the effective maintenance of the treated soil layer and access controls and the proper enforcement of the institutional controls.

4.3.5.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

A reduction of toxicity and mobility will be achieved though treatment. The volume of the contaminated soils would not be reduced under this alternative.

4.3.5.1.5 Short-Term Effectiveness

This alternative would involve treating waste in-situ. While these actions present some potential risk to on-site workers through dermal contact and inhalation, these exposures can be minimized by utilizing proper protective equipment and engineering controls. The vehicle traffic associated with in-situ treatment could impact the local roadway system and nearby residents through increased noise levels. Under this alternative, there is a potential for increased stormwater runoff and erosion during and following treatment activities that would have to be properly managed to prevent excessive water and waste material loading. Engineering controls would be taken during excavation activities to prevent transport of fugitive dust.

4.3.5.2 Implementability

It is estimated that this alternative would require approximately 6 days for soil preparation and 6 days for soil in-situ treatment, and would take 1.5 months to implement.

Immobilization involves processes that can be easily implemented. Labor, equipment, and materials for this alternative are conventional and readily available. A limited number of contractors, using specialized techniques and equipment, could perform the in-situ soil treatment. Equipment, services, and materials for this work are readily available. The actions under this alternative would necessitate the implementation of institutional controls such as the imposition of an environmental easement. In addition, the current property owner may be required to maintain a Site Management Plan to ensure the institutional and engineering controls remain in place and are effective.

4.3.5.3 Cost

The estimated capital, transportation and disposal costs, and indirect costs are presented below.

Capital Cost	Transportation and Disposal Costs	Operation and Maintenance Costs	Indirect Costs	Total Cost
$145,455	$0	$112,860	$21,000	$279,315

5.0 COMPARATIVE ANALYSIS OF ALTERNATIVES AND RECOMMENDED REMOVAL ACTION ALTERNATIVE

5.1 INTRODUCTION

This Section presents the comparative analysis of the five removal action alternatives identified and individually evaluated in the preceding Section. The comparative analysis highlights the features of each of the alternatives in terms of the evaluation criteria and identifies the merits and demerits of each alternative to one another. The comparative analysis included as Table 5-1 in Attachment I provides a summary of the comparative analysis of the alternatives.

5.2 COMPARATIVE ANALYSIS OF ALTERNATIVES

5.2.1 Effectiveness

5.2.1.1 Overall Protection of Public Health and the Environment

Alternative 1 (no action) would not be protective of human health and the environment since it does not actively address the potential human health and ecological risks posed by the contaminated soils.

Alternative 2 (excavation and off-Site disposal) would be the most protective alternative, since the risk of incidental contact with waste by humans and ecological receptors and the potential for contaminant migration from the property would be eliminated by permanently removing the contaminated soils.

Alternative 3 (capping) would be protective of human health and the environment. This alternative reduces the risk of incidental contact with waste by humans and ecological receptors by containing the contaminated soil. Capping would also prevent surface contaminant migration from the property and reduce the potential migration to the groundwater.

Alternative 4 (paving) would be protective of human health and the environment; however, it is less protective than Alternative 2 or Alternative 3 because the depth of the cap is less and the potential is therefore greater for direct contact with principle threat wastes if the cap is disturbed or breached. This alternative reduces the risk of incidental contact with waste by humans and ecological receptors by containing the contaminated soil. The asphalt paving would also prevent surface contaminant migration from the property and reduce the potential migration to the groundwater.

Alternative 5 (immobilization) would be protective of human health and the environment. Immobilization of contaminants in the top two feet of contaminated soil via in-situ treatment with a concrete additive would immobilize the lead in the soil, prevent surface contaminant migration from the property and reduce the potential migration to the groundwater, as well as preventing contact with deeper, untreated, lead-impacted soils. This alternative reduces the risk of incidental contact with waste by humans and ecological receptors by treating the top two feet of contaminated soil.

5.2.1.2 Compliance with ARARs, TBCs, and Other Criteria

Since the contaminated soils would not be addressed under Alternative 1 (no action), this alternative would not comply with the site specific PRG.

Alternative 2 (excavation and off-Site treatment/disposal) excavation will comply with the ARARS (e.g., the RCRA disposal regulations). Also, EPA in consultation with NYSDEC has established a site-specific PRG for the lead at the Site, based in part on the Regional Screening Levels for Contaminants at Superfund Sites (November, 2010), Streamlined Human Health Risk Assessment and NYSDEC Part 375 SCOs. The PRG was used to estimate the volume of contaminated soils and waste materials at the Site.

Alternatives 3 (capping), 4 (paving), and 5 (immobilization) will not comply with ARARs, TBCs, and other criteria since soils will remain in place that exceed the site specific PRGs, however the threat of exposure to the contaminated soils would be greatly reduced by requiring the containment/capping of all those soils and waste material that exceed the PRGs.

5.2.1.3 Long-Term Effectiveness and Permanence

Alternative 1 (no action) would involve no controls and, therefore, would not be effective in preventing exposure to contaminants on-Site or the migration of contaminants from the property.

Alternative 2 (excavation and off-Site treatment/disposal) would provide a high degree of long-term protection of human health and the environment by eliminating the possibility of exposure to contaminants on-Site and the potential for contaminants migrating from the property. The removal of the contaminated soils under Alternative 2 would be effective and permanent.

Alternative 3 (capping) and Alternative 5 (immobilization) would both provide a high degree of long-term protection of human health and the environment in that they would eliminate the possibility of exposure to contaminants on-Site and the potential for contaminants migrating from the property. The effectiveness and permanence of both of these alternatives would be dependent upon the effective maintenance of the cap and the proper enforcement of the institutional controls.

Alternative 4 (paving) would provide a high degree of long-term protection of human health and the environment; however, the potential exists for direct contact with contaminants if the asphalt cap is disturbed or breached. The depth of the protective cap in this alternative, as opposed to Alternative 2 and Alternative 3, is significantly less and thus less protective.

5.2.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 1 (no action) would provide no reduction in toxicity, mobility or volume.

Under Alternative 2 (excavation and off-site treatment/disposal), contaminants above the PRG would be removed from the property for treatment/disposal, thereby reducing their toxicity, mobility, and volume. It is not known, however, to what extent the excavated soils would require treatment prior to disposal under this alternative.

Alternative 3 (capping) and Alternative 4 (paving) include the reduction of toxicity through treatment for that portion of soil removed from the property and treated as a result of TCLP failure (estimated at 2,400 and 500 cubic yards, respectively). The mobility or volume would not be reduced through treatment. These Alternatives would reduce the migration of and potential exposure to contaminated soils and waste materials.

Alternative 5 (immobilization) would not result in the reduction of the toxicity or volume of contaminants in Site soils through treatment. The mobility of the contaminants would be greatly reduced, preventing the migration of contamination to the ground water and/or surface water.

5.2.1.5 Short-Term Effectiveness

Since Alternative 1 (no action) does not include any physical construction measures in any areas of contamination, it would not present a risk to the community as a result of its implementation.

Alternative 2 (excavation and off-site treatment/disposal), Alternative 3 (capping), Alternative 4 (paving), and Alternative 5 (immobilization) would involve excavating, moving, placing, and, in the case of Alternatives 3 and 4, re-grading waste. While all of these four action alternatives present some risk to on-site workers through dermal contact and inhalation, these exposures can be minimized by utilizing proper protective equipment and engineering controls. The vehicle traffic associated with cap construction and the off-site transport of contaminated soils could impact the local roadway system and nearby residents through increased noise level. Alternative 2 would require the off-site transport of a considerable amount of contaminated soil. Alternative 3 and 4 would require the delivery of cap construction materials, and off-site transport of a much lower volume of contaminated soil removed to re-grade the property. Alternative 5 would require the delivery of a concrete additive.

Under all of the removal action alternatives except the no action alternative, disturbance of the land during excavation and/or construction activities could affect the surface water hydrology of the property. There is a potential for increased stormwater runoff and erosion during excavation and construction activities that would have to be properly managed to prevent excessive water and waste material loading. Appropriate measures would have to be taken during excavation activities to prevent transport of fugitive dust and exposure of workers and downgradient receptors to contaminants.

5.2.2 Implementability

5.2.2.1 Technical and Administrative Feasibility

There are no implementability issues for the No Action, Alternative 1.

Alternative 2 (excavation and off-Site treatment/disposal) would use proven earthmoving equipment and techniques and established administrative procedures, and sufficient facilities are available for treatment and disposal of the excavated soils. Therefore, this alternative would be easily implemented.

Alternative 3 (capping), Alternative 4 (paving) and Alternative 5 (immobilization) can be accomplished using technologies known to be reliable and can be readily implemented. Equipment, services and materials for this work are readily available. The actions under this alternative may be administratively difficult since the property owner would have to agree to the granting of an institutional control such as an environmental easement for the controlled property. In addition, the property owner may well be required to maintain a Site Management Plan in perpetuity to ensure the institutional and engineering controls remain in place and are effective.

5.2.2.2. State Acceptance

The State of New York has been providing input on this EE/CA during its preparation and agrees with the recommended removal action.

5.2.2.3 Community Acceptance

Community acceptance will be assessed following review of the public comments received on the EE/CA.

5.2.3 Cost

The following is a summary of costs for each of the Alternatives. A detailed cost summary is presented in Removal Action Alternatives Report prepared by WESTON for EPA included in Attachment III. The post-removal site control costs where required include O&M and monitoring. The present-worth costs include the capital costs plus the present value of 30 years of post-removal site control costs (calculated at a 7 percent discount rate).

Alternatives	Capital Cost	Transportation and Disposal Costs	Annual Post-Removal Site Control Costs	Present-Worth Costs
Alternative 1 No Action	$0	$0	$0	$10,050
Alternative 2 Excavation	$171,146	$626,787	$14,509	$924,153
Alternative 3 Capping	$119,450	$354,618	$112,860	$644,076
Alternative 4 Paving	$139,500	$73,879	$112,860	$354,711
Alternative 5 Immobilization	$145,455	$0	$112,860	$279,315

Alternative 2 has the highest present worth cost ($924,153) of the alternatives considered, but it has no operation and maintenance costs. Alternative 5 has low capital cost, no transportation and disposal costs, but it is not a permanent solution and has on-going operation and maintenance costs.

5.3 RECOMMENDED REMOVAL ACTION ALTERNATIVE

EPA has identified Alternative 2, Excavation and Disposal, as the removal action that best satisfies the evaluation criteria based on the comparative analysis. This determination is based on the proven effectiveness of the action, the ease of implementation, and the relative cost.

The preferred alternative would excavate and remove approximately 4,424-cubic yards of lead contaminated soil from the 2000-2012 Richmond Terrace property. While Alternative 2 has a substantially higher cost ($924,153) than the other removal alternatives, it compares favorably to the remaining alternatives and provides a proportionately higher level of protection of human health and the environment. In addition, the excavation and disposal of the lead contaminated soils would result in a permanent removal action that requires no additional long-term oversight, operation and maintenance, and monitoring.

Alternative 2 is the proposed preferred removal action for the Site. Changes to the preferred removal action or a change from the preferred removal action to another removal action may be made if public comments or additional data indicate that such a change will result in a more appropriate action.

The final decision regarding the response action will be made after EPA has taken into consideration all public comments. The decision will be documented in an Action Memorandum, which will also address public comments received on this proposed removal action. The Administrative Record will include a responsiveness summary which will address all public comments.

Attachment I

Table 5-1
Summary of Comparative Analysis of Response Action Alternatives

Criteria	Alternative 1: No Action	Alternative 2: Excavation and Off-Site Treatment /Disposal	Alternative 3: Capping	Alternative 4: Paving	Alternative 5: Immobility
Overall Protection of Human Health and the Environment	The no action alternative would not be protective of human health and the environment, since it would not actively address the potential human health and ecological risks posed by the contaminated soils, and would not minimize the migration of hazardous constituents.	Alternative 2 would be protective of human health and the environment by eliminating the risk of incidental contact with the contaminated soils by humans and ecological receptors and by eliminating the potential for future migration of hazardous substances from the Site by permanently removing the contaminated soils.	Alternative 3 would reduce the potential for future migration of contaminants by containing the contaminated soils. The remedy is protective of human health and the environment because the risk of incidental contact with waste by humans and ecological receptors would be significantly reduced by containing the contaminated soil. Capping would also prevent surface contaminant migration from the Site.	Alternative 4 would reduce the potential for future migration of contaminants by containing the contaminated soils. The remedy is protective of human health and the environment because the risk of incidental contact with waste by humans and ecological receptors would be significantly reduced by containing the contaminated soil. Capping would also prevent surface contaminant migration from the Site.	Alternative 5 would reduce the potential for future migration of contaminants by treating the top 2' of the contaminated soils. The remedy is protective of human health and the environment because the risk of incidental contact with waste by humans and ecological receptors would be significantly reduced by containing the contaminated soil. Immobilizing the lead contaminated soils would also prevent surface contaminant migration from the Site.
Compliance with ARARs	Alternative 1 does not comply with ARARs, since the contaminated soils will not be addressed.	ARARs will be addressed.	All applicable ARARs will be addressed; however, this alternative would leave soils in place beneath the cap that exceed NYSDEC Part 375 RUSCOs.	All applicable ARARs will be addressed; however, this alternative would leave soils in place beneath the cap that exceed NYSDEC Part 375 RUSCOs.	All applicable ARARs will be addressed; however, this alternative would leave soils in place beneath the cap that exceed NYSDEC Part 375 RUSCOs.

Criteria	Alternative 1: No Action	Alternative 2: Excavation and Off-Site Treatment /Disposal	Alternative 3: Capping	Alternative 4: Paving	Alternative 5: Immobility
Long-Term Effectiveness and Permanence	Alternative 1 involves no controls and would not be effective in permanently minimizing the migration of hazardous constituents or eliminate unacceptable risk to human and ecological receptors.	Excavation and disposal of the contaminated soil would provide long-term protection of human health and the environment and minimize the potential migration of hazardous constituents.	Would provide a high degree of long-term protection of human health and the environment. The effectiveness and permanence of this remedy would be dependent upon the effective maintenance of the cap and access controls and the proper enforcement of the land-use controls.	Would provide a high degree of long-term protection of human health and the environment. The effectiveness and permanence of this remedy would be dependent upon the effective maintenance of the cap and access controls and the proper enforcement of the land-use controls.	Would provide a high degree of long-term protection of human health and the environment, since it prevents contact with deeper, untreated, lead-impacted soils. The effectiveness and permanence of this remedy would be dependent upon the effective maintenance of the treated surface and access controls and the proper enforcement of the land-use controls.
Reduction of Toxicity, Mobility and Volume through Treatment	Alternative 1 would not result in the reduction of the toxicity, mobility, and volume of contaminants in site soils.	Contaminants would be removed from the Site property for treatment/disposal, thereby reducing their toxicity, mobility and volume.	With the exception of any excavated contaminated soils that require off-site treatment/disposal, any reduction of toxicity, mobility, or volume would not be through treatment. The mobility of the contaminated soils would be reduced under this alternative through containment, not treatment; there would be no reduction of toxicity or volume.	With the exception of any excavated contaminated soils that require off-site treatment/disposal, any reduction of toxicity, mobility, or volume would not be through treatment. The mobility of the contaminated soils would be reduced under this alternative through containment, not treatment; there would be no reduction of toxicity or volume.	Alternative 5 would not result in the reduction of the toxicity or volume of contaminants in site soils. But would immobilize the lead in the soil, preventing leaching to surface water and groundwater.

Criteria	Alternative 1: No Action	Alternative 2: Excavation and Off-Site Treatment /Disposal	Alternative 3: Capping	Alternative 4: Paving	Alternative 5: Immobility
Short-Term Effectiveness	Alternate 1 does not include any physical construction measures in any areas of contamination, so it would not present a risk to the community or on-site workers as a result of its implementation.	While alternative 2 would present some risk to on-site workers through dermal contact and inhalation, these exposures could be minimized by utilizing proper protective equipment and appropriate engineering controls. The vehicular traffic associated with the off-site transport of contaminated soils could impact the local roadway system and nearby residents through increased noise levels. Under this alternative, there is a potential for increased stormwater runoff and erosion during excavation activities that would have to be properly managed to prevent excessive water and waste material loading. Appropriate measures would have to be taken to prevent the transport of fugitive dusts.	Alternative 3 would involve excavating, moving, placing and re-grading waste, which would present some risk to on-Site workers through dermal contact and inhalation. These exposures can be minimized by using proper protective equipment and appropriate engineering controls. The vehicular traffic associated with the off-site transport of contaminated soils could impact the local roadway system and nearby residents through increased noise levels. There is a potential for increased stormwater runoff and erosion that would have to be properly managed to prevent excessive water and waste material loading. Appropriate measures would have to be taken to prevent the transport of fugitive dusts.	Alternative 4 would involve excavating, moving, placing and re-grading waste, which would present some risk to on-Site workers through dermal contact and inhalation. These exposures can be minimized by using proper protective equipment and appropriate engineering controls. The vehicular traffic associated with the off-site transport of contaminated soils could impact the local roadway system and nearby residents through increased noise levels. There is a potential for increased stormwater runoff and erosion that would have to be properly managed to prevent excessive water and waste material loading. Appropriate measures would have to be taken to prevent the transport of fugitive dusts.	Alternative 5 would involve excavating, moving, placing and re-grading waste, which would present some risk to on-Site workers through dermal contact and inhalation. These exposures can be minimized by using proper protective equipment and appropriate engineering controls. The treatment would be accomplished by adding the concrete additive and water to the soil via an industrial tilling machine, in two, 1-ft lifts, which may result in an increased potential for wind-blown migration of lead-contaminated soils and appropriate measures would have to be taken to prevent the transport of fugitive dusts. There is also the potential for increased stormwater runoff that would have to be properly managed.

Criteria	Alternative 1: No Action	Alternative 2: Excavation and Off-Site Treatment /Disposal	Alternative 3: Capping	Alternative 4: Paving	Alternative 5: Immobility
Implementability	There are no construction related costs with the implementation of the no action alternative.	The actions under this alternative would use proven earthmoving equipment and techniques and established administrative procedures. In addition, sufficient facilities are available for treatment and disposal of the excavated soils and waste material. Therefore this alternative would be easily implemented.	Capping involves processes that can be easily implemented. Labor, equipment, and materials for this alternative are conventional and readily available. Numerous contractors, using conventional techniques and equipment, could install the soil cover. Equipment, services, and materials for this work are readily available. The actions under this alternative would be administratively difficult, since construction of a cap would require imposition of an environmental easement. In addition, the current property owner may be required to maintain a Site Management Plan to assure the institutional and engineering controls remain in place and are effective.	Paving involves processes that can be easily implemented. Labor, equipment, and materials for this alternative are conventional and readily available. Numerous contractors, using conventional techniques and equipment, could install the soil cover. Equipment, services, and materials for this work are readily available. The actions under this alternative would be administratively difficult, since construction of a cap would require imposition of an environmental easement. In addition, the current property owner may be required to maintain a Site Management Plan to assure the institutional and engineering controls remain in place and are effective.	Treating the lead-contaminated soils to immobilize the lead involves processes that can be easily implemented. Labor, equipment, and materials for this alternative are conventional and readily available. Numerous contractors, using conventional techniques and equipment, could install the soil cover. Equipment, services, and materials for this work are readily available. The actions under this alternative would be administratively difficult, since construction of a cap would require imposition of an environmental easement granted. In addition, the current property owner may be required to maintain a Site Management Plan to assure the institutional and engineering controls remain in place and are effective.

Criteria	Alternative 1: No Action	Alternative 2: Excavation and Off-Site Treatment /Disposal	Alternative 3: Capping	Alternative 4: Paving	Alternative 5: Immobility
Cost	There are no costs associated with the no-action alternative.	Moderate capital, no post-removal site control due to removal of contaminants.	Moderate capital, moderate post-removal site control costs for maintaining the cap and ground water monitoring.	Moderate capital, moderate post-removal site control costs for maintaining the paving and ground water monitoring.	Low capital, moderate post-removal site control costs for maintaining the cap and ground water monitoring.

Attachment II

REFERENCE

Doroski, Christopher. New York State Department of Health (NYSDOH), Letter of Technical Assistance. 25 March 2009.

Doroski, Christopher. New York State Department of Health (NYSDOH), Letter Health Consultation. 11 Feb 2010.

Hoeger, Sven. (Creative Habitat Corp.) Site Investigation Summary Report. 3 Oct 2009.

Magriples, Nick. (U.S. Environmental Protection Agency, Region 2), 2009. Removal Site Evaluation for Jewett White Lead Company Site (2000 Richmond Terrace), Borough of Staten Island, Richmond County, New York. 24 April 2009.

Mazella, John (City of New York), 2011. Facsimile RE: 5/185/548. 3 Jan 2011.

McPherson, Julie A. (U.S. Environmental Protection Agency, Region 2), 2011. Streamlined Human Health Risk Assessment, Jewett White Lead Company Site, 2000-2012 Richmond Terrace. Jan 2011.

New York State Department of Environmental Conservation (NYSDEC) 2006. Division of Environmental Remediation 6NYCRR Part 375 Environmental Remediation Programs.

Pensak, Mindy. (U.S. Environmental Protection Agency, Region 2), 2011. Streamlined Screening Level Ecological Risk Assessment, Jewett White Lead Company Site, 2000-2012 Richmond Terrace. Jan 2011.

Staiger, Kimberly. (U.S. Environmental Protection Agency, Region 2), 2010. Removal Site Evaluation for Jewett Off-Site Soil Sampling, Borough of Staten Island, Richmond County, New York. 18 March 2010.

United States Environmental Protection Agency. Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA (EPA/540-R-93-057). Aug 1993

United States Environmental Protection Agency. OSWER Directive: Revised Interim Soil Lead Guidance For CERCLA Sites and RCRA Corrective Action Facilities. OSWER Directive #9355.4-12. Aug 1994.

United States Environmental Protection Agency Regions 3, 6, and 9. 2010. Regional Screening Levels for Chemical Contaminants at Superfund Sites. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm.

United States Environmental Protection Agency. Presumptive Remedy for Metals-in-Soil Sites. OSWER-9355.0-72FS. Sept 1999.

Attachment III

REMOVAL ACTION ALTERNATIVES REPORT
JEWETT WHITE LEAD COMPANY SITE
2000-2012 RICHMOND TERRACE
STATEN ISLAND, NEW YORK

CERCLIS ID NYD980531545

Prepared for:

U.S. ENVIRONMENTAL PROTECTION AGENCY, REGION 2
2890 Woodbridge Avenue
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January 2011

Work Order No. 20401.122.018

TABLE OF CONTENTS

Section **Page**

TABLE OF CONTENTS
(Continued)

Section **Page**

LIST OF FIGURES

Title

LIST OF TABLES

Title

LIST OF APPENDICES

LIST OF ACRONYMS

ARAR	Applicable or Relevant and Appropriate Requirements
ATSDR	Agency for Toxic Substances and Disease Registry
BAF	bioaccumulation factor
bgs	below ground surface
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Liability, and Compensation Act
CFR	Code of Federal Regulations
COPCs	Contaminants of Potential Concern
CSM	Conceptual Site Model
cyd	cubic yard
EE/CA	Engineering Evaluation/Cost Analysis
EPA	U.S. Environmental Protection Agency
FPXRF	Field portable X-Ray fluorescence
FSP	Field Sampling Plan
ft	feet/foot
HDPE	High-Density Polyethylene
HI	Hazard Index
HQ	Hazard Quotient
IDLH	Immediately Dangerous to Health
MCL	maximum contaminant levels
mg/L	milligrams per liter
mg/kg	milligrams per kilogram
mL	milliliter
MS	matrix spike
MSD	matrix spike duplicate
NAAQS	National Ambient Air Quality Standards
NIOSH	National Institute for Occupational Safety and Health
NYCRR	New York Compilation of the Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OSC	On-Scene Coordinator
O&M	Operation and Maintenance
PEL	Permissible Exposure Limit
PRC	Perfetto Realty Corporation

LIST OF ACRONYMS
(Concluded)

PRGs	Preliminary Remediation Goals
QAPP	Quality Assurance Project Plan
RAA	Removal Action Alternatives
RAAS Report	Removal Action Alternatives Report
RAO	Response Action Objective
RBCs	risk-based concentrations
RCRA	Resource Conservation and Recovery Act
REL	recommended exposure limit
RPD	Relative Percent Difference
RSL	Regional Screening Level
RST 2	Removal Support Team, EPA Region 2
RUSCO	Restricted Use Soil Cleanup Objective
Site	Jewett White Lead Company Site
SOP	Standard Operating Procedure
SOW	Scope of Work
SPLP	Synthetic Precipitation Leaching Procedure
SHHRA	Streamlined Human Health Risk Assessment
SSLERA	Streamlined Screening Level Environmental Risk Assessment
TAL	Target Analyte List
TBC	To Be Considered
TCLP	Toxicity Characteristic Leaching Procedure
TLV	threshold limit values
TSDF	Treatment, Storage, and Disposal Facility
TWA	Time-Weighted Average
UFP-QAPP	Uniform Federal Policy Quality Assurance Project Plan
U.S.	United States
WESTON®	Weston Solutions, Inc.
XRF	X-Ray fluorescence

SECTION 1

INTRODUCTION/SITE DESCRIPTION

1. INTRODUCTION/SITE DESCRIPTION

1.1 INTRODUCTION

This Removal Alternatives Assessment (RAA) Report is being submitted by Weston Solutions, Inc. (WESTON®) to the United States (U.S.) Environmental Protection Agency (EPA) Region 2 for the former Jewett White Lead Company Site (Site), Comprehensive Environmental Response, Liability and Compensation Information System Identification Number NYD980531545, located at 2000-2012 and 2015 Richmond Terrace, Staten Island, Richmond County, New York. This submittal is in accordance with the "Assessment/Inspection Activities" portion of the RST Performance Work Statement, and in accordance with Phase 2 “Removal Alternatives Evaluation” requirements of the Scope of Work (SOW) for Task Order 0018, Modification 0002, issued to Removal Support Team, EPA Region 2 (RST 2) on 24 June 2010. Figure 1-1 is a Locus Map for the Site.

1.2 SCOPE OF WORK

Phase 2 of the SOW for Task Order 0018, Modification 0002 directed WESTON to develop removal alternatives, evaluate alternatives using the criteria identified in EPA guidance, and develop cost estimates for the identified alternatives. This evaluation is to be reported in a Removal Alternatives Report which can be used by EPA to support its Engineering Evaluation/Cost Analysis (EE/CA). Removal Alternative Evaluation activities shall include:

- Based upon existing information, identify site-specific removal action objectives which should be developed to protect human health and the environment. The objectives should specify the contaminant(s) and media of concern, the exposure route(s) and receptor(s), and an acceptable contaminant level or range of levels for each exposure route (i.e., preliminary remediation goals), based upon the streamlined risk evaluation to be provided by EPA.

- Develop general response actions for each medium of interest to satisfy the removal action objectives.

- Identify and screen technologies based on the developed general response actions.

- Evaluate the effectiveness and compliance of the tested or proposed technologies with federal and state requirements. Screen the "Removal Action Alternatives for Effectiveness and Implementability." The individual removal alternatives are to be assessed against the criteria of effectiveness, implementability, and cost, in addition to a comparative analysis of the options. EPA will review all evaluations and make any and all decisions regarding the proposed technologies.

- Draft a Removal Action Alternatives Report (RAAS Report) that refers to the August 1993, "Guidance on Conducting Non-Time Critical Removal Actions Under Comprehensive Environmental Response, Liability, and Compensation Act (CERCLA)" for report content and formal. The Draft RAAS Report shall include:

    a. A technical description of each alternative that outlines the waste management strategy involved and identifies the key Applicable or Relevant and Appropriate Requirements (ARAR) associated with each alternative.

    b. A discussion that profiles the performance of that alternative with respect to each of the evaluation criteria.

    c. Once the individual analysis is complete, the alternatives will be compared and contrasted to one another with respect to each of the evaluation criteria.

EPA further directed WESTON to perform the following additional activities:

- Conduct a well search to include the area within 2 miles of the Site (Staten Island only).

- Develop Conceptual Site Model (CSM) and provide a draft of the CSM in conjunction with Draft Quality Assurance Project Plan (QAPP) to the On-Scene Coordinator (OSC).

- Update the CSM periodically to reflect any new data generated from on-site activities.

1.3 SITE DESCRIPTION

The Site consists of the historic footprint of the former Jewett White Lead Company facility and the extent of contamination which includes the 1.07-acre parcel of land at 2000-2012 Richmond Terrace and the approximately 4.41-acre parcel of land at 2015 Richmond Terrace (of which, approximately 2.25-acres is not covered by the surface waters of the Kill Van Kull). The portion of the Site which is the subject of this EE/CA includes a 1.07-acre parcel of land at 2000-2012 Richmond Terrace, in the Borough of Staten Island, New York, which is designated as Lot 32 of Block 1006 on Richmond County tax map R5/1. Figure 1-2 depicts the Site and its environs. The 2000-2012 Richmond Terrace portion of the Site (the 2000-2012 Richmond Terrace Property) is bounded by Park Avenue and commercial buildings to the northwest, Richmond Terrace and the 2015 Richmond Terrace portion of the Site to the northeast, and by an elevated rail line to the south.

The area within 1 mile of the Site can be characterized as residential with heavy concentrations of industrial and manufacturing use along the waterfront. The Site is located within the Port Richmond section of the Borough of Staten Island, New York. Located along the North Shore of Staten Island, the neighborhood is defined by the Kill Van Kull to the north, the Bayonne Bridge and MLK Expressway to the west, Forest Avenue to the south and Broadway to the east. Port Richmond is an economically distressed community; with the Borough's second-lowest median household income, the second-highest poverty rate, and the highest concentration of older housing in Staten Island.

The the 2000-2012 Richmond Terrace Property was formerly used for commercial/industrial purposes and could be used for this purpose again. Portions of the former industrial buildings remain in place or as construction debris within the fill at the Site. A fence that was earlier installed has restricted access to the Site. These site features comprise elements of the CSM, and are depicted in Figure 1-3.

1.4 HYDROGEOLOGICAL AND GEOLOGICAL CONDITIONS

1.4.1 Regional Geology

The Site is located between the Newark Basin to the west, and the coastal plain to the east, in an area known as the Manhattan Prong. The southernmost portion of the Manhattan Prong, which terminates approximately 15 miles southwest of the Site, consists of metamorphic bedrock, surrounded by layers of sedimentary rocks of the Newark basin to the northwest and coastal plain to the southeast, which is covered to a larger extent by unconsolidated glacial deposits (Benimoff and Ohan, 2003).

The bedrock beneath the Site and general vicinity comprises the Lower Cambrian Staten Island Serpentinite, and consists predominately of the serpentine minerals, antigorite, chrysotile (an asbestos mineral for which the deposit has been mined commercially), and lizardite. The sepentinite appears in a fenster (or window) in the younger Mesozoic sedimentary rocks, which have been eroded away beneath the Site. The Mesozoic bedrock units generally strike northeast-southwest and dip gently to the west (Benimoff and Ohan, 2003).

The regional surficial geology consists of till and the Harbor Hill terminal moraine deposits, with minor marine and lacustrine sands and glacial outwash deposits. The southern boundary of the Wisconsin glacier is now represented by the terminal moraine which crosses Staten Island, approximately 2.5 miles southeast of the Site (Benimoff and Ohan, 2003).

1.4.2 Regional Hydrogeology

The regional surficial hydrostratigraphic units are considered to be poor aquifers. The fine-grained and dense nature of the glacial till (silty clay) indicates that only sandy parts of these deposits may yield small water supplies. Otherwise, this unit is considered not to be water yielding. This supposition is supported by the relatively low yield of the overburden monitoring wells installed at the Site, which yielded less than 100 milliliter (mL) per minute.

The Site and vicinity is located within the Kill Van Kull drainage basin. Runoff from the Site enters stormwater drainage structures located along Richmond Terrace and discharges either directly to the Kill Van Kull northwest of the Site, or to Bodine Creek, a tidal estuary, which flows approximately 500 feet (ft) northeast to the Kill Van Kull.

1.4.3 Site Geology

The site-specific investigation of geology has been limited to soil borings advanced no more than 10 ft below ground surface (bgs). The geologic deposits beneath the 2000-2012 Richmond Terrace portion of the Site comprise the following three stratigraphic units in order of increasing depth, and are depicted as elements of the CSM depicted in Figure 1-3:

- The Fill Unit is continuous across the Site and consists of fine- to coarse-grained sand and gravel with varying amounts of construction debris, including brick, concrete, pipe, wire, and glass. This unit also includes reworked, native material, which can be indistinguishable from locally-obtained fill. The unit has an average thickness of 2.5 ft, but ranges from 1 to 6 ft bgs.

- The Glacial Till Unit is continuous across the Site and is predominantly composed of light reddish brown to light gray (where saturated) silty clay, with fine sand. In many cases, the uppermost portion of this unit comprised dark brown to black, organic-rich deposits of up to 2 ft thickness, which represent the former ground surface. This unit has a greater than 5 to 12 ft thickness beneath the Site, as bedrock was not encountered in any of the soil borings advanced at the Site.

- The Bedrock Unit is mapped by the U.S. Geological Survey as fractured sepentinite and underlies the Site at an unknown depth. There are no bedrock outcrops at the Site, and bedrock was not encountered in any of the soil borings advanced at the Site.

1.4.4 Site Hydrogeology

The site-specific investigation of hydrogeology has been limited to three overburden monitoring wells installed on the 2000-2012 Richmond Terrace portion of the Site. The depth to groundwater beneath the Site is approximately 10 to 12 ft bgs, based on the measurements obtained from wells PO-1 and PO-2. Well PO-3, which has a total depth of 12.2 ft bgs, was found to be dry following its installation, despite having indications of saturation at 6 ft bgs during its installation. It is presumed that a perched water table was present in this area, which subsequently drained off via the well.

As noted above, the silty clay glacial till which comprises the uppermost hydrogeological unit has a relatively low hydraulic conductivity, as evidenced by the yield of less than 100 mL per minute from overburden monitoring wells PO-1 and PO-2. Groundwater from the Site flows northeasterly and discharges to the Kill Van Kull, as depicted in Figure 1-4. The site hydrogeology is also depicted as an element of the CSM are depicted in Figure 1-3.

1.5 SITE HISTORY

Historically, John Jewett & Sons White Lead Company operated a white lead manufacturing facility at 2015 Richmond Terrace where they owned and operated the Site from 1839 until 3 April 1890 when National Lead & Oil Company of New York ("National Lead") acquired the site property. When National Lead purchased the business, they extended the white lead operations across the street to include the property at 2000 Richmond Terrace. National Lead owned and operated at both properties until approximately 1943.

In 1943, the property at 2015 Richmond Terrace (Block 185, Lot 548) was acquired by the Moran Towing Corporation. Moran Towing Corporation currently owns and operates an active tug boat facility at the 2015 Richmond Terrace property. In addition to tug operations, Moran also provides ship docking services and general harbor assist work.

On 31 May 1946, National Lead sold the remaining parcel of land located at 2000 Richmond Terrace.

Between 1949 and 1990, various businesses operated at the 2000-2012 Richmond Terrace Property including Sedutto's Ice Cream factory. The buildings and any remaining debris on this 2000-2012 Richmond Terrace Property were eventually razed and cleared in 2000 after several fires occurred at the Sedutto's Ice Cream factory. The 2000-2012 Richmond Terrace Property was sold at auction on 26 January 2007 to Leewood Park Avenue LLC, who then sold the property to Perfetto Realty Co., Inc. (PRC) on 18 October 2007. PRC used the 2000-2012 Richmond Terrace Property to store construction equipment and materials from a local construction project. Currently, the property at 2000-2012 Richmond Terrace consists of vacant land that is entirely fenced. The ground surface, which consists of mostly unvegetated soil with some stone near the entrance, had previously been disturbed due to the presence of heavy machinery and vehicular movement.

On 3 June 2008, the Council of the City of New York submitted a written request to EPA to evaluate the 2000-2012 Richmond Terrace Property located at 2000-2012 Richmond Terrace for potential environmental contamination. In December 2008, EPA and contractor representatives collected soil samples throughout the 2000-2012 Richmond Terrace property. The average surface lead concentration was 5,081 milligrams per kilogram (mg/kg).

1.6 SUMMARY OF PREVIOUS SITE INVESTIGATIONS

During the period of 17 to 18 December 2008, EPA and contractor representatives from the RST 2 collected soil samples from 16 test pits that were excavated to a depth of approximately 4 ft below grade. Many of the test pits were found to contain either blackened soil; concrete in the form of slabs and/or footings; asphalt, bricks, and wood. Off-site samples were collected from four locations along Richmond Terrace in order to determine if contamination had migrated from the Site. Figure 1-5 depicts the sample locations.

The analytical results from the sampling event in December 2008 revealed the presence of elevated levels of lead throughout most of the Site, both laterally and with depth. The average surface lead concentration was 5,081 mg/kg. The highest lead concentration detected at the surface was 37,100 mg/kg, near the gate on Park Avenue. Thirteen of sixteen surface locations exceeded 400 mg/kg. The average lead concentration in the soil samples collected at depths of 1-foot (ft), 2-ft, and 3-ft below grade were 28,245 mg/kg, 61,201 mg/kg, and 53,398 mg/kg, respectively. The highest lead concentration detected in the subsurface was 240,000 mg/kg. Six of the test pit locations contained a lead concentration that exceeded 100,000 mg/kg. Other heavy metals were detected sporadically in the test pits throughout the Site. The maximum concentrations detected of arsenic, copper, nickel, and zinc were 81.5 mg/kg, 1,480 mg/kg, 2,070 mg/kg, and 7,660 mg/kg, respectively. The four off-site sample locations were found to contain lead in concentrations ranging from 383 mg/kg to 2,760 mg/kg.

The New York State Department of Health (NYSDOH), under cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR), prepared a Letter of Technical Assistance for the Site dated 25 March 2009. NYSDOH concluded that the apparent migration of lead-contaminated dust warranted immediate mitigation measures to limit the use of the Site to prevent additional migration of lead-containing fugitive dust. It concluded that the concentrations of lead detected in the surface soil at the 2000-2012 Richmond Terrace property and the off-property road dust represent a significant public health concern if people, especially children, are exposed to them.

At EPA's request and oversight, an interim removal action was taken by the current 2000-2012 Richmond Terrace Property owner in April 2009 to prevent the migration of lead-contaminated soils from the portion of the Site located at 2000-2012 Richmond Terrace. The interim removal action included: improving the existing fencing, installing a silt fence and hay bales around the fence line of property, spreading grass seed and mulch on the 2000-2012 Richmond Terrace Property to hold the lead-contaminated soils in place, posting "lead hazard" signs on fencing, and removing the lead-contaminated soils and sediments from the sidewalks and near curb line adjacent to the 2000-2012 Richmond Terrace Property. The ground surface is now mostly covered with grass, and a fabric windscreen has been placed along the entire fence line.

On 15 June 2009, EPA collected 14 surficial soil samples from the 2015 Richmond Terrace portion of the Site. The soil samples were collected from portions of this property where exposed soil was present or where the concrete and asphalt appeared to be in disrepair. The analytical results from the sampling event revealed the presence of lead that is present in the exposed surface soils or in collected grit and debris that has collected on the surface of the macadam cap that covers the majority of the property. Surface lead levels ranged from 145 mg/kg to 2,730 mg/kg, with the highest lead concentrations present in the surface soils adjacent the Richmond Terrace sidewalk.

SECTION 2

REMOVAL ACTION ASSESSMENT INVESTIGATION

2. REMOVAL ACTION ASSESSMENT INVESTIGATION

2.1 SCOPE OF WORK

Phase 1 sampling activities were designed to determine the extent of contamination at the Site, allowing for the evaluation of potential removal alternatives. Phase 1 of the SOW for Task Order 0018, Modification 0002, as it pertains to the portion of the Site located at 2000-2012 Richmond Terrace, directed WESTON to conduct fieldwork including environmental sampling of the following media:

The Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP) and Field Sampling (FSP) Plan for fieldwork at the Site, the final version of which was approved by EPA on 23 September 2010 (to reflect ongoing modifications to the SOW made by EPA to reflect changes in the CSM noted during field activities) called for the following:

- Surface and subsurface soil samples collected in 1-ft depth increments to a maximum of 8 ft bgs from 25 test pits, all soil samples to be analyzed for total lead using a field portable
  X-Ray fluorescence (FPXRF) unit, and a representative fraction of the samples (approximately 10%) to be analyzed for total lead, Toxicity Characteristic Leaching Procedure (TCLP) lead, and Synthetic Precipitation Leaching Procedure (SPLP) lead.

- Up to 10 co-located sediment and surface water samples collected along the surface water drainage pathway from the Site, including samples collected from nearby stormwater structures, their outfalls to surface water, and the Kill Van Kull from an EPA-supplied boat, the sediment samples to be analyzed for total lead, TCLP lead, and SPLP lead and the surface water samples to be analyzed for total lead.

- Groundwater samples collected from three shallow overburden monitoring wells (PO-1 through PO-3) installed during the investigation, to be analyzed for total and dissolved lead.

A copy of the UFP-QAPP is included as Appendix A.

2.2 DESCRIPTION OF WORK PERFORMED

Prior to the initiation of field activities, on 2 September 2010, WESTON performed research at various agencies of the City of New York, in order to determine whether any private wells were located in the vicinity of the Site. According to all sources queried, there are no known private wells located on Staten Island (Rubin, 2010). WESTON also obtained available subsurface utility maps in order to assess the safety of proposed subsurface investigation locations (test pits and soil borings).

WESTON conducted an off-site reconnaissance on 7 July 2010, to assess access and potential barriers to fieldwork at the Site. Following proposed subsurface investigation location mark-outs, WESTON obtained DigSafe site clearance, and further, contracted a geophysical survey of each proposed subsurface investigation location to ensure there were no subsurface utilities at any location.

Between 4 and 8 October 2010, WESTON collected 155 soil samples from a total of 23 test pit locations on the 2000-2012 Richmond Terrace portion of the Site to better document existing soil conditions and to estimate the extent of soil that will need to be addressed at the 2000-2012 Richmond Terrace Property. Figure 2-1 depicts the sample locations. The soil samples were collected from each of these test pit locations at 1 foot intervals from the surface to a depth to be determined at each location, based on the extent of lead impacts or the depth of the water table, whichever was shallower. A copy of the Test Pit Log for each test pit is included in Appendix B. All soil samples were screened for lead on-site using a FPXRF unit, and six duplicate sample analyses were performed. A copy of the field XRF results for these samples is included in Appendix B. Eleven of the soil samples were also submitted to CLP for confirmatory analysis for Target Analyte List (TAL) metals via EPA Standard Operating Procedure (SOP) C-109/C-110, as well as TCLP and SPLP lead via EPA Methods 1311 and 1312, respectively. One matrix spike (MS)/matrix spike duplicate (MSD) and one field duplicate soil sample was submitted to EPA’s DESA Laboratory. Following the sampling activities, the test pit locations were restored by seeding with grass seed.

Three overburden monitoring wells (PO-1 through PO-3) were installed on 7 and 8 October 2010 at the 2000-2012 Richmond Terrace portion of the Site using HSA drilling methods. Figure 2-1 depicts the monitoring well locations. Soil samples were collected from each well location at 1 ft intervals to the depth of the water table. A copy of the Well Construction Log for each well location is included in Appendix B. Twenty-four soil samples were screened for lead on-site using a FPXRF unit, and three duplicate sample analyses were performed. A copy of the field XRF results for these samples is included in Appendix B. Soil samples from the depth interval intersecting the water table at each location were also submitted to EPA’s DESA Laboratory for confirmatory analysis for TAL metals via EPA SOP C-109/C-110, as well as TCLP and SPLP lead via EPA Methods 1311 and 1312, respectively. Each well was subsequently developed and surveyed for location and elevation. Following two weeks of equilibration, groundwater samples were collected from two of the wells (PO-1 and PO-3; well PO-2 was found to be dry) using low-flow methodology and submitted to EPA’s DESA Laboratory for TAL metals analysis via EPA SOP C-109/C-110. One MS/MSD and field duplicate groundwater sample were also submitted to EPA’s DESA Laboratory. A copy of Low-Flow Groundwater Sampling Field Sheets for each well location is included in Appendix B.

As-built plans for the storm sewer system surrounding the Site were obtained from local authorities and reconnoitered to identify potential sediment/surface water sample locations. Six collocated sediment/surface water samples were collected from storm sewers or their outfalls adjacent to the Site, as well as the Kill Van Kull downstream of the Site. On 19 October 2010, four sediment samples collected from the Kill Van Kull were collected using a ponar sampler deployed from an EPA boat, while four collocated surface water samples were collected directly into the sample containers. Figure 2-2 depicts the sample locations. The surface water parameters and sediment descriptions for each location are included in Appendix B.

On 28 October 2010, sediment samples were collected from the storm drains using a stainless steel extended sampler, while surface water samples were collected using a peristaltic pump. Figure 2-1 depicts the sample locations. The surface water parameters and sediment descriptions for each location are included in Appendix B. The samples were submitted to EPA's DESA Laboratory for analysis by TAL metals via EPA SOP C-109/C-110, with the sediment samples also analyzed for TCLP and SPLP lead via EPA Methods 1311 and 1312, respectively. Two MS/MSD and field duplicate sediment and surface water samples were also submitted to EPA's DESA Laboratory.

EPA requested that the EPA's DESA Laboratory retain confirmatory soil and sediment samples for up to six months, to accommodate potential subsequent specialized analyses which may be required based on the validated analytical results.

Between 4 and 14 October 2010, ambient air particulate monitoring was conducted at upwind and downwind locations along the perimeter of the Site during intrusive activities to ensure no off-site migration of lead-impacted soils. In addition, sampling personnel wore particulate samplers during each day of intrusive work. The particulate samples were submitted to EMSL Analytical for total lead analyses. The results of the perimeter and personnel monitoring indicated no detectable lead in any of the samples. The ambient air particulate monitoring results are included in Appendix C.

The results of the removal assessment investigation are summarized in Section 3 of this EE/CA Report.

2.3 DEVIATIONS FROM THE SCOPE OF WORK

The following deviations from the final UFP-QAPP have been noted.

At the request of the EPA OSC, the total lead analyses were expanded to analysis for TAL metals via EPA SOP C-109/C-110.

Sediment samples SD-05 and SD-06, collected on 28 October 2010, were not analyzed for TCLP lead or SPLP lead, due to an error.

Groundwater samples were analyzed for total TAL metals via EPA SOP C-109/C-110, only rather than for total and dissolved lead. The increased analyte list was performed at the request of the EPA OSC, and the lack of dissolved metals analysis was to eliminate redundant results, since low-flow groundwater sampling techniques are designed to generate dissolved metals results without filtration.

Monitoring well PO-3 was found to be dry when gauged on 28 October 2010, and thus, a groundwater sample could not be collected from the well.

SECTION 3

REMOVAL ACTION INVESTIGATION RESULTS

3. REMOVAL ACTION INVESTIGATION RESULTS

3.1 CONTAMINANTS OF POTENTIAL CONCERN

In order to develop a list of contaminants of potential concern (COPC) for each medium, the maximum detected concentrations of the site related constituents were compared to their respective Regional Screening Levels (RSL) from the RSLs for Contaminants at Superfund Sites (EPA, 2010). The screening levels utilized in this streamlined risk evaluation correspond to either a cancer risk of 1×10^{-6} or a non-cancer hazard quotient of 0.1. The non-cancer hazard RSLs have been adjusted to 0.1 to take into account potential exposures to multiple chemicals. Constituents which exceeded their respective RSLs are identified as COPCs. Group A Carcinogens (Known Human Carcinogens) that were detected were also selected as COPCs regardless of the level at which they were detected (McPherson, 2010). In addition, the maximum detected concentrations of the site related constituents were also compared to their respective New York State Department of Environmental Conservation (NYSDEC) Title 6, Part 375 Restricted Use Soil Cleanup Objectives (RUSCOs) for commercial soils and protection of groundwater (NYSDEC, 2006), and NYSDEC Chapter X, Part 703 surface water and groundwater quality standards (NYSDEC, 1999).

As shown in Table 3-1, eight substances detected in soil, aluminum, antimony, arsenic, copper, iron, manganese, lead, and mercury exceeded their respective EPA RSLs. Two substances detected in soil, barium and lead, exceeded their NYSDEC Commercial RUSCOs. It should be noted that there are no NYSDEC Commercial RUSCOs for aluminum, antimony, and iron. Three detected substances, arsenic, iron, and manganese, exceeded their respective EPA tap water screening criteria and their NYSDEC groundwater quality standards. It should be noted that there are no NYSDEC groundwater quality standards for aluminum.

However, review of the occurrence of the COPCs, particularly how the COPC concentrations correlate with lead concentrations, provides further insight regarding which COPCs are likely associated with former industrial activities at the Site. As shown in Table 3-1, in some cases, the highest concentrations of COPCs are 100% correlated with elevated lead concentrations (antimony, barium, and manganese), which in other cases, the highest concentrations of COPCs are 100% correlated with relatively low lead concentrations (aluminum, arsenic, and iron). The three highest concentrations of copper are only twice collocated with the most elevated lead concentrations, and the four highest concentrations of mercury detected in soil are only twice collocated with the most elevated lead concentrations, resulting in less certain correlations.

Based on this review, it does not appear that aluminum, arsenic, and iron, are associated with lead contamination at the Site, although this does not rule them out as COPCs for the Site. For the remaining COPCs, antimony, arsenic, barium, copper, and manganese, and possibly copper and mercury, it appears that tracking elevated lead concentrations will also address their impacts.

3.2 DATA QUALITY/DATA USABILITY

3.2.1 Data Validation

Environmental sample analytical results collected during the removal action investigation were validated using EPA Region 2 Functional Guidelines. The majority of the data validation was performed by EPA Region 2 DESA personnel. Data validation pertaining to field duplicate samples performance, to which the laboratory was "blind", was performed by a WESTON Chemist. The following issues were identified during the data validation process:

- Mercury Analysis: Samples SD-01 through SD-04, SW-01 through SW-04, and RB-05, collected on 19 October 2010. Due to laboratory error with the sample receipt, the samples were analyzed past the 28-day holding time established for the analysis. All results were qualified with a "J" to indicate the data are estimated, potentially biased low.

- TAL Metals Analysis: Samples SD-01 through SD-04, SW-01 through SW-04, and RB-05, collected on 19 October 2010, were removed from the refrigerator for preparation for TCLP and SPLP analysis. The samples were left out at room temperature for three days, in error, prior to conducting the Total Analysis for the TAL metals. Since the samples were not maintained at 4°C for those three days, all Total metals results should be considered as "estimated", potentially biased low.

- Field Duplicates: The following analytical results were qualified with a "J" to indicate the data are estimated, with an unknown bias, due to non-compliant field duplicate relative percent difference (RPD).

    - Total lead and mercury, TCLP lead, and SPLP lead in samples S-PO2-0506 and S-PO2-0506-E.

    - Total lead in samples GW-PO3-1010 and GW-PO3-1010-E.

    - Total arsenic, calcium, magnesium, and lead in samples SD-05 and SD-05-E.

The environmental sample analytical results collected during the removal action investigation are considered usable, as qualified.

3.2.2 Comparison of Field XRF and Laboratory Soil Sample Total Lead Results

One of the objectives of the removal action investigation was to determine the comparability of the FPXRF results to laboratory results, in order to verify that the FPXRF results could be used to determine the extent of lead impacts at the Site. To accomplish this, a total of 24 soil samples analyzed for lead by FPXRF were also submitted for total lead analysis by EPA's DESA Laboratory. Table 3-2 summarizes the comparison of the two data sets.

In general, the laboratory analytical results were higher than the FPXRF results in 62% of the cases, which suggests that the FPXRF data may be biased low. The data sets were also compared using EPA Region 2 data validation guidelines regarding duplicate samples, and RPDs were calculated for each sample pair. It was found that 17 of the 24 of the sample pairs (71%) met the 75% RPD objective, and that the average RPD for the 24 sample pairs was 80%, only slightly above the 75% objective. Finally, the average total lead concentration for the FPXRF data is 15,419 mg/kg which is fairly consistent (within the RPD requirement of 75%) with the average lead concentration for the laboratory data, 23,708 mg/kg. This result further supports the observation that the FPXRF data appear to be biased low.

The conclusions that can be made from these data comparisons are that the FPXRF data only estimate the laboratory results for soil lead, and that they may be biased low. With an understanding of these limitations, the FPXRF data may be used to estimate the extent of lead impacts at the Site.

3.2.3 Comparison of Total Lead and SPLP Lead Results

Another objective of the removal action investigation was to determine the comparability of the total lead to SPLP lead results, in order to verify whether the total lead results could be used to predict SPLP results. A total of 27 sample pairs include both total lead and TCLP lead results which can be used for this comparison. Table 3-3 summaries the data used to make this comparison, and includes the calculation of a ratio of SPLP lead concentration [in milligrams per liter (mg/L)] to total lead concentration (in mg/kg). Calculation of statistics in the table indicate that average SPLP lead to total lead ratio is 0.18, but that the range of the ratio varies from 1.1 to 0.0046, across four orders of magnitude. Further insight into this relationship can be obtained by reviewing graphs of the data, included in Figure 3-1. The common graph of total lead and SPLP lead results appears to show good correlation at the lower lead concentrations, but poorer correlation for the higher lead concentrations (although better than the correlation with TCLP lead results shown in Figure 3-1), but this is once again an artifact of the graphic depiction. The plot of lead concentrations and TCLP lead/total lead ratios clearly shows that the ratio is only greater than 0.11 at the lowest total lead concentrations (below 200 mg/kg), and that the range of SPLP lead concentrations varies by only two orders of magnitude at total lead concentrations greater than 200 mg/kg, and less than one order of magnitude at total lead concentrations greater than 17,000 mg/kg.

Based on the review of the total lead and SPLP lead datasets, the correlativity of total lead and SPLP lead results is proportional to total lead concentration. It is concluded that total lead analytical results are a poor to moderate predictor of SPLP lead results below total lead concentrations of 17,000 mg/kg, but can be used to estimate SPLP lead concentrations at higher total lead concentrations.

3.2.4 Comparison of Total Lead and TCLP Lead Results

Another objective of the removal action investigation was to determine the comparability of the total lead to TCLP lead results, in order to verify whether the total lead results could be used to predict TCLP results. A total of 27 sample pairs include both total lead and TCLP lead results which can be used for this comparison. Table 3-4 summaries the data used to make this comparison, and includes the calculation of a ratio of TCLP lead concentration (in mg/L) to total lead concentration (in mg/kg). Calculation of statistics in the table indicate that average TCLP lead to total lead ratio is 0.41, but that the range of the ratio varies from 1.8 to 0.0056, across four orders of magnitude. Further insight into this relationship can be obtained by reviewing graphs of the data, included in Figure 3-2. The common graph of total lead and TCLP lead results appears to show good correlation at the lower lead concentrations, but poorer correlation for the higher lead concentrations, but this is an artifact of the graphic depiction. The plot of lead concentrations and TCLP lead/total lead ratios clearly shows that the ratio varies widely across the range of total lead concentrations.

Based on the review of the total lead and TCLP lead datasets, it is concluded that total lead analytical results are a poor predictor of TCLP lead results. This may be the result of a variety of types of lead present in site soils, which exhibit different TCLP leachability.

3.3 SOIL INVESTIGATION

As noted in Subsection 3.1, the concentrations of most of the COPCs at the Site, with the exception of aluminum and iron, and possibly mercury, correlate well with lead concentrations. For this reason, the concentrations of lead in soil will be used as the primary criteria to determine the extent of soil impacts at the Site.

The CSM regarding the distribution of lead at the Site is that lead-impacted soils generally occur from the ground surface downward, and that lead impacts were caused primarily by disposal of lead wastes to the ground surface or inside of buildings formerly present at the Site. During the process of demolition of the buildings, lead-impacted soils may have come to be buried at depth, and relatively lead-free soils may now overlie lead-impacted soils. Figure 1-3 depicts the elements of the CSM for the site.

The soil lead analytical data (both FPXRF and laboratory data from both the 2008 and 2010 sampling activities) provide excellent corroboration of the CSM regarding the distribution of lead in soil at the Site. Table 3-5 summarizes the 2008 soil analytical results, Table 3-6 summarizes FPXRF soil analytical results, and Table 3-7 summarizes laboratory analytical results. Figure 3-3 presents the FPXRF and laboratory lead results for each soil sample location.

The vertical distribution of lead within soils displays a few common trends. In a number of samples, surficial soil lead concentrations are lower than subsurface soil lead concentrations, as anticipated by the CSM, likely reflecting the movement and/or burial of lead-impacted soils during construction or demolition activities at the 2000-2012 Richmond Terrace Property. Further, at locations AB-1 and ZA-3.5, below the 3 and 5 ft depth, respectively, soil lead concentrations drop below 800 mg/kg, but increase again at depths of 7 and 8 ft, respectively, likely reflecting the depth of excavations at the 2000-2012 Richmond Terrace Property for building foundations, etc.

The figure clearly shows that there are only 2 of the 41 sample locations at the Site (locations A-3 and D-4), where lead was not detected at any depth interval in excess of the 800 mg/kg RSL for the Site, as determined in Section 2.3 of the EE/CA. The figure also shows that the depth of lead-impacts at the Site ranges from 1 ft to up to 8 ft, with an average depth of 3.2 ft, although it should be noted that 9 of the 16 soil sample locations from December 2008 documented lead impacts greater than 800 mg/kg at the 3 to 4 ft depth interval, with no deeper sampling performed. The depth of lead impacts is generally shallower in the eastern portion of the Site. The extent of lead impacts related to the Site is generally not bounded horizontally by samples documenting compliant lead concentrations. The extent of lead impacts is only bounded vertically by 5 of the 16 December 2008 soil samples (A-1, B-1, D-1, D-2, and E-2), and all but one of the October 2010 soil sample results (ZA-3.5), where lead impacts greater than 800 mg/kg were detected in the 7 to 8 ft depth interval (location ZA-3.5 is also at the western boundary of the Site). Thus, it may be concluded that the available data will form the basis for a minimum extent of contamination, and that the actual volume of soil requiring remediation will likely be greater. Figure 3-4 depicts an isopach map of the thickness of lead-impacted soils which exceed the 800 mg/kg RSL.

3.4 GROUNDWATER INVESTIGATION

As noted in Subsection 2.3, monitoring well PO-3 was found to be dry when gauged on 28 October 2010, and a groundwater sample could not be collected from the well. Thus, the groundwater data pertaining to the portion of the Site located at 2000-2012 Richmond Terrace comprise measurements and samples from wells PO-1 and PO-2.

3.4.1 Groundwater Depth and Flow Direction

Depth to groundwater was measured prior to the 28 October 2010 sampling event, and the data from well PO-3 can also be used to estimate the depth to groundwater beneath the Site, between 9.61 and 12.2 ft bgs. Utilizing the groundwater elevation measurements from both this portion of the Site and those measured synchronously on 28 October 201 on the portion of the Site at 2015 Richmond Terrace, the horizontal direction of groundwater flow is northerly, toward the Kill Van Kull. Figure 1-4 depicts groundwater elevations and the direction of groundwater flow beneath the Site.

3.4.2 Groundwater Quality Parameters

Groundwater quality parameters of temperature, specific conductivity, pH, dissolved oxygen, oxidation-reduction potential, and turbidity were measured prior to the 28 October 2010 sampling event, and are summarized in Table 3-8.

3.4.3 Groundwater Quality

Table 3-9 summarizes the results of the groundwater samples collected from the Site on 20 October 2010. As noted in Subsection 3.1, only arsenic, iron, and manganese exceeded their EPA tap water screening values and NYSDEC groundwater quality standards; lead was not detected in any of the groundwater samples collected from the 2000-2012 Richmond Terrace portion of the site, with a detection limit of 8 micrograms per liter (µg/L), which is lower than both its EPA Maximum Contaminant Limit (MCL) (15 µg/L) and NYSDEC groundwater quality standard (50 µg/L). As also discussed in Subsection 3.1, while arsenic and manganese appear to be COPCs based on their correlation with lead-impacted soils, iron does not. The absence of detectable lead in the groundwater samples suggests that the conditions beneath the Site are not conducive to the leaching of lead to groundwater beneath the Site. However, it should be noted that there are no identified drinking water supplies located in the vicinity of the Site.

3.5 SURFACE WATER INVESTIGATION

Surface water runoff from the portion of the Site located at 2000-2012 Richmond Terrace flows to the northeast and northwest, and enters storm drains located along Richmond Terrace and Park Avenue, respectively. The stormwater drainage system along Richmond Terrace flows via underground piping to an outfall located along Bodine Creek, approximately 0.2 miles east of the Site. The stormwater drainage system along Park Avenue flows via underground piping to an outfall located at the end of Port Richmond Avenue, approximately 0.1 mile northwest of the Site.

3.5.1 Surface Water Quality Parameters

Surface water quality parameters of temperature, specific conductivity, pH, dissolved oxygen, oxidation-reduction potential, and turbidity were measured prior to the 28 October 2010 sampling event, and are summarized in Table 3-10.

3.5.2 Background Sediment/Surface Water Locations

Both the Kill Van Kull and Bodine Creek are tidally-influenced estuaries, making it difficult to establish upstream reference locations. In lieu of an upstream reference location, the most distal sample locations, sample locations SW/SD-2 and SW/SD-4, have been selected to represent background sediment and surface water concentrations. However, sample locations SW/SD-2 and SW/SD-4 were located in the brackish water of the estuary, and are not appropriate background locations for sample locations SW/SD-5 and SW/SD-6, which comprised fresh water.

3.5.3 Sediment Sample Analytical Results

Table 3-11 summarizes sediment sample analytical results. Lead was detected in each sediment sample, with the results from SD-01 and its duplicate, SD-01-E, being highest, The concentrations of lead detected in sediment samples SD-05, SD-05-E, and SD-06 were statistically the same, particularly considering the lead results for samples SD-05 and SD-05-E were estimated due to poor duplicate performance. None of the sediment lead results exceeded the site-specific Screening Level.

Regarding other COPCs, aluminum, arsenic, copper, iron, manganese, and mercury occurred at their highest, at concentrations in sediment samples SD-01, SD-01-E, and SD-03, which were collected at the outfalls from the stormwater drainage system. However, only copper and iron had elevated concentrations in sample SD-06, which was collected from the catch basin downstream of the Site, relative to the background concentrations in samples SD-05 and SD-05-E. In general, the concentrations of most TAL metals were highest in sample SD-03, collected from the stormwater drainage system outfall at Bodine Creek.

Based on these analytical results, it may be concluded that the stormwater drainage system outfalls, particularly the one located at Bodine Creek, are sources of potential impact to sediment of the Kill Van Kull. It should be noted, however, that while the source of these contaminants in the Kill Van Kull, which is a tidal waterbody, is unknown, the source of sediment contaminants does not appear to be a release from the Site. The finding that urban runoff from non-point sources is the likely source of sediment impacts is consistent with the CSM.

3.5.4 Surface Water Sample Analytical Results

Table 3-12 summarizes surface water sample analytical results. Lead was only detected in surface water samples SW-05 and its duplicate, SW-05-E, and SW-06, at concentrations greater than the 1.5 mg/L EPA MCL. Other analytes detected only in the surface water samples collected from the catch basins are copper and zinc. The concentrations of manganese detected in the samples collected from the catch basins were approximately three times those detected in samples collected from Bodine Creek and the Kill Van Kull, and the concentrations of iron detected in the samples collected from the catch basins were approximately 10 times those detected in samples collected from Bodine Creek and the Kill Van Kull. These data suggest that copper, iron, lead, and manganese may be migrating from the Site to surface water. Zinc is not a COPC for the Site, and thus, may be due to releases from other sources than the Site. Further, the concentrations of calcium, copper, magnesium, manganese, potassium, sodium, and zinc are substantially greater in the background samples SD-05 and SD-05-E than in sample SD-06, suggesting that these substances are due to releases from sources other than the Site.

However, the surface water analytical results from Bodine Creek and the Kill Van Kull indicate that copper and lead are not detectable (and thus, may be assumed to have no impact to these downstream water bodies), and that the concentrations of iron and manganese are substantially attenuated in the downstream water bodies. The concentrations of the six detected analytes in surface water samples collected from Bodine Creek and the Kill Van Kull, calcium, iron, magnesium, manganese, potassium, and sodium are all similar, supporting a conclusion that there are no impacts to surface water due to releases from the Site, which is again consistent with the CSM.

SECTION 4

REMOVAL ACTION ALTERNATIVES EVALUATION

4. REMOVAL ACTION ALTERNATIVES EVALUATION

4.1 RESPONSE ACTION AND OBJECTIVES

This section describes the statutory limitations on the response actions, presents the overall goals and objectives of the proposed non-time-critical response action, and describes the anticipated timetable for the implementation of the non-time-critical response action.

EPA, in consultation with NYSDEC, has set the following site specific Risk-Based Concentrations (RBCs), or site-specific Screening Levels for the COPCs at the 2000-2012 Richmond Terrace portion of the Site. These site-specific Screening Levels, listed below, based in part on the Regional Screening Levels for Contaminants at Superfund Sites (November, 2010) and the Streamlined Human Health Risk Assessment (SHHRA), will be used to define which contaminants potentially pose a concern. The values in the table provided are not based upon the NYSDEC-promulgated standards, but rather, risk-based criteria.

Aluminum	99,000 mg/kg
Antimony	41 mg/kg
Arsenic	1.6 mg/kg
Copper	4,100 mg/kg
Iron	72,000 mg/kg
Manganese	2,300 mg/kg
Lead	800 mg/kg
Mercury	3.4 mg/kg

4.2 CONDITIONS THAT JUSTIFY A REMOVAL ACTION

Site characterization investigations described in Sections 2 and 3 indicated that the wastes and soils located on the Site contain hazardous substances including metals. These contaminants are present at the Site at levels that pose a threat to public health, welfare, and the environment. Therefore, EPA has determined that a non-time-critical removal action is appropriate at the Site to abate, prevent, minimize, stabilize, mitigate, or eliminate these threats. Specifically, action(s) will be undertaken to restrict or disassociate human exposure to the contaminated areas at the Site, and to prevent or minimize the migration of hazardous substances released at the Site to the area soils, sediment, surface water, and groundwater. The general response actions which are considered appropriate and applicable to accomplish these objectives are considered in the following sections.

4.3 RESPONSE ACTION SCHEDULE

It is anticipated that the response action could be accomplished in less than a year from the start date. At this point, the start date is not known. A detailed schedule and time line for required tasks to perform the response action will be prepared prior to commencing field activities.

4.3.1 Summary of Risk Assessments

4.3.1.1 Human Health Risk Assessment

In January 2011, EPA performed a SHHRA to support the EE/CA for the portion of the Site located at 2000-2012 Richmond Terrace, which is included in Appendix D. The SHHRA utilized the 2010 soil and groundwater analytical results for the Site. The maximum detected concentrations of the constituents detected (lab data) were compared to their respective site-specific Screening Levels (McPherson, 2011).

In soil, eight detected chemicals, designated as COPCs, exceeded their respective residential screening criteria. When compared to their respective screening criteria, a cancer risk and non-cancer hazard was generated for each chemical based upon the maximum detected concentration. The non-residential cancer risk for arsenic and non-residential, non-cancer risk for manganese exceeded their cancer benchmark and hazard index (HI) threshold, respectively, without the contributions from other COPCs. The lead results indicate that the average concentration on the Site (surface and subsurface) presents an unacceptable risk to the current industrial/commercial receptor and the potential future resident (McPherson, 2011).

Three detected chemicals exceeded their respective tap water screening criteria. The non-residential, non-cancer risk for iron and manganese exceeded their HI thresholds, respectively, without the contributions from other COPCs. The maximum detected concentration of arsenic corresponds to a cancer risk of 1.6×10^{-6}, which exceeds EPA cancer risk range (McPherson, 2011). Lead was not detected in groundwater beneath the Site.

4.3.1.2 Environmental Risk Assessment

In January 2011, Alion Science and Technology performed an Streamlined Screening Level Environmental Risk Assessment (SSLERA) to support the EE/CA for the portion of the Site located at 2000-2012 Richmond Terrace, which is included in Appendix D (Alion Science and Technology, 2011).

The SSLERA found that there appears to be the potential for risk to ecological receptors at the 2000-2012 Richmond Terrace portion of the Site. Contaminant concentrations measured at the 2000-2012 Richmond Terrace Property exceeded screening benchmarks for many contaminants in soil, in catch basin water and sediments, and in sediment and surface water at the outfalls in the Kill Van Kull. Hazard quotients (HQs) for surface water and sediment (both freshwater and marine) were generally low, but still exceeded threshold values. Concentrations of contaminants in soil were very high for some contaminants, particularly lead, aluminum, iron, nickel, and chromium. In addition, food chain models indicated the potential for risk to all assessment endpoints evaluated (herbivorous birds and mammals, invertivorous birds and mammals, and carnivorous birds and mammals). For all assessment endpoints except carnivorous mammals, lead was the primary contaminant of concern, with HQs reaching 107,573 for the American Woodcock. For carnivorous mammals, the highest HQ was calculated for aluminum. This is likely due to using the default bioaccumulation factor (BAF) of 1.0, which was applied because soil to small mammal values could not be found in the published literature. This BAF is likely to be overly conservative and may cause aluminum to appear to be a disproportionately important COPC (Alion Science and Technology, 2011).

The SSLERA clearly indicates that concentrations of lead and other metals at the 2000-2012 Richmond Terrace Property are sufficiently high to present risk to ecological receptors. The fact that little viable habitat exists at the property may represent a mitigating factor by reducing the possibility of ecological exposure. The conclusion of the SSLERA is that there appears to be the potential for risk to ecological receptors at the Site (Alion Science and Technology, 2011).

4.4 IDENTIFICATION AND ANALYSIS OF RESPONSE ACTION ALTERNATIVES

Five response alternatives are identified as potential actions toward achieving the primary objectives of this non-time-critical response action to eliminate or mitigate existing and/or potential threats to the public health and the environment by: (a) restricting human exposure to the contaminated area; and (b) preventing or minimizing the migration of hazardous constituents to area soils, sediment, surface water, and groundwater. These alternatives are as follows.

4.4.1 Alternative 1: No Action

The Superfund program requires that the "no-action" alternative be considered as a baseline for comparison with the other alternatives. The no-action alternative does not include any remedial measures that address the contaminated media. This alternative would; however, include the implementation of public awareness program to ensure that nearby residents are familiar with the threats posed by the contamination located on the Site.

4.4.2 Alternative 2: Excavation and Off-Site Treatment/Disposal

Site preparation activities under this alternative would include the construction of a vehicle decontamination pad and material stockpile and staging areas, clearing and grubbing, removal of on-site materials, such as construction equipment stored on the 2000-2012 Richmond Terrace Property, decommissioning of the existing monitoring wells, and reconstructing erosion control measures. Following these activities, approximately 4,242 cubic yards (cyd) of soils exceeding the site-specific Screening Levels would be excavated. The available soil analytical results will be used to determine initial excavation dimensions, and the removal volume was estimated using geographic information system software, based on the soil lead isopach map presented in Figure 3-4. As the initial excavation is completed, additional soil samples would be collected from the walls and base of the excavation and analyzed for metals. If analytical results of the post-excavation samples indicate residual concentrations exceed the site-specific Screening Levels, additional soil would be excavated, followed by additional confirmatory sampling. The process would be repeated until analytical results reveal that all the soils containing metals concentrations greater than the site-specific Screening Levels have been removed.

Once confirmatory sampling results indicate that excavation activities are completed, the excavated areas would be backfilled to restore the Site to the existing grade. Backfill would consist of certified clean soil from an approved off-site source. The top 6 inches of backfill would be soil that would meet the needs of the 2000-2012 Richmond Terrace Property owner, either organic-rich loam capable of supporting vegetative growth, an inorganic travel layer (i.e., stone dust or crushed stone), or a combination of both. A vegetative cover would be planted immediately following placement of any topsoil layer. The three on-site monitoring wells would be replaced following the placement of final cover, and monitored semi-annually for at least 2 years, to demonstrate the effectiveness of the remedy.

Excavated soil will be sampled at the rate required by the proposed Treatment, Storage, and Disposal Facility (TSDF), using TCLP analytical methods. As the final phase of this action, excavated soils will be transported and disposed of an appropriate TSDF. The equipment required for this alternative would be standard earthmoving equipment, such as bulldozers, hydraulic excavators, front-end loaders, and tri-axle and semi dump trucks.

4.4.3 Alternative 3, Capping

Site preparation activities under this alternative would include the construction of a vehicle decontamination pad and material stockpile and staging areas, clearing and grubbing, removal of on-site materials, such as construction equipment stored on the 2000-2012 Richmond Terrace Property, reconstructing erosion control measures, and decommissioning the existing on-site groundwater monitoring wells. Following these activities, an approximately 1-acre multi-layer cap would be constructed over the consolidated contaminated soils. The cap layers, from bottom to top, would comprise the following:

- Grading: In order to maintain the current grade at the Site, the top 2 ft of contaminated soil would be removed, in order to accommodate the 2-ft Barrier Protection Layer. Soils with the highest lead concentrations (i.e., those expected to exceed TCLP criteria), approximately 2,400 cyd, will be removed and the remaining soils would be regraded. Common fill would be placed to create positive surface water run-off. Some on-site materials would be used for common fill.

- Barrier Protection Layer: A 40-mil (0.040-inch) thick flexible membrane liner manufactured from high-density polyethylene (HDPE). The HDPE liner provides a low-permeability layer that would act as the primary liner in retarding infiltration. Common fill layer would be placed at a thickness of 18 inches to provide protection for the HDPE and drainage liners.

- Geosynthetic Drainage Layer: The drainage layer would be used to remove surface water that infiltrates through the upper layers of the cap. The drainage layer would tie into a drainage system located within an anchor trench around the perimeter of the cap.

- Common Fill Layer – This layer would provide protection for the barrier and drainage layers, and would comprise approximately 1.5 ft of common fill.

- Vegetative Soil Layer/Travel Layer: A uppermost cover layer that would meet the needs of the 2000-2012 Richmond Terrace Property owner, either organic-rich loam capable of supporting vegetative growth, an inorganic travel layer (i.e., stone dust or crushed stone), or a combination of both would be placed at a thickness of 6 inches to accommodate the root system of the vegetation selected for the cap.

After capping, the three on-site monitoring wells would be replaced, and their surface completions would be sealed to the liner. Following monitoring well installation and development, the Site would be landscaped, fenced, and posted. This alternative would also include implementing institutional controls necessary to maintain the integrity of the soil cap.

Groundwater beneath the site will be monitored at the three on-site wells semi-annually for a period of up to 30 years, to verify the success of the remedy. Site maintenance activities, including maintaining the fence and signs, removal of trees and shrubs that can puncture the geomembrane with root growth, monitoring for invasion by burrowing animals, and repair of any erosion, would be necessary to maintain the integrity of the cap system.

4.4.4 Alternative 4, Paving

Site preparation activities under this alternative would include the construction of a vehicle decontamination pad and material stockpile and staging areas, clearing and grubbing, removal of on-site materials, such as construction equipment stored on the 2000-2012 Richmond Terrace Property, and reconstructing erosion control measures. The existing on-site groundwater monitoring wells could be left in place.

In order to maintain the current grade at the Site, the top 6 inches of contaminated soil would be removed, in order to accommodate the pavement. Soils with the highest lead concentrations (i.e., those expected to exceed TCLP criteria), approximately 500 cyd, will be removed and the remaining soils would be regraded. Some on-site materials would be used for common fill.

Following these activities, an approximately 1-acre asphalt pavement would be constructed over the graded contaminated soils. After paving, the Site would be fenced and posted. This alternative would also include implementing institutional controls necessary to maintain the integrity of the pavement.

Groundwater beneath the site will be monitored at the three on-site wells semi-annually for a period of up to 30 years, to verify the success of the remedy. Site maintenance activities, including maintaining the pavement, fence, and signs, would be necessary to maintain the integrity of the pavement system.

4.4.5 Alternative 5, Immobilization

Site preparation activities under this alternative would include the construction of a vehicle decontamination pad and material stockpile and staging areas, clearing and grubbing, removal of on-site materials, such as construction equipment stored on the 2000-2012 Richmond Terrace Property, reconstructing erosion control measures, and decommissioning the existing on-site groundwater monitoring wells.

Following these activities, the top 2 ft of lead contaminated soil would be treated in-situ with a concrete additive which would immobilize the lead in the soil, preventing leaching to surface water and groundwater (soils would meet TCLP criteria), as well as preventing contact with deeper, untreated, lead-impacted soils. The treatment would be accomplished by adding the concrete additive and water to the soil via an industrial tilling machine, in two, 1-ft lifts. The additive would not significantly increase the volume of treated soils, such that no soil removal will be required to maintain current grade. Once cured, the treated area will provide a surface that precludes vegetation growth and burrowing animals, and a suitable surface for the current site use, storage of construction equipment. No further cover will be required.

After immobilization, the three on-site monitoring wells would be replaced, and their surface completions would be sealed to the ground surface. Following monitoring well installation and development, the Site would be fenced, and posted. This alternative would also include implementing institutional controls necessary to maintain the integrity of the soil cap.

Groundwater beneath the site will be monitored at the three on-site wells semi-annually for a period of up to 30 years, to verify the success of the remedy. Site maintenance activities, including maintaining the fence and signs, would be necessary to maintain the integrity of the cap system.

4.5 OVERVIEW OF EVALUATION CRITERIA

Each alternative would be assessed against the following three evaluation criteria and their components, in conformance with the non-time-critical removal action guidance.

4.5.1 Effectiveness

This refers to the ability of each alternative to meet the remedial action objectives (RAO) within the scope of the removal action. Each alternative is evaluated against the scope of the removal action and against each specific objective for final disposition of the wastes (if applicable) and the level of cleanup desired.

4.5.1.1 Overall Protection of Public Health and the Environment

This criterion assesses whether the alternatives are protective of public health and the environment. The evaluation will focus on how each alternative achieves adequate protection and describe how the alternative will reduce, control, or eliminate risks at the Site through the use of treatment, engineering, or institutional controls. The evaluation will identify any unacceptable short-term impacts. The overall assessment of protectiveness is based on a composite of factors assessed under the evaluation criteria, including long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

4.5.1.2 Compliance with ARARs and Other Criteria, Advisories, and Guidance

This criterion addresses whether or not a remedy would meet all of the applicable or relevant and appropriate requirements of other federal and state environmental statutes and requirements or provide grounds for invoking a waiver. These requirements are discussed within this section.

Section 121(d) of CERCLA, 42 U.S.C. §9621(d), requires that remedial actions at CERCLA Sites attain at least legally applicable or relevant and appropriate federal and state requirements, standards, criteria, and limitation which are collectively referred to as ARARs, unless such ARARs are waived under CERCLA §121(d)(4). Removal actions, such as this non-time-critical removal action, are required to attain ARARs to the extent practicable pursuant to the requirements of 40 Code of Federal Regulations (CFR) §300.415(j). Applicable requirements are those substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address hazardous substances, the action to be implemented at the Site, the location of the Site, or other circumstances present at the Site. Relevant and appropriate requirements are those substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law which while not applicable to the hazardous materials found at the Site, the response action itself, the site location or other circumstances at the Site, nevertheless address problems or situations sufficiently similar to those encountered at the Site that their use is well-suited to the Site. EPA also uses “To Be Considered” (TBC) that include non-binding criteria, advisories, guidance, and proposed standards. The TBCs are not potential ARARs; rather they are meant to complement the use of ARARs. It may be necessary to consult TBCs to interpret ARARs, or to determine preliminary remediation goals when ARARs do not exist for particular contaminants.

Applicable or Relevant and Appropriate Requirements are generally divided into three categories chemical-specific; location-specific; and action-specific. Chemical-specific ARARs provide guidance on acceptable or permissible contaminant concentrations in soil, air, and water. Location-specific ARARs govern activities in critical environments such as floodplains, wetlands, endangered species habitats, or historically significant areas, while action-specific ARARs are technology or activity-based requirements.

4.5.1.2.1 Chemical-Specific ARARs

Chemical-specific ARARs for the COPCs at the Site (e.g., metals) are discussed below. These ARARs would be the federal standards or the more stringent NYSDEC Chapter X, Part 703 surface water and groundwater quality standards (NYSDEC, 1999).

Appropriate federal requirements include the Resource Conservation and Recovery Act (RCRA), 42 U.S.C. §6901, *et seq*. which regulates the disposal of hazardous wastes.

New York State surface water standards have been promulgated by NYSDEC for the protection of human health and/or aquatic life and are legally enforceable. The surface water standards are dependent on the federal-assigned classification of the surface water body as well as the carbonate hardness of the surface water for inorganic constituents [6 New York Compilation of the Rules and Regulations (NYCRR) Part 701].

4.5.1.2.2 Location-Specific ARARs

Location-specific ARARs that may govern activities in critical environments such as wetlands, endangered species habitats, and historic locations are as follows.

The Endangered Species Act (16 U.S.C. §1531 *et seq.*) and the Endangered and Threatened Species of Fish and Wildlife; Species of Special Concern (6 NYCRR Part 182) addresses the protection of threatened and endangered species. There may be threatened or endangered species or habitats expected to be present within the area of study as determined by NYSDEC, based on a review of the Significant Habitat and Natural Heritage Program files for the Site (NYSDEC, 2010).

The National Historic Preservation Act addresses potential impacts to properties that are listed in the National Register of Historic Places, or ones that are eligible for such a listing. No historic places are located on or near the Site. Therefore, the non-time-critical removal action is not expected to have any impact on these potential resources.

4.5.1.2.3 Action-Specific ARARs

Comprehensive Environmental Response, Liability, and Compensation Act, 42 U.S.C. §9601-9675, as amended, specifically §121, states that the selected remedial alternative must attain a cleanup level that is protective of human health and the environment. The extent to which each of the response alternatives for the Site complies with this requirement will be assessed during the individual and comparative evaluation of alternatives.

Resource Conservation and Recovery Act, 42 U.S.C. §s 6901 *et seq*. and the New York State Hazardous Waste Regulations deal with the treatment and disposal methods of all hazardous wastes. The wastes from the Site, if there are any, must be in handled accordance with the federal hazardous waste regulations (40 CFR Parts 260-268 and 761) promulgated under RCRA, as well as New York State Hazardous Waste Regulations (6 NYCRR Parts 370-376). Determination of the presence and appropriate waste code for any hazardous wastes at the Site or residuals from the treatment of such wastes would be made in accordance with these regulations.

Soils or wastes which are deemed hazardous under RCRA would need to be treated/disposed of at a RCRA Subtitle C facility. Soils or wastes which do not have hazardous characteristics could be treated/disposed of at a RCRA Subtitle D facility (i.e., municipal landfill). Soils or wastes which are deemed hazardous deemed hazardous under RCRA left in place, would need to be capped and maintained in accordance with 40 CFR Part 264.310 landfill closure and post-closure care requirements.

The Occupational Safety and Health Administration has promulgated permissible exposure limits (PEL) for a variety of contaminants in the air (29 CFR 1910, Subpart Z). The PELs are based on time-weighted average (TWA) concentrations to which workers may be exposed over an 8-hr exposure period without adverse health effects. The PELs and TWAs are intended for adult workers exposed in an occupational setting, and are not directly applicable to CERCLA Sites. The PELs and TWAs may be used as guidance values to determine whether long-term exposures to contaminants in air may pose a human health risk.

4.5.1.2.4 To Be Considered

Chemical-specific TBCs for the COPCs at the Site are discussed below.

NYSDEC provides a basis and procedure to determine soil cleanup levels under NYSDEC Title 6, Part 375 RUSCOs for commercial soils and protection of groundwater (NYSDEC, 2006). Attainment of these soil cleanup objectives will, eliminate all significant threats to human health and/or the environment posed by the inactive hazardous waste site.

EPA Region 3 and Region 9 (respectively) have established risk-based concentrations (RBC) or preliminary remediation goals (PRG) for many organic as well as inorganic contaminants found at CERCLA Sites. These RBCs or PRGs could be used as action or cleanup levels to address the COPCs found at the Jewett White Lead Company Site.

EPA's *Presumptive Remedy Guidance for Metals-in-Soil Sites* (OSWER 9355.0-72, September 1999) identifies a presumptive remedy for metals-in-soil sites, and summarizes technical factors that should be considered when selecting a presumptive remedy for these sites.

The Clean Air Act (CAA) (42 U.S.C. §7401 *et. seq.*) passed in 1977, governs air emissions resulting from remedial actions at CERCLA Sites. National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50) have been promulgated under the CAA for six criteria pollutants, including airborne particulates. NAAQS standards for lead have been promulgated at 1.5 micrograms per cubic meter averaged over a calendar quarter. To the extent that response actions undertaken at the Site emit regulated air contaminants, the CAA could be considered.

The National Institute for Occupational Safety and Health (NIOSH) has developed concentrations for contaminants in the air that are immediately dangerous to life or health (IDLH) for individuals in occupational settings. The IDLH is the maximum concentration, in the event of respirator failure, that could be tolerated for 30 minutes without experiencing any escape-impairing or irreversible health effects. The IDLHs are appropriate only for subchronic exposures to noncarcinogenic compounds or effects of compounds in air. These values are not directly applicable to CERCLA Sites; however, they may provide guidance concerning the upper bound of safe inhalation exposures to contaminants for workers on the Site. NIOSH also has recommended exposure limits (REL) for each contaminant of concern. An REL is generally a time-weighted average based on the toxicological and industrial hygiene data.

American Conference of Governmental Industrial Hygienists has developed threshold limit values (TLV) that are updated every year. The TLV is a time-weighted average concentration under which most people can work consistently for eight hours a day, day after day, and experience no harmful effects.

Action-Specific TBCs for the Site***:*** None identified

Location-Specific TBCs for the Site: None identified

4.5.1.3 Long-Term Effectiveness and Permanence

This criterion involves the evaluation of the extent and effectiveness of the controls that may be required to manage the risk posed by treatment residuals and/or untreated wastes at the Site. This criterion also considers the adequacy and reliability of controls and addresses the need for Post-Removal Site Control.

4.5.1.4 Reduction of Toxicity, Mobility, and Volume through Treatment

This criterion includes evaluating the anticipated performance of specific treatment technologies. This evaluation addresses the statutory preference for selecting response actions that employ treatment technologies to permanently and significantly reduce toxicity, mobility, or volume of wastes. Factors that will be considered, as appropriate, include the following:

- The treatment processes the alternatives employ and the materials they will treat.
- The amount of hazardous materials to be destroyed or treated.
- The degree of reduction expected in toxicity, mobility, or volume.
- The degree to which the treatment would be irreversible.
- The type and quantity of residuals that would remain after treatment.
- Whether the alternative would satisfy the preference for treatment.

4.5.1.5 Short-Term Effectiveness

This criterion examines the effectiveness of alternatives in protecting public health and the environment during the construction and implementation period until the RAOs have been met. The following factors will be considered:

- Potential for short-term risks to the affected community as a result of the response action.

- Potential impacts on workers during the response action, and the effectiveness and reliability of protective measures that would be taken.

- Potential adverse environmental impacts of the response action, and the effectiveness and reliability of protective measures that would be taken.

- Time until protection is achieved.

4.5.2 Implementability

4.5.2.1 Technical and Administrative Feasibility

The feasibility of implementing the response alternatives will be assessed by considering the following factors:

- Technical feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology, the reliability of the technology, ease of undertaking additional response actions, the ability to monitor the effectiveness of the remedy, and the extent to which the removal action contributes to the efficient performance of any long-term remedial action.

- Administrative feasibility, including activities needed to coordinate with other offices and agencies, the ability to obtain necessary approvals and permits from other agencies (for off-site actions), and statutory limits on removal actions.

- Availability of services and materials, including the availability of adequate on or off-site treatment, storage capacity, and disposal capacity and services. The availability of necessary equipment and specialists, and provisions to ensure any necessary additional resources; and the availability of prospective technologies for full-scale application.

4.5.3 Cost

The costs that will be assessed include the following:

- Capital costs, including both indirect and direct costs.
- Post-removal Site control costs, which include annual operation and maintenance (O&M), monitoring, and residual disposal costs.

Present-worth costs, which include the capital costs plus the present value of 5 years or more of post-removal site control costs (calculated at a 7 percent discount rate).

4.6 COMPARATIVE ANALYSIS OF ALTERNATIVES AND RECOMMENDED REMOVAL ACTION ALTERNATIVE

A description of each response action alternative, including a summary of the effectiveness, implementability, and cost for each of the alternatives, is presented in this section.

4.6.1 Alternative 1: No Action

The Superfund program requires that the "no-action" alternative be considered as a baseline for comparison with the other alternatives. Alternative 1 does not include any remedial measures to address the contaminated media. This alternative would; however, include the implementation of a public awareness program to ensure that the nearby residents are familiar with the threats posed by the contamination located on the Site, and would include the cost of implementing land-use restrictions.

4.6.1.1 Effectiveness

4.6.1.1.1 Overall Protection of Human Health and the Environment

Alternative 1 would not be protective of human health and the environment, since it would not actively address the potential human health and ecological risks posed by the contaminated soils, and would not minimize the migration of hazardous constituents to area soils, sediment, surface water, and groundwater.

4.6.1.1.2 Compliance with ARARs

Since the contaminated soils would not be addressed under Alternative 1, this alternative would not comply with all pertinent ARARs.

4.6.1.1.3 Long-Term Effectiveness and Permanence

Alternative 1 involves no controls and would not be effective in permanently minimizing the migration of hazardous constituents to area soils, sediment, surface water, and groundwater.

4.6.1.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 1 would not result in the reduction of the toxicity, mobility, and volume of contaminants in site soils. Alternative 1 does not meet the statutory preference for selecting response actions that employ treatment technologies to permanently and significantly reduce toxicity, mobility, or volume of wastes.

4.6.1.1.5 Short-Term Effectiveness

Since this alternative does not include any physical construction measures in any areas of contamination, it would not present a risk to the community or on-site workers as a result of its implementation.

4.6.1.2 Implementability

There are no construction-related considerations associated with the no action alternative.

4.6.1.2.1 Cost

There are no capital or transportation and disposal costs associated with the no-action alternative. The estimated indirect costs are presented below. However, a public site information repository would be established for the local residents and other interested parties in the community. A detailed cost summary is presented in Table E-1 of Appendix E.

Capital Cost	Transportation and Disposal Costs	Operation and Maintenance Costs	Indirect Costs	Total Cost
$0	$0	$0	$10,050	$10,050

4.6.2 Alternative 2: Soil Excavation, Off-Site Treatment/Disposal

Under this alternative, the contaminated soils would be excavated and transported off-site for treatment/disposal. The excavated areas would be backfilled with clean fill and revegetated.

4.6.2.1 Effectiveness

4.6.2.1.1 Overall Protection of Human Health and the Environment

The potential for future migration of hazardous substances from the Site would be completely eliminated by permanently removing the contaminated soils under this alternative. The remedy is protective of human health and the environment because the risk of incidental contact with waste by humans and ecological receptors would be significantly reduced by removing the contaminated soil.

4.6.2.1.2 Compliance with ARARs

As discussed in Subsection 4.1, EPA in consultation with NYSDEC has set site-specific Screening Levels for the COPCs detected at the Site. Those soils exceeding site-specific Screening Levels would be removed from the Site under this alternative.

Soils exceeding the above site-specific Screening Levels would be excavated. Samples would be collected from the walls and base of the excavation and analyzed for metals. If analytical results of post-excavation samples indicate that residual concentrations exceed the action level, additional soil would be excavated, followed by additional confirmatory sampling. The process would be repeated until analytical results reveal that all the soils containing metals concentrations greater than the minimum action level have been removed.

All excavated soils would be subjected to RCRA hazardous waste characteristic testing. Those soils that pass the RCRA characteristic testing would be sent off-site for disposal at a RCRA Subtitle D facility (i.e., a municipal landfill). Those soils that do not pass the RCRA characteristic testing would be sent off-site for treatment/disposal at a RCRA Subtitle C facility.

Alternative 2 would be subject to New York State and federal regulations regarding transportation and off-site treatment/disposal of wastes would require compliance with fugitive dust emission regulations.

4.6.2.1.3 Long-Term Effectiveness and Permanence

Excavation and off-site disposal of the contaminated soil would provide long-term protection of human health and the environment and the migration of hazardous constituents to area soils, sediment, surface water, and groundwater.

4.6.2.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Under this alternative, contaminants would be removed from the Site for treatment/disposal, thereby reducing their toxicity, mobility, and volume. It is not known to what extent the excavated soils would require treatment prior to disposal under this alternative.

4.6.2.1.5 Short-Term Effectiveness

This alternative would involve excavating, moving, and placing waste. While this would present some risk to on-site workers through dermal contact and inhalation, these exposures could be minimized by utilizing proper protective equipment and appropriate engineering controls. The vehicular traffic associated with the off-site transport of contaminated soils could impact the local roadway system and nearby residents through increased noise levels. Under this alternative, there is a potential for increased stormwater runoff and erosion during excavation activities that would have to be properly managed to prevent excessive water and waste material loading. Appropriate measures would have to be taken during excavation activities to prevent the transport of fugitive dust.

4.6.2.2 Implementability

It is estimated that this alternative would require approximately 15 days for soil excavation and 15 days for soil backfilling, and would take 2 months to implement.

The actions under this alternative would use proven earthmoving equipment and techniques and established administrative procedures. In addition, sufficient facilities are available for treatment and disposal of the excavated soils. Therefore, this alternative would be easily implemented.

4.6.2.3 Cost

The estimated capital, transportation and disposal costs, and indirect costs are presented below. A detailed cost summary is presented in Table E-2 of Appendix E.

Capital Cost	Transportation and Disposal Costs	Operation and Maintenance Costs	Indirect Costs	Total Cost
$171,146	$626,787	$14,509	$111,711	$924,153

4.6.3 Alternative 3: Capping

This alternative would involve the excavation and consolidation of contaminated soils under a soil cap cover. The removal of the upper 2 ft of soil at the site would be required to maintain existing grade and accommodate the 2-ft cap. Soils with the highest lead concentrations (i.e., those expected to exceed TCLP criteria), approximately 2,400 cyd, will be removed and the remaining soils would be regraded. The Site would then be landscaped, fenced, and posted. This alternative would also include implementing long-term groundwater monitoring activities, and the implementation of institutional controls necessary to maintain the integrity of the soil cap at the Site.

4.6.3.1 Effectiveness

4.6.3.1.1 Overall Protection of Public Health and the Environment

Under this alternative, the potential for future migration of contaminants would be reduced by containing the contaminated soils. The remedy is protective of human health and the environment because the risk of incidental contact with waste by humans and ecological receptors would be significantly reduced by containing the contaminated soil. Capping would also prevent surface contaminant migration from the Site.

4.6.3.1.2 Compliance with ARARs

As discussed in Subsection 4.1, EPA in consultation with NYSDEC has set site-specific Screening Levels for the COPCs detected at the Site. Those soils exceeding site-specific Screening Levels would be contained by a cap under this alternative. This alternative would leave soils in place beneath the cap that exceed NYSDEC Part 375 RUSCOs.

This alternative would also require compliance with fugitive dust emission regulations.

The excavated soils or wastes transported off-site under this alternative would be subject to New York State and federal regulations regarding transportation and off-site treatment/disposal of wastes.

4.6.3.1.3 Long-Term Effectiveness and Permanence

Capping would provide a high degree of long-term protection of human health and the environment. The vegetated soil cover would help protect the cap against erosion and the fencing, signs, and land-use restrictions would ensure the integrity of the containment system. The effectiveness and permanence of this remedy would be entirely dependent upon the effective maintenance of the multilayer cap and access controls and the proper enforcement of the land-use controls.

4.6.3.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

With the exception of any excavated contaminated soils that require off-site treatment/disposal, any reduction of toxicity, mobility, or volume would not be through treatment. The mobility of the contaminated soils would be reduced under this alternative through containment, not treatment; there would be no reduction of the toxicity. The volume would be reduced under this alternative through removal, not treatment

4.6.3.1.5 Short-Term Effectiveness

This alternative would involve excavating, moving, placing, and regrading waste. While these actions present some potential risk to on-site workers through dermal contact and inhalation, these exposures can be minimized by utilizing proper protective equipment and engineering controls. The vehicle traffic associated with cap construction could impact the local roadway system and nearby residents through increased noise levels. Under this alternative, there is a potential for increased stormwater runoff and erosion during excavation activities that would have to be properly managed to prevent excessive water and waste material loading. Engineering controls would be taken during excavation activities to prevent transport of fugitive dust.

It is estimated that this alternative would require one month to implement.

4.6.3.2 Implementability

It is estimated that this alternative would require approximately 6 days for soil excavation, 6 days for soil backfilling and liner construction and would take 1.5 months to implement.

Capping involves processes that can be easily implemented. Labor, equipment, and materials for this alternative are conventional and readily available. Numerous contractors, using conventional techniques and equipment, could install the soil cover. Equipment, services, and materials for this work are readily available. The actions under this alternative would require the implementation of institutional controls that may be administratively difficult, since construction of the cap would require the imposition of an environmental easement. In addition, the current

2000-2012 Richmond Terrace Property owner would be required to maintain a Site Management Plan to ensure the institutional and engineering controls remain in place and are effective..

4.6.3.3 Cost

The estimated capital, transportation and disposal costs, and indirect costs are presented below. A detailed cost summary is presented in Table E-3 of Appendix E.

Capital Cost	Transportation and Disposal Costs	Operation and Maintenance Costs	Indirect Costs	Total Cost
$119,450	$354,618	$129,583	$57,147	$404,907

4.6.4 Alternative 4: Paving

This alternative would involve the consolidation of contaminated soils under an asphalt cover. The removal of the upper 6 inches of soil at the site would be required to maintain existing grade and accommodate the pavement. Soils with the highest lead concentrations (i.e., those expected to exceed TCLP criteria), approximately 500 cyd, will be removed and the remaining soils would be regraded. The Site would then be fenced and posted. This alternative would also include implementing long-term groundwater monitoring activities, and the implementation of institutional controls to maintain the asphalt cover at the Site.

4.6.4.1 Effectiveness

4.6.4.1.1 Overall Protection of Public Health and the Environment

Under this alternative, the potential for future migration of contaminants would be reduced by containing the contaminated soils. The remedy is protective of human health and the environment because the risk of incidental contact with waste by humans and ecological receptors would be significantly reduced by containing the contaminated soil; however, the potential exists for direct contact with the lead-contaminated soils should the cap be disturbed. Paving would also prevent surface contaminant migration from the Site.

4.6.4.1.2 Compliance with ARARs

As discussed in Subsection 4.1, EPA in consultation with NYSDEC has set site-specific Screening Levels for the COPCs detected at the Site. Those soils exceeding site-specific Screening Levels would be contained by a cap under this alternative. This alternative would leave soils in place beneath the cap that exceed NYSDEC Part 375 RUSCOs.

This alternative would also require compliance with fugitive dust emission regulations.

The excavated soils or wastes transported off-site under this alternative would be subject to New York State and federal regulations regarding transportation and off-site treatment/disposal of wastes.

4.6.4.1.3 Long-Term Effectiveness and Permanence

Paving would provide a high degree of long-term protection of human health and the environment. The asphalt pavement cover would be resistant to erosion and the fencing, signs, and institutional controls would ensure the integrity of the containment system. The effectiveness and permanence of this remedy would be entirely dependent upon the effective maintenance of the asphalt pavement cap and access controls and the proper enforcement of the land-use controls.

4.6.4.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

With the exception of any excavated contaminated soils that require off-site treatment/disposal, any reduction of toxicity, mobility, or volume would not be through treatment. The mobility of the contaminated soils would be reduced under this alternative through containment, not treatment; there would be no reduction of the toxicity. The volume would be reduced under this alternative through removal, not treatment.

4.6.4.1.5 Short-Term Effectiveness

This alternative would involve excavating, moving, placing, and regrading waste. While these actions present some potential risk to on-site workers through dermal contact and inhalation, these exposures can be minimized by utilizing proper protective equipment and engineering controls. The vehicle traffic associated with paving could impact the local roadway system and nearby residents through increased noise levels. Under this alternative, there is a potential for increased stormwater runoff and erosion during and following excavation activities that would have to be properly managed to prevent excessive water and waste material loading. Engineering controls would be taken during excavation activities to prevent transport of fugitive dust.

It is estimated that this alternative would require one month to implement.

4.6.4.2 Implementability

It is estimated that this alternative would require approximately 5 days for soil excavation and grading, 3 days for paving and would take 1 month to implement.

Paving involves processes that can be easily implemented. Labor, equipment, and materials for this alternative are conventional and readily available. Numerous contractors, using conventional techniques and equipment, could install the pavement. Equipment, services, and materials for this work are readily available. The actions under this alternative would require the implementation of institutional controls that may be administratively difficult, since construction of the asphalt cap would require the imposition of an environmental easement. In addition, the current property owner would be required to maintain a Site Management Plan to ensure the institutional and engineering controls remain in place and are effective.

4.6.4.3 Cost

The estimated capital, transportation and disposal costs, and indirect costs are presented below. A detailed cost summary is presented in Table E-4 of Appendix E.

Capital Cost	Transportation and Disposal Costs	Operation and Maintenance Costs	Indirect Costs	Total Cost
$139,500	$73,879	$129,583	$28,472	$354,711

4.6.5 Alternative: Immobilization

This alternative would involve the immobilization of contaminants in the top 2 ft of contaminated soil via in-situ treatment with a concrete additive which would immobilize the lead in the soil, preventing leaching to surface water and groundwater, as well as preventing contact with deeper, untreated, lead-impacted soils.. No further cover will be required. The Site would then be fenced and posted. This alternative would also include implementing long-term groundwater monitoring activities, and the implementation of institutional controls at the Site.

4.6.5.1 Effectiveness

4.6.5.1.1 Overall Protection of Public Health and the Environment

Under this alternative, the potential for future migration of contaminants would be reduced by immobilizing the upper 2 ft of contaminated soils, and providing an impermeable barrier for the remaining contaminated soils. The remedy is protective of human health and the environment because the risk of incidental contact with waste by humans and ecological receptors would be significantly reduced by immobilizing/containing the contaminated soil. Immobilization would also prevent surface contaminant migration from the Site.

4.6.5.1.2 Compliance with ARARs

As discussed in Subsection 4.1, EPA in consultation with NYSDEC has set site-specific Screening Levels for the COPCs detected at the Site. Those soils exceeding site-specific Screening Levels would be contained by a cap under this alternative. This alternative would leave soils in place beneath the cap that exceed NYSDEC Part 375 RUSCOs.

This alternative would also require compliance with fugitive dust emission regulations.

4.6.5.1.3 Long-Term Effectiveness and Permanence

Immobilization would provide a high degree of long-term protection of human health and the environment. The treated soil would be resistant against erosion and the fencing, signs, and land-use restrictions would ensure the integrity of the containment system. The effectiveness and permanence of this remedy would be entirely dependent upon the effective maintenance of the treated soil layer and access controls and the proper enforcement of the institutional controls.

4.6.5.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

A reduction of toxicity and mobility will be achieved though treatment. The volume of the contaminated soils would not be reduced under this alternative.

4.6.5.1.5 Short-Term Effectiveness

This alternative would involve treating waste in-situ. While these actions present some potential risk to on-site workers through dermal contact and inhalation, these exposures can be minimized by utilizing proper protective equipment and engineering controls. The vehicle traffic associated with in-situ treatment could impact the local roadway system and nearby residents through increased noise levels. Under this alternative, there is a potential for increased stormwater runoff and erosion during and following treatment activities that would have to be properly managed to prevent excessive water and waste material loading. Engineering controls would be taken during excavation activities to prevent transport of fugitive dust.

It is estimated that this alternative would require two months to implement.

4.6.5.2 Implementability

It is estimated that this alternative would require approximately 6 days for soil preparation and 6 days for soil in-situ treatment, and would take 1.5 months to implement.

Immobilization involves processes that can be easily implemented. Labor, equipment, and materials for this alternative are conventional and readily available. A limited number of contractors, using specialized techniques and equipment, could perform the in-situ soil treatment. Equipment, services, and materials for this work are readily available. The actions under this alternative would require the implementation of institutional controls that may be administratively difficult, since construction of the concrete cap would require the imposition of an environmental easement. In addition, the current 2000-2012 Richmond Terrace Property owner would be required to maintain a Site Management Plan to ensure the institutional and engineering controls remain in place and are effective.

4.6.5.3 Cost

The estimated capital, transportation and disposal costs, and indirect costs are presented below. A detailed cost summary is presented in Table E-5 of Appendix E.

Capital Cost	Transportation and Disposal Costs	Operation and Maintenance Costs	Indirect Costs	Total Cost
$145,455	$0	$129,583	$21,000	$279,315

4.7 COMPARATIVE ANALYSIS OF ALTERNATIVES

4.7.1 Overall Protection of Public Health and the Environment

Alternative 1 (no action) would not be protective of human health and the environment since it does not actively address the potential human health and ecological risks posed by the contaminated soils.

Alternative 2 (excavation and off-site treatment/disposal) would be the most protective alternative, since the risk of incidental contact with waste by humans and ecological receptors and the potential for contaminant migration from the Site would be eliminated by permanently removing the contaminated soils, and would require no ongoing institutional controls.

Alternative 3 (capping), Alternative 4 (paving), and Alternative 5 (immobilization) would be protective of human health and the environment. These alternatives reduce the risk of incidental contact with waste by humans and ecological receptors by containing the contaminated soil. Capping, paving, and immobilization would also prevent surface contaminant migration from the Site and reduce migration to the groundwater. However, these alternatives would require ongoing institutional controls, and a Site Management Plan.

4.7.2 Compliance with ARARs

Since the contaminated soils would not be addressed under Alternative 1 (no action), this alternative would not comply with the soil cleanup objectives.

Alternative 2 (excavation and off-site treatment/disposal) will comply with the ARARS. EPA, in consultation with NYSDEC has set site-specific Screening Levels for the COPCs detected at the Site, which do not necessarily meet NYSDEC Part 375 RUSCOs. This alternative would remove soils impacted by lead, the main COPC to levels below NYSDEC Part 375 RUSCOs for commercial sites, but may leave soils containing other constituents in excess of their NYSDEC Part 375 RUSCOs.

All excavated soils would be subjected to RCRA hazardous waste characteristic testing. Those soils that pass the RCRA characteristic testing would be sent off-site for disposal at a RCRA Subtitle D facility. Those soils that do not pass the RCRA characteristic testing would be sent off-site for treatment/disposal at a RCRA Subtitle C facility.

Alternative 2 would be subject to New York State and federal regulations regarding transportation and off-site treatment/disposal of wastes and would require compliance with fugitive dust emission regulations.

Alternative 3 (capping) and Alternative 4 (paving) will also comply with ARARs by requiring the containment/capping of all those soils and waste material that exceed their respective site-specific Screening Levels.

All excavated soils would be subjected to RCRA hazardous waste characteristic testing. Those soils that pass the RCRA characteristic testing would be consolidated with the contaminated soil that will be capped. Those soils that do not pass the RCRA characteristic testing would be sent off-site for treatment/disposal at a RCRA subtitle C facility.

These alternatives would also require compliance with fugitive dust emission regulations. Any excavated soils or wastes that are transported off-site under these alternatives would be subject to New York State and federal regulations regarding transportation and off-site treatment/disposal of wastes.

Alternative 5 (immobilization) will also comply with ARARs by requiring the treatment/containment of all those soils and waste material that exceed their respective site-specific Screening Levels. All soils within the top 2 ft will be immobilized, and no soils would be subjected to RCRA hazardous waste characteristic testing, as this alternative calls for no soil to be removed from the Site. This alternative would require compliance with fugitive dust emission regulations.

4.7.3 Long-Term Effectiveness and Permanence

Alternative 1 (no action) would involve no controls and, therefore, would not be effective in preventing exposure to contaminants on-site or the migration of contaminants off-site.

Alternative 2 (excavation and off-site treatment/disposal) would provide a high degree of long-term protection of human health and the environment in that it would both eliminate the possibility of exposure to contaminants on-site and the potential for contaminants migrating off-site. The removal of the contaminated soils under Alternative 2 would be effective and permanent and require no institutional controls.

Alternative 3 (capping), Alternative 4 (paving), and Alternative 5 (immobilization) would provide a high degree of long-term protection of human health and the environment in that they would also both eliminate the possibility of exposure to contaminants on-site and the potential for contaminants migrating off-site. The vegetated soil cover under Alternative 3 would help protect the cap against erosion, while the asphalt cap under Alternative 4 and the immobilized soil cap under Alternative 5 would require continuing maintenance, and the fencing, signs, and land-use restrictions would ensure the integrity of each of the containment systems. The effectiveness and permanence of Alternatives 3, 4, and 5 would be entirely dependent upon the effective maintenance of the containment and access controls and the proper enforcement of the institutional controls.

4.7.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 1 (no action) would provide no reduction in toxicity, mobility, or volume.

Under Alternative 2 (excavation and off-site treatment/disposal), contaminants would be removed from the Site for treatment/disposal, thereby reducing their toxicity, mobility, and volume. It is not known to what extent the excavated soils would require treatment prior to disposal under this alternative.

Under Alternative 3 (capping) and Alternative 4 (paving) any reduction of toxicity, mobility, or volume would not be through treatment. These Alternatives would reduce the migration of and potential exposure to contaminated soils and waste materials.

Under Alternative 5 (immobilization), soils within the top 2 ft would be treated to reduce their toxicity. Any reduction of toxicity, mobility, or volume for soils deeper than 2 ft would not be through treatment. This Alternative would reduce the migration of and potential exposure to contaminated soils and waste materials.

4.7.5 Short-Term Effectiveness

Since Alternative 1 (no action) does not include any physical construction measures in any areas of contamination, it would not present a risk to the community as a result of its implementation.

Alternative 2 (excavation and off-site treatment/disposal), Alternative 3 (capping), Alternative 4 (paving), and Alternative 5 (immobilization) would involve excavating, moving, placing, and, in the case of Alternatives 3 and 4, regrading waste. While all of the action alternatives present some risk to on-site workers through dermal contact and inhalation, these exposures can be minimized by utilizing proper protective equipment and engineering controls. The vehicle traffic associated with cap construction and the off-site transport of contaminated soils could impact the local roadway system and nearby residents through increased noise level. Alternative 2 would require the off-site transport of a considerable amount of contaminated soil. Alternatives 3, 4, and 5 would require the delivery of cap construction or treatment materials. Under all of the action alternatives, disturbance of the land during excavation and/or construction activities could affect the surface water hydrology of the Site. There is a potential for increased stormwater runoff and erosion during excavation and construction activities that would have to be properly managed to prevent excessive water and waste material loading. For Alternatives 2, 3, 4, and 5, appropriate measures would have to be taken during excavation activities to prevent transport of fugitive dust and exposure of workers and downgradient receptors to contaminants.

Alternative 1 would require no implementation time. It is estimated that Alternatives 2, 3, 4, and 5 would require 2 to 1.5 months to implement.

4.7.6 Implementability

There are no implementability issues for the No Action, Alternative 1.

Alternative 2 (excavation and off-site treatment/disposal) would use proven earthmoving equipment and techniques, and established administrative procedures, and sufficient facilities are available for treatment and disposal of the excavated soils. Therefore, this alternative would be easily implemented.

Alternative 3 (capping) and Alternative 4 (paving) can be accomplished using technologies known to be reliable and can be readily implemented. Equipment, services and materials for this work are readily available. The actions under this alternative, including implementation of institutional controls, may be administratively difficult, since construction of the cap would require the imposition of an environmental easement. In addition, the current 2000-2012

Richmond Terrace Property owner would be required to maintain a Site Management Plan to ensure the institutional and engineering controls remain in place and are effective.

Alternative 5 (immobilization) can be accomplished using specialized technologies known to be reliable and can be readily implemented. Equipment, services and materials for this work are available, through specialized contractors. The actions under this alternative, including implementation of institutional controls, may be administratively difficult, since construction of the cap would require the imposition of an environmental easement. In addition, the current 2000-2012 Richmond Terrace Property owner would be required to maintain a Site Management Plan to ensure the institutional and engineering controls remain in place and are effective.

4.7.7 Cost

The following is a summary of costs for each of the Alternatives. A detailed cost summary for each alternative is presented in Appendix E.

Alternative	Capital Cost	Transportation and Disposal Costs	Operation and Maintenance Costs	Indirect Cost	Total Cost
Alternative 1	$0	$0	$0	$10,050	$10,050
Alternative 2	$171,146	$626,787	$14,509	$111,711	$924,153
Alternative 3	$119,450	$354,618	$129,583	$57,147	$404,907
Alternative 4	$139,500	$73,879	$129,583	$28,472	$354,711
Alternative 5	$145,455	$0	$129,583	$21,000	$279,315

Alternative 2 has the highest total cost ($924,153) of the alternatives considered, but negligible operation and maintenance costs. Alternative 5 has an average capital cost, no transportation and disposal costs, but is not a permanent solution, and, like Alternatives 3 and 4, has ongoing operation and maintenance costs.

SECTION 5

REFERENCES

5. REFERENCE

Alion Science and Technology, 2011. Streamlined Screening Level Ecological Risk Assessment, Jewett White Lead Site. 4 January.

Benimoff, A.I., and Ohan, A.A., 2003. The Geology of Staten Island. www.library.csi.cuny.edu/dept/as/geo/geo.html 22 December.

http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm November.

McPherson, Julie A. (U.S. Environmental Protection Agency, Region 2), 2011. Streamlined Human Health Risk Assessment, Jewett White Lead Company Site. 4 January.

New York State Department of Environmental Conservation (NYSDEC, 1999). Chapter X, Part 703, Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations, effective date 4 August.

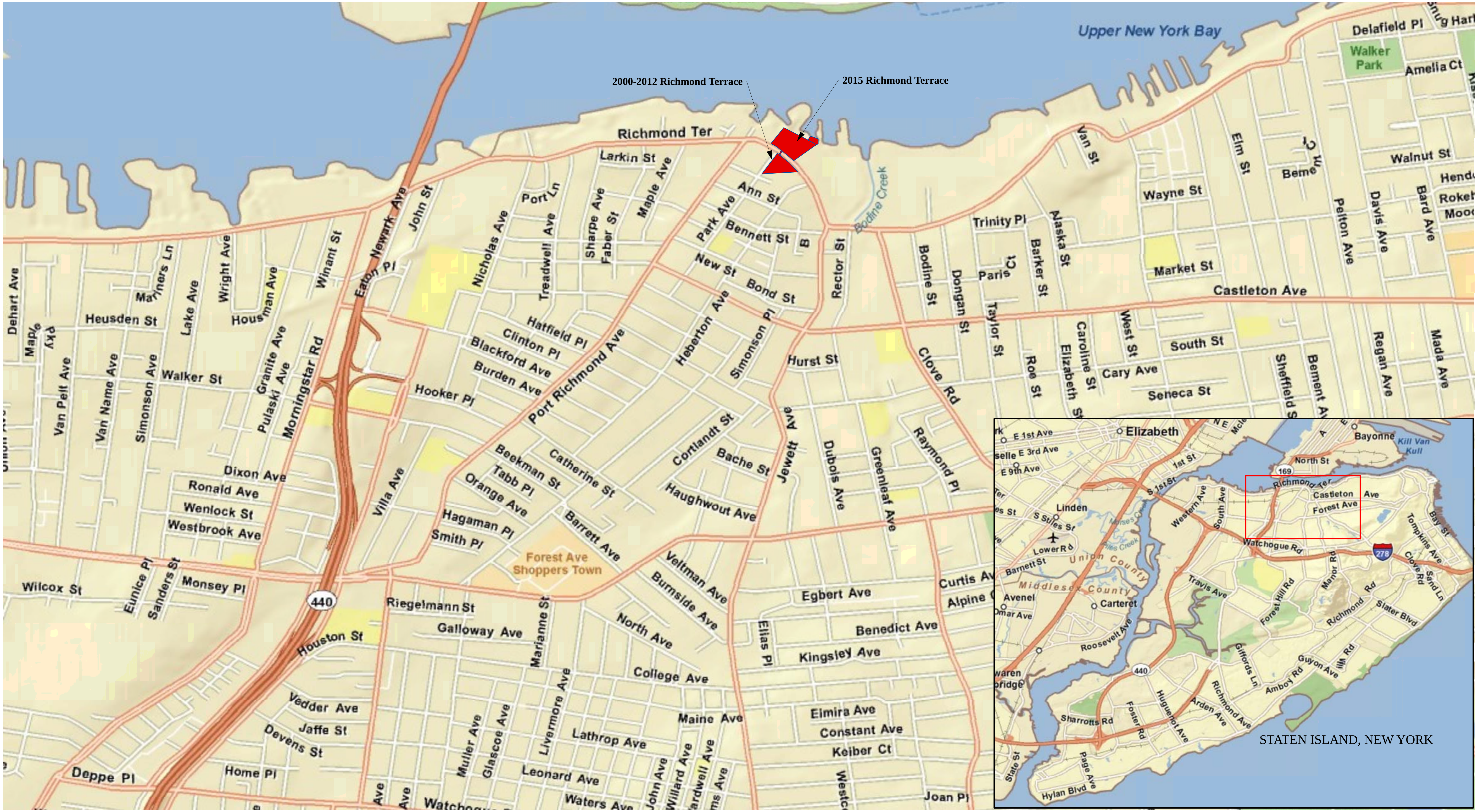
NYSDEC, 2006. Title 6 of the Official Compilation of New York Codes, Rules and Regulations, Part 375, effective date 14 December.

NYSDEC, 2010. Rare Animal and Plants/Natural Communities from Environmental Resources Mapper website http://www.dec.ny.gov/imsmaps/ERM/viewer.htm, accessed 20 December.

Rubin, Eric (Weston Solutions, Inc.), 2010. Electronic Mail RE: Staten Island Site. 7 September.

United States Environmental Protection Agency Regions 3, 6, and 9. (2010). Regional Screening Levels for Chemical Contaminants at Superfund Sites.

FIGURES



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Miles

SOURCES:
ESRI_StreetMap_World_2D: http://services.arcgisonline.com/arcgis/services.

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LEGEND:
🟥 Project Area

N

PROJECT:
JEWETT WHITE LEAD COMPANY
REMOVAL ACTION ALTERNATIVES REPORT

TITLE:

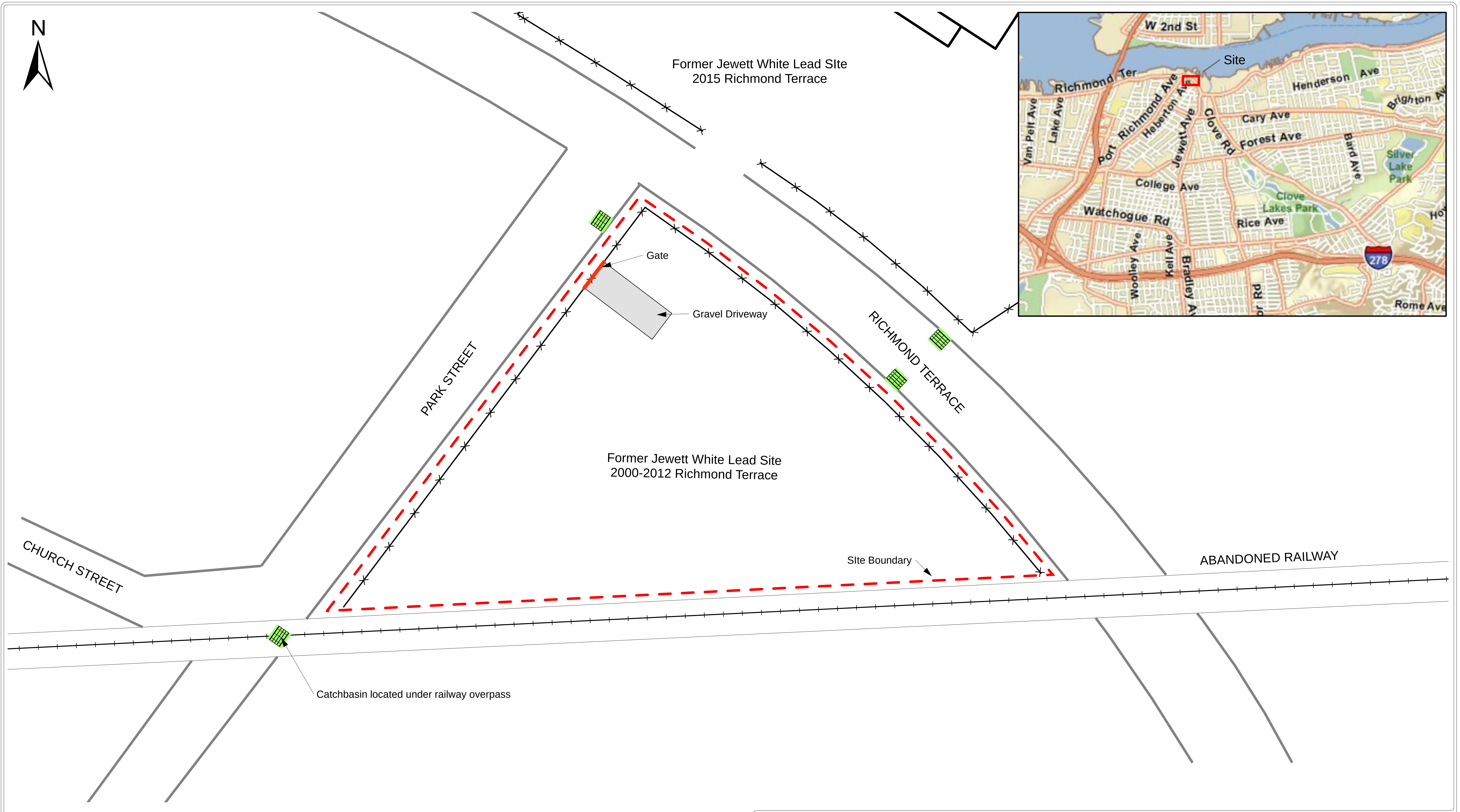
SITE LOCATION MAP
JEWETT WHITE LEAD COMPANY
2015 RICHMOND TERRACE AND
2000-2012 RICHMOND TERRACE
STATEN ISLAND, NEW YORK

CLIENT NAME:
USEPA

WESTON SOLUTIONS SM

DATE:
01/06/2011

FIGURE #:
1-1



0 30 60 120 180 240

Feet

LEGEND:

🟩	Stormwater Catchbasin	—	Building
⬚	Site Boundary	—	Roadway
×—×	Fence	┼—┼	Railroad

TITLE:

SITE MAP
JEWETT WHITE LEAD COMPANY
2000-2012 RICHMOND TERRACE
STATEN ISLAND, NEW YORK

PROJECT: JEWETT WHITE LEAD COMPANY
REMOVAL ACTION ALTERNATIVES REPORT

CLIENT NAME: USEPA

WESTON SOLUTIONS SM

DATE: 01/06/2011

FIGURE #: 1-2

SOURCES:
ESRI_StreetMap_World_2D: http://services.arcgisonline.com/arcgis/services.
Vector map features digitized from aerial imagery, ESRI_Imagery_World_2D: http://services.arcgisonline.com/arcgis/services.

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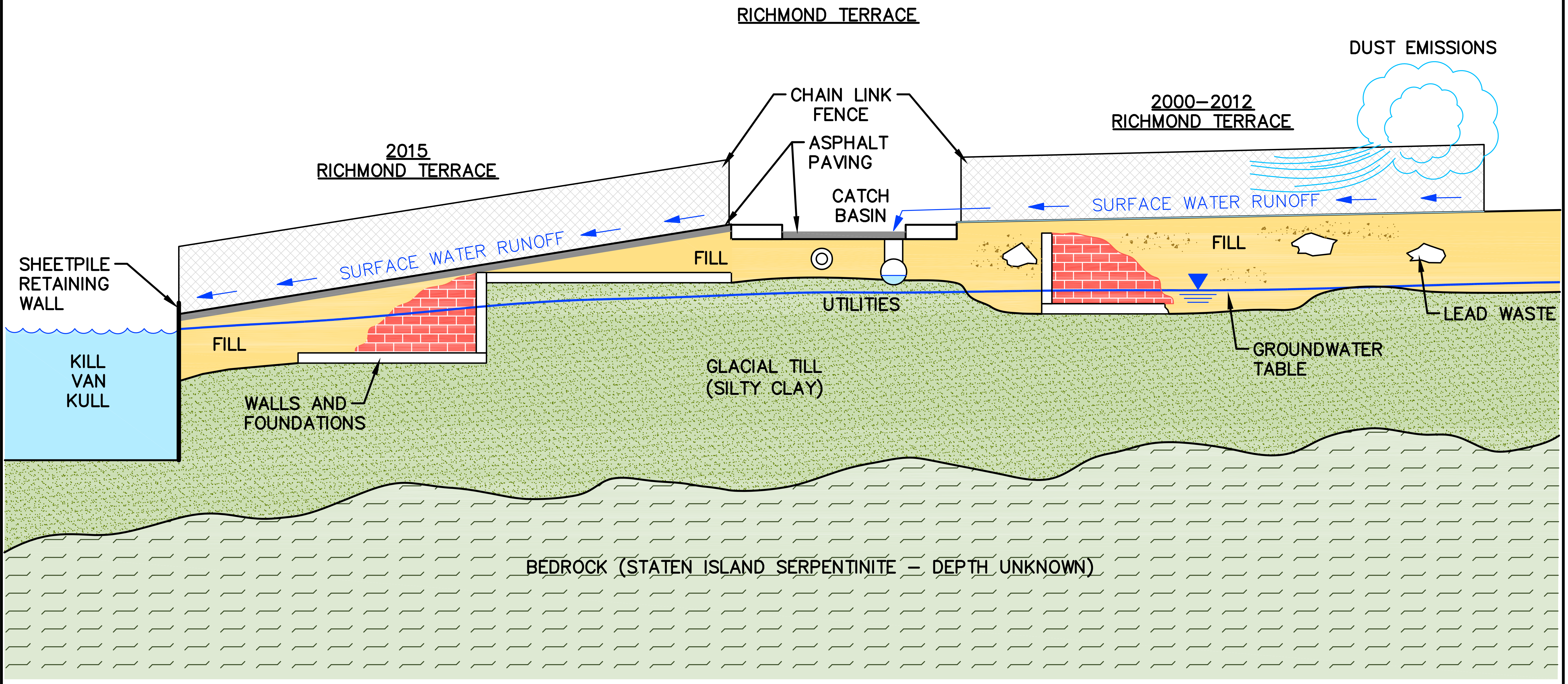


LEGEND

▨ LEAD IMPACTED SOILS

NOT TO SCALE

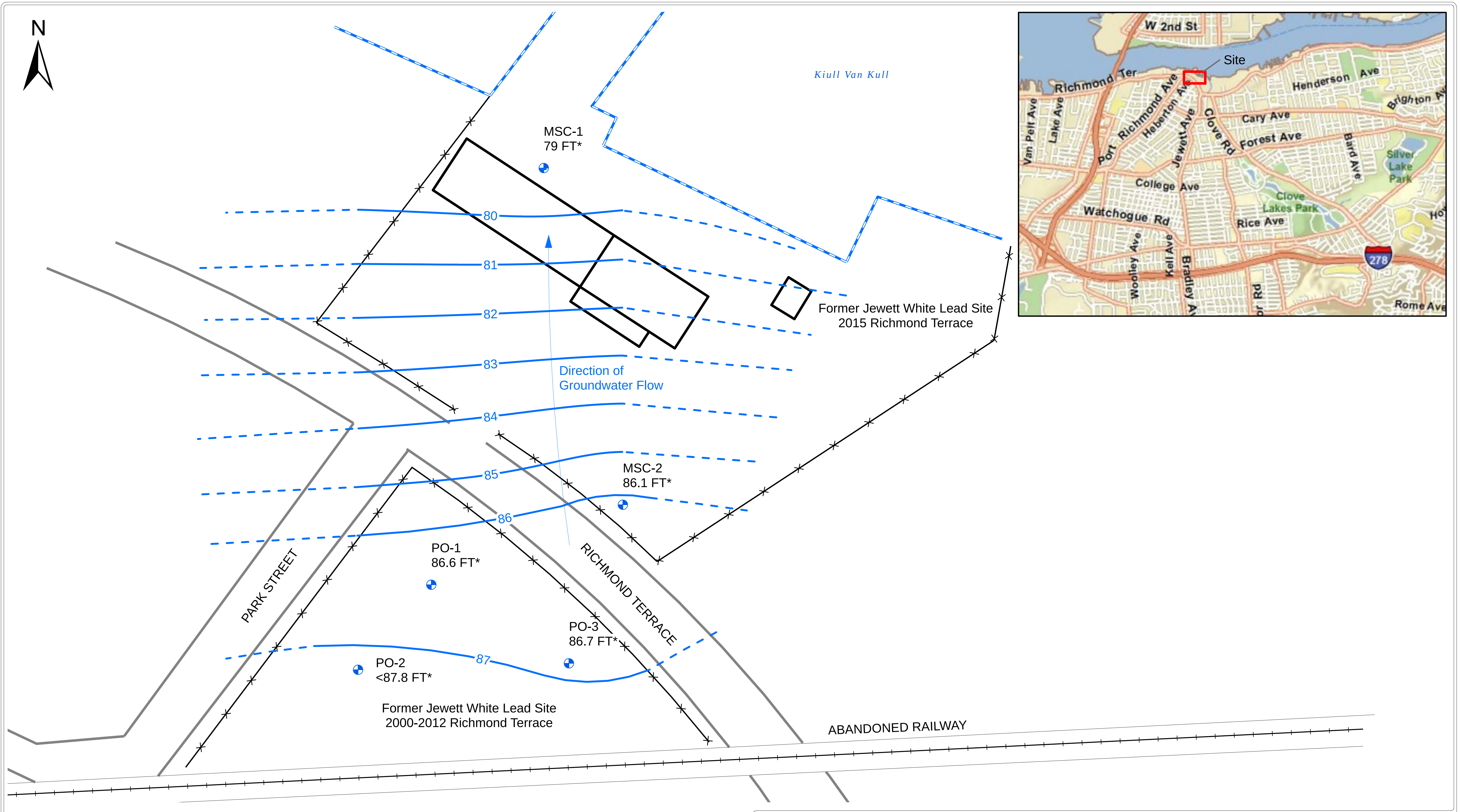
SITE CONCEPTUAL MODEL

JEWETT WHITE LEAD
2000–2012 RICHMOND TERRACE
STATEN ISLAND, NEW YORK

WESTON SOLUTIONS
CONCORD NEW HAMPSHIRE

DRAWN BEG	DATE JAN 2011	DES. ENG.	DATE	W.O. NO. 20401.122.018
CHECKED JS	DATE JAN 2011	SCALE AS SHOWN	REVISION	FIGURE NO. 1–3

M:\Design\DWG\Jewett White Lead Company Site\section.dwg, Layout1, 1/4/2011 3:23:10 PM, girardeb, 1:1



0 40 80 160 240 320

Feet

NOTES:
* Groundwater elevations based on arbitrary reference datum of 100 feet established at monitoring well location PO-2.
PO-2 was a "dry well" when sampled. The ground water elevation depicted (<87.8 FT) represents bottom of the screening interval.

SOURCES:
ESRI_StreetMap_World_2D: http://services.arcgisonline.com/arcgis/services.
Vector map features digitized from aerial imagery, ESRI_Imagery_World_2D: http://services.arcgisonline.com/arcgis/services.

LEGEND:

●	Monitoring Well Location	▬	Building
▬	Groundwater Contour	▬	Roadway
- -	Inferred Groundwater Contour	✕—✕	Fence
- -	Waterfront	—+—	Railroad

PROJECT: JEWETT WHITE LEAD COMPANY
REMOVAL ACTION ALTERNATIVES REPORT

CLIENT NAME: USEPA

TITLE:

GROUNDWATER ELEVATION MAP
JEWETT WHITE LEAD COMPANY
2015 RICHMOND TERRACE AND
2000-2012 RICHMOND TERRACE
STATEN ISLAND, NEW YORK

WESTON SOLUTIONS SM

DATE: 01/06/2011

FIGURE #: 1-4

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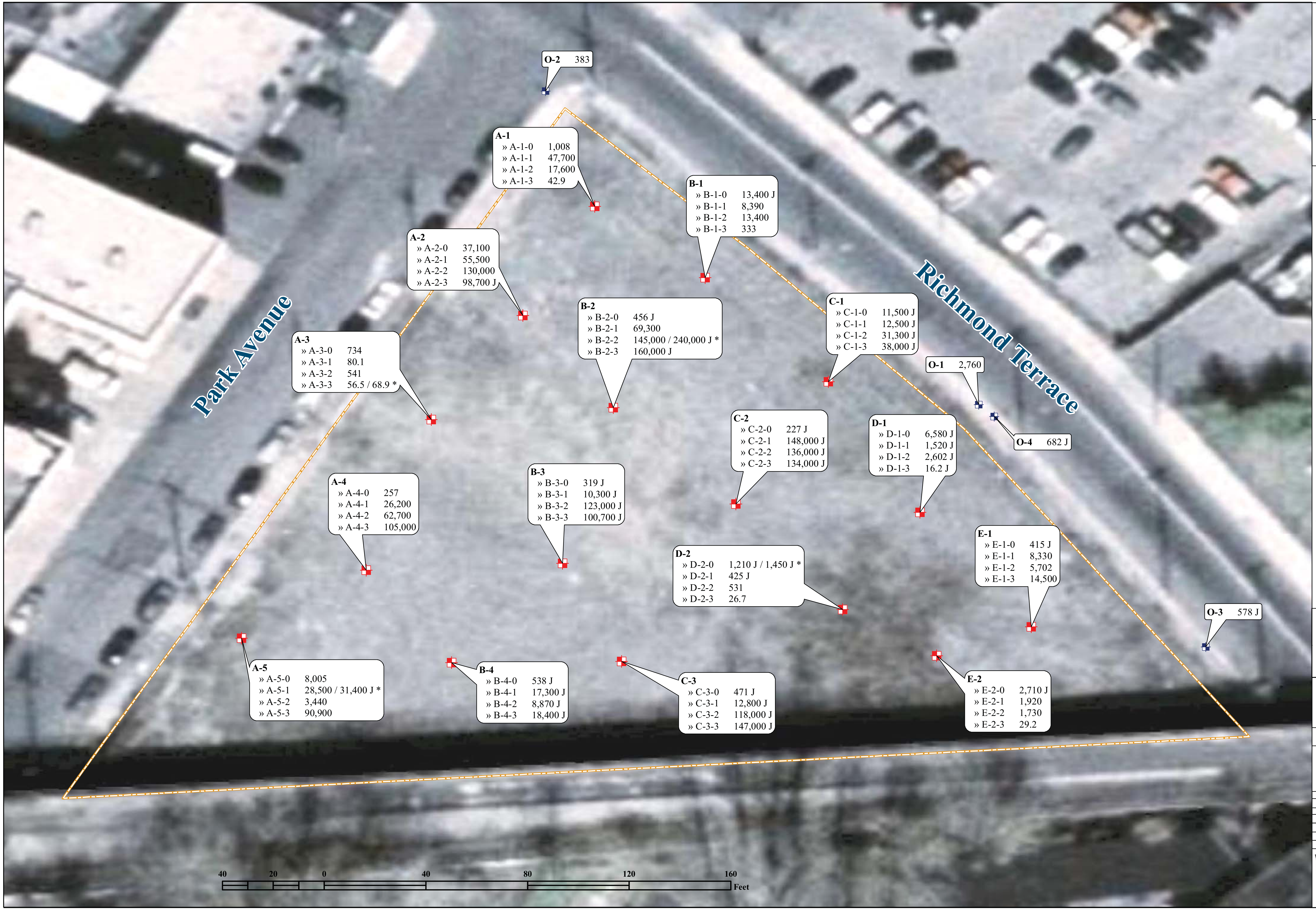


N
W
E
S

SCALE

1:423

LEGEND

🟦 Off-Site Sampling Location

🟥 Test Pit Locations

NOTE(S):
» * Duplicate sample taken at this location.
» All sample results are depicted in mg/Kg.
» Sample format is as follows:

Sample ID	Depth
A-1-0	0 - 3"
A-1-1	1'
A-1-2	2'
A-1-3	3'

Figure 1-5
Sample Location Map
December 2008

JEWETT WHITE LEAD COMPANY SITE
STATEN ISLAND, NEW YORK

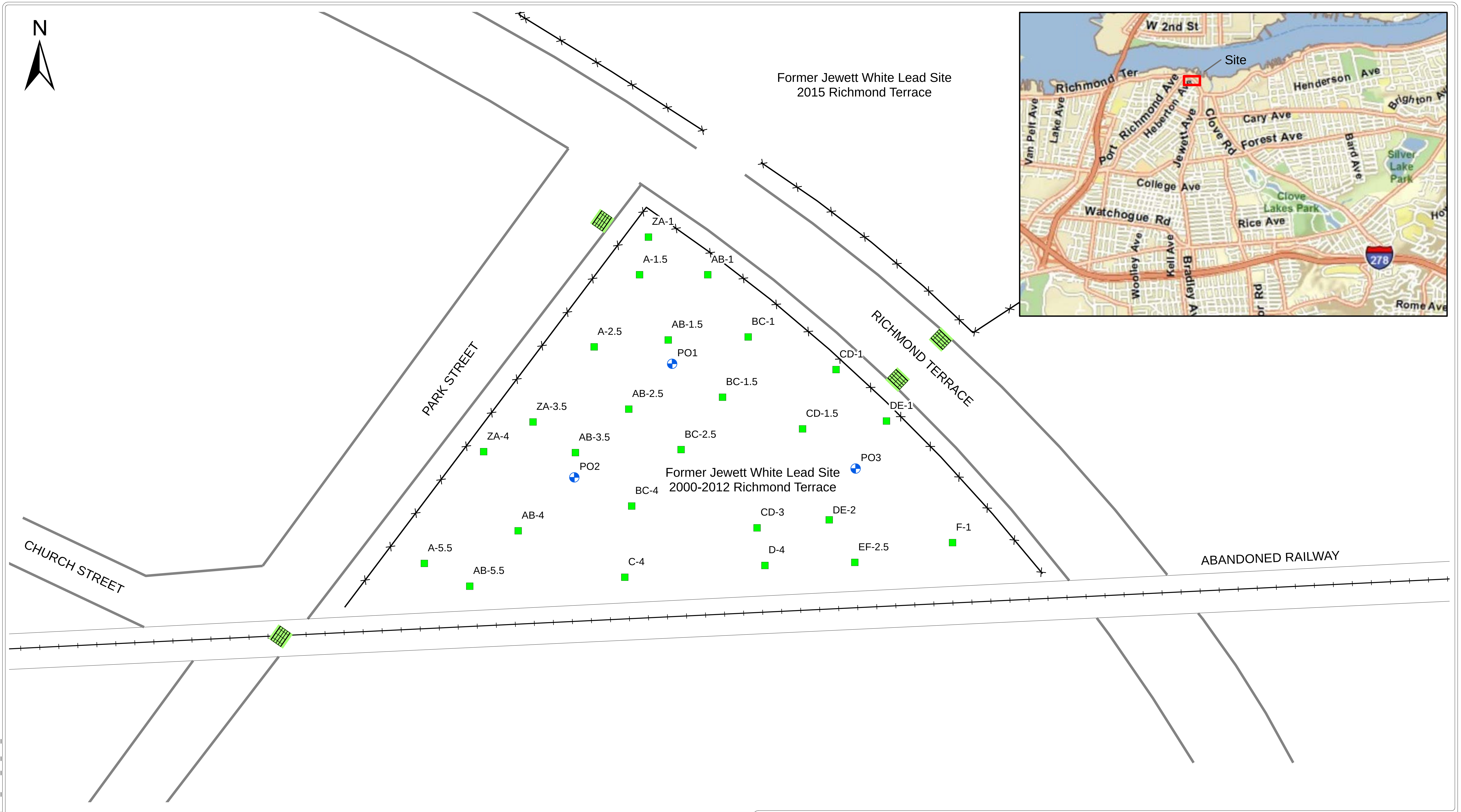
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REMOVAL SUPPORT TEAM 2
CONTRACT # EP-W-06-072

Weston Solutions, Inc.
Northeast Divison

In Association With
Scientific and Environmental Associates, Inc.,
Innovative Technical Solutions, Inc. &
Avatar Environmental, LLC

GIS ANALYST:	J. SCHMIDL
EPA OSC:	K. STAIGER
RST 2 SPM:	J. SCHMIDL
FILENAME:	Fig1-4_SampleLocationMapDecember2008.pdf
FIGURE	1-5
REVISION	J. SCHMIDL
DATE MODIFIED	1/6/2011

WESTON SOLUTIONS



LEGEND:

- Monitoring Well
- 🟩 Soil Sample Location
- ▦ Stormwater Catchbasin
- Fence
- Railroad
- Roadway

TITLE:

SOIL AND GROUNDWATER SAMPLE LOCATION MAP OCTOBER 2010

JEWETT WHITE LEAD COMPANY
STATEN ISLAND, NEW YORK

PROJECT: JEWETT WHITE LEAD COMPANY
REMOVAL ACTION ALTERNATIVES REPORT

CLIENT NAME: USEPA

WESTON SOLUTIONS SM

DATE: 01/06/2011

FIGURE #: 2-1

SOURCES:
ESRI_StreetMap_World_2D: http://services.arcgisonline.com/arcgis/services.
Vector map features digitized from aerial imagery, ESRI_Imagery_World_2D: http://services.arcgisonline.com/arcgis/services.

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SOURCES:
ESRI_StreetMap_World_2D: http://services.arcgisonline.com/arcgis/services.
Vector map features digitized from aerial imagery, ESRI_Imagery_World_2D: http://services.arcgisonline.com/arcgis/services.

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LEGEND:

⬟	Offshore Sediment Sample Location	✕—✕	Fence
▨	Stormwater Catchbasin	+—+	Railroad
- - -	Waterfront	—	Roadway

PROJECT: JEWETT WHITE LEAD COMPANY
REMOVAL ACTION ALTERNATIVES REPORT

CLIENT NAME: USEPA

TITLE:

SEDIMENT AND SURFACE WATER SAMPLE LOCATION MAP OCTOBER 2010

JEWETT WHITE LEAD COMPANY
STATEN ISLAND, NEW YORK

WESTON SOLUTIONS SM

DATE: 01/06/2011

FIGURE #: 2-2

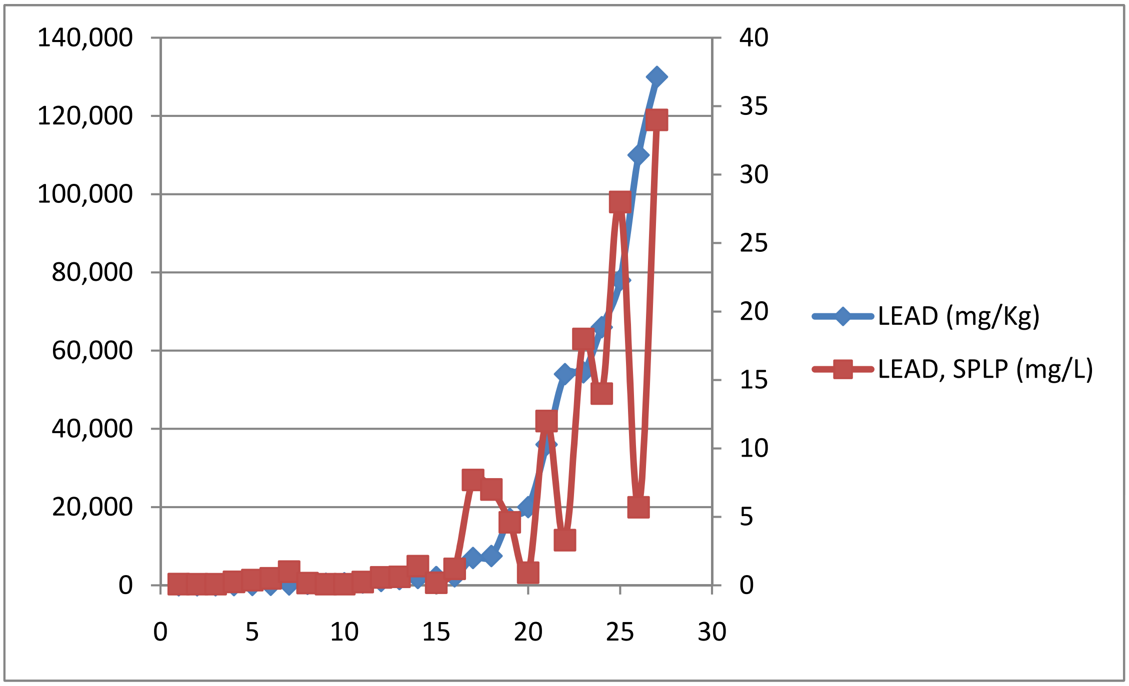
Figure 3-1

Comparison of Total Lead and SPLP Lead Analytical Results

Jewett White Lead Company Site

2000-2012 Richmond Terrace, Staten Island, New York

Removal Action Alternatives Report



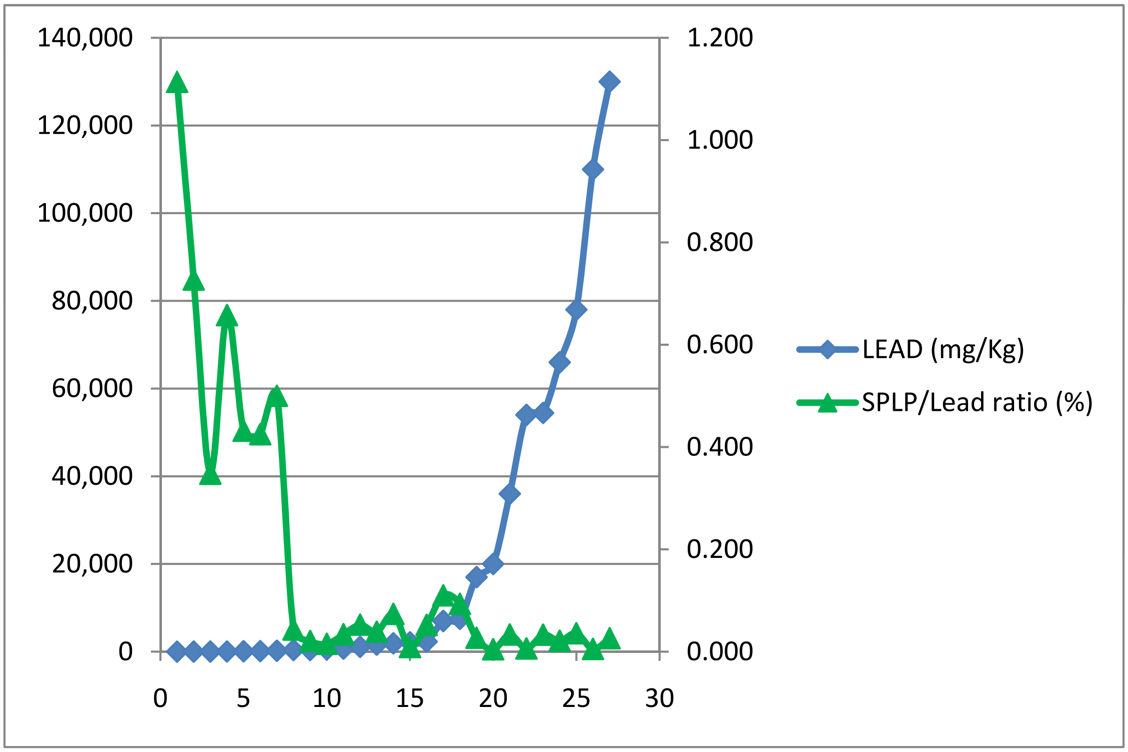
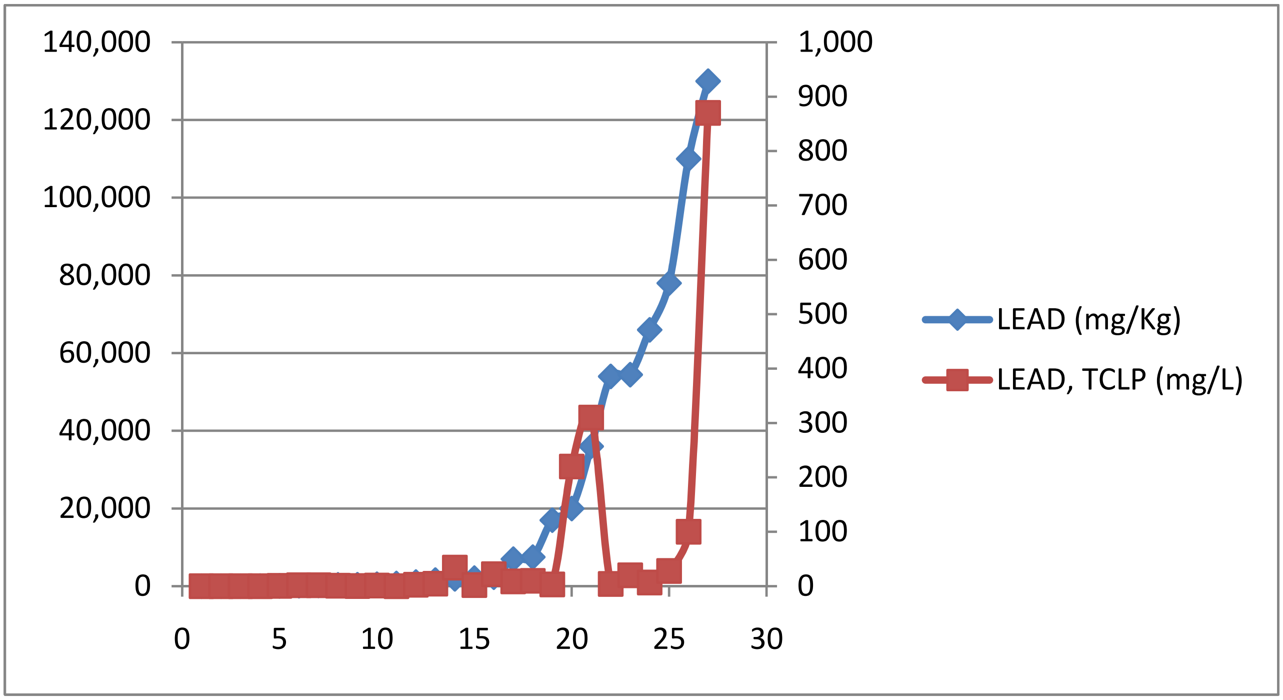
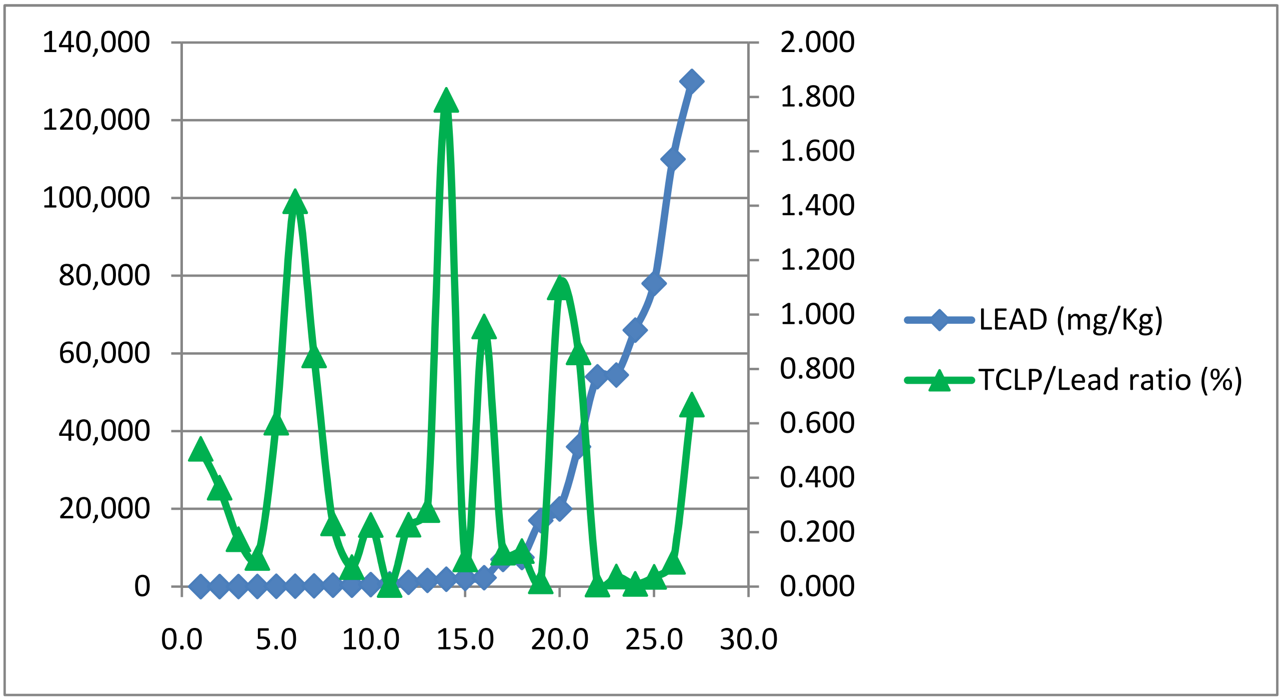


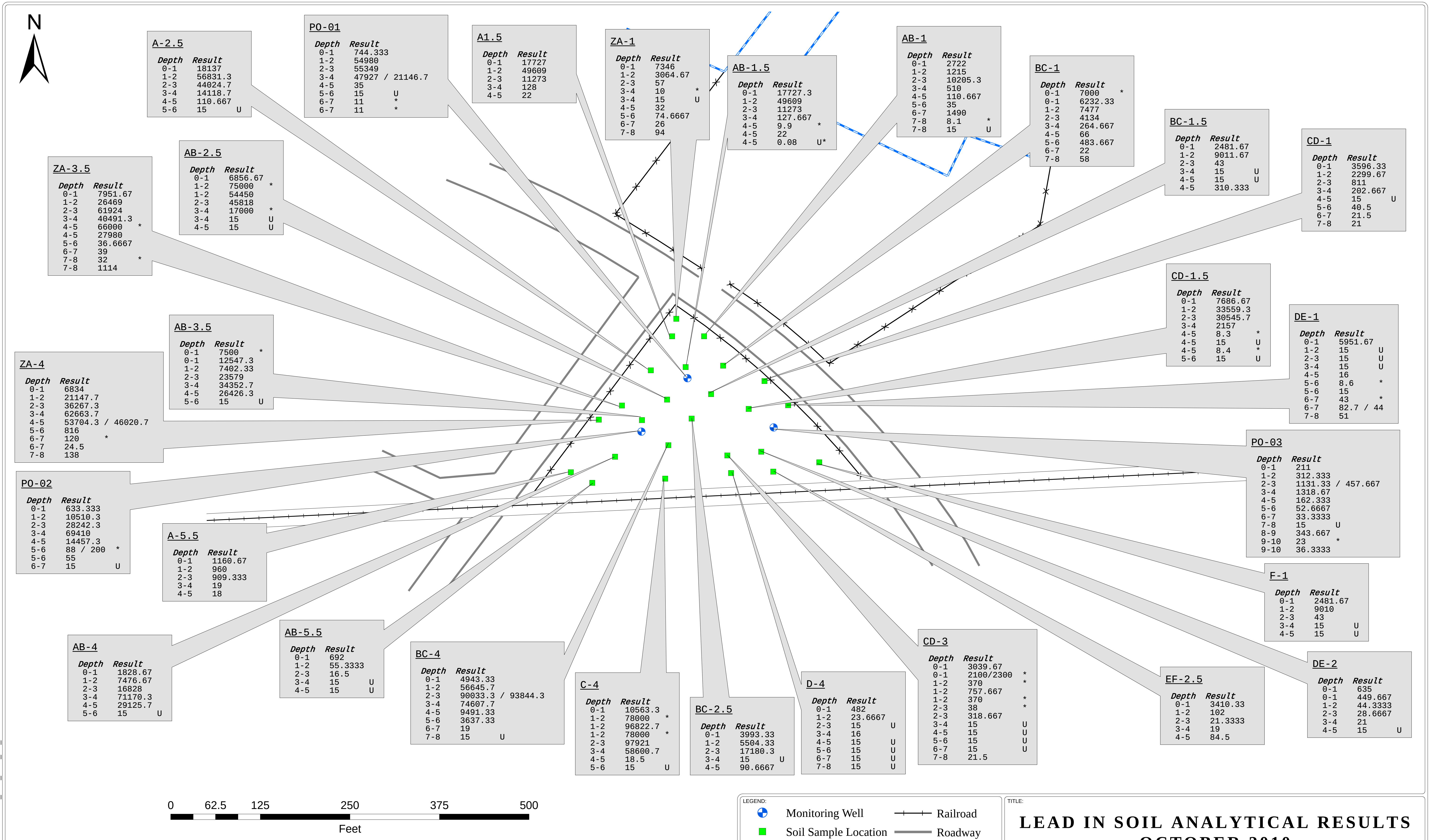
Figure 3-2

Comparison of Total Lead and TCLP Lead Concentrations

Jewett White Lead Company Site
2000-2012 Richmond Terrace, Staten Island, New York
Removal Action Alternatives Report







A-2.5

Depth	Result	
0-1	18137	
1-2	56831.3	
2-3	44024.7	
3-4	14118.7	
4-5	110.667	
5-6	15	U

PO-01

Depth	Result	
0-1	744.333	
1-2	54980	
2-3	55349	
3-4	47927 / 21146.7	
4-5	35	
5-6	15	U
6-7	11	*
6-7	11	*

A1.5

Depth	Result
0-1	17727
1-2	49609
2-3	11273
3-4	128
4-5	22

ZA-1

Depth	Result	
0-1	7346	
1-2	3064.67	
2-3	57	
3-4	10	*
3-4	15	U
4-5	32	
5-6	74.6667	
6-7	26	
7-8	94	

AB-1.5

Depth	Result	
0-1	17727.3	
1-2	49609	
2-3	11273	
3-4	127.667	
4-5	9.9	*
4-5	22	
4-5	0.08	U*

AB-1

Depth	Result	
0-1	2722	
1-2	1215	
2-3	10205.3	
3-4	510	
4-5	110.667	
5-6	35	
6-7	1490	
7-8	8.1	*
7-8	15	U

BC-1

Depth	Result	
0-1	7000	*
0-1	6232.33	
1-2	7477	
2-3	4134	
3-4	264.667	
4-5	66	
5-6	483.667	
6-7	22	
7-8	58	

BC-1.5

Depth	Result	
0-1	2481.67	
1-2	9011.67	
2-3	43	
3-4	15	U
4-5	15	U
4-5	310.333	

CD-1

Depth	Result	
0-1	3596.33	
1-2	2299.67	
2-3	811	
3-4	202.667	
4-5	15	U
5-6	40.5	
6-7	21.5	
7-8	21	

ZA-3.5

Depth	Result	
0-1	7951.67	
1-2	26469	
2-3	61924	
3-4	40491.3	
4-5	66000	*
4-5	27980	
5-6	36.6667	
6-7	39	
7-8	32	*
7-8	1114	

AB-2.5

Depth	Result	
0-1	6856.67	
1-2	75000	*
1-2	54450	
2-3	45818	
3-4	17000	*
3-4	15	U
4-5	15	U

CD-1.5

Depth	Result	
0-1	7686.67	
1-2	33559.3	
2-3	30545.7	
3-4	2157	
4-5	8.3	*
4-5	15	U
4-5	8.4	*
5-6	15	U

DE-1

Depth	Result	
0-1	5951.67	
1-2	15	U
2-3	15	U
3-4	15	U
4-5	16	
5-6	8.6	*
5-6	15	
6-7	43	*
6-7	82.7 / 44	
7-8	51	

AB-3.5

Depth	Result	
0-1	7500	*
0-1	12547.3	
1-2	7402.33	
2-3	23579	
3-4	34352.7	
4-5	26426.3	
5-6	15	U

ZA-4

Depth	Result	
0-1	6834	
1-2	21147.7	
2-3	36267.3	
3-4	62663.7	
4-5	53704.3 / 46020.7	
5-6	816	
6-7	120	*
6-7	24.5	
7-8	138	

PO-03

Depth	Result	
0-1	211	
1-2	312.333	
2-3	1131.33 / 457.667	
3-4	1318.67	
4-5	162.333	
5-6	52.6667	
6-7	33.3333	
7-8	15	U
8-9	343.667	
9-10	23	*
9-10	36.3333	

PO-02

Depth	Result	
0-1	633.333	
1-2	10510.3	
2-3	28242.3	
3-4	69410	
4-5	14457.3	
5-6	88 / 200	*
5-6	55	
6-7	15	U

A-5.5

Depth	Result
0-1	1160.67
1-2	960
2-3	909.333
3-4	19
4-5	18

F-1

Depth	Result	
0-1	2481.67	
1-2	9010	
2-3	43	
3-4	15	U
4-5	15	U

AB-4

Depth	Result	
0-1	1828.67	
1-2	7476.67	
2-3	16828	
3-4	71170.3	
4-5	29125.7	
5-6	15	U

AB-5.5

Depth	Result	
0-1	692	
1-2	55.3333	
2-3	16.5	
3-4	15	U
4-5	15	U

BC-4

Depth	Result	
0-1	4943.33	
1-2	56645.7	
2-3	90033.3 / 93844.3	
3-4	74607.7	
4-5	9491.33	
5-6	3637.33	
6-7	19	
7-8	15	U

C-4

Depth	Result	
0-1	10563.3	
1-2	78000	*
1-2	96822.7	
1-2	78000	*
2-3	97921	
3-4	58600.7	
4-5	18.5	
5-6	15	U

BC-2.5

Depth	Result	
0-1	3993.33	
1-2	5504.33	
2-3	17180.3	
3-4	15	U
4-5	90.6667	

D-4

Depth	Result	
0-1	482	
1-2	23.6667	
2-3	15	U
3-4	16	
4-5	15	U
5-6	15	U
6-7	15	U
7-8	15	U

CD-3

Depth	Result	
0-1	3039.67	
0-1	2100/2300	*
1-2	370	*
1-2	757.667	
1-2	370	*
2-3	38	*
2-3	318.667	
3-4	15	U
4-5	15	U
5-6	15	U
6-7	15	U
7-8	21.5	

EF-2.5

Depth	Result
0-1	3410.33
1-2	102
2-3	21.3333
3-4	19
4-5	84.5

DE-2

Depth	Result	
0-1	635	
0-1	449.667	
1-2	44.3333	
2-3	28.6667	
3-4	21	
4-5	15	U

NOTES:
1). Samples associated with an asterisk (*) as a flag value denotes laboratory measured value for Lead (Method 6010). All other values are based on XRF Field Screening.

SOURCES:
ESRI_StreetMap_World_2D: http://services.arcgisonline.com/arcgis/services.
Vector map features digitized from aerial imagery, ESRI_Imagery_World_2D: http://services.arcgisonline.com/arcgis/services.

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LEGEND:

● Monitoring Well	┼─┼ Railroad
🟩 Soil Sample Location	─ Roadway
✕─✕ Fence	┅ Waterfront

PROJECT: JEWETT WHITE LEAD COMPANY
REMOVAL ACTION ALTERNATIVES REPORT

TITLE:

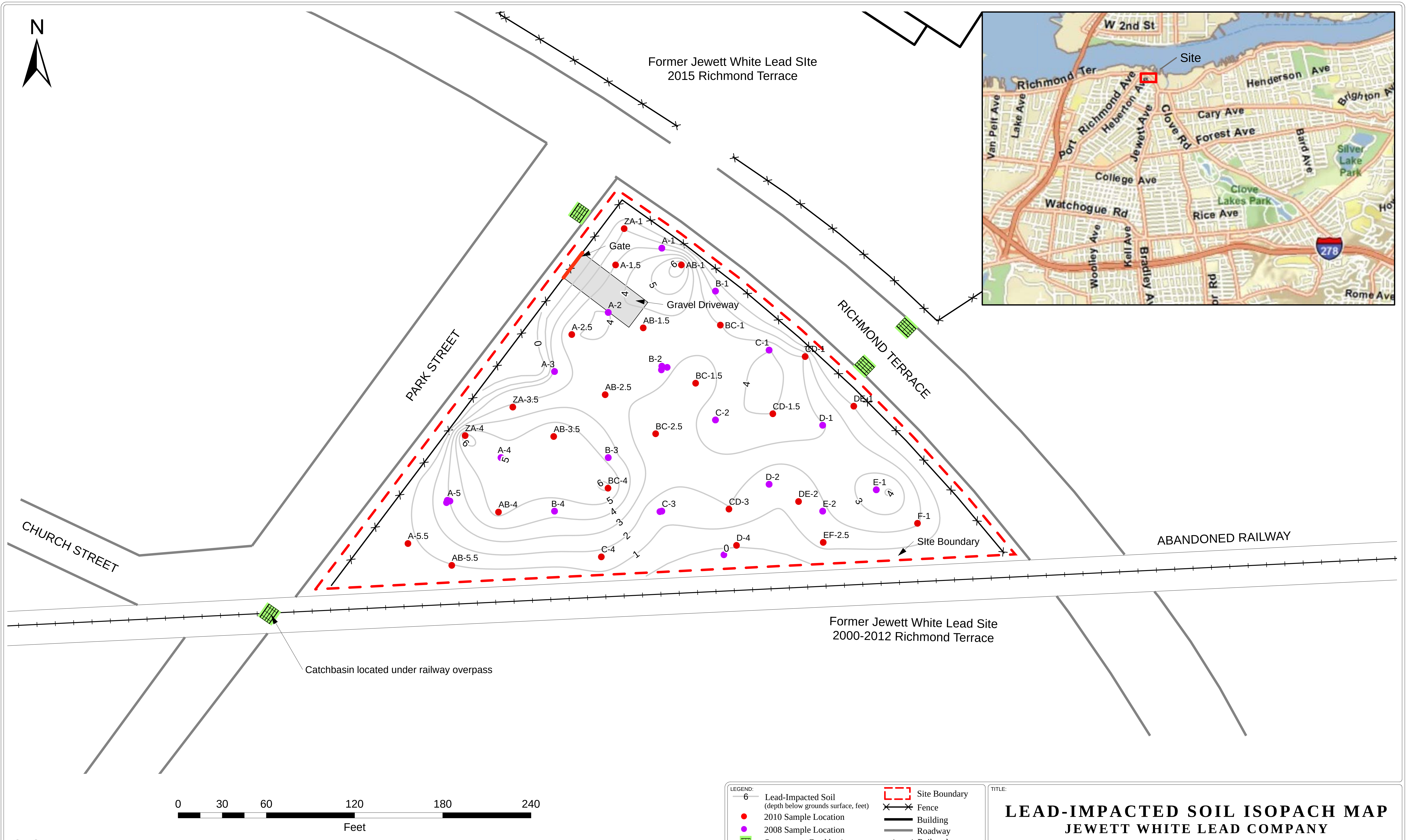
LEAD IN SOIL ANALYTICAL RESULTS
OCTOBER 2010
JEWETT WHITE LEAD COMPANY
STATEN ISLAND, NEW YORK

CLIENT NAME: USEPA

WESTON SOLUTIONS SM

DATE: 01/06/2011

FIGURE #: 3-3



LEGEND:

6	Lead-Impacted Soil (depth below grounds surface, feet)
●	2010 Sample Location
●	2008 Sample Location
▨	Stormwater Catchbasin
⌐ ¬	Site Boundary
✕—✕	Fence
—	Building
—	Roadway
+—+	Railroad

NOTES:
1. Contours depicted represent the depth of lead-impacted soils below ground surface measured in feet.

SOURCES:
ESRI_StreetMap_World_2D: http://services.arcgisonline.com/arcgis/services.
Vector map features digitized from aerial imagery, ESRI_Imagery_World_2D: http://services.arcgisonline.com/arcgis/services.

P:\JewettWhiteLead\GIS\MXD\08787_JWL_Pb_Soil_IsopachMap.mxd

TITLE:

LEAD-IMPACTED SOIL ISOPACH MAP
JEWETT WHITE LEAD COMPANY
2000-2012 RICHMOND TERRACE
STATEN ISLAND, NEW YORK

PROJECT: JEWETT WHITE LEAD COMPANY
REMOVAL ACTION ALTERNATIVES REPORT

CLIENT NAME: USEPA

WESTON SOLUTIONS SM

DATE: 01/06/2011

FIGURE #: 3-4

TABLES

Table 3-1
Correlation for Soil Analytical Results
Jewett White Lead Company Site
2000-2012 Richmond Terrace, Staten Island, New York
Removal Action Alternatives Report

Location	EPA Residential RSL[1]	EPA Industrial RSL[2]	NYSDEC Commercial RUSCO[3]	AB-1.5	AB-1	AB-2.5	AB-2.5	AB-3.5	BC-1	C-4	CD-1.5	CD-3	CD-3	CD-3	CD-3	DE-1	DE-1	PO-01	PO-02	PO-02	PO-03	ZA-1	ZA-3.5	ZA-3.5	ZA-4
Sample No.				S-AB1.5-0405	S-AB1-0708	S-AB2.5-0102	S-AB2.5-0304	S-AB3.5-0001	S-BC1-0001	S-C4-0102	S-CD1.5-0405	S-CD3-0001	S-CD3-0001-E	S-CD3-0102	S-CD3-0203	S-DE1-0506	S-DE1-0607	S-PO1-0607	S-PO2-0506	S-PO2-0506-E	S-PO3-0910	S-ZA1-0304	S-ZA3.5-0405	S-ZA3.5-0708	S-ZA4-0607
Sample Date				10/6/2010	10/4/2010	10/8/2010	10/8/2010	10/8/2010	10/4/2010	10/7/2010	10/5/2010	10/7/2010	10/7/2010	10/7/2010	10/7/2010	10/5/2010	10/5/2010	10/7/2010	10/7/2010	10/7/2010	10/7/2010	10/4/2010	10/6/2010	10/6/2010	10/6/2010
Target Analyte List Metals (milligrams per kilogram)																									
Aluminum	7,700	99,000	--	**8,200**	**6,500**	**1,900**	**2,700**	**6,000**	**5,900**	**2,800**	**6,700**	**7,400**	**7,000**	**8,900**	**5,300**	**5,400**	**5,700**	**6,600**	**6,700**	**7,300**	**11,000**	**6,000**	**1,200**	**5,800**	**6,400**
Antimony	3.1	41	--	2.3 U	2.4 U	**3.8**	3.8 U	2.2 U	2.5 U	**3.8**	2.4 U L	2.1 U	2.1 U	2.2 U	2.2 U	2.5 U	2.4 U	2.1 U	2.1 U	2.2 U	2.0 U	2.5 U	4.6 U	2.2 U	2.2 U
Arsenic	0.39	1.6	16	**4.7**	**8.7**	**6.8**	1.5 U	**8.6**	**8.2**	**6.7**	**5.9**	**5.9**	**5.9**	**6.8**	**5**	**1.9**	**6.5**	**8.9**	**2.6**	**3.4**	**5.4**	**2.3**	1.8 U	**1.5**	**3.4**
Barium	1,500	19,000	400	**21**	**21**	**670**	**520**	**140**	**120**	**650**	**25**	**130**	**130**	**76**	**26**	**15**	**18**	**43**	**37**	**37**	**45**	**16**	**890**	**44**	**36**
Beryllium	16	200	590	**0.45**	**0.37**	0.49 U	0.57 U	**0.41**	**0.41**	0.45 U	0.36 U	**0.51**	**0.53**	**0.48**	**0.39**	0.38 U	**0.38**	0.32 U	0.31 U	0.32 U	**0.58**	0.37 U	0.68 U	0.33 U	**0.4**
Cadmium	7	81	9	0.34 U	0.36 U	**1.5**	0.57 U	**1.4**	**0.6**	**2.1**	0.36 U	**0.56**	**0.56**	0.33 U	0.31 U	0.38 U	0.36 U	0.32 U	0.31 U	0.32 U	0.29 U	0.37 U	**2.4**	0.33 U	0.33 U
Calcium	--	--	--	**970**	**1,200**	**51,000**	**41,000**	**37,000**	**18,000**	**45,000**	**760**	**13,000**	**12,000**	**6,700**	**860**	**400**	**810**	**2,600**	**1,200**	**1,200**	**1,100**	**590**	**110,000**	**1,000**	**1,900**
Chromium	28	140	400	**14**	**12**	**9.4**	**5.7**	**25**	**15**	**15**	**12**	**15**	**15**	**16**	**9.6**	**8.4**	**12**	**14**	**11**	**12**	**22**	**10**	**5.8**	**12**	**9.9**
Cobalt	2.3	30	--	**4.9**	**5**	3.3 U	3.8 U	**8.1**	**5.8**	**12**	**4.2**	**5.4**	**5.8**	**5.3**	**6.7**	**5.9**	**7.9**	**7.5**	**3.8**	**4**	**8.2**	**4.1**	4.6 U	**4.5**	**6.4**
Copper	31	4,100	270	**16**	**13**	**120**	**32**	**140**	**100**	**140**	**8.7**	**60**	**54**	**20**	**8.2**	**8.8**	**18**	**18**	**13**	**13**	**18**	**7.3**	**86**	**7.5**	**12**
Iron	5,500	72,000	--	**16,000**	**18,000**	**12,000**	**4,900**	**15,000**	**15,000**	**13,000**	**14,000**	**15,000**	**15,000**	**19,000**	**15,000**	**12,000**	**20,000**	**26,000**	**13,000**	**13,000**	**21,000**	**13,000**	**3,700**	**11,000**	**12,000**
Lead	400	800	1,000	**9.9**	**8.1**	**75,000**	**17,000**	**7,500**	**7,000**	**78,000**	**8.3**	**2,100**	**2,300**	**370**	**38**	**8.6**	**43**	**11**	**88 J**	**200 J**	**23**	**10**	**66,000**	**32**	**120**
Magnesium	--	--	--	**3,900**	**2,100**	**2,500**	**1,900**	**9,800**	**6,900**	**1,700**	**2,200**	**3,800**	**3,300**	**2,200**	**1,500**	**2,000**	**1,700**	**1,800**	**2,000**	**2,100**	**4,600**	**2,100**	**1,700**	**2,200**	**2,200**
Manganese	180	2,300	10,000	**210**	**450**	**3,300**	**550**	**410**	**400**	**1,800**	**160**	**360**	**390**	**320**	**360**	**530**	**460**	**370**	**140**	**140**	**260**	**120**	**2,200**	**140**	**270**
Mercury	0.67	28	2.8	**0.013 L**	**0.019**	**0.56**	**1.3**	**0.42**	**0.2**	**0.42**	**0.017**	**0.45**	**0.36**	**0.093**	**0.055**	**0.014**	**0.026**	**0.022**	**0.011**	**0.02**	0.0033 U	**0.015**	**1.1**	**0.016**	**0.015**
Nickel	160	2,000	310	**10**	**9.4**	**64**	**4.2**	**87**	**23**	**84**	**10**	**19**	**19**	**10**	**8**	**9.8**	**8.8**	**9.4**	**9**	**9.7**	**18**	**9.8**	**7.1**	**11**	**8.9**
Potassium	--	--	--	**640**	**570**	**260**	**300**	**620**	**600**	**330**	**510**	**720**	**700**	**830**	**520**	**320**	**470**	**570**	**590**	**590**	**1,900**	**370**	**260**	**480**	**600**
Selenium	39	510	1,500	2.3 U	2.4 U	**3.4**	3.8 U	2.2 U	2.5 U	3.0 U	2.4 U	2.1 U	2.1 U	2.2 U	2.1 U	2.5 U	2.4 U	2.1 U	2.1 U	2.2 U	2.0 U	2.5 U	4.6 U	2.2 U	2.2 U
Silver	--	--	1,500	0.57 U	0.60 U	**1.0**	0.94 U	0.56 U	0.62 U	**0.9**	0.60 U	0.53 U	0.54 U	0.54 U	0.51 U	0.63 U	0.60 U	0.54 U	0.52 U	0.54 U	0.49 U	0.62 U	1.1 U	0.55 U	0.55 U
Sodium	--	--	--	110 U	120 U	**170**	190 U	**200**	120 U	**200**	120 U	110 U	110 U	110 U	100 U	130 U	120 U	110 U	100 U	110 U	98 U	120 U	**280**	110 U	110 U
Thallium	0.51	6.6	--	2.3 U	2.4 U	3.3 U	3.8 U	2.2 U	2.5 U	3.0 U	2.4 U	2.1 U	2.1 U	2.2 U	2.1 U	2.5 U	2.4 U	2.1 U	2.1 U	2.2 U	2.0 U	2.5 U	4.6 U	2.2 U	2.2 U
Vanadium	55	720	--	**20**	**17**	**8.3**	**4.2**	**24**	**22**	**12**	**18**	**19**	**20**	**24**	**16**	**9**	**14**	**17**	**15**	**15**	**32**	**12**	4.6 U	**11**	**15**
Zinc	2,300	31,000	10,000	**31**	**27**	**100**	**54**	**230**	**200**	**270**	**30**	**230**	**190**	**74**	**27**	**38**	**38**	**33**	**29**	**32**	**80**	**28**	**160**	**29**	**28**

Results in **Bold** font indicate detected analytes.

Highlighted results indicate exceedance of EPA or NYSDEC screening value.

1 = U.S. Environmental Protection Agency Region 3 Regional Screening Toxicity Value - Residential, for soil representing a cancer benchmark of $1x10^{-6}$ or a HQ = 0.1 (EPA November 2010 RSL Screening Toxicity Values).

2 = U.S. Environmental Protection Agency Region 3 Regional Screening Toxicity Value - Industrial, for soil representing a cancer benchmark of $1x10^{6}$ or a HQ = 0.1 (EPA November 2010 RSL Screening Toxicity Values).

3 = 6 New York State Department of Environmental Conservation Part 375 Commercial Restricted Use Soil Cleanup Objective.

U = Analyte not detected; method detection limit listed.

J = Analyte detected; concentration estimated due to quality control issues.

UJ = Analyte not detected; estimated method detection limit listed, due to quality control issues.

-- = Not listed.

Table 3-2
Total Lead versus Laboratory Lead Results
Jewett White Lead Company Site
2000-2012 Richmond Terrace, Staten Island, New York
Removal Action Alternatives Report

Sample Number	S-AB2.5-0102	S-AB2.5-0304	S-AB3.5-0001	S-BC1-0001	S-C4-0102	S-CD3-0001	S-CD3-0102	S-CD3-0203	S-ZA3.5-0405
FPXRF Lead (mg/kg)	54,450	7.5	12,547	6,232	96,823	3,040	758	319	27,980
Laboratory Lead (mg/kg)	75,000	17,000	7,500	7,000	78,000	2,200	370	38	66,000
RPD (%)	32	200	50	12	22	37	69	157	81
FPXRF>Laboratory	Yes	No	Yes	No	Yes	Yes	Yes	Yes	No

Sample Number	S-ZA4-0607	S-PO1-0607	S-PO2-0506	S-PO3-0910	S-MSC1-0708	S-MSCB1-0102	S-MSCB1-0304	S-MSCC1-0102	S-MSCC1-0203
FPXRF Lead (mg/kg)	25	8	55	36	1,126	642	8,618	7.5	3,507
Laboratory Lead (mg/kg)	120	11	144	23	1,600	390	36,000	7.9	1,900
RPD (%)	132	38	89	45	35	49	123	5.2	59.433
FPXRF>Laboratory	No	No	No	Yes	No	Yes	No	No	Yes

Sample Number	S-MSCC5-0102	S-MSCC5-0506	S-MSCD1-0102	S-MSCD4-0304	S-MSCD5-0405	S-MSCF4-0405	Maximum	Minimum	Average
FPXRF Lead (mg/kg)	141	274	47	26,081	6,790	100,000	100,000	7.5	14,563
Laboratory Lead (mg/kg)	1,100	710	530	54,000	110,000	130,000	130,000	7.9	24,568
RPD (%)	132	38	89	45	35	49	200	5.2	68
FPXRF>Laboratory	No	No	No	Yes	No	Yes			

mg/kg = milligrams per kilogram

Results in RED denote one-half detection limits where the analyte was not detected.

FPXRF = Field portable X-Ray fluoresence.

RPD = Relative Percent Difference.

Duplicate laboratory analytical results for samples from locations CD-3 and PO-2 were averaged to provide a single result for statistical anaysis.

Dataset includes 13 samples from 2000-2012 Richmond Terrace and 11 samples from 2015 Richmond Terrace.

17 of 24 RPD calculations (71%) meet 75%

9 of 24 FPXRF>Laboratory comparisons (38%) are affirmative

Table 3-3
Total Lead and SPLP Lead Results
Jewett White Lead Company Site
2000-2012 Richmond Terrace, Staten Island, New York
Removal Action Alternatives Report

Sample Number	S-AB2.5-0102	S-AB2.5-0304	S-AB3.5-0001	S-BC1-0001	S-C4-0102	S-CD3-0001	S-CD3-0001-E	S-CD3-0102	S-CD3-0203	S-ZA3.5-0405
LEAD (mg/kg)	75,000	17,000	7,500	7,000	78,000	2,100	2,300	370	38	66,000
LEAD, SPLP (mg/L)	18	4.6	7.0	7.7	28	0.19	1.2	0.16	0.25	14
SPLP/Lead ratio (%)	0.033	0.027	0.093	0.110	0.036	0.009	0.052	0.043	0.658	0.021

Sample Number	S-ZA4-0607	S-PO1-0607	S-PO2-0506	S-PO2-0506-E	S-PO3-0910	S-MSC1-0708	S-MSC2-0708	S-MSCB1-0102	S-MSCB1-0304	S-MSCC1-0102
LEAD (mg/kg)	120	11	88	200	23	1,600	20,000	390	36,000	7.9
LEAD, SPLP (mg/L)	0.51	0.08	0.38	1.0	0.08	0.62	0.92	0.08	12	0.088
SPLP/Lead ratio (%)	0.425	0.727	0.432	0.500	0.348	0.039	0.005	0.021	0.033	1.114

Sample Number	S-MSCC1-0203	S-MSCC5-0102	S-MSCC5-0506	S-MSCD1-0102	S-MSCD4-0304	S-MSCD5-0405	S-MSCF4-0405	Maximum	Minimum	Average
LEAD (mg/kg)	1,900	1,100	710	530	54,000	110,000	130,000	130,000	7.9	22,666
LEAD, SPLP (mg/L)	1	1	0.24	0.08	3.3	6	34	34	0.080	5
SPLP/Lead ratio (%)	0.074	0.053	0.034	0.015	0.006	0.005	0.026	1.1	0.0046	0.18

mg/kg = milligrams per kilogram
Results in RED denote one-half detection limits where the analyte was not detected.

Dataset includes 15 samples from 2000-2012 Richmond Terrace and 12 samples from 2015 Richmond Terrace.

Table 3-4

Total Lead and TCLP Lead Results

Jewett White Lead Company Site

2000-2012 Richmond Terrace, Staten Island, New York

Removal Action Alternatives Report

Sample Number	S-AB2.5-0102	S-AB2.5-0304	S-AB3.5-0001	S-BC1-0001	S-C4-0102	S-CD3-0001	S-CD3-0001-E	S-CD3-0102	S-CD3-0203	S-ZA3.5-0405
LEAD (mg/kg)	75,000	17,000	7,500	7,000	78,000	2,100	2,300	370	38	66,000
LEAD, TCLP (mg/L)	20	3.3	9.8	8.7	28	2.1	22	0.86	0.04	6.6
TCLP/Lead ratio (%)	0.027	0.019	0.131	0.124	0.036	0.100	0.957	0.232	0.105	0.010

Sample Number	S-ZA4-0607	S-PO1-0607	S-PO2-0506	S-PO2-0506-E	S-PO3-0910	S-MSC1-0708	S-MSC2-0708	S-MSCB1-0102	S-MSCB1-0304	S-MSCC1-0102
LEAD (mg/kg)	120	11	88	200	23	1,600	20,000	390	36,000	7.9
LEAD, TCLP (mg/L)	1.7	0.04	0.53	1.7	0.04	5	220	0.28	310	0.04
TCLP/Lead ratio (%)	1.417	0.364	0.602	0.850	0.174	0.281	1.100	0.072	0.861	0.506

Sample Number	S-MSCC1-0203	S-MSCC5-0102	S-MSCC5-0506	S-MSCD1-0102	S-MSCD4-0304	S-MSCD5-0405	S-MSCF4-0405	Maximum	Minimum	Average
LEAD (mg/kg)	1,900	1,100	710	530	54,000	110,000	130,000	130,000	7.9	22,666
LEAD, TCLP (mg/L)	34	3	0.04	1	4.0	100	870	870	0.040	61
TCLP/Lead ratio (%)	1.789	0.227	0.006	0.226	0.007	0.091	0.669	1.8	0.0056	0.41

mg/kg = milligrams per kilogram
Results in RED denote one-half detection limits where the analyte was not detected.

Dataset includes 15 samples from 2000-2012 Richmond Terrace and 12 samples from 2015 Richmond Terrace.

Table 3-5

December 2008 Soil Lead Results

Jewett White Lead Company Site

2000-2012 Richmond Terrace, Staten Island, New York

Removal Action Alternatives Report

Sample ID	Depth (ft)	Lead (mg/kg)	Sample ID	Depth (ft)	Lead (mg/kg)	Sample ID	Depth (ft)	Lead (mg/kg)	Sample ID	Depth (ft)	Lead (mg/kg)
A-1-0	0-0.25	1,008	B-1-0	0-0.25	13,400 J	C-1-0	0-0.25	11,500 J	D-1-0	0-0.25	6,580 J
A-1-1	1	47,700	B-1-1	1	8,390	C-1-1	1	12,500 J	D-1-1	1	1,520 J
A-1-2	2	17,600	B-1-2	2	13,400	C-1-2	2	31,300 J	D-1-2	2	2,602 J
A-1-3	3	42.9	B-1-3	3	333	C-1-3	3	38,000 J	D-1-3	3	16.2 J
A-2-0	0-0.25	37,100	B-2-0	0-0.25	4,56J	C-2-0	0-0.25	227 J	D-2-0	0-0.25	1,210 J/1,450 J*
A-2-1	1	55,500	B-2-1	1	69,300	C-2-1	1	148,000 J	D-2-1	1	425 J
A-2-2	2	130,000	B-2-2	2	145,000/240,000 J*	C-2-2	2	136,000 J	D-2-2	2	531
A-2-3	3	98,700 J	B-2-3	3	160,000 J	C-2-3	3	134,000 J	D-2-3	3	26.7
A-3-0	0-0.25	734	B-3-0	0-0.25	319 J	C-3-0	0-0.25	471 J			
A-3-1	1	80	B-3-1	1	10,300 J	C-3-1	1	12,800 J			
A-3-2	2	541	B-3-2	2	123,000 J	C-3-2	2	118,000 J			
A-3-3	3	56.5/68.9*	B-3-3	3	100,700 J	C-3-3	3	147,000 J			
A-4-0	0-0.25	257	B-4-0	0-0.25	538 J				E-1-0	0-0.25	415 J
A-4-1	1	26,200	B-4-1	1	17,300 J				E-1-1	1	8,330
A-4-2	2	62,700	B-4-2	2	8,870 J				E-1-2	2	5,702
A-4-3	3	105,000	B-4-3	3	18,400 J				E-1-3	3	14,500
A-5-0	0-0.25	8,005							E-2-0	0-0.25	2,710 J
A-5-1	1	28,500/31,400*							E-2-1	1	1,920
A-5-2	2	3,440							E-2-2	2	1,730
A-5-3	3	90,900							E-2-3	3	29.2

Notes:

mg/kg = milligrams per kilogram (parts per million).

J = The reported value was obtained from a reading that was less than the Contract Required Quantitation Limit (CRQL) but greater than or equal to the MDL (Method Detection Limit).

* = Duplicate sample taken at this location.

Table 3-6
October 2010 FPXRF Soil Lead Results
Jewett White Lead Company Site
2000-2012 Richmond Terrace, Staten Island, New York
Removal Action Alternatives Report

Sample ID	Date	Time	Results (mg/kg) Average
S-A1.5-0001	10/8/10	7:48	17,727
S-A1.5-0102	10/8/10	7:50	49,609
S-A1.5-0203	10/8/10	7:52	11,273
S-A1.5-0304	10/8/10	7:55	128
S-A1.5-0405	10/8/10	7:57	22
S-A2.5-0001	10/8/10	8:33	18,137
S-A2.5-0102	10/8/10	8:38	56,831
S-A2.5-0203	10/8/10	8:40	44,025
S-A2.5-0304	10/8/10	8:42	14,119
S-A2.5-0405	10/8/10	8:44	111
S-A2.5-0506	10/8/10	8:46	nd
S-A5.5-0001	10/6/10		1,161
S-A5.5-0102	10/6/10		960
S-A5.5-0203	10/6/10		909
S-A5.5-0304	10/6/10		19
S-A5.5-0405	10/6/10		18
S-AB1-0001	10/4/10	12:50	2,722
S-AB1-0102	10/4/10	12:55	1,215
S-AB1-0203	10/4/10	13:00	10,205
S-AB1-0304	10/4/10	13:05	510
S-AB1-0405	10/4/10	13:10	111
S-AB1-0506	10/4/10	13:15	35
S-AB1-0607	10/4/10	13:20	1,490
S-AB1-0708	10/4/10	13:25	nd
S-AB1.5-0001	10/6/10	9:52	37,877
S-AB1.5-0102	10/6/10	9:54	58,546
S-AB1.5-0203	10/6/10	9:56	32,843
S-AB1.5-0304	10/6/10	10:00	246
S-AB1.5-0405	10/6/10	10:02	82
S-AB2.5-0001	10/8/10	11:10	6,857
S-AB2.5-0102	10/8/10	11:12	54,450
S-AB2.5-0203	10/8/10	11:14	45,818
S-AB2.5-0304	10/8/10	11:16	nd
S-AB2.5-0405	10/8/10	11:18	nd
S-AB3.5-0001	10/8/10	10:10	12,547
S-AB3.5-0102	10/8/10	10:12	7,402
S-AB3.5-0203	10/8/10	10:13	23,579
S-AB3.5-0304	10/8/10	10:20	34,353
S-AB3.5-0405	10/8/10	10:22	26,426
S-AB3.5-0506	10/8/10	10:35	nd
S-AB4-0001	10/8/10	9:27	1,829
S-AB4-0102	10/8/10	9:30	7,477
S-AB4-0203	10/8/10	9:32	16,828
S-AB4-0304	10/8/10	9:35	71,170
S-AB4-0405	10/8/10	9:37	29,126
S-AB4-0506	10/8/10	9:40	nd
S-AB5.5-0001	10/7/10	14:20	692
S-AB5.5-0102	10/7/10	14:22	55
S-AB5.5-0203	10/7/10	14:24	17
S-AB5.5-0304	10/7/10	14:26	nd
S-AB5.5-0304-E	10/7/10	14:30	35
S-AB5.5-0405	10/7/10	14:28	nd

Sample ID	Date	Time	Results (mg/kg) Average
S-BC1-0001	10/4/10	14:00	6,232
S-BC1-0102	10/4/10	14:03	7,477
S-BC1-0203	10/4/10	14:06	4,134
S-BC1-0304	10/4/10	14:15	265
S-BC1-0405	10/4/10	14:17	66
S-BC1-0506	10/4/10	14:20	484
S-BC1-0607	10/4/10	14:23	22
S-BC1-0708	10/4/10	14:27	58
S-BC1.5-0001	10/6/10	8:52	2,482
S-BC1.5-0102	10/6/10	8:54	9,012
S-BC1.5-0203	10/6/10	8:56	43
S-BC1.5-0304	10/6/10	9:00	nd
S-BC1.5-0405	10/6/10	9:02	nd
S-BC1.5-0405-E	10/6/10	9:02	310
S-BC2.5-0001	10/7/10	10:28	3,993
S-BC2.5-0102	10/7/10	10:30	5,504
S-BC2.5-0203	10/7/10	10:32	17,180
S-BC2.5-0304	10/7/10	10:35	nd
S-BC2.5-0405	10/7/10	10:38	91
S-BC4-0001	10/7/10	11:42	4,943
S-BC4-0102	10/7/10	11:44	56,646
S-BC4-0203	10/7/10	11:46	90,033
S-BC4-0203-E	10/7/10	11:46	93,844
S-BC4-0304	10/7/10	11:48	74,608
S-BC4-0405	10/7/10	11:52	9,491
S-BC4-0506	10/7/10	12:44	3,637
S-BC4-0607	10/7/10	12:46	19
S-BC4-0708	10/7/10	12:48	nd
S-C4-0001	10/7/10	13:22	10,563
S-C4-0102	10/7/10	13:24	96,823
S-C4-0203	10/7/10	13:26	97,921
S-C4-0304	10/7/10	13:30	58,601
S-C4-0405	10/7/10	13:32	19
S-C4-0506	10/7/10	13:35	nd
S-CD1.5-0001	10/5/10	14:27	7,687
S-CD1.5-0102	10/5/10	14:30	33,559
S-CD1.5-0203	10/5/10	14:32	30,546
S-CD1.5-0304	10/5/10	14:45	2,157
S-CD1.5-0405	10/5/10	14:47	nd
S-CD1.5-0506	10/5/10	14:55	nd
S-CD1-0001	10/5/10	8:12	3,596
S-CD1-0102	10/5/10	8:14	2,300
S-CD1-0203	10/5/10	8:16	811
S-CD1-0304	10/5/10	8:20	203
S-CD1-0405	10/5/10	8:25	nd
S-CD1-0506	10/5/10	8:30	41
S-CD1-0607	10/5/10	8:32	22
S-CD1-0708	10/5/10	8:34	21
S-CD3-0001	10/7/10	9:42	3,040
S-CD3-0102	10/7/10	9:44	758
S-CD3-0203	10/7/10	9:46	319
S-CD3-0304	10/7/10	9:52	nd
S-CD3-0405	10/7/10	9:54	nd
S-CD3-0506	10/7/10	9:56	nd
S-CD3-0607	10/7/10	9:58	nd
S-CD3-0708	10/7/10	10:00	22

Sample ID	Date	Time	Results (mg/kg) Average
S-D4-0001	10/7/10	8:52	482
S-D4-0102	10/7/10	8:54	24
S-D4-0203	10/7/10	8:56	nd
S-D4-0304	10/7/10	9:00	16
S-D4-0405	10/7/10	9:02	nd
S-D4-0506	10/7/10	9:04	nd
S-D4-0607	10/7/10	9:06	nd
S-D4-0708	10/7/10	9:08	nd
S-DE1-0001	10/5/10	9:25	5,952
S-DE1-0102	10/5/10	9:27	nd
S-DE1-0203	10/5/10	9:30	nd
S-DE1-0304	10/5/10	9:35	nd
S-DE1-0405	10/5/10	9:38	16
S-DE1-0506	10/5/10	9:40	15
S-DE1-0607	10/5/10	9:43	83
S-DE1-0607-E	10/5/10	9:43	44
S-DE1-0708	10/5/10	9:45	51
S-DE2-0001	10/5/10	13:22	635
S-DE2-0001-E	10/5/10	13:32	450
S-DE2-0102	10/5/10	13:25	44
S-DE2-0203	10/5/10	13:28	29
S-DE2-0304	10/5/10	12:33	21
S-DE2-0405	10/5/10	12:35	nd
S-EF2.5-0001	10/5/10	12:27	3,410
S-EF2.5-0102	10/5/10	12:30	102
S-EF2.5-0203	10/5/10	12:33	21
S-EF2.5-0304	10/5/10	12:35	19
S-EF2.5-0405	10/5/10	12:38	85
S-F1-0001	10/5/10	10:28	2,482
S-F1-0102	10/5/10	10:30	9,010
S-F1-0203	10/5/10	10:33	43
S-F1-0304	10/5/10	10:35	nd
S-F1-0405	10/5/10	10:38	nd
S-ZA1-0001	10/4/10	10:30	7,346
S-ZA1-0102	10/4/10	10:35	3,065
S-ZA1-0203	10/4/10	10:40	57
S-ZA1-0304	10/4/10	10:45	nd
S-ZA1-0405	10/4/10	10:50	32
S-ZA1-0506	10/4/10	10:55	75
S-ZA1-0607	10/4/10	11:00	26
S-ZA1-0708	10/4/10	11:05	94
S-ZA3.5-0001	10/6/10	14:16	7,952
S-ZA3.5-0102	10/6/10	14:18	26,469
S-ZA3.5-0203	10/6/10	14:20	61,924
S-ZA3.5-0304	10/6/10	14:25	40,491
S-ZA3.5-0405	10/6/10	14:28	27,980
S-ZA3.5-0506	10/6/10	14:30	37
S-ZA3.5-0607	10/6/10	14:32	39
S-ZA3.5-0708	10/6/10	14:35	1,114
S-ZA4-0001	10/6/10		6,834
S-ZA4-0102	10/6/10		21,148
S-ZA4-0203	10/6/10		36,267
S-ZA4-0304	10/6/10		62,664
S-ZA4-0405	10/6/10	13:08	53,704
S-ZA4-0405-E	10/6/10	13:08	46,021
S-ZA4-0506	10/6/10	13:34	816
S-ZA4-0607	10/6/10	13:36	25
S-ZA4-0708	10/6/10	13:40	138

mg/kg = milligrams per kilogram (parts per million).

Table 3-7
October 2010 Soil Analytical Results
Jewett White Lead Company Site
2000-2012 Richmond Terrace, Staten Island, New York
Removal Action Alternatives Report

Location	AB-1.5	AB-1	AB-2.5	AB-2.5	AB-3.5	BC-1	C-4	CD-1.5	CD-3	CD-3	CD-3	CD-3	DE-1	DE-1	PO-01	PO-02	PO-02	PO-03	ZA-1	ZA-3.5	ZA-3.5	ZA-4		
Sample No.	S-AB1.5-0405	S-AB1-0708	S-AB2.5-0102	S-AB2.5-0304	S-AB3.5-0001	S-BC1-0001	S-C4-0102	S-CD1.5-0405	S-CD3-0001	S-CD3-0001-E	S-CD3-0102	S-CD3-0203	S-DE1-0506	S-DE1-0607	S-PO1-0607	S-PO2-0506	S-PO2-0506-E	S-PO3-0910	S-ZA1-0304	S-ZA3.5-0405	S-ZA3.5-0708	S-ZA4-0607	RB-01	RB-02
Sample Date	10/6/2010	10/4/2010	10/8/2010	10/8/2010	10/8/2010	10/4/2010	10/7/2010	10/5/2010	10/7/2010	10/7/2010	10/7/2010	10/7/2010	10/5/2010	10/5/2010	10/7/2010	10/7/2010	10/7/2010	10/7/2010	10/4/2010	10/6/2010	10/6/2010	10/6/2010	10/8/2010	10/8/2010
Target Analyte List Metals (milligrams per kilogram)																								
Aluminum	**8,200**	**6,500**	**1,900**	**2,700**	**6,000**	**5,900**	**2,800**	**6,700**	**7,400**	**7,000**	**8,900**	**5,300**	**5,400**	**5,700**	**6,600**	**6,700**	**7,300**	**11,000**	**6,000**	**1,200**	**5,800**	**6,400**	100 U	100 U
Antimony	2.3 U	2.4 U	**3.8**	3.8 U	2.2 U	2.5 U	**3.8**	2.4 U L	2.1 U	2.1 U	2.2 U	2.2 U	2.5 U	2.4 U	2.1 U	2.1 U	2.2 U	2.0 U	2.5 U	4.6 U	2.2 U	2.2 U	20 U	20 U
Arsenic	**4.7**	**8.7**	**6.8**	1.5 U	**8.6**	**8.2**	**6.7**	**5.9**	**5.9**	**5.9**	**6.8**	**5**	**1.9**	**6.5**	**8.9**	**2.6**	**3.4**	**5.4**	**2.3**	1.8 U	**1.5**	**3.4**	8 U	8 U
Barium	**21**	**21**	**670**	**520**	**140**	**120**	**650**	**25**	**130**	**130**	**76**	**26**	**15**	**18**	**43**	**37**	**37**	**45**	**16**	**890**	**44**	**36**	100 U	100 U
Beryllium	**0.45**	**0.37**	0.49 U	0.57 U	**0.41**	**0.41**	0.45 U	0.36 U	**0.51**	**0.53**	**0.48**	**0.39**	0.38 U	**0.38**	0.32 U	0.31 U	0.32 U	**0.58**	0.37 U	0.68 U	0.33 U	0.4	3 U	3 U
Cadmium	0.34 U	0.36 U	**1.5**	0.57 U	**1.4**	**0.6**	**2.1**	0.36 U	**0.56**	**0.56**	0.33 U	0.31 U	0.38 U	0.36 U	0.32 U	0.31 U	0.32 U	0.29 U	0.37 U	2.4	0.33 U	0.33 U	3 U	3 U
Calcium	**970**	**1,200**	**51,000**	**41,000**	**37,000**	**18,000**	**45,000**	**760**	**13,000**	**12,000**	**6,700**	**860**	**400**	**810**	**2,600**	**1,200**	**1,200**	**1,100**	**590**	**110,000**	**1,000**	**1,900**	500 U	500 U
Chromium	**14**	**12**	**9.4**	**5.7**	**25**	**15**	**15**	**12**	**15**	**15**	**16**	**9.6**	**8.4**	**12**	**14**	**11**	**12**	**22**	**10**	**5.8**	**12**	**9.9**	5 U	5 U
Cobalt	**4.9**	**5**	3.3 U	3.8 U	**8.1**	**5.8**	**12**	**4.2**	**5.4**	**5.8**	**5.3**	**6.7**	**5.9**	**7.9**	**7.5**	**3.8**	**4**	**8.2**	**4.1**	4.6 U	**4.5**	**6.4**	20 U	20 U
Copper	**16**	**13**	**120**	**32**	**140**	**100**	**140**	**8.7**	**60**	**54**	**20**	**8.2**	**8.8**	**18**	**18**	**13**	**13**	**18**	**7.3**	**86**	**7.5**	**12**	10 U	10 U
Iron	**16,000**	**18,000**	**12,000**	**4,900**	**15,000**	**15,000**	**13,000**	**14,000**	**15,000**	**15,000**	**19,000**	**15,000**	**12,000**	**20,000**	**26,000**	**13,000**	**13,000**	**21,000**	**13,000**	**3,700**	**11,000**	**12,000**	110	50 U
Lead	**9.9**	**8.1**	**75,000**	**17,000**	**7,500**	**7,000**	**78,000**	**8.3**	**2,100**	**2,300**	**370**	**38**	**8.6**	**43**	**11**	**88 J**	**200 J**	**23**	**10**	**66,000**	**32**	**120**	36	8 U
Magnesium	**3,900**	**2,100**	**2,500**	**1,900**	**9,800**	**6,900**	**1,700**	**2,200**	**3,800**	**3,300**	**2,200**	**1,500**	**2,000**	**1,700**	**1,800**	**2,000**	**2,100**	**4,600**	**2,100**	**1,700**	**2,200**	**2,200**	500 U	500 U
Manganese	**210**	**450**	**3,300**	**550**	**410**	**400**	**1,800**	**160**	**360**	**390**	**320**	**360**	**530**	**460**	**370**	**140**	**140**	**260**	**120**	**2,200**	**140**	**270**	5 U	5 U
Mercury	**0.013 L**	**0.019**	**0.56**	**1.3**	**0.42**	**0.2**	**0.42**	**0.017**	**0.45**	**0.36**	**0.093**	**0.055**	**0.014**	**0.026**	**0.022**	**0.011**	**0.02**	0.0033 U	**0.015**	**1.1**	**0.016**	**0.015**	0.2 U	0.2 U
Nickel	**10**	**9.4**	**64**	**4.2**	**87**	**23**	**84**	**10**	**19**	**19**	**10**	**8**	**9.8**	**8.8**	**9.4**	**9**	**9.7**	**18**	**9.8**	**7.1**	**11**	**8.9**	20 U	20 U
Potassium	**640**	**570**	**260**	**300**	**620**	**600**	**330**	**510**	**720**	**700**	**830**	**520**	**320**	**470**	**570**	**590**	**590**	**1,900**	**370**	**260**	**480**	**600**	1,000 U	1,000 UJ
Selenium	2.3 U	2.4 U	**3.4**	3.8 U	2.2 U	2.5 U	3.0 U	2.4 U	2.1 U	2.1 U	2.2 U	2.1 U	2.5 U	2.4 U	2.1 U	2.1 U	2.2 U	2.0 U	2.5 U	4.6 U	2.2 U	2.2 U	20 U	20 U
Silver	0.57 U	0.60 U	**1.0**	0.94 U	0.56 U	0.62 U	**0.9**	0.60 U	0.53 U	0.54 U	0.54 U	0.51 U	0.63 U	0.60 U	0.54 U	0.52 U	0.54 U	0.49 U	0.62 U	1.1 U	0.55 U	0.55 U	5 U	5 U
Sodium	110 U	120 U	**170**	190 U	**200**	120 U	**200**	120 U	110 U	110 U	110 U	100 U	130 U	120 U	110 U	100 U	110 U	98 U	120 U	**280**	110 U	110 U	1,000 U	1,000 U
Thallium	2.3 U	2.4 U	3.3 U	3.8 U	2.2 U	2.5 U	3.0 U	2.4 U	2.1 U	2.1 U	2.2 U	2.1 U	2.5 U	2.4 U	2.1 U	2.1 U	2.2 U	2.0 U	2.5 U	4.6 U	2.2 U	2.2 U	20 U	20 U
Vanadium	**20**	**17**	**8.3**	**4.2**	**24**	**22**	**12**	**18**	**19**	**20**	**24**	**16**	**9**	**14**	**17**	**15**	**15**	**32**	**12**	4.6 U	**11**	**15**	20 U	20 U
Zinc	**31**	**27**	**100**	**54**	**230**	**200**	**270**	**30**	**230**	**190**	**74**	**27**	**38**	**38**	**33**	**29**	**32**	**80**	**28**	**160**	**29**	**28**	20 U	20 U
Toxicity Characteristic Leaching Procedure Analysis (milligrams per Liter)																								
Lead, SPLP	0.08 U	0.08 U	**18**	**4.6**	**7**	**7.7**	**28**	0.08 U	**0.19**	**1.2**	**0.16**	**0.25**	0.08 U	0.08 U	0.16 U	**0.38**	**1**	0.16 U	0.08 U	**14**	0.08 U	**0.51**	na	na
Synthetic Precipitation Leaching Procedure Analysis (milligrams per Liter)																								
Lead, TCLP	0.08 U	0.08 U	**20**	**3.3**	**9.8**	**8.7**	**28**	0.08 U	**2.1**	**22**	**0.86**	0.08 U	0.08 U	0.08 U	0.08 U	**0.53**	**1.7**	0.08 U	0.08 U	**6.6**	0.08 U	**1.7**	na	na

Results in **Bold** font indicate detected analytes.

U = Analyte not detected; method detection limit listed.

J = Analyte detected; concentration estimated due to quality control issues.

UJ = Analyte not detected; estimated method detection limit listed, due to quality control issues.

L =

na = Not analyzed.

Table 3-8

Summary of Groundwater Quality Parameters

Jewett White Lead Company Site

2000-2012 Richmond Terrace, Staten Island, New York

Removal Action Alternatives Report

Station Name	Field Sample ID	Sample Date	Temperature (ºC)	Specific Conductivity (µS/cm^2)	pH	Oxidation-Reduction Potential (mV)	Dissolved Oxygen (mg/L)	Turbidity (NTU)
PO-1	GW-PO1-1010	10/28/2010	17.53	1.369	6.6	-50	1.31	-1.7
PO-3	GW-PO2-1010	10/28/2010	17.53	0.723	6.74	92.3	3.69	13.5

Notes:

ºC = degrees Centigrade

µS/cm^2 = microSiemens per square centimeter

pH = logrithmic hydrogen ion concentration

mV = milliVolts

mg/L = milligrams per liter (parts per million)

NTU = Nephelometric Turbidity Units

Table 3-9
Groundwater Analytical Results
Jewett White Lead Company Site
2000-2012 Richmond Terrace, Staten Island, New York
Removal Action Alternatives Report

Location	MSC-01	MSC-02	PO-01	PO-03	PO-03	
Sample No.	GW-MSC1-1010	GW-MSC2-1010	GW-PO1-1010	GW-PO3-1010	GW-PO3-1010-E	RB-06
Sample Date	10/28/2010	10/28/2010	10/28/2010	10/28/2010	10/28/2010	10/28/2010
Target Analyte List Metals (micrograms per liter)						
Aluminum	100 U	100 U	100 U	100 U	**130**	100 U
Antimony	20 U	20 U	20 U	20 U	20 U	20 U
Arsenic	**12**	8 U	**73**	8 U	8 U	8 U
Barium	**110**	**350**	**170**	**220**	**240**	100 U
Beryllium	3 U	3 U	3 U	3 U	3 U	3 U
Cadmium	3 U	3 U	3 U	3 U	3 U	3 U
Calcium	**240,000**	**140,000**	**280,000**	**110,000**	**110,000**	500 U
Chromium	5 U	5 U	5 U	5 U	5 U	5 U
Cobalt	20 U	20 U	20 U	20 U	20 U	20 U
Copper	10 U	10 U	10 U	10 U	10 U	10 U
Iron	**280**	**860**	**24,000**	**56 J**	**120 J**	50 U
Lead	**39**	8 U	8 U	8 U	8 U	8 U
Magnesium	**670,000**	**26,000**	**28,000**	**26,000**	**27,000**	500 U
Manganese	**460**	**1,200**	**4,400**	**4,700**	**5,000**	5 U
Mercury	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 U
Nickel	20 U	20 U	20 U	20 U	20 U	20 U
Potassium	**260,000**	**28,000**	**11,000**	**14,000**	**14,000**	1,000 U
Selenium	20 U	20 U	20 U	20 U	20 U	20 U
Silver	5 U	5 U	5 U	5 U	5 U	5 U
Sodium	**1,100,000 J**	**36,000**	**17,000**	**35,000**	**35,000**	1,000 U
Thallium	20 U	20 U	20 U	20 U	20 U	20 U
Vanadium	20 U	20 U	20 U	20 U	20 U	20 U
Zinc	20 U	20 U	20 U	20 U	20 U	20 U

Results in **Bold** font indicate detected analytes.

U = Analyte not detected; method detection limit listed.

J = Analyte detected; concentration estimated due to quality control issues.

UJ = Analyte not detected; estimated method detection limit listed, due to quality control issues.

Table 3-10

Summary of Surface Water Quality Parameters

Jewett White Lead Company Site

2000-2012 Richmond Terrace, Staten Island, New York

Removal Action Alternatives Report

Station Name	Field Sample ID	Sample Date	Temperature (ºC)	Specific Conductivity (mS/cm)	pH	Oxidation-Reduction Potential (mV)	Dissolved Oxygen (mg/L)
SW-1	SW01-1109	10/19/2010	15.90	32,450	7.92	108.9	7.20
SW-2	SW02-1109	10/19/2010	15.90	28,007	7.99	114.4	7.92
SW-3	SW03-1109	10/19/2010	16.00	28,506	7.99	113.1	7.39
SW-4	SW04-1109	10/19/2010	16.00	28,999	8.02	113.5	7.23
SW-5	SW05-1109	10/28/2010	18.25	0.3112	6.33	41.7	4.02
SW-6	SW06-1109	10/28/2010	19.85	0.085	7.62	68.8	3.27

Notes:

ºC = degrees Centigrade

mS/cm = milliSiemens per centimeter

pH = logrithmic hydrogen ion concentration

mV = milliVolts

mg/L = milligrams per liter (parts per million)

Table 3-11
Sediment Analytical Results
Jewett White Lead Company Site
2000-2012 Richmond Terrace, Staten Island, New York
Removal Action Alternatives Report

Location	SW/SD-01	SW/SD-01	SW/SD-02	SW/SD-03	SW/SD-04	SW/SD-05	SW/SD-05	SW/SD-06	
Sample No.	SD-01	SD-01-E	SD-02	SD-03	SD-04	SD-05	SD-05-E	SD-06	RB-05
Sample Date	10/19/2010	10/19/2010	10/19/2010	10/19/2010	10/19/2010	10/28/2010	10/28/2010	10/28/2010	10/19/2020
Sample Location	Outfall	Outfall	Background	Outfall	Background	Catchbasin	Catchbasin	Catchbasin	
Target Analyte List Metals (milligrams per kilogram)									
Aluminum	**5,200**	**2,400**	**5,000**	**11,000**	**3,900**	**3,400**	**2,500**	**3,300**	100 U
Antimony	2.5 U	2.6 U	2.4 U	4.4 U	**4.8**	1.8 U	1.6 U	**2.4**	20 U
Arsenic	**4.9**	**2.8**	**8**	**11**	**3.2**	**3.2 J**	**1.7 J**	**2.3**	8 U
Barium	**53**	**29**	**38**	**68**	**28**	**43**	**32**	**51**	100 U
Beryllium	**2.9**	**0.92**	**0.58**	0.66 U	0.43 U	0.27 U	0.24 U	0.30 U	3 U
Cadmium	**0.63**	0.38 U	0.36 U	0.66 U	0.43 U	**0.29**	0.24 U	**0.38**	3 U
Calcium	**5,500**	**7,000**	**29,000**	**9,200**	**3,800**	**49,000 J**	**26,000 J**	**13,000**	500 U
Chromium	**54**	**21**	**22**	**70**	**24**	**13**	**8**	**42**	5 U
Cobalt	**16 L**	**6**	**6**	**19**	**6**	**4**	**4**	**5.3**	20 U
Copper	**300**	**270**	**160**	**80**	**36**	**36**	**41**	**88**	10 U
Iron	**19,000**	**11,000**	**12,000**	**28,000**	**11,000**	**9,400**	**9,400**	**15,000**	50 U
Lead	**480**	**170**	**58**	**130**	**89**	**61 J**	**130 J**	**89**	8 U
Magnesium	**7,900**	**5,000**	**4,500**	**24,000**	**6,800**	**22,000 J**	**9,200 J**	**6,700**	500 U
Manganese	**240**	**100**	**130**	**470**	**130**	**120**	**90**	**120**	5 U
Mercury	**0.22 J**	**0.11**	**0.19 J**	**1.1 J**	**0.21 J**	**0.032**	0.069 U	**0.037**	0.2 UJ
Nickel	**160**	**39**	**31**	**260**	**58**	**11**	**8.3**	**19**	20 U
Potassium	**1,100**	**510**	**1,100**	**3,100**	**920**	**470**	**450**	**910**	1,000 U
Selenium	2.5 U	2.6 U	2.4 U	4.4 U	2.9 U	1.8 U	1.6 U	2.0 U	20 U
Silver	**4.7**	**2.5**	**3.3**	**7.8**	**3**	0.44 U	0.40 U	0.50 U	5 U
Sodium	**3,100**	**2,400**	**3,000**	**9,200**	**1,400**	**450**	**470**	**200**	2,900
Thallium	2.5 U	2.6 U	2.4 U	4.48 U	2.9 U	1.8 U J	1.6 U	2.0 U	20 U
Vanadium	**17**	**11**	**15**	**32**	**14**	**19**	**27**	**29**	20 U
Zinc	**900**	**420**	**160**	**180**	**130**	**130**	**120**	**290**	20 U
Toxicity Characteristic Leaching Procedure Analysis (milligrams per Liter)									
Lead, SPLP	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	na	na	na	na
Synthetic Precipitation Leaching Procedure Analysis (milligrams per Liter)									
Lead, TCLP	**0.75**	**3.8**	0.08 U	**0.09**	**0.22**	na	na	na	na

Results in **Bold** font indicate detected analytes.

U = Analyte not detected; method detection limit listed.

J = Analyte detected; concentration estimated due to quality control issues.

UJ = Analyte not detected; estimated method detection limit listed, due to quality control issues.

na = Not analyzed.

Table 3-12

Surface Water Analytical Results

Jewett White Lead Company Site

2000-2012 Richmond Terrace, Staten Island, New York

Removal Action Alternatives Report

Location	SW/SD-01	SW/SD-02	SW/SD-03	SW/SD-04	SW/SD-05	SW/SD-05	SW/SD-06	
Sample No.	SW-01	SW-02	SW-03	SW-04	SW-05	SW-05-E	SW-06	RB-06
Sample Date	10/19/2010	10/19/2010	10/19/2010	10/19/2010	10/28/2010	10/28/2010	10/28/2010	10/28/2010
Sample Location	Outfall	Background	Outfall	Background	Catchbasin	Catchbasin	Catchbasin	
Target Analyte List Metals (micrograms per Liter))								
Aluminum	100 U	100 U	100 U	100 U	120	130	310	100 U
Antimony	20 UJ	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Arsenic	8 U	8 U	8 U	8 U	8 U	8 U	8 U	8 U
Barium	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U
Beryllium	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Cadmium	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Calcium	**220,000**	**230,000**	**230,000**	**230,000**	**21,000**	**20,000**	**10,000**	500 U
Chromium	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Cobalt	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Copper	10 U	10 U	10 U	10 U	**29**	**28**	**11**	10 U
Iron	**100**	**160**	**170**	**280**	**1,700**	**1,600**	**2,500**	50 U
Lead	8 U	8 U	8 U	8 U	**15**	**15**	**22**	8 U
Magnesium	**690,000**	**710,000**	**710,000**	**700,000**	**2,500**	**2,400**	**1,300**	500 U
Manganese	**28**	**42**	**35**	**42**	**130**	**130**	**89**	5 U
Mercury	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 U	0.2 U	0.2 U
Nickel	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Potassium	**290,000 J**	**310,000**	**330,000**	**330,000**	**13,000**	**13,000**	**3,000**	1,000 U
Selenium	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Silver	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Sodium	**6,000,000**	**6,100,000**	**6,100,000**	**6,100,000**	**14,000**	**14,000**	**7,000**	1,000 U
Thallium	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Vanadium	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Zinc	20 U	20 U	20 U	20 U	**150**	**140**	**92**	20 U

Results in **Bold** font indicate detected analytes.

U = Analyte not detected; method detection limit listed.

APPENDIX A

UNIFIED FEDERAL POLICY – QUALITY ASSURANCE PROJECT PLAN/ FIELD SAMPLING PLAN

SITE QUALITY ASSURANCE PROJECT PLAN
AND FIELD SAMPLING PLAN
JEWETT WHITE LEAD SITE
2000-2012, 2015 Richmond Terrace, Borough of Staten Island, Richmond County, New York, 10302

NON-TIME CRITICAL

Prepared By:

Removal Support Team 2
Weston Solutions, Inc.
Northeast Division
Edison, New Jersey 08837

DCN No.: RST 2-02-F-1398
Task Order No.: 18
EPA Contract No.: EP-W-06-072

September 2010

TABLE OF CONTENTS

ATTACHMENTS:

ATTACHMENT A: Site Location Map

ATTACHMENT B: SOP No.: 2001 - General Field Sampling Guides
SOP No.: 2006 - Sampling Equipment Decontamination (All Media)
SOP No.: 2007 - Groundwater Sampling
SOP No.: 2012 - Soil Sampling
SOP No.: 2013 - Surface Water Sampling
SOP No.: 2016 - Sediment Sampling
Innov-X Model X-50 Unit User's Manual
EPA Method 6200

LIST OF ACRONYMS

bgs	below ground surface
CLP	Contract Laboratory Program
COC	Chain-of-Custody
CRQL	Contract Required Quantitation Limit
DCN	Document Control Number
DESA	Division of Environmental Science and Assessment
DQI	Data Quality Indicator
DQO	Data Quality Objective
EPA	Environmental Protection Agency
ERT	Environmental Response Team
ESAT	Environmental Services Assistance Team
FPXRF	Field Portable X-Ray Fluorescence
ft	feet/foot
HASP	Health and Safety Plan
HSA	hollow-stem auger
HSO	Health and Safety Officer
LCSS	Laboratory Control Sample, Soil
LCSW	Laboratory Control Sample, Water
µg/L	micrograms per liter
mg/kg	milligrams per kilogram
MPC	measurement performance criteria
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NYSDEC	New York State Department of Environmental Conservation
OSC	On-Scene Coordinator
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
PARCCS	Precision, Accuracy, Representativeness, Completeness, Comparability, Sensitivity
PQO	project quality objectives
PRP	Potentially Responsible Party
PVC	polyvinyl chloride
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QAO	Quality Assurance Officer
QA/QC	Quality Assurance/Quality Control
QC	Quality Control

RAS	Regular Analytical Services

LIST OF ACRONYMS
(concluded)

RL	reporting limit
RPD	Relative Percent Difference
RPM	Remedial Program Manager
RSCC	Regional Sample Control Coordinator
RST	Removal Support Team
SCOs	Soil Cleanup Objectives
SOP	Standard Operating Practice
SOW	Statement of Work
SPLP	Synthetic Precipitation Leaching Procedure
SPM	Site Project Manager
STR	Sampling Trip Report
TAL	Target Analyte List
TBD	to be determined
TCLP	Toxicity Characteristic Leaching Procedure
TDD	Technical Direction Document
UFP	Uniform Federal Policy

CROSSWALK

The following table provides a "cross-walk" between the QAPP elements outlined in the Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP Manual), the necessary information, and the location of the information within the text document and corresponding QAPP Worksheet. Any QAPP elements and required information that are not applicable to the project are circled.

QAPP Element(s) and Corresponding Section(s) of UFP-QAPP Manual	Required Information	Crosswalk to QAPP Section	Crosswalk to QAPP Worksheet No.
Project Management and Objectives			
2.1 Title and Approval Page	- Title and Approval Page	Approval Page	1
2.2 Document Format and Table of Contents 2.2.1 Document Control Format 2.2.2 Document Control Numbering System 2.2.3 Table of Contents 2.2.4 QAPP Identifying Information	- Table of Contents - QAPP Identifying Information	TOC Approval Page	2
2.3 Distribution List and Project Personnel Sign-Off Sheet 2.3.1 Distribution List 2.3.2 Project Personnel Sign-Off Sheet	- Distribution List - Project Personnel Sign-Off Sheet	Approval Page	3 4
2.4 Project Organization 2.4.1 Project Organizational Chart 2.4.2 Communication Pathways 2.4.3 Personnel Responsibilities and Qualifications 2.4.4 Special Training Requirements and Certification	- Project Organizational Chart - Communication Pathways - Personnel Responsibilities and Qualifications - Special Personnel Training Requirements	2	5 6 7 8
2.5 Project Planning/Problem Definition 2.5.1 Project Planning (Scoping) 2.5.2 Problem Definition, Site History, and Background	- Project Planning Session Documentation (including Data Needs tables) - Project Scoping Session Participants Sheet - Problem Definition, Site History, and Background - Site Maps (historical and present)	1	9 10
2.6 Project Quality Objectives and Measurement Performance Criteria 2.6.1 Development of Project Quality Objectives Using the Systematic Planning Process 2.6.2 Measurement Performance Criteria	- Site-Specific PQOs - Measurement Performance Criteria	3	11 12
2.7 Secondary Data Evaluation	- Sources of Secondary Data and Information - Secondary Data Criteria and Limitations	1 2	13
2.8 Project Overview and Schedule 2.8.1 Project Overview 2.8.2 Project Schedule	- Summary of Project Tasks - Reference Limits and Evaluation - Project Schedule/Timeline	4	14 15 16

Measurement/Data Acquisition			
3.1 Sampling Tasks 3.1.1 Sampling Process Design and Rationale 3.1.2 Sampling Procedures and Requirements 3.1.2.1 Sampling Collection Procedures 3.1.2.2 Sample Containers, Volume, and Preservation 3.1.2.3 Equipment/Sample Containers Cleaning and Decontamination Procedures 3.1.2.4 Field Equipment Calibration, Maintenance, Testing, and Inspection Procedures 3.1.2.5 Supply Inspection and Acceptance Procedures 3.1.2.6 Field Documentation Procedures	- Sampling Design and Rationale - Sample Location Map - Sampling Locations and Methods/SOP Requirements - Analytical Methods/SOP Requirements - Field Quality Control Sample Summary - Sampling SOPs - Project Sampling SOP References - Field Equipment Calibration, Maintenance, Testing, and Inspection	5	17 18 19 20 21 NA
3.2 Analytical Tasks 3.2.1 Analytical SOPs 3.2.2 Analytical Instrument Calibration Procedures 3.2.3 Analytical Instrument and Equipment Maintenance, Testing, and Inspection Procedures 3.2.4 Analytical Supply Inspection and Acceptance Procedures	- Analytical SOPs - Analytical SOP References - Analytical Instrument Calibration - Analytical Instrument and Equipment Maintenance, Testing, and Inspection	6	23 24 25
3.3 Sample Collection Documentation, Handling, Tracking, and Custody Procedures 3.3.1 Sample Collection Documentation 3.3.2 Sample Handling and Tracking System 3.3.3 Sample Custody	- Sample Collection Documentation Handling, Tracking, and Custody SOPs Sample Container Identification - Sample Handling Flow Diagram - Example Chain-of-Custody Form and Seal	7	27 26
3.4 Quality Control Samples 3.4.1 Sampling Quality Control Samples 3.4.2 Analytical Quality Control Samples	- QC Samples - Screening/Confirmatory Analysis Decision Tree	5	28
3.5 Data Management Tasks 3.5.1 Project Documentation and Records 3.5.2 Data Package Deliverables 3.5.3 Data Reporting Formats 3.5.4 Data Handling and Management 3.5.5 Data Tracking and Control	- Project Documents and Records - Analytical Services - Data Management SOPs	6	29 30

Assessment/Oversight			
4.1 Assessments and Response Actions 4.1.1 Planned Assessments 4.1.2 Assessment Findings and Corrective Action Responses	- Assessments and Response Actions - Planned Project Assessments - Audit Checklists - Assessment Findings and Corrective - Action Responses	8	31 32
4.2 QA Management Reports	- QA Management Reports		33
4.3 Final Project Report	- Final Report(s)		33
Data Review			
5.1 Overview			
5.2 Data Review Steps 5.2.1 Step I: Verification 5.2.2 Step II: Validation 5.2.2.1 Step IIa Validation Activities 5.2.2.2 Step IIb Validation Activities 5.2.3 Step III: Usability Assessment 5.2.3.1 Data Limitations and Actions from Usability Assessment 5.2.3.2 Activities	- Verification (Step I) Process - Validation (Steps IIa and IIb) Process - Validation (Steps IIa and IIb) Summary - Usability Assessment	9	34 35 36 37

QAPP Worksheet #1: Title and Approval Page

Title: Site Quality Assurance Project Plan and Field Sampling Plan
Site Name/Project Name: Jewett White Lead Site
Site Location: Staten Island, New York
Revision Number: 04
Revision Date:

Weston Solutions, Inc
Lead Organization

Joseph Schmidl, PG, CWS
1090 King Georges Post Road, Suite 201
Edison, NJ 08837
Email: Joseph.Schmidl@WestonSolutions.com

Preparer's Name and Organizational Affiliation

Joseph Schmidl, PG, CWS

23 October 2010
Preparation Date (Day/Month/Year)

Site Project Manager: 11/17/10
Signature
Joseph Schmidl, PG, CWS/Weston Solutions, Inc.
Printed Name/Organization/Date

QA Officer/Technical Reviewer: 11/18/10
Signature
Smita Sumbaly/Weston Solutions, Inc.
Printed Name/Organization/Date

EPA Region 2 On-Scene Coordinator (OSC): 11/[illegible]
Signature
Kimberly Staiger/EPA Region 2
Printed Name/Organization/Date

EPA Region 2 Quality Assurance Officer (QAO):
Signature

Printed Name/Organization/Date

Document Control Number: RST 2-02-1398

QAPP Worksheet #2
QAPP Identifying Information

Site Name/Project Name: Jewett White Lead Site
Site Location: 2000-2012 Richmond Terrace, Staten Island, Richmond County, NY 10302
Operable Unit: 00
Title: Quality Assurance Project Plan
Revision Number: 00
Revision Date:

1. **Identify guidance used to prepare QAPP:**
   Uniform Federal Policy for Quality Assurance Project Plans. Refer to CLP Methods.

2. **Identify regulatory program:** EPA Region 2

3. **Identify approval entity:** EPA Region 2

4. **Indicate whether the QAPP is a generic or a Site-specific QAPP.**

5. **List dates of scoping sessions that were held:** 7 July 2010

6. **List dates and titles of QAPP documents written for previous site work, if applicable:**

   Site Quality Assurance Project Plan – Jewett White Lead Company Site,
   DCN: RST-2-F-0755, 10 December 2008.

   Final Quality Assurance Project Plan – Jewett White Lead Company Site,
   DCN: RST-2-F-1214, 15 December 2009.

7. **List organizational partners (stakeholders) and connection with lead organization:** None

8. **List data users:**
   EPA Region 2 (see Worksheet #4 for individuals)

9. **If any required QAPP elements and required information are not applicable to the project, then provide an explanation for their exclusion below:**

   None excluded

10. **Document Control Number:**
    RST 2-02-1398

QAPP Worksheet #3: Distribution List

[List those entities to which copies of the approved QAPP, subsequent QAPP revisions, addenda, and amendments are sent]

QAPP Recipient	Title	Organization	Telephone Number	Fax Number	E-mail Address	Document Control Number
Kimberly Staiger	EPA, On-Scene Coordinator	EPA Region 2	(732) 452-6415	(732) 906-6182	Staiger.Kimberly@epa.gov	RST 2-02-1398
Joseph Schmidl, PG, CWS	Site Project Manager, RST 2, ID/IQ staff	Weston Solutions, Inc.	(603) 656-5461	(603) 656-5401	Joseph.Schmidl@WestonSolutions.com	RST 2-02-1398
Jennifer Sy	HSO, RST 2	Weston Solutions, Inc.	(732) 585-4411	(732) 225-7037	Jennifer.Sy@WestonSolutions.com	RST 2-02-1398
Smita Sumbaly	QA Officer, RST 2	Weston Solutions, Inc.	(732) 585-4410	(732) 225-7037	S.Sumbaly@WestonSolutions. com	RST 2-02-1398
Site TDD File	RST 2 Site TDD File	Weston Solutions, Inc.	-	-	-	-

QAPP Worksheet #4: Project Personnel Sign-Off Sheet

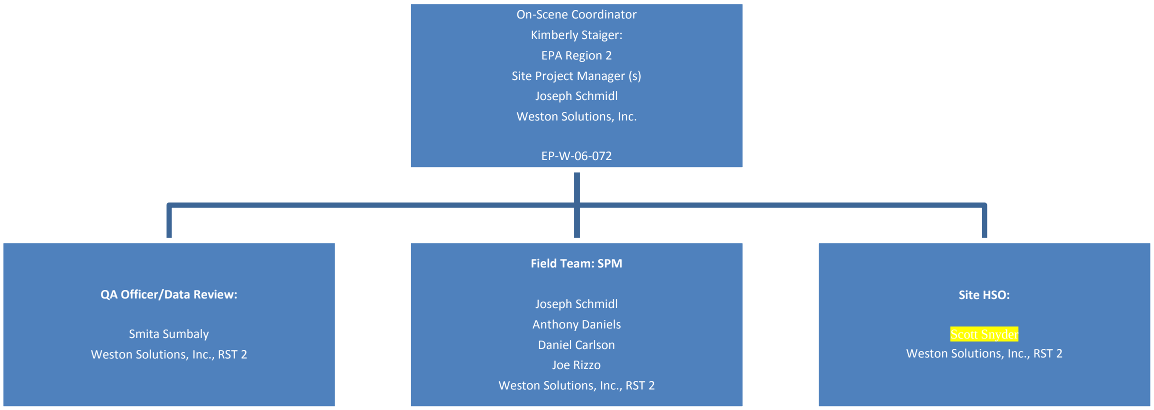
[Copies of this form signed by key project personnel from each organization to indicate that they have read the applicable sections of the QAPP and will perform the tasks as described; add additional sheets as required. Ask each organization to forward signed sheets to the central project file.]

Organization: Weston Solutions, Inc.

Project Personnel	Title	Telephone Number	Signature	Date QAPP Read
Kimberly Staiger	EPA Region 2, On-Scene Coordinator	(732) 452-6415		
Joseph Schmidl, PG, CWS	Site Project Manager, RST 2	(603) 656-5461		
Smita Sumbaly	QAO, RST 2	(732) 585-4410		
Jennifer Sy	HSO, RST 2	(732) 585-4411		
Anthony Daniels	Field Personnel, RST 2	(732) 585-4447		
Daniel Carlson	Field Personnel, RST 2	(732) 417-5863		
Scott Snyder	Field Personnel, RST 2	(732) 417-5812		
Joe Rizzo	Field Personnel, RST 2	(732) 417-5856		

QAPP Worksheet #5: Project Organizational Chart

Identify reporting relationship between all organizations involved in the project, including the lead organization and all contractor and subcontractor organizations. Identify the organizations providing field sampling, on-site and off-site analysis, and data review services, including the names and telephone numbers of all project managers, project team members, and/or project contacts for each organization.



Acronyms:

QA: Quality Assurance
SPM: Site Project Manager
HSO: Health & Safety Officer
TBD: To be determined

QAPP Worksheet #6: Communication Pathways

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure
Point of contact with EPA OSC	Site Project Manager, Weston Solutions, Inc., RST 2	Joseph Schmidl	603-656-5461	All technical, QA and decision-making matters in regard to the project (verbal, written or electronic)
Adjustments to QAPP	Site Project Manager, Weston Solutions, Inc., RST 2	Joseph Schmidl	603-656-5461	QAPP approval dialogue
Health and Safety On-Site Meeting	Site Project Manager, Weston Solutions, Inc., RST 2	Joseph Schmidl	603-656-5461	Explain Site hazards, personnel protective equipment, hospital location, etc.

OSC: On-Scene Coordinator

QAPP Worksheet #7: Personnel Responsibilities and Qualifications Table

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
Kimberly Staiger	EPA On-Scene Coordinator	EPA, Region 2	All project coordination, direction and decision making.	NA
Joseph Schmidl	Site Project Manager, RST 2	Weston Solutions, Inc.	Implementing and executing the technical, QA and health and safety during sampling event and sample management.	20 years experience*
Scott Snyder	Field Personnel, RST 2	Weston Solutions, Inc.	HSO, Sample management	12 years experience*
Daniel Carlson	Field Personnel, RST 2	Weston Solutions, Inc.	Sample collection	1 year experience*
Anthony Daniels	Field Personnel, RST 2	Weston Solutions, Inc.	Sample collection	1 year experience*
Joe Rizzo	Field Personnel, RST 2	Weston Solutions, Inc.	Sample collection	1 year experience*

*All RST 2 members, including subcontractor's resumes are in possession of RST 2 Program Manager, EPA Project Officer and Contracting officers.
NA = not applicable

QAPP Worksheet #8: Special Personnel Training Requirements Table

Project Function	Specialized Training By Title or Description of Course	Training Provider	Training Date	Personnel / Groups Receiving Training	Personnel Titles / Organizational Affiliation	Location of Training Records / Certificates1
QAPP Training	This training is presented to all RST 2 personnel to introduce the provisions, requirements, and responsibilities detailed in the UFP QAPP. The training presents the relationship between the site-specific QA Project Plans (QAPPs), SOPs, work plans, and the Generic QAPP. QAPP refresher training will be presented to all employees following a major QAPP revision.	Weston Solutions, Inc., QAO	As needed	All RST 2 field personnel upon initial employment and as refresher training	Weston Solutions, Inc.	Weston Solutions, Inc., EHS Database
Health and Safety Training	Health and safety training will be provided to ensure compliance with Occupational Safety and Health Administration (OSHA) as established in 29 CFR 1910.120.	Weston Solutions, Inc., HSO	Yearly at a minimum	All Employees upon initial employment and as refresher training every year	Weston Solutions, Inc.	Weston Solutions, Inc., EHS Database
Others	FORMS II Lite, Scribe, ICS 100 and 200, and Air Monitoring Equipment Trainings provided to all employees	Weston Solutions, Inc., QAO/Group Leader's	Upon initial employment and as needed			
	Dangerous Goods Shipping	Weston Solutions, Inc., HSO	Every 2 years			

All team members are trained in the concepts and procedures in recognizing opportunities for continual improvement, and the approaches required to improve procedures while maintaining conformance with legal, technical, and contractual obligations.

*All RST 2 members, including subcontractor's certifications are in possession of RST 2 HSO.

QAPP Worksheet #9: Project Scoping Session Participants Sheet

Site Name/Project Name: Jewett White Lead Site
Site Location: 2000-2012, 2015 Richmond Terrace, Staten Island, NY 10302
Operable Unit: 00
Date of Session: July 7, 2010
Scoping Session Purpose: To discuss questions, comments, and assumptions regarding technical issues involved with the project.

Name	Title	Affiliation	Phone #	E-mail Address	*Project Role
Joseph Schmidl	Site Project Manager	Weston Solutions, Inc.	603-656-5461	Joseph.Schmidl@WestonSolutions.com	Site Project Management
Kimberly Staiger	EPA OSC	EPA Region 2	732-452-6415	Kimberly.Staiger@epa.gov	OSC
Jennifer Sy	Group Leader	Weston Solutions, Inc.	732-585-4411	Jennifer.Sy@WestonSolutions.com	Group Leader

Comments/Decisions: Four RST 2 members will conduct the sampling. At 2000-2012 Richmond Terrace, soil samples will be collected from a total of 26 test pits excavated using a backhoe. At 2015 Richmond Terrace, soil samples will be collected from a total of 25 locations using a direct-push unit. Soil samples will be collected from 1-ft depth intervals from the surface at each location, with the depth below ground surface (bgs) of each soil boring or test pit determined based on the extent of lead impacts documented by field screening for lead on-site using a field portable X-ray fluorescence (FPXRF) unit. Twenty of these soil samples will be submitted to CLP for confirmatory analysis for total Lead, as well as Toxicity Characteristic Leaching Procedure (TCLP) and Synthetic Precipitation Leaching Procedure (SPLP) Lead.

Five overburden monitoring wells will be installed on-site (three at 2000 and two at 2015 Richmond Terrace) using hollow-stem auger (HSA) drilling methods. Each well will be developed and surveyed for location and elevation. Following equilibration, groundwater samples will be collected using low-flow methodology and submitted to CLP for total Lead analysis. Additional overburden monitoring wells may be installed in the future.

Up to five collocated sediment/surface water samples will be collected from storm sewer outfalls adjacent to the Site. The samples will be submitted to CLP for total Lead analysis.

Action Items: RST 2 will prepare the UFP-QAPP, submit the Analytical Request Form, and prepare for the sampling event. EPA will provide the UFP-QAPP to property owners and obtain site access

Consensus Decisions: Samples will be collected for definitive data. Sampling will be conducted during mid-September 2010.

QAPP Worksheet #10: Problem Definition

PROBLEM DEFINITION

EPA Region 2 has requested that RST 2 collect additional environmental data from the Jewett White Lead Site to support an Engineering Evaluation/Cost Analysis (EE/CA) of the historic footprint of the former Jewett White Lead Company facility and extent of contamination, which includes the 1-acre parcel of land at 2000-2012 Richmond Terrace and the approximately 1.5-acre parcel of land at 2015 Richmond Terrace.

SITE HISTORY/CONDITIONS

Historically, John Jewett & Sons White Lead Company operated a white lead manufacturing facility at the Site. John Jewett & Sons White Lead Company owned the Site from 1839 until April 3, 1890 when National Lead & Oil Company of New York ("National Lead") acquired the Site property. National Lead continued the manufacture of white lead, an additive found in lead-based paint and ceramics, at the Site until about 1943. A fire destroyed the plant's main building and storage house in 1920. On December 31, 1943, Moran Towing Corporation acquired the 2015 Richmond Terrace portion of the Site from National Lead. On May 31, 1946, National Lead sold the remaining parcel of land located at 2000 Richmond Terrace. Between 1949 and 1990 various businesses operated at 2000-2012 Richmond Terrace, including Sedutto's Ice Cream factory.

Currently, the portion of the Site located at 2000-2012 Richmond Terrace is being used to store construction equipment and materials from local construction projects. The portion of the Site located at 2015 Richmond Terrace is presently owned by the Moran Towing Corporation, an active tug boat facility.

On June 3, 2008, the Council of the City of New York submitted a written request to EPA to evaluate the Site for a possible cleanup. In December 2008, EPA and contractor representatives collected soil samples throughout the 2000-2012 Richmond Terrace property. Elevated levels of lead were found throughout most of the property, both laterally and with depth. Elevated levels of lead were identified in a small area of the sidewalk on Richmond Terrace, demonstrating that lead contaminated soil had migrated from the Site onto the adjacent sidewalk during heavy rain events.

On 15 June 2009, EPA collected 14 surficial soil samples, some of which were identified as “grit”, from portions of the 2015 Richmond Terrace property where exposed soil was present or where the concrete and asphalt appeared to be in disrepair. Elevated levels of lead were found to be in the surface soils, with the highest levels of lead present in the surface soils and grit immediately adjacent the Richmond Terrace sidewalk.

EPA has determined that an immediate cleanup is needed to address the potential for soil contamination to migrate offsite due to the current use of the Site.

RST 2 conducted an off-site reconnaissance on 7 July 2010, to assess access and potential barriers to fieldwork at the Site.

QAPP Worksheet #10: Problem Definition (continued)

PROJECT DESCRIPTION

During the Scoping Meeting, EPA indicated that soil, groundwater, sediment, and surface water data gaps will be eliminated by the collection of additional environmental samples. RST 2 has been tasked to collect soil samples from the two properties (2000-2012 and 2015 Richmond Terrace) that comprise the Site to better document existing soil conditions and to estimate the extent of soil that will need to be removed from the Site. RST 2 will collect soil samples from a total of 51 locations selected by RST 2 and EPA based on grid pattern. Soil samples will be collected from each of these locations at 1 foot intervals from the surface to a depth to be determined at each location, based on the extent of lead impacts or the depth of the water table, whichever is shallower. All soil samples will be screened for lead onsite using a FPXRF unit, and seven duplicate sample analyses will be performed. 10% of soil samples will be submitted to CLP for confirmatory analysis for total Lead, as well as TCLP and SPLP Lead. One MS/MSD and one field duplicate soil samples will be submitted to CLP.

Five overburden monitoring wells will be installed (three at 2000-2012, and two at 2015 Richmond Terrace) using HSA drilling methods. Soil samples will be collected from each of the well locations at 1 foot intervals to the depth of the water table. Soil samples from the depth interval intersecting the water table will be submitted to CLP for confirmatory analysis for total Lead, as well as TCLP and SPLP Lead. Each well will be developed and surveyed for location and elevation. Following equilibration, groundwater samples will be collected using low-flow methodology and submitted to CLP for total Lead analysis. One MS/MSD and field duplicate groundwater sample will be submitted to CLP. Based on the validated analytical results, additional overburden monitoring wells may be required, and will be installed during a second-phase of investigation.

As-built plans for the storm sewer system surrounding the Site will be obtained from local authorities and reconnoitered to identify potential sediment/surface water sample locations. Up to ten collocated sediment/surface water samples will be collected from storm sewers or their outfalls adjacent to the Site, as well as the Kill Van Kull. Sediment and surface water samples collected from the Kill Van Kull will be collected using a ponar sampler deployed from an EPA boat. The samples will be submitted to CLP for total Lead analysis. One MS/MSD and field duplicate sediment and surface water sample will be submitted to CLP.

EPA will request that the laboratory retain confirmatory soil and sediment samples for up to six months, to accommodate potential subsequent specialized analyses which may be required based on the validated analytical results.

Additional samples may be collected at the direction of the OSC based upon field conditions.

Ambient air monitoring will be conducted at upwind and downwind locations along the perimeter of the Site during intrusive activities to ensure no off-site migration of lead-impacted soils. Engineering controls, such as dust suppression via water spray, will be employed to eliminate dust generation. On-site personnel will wear personal dust monitors to document potential lead exposures.

QAPP Worksheet #10: Problem Definition (concluded)

PROJECT DECISION STATEMENTS

Site data will be evaluated in a Removal Action Alternatives Report. If the available environmental data are found to fully characterize lead impacts at the Site, then, removal options for soils which contain lead at concentrations above the EPA Soil Screening Value for commercial areas (800 mg/kg) will be evaluated in the Report. If the available environmental data are found to contain data gaps, then, additional multi-media sampling will be proposed to determine the extent of contamination.

QAPP Worksheet # 11: Project Quality Objectives/Systematic Planning Process Statement

Overall project objectives include: Sampling will be conducted by RST 2 to identify/confirm the presence of contamination in site soils, groundwater, sediment, and surface water.

Who will use the data? Data will be used by EPA Region 2 OSC.

What will the data be used for? Data from this sampling event will be used to determine the nature and extent of soil, groundwater, sediment and surface water impacts, and will also be used to evaluate removal options for the Site.

What types of data are needed?
Matrix: Soil (Soil and Sediment); Aqueous (Groundwater, Surface Water, and Equipment Rinsate Blanks)
Type of Data: Screening and definitive data
Analytical Techniques: On-site screening analysis and off-site laboratory analyses
Parameters: Total Lead; TCLP Lead, and SPLP Lead (soil samples only)
Type of sampling equipments: Plastic bags, plastic scoops (soils and sediments); plastic tubing (groundwater)
Access Agreement(s): None. EPA will obtain access to 2000-2012 and 2015 Richmond Terrace.
Sampling locations: On-site and off-site

How many data are needed? In addition to available analytical results, soil samples at one foot intervals at up to 51 locations for a total of 204 samples (field screening results), with approximately 20 soil samples submitted to CLP. In addition, five groundwater samples and five sediment and surface water samples.

How "good" does the data need to be in order to support the environmental decision?
Sampling/analytical measurement performance criteria for PARCCS parameters will be established. Refer to Worksheet #12, criteria for performance measurement for screening and definitive data.

Where, when, and how should the data be collected/generated? Two properties (2000-2012 and 2015 Richmond Terrace) have been selected for soil sampling. Soil sample locations will be based on a 50-ft grid on 2000-2012 Richmond Terrace and a 100-ft grid on 2015 Richmond Terrace, without bias. Sediment and surface water samples will be collected from storm water catch basins proximal to the site, the outfalls from the storm water drainage system, and The Kill Van Kull. The sampling event is scheduled to be conducted in early September 2010. Additional samples may be collected at the direction of the OSC based upon field conditions.

Who will collect and generate the data? The samples will be collected by Weston Solutions, Inc. Soil samples will be screened for lead by a Weston Solutions, Inc. FPXRF operator. Laboratory samples will be analyzed by EPA's DESA Laboratory and validated by EPA's Environmental Services Assistance Team (ESAT).

QAPP Worksheet # 11: Project Quality Objectives/Systematic Planning Process Statement (concluded)

How will the data be reported? Data will be reported by the assigned laboratories (Preliminary, Electronics, and Hard Copy format). The Site Project Manager will provide a Sampling Trip Report, Status Reports, Maps/Figures, Analytical Report, and Data Validation Report to the EPA OSC.

How will the data be archived? Electronic data deliverables will be archived in the database. CLP data will be archived in EPA's document control room.

QAPP Worksheet #12: Measurement Performance Criteria Table
Worksheet # 12A: Lead - Inorganics/RST 2 Field Screen Lead EPA Method 6200

(UFP-QAPP Manual Section 2.6.2)
Complete this worksheet for each matrix, analytical group, and concentration level. Identify the data quality indicators (DQI), measurement performance criteria (MPC) and QC sample and/or activity used to assess the measurement performance for both the sampling and analytical measurement systems. Use additional worksheets if necessary. If MPC for specific DQI vary within an analytical parameter, i.e., MPC are analyte-specific, then provide analyte-specific MPC on an additional worksheet.

Matrix	Soil
Analytical Group	Lead Field Screen by FPXRF
Concentration Level	(mg/kg)

Sampling Procedure[1]	**Analytical Method/SOP**[2]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
	EPA Method 6200/ Innov-X Model X-50 FPXRF Unit User's Manual	Precision (field)	≤ 20% RPD*	Field Duplicate	S & A
		Accuracy (field)	No analyte > RL*	Standardization Blank	S & A
		Precision (laboratory)	≤ 20% RPD*	Duplicate Sample **	A
		Accuracy (laboratory)	75–125%; 80–120 %	Standardization Blank	A A

[1] Reference number from QAPP Worksheet #21.
[2] Reference number from QAPP Worksheet #23.
*Reference USEPA Region 2 SOP No. HW-2, Revision 13/Evaluation of Metals Data for CLP - (include absolute difference criteria):
http://www.epa.gov/region02/qa/qa_documents/SOP%20HW02%20FINAL%20Rev-13-ILM05_3.pdf
**Reference USEPA CLP ILM05.4, Exhibit D of ICP-AES for Duplicate Sample Criteria - (include absolute difference criteria)

QAPP Worksheet #12: Measurement Performance Criteria Table
Worksheet # 12B: TAL Metals - Inorganics/CLP ILMO5.4

(UFP-QAPP Manual Section 2.6.2)
Complete this worksheet for each matrix, analytical group, and concentration level. Identify the data quality indicators (DQI), measurement performance criteria (MPC) and QC sample and/or activity used to assess the measurement performance for both the sampling and analytical measurement systems. Use additional worksheets if necessary. If MPC for specific DQI vary within an analytical parameter, i.e., MPC are analyte-specific, then provide analyte-specific MPC on an additional worksheet.

Matrix	Soil (Soil, Sediment)
Analytical Group	Total Lead
Concentration Level	ICP-AES (mg/kg)

Sampling Procedure[1]	**Analytical Method/SOP**[2]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
	ILM05.4	Precision (field)	≤ 35% RPD*	Field Duplicate	S & A
		Accuracy (field)	No analyte > CRQL*	Field Blank	S & A
		Precision (laboratory)	≤ 35% RPD*	Duplicate Sample**	A
		Accuracy (laboratory)	75–125%;	Matrix Spike***; LCSS****	A

[1] Reference number from QAPP Worksheet #21.
[2] Reference number from QAPP Worksheet #23.
*Reference USEPA Region 2 SOP No. HW-2, Revision 13/Evaluation of Metals Data for CLP - (include absolute difference criteria): http://www.epa.gov/region02/qa/qa_documents/SOP%20HW02%20FINAL%20Rev-13-ILM05_3.pdf
**Reference USEPA CLP ILM05.4, Exhibit D of ICP-AES for Duplicate Sample Criteria
***Reference USEPA CLP ILM05.4, Exhibit D of ICP-AES for Spike Sample Criteria
****Reference USEPA CLP ILM05.4, Exhibit D of ICP-AES for solid Laboratory Control Sample (LCSS) **Note: Control Limits established by USEPA for LCSS:** http://www.epa.gov/superfund/programs/clp/ilm5.htm

QAPP Worksheet #12: Measurement Performance Criteria Table
Worksheet # 12C: TCLP Metals - Inorganics/CLP EPA Method 1311 Extraction/ILMO5.4

(UFP-QAPP Manual Section 2.6.2)
Complete this worksheet for each matrix, analytical group, and concentration level. Identify the data quality indicators (DQI), measurement performance criteria (MPC) and QC sample and/or activity used to assess the measurement performance for both the sampling and analytical measurement systems. Use additional worksheets if necessary. If MPC for specific DQI vary within an analytical parameter, i.e., MPC are analyte-specific, then provide analyte-specific MPC on an additional worksheet.

Matrix	Soil (Soil)
Analytical Group	TCLP
Concentration Level	ICP-AES (mg/L)

Sampling Procedure[1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
	SW 846 Method 1311 TCLP Extraction and ILM05.4	Precision (field)	≤ 35% RPD*	Field Duplicate	S & A
		Accuracy (field)	No analyte > CRQL*	Field Blank	S & A
		Precision (laboratory)	≤ 35% RPD*	Duplicate Sample**	A
		Accuracy (laboratory)	75–125%;	Matrix Spike***; LCSS****	A

[1] Reference number from QAPP Worksheet #21.
[2] Reference number from QAPP Worksheet #23.
*Reference USEPA Region 2 SOP No. HW-2, Revision 13/Evaluation of Metals Data for CLP – (include absolute difference criteria): http://www.epa.gov/region02/qa/qa_documents/SOP%20HW02%20FINAL%20Rev-13-ILM05_3.pdf
**Reference USEPA CLP ILM05.4, Exhibit D of ICP-AES for Duplicate Sample Criteria
***Reference USEPA CLP ILM05.4, Exhibit D of ICP-AES for Spike Sample Criteria
****Reference USEPA CLP ILM05.4, Exhibit D of ICP-AES for solid Laboratory Control Sample (LCSS) Note: Control Limits established by USEPA for LCSS: http://www.epa.gov/superfund/programs/clp/ilm5.htm

QAPP Worksheet #12: Measurement Performance Criteria Table
Worksheet # 12D: SPLP Metals - Inorganics/CLP EPA Method 1312 Extraction/ILMO5.4

(UFP-QAPP Manual Section 2.6.2)
Complete this worksheet for each matrix, analytical group, and concentration level. Identify the data quality indicators (DQI), measurement performance criteria (MPC) and QC sample and/or activity used to assess the measurement performance for both the sampling and analytical measurement systems. Use additional worksheets if necessary. If MPC for specific DQI vary within an analytical parameter, i.e., MPC are analyte-specific, then provide analyte-specific MPC on an additional worksheet.

Matrix	Soil (Soil)
Analytical Group	SPLP
Concentration Level	ICP-AES (mg/L)

Sampling Procedure[1]	**Analytical Method/SOP**[2]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
	SW 846 Method 1312 SPLP Extraction and ILM05.4	Precision (field)	≤ 35% RPD*	Field Duplicate	S & A
		Accuracy (field)	No analyte > CRQL*	Field Blank	S & A
		Precision (laboratory)	≤ 35% RPD*	Duplicate Sample**	A
		Accuracy (laboratory)	75–125%;	Matrix Spike***; LCSS****	A

[1] Reference number from QAPP Worksheet #21.
[2] Reference number from QAPP Worksheet #23.
*Reference USEPA Region 2 SOP No. HW-2, Revision 13/Evaluation of Metals Data for CLP – (include absolute difference criteria): http://www.epa.gov/region02/qa/qa_documents/SOP%20HW02%20FINAL%20Rev-13-ILM05_3.pdf
**Reference USEPA CLP ILM05.4, Exhibit D of ICP-AES for Duplicate Sample Criteria
***Reference USEPA CLP ILM05.4, Exhibit D of ICP-AES for Spike Sample Criteria
****Reference USEPA CLP ILM05.4, Exhibit D of ICP-AES for solid Laboratory Control Sample (LCSS) Note: Control Limits established by USEPA for LCSS: http://www.epa.gov/superfund/programs/clp/ilm5.htm

QAPP Worksheet #12: Measurement Performance Criteria Table
Worksheet # 12E: TAL Metals - Inorganics/CLP ILMO5.4

(UFP-QAPP Manual Section 2.6.2)
Complete this worksheet for each matrix, analytical group, and concentration level. Identify the data quality indicators (DQI), measurement performance criteria (MPC) and QC sample and/or activity used to assess the measurement performance for both the sampling and analytical measurement systems. Use additional worksheets if necessary. If MPC for specific DQI vary within an analytical parameter, i.e., MPC are analyte-specific, then provide analyte-specific MPC on an additional worksheet.

Matrix	Aqueous (Groundwater, Surface Water, Rinsate Blank)
Analytical Group	Total Lead
Concentration Level	ICP-AES (µg/L)

Sampling Procedure[1]	**Analytical Method/SOP**[2]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
	ILM05.4	Precision (field)	≤ 20% RPD*	Field Duplicate	S & A
		Accuracy (field)	No analyte > CRQL*	Field Blank	S & A
		Precision (laboratory)	≤ 20% RPD*	Duplicate Sample **	A
		Accuracy (laboratory)	75–125%; 80–120 %	*** Matrix Spike; LCSW****	A A

[1] Reference number from QAPP Worksheet #21.
[2] Reference number from QAPP Worksheet #23.
*Reference USEPA Region 2 SOP No. HW-2, Revision 13/Evaluation of Metals Data for CLP - (include absolute difference criteria):
http://www.epa.gov/region02/qa/qa_documents/SOP%20HW02%20FINAL%20Rev-13-ILM05_3.pdf
**Reference USEPA CLP ILM05.4, Exhibit D of ICP-AES for Duplicate Sample Criteria - (include absolute difference criteria)
***Reference USEPA CLP ILM05.4, Exhibit D of ICP-AES for Spike Sample Criteria
****Reference USEPA CLP ILM05.4, Exhibit D of ICP-AES for aqueous Laboratory Control Sample (LCSW) Criteria w/exception of Ag and Sb
http://www.epa.gov/superfund/programs/clp/ilm5.htm

QAPP Worksheet #12: Measurement Performance Criteria Table
Worksheet # 12F: TAL Metals - Inorganics/NIOSH Method 7082

(UFP-QAPP Manual Section 2.6.2)
Complete this worksheet for each matrix, analytical group, and concentration level. Identify the data quality indicators (DQI), measurement performance criteria (MPC) and QC sample and/or activity used to assess the measurement performance for both the sampling and analytical measurement systems. Use additional worksheets if necessary. If MPC for specific DQI vary within an analytical parameter, i.e., MPC are analyte-specific, then provide analyte-specific MPC on an additional worksheet.

Matrix	Particulate (Dust Monitor Filter)
Analytical Group	Total Lead
Concentration Level	Flame AAS (µg/m^3)

Sampling Procedure[1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
	NIOSH 7082	Precision (field)	$\leq$ 20% RPD	None	S & A
		Accuracy (field)	No analyte > CRQL	None	S & A
		Precision (laboratory)	$\leq$ 20% RPD*	None	A
		Accuracy (laboratory)	75–125%; 80–120 %	None	A A

[1] Reference number from QAPP Worksheet #21.
[2] Reference number from QAPP Worksheet #23.

QAPP Worksheet #13: Secondary Data Criteria and Limitations Table

Any data needed for project implementation or decision making that are obtained from non-direct measurement sources such as computer databases, background information, technologies and methods, environmental indicator data, publications, photographs, topographical maps, literature files and historical data bases will be compared to the DQOs for the project to determine the acceptability of the data. Thus, for example, analytical data from historical surveys will be evaluated to determine whether they satisfy the validation criteria for the project and to determine whether sufficient data was provided to allow an appropriate validation to be done. If not, then a decision to conduct additional sampling for the site may be necessary.

Secondary Data	Data Source (Originating Organization, Report Title, and Date)	Data Generator(s) (Originating Org., Data Types, Data Generation/ Collection Dates)	How Data May Be Used (if deemed usable during data assessment stage)	Limitations on Data Use
Previous Investigation Sampling Results	Data Reports, Sampling Trip Reports delivered to EPA.	EPA Region 2. 15 December 2008 (Sampling Report Data Presentation), 3 February 2009 (Sampling Trip Report), and USEPA-CLP Inorganic Analysis Data Sheets for samples received on 16 June 2009.	Data used to confirm soil and sediment contamination.	None.

QAPP Worksheet #14: Summary of Project Tasks

Sampling Tasks: Soil: Up to 104 soil samples will be collected from up to 25 test pits at 2000-2012 Richmond Terrace. Soil samples will be collected at each location at 1-ft depth intervals, beginning at the surface and extending to limit of lead impacts or the water table, whichever is shallower. In addition, soil samples will be collected at each monitoring well location at 1-ft depth intervals, beginning at the water table and extending to limit of lead impacts, or 7 ft below the water table, whichever is shallower. Up to 100 soil samples will be collected from up to 25 direct-push boring locations at 2015 Richmond Terrace. Four samples will be collected at each location at 1-ft depth intervals, beginning at the surface and extending to limit of lead impacts or the water table, whichever is shallower.

Groundwater: Installation, development, surveying, and sampling of five overburden monitoring wells (3 at 2000-2012 Richmond Terrace and 2 at 2015 Richmond Terrace).

Sediment and Surface Water: Up to ten collocated sediment/surface water samples will be collected from storm sewers or their outfalls adjacent to the Site, as well as the Kill Van Kull. Sediment and surface water samples collected from the Kill Van Kull will be collected using a ponar sampler deployed from an EPA boat. Sample locations will be based on the results of Site reconnaissance and available as-built plans for the storm sewer system surrounding the Site, and will be approved by the OSC.

Analysis Tasks: Field screening of 211 soil samples using FPXRF by EPA Method 6200
Total Lead – Soil and Aqueous – CLP ILMO5.4
TCLP Lead – Soil– SW 846 Method 1311 TCLP Extraction and CLP ILMO5.4
SPLP Lead – Soil– SW 846 Method 1312 SPLP Extraction and CLP ILMO5.4

Quality Control Tasks: QA/QC samples will include the collection of one duplicate and additional volume for one MS/MSD at the ratio of 1 per 20 samples and one rinsate blank per day.

Data Management Tasks: The data collected for the sampling activities will be organized, analyzed, and summarized in status and trip reports and other deliverables (e.g., analytical reports, final reports) that will be submitted to the OSC according to the Project Schedule. The reports will be prepared by the Project Manager and include appropriate data quality assessment. Standard methods and references will be used as guidelines for data reduction and reporting.

Documentation and Records: Field logbook, photodocumentation, sample labels, custody seals, chain of custody, sample logs, soil boring logs, well construction logs, test pit logs, etc.

All sample documents will be completed legibly, in ink. Any corrections or revisions will be made by lining through the incorrect entry and by initialing the error.

The following deliverables will be provided under this project:

Trip Report: A trip report will be prepared to provide a detailed accounting of what occurred during each sampling mobilization. The trip report will be prepared within 2 weeks of the last day of each sampling mobilization. Information will be provided on time of major events, dates, and personnel on-site (including affiliations).

QAPP Worksheet #14: Summary of Project Tasks (continued)

Maps/Figures: Maps depicting site layout, contaminant source areas, and sample locations will be included in the trip report, as appropriate.

Field Logbook: The field logbook is essentially a descriptive notebook detailing site activities and observations so that an accurate account of field procedures can be reconstructed in the writer's absence. The field logbook will be bound and paginated. All entries will be dated and signed by the individuals making the entries, and should include (at a minimum) the following:

1. Site name and project number
2. Name(s) of personnel on-site
3. Dates and times of all entries (military time preferred)
4. Descriptions of all site activities, site entry and exit times
5. Noteworthy events and discussions
6. Weather conditions
7. Site observations
8. Sample and sample location identification and description*
9. Subcontractor information and names of on-site personnel
10. Date and time of sample collections, along with chain of custody information
11. Record of photographs
12. Site sketches

* The description of the sample location will be noted in such a manner as to allow the reader to reproduce the location in the field at a later date.

Sample Labels: Sample labels will clearly identify the particular sample, and should include the following:

1. Site/project number.
2. Sample identification number.
3. Sample collection date and time.
4. Designation of sample (grab or composite).
5. Sample preservation.
6. Analytical parameters.
7. Name of sampler.

Sample labels will be written in indelible ink and securely affixed to the sample container. Tie-on labels can be used if properly secured.

Custody Seals: Custody seals demonstrate that a sample container has not been tampered with or opened. The individual in possession of the sample(s) will sign and date the seal, affixing it in such a manner that the container cannot be opened without breaking the seal. The name of this individual, along with a description of the sample packaging, will be noted in the field logbook.

Assessment/Audit Tasks: No performance audit of field operations is anticipated at this time. If conducted, performance and systems audits will be in accordance with the project plan.

Data Review Tasks: All CLP data will be validated by EPA Region 2 DESA/HWSB/ HWSS in accordance with latest SOW.

QAPP Worksheet #15: Reference Limits and Evaluation Tables

Matrix: Soil (Soil)
Analytical Group: Field Screen Lead
Concentration Level: Low FPXRF

Analyte	CAS Number	NYSDEC Restricted Use Soil Cleanup Objectives (mg/kg)*		NYSDEC Unrestricted Soil Cleanup Objectives (mg/kg)**	EPA Restricted Use Soil Screening Value (mg/kg)	Project Quantitation Limit (mg/kg)	Analytical Method – EPA 6200 Quantitation Limits (mg/kg)
		Residential	Commercial				
Lead	7439-92-1	400	1,000	63	800	NS	5

*New York State Department of Environmental Protection (NYSDEC) – SubPart 375-6.4, Restricted Use Soil Cleanup Objectives, 14 December 2006.
**New York State Department of Environmental Protection (NYSDEC) – SubPart 375-6.3, Unrestricted Use Soil Cleanup Objectives, 14 December 2006.
NS = Not Specified

Matrix: Soil (Soil, Sediment***)
Analytical Group: Target Analyte List Lead
Concentration Level: Low – ICP-AES

Analyte	CAS Number	NYSDEC Restricted Use Soil Cleanup Objectives (mg/kg)*		NYSDEC Unrestricted Soil Cleanup Objectives (mg/kg)**	EPA Restricted Use Soil Screening Value (mg/kg)	Project Quantiation Limit (mg/kg)	Analytical Method – SOM01.2 Quantitation Limits (mg/kg)
		Residential	Commercial				
Lead	7439-92-1	400	1,000	63	800	NS	1

*New York State Department of Environmental Protection (NYSDEC) – SubPart 375-6.4, Restricted Use Soil Cleanup Objectives, 14 December 2006.
**New York State Department of Environmental Protection (NYSDEC) – SubPart 375-6.3, Unrestricted Use Soil Cleanup Objectives, 14 December 2006.
***For the purposes of this evaluation, and based on the lack of environmental targets, sediment lead concentrations will be compared to residential/commercial soil human health standards.
NS = Not Specified

QAPP Worksheet #15: Reference Limits and Evaluation Tables (concluded)

Matrix: Aqueous (Groundwater, Surface Water, Rinsate*)
Analytical Group: Target Analyte List Lead
Concentration Level: Low – ICP-AES

Analyte	CAS Number	NYSDEC Groundwater Quality Standards **(µg/L)	NYS Surface Water Quality Standards*** (µg/L)	Project Quantiation Limit (µg/L)	Analytical Method – ILMO5.4 ICP-AES Quantitation Limits (µg/L)
Lead	7439-92-1	25	50	NS	10

* Rinsate blanks and will be collected to assess the efficacy of the decontamination process.
** Based on NYSDEC Part 703 Water Quality Standards for human health for groundwater used as a drinking water source.
*** Based on NYSDEC Part 703 Water Quality Standards for human health for surface water used as a drinking water source.
NS = Not Specified

QAPP Worksheet #16: Project Schedule/Timeline Table

		Dates			
Activities Org	**anization**	**Anticipated Date(s) of Initiation**	**Anticipated Date of Completion**	**Deliverable**	**Deliverable Due Date**
Preparation of QAPP	RST 2 Contractor Site Project Manager	Prior to sampling date	30 July 2010	QAPP	30 July 2010
Review of QAPP	RST 2 Contractor QAO and/or Group Leader	Prior to sampling date	4 August 2010	Approved QAPP	4 August 2010
Preparation of Health and Safety Plan	RST 2 Contractor Site Project Manager	Prior to sampling date	6 August 2010	HASP	30 August 2010
Procurement of Field Equipment	RST 2 Contractor Site Project Manager and/or Equipment Officer	Prior to sampling date	27 August 2010	NA	NA
Laboratory Request	RST 2 Contractor Site Project Manager and/or QAO	Prior to sampling date	6 August 2010	CLP Request Form	NA
Field Reconnaissance/Access	RST 2 Contractor Site Project Manager; or EPA Region 2 OSC	Prior to sampling date	7 July 2010	Access Agreement(s)	27 August 2010
Collection of Field Samples	RST 2 Contractor Site Project Manager	6 September 2010	10 September 2010	Sampling Trip Report	24 September 2010
Laboratory Electronic Data Received	EPA Region 2 DESA	13 September 2010	24 September 2010	Preliminary Data	24 September 2010
Laboratory Package Received	EPA Region 2 DESA	13 September 2010	1 October 2010	Laboratory Data Package	1 October 2010
Validation of Laboratory Results	EPA Region 2 DESA	4 October 2010	22 October 2010	Data Validation Report	22 October 2010
Data Evaluation/ Preparation of Final Report	RST 2 Contractor Site Project Manager	TBD	TBD	Final Report	TBD

QAPP Worksheet #17: Sampling Design and Rationale

Soil Sampling: RST 2 will collect up to 204 soil samples and 10 duplicate samples from up to 51 locations at the Site. All sampling will be conducted by RST 2, under the direction of the EPA OSC. The soil/aqueous samples will be collected for Total Lead analysis. These locations include 26 test pits to be excavated at 2000-2012 Richmond Terrace, designed to in-fill the existing 100-ft sampling grid, to result in 50-ft soil sample spacing, and 25 direct-push sample locations at 2015 Richmond Terrace, arranged in a 100-ft grid spacing. In the event that direct-push sampler refusal prevents sample collection to the required depth at 2015 Richmond Terrace, HAS drilling techniques will be employed to obtain the samples. In combination with existing soil data, the resultant dataset should provide adequate coverage to define the nature and extent of lead impacts associated with the Site. This sampling design is based on information currently available and may be modified onsite in light of field-screening results and other acquired information.

Soil sampling activities will be conducted in accordance with guidelines outlined in EPA/ERT Soil Sampling SOP #2012. Soil samples will be collected at up to 51 locations on Site, to the depth where lead impacts from the Site cease. Each test pit or soil core will be logged to characterize soil type, color, moisture, and other distinctive features. Soil samples will be collected from test pits or soil cores using disposable plastic tools, with grab samples being collected from each 1-foot depth interval at each location. At 2000-2012 Richmond Terrace, test pits will initially be sampled from the surface to 4 ft bgs. If FPXRF soil lead screening results indicate lead impacts (soil lead concentrations greater than 800 mg/kg) at 3 to 4 ft bgs, deeper soil samples will be collected, to the depth of the water table, whichever is shallower. At 2015 Richmond Terrace, the four initial soil boring sampling depths will be 0 to 1 ft., 1 to 2 ft., 2 to 3 ft., and 3 to 4 ft bgs. If FPXRF soil lead screening results indicate lead impacts (soil lead concentrations greater than 800 mg/kg) at 3 to 4 ft bgs, deeper soil samples will be collected, to the depth of the water table, if necessary. In addition, soil samples will be collected at each monitoring well location at 1-ft depth intervals, beginning at the water table and extending to limit of lead impacts (soil lead concentrations greater than 800 mg/kg), or 7 ft below the water table, whichever is shallower. Soils samples will be placed into 12-ounce polyethylene bags.

Field screening for lead in soil will be performed using FPXRF technology on-site. FPXRF sample analyses and handling will be conducted in accordance with the Innov-X Model X-50 FPXRF Unit User's Manual and EPA Method 6200 (see Attachment B). The samples will be homogenized within their polyethylene bag and analyzed for lead using the FPXRF three times. Organic debris and gravel will be removed from the sample before homogenization. Each XRF sample screening interval will last 30 seconds. The three results will be averaged to determine the lead concentration in the sample. Duplicate samples for FPXRF analysis will be split from the field sample following homogenization and analyzed separately. The FPXRF analysis results for lead will be logged electronically and recorded in the site logbook. Following FPXRF analyses, the soil samples will be cooled to 4°C and held until FPXRF analysis is complete for the Site.

QAPP Worksheet #17: Sampling Design and Rationale (continued)

Following FPXRF analysis, RST will select 20 of the 204 FPXRF samples and one of the FPXRF duplicate samples for confirmatory total Lead analysis. Samples will be selected to represent the range of soil types and FPXRF Total Lead analytical results noted at the Site, and will be approximately evenly distributed between samples from 2000-2012 and 2015 Richmond Terrace. Soil from each polyethylene sample bag will be placed into an 8-ounce amber glass jar with Teflon-lined septum cap, then labeled and sealed according to CLP protocols. EPA will request that the laboratory retain confirmatory samples for up to six months, to accommodate potential subsequent specialized analyses which may be required based on the validated analytical results.

Sediment: Sediment will be collected from up to ten or more locations where runoff from the Site appears to travel or collect, including swales, ditches, storm sewers, storm water outfalls, and the Kill Van Kull. Sample locations will be based on the results of Site reconnaissance and available as-built plans for the storm sewer system surrounding the Site, and will be approved by the OSC. Sediment samples will be collocated with surface water samples, where possible, and collected following surface water sample collection, in accordance with EPA/ERT 4 Sediment Sampling SOP# 2016. Sediment will be described to characterize soil type, color, moisture, and other distinctive features. Sediment samples will be homogenized in place and collected using disposable plastic tools directly into 8-ounce amber glass jars with Teflon-lined septum caps, then labeled and sealed according to CLP protocols. The sediment samples will be collected for Total Lead analysis. EPA will request that the laboratory retain sediment samples for up to six months, to accommodate potential subsequent specialized analyses which may be required based on the validated analytical results.

Groundwater: Five overburden groundwater monitoring wells will be installed using hollow-stem auger techniques, with three of the wells installed at 2000-2012 Richmond Terrace at previous soil sample locations A-4, B-2, and E-1, and the remaining two wells installed in the western and southern corners of 2015 Richmond Terrace. The wells will be constructed of 2-inch diameter Schedule 40 polyvinyl chloride (PVC), with 10-ft, 0.010-inch slotted, PVC well screen. The well annulus will be filled with a size 0 silica sand filter pack to 1 ft above the top of the well screen, a 2-ft bentonite seal, and cement/bentonite grout to the ground surface. Each well screen will be set to intercept the top of the water table, with approximately 3 ft of screen above the top of the water table. Each well will be completed with a 4-inch protective, flush-mount casing, and will be fitted with a lockable riser plug. No less than 24 hours following installation, each well will be developed by surging and pumping to remove fines from the filter pack to ensure a good hydraulic connection with the water table. Development water will be discharged to the ground surface. Wells will be surveyed for elevation (to the nearest 0.01 ft) following installation.

QAPP Worksheet #17: Sampling Design and Rationale (continued)

No less than two weeks following well installation, each well will be sampled for total Lead, using EPA's low-flow methodology, according to groundwater sample guidelines outlined in EPA/ERT 4 Groundwater Sampling SOP# 2007. Each will be purged using a peristaltic pump using Teflon-lined polyethylene tubing until groundwater parameters (measured using a flow through cell) stabilize. Purge water will be discharged to the ground surface, and the flow-through cell will be disconnected prior to sample collection. Groundwater samples will be collected using the same pump and tubing into 1-liter polyethylene bottles with Teflon-lined septum caps, pre-preserved with nitric acid, then labeled and sealed according to CLP protocols. The groundwater samples will be collected for Total Lead analysis.

Surface Water: Surface water will be collected from up to ten locations where runoff from the Site appears to travel or collect. Surface water samples will be collocated with sediment samples, where possible, and collected before sediment sample collection, in accordance with EPA/ERT 4 Surface Water Sampling SOP# 2013. Where sufficient surface water depth is present, surface water parameters will be measured in situ prior to sample collection. Surface water samples will be collected directly into 1-liter polyethylene bottles with Teflon-lined septum caps pre-preserved with nitric acid, then labeled and sealed according to CLP protocols. The surface water samples will be collected for Total Lead analysis.

Rinsate Blanks: Rinsate blank samples will be collected for each matrix/collection technique at a rate of 1 per day. Soil and sediment sample rinsate blanks will include a disposable plastic scoop; groundwater rinsate blanks will include a section of Teflon-lined polyethylene tubing. It is anticipated that surface water samples will be collected directly into sample containers, so no rinsate blank will be required. The aqueous samples will be collected for Total Lead analysis.

QAPP Worksheet #17: Sampling Design and Rationale (concluded)

Decontamination: All reusable sampling equipment (i.e., soil sample core barrels and cutting shoes, groundwater monitoring equipment) involved in field-sampling activities will be decontaminated in accordance to EPA/ERT SOP #2006 prior to and subsequent to sampling, as well as between sampling locations. Decontamination of sampling equipment will be conducted as follows:

1. Alconox detergent and potable water scrub.
2. Potable water rinse.
3. Deionized water rinse.
4. 10% Nitric Acid rinse.
5. Deionized water rinse.
6. Deionized water rinse and air dry.
7. Wrap or cover exposed ends of sampling equipment with aluminum foil (shiny side out) for transport and handling.

Decontamination of excavation/drilling equipment (i.e., backhoe, drill rig, hollow-stem augers) will be conducted as follows:

1. Pressure washing using potable water.
2. Potable water rinse.
3. Deionized water rinse and air dry.

The following laboratories will provide the analyses indicated:

Lab Name/Location	Sample Type	Parameters
DESA	Soil and Aqueous	Total Lead
DESA	Soil	TCLP Lead and SPLP Lead
EMSL Analytical	Particulate	Total Lead

Refer to Worksheet #21 for QA/QC samples, sampling methods and SOP.

QAPP Worksheet #18: Sampling Locations and Methods/SOP Requirements Table

Matrix	Sampling Location(s)	Units	Analytical Group(s)	Concentration Level	No. of Samples (identify field duplicates)	Sampling SOP Reference	Rationale for Sampling Location
Soil	25 Test Pit locations*	mg/kg	Lead (field screen), total Lead	Low	100 samples plus 5 duplicates	EPA ERT SOP No.: 2012	Characterization of soil lead concentrations at 2000-2012 Richmond Terrace property
	26 direct-push sample locations	mg/kg	Lead (field screen), total Lead	Low	104 samples plus 5 duplicates	EPA ERT SOP No.: 2012	Characterization of soil lead concentrations at 2015 Richmond Terrace property
	10 sediment locations	mg/kg	total Lead	Low	5 samples plus 1 duplicate	EPA ERT SOP No.: 2016	Characterization of sediment lead concentrations adjacent to Site
Aqueous	5 overburden monitoring wells	µg/L	total Lead	Low	5 samples plus 1 duplicate	EPA ERT SOP No.: 2007	Characterization of lead in groundwater beneath Site
	10 surface water locations	µg/L	total Lead	Low	5 samples plus 1 duplicate	EPA ERT SOP No.: 2013	Characterization of surface water lead concentrations adjacent to Site
	Rinsate Blanks	µg/L	total Lead	Low	1 sample per day per matrix	EPA ERT SOP No.: 2006	QA for Decontamination Process
Particulate	Site Perimeter and Personnel	µg/m^3	total Lead	Low	1 upwind, 2 downwind, personnel		Health and Safety Compliance

The website for EPA-ERT SOPs is: http://www.ert.org/mainContent.asp?section=Products&subsection=List
*Four samples will be collected at each location at depths of 0 to1 ft., 1 to 2 ft., 2 to 3 ft., and 3 to 4 ft.

QAPP Worksheet #19: Analytical SOP Requirements Table

Matrix	Number of Samples*	Analytical Group [Lab Assignment]	Concentration Level	Analytical and Preparation Method/SOP Reference	Sample Volume	Containers (number, size, and type)	Preservation Requirements	Maximum Holding Time (preparation/ analysis)
Soil*	214	Lead [field screen]	Low	ILM05.4	250 grams	(1) 12 oz. polyethylene bag	Cool to 4°C	180 days
	26	Total Lead [CLP]	Low	ILM05.4	250 grams	(1) 8 oz. glass jar w/Teflon lined cap	Cool to 4°C	180 days
	21	TCLP Lead [CLP]	Low	ILM05.4	250 grams	(1) 8 oz. glass jar w/Teflon lined cap	Cool to 4°C	180 days
	21	SPLP Lead [CLP]	Low	ILM05.4	250 grams	(1) 8 oz. glass jar w/Teflon lined cap	Cool to 4°C	180 days
Aqueous**	12	Total Lead [CLP]	Low	ILM05.4	1 liter	(1) 1-liter. Polyethylene bottle w/Teflon lined cap	$HNO_3$to pH<2, Cool to 4°C	180 days
Rinsate***	8	Total Lead [CLP]	Low	ILM05.4	250 mL	(1) 1-liter. Polyethylene bottle w/Teflon lined cap	HNO_3 to pH<2; cool to 4°C	180 days
Particulate	50	Total Lead	Low	NIOSH Method 7082	1 filter	0.8-micron cellulose ester membrane	none	180 days

*Includes soil and sediment samples, and their duplicates.
** Includes groundwater, surface water, and their duplicates.
*** One equipment rinsate blank sample will be collected per day.
HNO_3 = Nitric acid.
mL = milliliters.
°C = Degrees Centigrade.

QAPP Worksheet #20: Field Quality Control Sample Summary Table

Matrix	Analytical Group	Concentration Level	Analytical and Preparation SOP Reference	No. of Sampling Locations	No. of Field Duplicate Pairs	No. of Extra Volume Laboratory QC (e.g., MS/MSD) Samples	No. of Rinsate Blanks***	No. of Trip. Blanks	No of PE Samples	Total No. of Samples to Lab
Soil*	Lead (FPXRF)	Low	SOM01.2	204	1/20 samples per matrix	NR	NR	NR	NR	214
	Total Lead	Low	ILM05.4	20		1/20 samples per matrix	2-6	NR	NR	23-27
	TCLP Lead	Low	SOM01.2	20		1/20 samples per matrix	NR	NR	NR	21
	SPLP Lead	Low	SOM01.2	20		1/20 samples per matrix	NR	NR	NR	21
Aqueous**	Total Lead	Low	ILM05.4	5 +5		1/20 samples per matrix	1	NR	NR	11

*Includes soil and sediment samples, and their duplicates.
** Includes groundwater, surface water, and their duplicates.
*** One equipment rinsate blank sample will be collected per day.
MS/MSD – Matrix Spike/Matrix Spike Duplicate
NR – not required

QAPP Worksheet #21: Project Sampling SOP References Table

Reference Number	Title, Revision Date and/or Number	Originating Organization	Equipment Type	Modified for Project Work? (Y/N)	Comments
SOP #2001	General Field Sampling Guidelines	EPA/OSWER/ERT	Plastic scoops	N	
SOP # 2012	Soil Sampling from the Compendium of ERT Soil Sampling and Surface Geophysics Procedures.	EPA/OSWER/ERT	Plastic scoops	N	
SOP # 2016	Sediment Sampling from the Compendium of ERT Soil Sampling and Surface Geophysics Procedures.	EPA/OSWER/ERT	Plastic scoops	N	
SOP # 2007	Groundwater Sampling from the Compendium of ERT Soil Sampling and Surface Geophysics Procedures.	EPA/OSWER/ERT	Peristaltic Pump, Tubing, Water Quality Meter	N	
SOP # 2013	Surface Water Sampling from the Compendium of ERT Soil Sampling and Surface Geophysics Procedures.	EPA/OSWER/ERT	Water Quality Meter	N	
SOP# 2006	Sampling Equipment Decontamination (all media); Rev 0.0 August 1994	EPA/OSWER/ERT	Non-phosphate Detergent, Tap Water. Distilled/Deionized Water, 10% Nitric Acid, Solvent Rinse (Pesticide Grade)	N	
	EPA Method 6200 Field Portable X-ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment	EPA/OSWER/ERT	FPXRF	Y	Drying and sieving not anticipated
PN 101475	Innov-X Model X-50 Field Portable X-ray Fluorescence Unit User's Manual	Innov-X	FPXRF	N	

See Attachment B for SOP # 2006 and 2012
Note: The website for EPA-ERT SOPs is: www.ert.org/mainContent.asp?section=Products&subsection=List

QAPP Worksheet #22: Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment	**Calibration Activity**	**Maintenance Activity**	**Testing/ Inspection Activity**	**Frequency**	**Acceptance Criteria**	**Corrective Action**	**Responsible Person**	**SOP Reference**
MiniRAM Dust Monitor	Calibrate with background air	Check/ replace battery	None	Prior to day’s activities	None	Replace battery or Replace Unit	Equipment Vendor	
Innov-X Model X-50 FPXRF Unit	Standardize per manufacturer’s instructions	None	Periodic standardization	Per manufacturer’s instructions	< 20% relative percent difference	Replace Unit	Innov-X	PN 101475
Trimble® GeoXT™ handheld	None	Check/ replace battery	None	Prior to day’s activities	None	Replace Unit	GPS Operator	

QAPP Worksheet #23

Analytical SOP References Table

Reference Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
SW-846	EPA Method 6200 Field Portable X-ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment	Screening	Lead	FPXRF	RST 2/Site Project Manager	Y
ILM05.4	USEPA Contract Laboratory Program Statement of Work for Multi-Media, Multi-Concentration Inorganic Analysis,; December 2006	Definitive	Target Analyte List Lead	ICP-AES / ICP-MS	DESA Laboratory	N
ILM05.4	USEPA Contract Laboratory Program Statement of Work for Multi-Media, Multi-Concentration Inorganic Analysis,; December 2006	Definitive	TCLP Lead	ICP-AES / ICP-MS	DESA Laboratory	N
ILM05.4	USEPA Contract Laboratory Program Statement of Work for Multi-Media, Multi-Concentration Inorganic Analysis,; December 2006	Definitive	SPLP Lead	ICP-AES / ICP-MS	DESA Laboratory	N
	NIOSH Laboratory Method, Issue 2: August 1994	Definitive	Lead	Flame AAS	EMSL Analytical	N

QAPP Worksheet #24: Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
FPXRF	Factory calibrated	Prior to issuance	Initial calibration/ Continuing calibration: relative percent difference less than or equal to minimum acceptable 20%.	Replace unit.	Innov-X	PN 101475
ICP-AES / ICP-MS	See ILM05.4; as per instrument manufacturer's recommended procedures	ICP-AES or ICP-MS Initial calibration: daily or once every 24 hours and each time the instrument is set up. ICP-AES or ICP-MS Continuing calibration: beginning and end of run and frequency of 10% or every 2 hours during an analysis run.	ICP-AES: As per instrument manufacturer's recommended procedures, with at least 2 standards. ICP-MS: As per instrument manufacturer's recommended procedures, with at least 2 standards. A minimum of three replicate integrations are required for data acquisition.	ICP-AES or ICP-MS: inspect the system, correct problem, re-calibrate, and re-analyze samples.	EPA DESA Laboratory ICP-AES / ICP-MS Technician	ILM05.4

QAPP Worksheet #25: Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Instrument/ Equipment	Maintenance Activity	Testing/ Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
FPXRF	None	Periodic standardization per instrument manufacturer's recommendations	Per instrument manufacturer's recommendations	Relative percent difference less than or equal to minimum acceptable 20%.	Replace unit.	Innov-X, FPXRF Operator	PN 101475
ICP-AES / ICP-MS	As per instrument manufacturer's recommendations	As per instrument manufacturer's recommendations; check connections	As per instrument manufacturer's recommendations	Acceptable re-calibration; see ILM05.4	Inspect the system, correct problem, re-calibrate and/or reanalyze samples.	EPA DESA Laboratory ICP-AES/ICP-MS Technician	ILM05.4

QAPP Worksheet #26: Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): RST 2 Site Project Manager, Weston Solutions, Inc., Region 2
Sample Packaging (Personnel/Organization): RST 2 Site Project Manager and sampling team members, Weston Solutions, Inc., Region 2
Coordination of Shipment (Personnel/Organization): RST 2 Site Project Manager, sampling team members, Weston Solutions, Inc., Region 2
Type of Shipment/Carrier: FedEx delivery.
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): DESA Laboratory
Sample Custody and Storage (Personnel/Organization): EPA DESA Laboratory
Sample Preparation (Personnel/Organization): EPA DESA Laboratory
Sample Determinative Analysis (Personnel/Organization): EPA DESA Laboratory
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): Up to 60 days
Sample Extract/Digestate Storage (No. of days from extraction/digestion): up to 60 days
Biological Sample Storage (No. of days from sample collection): N/A
SAMPLE DISPOSAL
Personnel/Organization: Sample Technicians, EPA DESA Laboratory
Number of Days from Analysis: Until analysis and QA/QC checks are completed; as per analytical methodology; see Worksheet #19.

QAPP Worksheet #27: Sample Custody Requirements

Sample Identification Procedures: Each sample collected by Region II RST 2 will be designated by a code that will identify the sample matrix. The sample location and sample depth will follow the matrix. A hyphen will separate the matrix, sample location, and sample depth. This will then be followed by the sample number. Samples will also be labeled with a CLP assigned number. Specific media types are as follows:

S – Soil; SD – Sediment; GW – Groundwater; SW – Surface Water; RB – Rinsate Blank

Matrix - Sample Location – Depth (e.g. S–A5–0102)

Duplicate samples will be identified in the same manner as other samples and will be distinguished with an –E suffix and documented in the field logbook.

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory): Each sample will be individually identified and labeled after collection, then sealed with custody seals. Each sample bottle will be sealed and labeled according to the following protocol. The cap will be secured with custody seals. The bottle label will contain all required information including site/project code and sample number, time and date of collection, analyses requested, and preservative used. The sealed bottle will be placed in plastic coolers, and padded with an absorbent material such as vermiculite. All packaging will conform to IATA shipping regulations for overnight carriers.

The sample information will be recorded on chain-of custody (COC) forms, and the samples shipped to the appropriate laboratory via overnight delivery service or courier. The sample documents will be sealed in a plastic bag and affixed to the underside of each cooler lid. The lid will be sealed and affixed on at least two sides with custody seals so that any sign of tampering is easily visible. Chain-of-custody records will be prepared in FORMS II Lite to accompany samples from the time of collection and throughout the shipping process. Each individual in possession of the samples must sign and date the sample COC Record. The chain-of-custody record will be considered completed upon receipt at the laboratory. A traffic report and chain-of-custody record will be maintained from the time the sample is taken to its final deposition. Every transfer of custody must be noted and signed for, and a copy of this record kept by each individual who has signed. When samples are not under direct control of the individual responsible for them, they must be stored in a locked container sealed with a custody seal. Specific information regarding custody of the samples projected to be collected on the weekend will be noted in the field logbook. The COC record should include (at minimum) the following: 1) Sample identification number; 2) Sample information; 3) Sample location; 4) Sample date; 5) Sample Time; 6) Sample Type Matrix; 7) Sample Container Type; 8) Sample Analysis Requested; 9) Name(s) and signature(s) of sampler(s); and 10) Signature(s) of any individual(s) with custody of samples.

A separate COC form must accompany each cooler for each daily shipment. The chain-of-custody form must address all samples in that cooler, but not address samples in any other cooler. This practice maintains the COC for all samples in case of mis-shipment.

QAPP Worksheet #27: Sample Custody Requirements (concluded)

Laboratory Sample Custody Procedures (receipt of samples, archiving, and disposal): Within the laboratory, the person responsible for sample receipt must sign and date the COC form; examine all samples for possible shipping damage and improper sample preservation; note on the COC record that specific samples were damaged; notify sampling personnel as soon as possible so that appropriate samples may be regenerated; verify that sample holding times have not been exceeded; maintain laboratory COC documentation; and place the samples in the appropriate laboratory storage. At this time, no samples will be archived at the laboratory. Disposal of the samples will occur only after analyses and QA/QC checks are completed.

Note: Refer to Contract Laboratory Program Guidance for Field Samplers, EPA-540-R-07-06, July 2007 at:
http://www.epa.gov/superfund/programs/clp/download/sampler/clp_sampler_guidance.pdf

QAPP Worksheet #28: QC Samples Table
Worksheet # 28A: Field Screen Lead/RST 2 – EPA Method 6200

(UFP-QAPP Manual Section 3.4)

Complete a separate worksheet for each sampling technique, analytical method/SOP, matrix, analytical group, and concentration level. If method/SOP QC acceptance limit exceed the measurement performance criteria, the data obtained may be unusable for making project decisions.

Matrix	Soil
Analytical Group	Field Portable X-Ray Fluorescence Screening (Lead)
Concentration Level	Low/Medium (mg/kg)
Sampling SOP(s)	EPA ERT SOP No. 2012
Analytical Method/SOP Reference	EPA Method 6200
Sampler's Name	Joseph Schmidl, PG, CWS
Field Sampling Organization	Weston Solutions, Inc.
Analytical Organization	RST 2
No. of Sample Locations	20

Lab QC Sample:	**Frequency/Number**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
SiO_2 Blank	Beginning and end of each day	No constituent > CRQL	Suspend analysis until source rectified	FPXRF Operator	Accuracy	No constituent > CRQL
Field Duplicate	1 per ≤ 20 samples	± 20% RPD**	Flag outliers	FPXRF Operator	Precision	± 20% RPD**
Standardization check	Per manufacturer's recommendation	Pass/fail	Replace unit	FPXRF Operator	Accuracy	75-125%R
Laboratory duplicate	1 per ≤ 20 samples	± 20% RPD**	Flag outliers	FPXRF Operator	Precision	± 20% RPD**

*except when the sample concentration is greater than 4 times the spike concentration, then disregard the recoveries; no data validation action taken
**Reference USEPA Region 2 SOP No. HW-2, Revision 13/Evaluation of Metals Data for CLP - (include absolute difference criteria)
**except when the sample and/or duplicate concentration is less than 5 times the CRQL, then ± CRQL.

QAPP Worksheet #28: QC Samples Table
Worksheet # 28B: TAL Metals – Inorganics/CLP ILMO5.4

(UFP-QAPP Manual Section 3.4)

Complete a separate worksheet for each sampling technique, analytical method/SOP, matrix, analytical group, and concentration level. If method/SOP QC acceptance limit exceed the measurement performance criteria, the data obtained may be unusable for making project decisions.

Matrix	Aqueous
Analytical Group	Target Analyte List Inorganics Metals (Lead)
Concentration Level	Low/Medium (µg/L)
Sampling SOP(s)	EPA ERT SOP No. 2007, 2013
Analytical Method/SOP Reference	ILM05.4
Sampler's Name	Joseph Schmidl, PG, CWS
Field Sampling Organization	Weston Solutions, Inc.
Analytical Organization	EPA DESA Laboratory
No. of Sample Locations	10

Lab QC Sample:	**Frequency/Number**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Preparation Blank	1 per ≤ 20 samples	No constituent > CRQL	Suspend analysis until source rectified; redigest and reanalyze affected samples	EPA DESA Laboratory ICP-AES/ICP-MS Technician	Accuracy	No constituent > CRQL
Spike	1 per ≤ 20 samples	75-125%R*	Flag outliers	EPA DESA Laboratory ICP-AES/ICP-MS Technician	Accuracy	75-125%R*
Duplicate	1 per ≤ 20 samples	± 20% RPD**	Flag outliers	EPA DESA Laboratory ICP-AES/ICP-MS Technician	Precision	± 20% RPD**
Post-Digestion Spike	after any analyte (except Ag and Hg) fails spike %R	75-125%R	Flag outliers	EPA DESA Laboratory ICP-AES/ICP-MS Technician	Accuracy	75-125%R
Interference Check Sample [ICP Analysis Only]	beginning, end and periodically (not less than once per 20 samples)	± 2 times CRQL of true value or ± 20% of true value, whichever is greater	Check calculations and instruments, reanalyze affected samples	EPA DESA Laboratory ICP-AES/ICP-MS Technician	Sensitivity	± 2 times CRQL of true value or ± 20% of true value, whichever is greater

*except when the sample concentration is greater than 4 times the spike concentration, then disregard the recoveries; no data validation action taken
**Reference USEPA Region 2 SOP No. HW-2, Revision 13/Evaluation of Metals Data for CLP - (include absolute difference criteria)
**except when the sample and/or duplicate concentration is less than 5 times the CRQL, then ± CRQL.

QAPP Worksheet #28: QC Samples Table
Worksheet # 28B: TAL Metals – Inorganics/CLP ILMO5.4 [cont'd]

(UFP-QAPP Manual Section 3.4)

Complete a separate worksheet for each sampling technique, analytical method/SOP, matrix, analytical group, and concentration level. If method/SOP QC acceptance limit exceed the measurement performance criteria, the data obtained may be unusable for making project decisions.

Matrix	Aqueous
Analytical Group	Target Analyte List Inorganics Metals (Lead) [cont'd]
Concentration Level	Low/Medium (µg/L)
Sampling SOP(s)	EPA ERT SOP No. 2007, 2013
Analytical Method/SOP Reference	ILM05.4
Sampler's Name	Joseph Schmidl, PG, CWS
Field Sampling Organization	Weston Solutions, Inc.
Analytical Organization	EPA DESA Laboratory
No. of Sample Locations	Up to 9

Lab QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Laboratory Control Sample	1 per ≤ 20 samples	80-120%R (except Ag and Sb)	Suspend analysis until source rectified; redigest and reanalyze affected samples	EPA DESA Laboratory ICP-AES/ICP-MS Technician	Accuracy	80-120%R (except Ag and Sb)

QAPP Worksheet #28: QC Samples Table
Worksheet # 28C: TAL Metals – Inorganics/CLP ILMO5.4

(UFP-QAPP Manual Section 3.4)

Complete a separate worksheet for each sampling technique, analytical method/SOP, matrix, analytical group, and concentration level. If method/SOP QC acceptance limit exceed the measurement performance criteria, the data obtained may be unusable for making project decisions.

Matrix	Soil
Analytical Group	Target Analyte List Inorganics Metals (Lead)
Concentration Level	Low/Medium (mg/kg)
Sampling SOP(s)	EPA ERT SOP No. 2012, 2016
Analytical Method/SOP Reference	ILM05.4
Sampler's Name	Joseph Schmidl, PG, CWS
Field Sampling Organization	Weston Solutions, Inc.
Analytical Organization	EPA DESA Laboratory
No. of Sample Locations	20

Lab QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Preparation Blank	1 per ≤ 20 samples	No constituent > CRQL	Suspend analysis until source rectified; redigest and reanalyze affected samples	EPA DESA Laboratory ICP-AES/ICP-MS Technician	Accuracy	No constituent > CRQL
Spike	1 per ≤ 20 samples	75-125%R*	Flag outliers	EPA DESA Laboratory ICP-AES/ICP-MS Technician	Accuracy	75-125%R*
Duplicate	1 per ≤ 20 samples	± 20% RPD**	Flag outliers	EPA DESA Laboratory ICP-AES/ICP-MS Technician	Precision	± 20% RPD**
Post-Digestion Spike	after any analyte (except Ag and Hg) fails spike %R	75-125%R	Flag outliers	EPA DESA Laboratory ICP-AES/ICP-MS Technician	Accuracy	75-125%R
Interference Check Sample [ICP Analysis Only]	beginning, end and periodically during run (2 times every 8 hours)	Within ± 2 times CRQL of true value or ± 20% of true value, whichever is greater	Check calculations and instruments, reanalyze affected samples	EPA DESA Laboratory ICP-AES/ICP-MS Technician	Sensitivity	Within ± 2 times CRQL of true value or ± 20% of true value, whichever is greater

*except when the sample concentration is greater than 4 times the spike concentration, then disregard the recoveries; no data validation action taken
**Reference USEPA Region 2 SOP No. HW-2, Revision 13/Evaluation of Metals Data for CLP - (include absolute difference criteria)
**except when the sample and/or duplicate concentration is less than 5 times the CRQL, then ± CRQL.

QAPP Worksheet #28: QC Samples Table
Worksheet # 28C: TAL Metals – Inorganics/CLP ILMO5.4 [cont'd]

(UFP-QAPP Manual Section 3.4)

Complete a separate worksheet for each sampling technique, analytical method/SOP, matrix, analytical group, and concentration level. If method/SOP QC acceptance limit exceed the measurement performance criteria, the data obtained may be unusable for making project decisions.

Matrix	Soil
Analytical Group	Target Analyte List Inorganics Metals (Lead) [cont'd]
Concentration Level	Low/Medium (mg/kg)
Sampling SOP(s)	EPA ERT SOP No. 2012, 2016
Analytical Method/SOP Reference	ILM05.4
Sampler's Name	Joseph Schmidl, PG, CWS
Field Sampling Organization	Weston Solutions, Inc.
Analytical Organization	EPA DESA Laboratory
No. of Sample Locations	20

Lab QC Sample:	**Frequency/Number**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Laboratory Control Sample	1 per ≤ 20 samples	Control limits established by EPA*	Suspend analysis until source rectified; redigest and reanalyze affected samples	EPA DESA Laboratory ICP-AES/ICP-MS Technician	Accuracy	Control limits established by EPA*

* If the EPA LCS is unavailable, other EPA QC samples or other certified materials may be used. In such cases, control limits for the LCS must be documented and provided.

QAPP Worksheet #28: QC Samples Table
Worksheet # 28D: TAL Metals – Inorganics/CLP ILMO5.4

(UFP-QAPP Manual Section 3.4)

Complete a separate worksheet for each sampling technique, analytical method/SOP, matrix, analytical group, and concentration level. If method/SOP QC acceptance limit exceed the measurement performance criteria, the data obtained may be unusable for making project decisions.

Matrix	Soil
Analytical Group	Toxicity Characteristic Leaching Procedure (Lead)
Concentration Level	Low/Medium (µg/L)
Sampling SOP(s)	EPA ERT SOP No. 2012
Analytical Method/SOP Reference	1311 Extraction/ILM05.4
Sampler's Name	Joseph Schmidl, PG, CWS
Field Sampling Organization	Weston Solutions, Inc.
Analytical Organization	EPA DESA Laboratory
No. of Sample Locations	20

Lab QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Preparation Blank	1 per ≤ 20 samples	No constituent > CRQL	Suspend analysis until source rectified; redigest and reanalyze affected samples	EPA DESA Laboratory ICP-AES/ICP-MS Technician	Accuracy	No constituent > CRQL
Spike	1 per ≤ 20 samples	75-125%R*	Flag outliers	EPA DESA Laboratory ICP-AES/ICP-MS Technician	Accuracy	75-125%R*
Duplicate	1 per ≤ 20 samples	± 20% RPD**	Flag outliers	EPA DESA Laboratory ICP-AES/ICP-MS Technician	Precision	± 20% RPD**
Post-Digestion Spike	after any analyte (except Ag and Hg) fails spike %R	75-125%R	Flag outliers	EPA DESA Laboratory ICP-AES/ICP-MS Technician	Accuracy	75-125%R
Interference Check Sample [ICP Analysis Only]	beginning, end and periodically during run (2 times every 8 hours)	Within ± 2 times CRQL of true value or ± 20% of true value, whichever is greater	Check calculations and instruments, reanalyze affected samples	EPA DESA Laboratory ICP-AES/ICP-MS Technician	Sensitivity	Within ± 2 times CRQL of true value or ± 20% of true value, whichever is greater

*except when the sample concentration is greater than 4 times the spike concentration, then disregard the recoveries; no data validation action taken
**Reference USEPA Region 2 SOP No. HW-2, Revision 13/Evaluation of Metals Data for CLP - (include absolute difference criteria)
**except when the sample and/or duplicate concentration is less than 5 times the CRQL, then ± CRQL.

QAPP Worksheet #28: QC Samples Table
Worksheet # 28E: TAL Metals – Inorganics/CLP ILMO5.4

(UFP-QAPP Manual Section 3.4)

Complete a separate worksheet for each sampling technique, analytical method/SOP, matrix, analytical group, and concentration level. If method/SOP QC acceptance limit exceed the measurement performance criteria, the data obtained may be unusable for making project decisions.

Matrix	Soil
Analytical Group	Synthetic Precipitation Leaching Procedure (Lead)
Concentration Level	Low/Medium (µg/L)
Sampling SOP(s)	EPA ERT SOP No. 2012
Analytical Method/SOP Reference	1312 Extraction/ILM05.4
Sampler's Name	Joseph Schmidl, PG, CWS
Field Sampling Organization	Weston Solutions, Inc.
Analytical Organization	EPA DESA Laboratory
No. of Sample Locations	20

Lab QC Sample:	**Frequency/Number**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Preparation Blank	1 per ≤ 20 samples	No constituent > CRQL	Suspend analysis until source rectified; redigest and reanalyze affected samples	EPA DESA Laboratory ICP-AES/ICP-MS Technician	Accuracy	No constituent > CRQL
Spike	1 per ≤ 20 samples	75-125%R*	Flag outliers	EPA DESA Laboratory ICP-AES/ICP-MS Technician	Accuracy	75-125%R*
Duplicate	1 per ≤ 20 samples	± 20% RPD**	Flag outliers	EPA DESA Laboratory ICP-AES/ICP-MS Technician	Precision	± 20% RPD**
Post-Digestion Spike	after any analyte (except Ag and Hg) fails spike %R	75-125%R	Flag outliers	EPA DESA Laboratory ICP-AES/ICP-MS Technician	Accuracy	75-125%R
Interference Check Sample [ICP Analysis Only]	beginning, end and periodically during run (2 times every 8 hours)	Within ± 2 times CRQL of true value or ± 20% of true value, whichever is greater	Check calculations and instruments, reanalyze affected samples	EPA DESA Laboratory ICP-AES/ICP-MS Technician	Sensitivity	Within ± 2 times CRQL of true value or ± 20% of true value, whichever is greater

*except when the sample concentration is greater than 4 times the spike concentration, then disregard the recoveries; no data validation action taken
**Reference USEPA Region 2 SOP No. HW-2, Revision 13/Evaluation of Metals Data for CLP - (include absolute difference criteria)
**except when the sample and/or duplicate concentration is less than 5 times the CRQL, then ± CRQL.

QAPP Worksheet #29: Project Documents and Records Table

Sample Collection Documents and Records	Analysis Documents and Records	Data Assessment Documents and Records	Other
• Site and field logbooks • COC forms • Field Data Sheets • GIS map for sampling locations	• Sample receipt logs • Internal and external COC forms • Equipment calibration logs • Sample preparation worksheets/logs • Sample analysis worksheets/run logs • Telephone/email logs • Corrective action documentation	• Data validation reports • Field inspection checklist(s) • Laboratory Audit checklist (if performed) • Review forms for electronic entry of data into database • Corrective action documentation • Laboratory Final Data	CLP request form Health and Safety Plan

QAPP Worksheet #30: Analytical Services Table

Matrix	Analytical Group	Concentration Level	Analytical SOP	Laboratory Data Package Turnaround Time	Laboratory/Organization (Name and Address, Contact Person and Telephone Number)	Backup Laboratory/Organization (Name and Address, Contact Person and Telephone Number)
Soil	Lead	Low	EPA Method 6200	1 day, electronic	RST 2, Site Project Manager, FPXRF Unit – Field Screening Analysis	NA
Aqueous and Soil	Total Lead	Low	ILM05.4	3 weeks written	EPA DESA Laboratory	NA
Soil	TCLP Lead	Low	ILM05.4	3 weeks written	EPA DESA Laboratory	NA
	SPLP Lead	Low	ILM05.4	3 weeks written	EPA DESA Laboratory	NA

QAPP Worksheet #31

Planned Project Assessments Table

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment (Title and Organizational Affiliation)	Person(s) Responsible for Responding to Assessment Findings (Title and Organizational Affiliation)	Person(s) Responsible for Identifying and Implementing Corrective Actions (Title and Organizational Affiliation)	Person(s) Responsible for Monitoring Effectiveness of Corrective Actions (Title and Organizational Affiliation)
Laboratory Technical Systems	Every Year	External	Regulatory Agency	Regulatory Agency	EPA DESA Laboratory	EPA DESA Laboratory	EPA or other Regulatory Agency
Performance Evaluation Samples**	None requested	External	Regulatory Agency	Regulatory Agency	EPA DESA Laboratory	EPA DESA Laboratory	EPA or other Regulatory Agency
Peer Review	Each Deliverable	Internal	Weston Solutions, Inc.	QAO, Group Leader, and Readiness Coordinator	SPM, Weston Solutions, Inc.	SPM, Weston Solutions, Inc.	EPA OSC and/or EPA QAO

QAPP Worksheet #32

Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title, Organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Name, Title, Org.)	Timeframe for Response
Project Readiness Review	Checklist or logbook entry summary	Site Project Manager, Weston Solutions, Inc.	Immediately to within 24 hours of review	Checklist or logbook entry	Site Project Manager, Weston Solutions, Inc.	Immediately to within 24 hours of review
Field Observations/ Deviations from Work Plan	Logbook	Site Project Manager, Weston Solutions, Inc. and EPA RPM	Immediately to within 24 hours of deviation	Logbook	Site Project Manager, Weston Solutions, Inc.and EPA RPM	Immediately to within 24 hours of deviation
Laboratory Technical Systems/ Performance Audits	Written Report	EPA CLP Laboratory	30 days	Letter	EPA CLP Laboratory	14 days
On-Site Field Inspection	Written Report	Site Project Manager, Weston Solutions, Inc.	7 calendar days after completion of the audit	Letter/Internal Memorandum	Site Project Manager, Weston Solutions, Inc. and/or EPA RPM	To be identified in the cover letter of the report
Peer Review	Deliverables	SPM, Weston Solutions, Inc.	Prior to deliverable due date	Comments directly on deliverable	SPM, Weston Solutions, Inc.	Prior to deliverable due date

QAPP Worksheet #33
QA Management Reports Table

Type of Report	Frequency (daily, weekly, monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (Title and Organizational Affiliation)	Report Recipient(s) (Title and Organizational Affiliation)
EPA DESA Laboratory Data (unvalidated)	As performed	Unknown	EPA DESA Laboratory	Adly Michael, RSCC, EPA Region 2 and Site Project Manager, Weston Solutions, Inc.
EPA DESA Laboratory Data (validated)	As performed	Up to 60 days after receipt of unvalidated data	EPA Region 2	Site Project Manager, Weston Solutions, Inc.
Laboratory Technical Systems/ Performance Audits	As performed	Unknown	EPA or other Regulatory Agency	EPA DESA Laboratory
Performance Evaluation Samples	Not requested	Unknown	EPA or other Regulatory Agency	EPA DESA Laboratory
On-Site Field Inspection	As performed	7 calendar days after completion of the inspection	Site Project Manager, Weston Solutions, Inc.	Site Project Manager, Weston Solutions, Inc.
Field Change Request	As required per field change	Three days after identification of need for field change	Site Project Manager, Weston Solutions, Inc.	EPA OSC
Final Report	As performed	2 weeks after receipt of EPA approval of data package	Site Project Manager, Weston Solutions, Inc.	EPA OSC

QAPP Worksheet #34
Verification (Step I) Process Table

Verification Input	Description	Internal/ External	[1]Responsible for Verification (Name, Organization)
Site/field logbooks	Field notes will be prepared daily by the RST 2 Site Project Manager and will be complete, appropriate, legible and pertinent. Upon completion of field work, logbooks will be placed in the project files.	I	Site Project Manager, Weston Solutions, Inc.
Chains of Custody	COC forms will be reviewed against the samples packed in the specific cooler prior to shipment. The reviewer will initial the form. An original COC will be sent with the samples to the laboratory, while copies are retained for (1) the Sampling Trip Report and (2) the project files.	I	Site Project Manager, Weston Solutions, Inc.
Sampling Trip Reports	STRs will be prepared for each week of field sampling [for which samples are sent to an EPA DESA laboratory.] Information in the STR will be reviewed against the COC forms, and potential discrepancies will be discussed with field personnel to verify locations, dates, etc.	I	Site Project Manager, Weston Solutions, Inc.
Laboratory Preliminary Data	Preliminary data – limited review for either contract compliance or technical compliance.	E	EPA DESA Laboratory
Laboratory analytical data package	Data packages will be reviewed/verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal.	E	EPA DESA Laboratory
Laboratory analytical data package	Data packages will be reviewed as to content and sample information upon receipt by EPA.	I/E	ESAT Data Validation Personnel, EPA Region 2
Final Sample Report	The project data results will be compiled in a sample report for the project. Entries will be reviewed/verified against hardcopy information.	I	Site Project Manager, Weston Solutions, Inc.

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[1] Responsible for verifications, and their name and organization will be added

QAPP Worksheet #35
Validation (Steps IIa and IIb) Process Table

Step IIa/IIb	Validation Input	Description	Responsible for Validation (Name, Organization)
IIa	SOPs	Ensure that the sampling methods/procedures outlined in QAPP were followed, and that any deviations were noted/approved.	Site Project Manager, Weston Solutions, Inc.
IIb	SOPs	Determine potential impacts from noted/approved deviations, in regard to PQOs.	Site Project Manager, Weston Solutions, Inc.
IIa	Chains of custody	Examine COC forms against QAPP and laboratory contract requirements (e.g., analytical methods, sample identification, etc.).	ESAT Data Validation Personnel, EPA Region 2
IIa	Laboratory data package	Examine packages against QAPP and laboratory contract requirements, and against COC forms (e.g., holding times, sample handling, analytical methods, sample identification, data qualifiers, QC samples, etc.).	ESAT Data Validation Personnel, EPA Region 2, and Site Project Manager, Weston Solutions, Inc.
IIb	Laboratory data package	Determine potential impacts from noted/approved deviations, in regard to PQOs. Examples include Practical Quantitation Limits and QC sample limits (precision/accuracy).	ESAT Data Validation Personnel, EPA Region 2, and Site Project Manager, Weston Solutions, Inc.
IIb	Field duplicates*	Compare results of field duplicate (or replicate) analyses with RPD criteria	ESAT Data Validation Personnel, EPA Region 2, and Site Project Manager, Weston Solutions, Inc.

* Site-specific QAPP may contain additional data validation inputs as required by the project objectives.

QAPP Worksheet #36: Validation (Steps IIa and IIb) Summary Table

Step IIa/IIb	Matrix	Analytical Group	Concentration Level	Validation Criteria	Data Validator (title and organizational affiliation)
IIa/IIb	Soil/ Aqueous	Total Lead	Low and Medium	Data Validation SOP for Inorganic Analysis of Low/Medium Concentrations Metals under SOW ILM05.4	EPA Region 2 Personnel with contractor support

QAPP Worksheet #37: Usability Assessment

Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used: Data, whether generated in the field or by the laboratory, are tabulated and reviewed for Precision, Accuracy, Representativeness, Completeness, and Comparability (PARCCS) by the SPM for field data or the data validator for laboratory data. The review of the PARCC Data Quality Indicators (DQI) will compare with the DQO detailed in the site-specific QAPP, the analytical methods used and impact of any qualitative and quantitative trends will be examined to determine if bias exists. A hard copy of field data is maintained in a designated field or site logbook. Laboratory data packages are validated, and final data reports are generated. All documents and logbooks are assigned unique and specific control numbers to allow tracking and management.

Where applicable, the following documents will be followed to evaluate data for fitness in decision making: EPA QA/G-4, *Guidance on Systematic Planning using the Data Quality Objectives Process*, EPA/240/B-06/001, February 2006, and EPA QA/G-9R, *Guidance for Data Quality Assessment*, A reviewer's Guide EPA/240/B-06/002, February 2006.

Describe the evaluative procedures used to assess overall measurement error associated with the project:

As delineated in the ***Uniform Federal Policy for Implementing Environmental Quality Systems: Evaluating, Assessing and Documenting Environmental Data Collection and Use Programs Part 1: UFP-QAPP (EPA-505-B-04-900A, March 2005); Part 2A: UFP-QAPP Workbook (EPA-505-B-04-900C, March 2005); Part 2B: Quality Assurance/Quality Control Compendium: Non-Time Critical QA/QC Activities (EPA-505-B-04-900B, March 2005);*** "Graded Approach" will be implemented for data collection activities that are either exploratory or small in nature or where specific decisions cannot be identified, since this guidance indicates that the formal DQO process is not necessary.

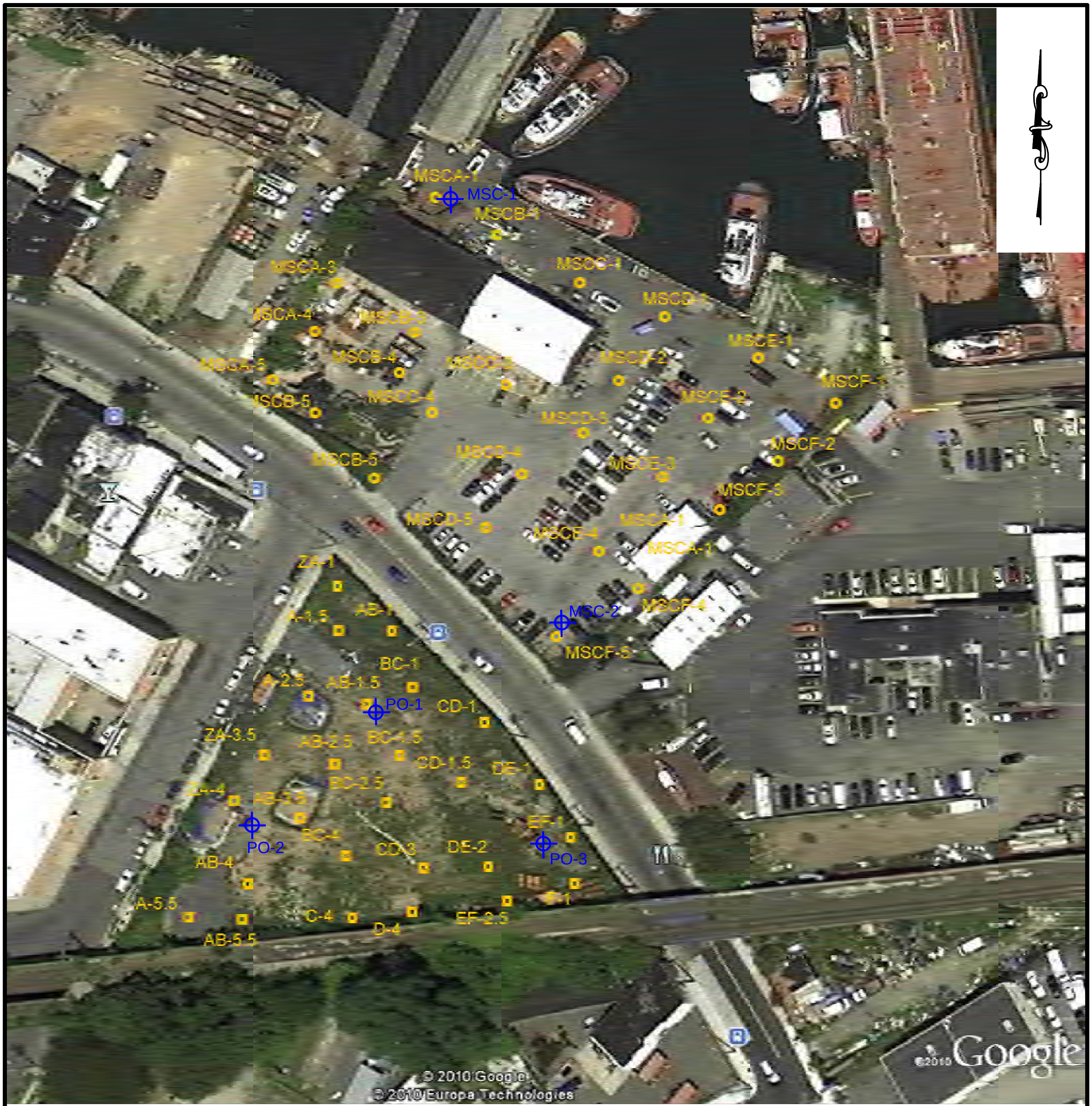
The data will be evaluated to determine whether they satisfy the PQO for the project, as outlined in QAPP Worksheet #15. The validation process determines if the data satisfy the QA criteria. After the data pass the data validation process, comparison of results with the PQO is done. For example, at the Jewett White Lead Company Site, QAPP Worksheet #15 specifies that the soil data are to be compared to New York Department of Environmental Conservation Restricted Use Soil Cleanup Objectives for this investigation; therefore, the results can then be used to determine if additional sampling is necessary to determine the extent of contamination.

Identify the personnel responsible for performing the usability assessment: Site Project Management Team, Data Validation Personnel, and EPA Region 2 OSC.

Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies: A copy of the most current approved QAPP, including any graphs, maps and text reports developed will be provided to all personnel identified on the distribution list.

and

Attachment A
Sample Location Map



SOURCE:
GOOGLE EARTH*

*THIS MAP IS SUBJECT TO
GOOGLE'S TERMS OF SERVICE,
AND GOOGLE IS THE OWNER
OF RIGHTS THEREIN.

LEGEND

● PROPOSED DIRECT–PUSH SAMPLING LOCATION
▣ PROPOSED TEST PIT LOCATION
⌖ PROPOSED MONITORING WELL

GRAPHIC SCALE
30 15 0 15 30
APPROXIMATE SCALE IN FEET

PROPOSED SAMPLE LOCATION MAP

CONCORD WESTON SOLUTIONS NEW HAMPSHIRE

REMEDIAL ACTION ALTERNATIVES REPORT
JEWETT WHITE LEAD COMPANY SITE
STATEN ISLAND, NEW YORK

DRAWN BEG	DATE AUG 2010	DES. ENG.	DATE	W.O. NO. 20101.122.018
CHECKED	DATE	SCALE AS SHOWN	REVISION	FIGURE NO. 1

M:\Design\DWG\Jewett White Lead Company Site\FIG 1.dwg, Layout1, 8/11/2010 5:01:26 PM, GIRARDEB, 1:1

Attachment B
Standard Operating Procedures

GENERAL FIELD SAMPLING GUIDELINES

SOP#: 2001
DATE: 08/11/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to provide general field sampling guidelines that will assist REAC personnel in choosing sampling strategies, location, and frequency for proper assessment of site characteristics. This SOP is applicable to all field activities that involve sampling.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Sampling is the selection of a representative portion of a larger population, universe, or body. Through examination of a sample, the characteristics of the larger body from which the sample was drawn can be inferred. In this manner, sampling can be a valuable tool for determining the presence, type, and extent of contamination by hazardous substances in the environment.

The primary objective of all sampling activities is to characterize a hazardous waste site accurately so that its impact on human health and the environment can be properly evaluated. It is only through sampling and analysis that site hazards can be measured and the job of cleanup and restoration can be accomplished effectively with minimal risk. The sampling itself must be conducted so that every sample collected retains its original physical form and chemical composition. In this way, sample integrity is insured, quality assurance standards are maintained, and the sample can accurately represent the larger body of material under investigation.

The extent to which valid inferences can be drawn from a sample depends on the degree to which the sampling effort conforms to the project's objectives. For example, as few as one sample may produce adequate, technically valid data to address the project's objectives. Meeting the project's objectives requires thorough planning of sampling activities, and implementation of the most appropriate sampling and analytical procedures. These issues will be discussed in this procedure.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

The amount of sample to be collected, and the proper sample container type (i.e., glass, plastic), chemical preservation, and storage requirements are dependent on the matrix being sampled and the parameter(s) of interest. Sample preservation, containers, handling, and storage for air and waste samples are discussed in the specific SOPs for air and waste sampling techniques.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

The nature of the object or materials being sampled may be a potential problem to the sampler. If a material is homogeneous, it will generally have a uniform composition throughout. In this case, any sample increment can be considered representative of the material. On the other hand, heterogeneous samples present problems to the sampler because of changes in the material over distance, both laterally and vertically.

Samples of hazardous materials may pose a safety threat to both field and laboratory personnel. Proper health and safety precautions should be implemented when handling this type of sample.

Environmental conditions, weather conditions, or non-target chemicals may cause problems and/or interferences when performing sampling activities or when sampling for a specific parameter. Refer to the specific SOPs for sampling techniques.

5.0 EQUIPMENT/APPARATUS

The equipment/apparatus required to collect samples must be determined on a site specific basis. Due to the wide variety of sampling equipment available, refer to the specific SOPs for sampling techniques which include lists of the equipment/apparatus required for sampling.

6.0 REAGENTS

Reagents may be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed. Decontamination solutions are specified in ERT SOP #2006, Sampling Equipment Decontamination.

7.0 PROCEDURE

7.1 Types of Samples

In relation to the media to be sampled, two basic types of samples can be considered: the environmental sample and the hazardous sample.

Environmental samples are those collected from streams, ponds, lakes, wells, and are off-site samples that are not expected to be contaminated with hazardous materials. They usually do not require the special handling procedures typically used for concentrated wastes. However, in certain instances, environmental samples can contain elevated concentrations of pollutants and in such cases would have to be handled as hazardous samples.

Hazardous or concentrated samples are those collected from drums, tanks, lagoons, pits, waste piles, fresh spills, or areas previously identified as contaminated, and require special handling procedures because of their potential toxicity or hazard. These samples can be further subdivided based on their degree of hazard; however, care should be taken when handling and shipping any wastes believed to be concentrated regardless of the degree.

The importance of making the distinction between environmental and hazardous samples is two-fold:

(1) Personnel safety requirements: Any sample thought to contain enough hazardous materials to pose a safety threat should be designated as hazardous and handled in a manner which ensures the safety of both field and laboratory personnel.

(2) Transportation requirements: Hazardous samples must be packaged, labeled, and shipped according to the International Air Transport Association (IATA) Dangerous Goods Regulations or Department of Transportation (DOT) regulations and U.S. EPA guidelines.

7.2 Sample Collection Techniques

In general, two basic types of sample collection techniques are recognized, both of which can be used for either environmental or hazardous samples.

Grab Samples

A grab sample is defined as a discrete aliquot representative of a specific location at a given point in time. The sample is collected all at once at one particular point in the sample medium. The representativeness of such samples is defined by the nature of the materials being sampled. In general, as sources vary over time and distance, the representativeness of grab samples will decrease.

Composite Samples

Composites are nondiscrete samples composed of more than one specific aliquot collected at various sampling locations and/or different points in time. Analysis of this type of sample produces an average value and can in certain instances be used as an alternative to analyzing a number of individual grab samples and calculating an average value. It should be noted, however, that compositing can mask problems by diluting isolated concentrations of some hazardous compounds below detection limits.

Compositing is often used for environmental samples and may be used for hazardous samples under certain conditions. For example, compositing of hazardous waste is often performed after compatibility tests have been completed to determine an average value over a number of different locations (group of drums). This procedure generates data that can be useful by providing an average concentration within a number of units, can serve to keep analytical costs down, and can provide information useful to transporters and waste disposal operations.

For sampling situations involving hazardous wastes, grab sampling techniques are generally preferred because grab sampling minimizes the amount of time sampling personnel must be in contact with the wastes, reduces risks associated with compositing unknowns, and eliminates chemical changes that might occur due to compositing.

7.3 Types of Sampling Strategies

The number of samples that should be collected and analyzed depends on the objective of the investigation. There are three basic sampling strategies: random, systematic, and judgmental sampling.

Random sampling involves collection of samples in a nonsystematic fashion from the entire site or a specific portion of a site. Systematic sampling involves collection of samples based on a grid or a pattern which has been previously established. When judgmental sampling is performed, samples are collected only from the portion(s) of the site most likely to be contaminated. Often, a combination of these strategies is the best approach depending on the type of the suspected/known contamination, the uniformity and size of the site, the level/type of information desired, etc.

7.4 QA Work Plans (QAWP)

A QAWP is required when it becomes evident that a field investigation is necessary. It should be initiated in conjunction with, or immediately following, notification of the field investigation. This plan should be clear and concise and should detail the following basic components, with regard to sampling activities:

- Objective and purpose of the investigation.
- Basis upon which data will be evaluated.
- Information known about the site including location, type and size of the facility, and length of operations/abandonment.
- Type and volume of contaminated material, contaminants of concern (including concentration), and basis of the information/data.
- Technical approach including media/matrix to be sampled, sampling equipment to be used, sample equipment decontamination (if necessary), sampling design and rationale, and SOPs or description of the procedure to be implemented.
- Project management and reporting, schedule, project organization and responsibilities, manpower and cost projections, and required deliverables.
- QA objectives and protocols including tables summarizing field sampling and QA/QC analysis and objectives.

Note that this list of QAWP components is not all-inclusive and that additional elements may be added or altered depending on the specific requirements of the field investigation. It should also be recognized that although a detailed QAWP is quite important, it may be impractical in some instances. Emergency responses and accidental spills are prime examples of such instances where time might prohibit the development of site-specific QAWPs prior to field activities. In such cases, investigators would have to rely on general guidelines and personal judgment, and the sampling or response plans might simply be a strategy based on preliminary information and finalized on site. In any event, a plan of action should be developed, no matter how concise or informal, to aid investigators in maintaining a logical and consistent order to the implementation of their task.

7.5 Legal Implications

The data derived from sampling activities are often introduced as critical evidence during litigation of a hazardous waste site cleanup. Legal issues in which sampling data are important may include cleanup cost recovery, identification of pollution sources and responsible parties, and technical validation of remedial design methodologies. Because of the potential for involvement in legal actions, strict adherence to technical and administrative SOPs is essential during both the development and implementation of sampling activities.

Technically valid sampling begins with thorough planning and continues through the sample collection and analytical procedures. Administrative requirements involve thorough, accurate documentation of all sampling activities. Documentation requirements include maintenance of a chain of custody, as well as accurate records of field activities and analytical instructions. Failure to observe these procedures fully and consistently may result in data that are questionable, invalid and non-defensible in court, and the consequent loss of enforcement proceedings.

8.0 CALCULATIONS

Refer to the specific SOPs for any calculations which are associated with sampling techniques.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

Refer to the specific SOPs for the type and frequency of QA/QC samples to be analyzed, the acceptance criteria for the QA/QC samples, and any other QA/QC activities which are associated with sampling techniques.

10.0 DATA VALIDATION

Refer to the specific SOPs for data validation activities that are associated with sampling techniques.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and corporate health and safety procedures.

SAMPLING EQUIPMENT DECONTAMINATION

SOP#: 2006
DATE: 08/11/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to provide a description of the methods used for preventing, minimizing, or limiting cross-contamination of samples due to inappropriate or inadequate equipment decontamination and to provide general guidelines for developing decontamination procedures for sampling equipment to be used during hazardous waste operations as per 29 Code of Federal Regulations (CFR) 1910.120. This SOP does not address personnel decontamination.

These are standard (i.e. typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitation, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Removing or neutralizing contaminants from equipment minimizes the likelihood of sample cross contamination, reduces or eliminates transfer of contaminants to clean areas, and prevents the mixing of incompatible substances.

Gross contamination can be removed by physical decontamination procedures. These abrasive and non-abrasive methods include the use of brushes, air and wet blasting, and high and low pressure water cleaning.

The first step, a soap and water wash, removes all visible particulate matter and residual oils and grease. This may be preceded by a steam or high pressure water wash to facilitate residuals removal. The second step involves a tap water rinse and a distilled/deionized water rinse to remove the detergent. An acid rinse provides a low pH media for trace metals removal and is included in the decontamination process if metal samples are to be collected. It is followed by another distilled/deionized water rinse. If sample analysis does not include metals, the acid rinse step can be omitted. Next, a high purity solvent rinse is performed for trace organics removal if organics are a concern at the site. Typical solvents used for removal of organic contaminants include acetone, hexane, or water. Acetone is typically chosen because it is an excellent solvent, miscible in water, and not a target analyte on the Priority Pollutant List. If acetone is known to be a contaminant of concern at a given site or if Target Compound List analysis (which includes acetone) is to be performed, another solvent may be substituted. The solvent must be allowed to evaporate completely and then a final distilled/deionized water rinse is performed. This rinse removes any residual traces of the solvent.

The decontamination procedure described above may be summarized as follows:

1. Physical removal
2. Non-phosphate detergent wash
3. Tap water rinse
4. Distilled/deionized water rinse
5. 10% nitric acid rinse
6. Distilled/deionized water rinse
7. Solvent rinse (pesticide grade)
8. Air dry
9. Distilled/deionized water rinse

If a particular contaminant fraction is not present at the site, the nine (9) step decontamination procedure specified above may be modified for site specificity. For example, the nitric acid rinse may be eliminated if metals are not of concern at a site. Similarly, the solvent rinse may be eliminated if organics are not of concern at a site. Modifications to the standard procedure should be documented in the site specific work plan or subsequent report.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

The amount of sample to be collected and the proper sample container type (i.e., glass, plastic), chemical preservation, and storage requirements are dependent on the matrix being sampled and the parameter(s) of interest.
More specifically, sample collection and analysis of decontamination waste may be required before beginning proper disposal of decontamination liquids and solids generated at a site. This should be determined prior to initiation of site activities.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

- The use of distilled/deionized water commonly available from commercial vendors may be acceptable for decontamination of sampling equipment provided that it has been verified by laboratory analysis to be analyte free (specifically for the contaminants of concern).

- The use of an untreated potable water supply is not an acceptable substitute for tap water. Tap water may be used from any municipal or industrial water treatment system.

- If acids or solvents are utilized in decontamination they raise health and safety, and waste disposal concerns.

- Damage can be incurred by acid and solvent washing of complex and sophisticated sampling equipment.

5.0 EQUIPMENT/APPARATUS

Decontamination equipment, materials, and supplies are generally selected based on availability. Other considerations include the ease of decontaminating or disposing of the equipment. Most equipment and supplies can be easily procured. For example, soft-bristle scrub brushes or long-handled bottle brushes can be used to remove contaminants. Large galvanized wash tubs, stock tanks, or buckets can hold wash and rinse solutions. Children's wading pools can also be used. Large plastic garbage cans or other similar containers lined with plastic bags can help segregate contaminated equipment. Contaminated liquid can be stored temporarily in metal or plastic cans or drums.

The following standard materials and equipment are recommended for decontamination activities:

5.1 Decontamination Solutions

- Non-phosphate detergent
- Selected solvents (acetone, hexane, nitric acid, etc.)
- Tap water
- Distilled or deionized water

5.2 Decontamination Tools/Supplies

- Long and short handled brushes
- Bottle brushes
- Drop cloth/plastic sheeting
- Paper towels
- Plastic or galvanized tubs or buckets
- Pressurized sprayers (H_2O)
- Solvent sprayers
- Aluminum foil

5.3 Health and Safety Equipment

Appropriate personal protective equipment (i.e., safety glasses or splash shield, appropriate gloves, aprons or coveralls, respirator, emergency eye wash)

5.4 Waste Disposal

- Trash bags
- Trash containers
- 55-gallon drums
- Metal/plastic buckets/containers for storage and disposal of decontamination solutions

6.0 REAGENTS

There are no reagents used in this procedure aside from the actual decontamination solutions. Table 1 (Appendix A) lists solvent rinses which may be required for elimination of particular chemicals. In general, the following solvents are typically utilized for decontamination purposes:

- C 10% nitric acid is typically used for inorganic compounds such as metals. An acid rinse may not be required if inorganics are not a contaminant of concern.
- C Acetone (pesticide grade)(1)
- C Hexane (pesticide grade)(1)
- C Methanol(1)

(1) - Only if sample is to be analyzed for organics.

7.0 PROCEDURES

As part of the health and safety plan, a decontamination plan should be developed and reviewed. The decontamination line should be set up before any personnel or equipment enter the areas of potential exposure. The equipment decontamination plan should include:

- C The number, location, and layout of decontamination stations.

- C Decontamination equipment needed.

- C Appropriate decontamination methods.

- C Methods for disposal of contaminated clothing, equipment, and solutions.

- C Procedures can be established to minimize the potential for contamination. This may include: (1) work practices that minimize contact with potential contaminants; (2) using remote sampling techniques; (3) covering monitoring and sampling equipment with plastic, aluminum foil, or other protective material; (4) watering down dusty areas; (5) avoiding laying down equipment in areas of obvious contamination; and (6) use of disposable sampling equipment.

7.1 Decontamination Methods

All samples and equipment leaving the contaminated area of a site must be decontaminated to remove any contamination that may have adhered to equipment. Various decontamination methods will remove contaminants by: (1) flushing or other physical action, or (2) chemical complexing to inactivate contaminants by neutralization, chemical reaction, disinfection, or sterilization.

Physical decontamination techniques can be grouped into two categories: abrasive methods and non-abrasive methods, as follows:

7.1.1 Abrasive Cleaning Methods

Abrasive cleaning methods work by rubbing and wearing away the top layer of the surface containing the contaminant. The mechanical abrasive cleaning methods are most commonly used at hazardous waste sites. The following abrasive methods are available:

Mechanical

Mechanical methods of decontamination include using metal or nylon brushes. The amount and type of contaminants removed will vary with the hardness of bristles, length of time brushed, degree of brush contact, degree of contamination, nature of the surface being cleaned, and degree of contaminant adherence to the surface.

Air Blasting

Air blasting equipment uses compressed air to force abrasive material through a nozzle at high velocities. The distance between nozzle and surface cleaned, air pressure, time of application, and angle at which the abrasive strikes the surface will dictate cleaning efficiency. Disadvantages of this method are the inability to control the amount of material removed and the large amount of waste generated.

Wet Blasting

Wet blast cleaning involves use of a suspended fine abrasive. The abrasive/water mixture is delivered by compressed air to the contaminated area. By using a very fine abrasive, the amount of materials removed can be carefully controlled.

7.1.2 Non-Abrasive Cleaning Methods

Non-abrasive cleaning methods work by forcing the contaminant off a surface with pressure. In general, the equipment surface is not removed using non-abrasive methods.

Low-Pressure Water

This method consists of a container which is filled with water. The user pumps air out of the container to create a vacuum. A slender nozzle and hose allow the user to spray in hard-to-reach places.

High-Pressure Water

This method consists of a high-pressure pump, an operator controlled directional nozzle, and a high-pressure hose. Operating pressure usually ranges from 340 to 680 atmospheres (atm) and flow rates usually range from 20 to 140 liters per minute.

Ultra-High-Pressure Water

This system produces a water jet that is pressured from 1,000 to 4,000 atmospheres. This ultra-high-pressure spray can remove tightly-adhered surface films. The water velocity ranges from 500 meters/second (m/s) (1,000 atm) to 900 m/s (4,000 atm). Additives can be used to enhance the cleaning action.

Rinsing

Contaminants are removed by rinsing through dilution, physical attraction, and solubilization.

Damp Cloth Removal

In some instances, due to sensitive, non-waterproof equipment or due to the unlikelihood of equipment being contaminated, it is not necessary to conduct an extensive decontamination procedure. For example, air sampling pumps hooked on a fence, placed on a drum, or wrapped in plastic bags are not likely to become heavily contaminated. A damp cloth should be used to wipe off contaminants which may have adhered to equipment through airborne contaminants or from surfaces upon which the equipment was set.

Disinfection/Sterilization

Disinfectants are a practical means of inactivating infectious agents. Unfortunately, standard sterilization methods are impractical for large equipment. This method of decontamination is typically performed off-site.

7.2 Field Sampling Equipment Decontamination Procedures

The decontamination line is setup so that the first station is used to clean the most contaminated item. It progresses to the last station where the least contaminated item is cleaned. The spread of contaminants is further reduced by separating each decontamination station by a minimum of three (3) feet. Ideally, the contamination should decrease as the equipment progresses from one station to another farther along in the line.

A site is typically divided up into the following boundaries: Hot Zone or Exclusion Zone (EZ), the Contamination Reduction Zone (CRZ), and the Support or Safe Zone (SZ). The decontamination line should be setup in the Contamination Reduction Corridor (CRC) which is in the CRZ. Figure 1 (Appendix B) shows a typical contaminant reduction zone layout. The CRC controls access into and out of the exclusion zone and confines decontamination activities to a limited area. The CRC boundaries should be conspicuously marked. The far end is the hotline, the boundary between the exclusion zone and the contamination reduction zone. The size of the decontamination corridor depends on the number of stations in the decontamination process, overall dimensions of the work zones, and amount of space available at the site. Whenever possible, it should be a straight line.

Anyone in the CRC should be wearing the level of protection designated for the decontamination crew. Another corridor may be required for the entry and exit of heavy equipment. Sampling and monitoring equipment and sampling supplies are all maintained outside of the CRC. Personnel don their equipment away from the CRC and enter the exclusion zone through a separate access control point at the hotline. One person (or more) dedicated to decontaminating equipment is recommended.

7.2.1 Decontamination Setup

Starting with the most contaminated station, the decontamination setup should be as follows:

Station 1: Segregate Equipment Drop

Place plastic sheeting on the ground (Figure 2, Appendix B). Size will depend on amount of equipment to be decontaminated. Provide containers lined with plastic if equipment is to be segregated. Segregation may be required if sensitive equipment or mildly contaminated equipment is used at the same time as equipment which is likely to be heavily contaminated.

Station 2: Physical Removal With A High-Pressure Washer (Optional)

As indicated in 7.1.2, a high-pressure wash may be required for compounds which are difficult to remove by washing with brushes. The elevated temperature of the water from the high-pressure washers is excellent at removing greasy/oily compounds. High pressure washers require water and electricity.

A decontamination pad may be required for the high-pressure wash area. An example of a wash pad may consist of an approximately 1 1/2 foot-deep basin lined with plastic sheeting and sloped to a sump at one corner. A layer of sand can be placed over the plastic and the basin is filled with gravel or shell. The sump is also lined with visqueen and a barrel is placed in the hole to prevent collapse. A sump pump is used to remove the water from the sump for transfer into a drum.

Typically heavy machinery is decontaminated at the end of the day unless site sampling requires that the machinery be decontaminated frequently. A separate decontamination pad may be required for heavy equipment.

Station 3: Physical Removal With Brushes And A Wash Basin

Prior to setting up Station 3, place plastic sheeting on the ground to cover areas under Station 3 through Station 10.
Fill a wash basin, a large bucket, or child's swimming pool with non-phosphate detergent and tap water. Several bottle and bristle brushes to physically remove contamination should be dedicated to this station . Approximately 10 - 50 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 4: Water Basin

Fill a wash basin, a large bucket, or child's swimming pool with tap water. Several bottle and bristle brushes should be dedicated to this station. Approximately 10-50 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 5: Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to contain the water during the rinsing process. Approximately 10-20 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 6: Nitric Acid Sprayers

Fill a spray bottle with 10% nitric acid. An acid rinse may not be required if inorganics are not a contaminant of concern. The amount of acid will depend on the amount of equipment to be decontaminated. Provide a 5-gallon bucket or basin to collect acid during the rinsing process.

Station 7: Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to collect water during the rinsate process.

Station 8: Organic Solvent Sprayers

Fill a spray bottle with an organic solvent. After each solvent rinse, the equipment should be rinsed with distilled/deionized water and air dried. Amount of solvent will depend on the amount of equipment to decontaminate. Provide a 5-gallon bucket or basin to collect the solvent during the rinsing process.

Solvent rinses may not be required unless organics are a contaminant of concern, and may be eliminated from the station sequence.

Station 9: Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to collect water during the rinsate process.

Station 10: Clean Equipment Drop

Lay a clean piece of plastic sheeting over the bottom plastic layer. This will allow easy removal of the plastic in the event that it becomes dirty. Provide aluminum foil, plastic, or other protective material to wrap clean equipment.

7.2.2 Decontamination Procedures

<u>Station 1</u>: <u>Segregate Equipment Drop</u>

Deposit equipment used on-site (i.e., tools, sampling devices and containers, monitoring instruments radios, clipboards, etc.) on the plastic drop cloth/sheet or in different containers with plastic liners. Each will be contaminated to a different degree. Segregation at the drop reduces the probability of cross contamination. Loose leaf sampling data sheets or maps can be placed in plastic zip lock bags if contamination is evident.

<u>Station 2</u>: <u>Physical Removal With A High-Pressure Washer (Optional)</u>

Use high pressure wash on grossly contaminated equipment. Do not use high- pressure wash on sensitive or non-waterproof equipment.

<u>Station 3</u>: <u>Physical Removal With Brushes And A Wash Basin</u>

Scrub equipment with soap and water using bottle and bristle brushes. Only sensitive equipment (i.e., radios, air monitoring and sampling equipment) which is waterproof should be washed. Equipment which is not waterproof should have plastic bags removed and wiped down with a damp cloth. Acids and organic rinses may also ruin sensitive equipment. Consult the manufacturers for recommended decontamination solutions.

<u>Station 4</u>: <u>Equipment Rinse</u>

Wash soap off of equipment with water by immersing the equipment in the water while brushing. Repeat as many times as necessary.

<u>Station 5</u>: <u>Low-Pressure Rinse</u>

Rinse sampling equipment with distilled/deionized water with a low-pressure sprayer.

<u>Station 6</u>: <u>Nitric Acid Sprayers (required only if metals are a contaminant of concern)</u>

Using a spray bottle rinse sampling equipment with nitric acid. Begin spraying (inside and outside) at one end of the equipment allowing the acid to drip to the other end into a 5-gallon bucket. A rinsate blank may be required at this station. Refer to Section 9.

<u>Station 7</u>: <u>Low-Pressure Sprayers</u>

Rinse sampling equipment with distilled/deionized water with a low-pressure sprayer.

<u>Station 8</u>: <u>Organic Solvent Sprayers</u>

Rinse sampling equipment with a solvent. Begin spraying (inside and outside) at one end of the equipment allowing the solvent to drip to the other end into a 5-gallon bucket. Allow the solvent to evaporate from the equipment before going to the next station. A QC rinsate sample may be required at this station.

<u>Station 9</u>: <u>Low-Pressure Sprayers</u>

Rinse sampling equipment with distilled/deionized water with a low-pressure washer.

<u>Station 10</u> : <u>Clean Equipment Drop</u>

Lay clean equipment on plastic sheeting. Once air dried, wrap sampling equipment with aluminum foil, plastic, or other protective material.

7.2.3 Post Decontamination Procedures

1. Collect high-pressure pad and heavy equipment decontamination area liquid and waste and store in appropriate drum or container. A sump pump can aid in the collection process. Refer to the Department of Transportation (DOT) requirements for appropriate containers based on the contaminant of concern.

2. Collect high-pressure pad and heavy equipment decontamination area solid waste and store in appropriate drum or container. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.

3. Empty soap and water liquid wastes from basins and buckets and store in appropriate

drum or container. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.

4. Empty acid rinse waste and place in appropriate container or neutralize with a base and place in appropriate drum. pH paper or an equivalent pH test is required for neutralization. Consult DOT requirements for appropriate drum for acid rinse waste.

5. Empty solvent rinse sprayer and solvent waste into an appropriate container. Consult DOT requirements for appropriate drum for solvent rinse waste.

6. Using low-pressure sprayers, rinse basins, and brushes. Place liquid generated from this process into the wash water rinse container.

7. Empty low-pressure sprayer water onto the ground.

8. Place all solid waste materials generated from the decontamination area (i.e., gloves and plastic sheeting, etc.) in an approved DOT drum. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.

9. Write appropriate labels for waste and make arrangements for disposal. Consult DOT regulations for the appropriate label for each drum generated from the decontamination process.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITYASSURANCE/ QUALITY CONTROL

A rinsate blank is one specific type of quality control sample associated with the field decontamination process. This sample will provide information on the effectiveness of the decontamination process employed in the field.

Rinsate blanks are samples obtained by running analyte free water over decontaminated sampling equipment to test for residual contamination. The blank water is collected in sample containers for handling, shipment, and analysis. These samples are treated identical to samples collected that day. A rinsate blank is used to assess cross contamination brought about by improper decontamination procedures. Where dedicated sampling equipment is not utilized, collect one rinsate blank per day per type of sampling device samples to meet QA2 and QA3 objectives.

If sampling equipment requires the use of plastic tubing it should be disposed of as contaminated and replaced with clean tubing before additional sampling occurs.

10.0 DATA VALIDATION

Results of quality control samples will be evaluated for contamination. This information will be utilized to qualify the environmental sample results in accordance with the project's data quality objectives.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow OSHA, U.S. EPA, corporate, and other applicable health and safety procedures.

Decontamination can pose hazards under certain circumstances. Hazardous substances may be incompatible with decontamination materials. For example, the decontamination solution may react with contaminants to produce heat, explosion, or toxic products. Also, vapors from decontamination solutions may pose a direct health hazard to workers by inhalation, contact, fire, or explosion.

The decontamination solutions must be determined to be acceptable before use. Decontamination materials may degrade protective clothing or equipment; some solvents can permeate protective clothing. If decontamination materials do pose a health hazard, measures should be taken to protect personnel or substitutions should be made to eliminate the hazard. The choice of respiratory protection based on contaminants of concern from the site may not be appropriate for solvents used in the decontamination process.

Safety considerations should be addressed when using abrasive and non-abrasive decontamination equipment. Maximum air pressure produced by abrasive equipment could cause physical injury. Displaced material requires control mechanisms.

Material generated from decontamination activities requires proper handling, storage, and disposal. Personal Protective Equipment may be required for these activities.

Material safety data sheets are required for all decontamination solvents or solutions as required by the Hazard Communication Standard (i.e., acetone, alcohol, and trisodiumphosphate).

In some jurisdictions, phosphate containing detergents (i.e., TSP) are banned.

12.0 REFERENCES

Field Sampling Procedures Manual, New Jersey Department of Environmental Protection, February, 1988.

A Compendium of Superfund Field Operations Methods, EPA 540/p-87/001.

Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual, USEPA Region IV, April 1, 1986.

Guidelines for the Selection of Chemical Protective Clothing, Volume 1, Third Edition, American Conference of Governmental Industrial Hygienists, Inc., February, 1987.

Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, NIOSH/OSHA/USCG/EPA, October, 1985.

APPENDIX A

Table

Table 1. Soluble Contaminants and Recommended Solvent Rinse

TABLE 1
Soluble Contaminants and Recommended Solvent Rinse

SOLVENT[1]	EXAMPLES OF SOLVENTS	SOLUBLE CONTAMINANTS
Water	Deionized water Tap water	Low-chain hydrocarbons Inorganic compounds Salts Some organic acids and other polar compounds
Dilute Acids	Nitric acid Acetic acid Boric acid	Basic (caustic) compounds (e.g., amines and hydrazines)
Dilute Bases	Sodium bicarbonate (e.g., soap detergent)	Acidic compounds Phenol Thiols Some nitro and sulfonic compounds
Organic Solvents [2]	Alcohols Ethers Ketones Aromatics Straight chain alkalines (e.g., hexane) Common petroleum products (e.g., fuel, oil, kerosene)	Nonpolar compounds (e.g., some organic compounds)
Organic Solvent[2]	Hexane	PCBs

[1] - Material safety data sheets are required for all decontamination solvents or solutions as required by the Hazard Communication Standard

[2] - WARNING: Some organic solvents can permeate and/or degrade the protective clothing

APPENDIX B

Figures

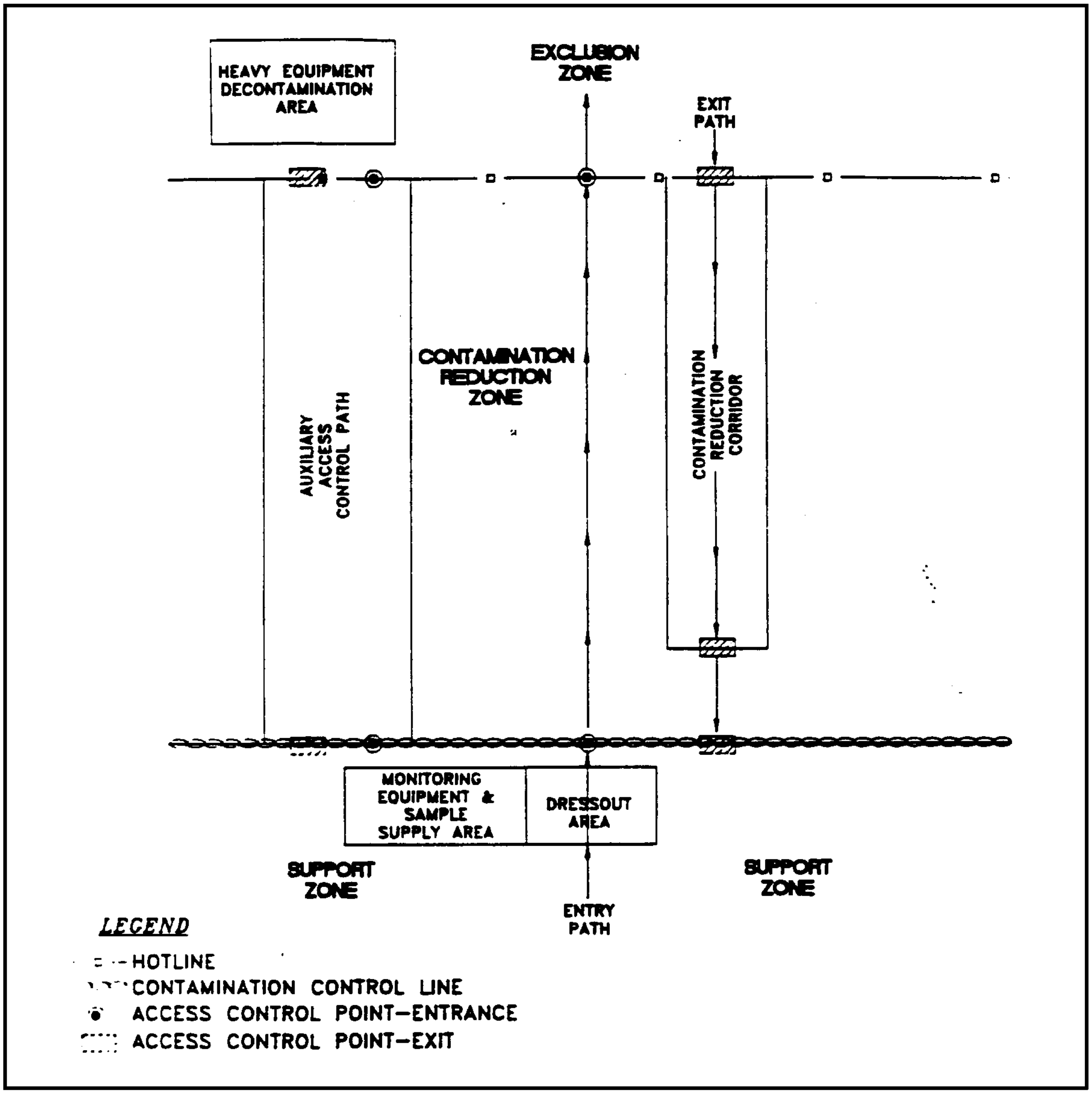
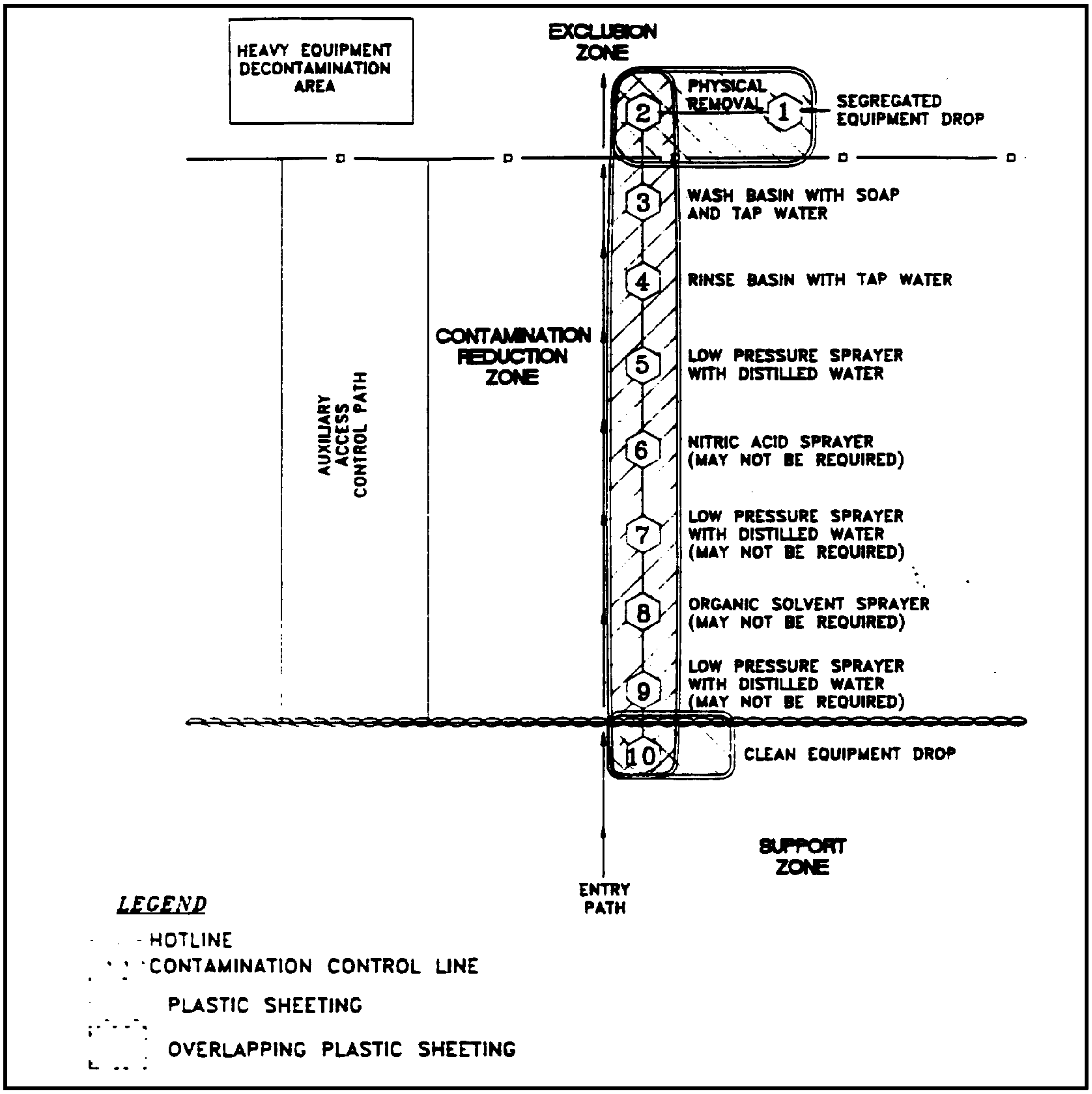


Figure 1. Contamination Reduction Zone Layout

APPENDIX B (Cont'd.)

Figures

Figure 2. Decontamination Layout



GROUNDWATER WELL SAMPLING

SOP#: 2007
DATE: 01/26/95
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The objective of this standard operating procedure (SOP) is to provide general reference information on sampling of ground water wells. This guideline is primarily concerned with the collection of water samples from the saturated zone of the subsurface. Every effort must be made to ensure that the sample is representative of the particular zone of water being sampled. These procedures are designed to be used in conjunction with analyses for the most common types of ground water contaminants (e.g., volatile and semi-volatile organic compounds, pesticides, metals, biological parameters).

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

In order to obtain a representative groundwater sample for chemical analysis it is important to remove stagnant water in the well casing and the water immediately adjacent to the well before collection of the sample. This may be achieved with one of a number of instruments. The most common of these are the bailer, submersible pump, non-contact gas bladder pump, inertia pump and suction pump. At a minimum, three well volumes should be purged, if possible. Equipment must be decontaminated prior to use and between wells. Once purging is completed and the correct laboratory-cleaned sample containers have been prepared, sampling may proceed. Sampling may be conducted with any of the above instruments, and need not be the same as the device used for purging. Care should be taken when choosing the sampling device as some will affect the integrity of the sample. Sampling should occur in a progression from the least to most contaminated well, if this information is known.

The growing concern over the past several years over low levels of volatile organic compounds in water supplies has led to the development of highly sophisticated analytical methods that can provide detection limits at part per trillion levels. While the laboratory methods are extremely sensitive, well controlled and quality assured, they cannot compensate for a poorly collected sample. The collection of a sample should be as sensitive, highly developed and quality assured as the analytical procedures.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

The type of analysis for which a sample is being collected determines the type of bottle, preservative, holding time, and filtering requirements. Samples should be collected directly from the sampling device into appropriate laboratory cleaned containers. Check that a Teflon liner is present in the cap, if required. Attach a sample identification label. Complete a field data sheet, a chain of custody form, and record all pertinent data in the site logbook.

Samples shall be appropriately preserved, labelled, logged, and placed in a cooler to be maintained at 4EC. Samples must be shipped well before the holding time is up and ideally should be shipped within 24 hours of sample collection. It is imperative that samples be shipped or delivered daily to the analytical laboratory in order to maximize the time available for the laboratory to perform the analyses. The bottles should be shipped with adequate packing and cooling to ensure that they arrive intact.

Sample retrieval systems suitable for the valid collection of volatile organic samples are: positive displacement bladder pumps, gear driven submersible pumps, syringe samplers and bailers (Barcelona, 1984; Nielsen, 1985). Field conditions and other constraints will limit the choice of appropriate systems. The focus of concern must remain to provide a valid sample for analysis, one which has been subjected to the least amount of turbulence possible.

Treatment of the sample with sodium thiosulfate preservative is required only if there is residual chlorine in the water that could cause free radical chlorination and change the identity of the original contaminants. It should not be used if there is no chlorine in the water.

Holding time for volatiles analysis is seven days. It is imperative that the sample be shipped or delivered daily to the analytical laboratory. The bottles must be shipped on their sides to aid in maintaining the airtight seal during shipment, with adequate packing and cooling to ensure that they arrive intact.

For collection of volatile organic samples, refer to the work plan to ensure that 40 mL glass sample vials with Teflon lined septa are ordered and in sufficient numbers. Check sampling supplies; field kit for chlorine, preservatives, Parafilm, foam sleeves and coolers. Due to the extreme trace levels at which volatile organics are detectable, cross contamination and introduction of contaminants must be avoided. Trip blanks are incorporated into the shipment package to provide a check against cross contamination.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

4.1 General

The primary goal in performing ground water sampling is to obtain a representative sample of the ground water body. Analysis can be compromised by field personnel in two primary ways: (1) taking an unrepresentative sample, or (2) by incorrect handling of the sample. There are numerous ways of introducing foreign contaminants into a sample, and these must be avoided by following strict sampling procedures and utilizing trained field personnel.

4.2 Purging

In a nonpumping well, there will be little or no vertical mixing of the water, and stratification will occur. The well water in the screened section will mix with the ground water due to normal flow patterns, but the well water above the screened section will remain isolated, become stagnant, and may lack the contaminants representative of the ground water. Persons sampling should realize that stagnant water may contain foreign material inadvertently or deliberately introduced from the surface, resulting in an unrepresentative sample. To safeguard against collecting nonrepresentative stagnant water, the following guidelines and techniques should be adhered to during sampling:

1. As a general rule, all monitor wells should be pumped or bailed prior to sampling. Purge water should be containerized on site or handled as specified in the site specific project plan. Evacuation of a minimum of one volume of water in the well casing, and preferably three to five volumes, is recommended for a representative sample. In a high-yielding ground water formation and where there is no stagnant water in the well above the screened section, evacuation prior to sample withdrawal is not as critical. However, in all cases where the monitoring data is to be used for enforcement actions, evacuation is recommended.

2. When purging with a pump (not a bailer), the pump should be set at the screened interval, or if the well is an open-rock well, it should be set at the same depth the sample will be collected. When sampling a screened well, the sample should also be collected from the same depth the pump was set at.

3. The well should be sampled as soon as possible after purging.

4. Analytical parameters typically dictate whether the sample should be collected through the purging device, or through a separate sampling instrument.

5. For wells that can be pumped or bailed to dryness with the equipment being used, the well should be evacuated and allowed to

recover prior to collecting a sample. If the recovery rate is fairly rapid and time allows, evacuation of more than one volume of water is preferred. If recovery is slow, sample the well upon recovery after one evacuation.

6. A non-representative sample can also result from excessive pre-pumping of the monitoring well. Stratification of the leachate concentration in the ground water formation may occur, or heavier-than-water compounds may sink to the lower portions of the aquifer. Excessive pumping can dilute or increase the contaminant concentrations from what is representative of the sampling point of interest.

4.3 Materials

Materials of construction for samplers and evacuation equipment (bladders, pump, bailers, tubing, etc.) should be limited to stainless steel, Teflon^{R}, and glass in areas where concentrations are expected to be at or near the detection limit. The tendency of organics to leach into and out of many materials make the selection of materials critical for trace analyses. The use of plastics, such as PVC or polyethylene, should be avoided when analyzing for organics. However, PVC may be used for evacuation equipment as it will not come in contact with the sample, and in highly contaminated wells, disposable equipment (i.e., polypropylene bailers) may be appropriate to avoid cross-contamination.

Materials of construction (bladders/ pumps, bailers, tubing, etc.) suitable for collecting and handling Volatile Organic Samples should be limited to stainless steel, Teflon and glass in areas which detection limit range concentrations are expected. The tendency of organics to leach into and out of many materials, make the selection of materials critical for these trace analyses. The use of plastics, e.g., PVC etc., should be avoided. There are numerous ways of introducing foreign contaminants into a sample, and these must be avoided by following strict sampling procedures and utlization of trained personnel.

4.4 Advantages/Disadvantages of Certain Equipment

4.4.1 Bailers

Advantages

C Only practical limitations on size and materials

C No power source needed

C Portable

C Inexpensive, so it can be dedicated and hung in a well, thereby reducing the chances of cross contamination

C Minimal outgassing of volatile organics while sample is in bailer

C Readily available

C Removes stagnant water first

C Rapid, simple method for removing small volumes of purge water

Disadvantages

C Time-consuming to flush a large well of stagnant water

C Transfer of sample may cause aeration

C Stoppers at the bottom of the bailer usually leak thus the bailer must be brought to the surface rapidly

C If the bailer is allowed to hit the bottom of the well boring, gravel can displace the ball valve not allowing the bailer to hold water

4.4.2 Submersible Pumps

Advantages

C Portable and can be transported to several wells

C Depending upon the size of the pump and the pumping depths, relatively high pumping rates are possible

C Generally very reliable and does not require priming

Disadvantages

- Potential for effects on analysis of trace organics
- Heavy and cumbersome to deal with, particularly in deeper wells
- Expensive
- Power source needed
- Sediment in water may cause problems with the pumps
- Impractical in low yielding or shallow wells

4.4.3 Non-Contact Gas Bladder Pumps

Advantages

- Maintains integrity of sample
- Easy to use
- Can sample from discrete locations within the monitor well

Disadvantages

- Difficulty in cleaning, though dedicated tubing and bladder may be used
- Only useful to about 100 feet
- Supply of gas for operation, gas bottles and/or compressors are often difficult to obtain and are cumbersome
- Relatively low pumping rates
- Requires air compressor or pressurized gas source and control box

4.4.4 Suction Pumps

Advantages

- Portable, inexpensive, and readily available

Disadvantages

- Restricted to areas with water levels within 20 to 25 feet of the ground surface
- Vacuum can cause loss of dissolved gasses and volatile organics
- Pump must be primed and vacuum is often difficult to maintain during initial stages of pumping

4.4.5 Inertia Pumps

Advantages

- Portable, inexpensive, and readily available
- Offers a rapid method for purging relatively shallow wells

Disadvantages

- Restricted to areas with water levels within 70 feet of the ground surface
- May be time consuming to purge wells with these manual pumps
- Labor intensive
- WaTerra pumps are only effective in 2-inch diameter wells

5.0 EQUIPMENT APPARATUS

5.1 Equipment Checklist

5.1.1 General

- Water level indicator
  - electric sounder
  - steel tape
  - transducer
  - reflection sounder
  - airline
- Depth sounder
- Appropriate keys for well cap locks
- Steel brush
- HNU or OVA (whichever is most appropriate)
- Logbook
- Calculator
- Field data sheets and samples labels

- Chain of custody records and seals
- Sample containers
- Engineer's rule
- Sharp knife (locking blade)
- Tool box (to include at least: screwdrivers, pliers, hacksaw, hammer, flashlight, adjustable wrench)
- Leather work gloves
- Appropriate Health & Safety gear
- 5-gallon pail
- Plastic sheeting
- Shipping containers
- Packing materials
- Bolt cutters
- Ziploc plastic bags
- Containers for evacuation liquids
- Decontamination solutions
- Tap water
- Non phosphate soap
- Several brushes
- Pails or tubs
- Aluminum foil
- Garden sprayer
- Preservatives
- Distilled or deionized water
- Fire extinguisher (if using a generator for your power source)

5.1.2 Bailers

- Clean, decontaminated bailers of appropriate size and construction material
- Nylon line, enough to dedicate to each well
- Teflon coated bailer wire
- Sharp knife
- Aluminum foil (to wrap clean bailers)
- Five gallon bucket

5.1.3 Submersible Pump

- Pump(s)
- Generator (110, 120, or 240 volt) or 12 volt battery if inaccessible to field vehicle - amp meter is useful
- 1" black PVC coil tubing - enough to dedicate to each well
- Hose clamps
- Safety cable
- Tool box supplement
  - pipe wrenches
  - wire strippers
  - electrical tape
  - heat shrink
  - hose connectors
  - Teflon tape
- Winch, pulley or hoist
- Gasoline for generator/gas can
- Flow meter with gate valve
- 1" nipples and various plumbing (i.e., pipe connectors)
- Control box (if necessary)

5.1.4 Non-Gas Contact Bladder Pump

- Non-gas contact bladder pump
- Compressor or nitrogen gas tank
- Batteries and charger
- Teflon tubing - enough to dedicate to each well
- Swagelock fitting
- Toolbox supplements - same as submersible pump
- Control box (if necessary)

5.1.5 Suction Pump

- Pump
- 1" black PVC coil tubing - enough to dedicate to each well
- Gasoline - if required
- Toolbox
- Plumbing fittings
- Flow meter with gate valve

5.1.6 Inertia Pump

- Pump assembly (WaTerra pump, piston pump)
- Five gallon bucket

6.0 REAGENTS

Reagents may be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed. Decontamination solutions are specified in ERT SOP #2006, Sampling Equipment Decontamination.

7.0 PROCEDURE

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed (i.e, diameter and depth of wells to be sampled).

2. Obtain necessary sampling and monitoring equipment, appropriate to type of contaminant being investigated. For collection of volatile organic samples, refer to the work plan to ensure that 40 mL glass sample vials with Teflon lined septa are ordered and in sufficient numbers. Check sampling supplies; field kit for chlorine, preservatives, Parafilm, foam sleeves and coolers. Due to extreme trace levels at which volatile organics are detectable, cross contamination and introduction of contaminants must be avoided. Trip blanks are incorporated into the shipment package to provide a check against cross contamination.

3. Decontaminate or preclean equipment, and ensure that it is in working order.

4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.

5. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.

6. Identify and mark all sampling locations.

7.2 Field Preparation

1. Start at the least contaminated well, if known.

2. Lay plastic sheeting around the well to minimize likelihood of contamination of equipment from soil adjacent to the well.

3. Remove locking well cap, note location, time of day, and date in field notebook or appropriate log form.

4. Remove well casing cap.

5. Screen headspace of well with an appropriate monitoring instrument to determine the presence of volatile organic compounds and record in site logbook.

6. Lower water level measuring device or equivalent (i.e., permanently installed transducers or airline) into well until water surface is encountered.

7. Measure distance from water surface to reference measuring point on well casing or protective barrier post and record in site logbook. Alternatively, if no reference point, note that water level measurement is from top of steel casing, top of PVC riser pipe, from ground surface, or some other position on the well head.

   If floating organics are of concern, this can be determined by measuring the water level with an oil/water interface probe which measures floating organics.

8. Measure total depth of well (at least twice to confirm measurement) and record in site logbook or on field data sheet.

9. Calculate the volume of water in the well and the volume to be purged using the calculations in Section 8.0.

10. Select the appropriate purging and sampling equipment.

11. If residual chlorine is suspected, use the Hach Field Test Kit for chlorine to determine if there is residual chlorine in the water to be sampled. If there is, treat the sample vial with a crystal of sodium thiosulfate prior to sample collection.

7.3 Purging

The amount of flushing a well receives prior to sample collection depends on the intent of the monitoring program as well as the hydrogeologic conditions. Programs where overall quality determination of water resources are involved may require long pumping periods to obtain a sample that is representative of a large volume of that aquifer. The pumped volume can be determined prior to sampling so that the sample is a collected after a known volume of the water is evacuated from the aquifer, or the well can be pumped until the stabilization of parameters such as temperature, electrical conductance, pH, or turbidity has occurred.

However, monitoring for defining a contaminant plume requires a representative sample of a small volume of the aquifer. These circumstances require that the well be pumped enough to remove the stagnant water but not enough to induce flow from other areas. Generally, three well volumes are considered effective, or calculations can be made to determine, on the basis of the aquifer parameters and well dimensions, the appropriate volume to remove prior to sampling.

During purging, water level measurements may be taken regularly at 15-30 second intervals. This data may be used to compute aquifer transmissivity and other hydraulic characteristics. The following well evacuation devices are most commonly used. Other evacuation devices are available, but have been omitted in this discussion due to their limited use.

7.3.1 Bailers

Bailers are the simplest purging device used and have many advantages. They generally consist of a rigid length of tube, usually with a ball check-valve at the bottom. A line is used to lower the bailer into the well and retrieve a volume of water. The three most common types of bailer are PVC, Teflon, and stainless steel.

This manual method of purging is best suited to shallow or narrow diameter wells. For deep, larger diameter wells which require evacuation of large volumes of water, other mechanical devices may be more appropriate.

7.3.1.1 Operation

Equipment needed will include a clean decontaminated bailer, Teflon or nylon line, a sharp knife, and plastic sheeting.

1. Determine the volume of water to be purged as described in 8.0, calculations.

2. Lay plastic sheeting around the well to prevent contamination of the bailer line with foreign materials.

3. Attach the line to the bailer and slowly lower until the bailer is completely submerged, being careful not to drop the bailer to the water, causing turbulence and the possible loss of volatile organic contaminants.

4. Pull bailer out ensuring that the line either falls onto a clean area of plastic sheeting or never touches the ground.

5. Empty the bailer into a pail until full to determine the number of bails necessary to achieve the required purge volume.

6. Thereafter, pour the water into a container and dispose of purge waters as specified in the site specific sampling plan.

7.3.2 Submersible Pumps

The use of submersible pumps for sample collection is permissible provided they are constructed of suitably noncontaminating materials. The chief drawback, however, is the difficulty avoiding cross-contamination between wells. Although some units can be disassembled easily to allow surfaces contacted by contaminants to be cleaned, field decontamination may be difficult and require solvents that can affect sample analysis. The use of submersible pumps in multiple well-sampling programs, therefore, should be carefully considered against other sampling mechanisms (bailers, bladder pumps). In most cases, a sample can be collected by bailer after purging with a submersible pump, however, submersible pumps may be the only practical sampling device for extremely deep wells (greater than 300 feet of water). Under those conditions, dedicated pump systems should be installed to eliminate the potential for cross-contamination of well samples.

Submersible pumps generally use one of two types of power supplies, either electric or compressed gas or air. Electric powered pumps can run off a 12 volt DC rechargeable battery, or a 110 or 220 volt AC power supply. Those units powered by compressed air normally use a small electric or gas-powered air compressor. They may also utilize compressed gas (i.e., nitrogen) from bottles. Different size pumps are available for different depth or diameter monitoring wells.

7.3.2.1 Operation

1. Determine the volume of water to be purged as described in 8.0 Calculations.
2. Lay plastic sheeting around the well to prevent contamination of pumps, hoses or lines with foreign materials.
3. Assemble pump, hoses and safety cable, and lower the pump into the well. Make sure the pump is deep enough so all the water is not evacuated. (Running the pump without water may cause damage.)
4. Attach flow meter to the outlet hose to measure the volume of water purged.
5. Use a ground fault circuit interrupter (GFCI) or ground the generator to avoid possible electric shock.
6. Attach power supply, and purge the well until the specified volume of water has been evacuated (or until field parameters, such as temperature, pH, conductivity, etc, have stabilized). Do not allow the pump to run dry. If the pumping rate exceeds the well recharge rate, lower the pump further into the well, and continue pumping.
7. Collect and dispose of purge waters as specified in the site specific sampling plan.

7.3.3 Non-Contact Gas Bladder Pumps

For this procedure, an all stainless-steel and Teflon Middleburg-squeeze bladder pump (e.g., IEA, TIMCO, Well Wizard, Geoguard, and others) is used to provide the least amount of material interference to the sample (Barcelona, 1985). Water comes into contact with the inside of the bladder (Teflon) and the sample tubing, also Teflon, that may be dedicated to each well. Some wells may have permanently installed bladder pumps, (i.e., Well Wizard, Geoguard), that will be used to sample for all parameters.

7.3.3.1 Operation

1. Assemble Teflon tubing, pump and charged control box.
2. Procedure for purging with a bladder pump is the same as for a submersible pump (Section 7.3.2.1).
3. Be sure to adjust flow rate to prevent violent jolting of the hose as sample is drawn in.

7.3.4 Suction Pumps

There are many different types of suction pumps. They include: centrifugal, peristaltic and diaphragm. Diaphragm pumps can be used for well evacuation at a fast pumping rate and sampling at a low pumping rate. The peristaltic pump is a low volume pump that uses rollers to squeeze the flexible tubing thereby creating suction. This tubing can be dedicated to a well to prevent cross contamination. Peristaltic pumps, however, require a power source.

7.3.4.1 Operation

1. Assembly of the pump, tubing, and power source if necessary.
2. Procedure for purging with a suction pump is exactly the same as for a submersible pump (Section 7.3.2.1).

7.3.5 Inertia Pumps

Inertia pumps such as the WaTerra pump and piston pump, are manually operated. They are most appropriate to use when wells are too deep to bail by hand, or too shallow or narrow (or inaccessible) to warrant an automatic (submersible, etc.) pump. These pumps are made of plastic and may be either decontaminated or discarded.

7.3.5.1 Operation

1. Determine the volume of water to be purged as described in 8.0, Calculations.
2. Lay plastic sheeting around the well to prevent contamination of pumps or hoses with foreign materials.
3. Assemble pump and lower to the appropriate depth in the well.
4. Begin pumping manually, discharging water into a 5 gallon bucket (or other graduated vessel). Purge until specified volume of water has been evacuated (or until field parameters such as temperature, pH,

conductivity, etc. have stabilized).

5. Collect and dispose of purge waters as specified in the site specific project plan.

7.4 Sampling

Sample withdrawal methods require the use of pumps, compressed air, bailers, and samplers. Ideally, purging and sample withdrawal equipment should be completely inert, economical to manufacture, easily cleaned, sterilized, reusable, able to operate at remote sites in the absence of power resources, and capable of delivering variable rates for sample collection.

There are several factors to take into consideration when choosing a sampling device. Care should be taken when reviewing the advantages or disadvantages of any one device. It may be appropriate to use a different device to sample than that which was used to purge. The most common example of this is the use of a submersible pump to purge and a bailer to sample.

7.4.1 Bailers

The positive-displacement volatile sampling bailer is perhaps the most appropriate for collection of water samples for volatile analysis. Other bailer types (messenger, bottom fill, etc.) are less desirable, but may be mandated by cost and site conditions.

7.4.1.1 Operation

1. Surround the monitor well with clean plastic sheeting. If using the GPI bailer, insert a vial into the claim and assemble the unit.

2. Attach a line to a clean decontaminated bailer.
3. Lower the bailer slowly and gently into the well, taking care not to shake the casing sides or to splash the bailer into the water. Stop lowering at a point adjacent to the screen.

4. Allow bailer to fill and then slowly and gently retrieve the bailer from the well avoiding contact with the casing, so as not to knock flakes of rust or other foreign materials into the bailer. If using the GPI bailer for collecting volatile organic samples, once at the surface, remove the bailer from the cable. Carefully open the GPI bailer unit and remove the vial. Begin slowly pouring from the bailer, and collect the duplicate samples from the midstream sample.

5. Remove the cap from the sample container and place it on the plastic sheet or in a location where it won't become contaminated. See Section 7.7 for special considerations on VOA samples.

6. Begin slowly pouring from the bailer.

7. Filter and preserve samples as required by sampling plan.

8. Cap the sample container tightly and place prelabeled sample container in a carrier.

9. Replace the well cap.

10. Log all samples in the site logbook and on field data sheets and label all samples.

11. Package samples and complete necessary paperwork.

12. Transport sample to decontamination zone for preparation for transport to analytical laboratory.

7.4.2 Submersible Pumps

Although it is recommended that samples not be collected with a submersible pump due to the reasons stated in Section 4.4.2, there are some situations where they may be used.

7.4.2.1 Operation

1. Allow the monitor well to recharge after purging, keeping the pump just above screened section.

2. Attach gate valve to hose (if not already fitted), and reduce flow of water to a manageable sampling rate.

3. Assemble the appropriate bottles.

4. If no gate valve is available, run the water

down the side of a clean jar and fill the sample bottles from the jar.

5. Cap the sample container tightly and place prelabeled sample container in a carrier.

6. Replace the well cap.

7. Log all samples in the site logbook and on the field data sheets and label all samples.

8. Package samples and complete necessary paperwork.

9. Transport sample to decontamination zone for preparation for transport to the analytical laboratory.

10. Upon completion, remove pump and assembly and fully decontaminate prior to setting into the next sample well. Dedicate the tubing to the hole.

7.4.3 Non-Contact Gas Bladder Pumps

The use of a non-contact gas positive displacement bladder pump is often mandated by the use of dedicated pumps installed in wells. These pumps are also suitable for shallow (less than 100 feet) wells. They are somewhat difficult to clean, but may be used with dedicated sample tubing to avoid cleaning. These pumps require a power supply and a compressed gas supply (or compressor). They may be operated at variable flow and pressure rates making them ideal for both purging and sampling.

Barcelona (1984) and Nielsen (1985) report that the non-contact gas positive displacement pumps cause the least amount of alteration in sample integrity as compared to other sample retrieval methods.

7.4.3.1 Operation

1. Allow well to recharge after purging.

2. Assemble the appropriate bottles.

3. Turn pump on, increase the cycle time and reduce the pressure to the minimum that will allow the sample to come to the surface.

4. Cap the sample container tightly and place prelabeled sample container in a carrier.

5. Replace the well cap.

6. Log all samples in the site logbook and on field data sheets and label all samples.

7. Package samples and complete necessary paperwork.

8. Transport sample to decontamination zone for preparation for transport to analytical laboratory.

9. On completion, remove the tubing from the well and either replace the Teflon tubing and bladder with new dedicated tubing and bladder or rigorously decontaminate the existing materials.

10. Nonfiltered samples shall be collected directly from the outlet tubing into the sample bottle.

11. For filtered samples, connect the pump outlet tubing directly to the filter unit. The pump pressure should remain decreased so that the pressure build up on the filter does not blow out the pump bladder or displace the filter. For the Geotech barrel filter, no actual connections are necessary so this is not a concern.

7.4.4 Suction Pumps

In view of the limitations of these type pumps, they are not recommended for sampling purposes.

7.4.5 Inertia Pumps

Inertia pumps may be used to collect samples. It is more common, however, to purge with these pumps and sample with a bailer (Section 7.4.1).

7.4.5.1 Operation

1. Following well evacuation, allow the well to recharge.

2. Assemble the appropriate bottles.

3. Since these pumps are manually operated,

the flow rate may be regulated by the sampler. The sample may be discharged from the pump outlet directly into the appropriate sample container.

4. Cap the sample container tightly and place prelabeled sample container in a carrier.
5. Replace the well cap.
6. Log all samples in the site logbook and on field data sheets and label all samples.
7. Package samples and complete necessary paperwork.
8. Transport sample to decontamination zone for preparation for transport to the analytical laboratory.
9. Upon completion, remove pump and decontaminate or discard, as appropriate.

7.4.6. Sample Retrieval - Syringe

A limited number of commercial syringe type samplers are available, (IEA, TIMCO, etc.) some are homemade devices. These devices are claimed to provide good quality samples for volatile analysis, but are severly limited in sample volume and are specific to sampling for volatiles. Essentially, they operated with an evacuated chamber that is lowered down the well, and allowed to fill with the pressure of the water. The entire mechanism is then brought to the surface with the sample. The sample may then be transferred to a sample vial, or the entire unit may be sent as the sample container.

1. Evacuate the syringe if necessary, and lower the sampling device to just below the well screen.
2. Remove the constriction from the device and allow the sample to fill the syringe, apply slight suction as necessary.
3. Bring unit to the surface. If necessary, transfer the sample to vials, as outlined in steps 2 through 7 above.

7.5 Filtering

For samples requiring filtering, such as total metals analysis, the filter must be decontaminated prior to and between uses. Filters work by two methods. A barrel filter such as the "Geotech" filter works with a bicycle pump, used to build up positive pressure in the chamber containing the sample which is then forced through the filter paper (minimum size 0.45 µm) into a jar placed underneath. The barrel itself is filled manually from the bailer or directly via the hose of the sampling pump. The pressure must be maintained up to 30 lbs/in^2 by periodic pumping.

A vacuum type filter involves two chambers; the upper chamber contains the sample and a filter (minimum size 0.45 µm) divides the chambers. Using a hand pump or a Gilian type pump, air is withdrawn from the lower chamber, creating a vacuum and thus causing the sample to move through the filter into the lower chamber where it is drained into a sample jar. Repeated pumping may be required to drain all the sample into the lower chamber. If preservation of the sample is necessary, this should be done after filtering.

7.6 Post Operation

After all samples are collected and preserved, the sampling equipment should be decontaminated prior to sampling another well to prevent cross-contamination of equipment and monitor wells between locations.

1. Decontaminate all equipment.
2. Replace sampling equipment in storage containers.
3. Prepare and transport ground water samples to the laboratory. Check sample documentation and make sure samples are properly packed for shipment.

7.7 Special Considerations for VO A Sampling

The proper collection of a sample for volatile organics requires minimal disturbance of the sample to limit volatilization and therefore a loss of volatiles from the sample.

Sample retrieval systems suitable for the valid collection of volatile organic samples are: positive displacement bladder pumps, gear driven submersible pumps, syringe samplers and bailers (Barcelona, 1984; Nielsen, 1985). Field conditions and other constraints will limit the choice of appropriate systems. The focus of concern must be to provide a valid sample for analysis, one which has been subjected to the least amount of turbulence possible.

The following procedures should be followed:

1. Open the vial, set cap in a clean place, and collect the sample during the middle of the cycle. When collecting duplicates, collect both samples at the same time.

2. Fill the vial to just overflowing. Do not rinse the vial, nor excessively overflow it. There should be a convex meniscus on the top of the vial.

3. Check that the cap has not been contaminated (splashed) and carefully cap the vial. Place the cap directly over the top and screw down firmly. Do not overtighten and break the cap.

4. Invert the vial and tap gently. Observe vial for at least ten (10) seconds. If an air bubble appears, discard the sample and begin again. It is imperative that no entrapped air is in the sample vial.

5. Immediately place the vial in the protective foam sleeve and place into the cooler, oriented so that it is lying on its side, not straight up.

6. The holding time for VOAs is seven days. Samples should be shipped or delivered to the laboratory daily so as not to exceed the holding time. Ensure that the samples remain at 4°C, but do not allow them to freeze.

8.0 CALCULATIONS

If it is necessary to calculate the volume of the well, utilize the following equation:

$$\textit{Well volume} = n r^2 h\,(cf) \qquad [\textit{Equation } 1]$$

where:

n = pi
r = radius of monitoring well (feet)
h = height of the water column (feet) [This may be determined by subtracting the depth to water from the total depth of the well as measured from the same reference point.]
cf = conversion factor (gal/ft^3) = 7.48 gal/ft^3 [In this equation, 7.48 gal/ft^3 is the necessary conversion factor.]

Monitor well diameters are typically 2", 3", 4", or 6". Knowing the diameter of the monitor well, there are a number of standard conversion factors which can be used to simplify the equation above.

The volume, in gallons per linear foot, for various standard monitor well diameters can be calculated as follows:

$$v(gal/ft) = n r^2\,(cf) \qquad [\textit{Equation } 2]$$

where:

n = pi
r = radius of monitoring well (feet)
cf = conversion factor (7.48 gal/ft^3)

For a 2" diameter well, the volume per linear foot can be calculated as follows:

$$\begin{aligned} vol/linear\ ft &= n r^2\,(cf) \qquad [\textit{Equation } 2] \\ &= 3.14\ (1/12\ ft)^2\ \ 7.48\ gal/ft^3 \\ &= 0.1632\ gal/ft \end{aligned}$$

Remember that if you have a 2" diameter well, you must convert this to the radius in feet to be able to use the equation.

The conversion factors for the common size monitor wells are as follows:

Well diameter	2"	3"	4"	6"
Volume (gal/ft.)	0.1632	0.3672	0.6528	1.4688

If you utilize the conversion factors above, Equation

1 should be modified as follows:

$$\textit{Well volume} = (h)(cf) \qquad [\textit{Equation } 3]$$

where:

h = height of water column (feet)
cf = the conversion factor calculated from Equation 2

The well volume is typically tripled to determine the volume to be purged.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

There are no specific quality assurance (QA) activities which apply to the implementation of these procedures. However, the following general QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented.

3. The collection of rinsate blanks is recommended to evaluate potential for cross contamination from the purging and/or sampling equipment.

4. Trip blanks are required if analytical parameters include VOAs.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA or REAC health and safety guidelines. More specifically, depending upon the site specific contaminants, various protective programs must be implemented prior to sampling the first well. The site health and safety plan should be reviewed with specific emphasis placed on the protection program planned for the well sampling tasks. Standard safe operating practices should be followed such as minimizing contact with potential contaminants in both the vapor phase and liquid matrix through the use of respirators and disposable clothing.

When working around volatile organic contaminants:

1. Avoid breathing constituents venting from the well.

2. Pre-survey the well head-space with an FID/PID prior to sampling.

3. If monitoring results indicate organic constituents, sampling activities may be conducted in Level C protection. At a minimum, skin protection will be afforded by disposable protective clothing.

Physical hazards associated with well sampling:

1. Lifting injuries associated with pump and bailers retrieval; moving equipment.

2. Use of pocket knives for cutting discharge hose.

3. Heat/cold stress as a result of exposure to extreme temperatures and protective clothing.

4. Slip, trip, fall conditions as a result of pump discharge.

5. Restricted mobility due to the wearing of protective clothing.

6. Electrical shock associated with use of submersible pumps is possible. Use a GFCI or a copper grounding stake to avoid this problem.

12.0 REFERENCES

Barcelona, M.J., Helfrich, J.A., Garske, E.E., and J.P. Gibb, Spring 1984. "A Laboratory Evaluation of Groundwater Sampling Mechanisms," Groundwater

Monitoring Review, 1984 pp. 32-41.

Barcelona, M.J., Helfrich, J.A., and Garske, E.E., "Sampling Tubing Effects on Groundwater Samples", Analy. Chem., Vol. 57, 1985 pp. 460-463.

Driscoll, F.G., Groundwater and Wells (2nd ed.) Johnson Division, UOP Inc., St. Paul, Minnesota, 1986, 1089 pp.

Gibb, J.P., R.M. Schuller, and R.A. Griffin,. Monitoring Well Sampling and Preservation Techniques, EPA-600/9-80-010, 1980. March, 1980.

Instrument Specialties Company, (January). Instruction Manual, Model 2100 Wastewater Sampler, Lincoln, Nebraska, 1980.

Keely, J.F. and Kwasi Boateng, Monitoring Well Installation, Purging and Sampling Techniques - Part I: Conceptualizations, Groundwater V25, No. 3, 1987 pp. 300-313.

Keith, Lawrence H., Principles of Environmental Sampling, American Chemical Society, 1988.

Korte, Nic, and Dennis Ealey,. Procedures for Field Chemical Analyses of Water Samples, U.S. Department of Energy, GJ/TMC-07, Technical Measurements Center, Grand Junction Project Office, 1983.

Korte, Nic, and Peter Kearl,. Procedures for the Collection and Preservation of Groundwater and Surface Water Samples and for the Installation of Monitoring Wells: Second Edition, U.S. Department of Energy, GJ/TMC-08, Technical Measurements Center, Grand Junction Projects Office, 1985.

National Council of the Paper Industry for Air and Stream Improvement, Inc.,. A Guide to Groundwater Sampling, Technical Bulletin No. 362, Madison, New York. January, 1982.

Nielsen, David M. and Yeates, Gillian L., Spring. "A Comparison of Sampling Mechanisms Available for Small-Diameter Groundwater Monitoring Wells," Groundwater Monitoring Review, 1985 pp. 83-99.

Scalf, et al. (M.J. Scalf, McNabb, W. Dunlap, R. Crosby, and J. Fryberger),. Manual for Groundwater Sampling Procedures. R.S. Kerr Environmental Research Laboratory, Office of Research and Development. 1980, Ada, OK.

Sisk, S.W. NEIC Manual for Ground/Surface Investigations at Hazardous Waste Sites, EPA-330/9-81-002, 1981.

U.S. Department of the Interior, National Handbook of Recommended Methods for Water-Data Acquisition, Reston, Virginia.

U.S. Environmental Protection Agency, 1977. Procedures Manual for Groundwater Monitoring at Solid Waste Disposal Facilities. EPA-530/SW-611. August, 1977.

U.S. Code of Federal Regulations, 49 CFR Parts 100 to 177, Transportation revised November 1, 1985.

U.S. Environmental Protection Agency, 1982. Handbook for Chemical and Sample Preservation of Water and Wastewater, EPA-600/4-82-029, Washington, D.C.

U.S. Environmental Protection Agency, 1983. Methods for Chemical Analysis of Water and Waste, EPA-600/4-79-020, Washington, D.C.

U.S. Environmental Protection Agency, 1984. Test Methods for Evaluation of Solid Waste, EPA-SW-846, Second Edition, Washington, D.C.

U.S. Environmental Protection Agency, 1981. Manual of Groundwater Quality Sampling Procedures, EPA-600/2-81-160, Washington, D.C.

U.S. Environmental Protection Agency, 1985. Practical Guide for Groundwater Sampling, EPA-600/2-85/104, September, 1985.

U.S. Environmental Protection Agency, 1986. RCRA Groundwater Monitoring Technical Enforcement Guidance Document, OSWER-9950-1, September, 1986.

Weston, 1987. Standard Operations Procedures for Monitor Well Installation. MOUND IGMP/RIP.

U.S. Environmental Protection Agency, 1982. <u>Handbook for Sampling and Sample Preservation of Water and Wastewater</u>, EPA-600/4-82-029, Washington, D.C.

--- 1981. <u>Manual of Groundwater Quality</u>

Sampling Procedures, EPA-600/2-81-160, Washington, D.C.

--- 1985. Practice Guide for Groundwater Sampling, EPA-600/2/85-104, September 1985.

Nielsen, David M. and Yeates, Gillian L., Spring 1985. "A Comparison of Sampling Mechanisms Available for Small-Diameter Groundwater Monitoring Wells," Groundwater Monitoring Review, pp. 83-99.

WESTON, 1987. Standard Operating Procedures for Monitor Well Installation. MOUND IGMP/RIP

Barcelona, M.J. Helfrich, J.A., and Garske, E.E., "Sampling Tubing Effects on Groundwater Samples". 1985, Analy. Chem., Vol. 57, pp. 460-463.

STANDARD OPERATING PROCEDURES

SOIL SAMPLING

CONTENTS

SUPERCEDES: SOP #2012; Revision 0.0; 11/16/94; U.S. EPA Contract 68-C4-0022.

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to describe the procedures for the collection of representative soil samples. Sampling depths are assumed to be those that can be reached without the use of a drill rig, direct-push, or other mechanized equipment (except for a back-hoe). Analysis of soil samples may determine whether concentrations of specific pollutants exceed established action levels, or if the concentrations of pollutants present a risk to public health, welfare, or the environment.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the actual procedures used should be documented and described in an appropriate site report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Soil samples may be collected using a variety of methods and equipment depending on the depth of the desired sample, the type of sample required (disturbed vs. undisturbed), and the soil type. Near-surface soils may be easily sampled using a spade, trowel, and scoop. Sampling at greater depths may be performed using a hand auger, continuous flight auger, a trier, a split-spoon, or, if required, a backhoe.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Chemical preservation of solids is not generally recommended. Samples should, however, be cooled and protected from sunlight to minimize any potential reaction. The amount of sample to be collected and proper sample container type are discussed in ERT/REAC SOP #2003 Rev. 0.0 08/11/94, *Sample Storage, Preservation and Handling*.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

There are two primary potential problems associated with soil sampling - cross contamination of samples and improper sample collection. Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary. Improper sample collection can involve using contaminated equipment, disturbance of the matrix resulting in compaction of the sample, or inadequate homogenization of the samples where required, resulting in variable, non-representative results.

5.0 EQUIPMENT

Soil sampling equipment includes the following:

- Maps/plot plan
- Safety equipment, as specified in the site-specific Health and Safety Plan
- Survey equipment or global positioning system (GPS) to locate sampling points
- Tape measure
- Survey stakes or flags
- Camera and film
- Stainless steel, plastic, or other appropriate homogenization bucket, bowl or pan
- Appropriate size sample containers
- Ziplock plastic bags
- Logbook
- Labels
- Chain of Custody records and custody seals
- Field data sheets and sample labels
- Cooler(s)
- Ice
- Vermiculite
- Decontamination supplies/equipment
- Canvas or plastic sheet
- Spade or shovel
- Spatula
- Scoop
- Plastic or stainless steel spoons
- Trowel(s)
- Continuous flight (screw) auger
- Bucket auger
- Post hole auger
- Extension rods
- T-handle
- Sampling trier
- Thin wall tube sampler
- Split spoons
- Vehimeyer soil sampler outfit
  - Tubes
  - Points
  - Drive head
  - Drop hammer
  - Puller jack and grip
- Backhoe

6.0 REAGENTS

Reagents are not used for the preservation of soil samples. Decontamination solutions are specified in ERT/REAC SOP #2006 Rev. 0.0 08/11/94, *Sampling Equipment Decontamination*, and the site specific work plan.

7.0 PROCEDURES

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies required.
2. Obtain necessary sampling and monitoring equipment.
3. Decontaminate or pre-clean equipment, and ensure that it is in working order.
4. Prepare schedules and coordinate with staff, client, and regulatory agencies, if appropriate.
5. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.
6. Use stakes, flagging, or buoys to identify and mark all sampling locations. Specific site factors, including extent and nature of contaminant, should be considered when selecting sample location. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. All staked locations should be utility-cleared by the property owner or the On-Scene-Coordinator (OSC) prior to soil sampling; and utility clearance should always be confirmed before beginning work.

7.2 Sample Collection

7.2.1 Surface Soil Samples

Collection of samples from near-surface soil can be accomplished with tools such as spades, shovels, trowels, and scoops. Surface material is removed to the required depth and a stainless steel or plastic scoop is then used to collect the sample.

This method can be used in most soil types but is limited to sampling at or near the ground surface. Accurate, representative samples can be collected with this procedure depending on the care and precision demonstrated by the sample team member. A flat, pointed mason trowel to cut a block of the desired soil is helpful when undisturbed profiles are required. Tools plated with chrome or other materials should not be used. Plating is particularly common with garden implements such as potting trowels.

The following procedure is used to collect surface soil samples:

1. Carefully remove the top layer of soil or debris to the desired sample depth with a pre-cleaned spade.

2. Using a pre-cleaned, stainless steel scoop, plastic spoon, or trowel, remove and discard a thin layer of soil from the area which came in contact with the spade.

3. If volatile organic analysis is to be performed, transfer the sample directly into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval or location into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

7.2.2 Sampling at Depth with Augers and Thin Wall Tube Samplers

This system consists of an auger, or a thin-wall tube sampler, a series of extensions, and a "T" handle (Figure 1, Appendix A). The auger is used to bore a hole to a desired sampling depth, and is then withdrawn. The sample may be collected directly from the auger. If a core sample is to be collected, the auger tip is then replaced with a thin wall tube sampler. The system is then lowered down the borehole, and driven into the soil to the completion depth. The system is withdrawn and the core is collected from the thin wall tube sampler.

Several types of augers are available; these include: bucket type, continuous flight (screw), and post-hole augers. Bucket type augers are better for direct sample recovery because they provide a large volume of sample in a short time. When continuous flight augers are used, the sample can be collected directly from the flights. The continuous flight augers are satisfactory when a composite of the complete soil column is desired. Post-hole augers have limited utility for sample collection as they are designed to cut through fibrous, rooted, swampy soil and cannot be used below a depth of approximately three feet.

The following procedure is used for collecting soil samples with the auger:

1. Attach the auger bit to a drill rod extension, and attach the "T" handle to the drill rod.

2. Clear the area to be sampled of any surface debris (e.g., twigs, rocks, litter). It may be advisable to remove the first three to six inches of surface soil for an area approximately six inches in radius around the drilling location.

3. Begin augering, periodically removing and depositing accumulated soils onto a plastic sheet spread near the hole. This prevents accidental brushing of loose material back down the borehole when removing the auger or adding drill rods. It also facilitates refilling the hole, and avoids possible contamination of the surrounding area.

4. After reaching the desired depth, slowly and carefully remove the auger from the hole. When sampling directly from the auger, collect the sample after the auger is removed from the hole and proceed to Step 10.

5. Remove auger tip from the extension rods and replace with a pre-cleaned thin wall tube sampler. Install the proper cutting tip.

6. Carefully lower the tube sampler down the borehole. Gradually force the tube sampler into the soil. Do not scrape the borehole sides. Avoid hammering the rods as the vibrations may cause the boring walls to collapse.

7. Remove the tube sampler, and unscrew the drill rods.

8. Remove the cutting tip and the core from the device.

9. Discard the top of the core (approximately 1 inch), as this possibly represents material collected before penetration of the layer of concern. Place the remaining core into the appropriate labeled sample container. Sample homogenization is not required.

10. If volatile organic analysis is to be performed, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly.

    When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

11. If another sample is to be collected in the same hole, but at a greater depth, reattach the auger bit to the drill and assembly, and follow steps 3 through 11, making sure to decontaminate the auger and tube sampler between samples.

12. Abandon the hole according to applicable state regulations. Generally, shallow holes can simply be backfilled with the removed soil material.

7.2.3 Sampling with a Trier

The system consists of a trier, and a "T" handle. The auger is driven into the soil to be sampled and used to extract a core sample from the appropriate depth.

The following procedure is used to collect soil samples with a sampling trier:

1. Insert the trier (Figure 2, Appendix A) into the material to be sampled at a 0^o to 45^o angle from horizontal. This orientation minimizes the spillage of sample.

2. Rotate the trier once or twice to cut a core of material.

3. Slowly withdraw the trier, making sure that the slot is facing upward.

4. If volatile organic analyses are required, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

7.2.4 Sampling at Depth with a Split Spoon (Barrel) Sampler

Split spoon sampling is generally used to collect undisturbed soil cores of 18 or 24 inches in length. A series of consecutive cores may be extracted with a split spoon sampler to give a complete soil column profile, or an auger may be used to drill down to the desired depth for sampling. The split spoon is then driven to its sampling depth through the bottom of the augured hole and the core extracted.

When split spoon sampling is performed to gain geologic information, all work should be performed in accordance with ASTM D1586-98, “Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils”.

The following procedures are used for collecting soil samples with a split spoon:

1. Assemble the sampler by aligning both sides of barrel and then screwing the drive shoe on the bottom and the head piece on top.

2. Place the sampler in a perpendicular position on the sample material.

3. Using a well ring, drive the tube. Do not drive past the bottom of the head piece or compression of the sample will result.

4. Record in the site logbook or on field data sheets the length of the tube used to penetrate the material being sampled, and the number of blows required to obtain this depth.

5. Withdraw the sampler, and open by unscrewing the bit and head and splitting the barrel. The amount of recovery and soil type should be recorded on the boring log. If a split sample is desired, a cleaned, stainless steel knife should be used to divide the tube contents in half, longitudinally. This sampler is typically available in 2 and 3 1/2 inch diameters. A larger barrel may be necessary to obtain the required sample volume.

6. Without disturbing the core, transfer it to appropriate labeled sample container(s) and seal tightly.

7.2.5 Test Pit/Trench Excavation

A backhoe can be used to remove sections of soil, when detailed examination of soil characteristics are required. This is probably the most expensive sampling method because of the relatively high cost of backhoe operation.

The following procedures are used for collecting soil samples from test pits or trenches:

1. Prior to any excavation with a backhoe, it is important to ensure that all sampling locations are clear of overhead and buried utilities.

2. Review the site specific Health & Safety plan and ensure that all safety precautions including appropriate monitoring equipment are installed as required.

3. Using the backhoe, excavate a trench approximately three feet wide and approximately one foot deep below the cleared sampling location. Place excavated soils on plastic sheets. Trenches greater than five feet deep must be sloped or protected by a shoring system, as required by OSHA regulations.

4. A shovel is used to remove a one to two inch layer of soil from the vertical face of the pit where sampling is to be done.

5. Samples are taken using a trowel, scoop, or coring device at the desired intervals. Be sure to scrape the vertical face at the point of sampling to remove any soil that may have fallen from above, and to expose fresh soil for sampling. In many instances, samples can be collected directly from the backhoe bucket.

6. If volatile organic analyses are required, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

7. Abandon the pit or excavation according to applicable state regulations. Generally, shallow excavations can simply be backfilled with the removed soil material.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

There are no specific quality assurance (QA) activities which apply to the implementation of these procedures. However, the following QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration

activities must occur prior to sampling/operation, and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OHSA and corporate health and safety procedures, in addition to the procedures specified in the site specific Health & Safety Plan..

12.0 REFERENCES

Mason, B.J. 1983. Preparation of Soil Sampling Protocol: Technique and Strategies. EPA-600/4-83-020.

Barth, D.S. and B.J. Mason. 1984. Soil Sampling Quality Assurance User's Guide. EPA-600/4-84-043.

U.S. Environmental Protection Agency. 1984 Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods, Second Edition. EPA-600/4-84-076.

de Vera, E.R., B.P. Simmons, R.D. Stephen, and D.L. Storm. 1980. Samplers and Sampling Procedures for Hazardous Waste Streams. EPA-600/2-80-018.

ASTM D 1586-98, ASTM Committee on Standards, Philadelphia, PA.

APPENDIX A
Figures
SOP #2012
February 2000

FIGURE 1. Sampling Augers

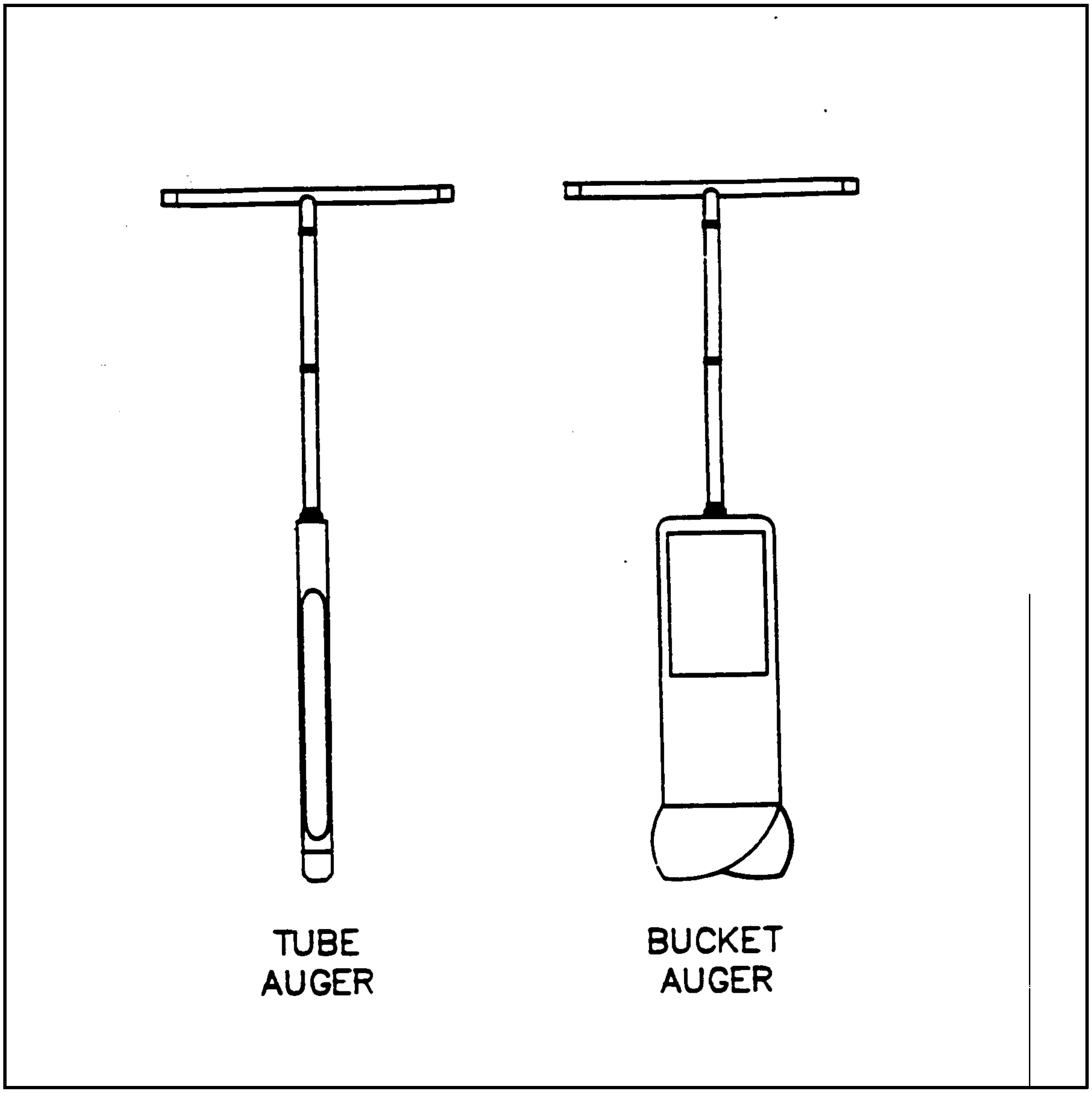
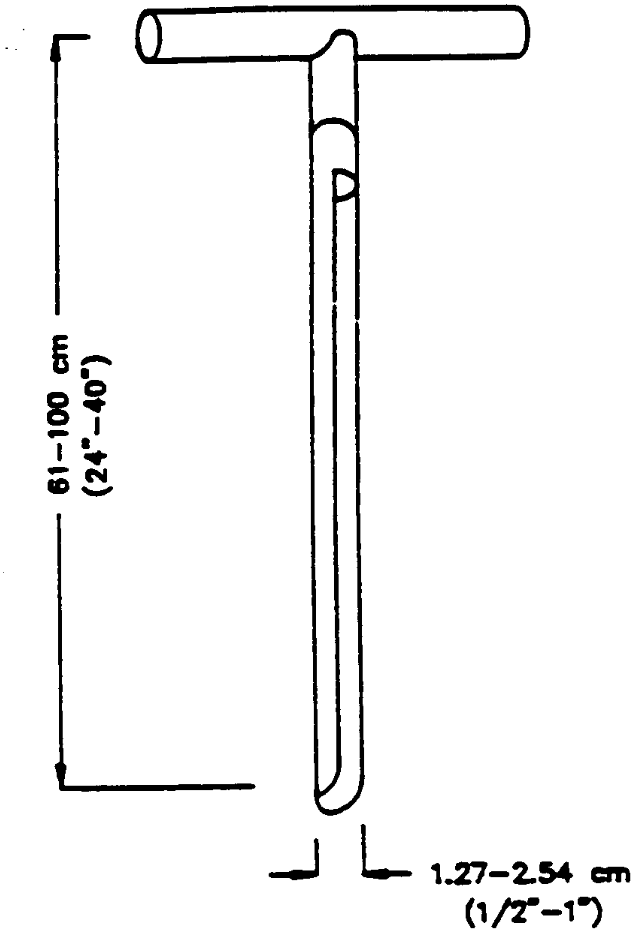


FIGURE 2. Sampling Trier



SOP#: 2013
DATE: 11/17/94
REV. #: 0.0

SURFACE WATER SAMPLING

1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) is applicable to the collection of representative liquid samples, both aqueous and non-aqueous from streams, rivers, lakes, ponds, lagoons, and surface impoundments. It includes samples collected from depth, as well as samples collected from the surface.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure or other procedure limitations. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Sampling situations vary widely, therefore, no universal sampling procedure can be recommended. However, sampling of both aqueous and non-aqueous liquids from the above mentioned sources is generally accomplished through the use of one of the following samplers or techniques:

- Kemmerer bottle
- Bacon bomb sampler
- Dip sampler
- Direct method

These sampling techniques will allow for the collection of representative samples from the majority of surface waters and impoundments encountered.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Once samples have been collected, the following procedure should be followed:

1. Transfer the sample(s) into suitable, labeled sample containers.

2. Preserve the sample if appropriate, or use pre-preserved sample bottles. Do not overfill bottles if they are pre-preserved.

3. Cap the container, place in a ziploc plastic bag and cool to 4°C.

4. Record all pertinent data in the site logbook and on field data sheets.

5. Complete the Chain of Custody record.

6. Attach custody seals to cooler prior to shipment.

7. Decontaminate all sampling equipment prior to the collection of additional samples with that sampling device.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

There are two primary interferences or potential problems with surface water sampling. These include cross contamination of samples and improper sample collection.

1. Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary. Refer to the Sampling Equipment Decontamination SOP.

2. Improper sample collection can involve using contaminated equipment, disturbance of the stream or impoundment substrate, and sampling in an obviously disturbed area.

Following proper decontamination procedures and minimizing disturbance of the sample site will eliminate these problems.

5.0 EQUIPMENT/APPARATUS

Equipment needed for collection of surface water samples may include (depending on technique chosen):

- Kemmerer bottles
- Bacon bomb sampler
- Dip sampler
- Line and messengers
- Sample bottles/preservatives
- Ziploc bags
- Ice
- Coolers
- Chain of Custody records, custody seals
- Field data sheets
- Decontamination equipment
- Maps/plot plan
- Safety equipment
- Compass
- Tape measure
- Survey stakes, flags, or buoys and anchors
- Camera and film
- Logbook/waterproof pen
- Sample bottle labels

6.0 REAGENTS

Reagents will be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed.

7.0 PROCEDURES

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.

2. Obtain the necessary sampling and monitoring equipment.

3. Decontaminate or pre-clean equipment, and ensure that it is in working order.

4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.

5. Perform a general site survey prior to site entry, in accordance with the site specific Health and Safety Plan.

6. Use stakes, flagging, or buoys to identify and mark all sampling locations. If required the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. If collecting sediment samples, this procedure may disturb the bottom.

7.2 Representative Sampling Considerations

In order to collect a representative sample, the hydrology and morphometrics of a stream or impoundment should be determined prior to sampling. This will aid in determining the presence of phases or layers in lagoons, or impoundments, flow patterns in streams, and appropriate sample locations and depths.

Water quality data should be collected in impoundments, and to determine if stratification is present. Measurements of dissolved oxygen, pH, and temperature can indicate if strata exist which would effect analytical results. Measurements should be collected at one-meter intervals from the substrate to the surface using the appropriate instrument (i.e., a Hydrolab or equivalent).

Water quality measurements such as dissolved oxygen, pH, temperature, conductivity, and oxidation-reduction potential can assist in the interpretation of analytical data and the selection of sampling sites and depths when surface water samples are collected.

Generally, the deciding factors in the selection of a sampling device for sampling liquids in streams, rivers, lakes, ponds, lagoons, and surface impoundments are:

1. Will the sample be collected from shore or from a boat?
2. What is the desired depth at which you wish to collect the sample?
3. What is the overall depth and flow direction of river or stream?
4. What type of sample will be collected (i.e., water or lagoon liquids)?

7.2.1 Sampler Composition

The appropriate sampling device must be of a proper composition. Selection of samplers constructed of glass, stainless steel, PVC or PFTE (Teflon) should be based upon the analyses to be performed.

7.3 Sample Collection

7.3.1 Kemmerer Bottle

A Kemmerer bottle (Figure 1, Appendix A) may be used in most situations where site access is from a boat or structure such as a bridge or pier, and where samples at depth are required. Sampling procedures are as follows:

1. Use a properly decontaminated Kemmerer bottle. Set the sampling device so that the sampling end pieces (upper and lower stoppers) are pulled away from the sampling tube (body), allowing the substance to be sampled to pass through this tube.
2. Lower the pre-set sampling device to the predetermined depth. Avoid bottom disturbance.
3. When the Kemmerer bottle is at the required depth, send down the messenger, closing the sampling device.
4. Retrieve the sampler and discharge from the bottom drain the first 10-20 mL to clear any potential contamination of the valve. Transfer the sample to the appropriate sample container.

7.3.2 Bacon Bomb Sampler

A bacon bomb sampler (Figure 2, Appendix A) may be used in situations similar to those outlined for the Kemmerer bottle. Sampling procedures are as follows:

1. Lower the bacon bomb sampler carefully to the desired depth, allowing the line for the trigger to remain slack at all times. When the desired depth is reached, pull the trigger line until taut. This will allow the sampler to fill.
2. Release the trigger line and retrieve the sampler.
3. Transfer the sample to the appropriate sample container by pulling up on the trigger.

7.3.3 Dip Sampler

A dip sampler (Figure 3, Appendix A) is useful in situations where a sample is to be recovered from an outfall pipe or along a lagoon bank where direct access is limited. The long handle on such a device allows access from a discrete location. Sampling procedures are as follows:

1. Assemble the device in accordance with the manufacturer's instructions.
2. Extend the device to the sample location and collect the sample by dipping the sampler into the substance.
3. Retrieve the sampler and transfer the sample to the appropriate sample container.

7.3.4 Direct Method

For streams, rivers, lakes, and other surface waters, the direct method may be utilized to collect water samples from the surface directly into the sample bottle. This method is not to be used for sampling lagoons or other impoundments where contact with contaminants is a concern.

Using adequate protective clothing, access the sampling station by appropriate means. For shallow stream stations, collect the sample under the water surface while pointing the sample container upstream; the container must be upstream of the collector. Avoid disturbing the substrate. For lakes and other impoundments, collect the sample under the water surface avoiding surface debris and the boat wake.

When using the direct method, do not use pre-preserved sample bottles as the collection method may dilute the concentration of preservative necessary for proper sample preservation.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

There are no specific quality assurance (QA) activities which apply to the implementation of these procedures. However, the following general QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA and corporate health and safety procedures.

More specifically, when sampling lagoons or surface impoundments containing known or suspected hazardous substances, adequate precautions must be taken to ensure the safety of sampling personnel. The sampling team member collecting the sample should not get too close to the edge of the impoundment, where bank failure may cause him/her to lose his/her balance. The person performing the sampling should be on a lifeline and be wearing adequate protective equipment. When conducting sampling from a boat in an impoundment or flowing waters, appropriate boating safety procedures should be followed.

12.0 REFERENCES

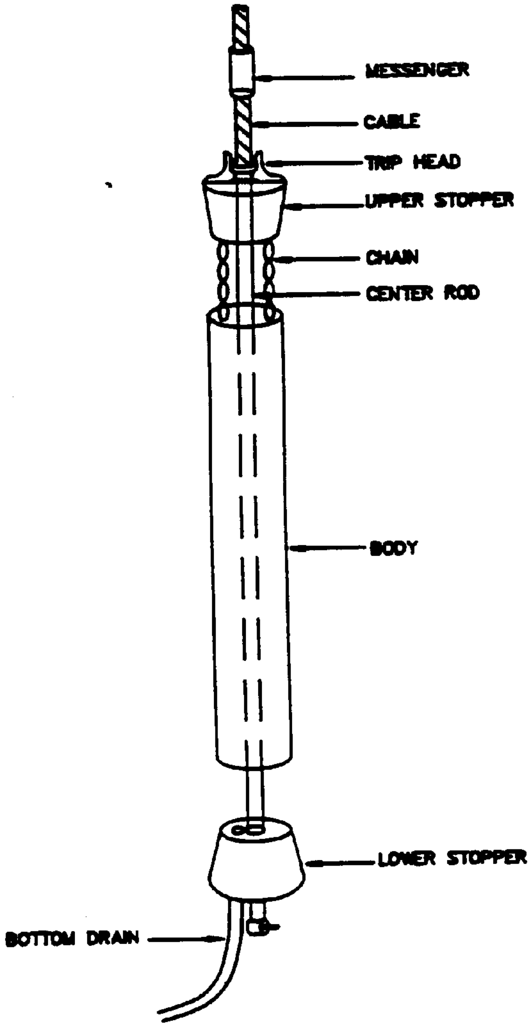
U.S. Geological Survey. 1977. National Handbook or Recommended Methods for Water Data Acquisition. Office of Water Data Coordination Reston, Virginia. (Chapter Updates available).

U.S. Environmental Protection Agency. 1984. Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods, Second Edition. EPA/600/4-84-076.

APPENDIX A

Figures

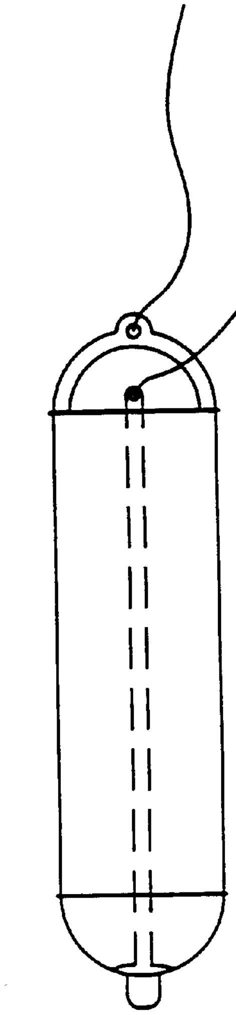
FIGURE 1. Kemmerer Bottle



APPENDIX A (Cont'd)

Figures

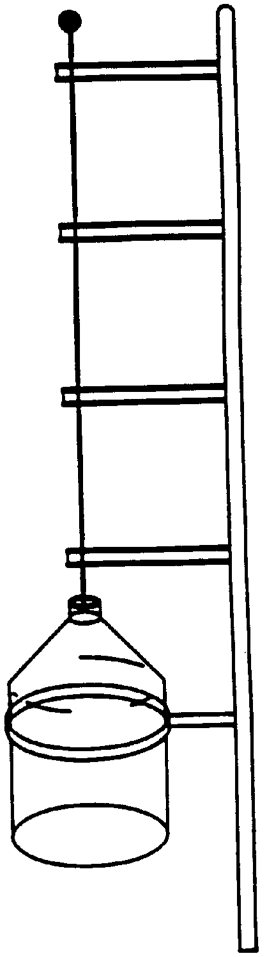
FIGURE 2. Bacon Bomb Sampler



APPENDIX A (Cont'd)

Figures

FIGURE 3. Dip Sampler



SEDIMENT SAMPLING

SOP#: 2016
DATE: 11/17/94
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1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) is applicable to the collection of representative sediment samples. Analysis of sediment may be biological, chemical, or physical in nature and may be used to determine the following:

- toxicity;
- biological availability and effects of contaminants;
- benthic biota;
- extent and magnitude of contamination;
- contaminant migration pathways and source;
- fate of contaminants;
- grain size distribution.

The methodologies discussed in this SOP are applicable to the sampling of sediment in both flowing and standing water. They are generic in nature and may be modified in whole or part to meet the handling and analytical requirements of the contaminants of concern, as well as the constraints presented by site conditions and equipment limitations. However, if modifications occur, they should be documented in a site or personal logbook and discussed in reports summarizing field activities and analytical results.

For the purposes of this procedure, sediments are those mineral and organic materials situated beneath an aqueous layer. The aqueous layer may be either static, as in lakes, ponds, and impoundments; or flowing, as in rivers and streams.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Sediment samples may be collected using a variety of methods and equipment, depending on the depth of the aqueous layer, the portion of the sediment profile required (surface vs. subsurface), the type of sample required (disturbed vs. undisturbed), contaminants present, and sediment type.

Sediment is collected from beneath an aqueous layer either directly, using a hand held device such as a shovel, trowel, or auger; or indirectly, using a remotely activated device such as an Ekman or Ponar dredge. Following collection, sediment is transferred from the sampling device to a sample container of appropriate size and construction for the analyses requested. If composite sampling techniques are employed, multiple grabs are placed into a container constructed of inert material, homogenized, and transferred to sample containers appropriate for the analyses requested. The homogenization procedure should not be used if sample analysis includes volatile organics; in this case, sediment, or multiple grabs of sediment, should be transferred directly from the sample collection device or homogenization container to the sample container.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING AND STORAGE

1. Chemical preservation of solids is generally not recommended. Cooling to 4°C is usually the best approach, supplemented by the appropriate holding time for the analyses requested.

2. Wide mouth glass containers with Teflon lined caps are utilized for sediment samples. The sample volume is a function of the analytical requirements and will be specified in the Work Plan.

3. If analysis of sediment from a discrete depth or location is desired, sediment is transferred directly from the sampling device to a labeled sample container(s) of appropriate size and construction for the analyses

requested. Transfer is accomplished with a stainless steel or plastic lab spoon or equivalent.

4. If composite sampling techniques or multiple grabs are employed, equal portions of sediment from each location are deposited into a stainless steel, plastic, or other appropriate composition (e.g., Teflon) containers. The sediment is homogenized thoroughly to obtain a composite representative of the area sampled. The composite sediment sample is transferred to a labeled container(s) of appropriate size and construction for the analyses requested. Transfer of sediment is accomplished with a stainless steel or plastic lab spoon or equivalent. Samples for volatile organic analysis must be transferred directly from the sample collection device or pooled from multiple areas in the homogenization container prior to mixing. This is done to minimize loss of contaminant due to volatilization during homogenization.

5. All sampling devices should be decontaminated, then wrapped in aluminum foil. The sampling device should remain in this wrapping until it is needed. Each sampling device should be used for only one sample. Disposable sampling devices for sediment are generally impractical due to cost and the large number of sediment samples which may be required. Sampling devices should be cleaned in the field using the decontamination procedure described in the Sampling Equipment Decontamination SOP.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Substrate particle size and organic matter content are a direct consequence of the flow characteristics of a waterbody. Contaminants are more likely to be concentrated in sediments typified by fine particle size and a high organic matter content. This type of sediment is most likely to be collected from depositional zones. In contrast, coarse sediments with low organic matter content do not typically concentrate pollutants and are generally found in erosional zones. The selection of a sampling location can, therefore, greatly influence the analytical results and should be justified and specified in the Work Plan.

5.0 EQUIPMENT/APPARATUS

Equipment needed for collection of sediment samples may include:

- Maps/plot plan
- Safety equipment
- Compass
- Tape measure
- Survey stakes, flags, or buoys and anchors
- Camera and film
- Stainless steel, plastic, or other appropriate composition bucket
- 4-oz., 8-oz., and one-quart wide mouth jars w/Teflon lined lids
- Ziploc plastic bags
- Logbook
- Sample jar labels
- Chain of Custody records, field data sheets
- Cooler(s)
- Ice
- Decontamination supplies/equipment
- Spade or shovel
- Spatula
- Scoop
- Trowel
- Bucket auger
- Tube auger
- Extension rods
- "T" handle
- Sediment coring device (tube, drive head, eggshell check value, nosecone, acetate tube, extension rods, "T" handle)
- Ponar dredge
- Ekman dredge
- Nylon rope or steel cable
- Messenger device

6.0 REAGENTS

Reagents are not used for preservation of sediment samples. Decontamination solutions are specified in the Sampling Equipment Decontamination SOP.

7.0 PROCEDURES

7.1 Preparation

1. Determine the objective(s) and extent of the sampling effort. The sampling methods to be employed, and the types and amounts of equipment and supplies required will be a function of site characteristics and objectives of the study.
2. Obtain the necessary sampling and monitoring equipment.
3. Prepare schedules, and coordinate with staff, client, and regulatory agencies, if appropriate.
4. Decontaminate or preclean equipment, and ensure that it is in working order.
5. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.
6. Use stakes, flagging, or buoys to identify and mark all sampling locations. Specific site factors including flow regime, basin morphometry, sediment characteristics, depth of overlying aqueous layer, contaminant source, and extent and nature of contamination should be considered when selecting sample locations. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

7.2 Sample Collection

Selection of a sampling device is most often contingent upon: (1) the depth of water at the sampling location, and (2) the physical characteristics of the sediment to be sampled. The following procedures may be utilized:

7.2.1 Sampling Surface Sediment with a Trowel or Scoop from Beneath a Shallow Aqueous Layer

For the purpose of this method, surface sediment is considered to range from 0 to six inches in depth and a shallow aqueous layer is considered to range from 0 to 12 inches in depth. Collection of surface sediment from beneath a shallow aqueous layer can be accomplished with tools such as spades, shovels, trowels, and scoops. Although this method can be used to collect both unconsolidated/consolidated sediment, it is limited somewhat by the depth and movement of the aqueous layer. Deep and rapidly flowing water render this method less accurate than others discussed below. However, representative samples can be collected with this procedure in shallow sluggish water provided care is demonstrated by the sample team member. A stainless steel or plastic sampling implement will suffice in most applications. Care should be exercised to avoid the use of devices plated with chrome or other materials; plating is particularly common with garden trowels.

The following procedure will be used to collect sediment with a scoop, shovel, or trowel:

1. Using a decontaminated sampling implement, remove the desired thickness and volume of sediment from the sampling area.
2. Transfer the sample into an appropriate sample or homogenization container. Ensure that non-dedicated containers have been adequately decontaminated.
3. Surface water should be decanted from the sample or homogenization container prior to sealing or transfer; care should be taken to retain the fine sediment fraction during this procedure.

7.2.2 Sampling Surface Sediment with a Bucket Auger or Tube Auger from Beneath a Shallow Aqueous Layer

For the purpose of this method, surface sediment is considered to range from 0 to six inches in depth and a shallow aqueous layer is considered to range from 0 to 24 inches in depth. Collection of surface sediment from beneath a shallow aqueous layer can be accomplished with a system consisting of bucket auger or tube auger, a series of extensions, and a "T" handle (Figure 1, Appendix A). The use of additional extensions in conjunction with a bucket auger can increase the depth of water from which sediment can be collected from 24 inches to 10 feet or more. However, sample handling and manipulation increases in difficulty with increasing depth of water. The bucket auger or tube auger is driven into the sediment and used to extract a core. The various depths represented by the core are homogenized or a subsample of the core is taken from the appropriate depth.

The following procedure will be used to collect sediment samples with a bucket auger or tube auger:

1. An acetate core may be inserted into the bucket auger or tube auger prior to sampling if characteristics of the sediments or waterbody warrant. By using this technique, an intact core can be extracted.

2. Attach the auger head to the required length of extensions, then attach the "T" handle to the upper extension.

3. Clear the area to be sampled of any surface debris.

4. Insert the bucket auger or tube auger into the sediment at a 0^{o} to 20^{o} angle from vertical. This orientation minimizes spillage of the sample from the sampler upon extraction from the sediment and water.

5. Rotate the auger to cut a core of sediment.

6. Slowly withdraw the auger; if using a tube auger, make sure that the slot is facing upward.

7. Transfer the sample or a specified aliquot of sample into an appropriate sample or homogenization container. Ensure that non-dedicated containers have been adequately decontaminated.

7.2.3 Sampling Deep Sediment with a Bucket Auger or Tube Auger from Beneath a Shallow Aqueous Layer

For the purpose of this method, deep sediment is considered to range from six to greater than 18 inches in depth and a shallow aqueous layer is considered to range from 0 to 24 inches. Collection of deep sediment from beneath a shallow aqueous layer can be accomplished with a system consisting of a bucket auger, a tube auger, a series of extensions and a "T" handle. The use of additional extensions can increase the depth of water from which sediment can be collected from 24 inches to five feet or more. However, water clarity must be high enough to permit the sampler to directly observe the sampling operation. In addition, sample handling and manipulation increases in difficulty with increasing depth of water. The bucket auger is used to bore a hole to the upper range of the desired sampling depth and then withdrawn. The tube auger is then lowered down the borehole, and driven into the sediment to the lower range of the desired sampling depth. The tube is then withdrawn and the sample recovered from the tube. This method can be used to collect firmly consolidated sediments, but is somewhat limited by the depth of the aqueous layer, and the integrity of the initial borehole.

The following procedure will be used to collect deep sediment samples with a bucket auger and a tube auger:

1. Attach the bucket auger bit to the required lengths of extensions, then attach the "T" handle to the upper extension.

2. Clear the area to be sampled of any surface debris.

3. Begin augering, periodically removing any accumulated sediment (i.e., cuttings) from the auger bucket. Cuttings should be disposed of far enough from the sampling area to minimize cross contamination of various depths.

4. After reaching the upper range of the desired depth, slowly and carefully remove bucket auger from the boring.

5. Attach the tube auger bit to the required lengths of extensions, then attach the "T" handle to the upper extension.

6. Carefully lower tube auger down borehole using care to avoid making contact with the borehole sides and, thus, cross contaminating the sample. Gradually force tube auger into sediment to the lower range of the desired sampling depth. Hammering of the tube auger to facilitate coring should be avoided as the vibrations may cause the boring walls

to collapse.

7. Remove tube auger from the borehole, again taking care to avoid making contact with the borehole sides and, thus, cross contaminating the sample.

8. Discard the top of core (approximately 1 inch); as this represents material collected by the tube auger before penetration to the layer of concern.

9. Transfer sample into an appropriate sample or homogenization container. Ensure that non-dedicated containers have been adequately decontaminated.

7.2.4 Sampling Surface Sediment with an Ekman or Ponar Dredge from Beneath a Shallow or Deep Aqueous Layer

For the purpose of this method, surface sediment is considered to range from 0 to six inches in depth. Collection of surface sediment can be accomplished with a system consisting of a remotely activated device (dredge) and a deployment system. This technique consists of lowering a sampling device (dredge) to the surface of the sediment by use of a rope, cable, or extended handle. The mechanism is activated, and the device entraps sediment in spring loaded or lever operated jaws.

An Ekman dredge is a lightweight sediment sampling device with spring activated jaws. It is used to collect moderately consolidated, fine textured sediment. The following procedure will be used for collecting sediment with an Ekman dredge (Figure 2, Appendix A):

1. Attach a sturdy nylon rope or stainless steel cable through the hole on the top of the bracket, or secure the extension handle to the bracket with machine bolts.

2. Attach springs to both sides of the jaws. Fix the jaws so that they are in open position by placing trip cables over the release studs. Ensure that the hinged doors on the dredge top are free to open.

3. Lower the sampler to a point 4 to 6 inches above the sediment surface.

4. Drop the sampler to the sediment.

5. Trigger the jaw release mechanism by lowering a messenger down the line, or by depressing the button on the upper end of the extension handle.

6. Raise the sampler and slowly decant any free liquid through the top of the sampler. Care should be taken to retain the fine sediment fraction during this procedure.

7. Open the dredge jaws and transfer the sample into a stainless steel, plastic or other appropriate composition (e.g., Teflon) container. Ensure that non-dedicated containers have been adequately decontaminated. If necessary, continue to collect additional sediment grabs until sufficient material has been secured to fulfill analytical requirements. Thoroughly homogenize and then transfer sediment to sample containers appropriate for the analyses requested. Samples for volatile organic analysis must be collected directly from the bucket before homogenization to minimize volatilization of contaminants.

A Ponar dredge is a heavyweight sediment sampling device with weighted jaws that are lever or spring activated. It is used to collect consolidated fine to coarse textured sediment. The following procedure will be used for collecting sediment with a Ponar dredge (Figure 3, Appendix A):

1. Attach a sturdy nylon rope or steel cable to the ring provided on top of the dredge.

2. Arrange the Ponar dredge with the jaws in the open position, setting the trip bar so the sampler remains open when lifted from the top. If the dredge is so equipped, place the spring loaded pin into the aligned holes in the trip bar.

3. Slowly lower the sampler to a point approximately two inches above the sediment.

4. Drop the sampler to the sediment. Slack on

the line will release the trip bar or spring loaded pin; pull up sharply on the line closing the dredge.

5. Raise the dredge to the surface and slowly decant any free liquid through the screens on top of the dredge. Care should be taken to retain the fine sediment fraction during this operation.

6. Open the dredge and transfer the sediment to a stainless steel, plastic or other appropriate composition (e.g., Teflon) container. Ensure that non-dedicated containers have been adequately decontaminated. If necessary, continue to collect additional sediment until sufficient material has been secured to fulfill analytical requirements. Thoroughly homogenized and then transfer sediment to sample containers appropriate for the analyses requested. Samples for volatile organic analysis must be collected directly from the bucket before homogenization to minimize volatilization of contaminants.

7.2.5 Sampling Subsurface Sediment with a Coring Device from Beneath a Shallow Aqueous Layer

For purposes of this method, subsurface sediment is considered to range from 6 to 24 inches in depth and a shallow aqueous layer is considered to range from 0 to 24 inches in depth. Collection of subsurface sediment from beneath a shallow aqueous layer can be accomplished with a system consisting of a tube sampler, acetate tube, eggshell check valve, nosecone, extensions, and "T" handle, or drivehead. The use of additional extensions can increase the depth of water from which sediment can be collected from 24 inches to 10 feet or more. This sampler may be used with either a drive hammer for firm sediment, or a "T" handle for soft sediment. However, sample handling and manipulation increases in difficulty with increasing depth of water.

The following procedure describes the use of a sample coring device (Figure 4, Appendix A) used to collect subsurface sediments.

1. Assemble the coring device by inserting the acetate core into the sampling tube.

2. Insert the "egg shell" check valve into the lower end of the sampling tube with the convex surface positioned inside the acetate core.

3. Screw the nosecone onto the lower end of the sampling tube, securing the acetate tube and eggshell check valve.

4. Screw the handle onto the upper end of the sampling tube and add extension rods as needed.

5. Place the sampler in a perpendicular position on the sediment to be sampled.

6. If the "T" handle is used, place downward pressure on the device until the desired depth is reached. After the desired depth is reached, rotate the sampler to shear off the core at the bottom. Slowly withdraw the sampler from the sediment and proceed to Step 15.

7. If the drive hammer is selected, insert the tapered handle (drive head) of the drive hammer through the drive head.

8. Drive the sampler into the sediment to the desired depth.

9. Record the length of the tube that penetrated the sample material, and the number of blows required to obtain this depth.

10. Remove the drive hammer and fit the keyhole-like opening on the flat side of the hammer onto the drive head. In this position, the hammer serves as a handle for the sampler.

11. Rotate the sampler to shear off the core at the bottom.

12. Lower the sampler handle (hammer) until it just clears the two ear-like protrusions on the drive head, and rotate about 90°.

13. Slowly withdraw the sampler from the sediment. If the drivehead was used, pull the hammer upwards and dislodge the sampler from the sediment.

14. Carefully remove the coring device from the water.

15. Unscrew the nosecone and remove the eggshell check valve.

16. Slide the acetate core out of the sampler tube. Decant surface water, using care to retain the fine sediment fraction. If head space is present in the upper end, a hacksaw may be used to shear the acetate tube off at the sediment surface. The acetate core may then be capped at both ends. Indicate on the acetate tube the appropriate orientation of the sediment core using a waterproof marker. The sample may be used in this fashion, or the contents transferred to a sample or homogenization container.

17. Open the acetate tube and transfer the sediment to a stainless steel, plastic or other appropriate composition (e.g., Teflon) container. Ensure that non-dedicated containers have been adequately decontaminated. If necessary, continue to collect additional sediment until sufficient material has been secured to fulfill analytical requirements. Thoroughly homogenize and then transfer sediment to sample containers appropriate for the analyses requested. Samples for volatile organic analysis must be collected directly from the bucket before homogenization to minimize volatilization of contaminants.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

There are no specific quality assurance (QA) activities which apply to the implementation of these procedures. However, the following QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA/OSHA and Corporate health and safety procedures.

More specifically, when sampling sediment from waterbodies, physical hazards must be identified and adequate precautions must be taken to ensure the safety of the sampling team. The team member collecting the sample should not get too close to the edge of the waterbody, where bank failure may cause loss of balance. To prevent this, the person performing the sampling should be on a lifeline, and be wearing adequate protective equipment. If sampling from a vessel is determined to be necessary, appropriate protective measures must be implemented.

12.0 REFERENCES

Mason, B.J., Preparation of Soil Sampling Protocol: Technique and Strategies. 1983 EPA-600/4-83-020.

Barth, D.S. and B.J. Mason, Soil Sampling Quality Assurance User's Guide. 1984 EPA-600/4-84-043.

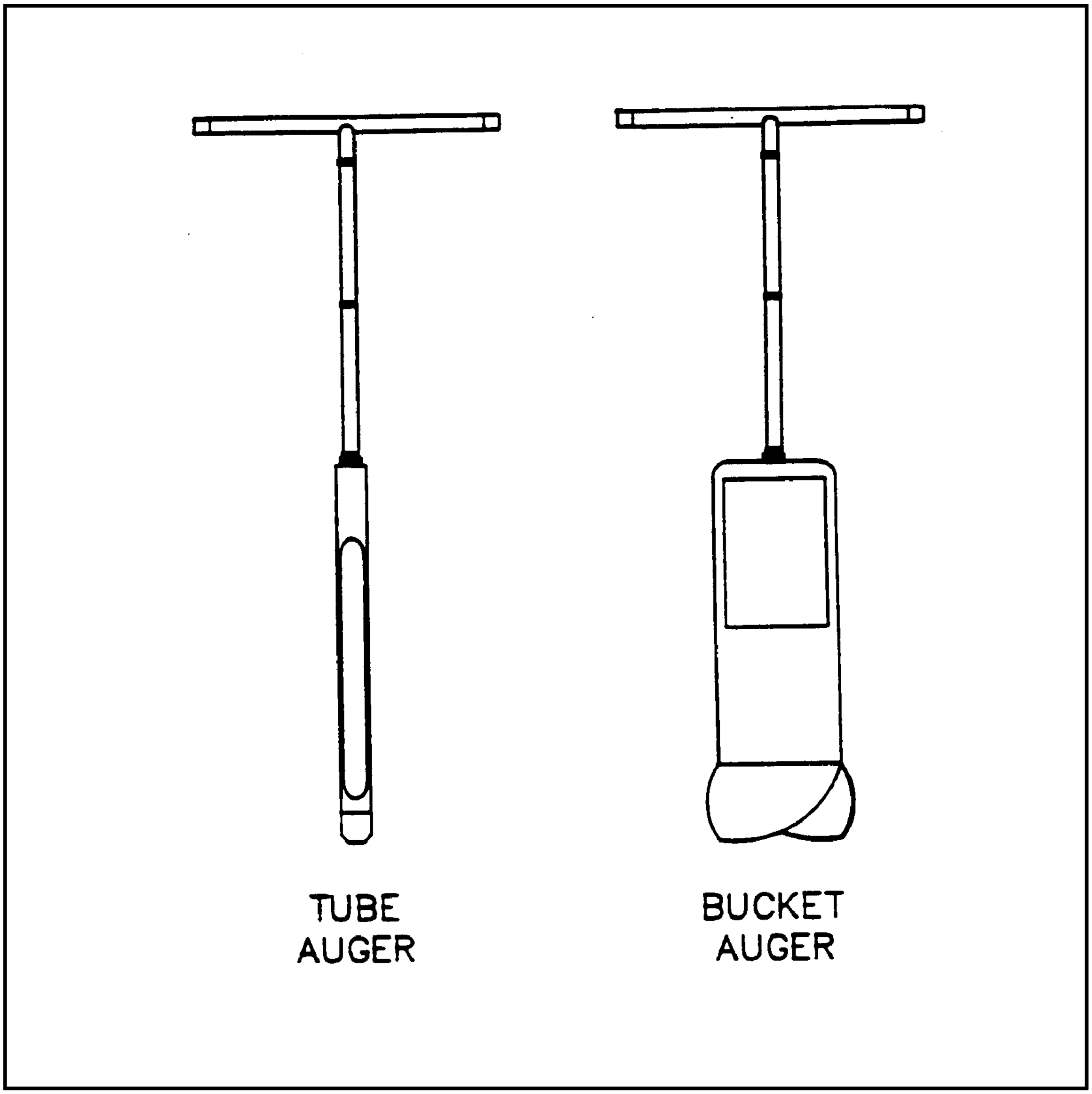
U.S. EPA. Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods, Second Edition. 1984 EPA-600/4-84-076.

de Vera, E.R., B.P. Simmons, R.D. Stephen, and D.L. Storm. Samplers and Sampling Procedures for Hazardous Waste Streams. 1980 EPA-600/2-80-018.

APPENDIX A

Figures

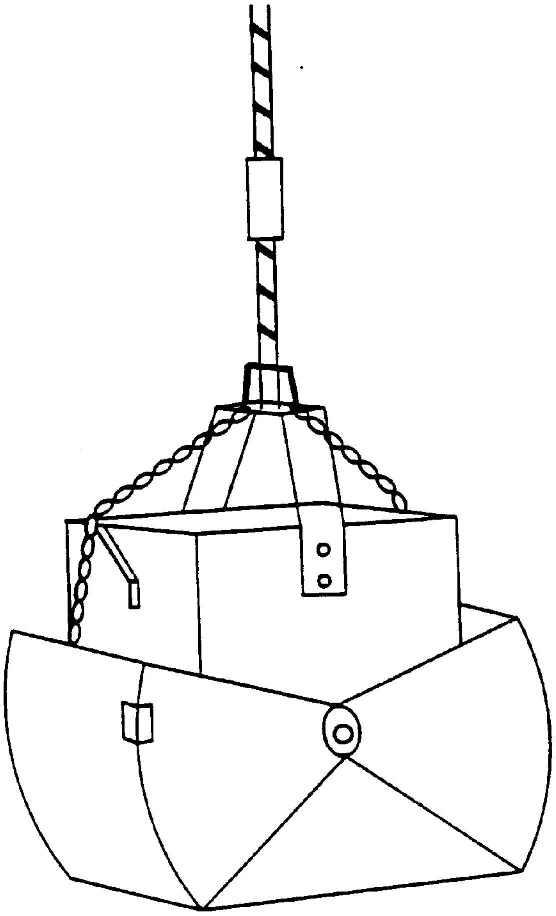
FIGURE 1. Sampling Auger



APPENDIX A (Cont'd)

Figures

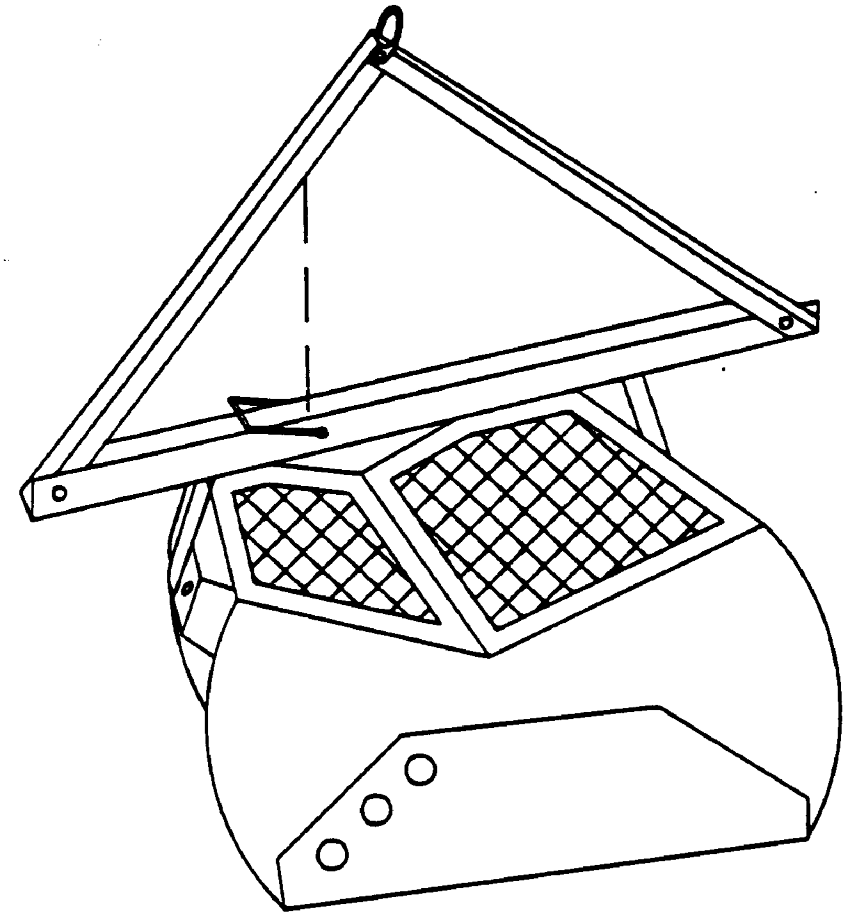
FIGURE 2. Ekman Dredge



APPENDIX A (Cont'd)

Figures

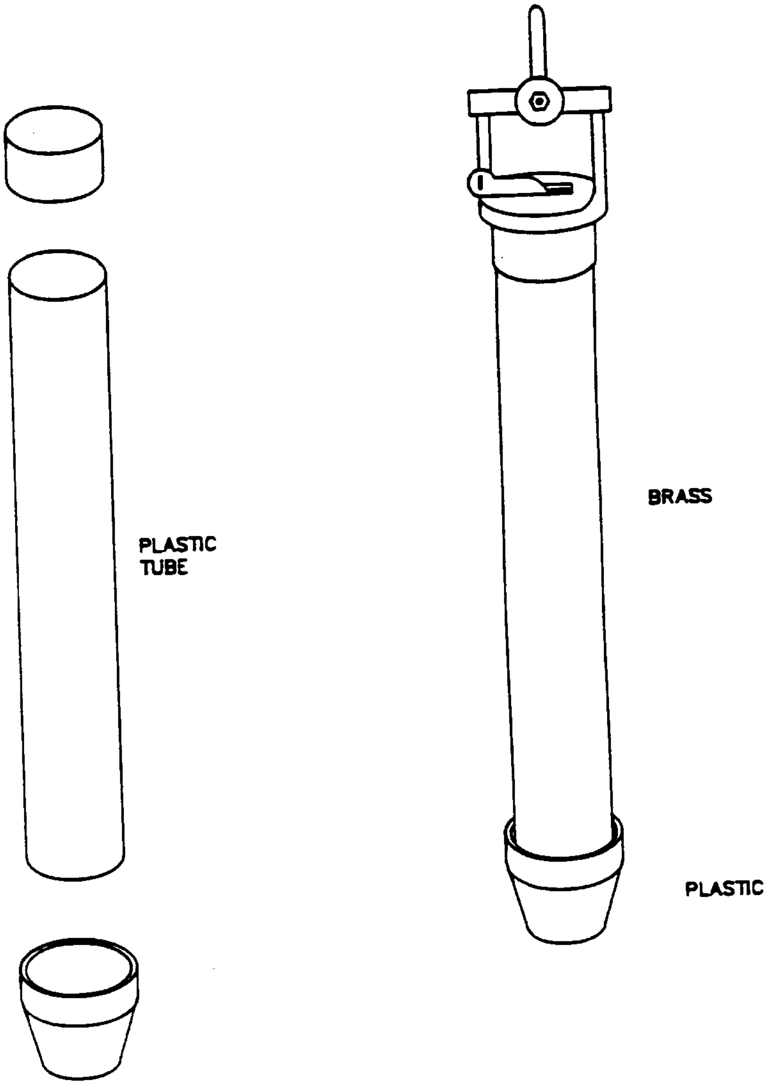
FIGURE 3. Ponar Dredge



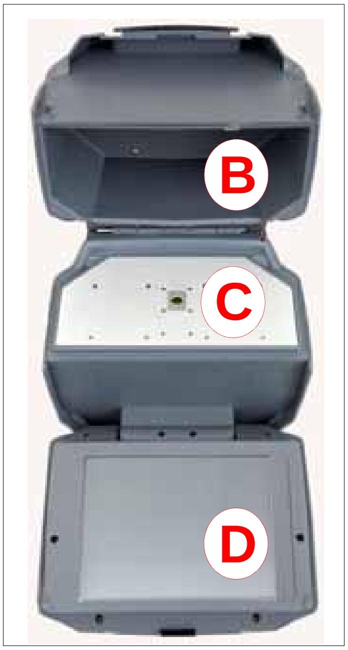
APPENDIX A (Cont'd)

Figures

FIGURE 4. Sample Coring Device



1. Introduction and System Tour



Getting Started includes:

- Tour of the system noting all major components.
- Instructions for these tasks...

Tour of the *X-50 Mobile XRF* System

A. **Molded enclosure** that forms a portable, radiation-safe test chamber.

B. **Hinged lid** with safety interlocks to ensure a closed beam system. Handle contains high intensity safety indicator lights.

C. **Main chassis** with test platform and Kapton measurement window.

- Chassis also contains sub-systems for...
  - Excitation including multibeam capability
  - Detection
  - Safety Interlocks
  - Input/Output (I/O) Panel

D. **Computer**, industrial style, including:

- A completely integrated package featuring...
  - Licensed Windows® XP Embedded Runtime software.
  - Folding panel with touch-screen I/O with consolidated keyboard function.

E. **Application Software**

- Easy operations with InnovX Version 2.0 User Interface
- Extensive sample identification and analysis.
- Fast results that can be viewed or saved.
- Major modes include...
  - Soil (multibeam options)
  - Mining
  - Analytical

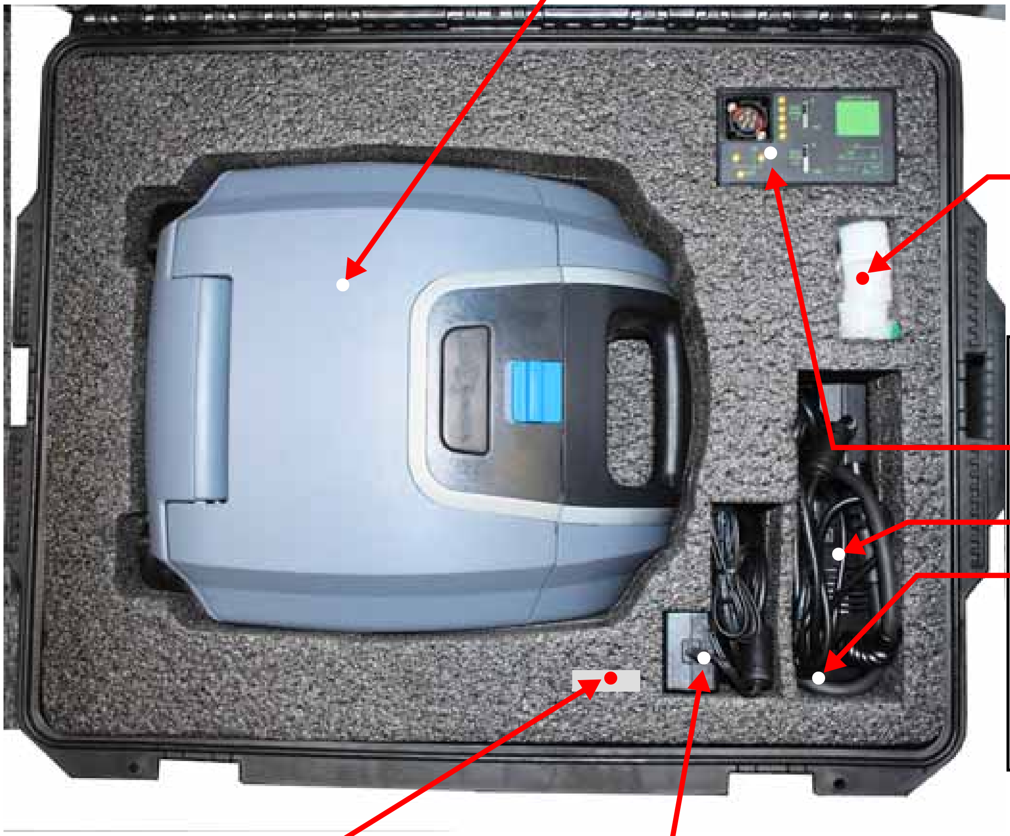
2. Unpack the Instrument

The X-50 analyzer and its accessories are shipped in an industrial carry case.

Use these steps to unpack the system:

1. Remove carry case from shipping carton.
2. Open the carry case and remove the X-50 instrument and all accessories.
3. Look for obvious damage to the parts.
4. Immediately report any problems to Innov-X.

ITEM CHECKLIST for Innov-X Systems X-50 Mobile XRF Analyzer



☐ Industrial Carry Case

☐ X-50 Analyzer

☐ Reference Samples

☐ Standardization Coupon

☐ AC Power Adapter (for X-50)

Optional Accessories

☐ Li-Ion Battery

☐ Battery Charger Assembly

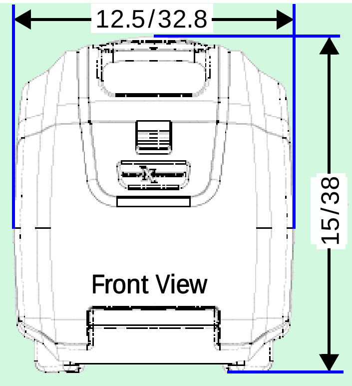
☐ Interconnect Cable

☐ Sample Holder/Guide (not shown)

☐ End User Documentation incl. S/W License (not shown)

3. Hardware Setup

When the X-50 is removed from its carrying case it is "ready to run."
No assembly is required.
However, there are physical and cabling considerations.



a. Physical Planning

— Where will the instrument be used?

It weighs about 26 pounds (11 kilograms). It can sit on a lab table (inside) or on the ground (outside at field sites).

— What precautions must be observed for outdoor use?

Do not operate it in the rain.

The unit can be operated when sitting at an angle. If the sample remains stationary over the measurement window and the lid closes properly, the test can proceed.

— How much space (area) to allocate?

To make a minimum footprint, add at least 6 inches beyond the actual 12.5" width. Plan on a 27" span front-to-back when the lid and computer panel are open.

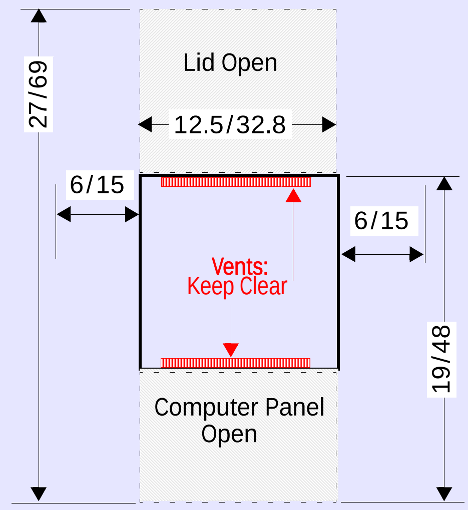
- Ensure that the cooling vents are not obstructed.

— Any special space issues for height?

The computer/monitor has a touchscreen input. Operator must be able to access the screen comfortably and reliably.

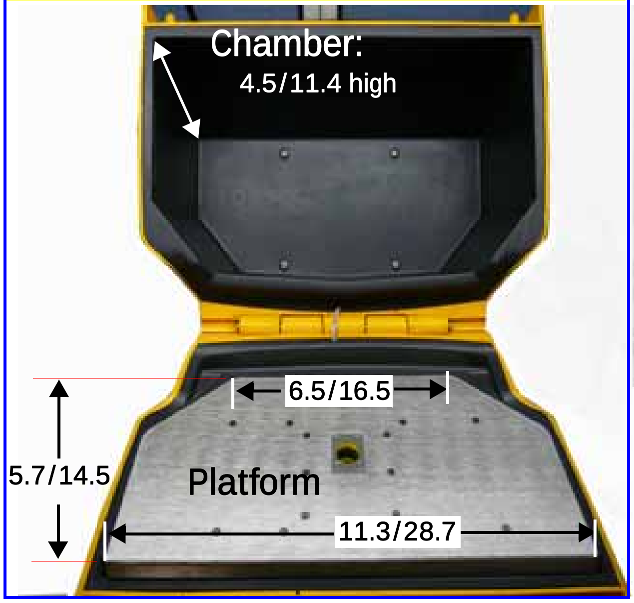
— What are the electrical power requirements?

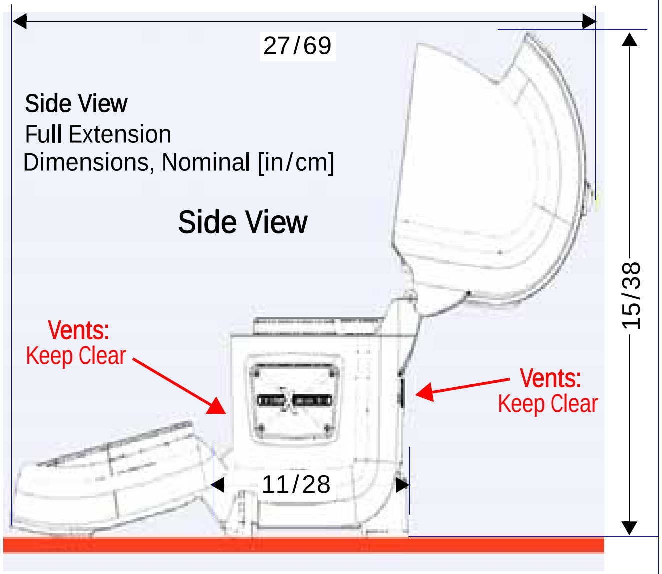
Minimal — Less than 70 watts draw.



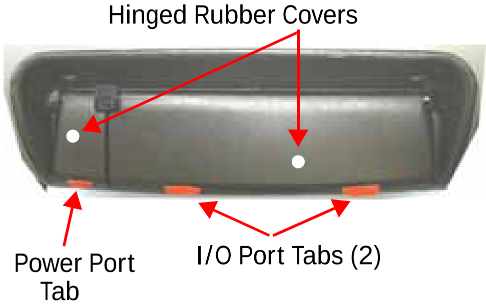
— Planning Footprint —

Prior to measuring a sample, note the dimensions of the test chamber/platform.
Ensure that the Lid can close completely



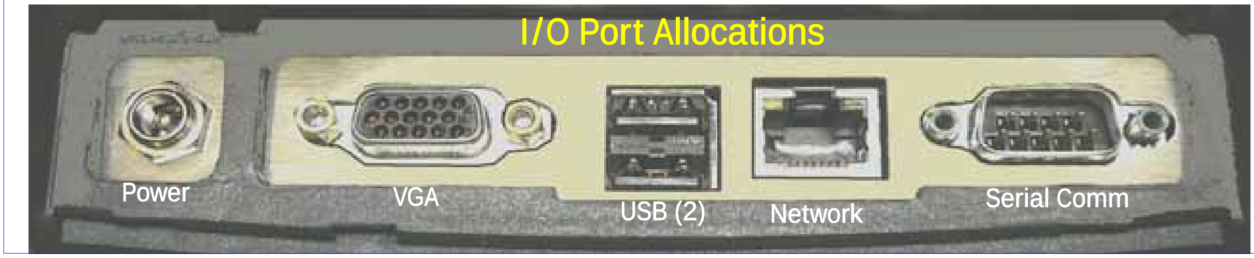


b. Cable Connections



Lift the hinged rubber covers from the Power port and I/O panel located on the lower rear of the unit to reveal:

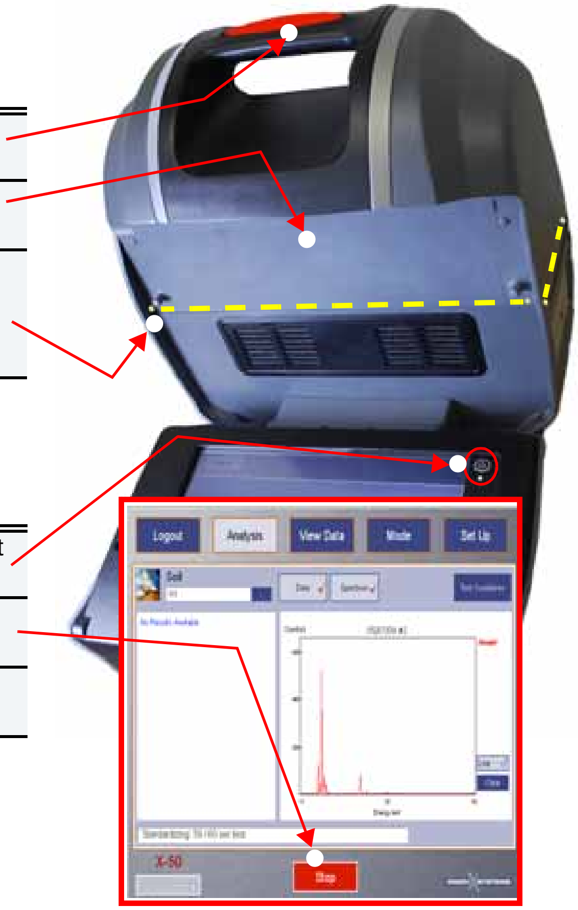
- **Power** port for AC Power adapter or Battery cable input.
- **VGA port** to attach an external monitor.
- **USB ports (2)** can be used for...
  - Local data storage via flash memory device.
  - External keyboard
  - External mouse
- **RJ45 socket** for network access (hardwired).
- **Serial Comm** port to attach external devices.



4.Safety Features

a. Hardware

X-Ray Indicator Handle	Three high intensity red LEDs glow when the X-ray beam is ON
Shielding	Entire test chamber (lid and measurement platform) is shielded.
Interlock Sensors	Lid interlocks ensure lid is closed prior to X-rays turning ON. Interrupts beam (X-rays OFF) if lid is lifted during an active test.



b. Emergency Shutoff

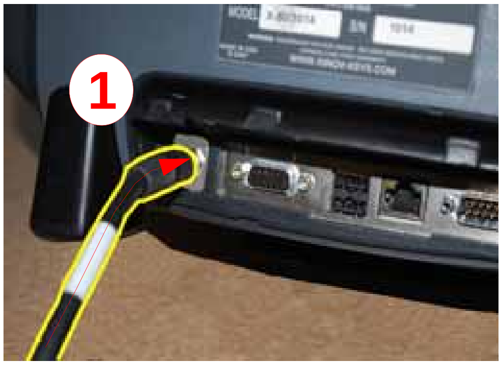
Membrane Switch	Press and hold **I/O** switch; entire unit shuts down within 5 seconds.
STOP button on User Interface (UI)	Press **STOP** button on UI to terminate X-ray beam immediately.
Power Cord	Pull Power adapter cord from unit; entire unit immediately shuts down

5. Operations

Typical Startup Sequence

1. Plug in power using the AC adapter or battery.
2. Set up other I/O conditions such as cabling alternatives, memory card, et al, for your needs
3. Pull the blue latch down and gently swing the touchscreen computer panel out and down.

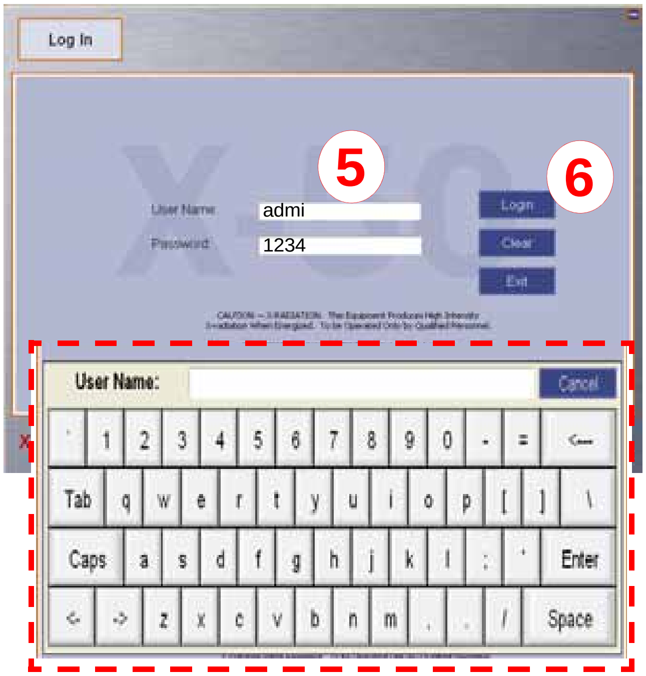
> ✓ TIP Support the panel on the same horizontal surface (bench or desk) as the main body of the X-50.



4. Turn on computer with the button (membrane switch) in the upper right corner.
    - Green LED comes on;
    - Windows® XP Embedded Runtime loads;
    - Electronic circuitry (including fans) comes on;
    - The X-50 Version 2.0 User Interface (UI) loads.
5. Enter your *User Name* and *Password*
   Touch each blank field to call the virtual keyboard

> ✓ TIP The default information is:
> *User Name* --> admi
> *Password* -—> 1234

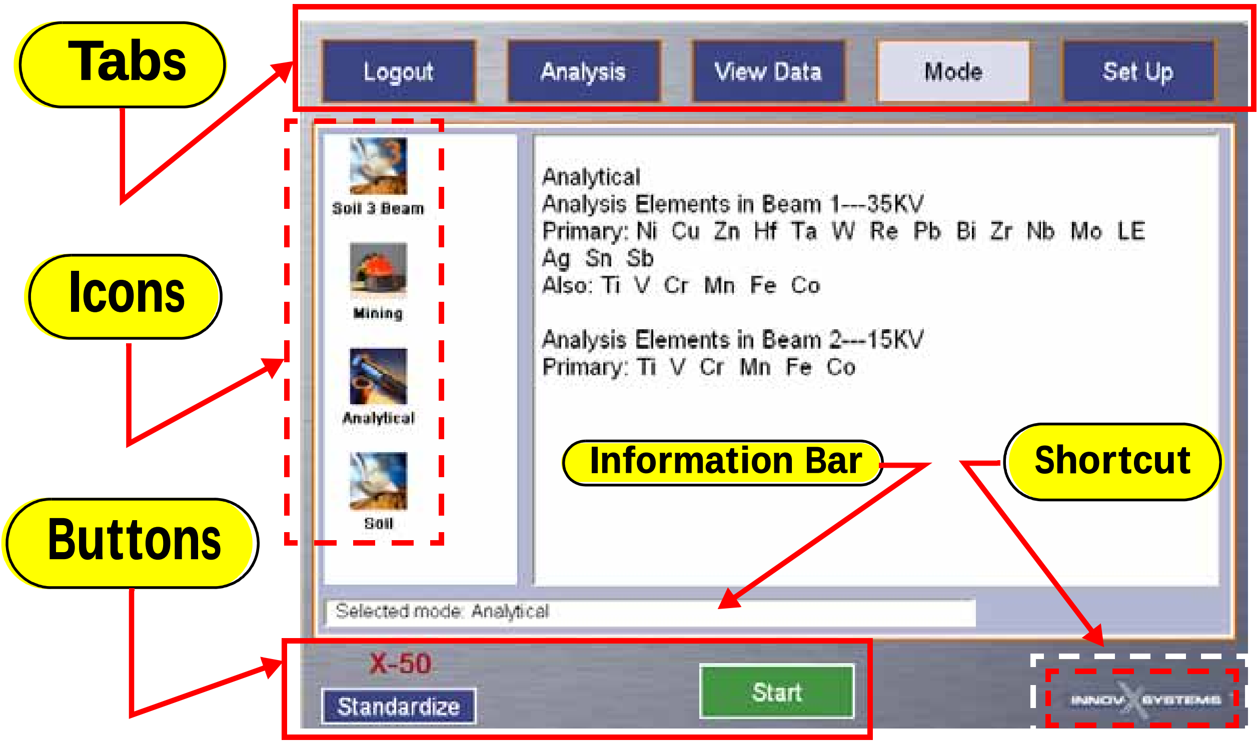
6. Press the *Login* button



User Name admi

Password 1234

Navigating the Ver. 2.0 User Interface (2.0_UI)



Analytical
Analysis Elements in Beam 1---35KV
Primary: Ni Cu Zn Hf Ta W Re Pb Bi Zr Nb Mo LE
Ag Sn Sb
Also: Ti V Cr Mn Fe Co

Analysis Elements in Beam 2---15KV
Primary: Ti V Cr Mn Fe Co

Selected mode: Analytical

Selecting Your Mode

By default the instrument starts up in the **last used** mode. If this is your desired current mode, continue with a Standardization or some other operation.
To change modes,

1. Press the Mode tab to invoke the screen shown above.
2. Choose your desired mode by selecting the appropriate Icon.

✓ TIP
- An external keyboard and mouse may be applied via the USB ports.

Standardizing the Unit

1. Open the lid and place the Standardization Coupon over the measuring widow;
   — Ensure that it completely covers the window.
2. Close the lid.
3. Press *Standardize* on current 2.0_UI screen.
   The Information Bar reports the progress of the operation.
4. After completing successfully, open the lid and remove the Standardization Coupon.

Using the Set Up Facilities

The SETUP tab introduces several facilities.

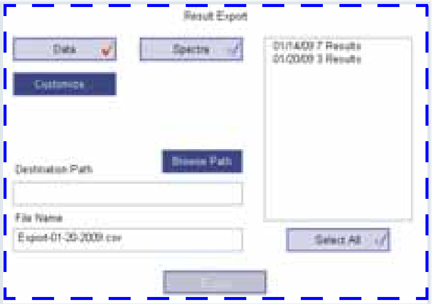
Select an Icon to call the desired screen.

Beam 1 Min: 0
Beam 1 Max: 5
Beam 2 Min: 0
Beam 2 Max: 5

- Sets testing parameters for each mode

Data Management

- Configure and export results



01/14/09 7 Results
01/20/09 3 Results

Destination Path:

File Name: Export-01-20-2009.csv

Results Test Info

- Configures user entered information fields.

User Management

- Change Users/Passwords

User name	Access Level
admin	Factory
mark	Admin
jared	Factory
brenda	User

Search Filter

- Set parameters to narrow results displayed in View Data tab

Mode: All

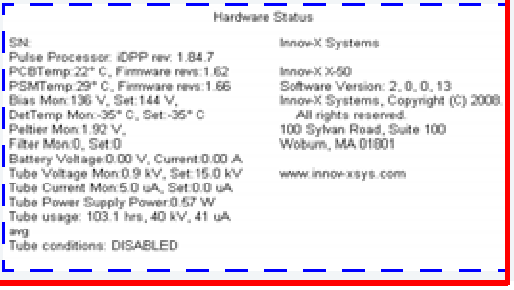
Date Range: Start Date 1/ 1/2008, End Date 1/20/2009

Test Info

Elemental

System Status

- Displays hardware & software status



SN:
Pulse Processor: iDPP rev: 1.84.7
PCBTemp:22° C, Firmware revs:1.62
PSMTemp:29° C, Firmware revs:1.66
Bias Mon:136 V, Set:144 V,
DetTemp Mon:-35° C, Set:-35° C
Peltier Mon:1.92 V,
Filter Mon:0, Set:0
Battery Voltage:0.00 V, Current:0.00 A
Tube Voltage Mon:0.9 kV, Set:15.0 kV
Tube Current Mon:5.0 uA, Set:0.0 uA
Tube Power Supply Power:0.57 W
Tube usage: 103.1 hrs, 40 kV, 41 uA avg
Tube conditions: DISABLED

Innov-X Systems

Innov-X X-50
Software Version: 2, 0, 0, 13
Innov-X Systems, Copyright (C) 2008.
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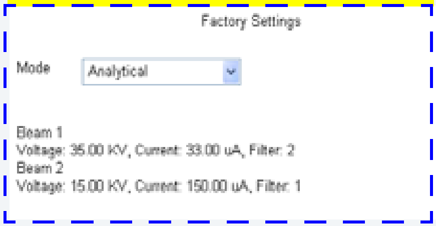
100 Sylvan Road, Suite 100
Woburn, MA 01801

www.innov-xsys.com

Factory Settings

- No user functions available



Mode: Analytical

Beam 1
Voltage: 35.00 KV, Current: 33.00 uA, Filter: 2
Beam 2
Voltage: 15.00 KV, Current: 150.00 uA, Filter: 1

Conducting a Test

1. Open lid.
2. Place sample over the measurement window.

TIPS

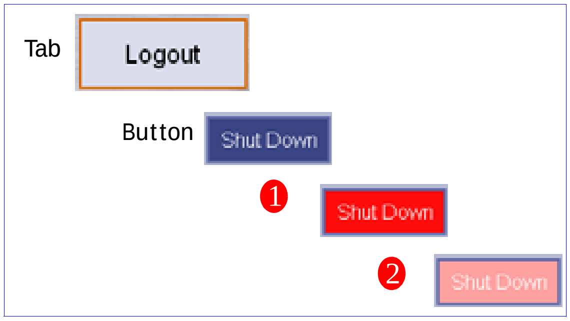
- **USE** the platform’s engraved alignment rings and cross-hairs to position a test specimen for **accurate** and **repeatable** readings.
- When using sample cups, ensure that they are FULL.
- When employing a plastic bag to measure soil samples…
  - – Arrange bag material so that at least a 2 cm thickness is over the window.
  - – Try to use bags with very thin walls (low cost “store brands” are better than national brands)

3. Close the lid.
4. Select *Start*
5. Testing begins, test status is displayed in Information Bar Results are available in several ways…
   a. Visually on Analysis screen.
   b. Saved to default internal hard disk.
   c. Exported to USB flash memory or network drive for later reporting and analysis.

Shutdown Procedures

The recommended shutdown procedure is:

- Go to Logout Tab
  Double touch the *Shutdown* button
  - – First press ① causes button to turn red, but no action occurs;
  - – Second press ② button turns pink and executes the shutdown procedure



Checking Results

Analysis Tab

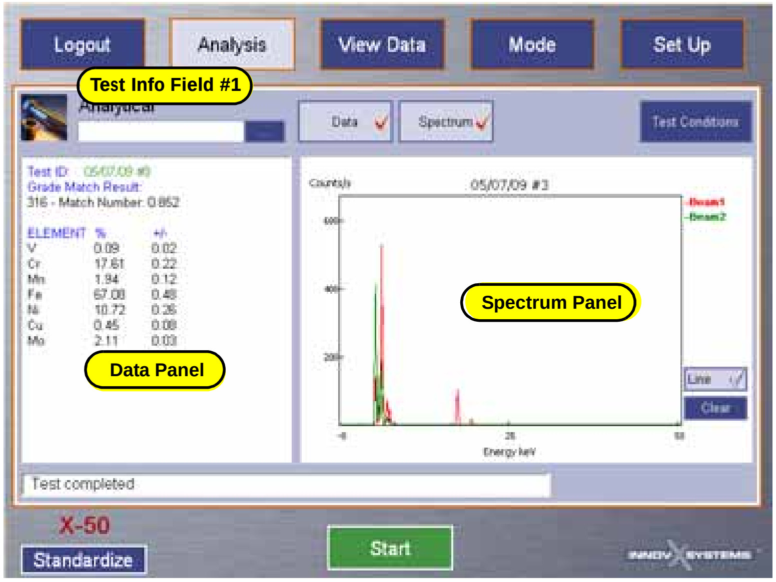
This tab displays the most recent result with the information reported in the data and spectrum panels.

Data panel shows a list of detected elements and their concentrations.

Touch a spectrum graph, the counts rate and energy at that point are displayed.

With the Line button toggled on, a touch on the spectral display shows the elemental energy lines in their appropriate locations.

The Clear button removes the lines.



Test ID: 05/07/09 #3
Grade Match Result:
316 - Match Number: 0.852

ELEMENT	%	+/-
V	0.09	0.02
Cr	17.61	0.22
Mn	1.94	0.12
Fe	67.08	0.48
Ni	10.72	0.26
Cu	0.45	0.08
Mo	2.11	0.03

Test completed

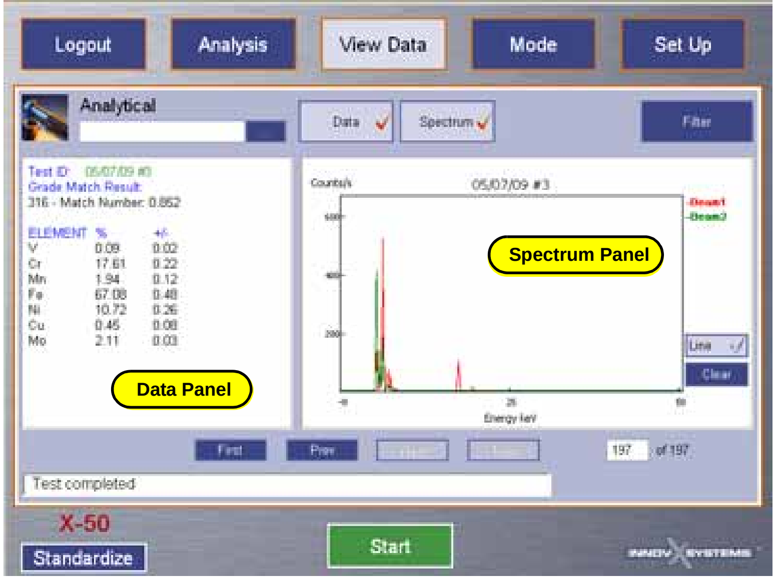
View Data Tab

Select this tab to view **ALL** historical test results.

Similar to the Analysis tab, results are reported in the data and spectrum panels.

Navigation buttons allow an operator to examine the entire test results data set.

Filter button is a shortcut to the Search Filter screen of the Setup tab.



Test ID: 05/07/09 #3
Grade Match Result:
316 - Match Number: 0.852

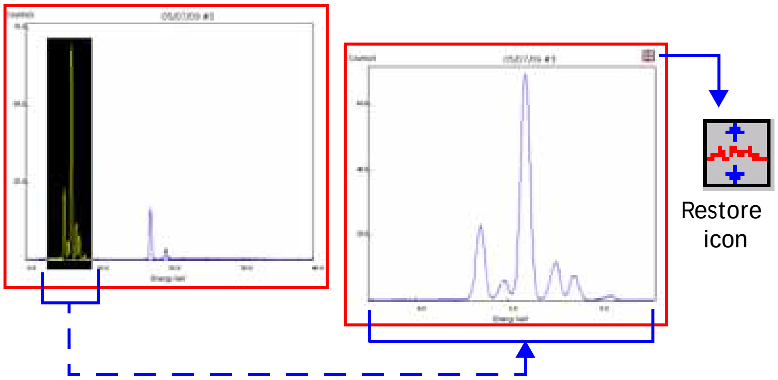
ELEMENT	%	+/-
V	0.09	0.02
Cr	17.61	0.22
Mn	1.94	0.12
Fe	67.08	0.48
Ni	10.72	0.26
Cu	0.45	0.08
Mo	2.11	0.03

Test completed

TIPS

To expand certain plot areas, use your finger (or mouse) to select one corner and drag out the region of interest.

Press the Restore icon to bring the plot back to full scale.



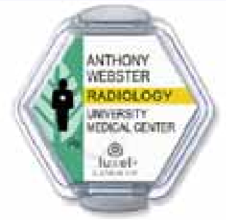
6. Safety Administration

The *X-50* analyzer is a very safe instrument when used according to Innov-X's recommended safety procedures.

- Detectable radiation is below the limit for an uncontrolled area and is within regulatory limits.
- The x-ray tube has a multi-tiered safety interlock structure. See *Product Safety Features, Page 4*.

Dosimeter

A dosimeter consists of a radiation-sensitive material packaged in a small container like a badge or ring.



Dosimeter
Badge Clip-on Style

Dosimeter
Ring Style

These devices record a person's accumulated radiation exposure over a period of time. It monitors workers using devices which emit ionizing radiation.

- Dosimeter badges are required by some states, and are optional with others.

Innov-X recommends that (at a minimum) all *X-50* analyzer operators wear badges/rings for the first year that their analyzer is in use.

7. Specifications

Component	Description
Carry Case and Enclosure	• Rugged carry case with wheels and telescoping handle • Analyzer enclosure is rugged injection molded multi-hinged unit • Dimensions: Closed — 15/38 H x 12.5/32.8 W x 11/28 D [inches/centimeters] • Dimensions: Open — 18/46 H x 12.5/32.8 W x 27/69 D [See *Page 3* for outline] • Weight: 26 lbs/11 kg
Sample Chamber	• Dimensions: 11.3/28.7 W x 5.7/14.5 D x 4.5/11.4 H at front edge of platform. • Lid has safety interlocks that create a closed beam system
Power Requirements	• 100 - 240 VAC, 50-60 Hz, auto switching power adapter; maximum draw less than 70 watts
Excitation System	• 50 kV, 200 uA X-ray tube
Primary Beam Filters	• Six position primary beam filters for optimal performance across the periodic table
Detection System	• High purity Si PiN detector delivers < 190 eV resolution
Computer	• Pentium processor with Windows® XP Embedded Runtime software; color touchscreen for display, mouse, and keyboard functions. I/O ports for external USB (2), serial, VGA devices, and network access.
Operating Environment	• Temperature: 0 - 50°C • Humidity: 10 - 90% Relative Humidity, non-condensing

8. Battery Option

For complete mobile functionality, the X-50 can be outfitted with a rechargeable military-grade lithium-ion battery.
The battery is initially shipped with a charged condition between 50 and 70% of capacity.

Innov-X recommends that you completely charge the battery as soon as practical. Instructions are shown below. A Charge Control Module (CCM) manages the power to the battery. Charging to 100% takes approximately three hours. The CCM prevents over-charging.

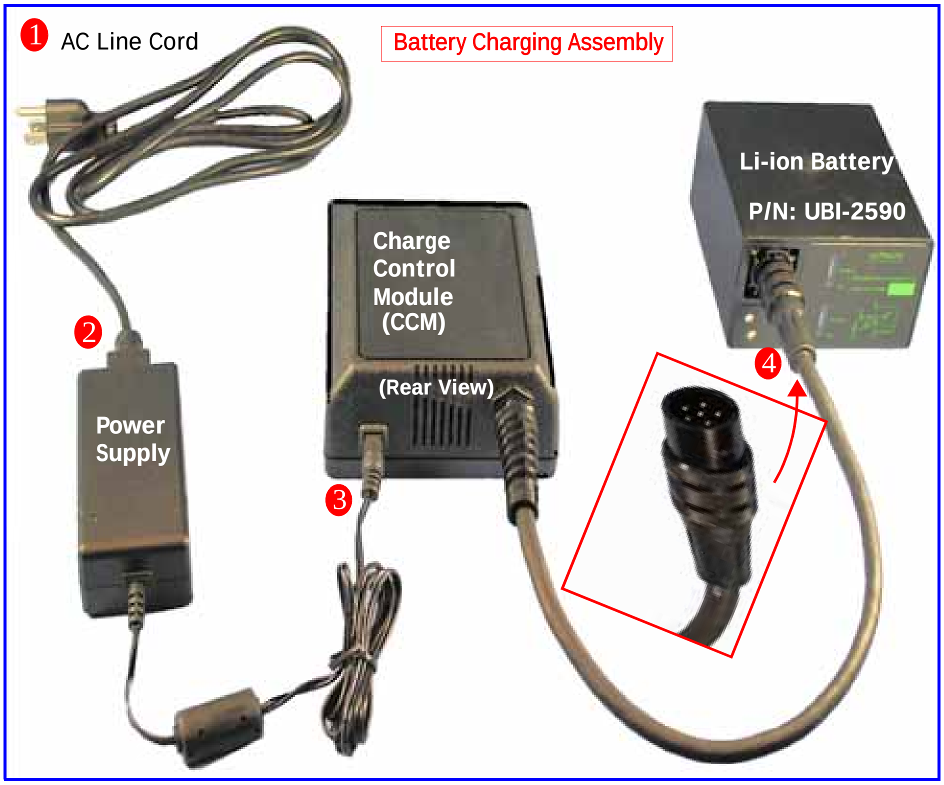
INSTRUCTIONS:
Battery Charging

① Plug AC line cord into grounded power source.

② Insert cord socket into the Power Supply

③ Insert DC Output into Charge Control Module DC Input Socket.

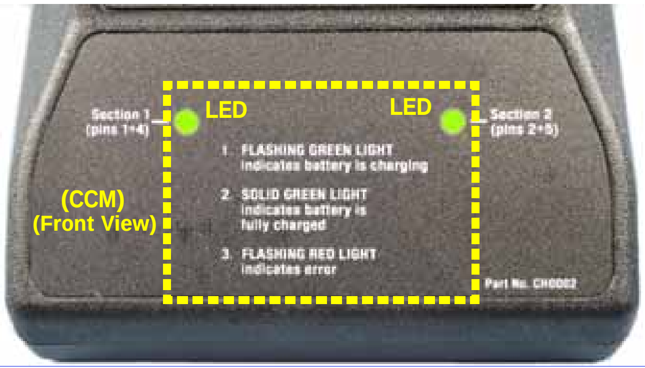
④ Insert CCM DC Output Connector into the Battery Input Socket.
–Ensure that the pins and guides are aligned.

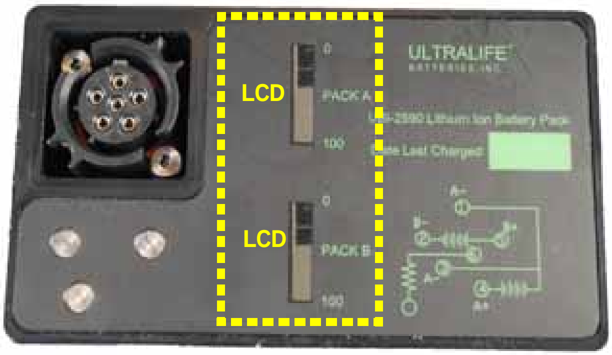


STATUS:
Battery Charge

Two LED indicators on the front of the CCM show the status of the charging cycle.

Two LCD indicators on the battery display the percent of capacity now available.



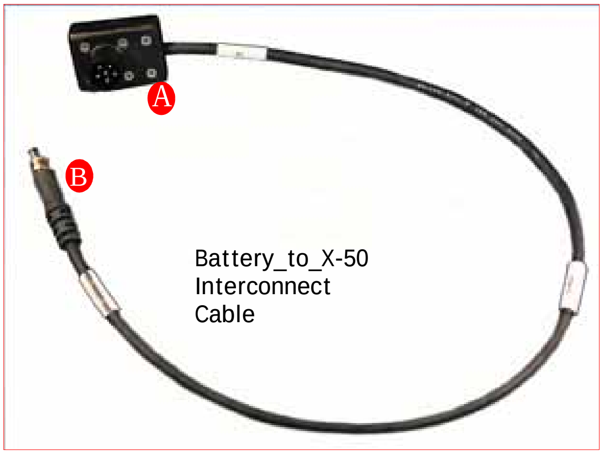


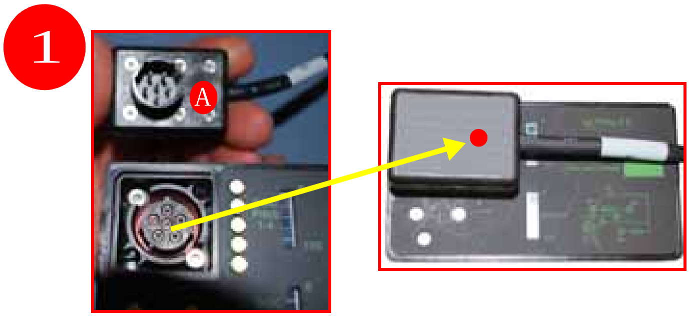
INSTRUCTIONS:
Battery Connection

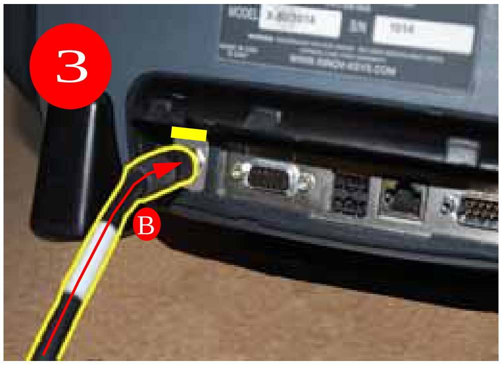
① Using the Interconnect Cable, plug connector Ⓐ into battery socket.

② Lift rubber cover over the X-50 Power socket.

③ Insert DC Output jack Ⓑ into Power socket.







WARNING

- **NEVER** puncture, drop, crush, throw, hit, open, or modify the battery or casing.
- Do **NOT** incinerate.
- Do **NOT** submerge this product in water or any liquid.

CAUTION

When shipping this Li-ion battery, always **observe** all local transportation regulations.

10. Packing and Return Shipping

If the instrument is not returned in the protective case, it can be damaged during shipping. Innov-X Systems reserves the right to void the warranty on instruments shipped without the protective case that are damaged during shipping. Prior to returning a unit, to receive the required RMA number and to answer any shipping questions, call Customer Service at 781-938-5005.

Follow these instructions to return your XRF Analyzer:

1. Pack the analyzer in the black protective case in which it arrived, using the original packing materials.
2. Include the RMA in the case and reference the RMA number in your shipping documents.
3. Close the protective case and either:
    - Secure it with plastic zip ties, or
    - Pack the protective case within another box.

METHOD 6200

FIELD PORTABLE X-RAY FLUORESCENCE SPECTROMETRY FOR THE DETERMINATION OF ELEMENTAL CONCENTRATIONS IN SOIL AND SEDIMENT

SW-846 is not intended to be an analytical training manual. Therefore, method procedures are written based on the assumption that they will be performed by analysts who are formally trained in at least the basic principles of chemical analysis and in the use of the subject technology.

In addition, SW-846 methods, with the exception of required method use for the analysis of method-defined parameters, are intended to be guidance methods which contain general information on how to perform an analytical procedure or technique which a laboratory can use as a basic starting point for generating its own detailed Standard Operating Procedure (SOP), either for its own general use or for a specific project application. The performance data included in this method are for guidance purposes only, and are not intended to be and must not be used as absolute QC acceptance criteria for purposes of laboratory accreditation.

1.0 SCOPE AND APPLICATION

1.1 This method is applicable to the in situ and intrusive analysis of the 26 analytes listed below for soil and sediment samples. Some common elements are not listed in this method because they are considered "light" elements that cannot be detected by field portable x-ray fluorescence (FPXRF). These light elements are: lithium, beryllium, sodium, magnesium, aluminum, silicon, and phosphorus. Most of the analytes listed below are of environmental concern, while a few others have interference effects or change the elemental composition of the matrix, affecting quantitation of the analytes of interest. Generally elements of atomic number 16 or greater can be detected and quantitated by FPXRF. The following RCRA analytes have been determined by this method:

Analytes	CAS Registry No.
Antimony (Sb)	7440-36-0
Arsenic (As)	7440-38-0
Barium (Ba)	7440-39-3
Cadmium (Cd)	7440-43-9
Chromium (Cr)	7440-47-3
Cobalt (Co)	7440-48-4
Copper (Cu)	7440-50-8
Lead (Pb)	7439-92-1
Mercury (Hg)	7439-97-6
Nickel (Ni)	7440-02-0
Selenium (Se)	7782-49-2
Silver (Ag)	7440-22-4
Thallium (Tl)	7440-28-0
Tin (Sn)	7440-31-5

Analytes	CAS Registry No.
Vanadium (V)	7440-62-2
Zinc (Zn)	7440-66-6

In addition, the following non-RCRA analytes have been determined by this method:

Analytes	CAS Registry No.
Calcium (Ca)	7440-70-2
Iron (Fe)	7439-89-6
Manganese (Mn)	7439-96-5
Molybdenum (Mo)	7439-93-7
Potassium (K)	7440-09-7
Rubidium (Rb)	7440-17-7
Strontium (Sr)	7440-24-6
Thorium (Th)	7440-29-1
Titanium (Ti)	7440-32-6
Zirconium (Zr)	7440-67-7

1.2 This method is a screening method to be used with confirmatory analysis using other techniques (e.g., flame atomic absorption spectrometry (FLAA), graphite furnance atomic absorption spectrometry (GFAA), inductively coupled plasma-atomic emission spectrometry, (ICP-AES), or inductively coupled plasma-mass spectrometry, (ICP-MS)). This method’s main strength is that it is a rapid field screening procedure. The method's lower limits of detection are typically above the toxicity characteristic regulatory level for most RCRA analytes. However, when the obtainable values for precision, accuracy, and laboratory-established sensitivity of this method meet project-specific data quality objectives (DQOs), FPXRF is a fast, powerful, cost effective technology for site characterization.

1.3 The method sensitivity or lower limit of detection depends on several factors, including the analyte of interest, the type of detector used, the type of excitation source, the strength of the excitation source, count times used to irradiate the sample, physical matrix effects, chemical matrix effects, and interelement spectral interferences. Example lower limits of detection for analytes of interest in environmental applications are shown in Table 1. These limits apply to a clean spiked matrix of quartz sand (silicon dioxide) free of interelement spectral interferences using long (100 -600 second) count times. These sensitivity values are given for guidance only and may not always be achievable, since they will vary depending on the sample matrix, which instrument is used, and operating conditions. A discussion of performance-based sensitivity is presented in Sec. 9.6.

1.4 Analysts should consult the disclaimer statement at the front of the manual and the information in Chapter Two for guidance on the intended flexibility in the choice of methods, apparatus, materials, reagents, and supplies, and on the responsibilities of the analyst for demonstrating that the techniques employed are appropriate for the analytes of interest, in the matrix of interest, and at the levels of concern.

In addition, analysts and data users are advised that, except where explicitly specified in a regulation, the use of SW-846 methods is *not* mandatory in response to Federal testing requirements. The information contained in this method is provided by EPA as guidance to be used by the analyst and the regulated community in making judgments necessary to generate results that meet the data quality objectives for the intended application.

1.5 Use of this method is restricted to use by, or under supervision of, personnel appropriately experienced and trained in the use and operation of an XRF instrument. Each analyst must demonstrate the ability to generate acceptable results with this method.

2.0 SUMMARY OF METHOD

2.1 The FPXRF technologies described in this method use either sealed radioisotope sources or x-ray tubes to irradiate samples with x-rays. When a sample is irradiated with x-rays, the source x-rays may undergo either scattering or absorption by sample atoms. This latter process is known as the photoelectric effect. When an atom absorbs the source x-rays, the incident radiation dislodges electrons from the innermost shells of the atom, creating vacancies. The electron vacancies are filled by electrons cascading in from outer electron shells. Electrons in outer shells have higher energy states than inner shell electrons, and the outer shell electrons give off energy as they cascade down into the inner shell vacancies. This rearrangement of electrons results in emission of x-rays characteristic of the given atom. The emission of x-rays, in this manner, is termed x-ray fluorescence.

Three electron shells are generally involved in emission of x-rays during FPXRF analysis of environmental samples. The three electron shells include the K, L, and M shells. A typical emission pattern, also called an emission spectrum, for a given metal has multiple intensity peaks generated from the emission of K, L, or M shell electrons. The most commonly measured x-ray emissions are from the K and L shells; only metals with an atomic number greater than 57 have measurable M shell emissions.

Each characteristic x-ray line is defined with the letter K, L, or M, which signifies which shell had the original vacancy and by a subscript alpha (α), beta (β), or gamma (γ) etc., which indicates the higher shell from which electrons fell to fill the vacancy and produce the x-ray. For example, a K_α line is produced by a vacancy in the K shell filled by an L shell electron, whereas a K_β line is produced by a vacancy in the K shell filled by an M shell electron. The K_α transition is on average 6 to 7 times more probable than the K_β transition; therefore, the K_α line is approximately 7 times more intense than the K_β line for a given element, making the K_α line the choice for quantitation purposes.

The K lines for a given element are the most energetic lines and are the preferred lines for analysis. For a given atom, the x-rays emitted from L transitions are always less energetic than those emitted from K transitions. Unlike the K lines, the main L emission lines (L_α and L_β) for an element are of nearly equal intensity. The choice of one or the other depends on what interfering element lines might be present. The L emission lines are useful for analyses involving elements of atomic number (Z) 58 (cerium) through 92 (uranium).

An x-ray source can excite characteristic x-rays from an element only if the source energy is greater than the absorption edge energy for the particular line group of the element, that is, the K absorption edge, L absorption edge, or M absorption edge energy. The absorption edge energy is somewhat greater than the corresponding line energy. Actually, the K absorption edge energy is approximately the sum of the K, L, and M line energies of the particular element, and the L absorption edge energy is approximately the sum of the L and M line energies. FPXRF is more sensitive to an element with an absorption edge energy close to but less than the excitation energy of the source. For example, when using a cadmium-109 source, which has an excitation energy of 22.1 kiloelectron volts (keV), FPXRF would exhibit better sensitivity for zirconium which has a K line energy of 15.77 keV than to chromium, which has a K line energy of 5.41 keV.

2.2 Under this method, inorganic analytes of interest are identified and quantitated using a field portable energy-dispersive x-ray fluorescence spectrometer. Radiation from one or more radioisotope sources or an electrically excited x-ray tube is used to generate characteristic x-ray emissions from elements in a sample. Up to three sources may be used to irradiate a sample. Each source emits a specific set of primary x-rays that excite a corresponding range of elements in a sample. When more than one source can excite the element of interest, the source is selected according to its excitation efficiency for the element of interest.

For measurement, the sample is positioned in front of the probe window. This can be done in two manners using FPXRF instruments, specifically, in situ or intrusive. If operated in the in situ mode, the probe window is placed in direct contact with the soil surface to be analyzed. When an FPXRF instrument is operated in the intrusive mode, a soil or sediment sample must be collected, prepared, and placed in a sample cup. The sample cup is then placed on top of the window inside a protective cover for analysis.

Sample analysis is then initiated by exposing the sample to primary radiation from the source. Fluorescent and backscattered x-rays from the sample enter through the detector window and are converted into electric pulses in the detector. The detector in FPXRF instruments is usually either a solid-state detector or a gas-filled proportional counter. Within the detector, energies of the characteristic x-rays are converted into a train of electric pulses, the amplitudes of which are linearly proportional to the energy of the x-rays. An electronic multichannel analyzer (MCA) measures the pulse amplitudes, which is the basis of qualitative x-ray analysis. The number of counts at a given energy per unit of time is representative of the element concentration in a sample and is the basis for quantitative analysis. Most FPXRF instruments are menu-driven from software built into the units or from personal computers (PC).

The measurement time of each source is user-selectable. Shorter source measurement times (30 seconds) are generally used for initial screening and hot spot delineation, and longer measurement times (up to 300 seconds) are typically used to meet higher precision and accuracy requirements.

FPXRF instruments can be calibrated using the following methods: internally using fundamental parameters determined by the manufacturer, empirically based on site-specific calibration standards (SSCS), or based on Compton peak ratios. The Compton peak is produced by backscattering of the source radiation. Some FPXRF instruments can be calibrated using multiple methods.

3.0 DEFINITIONS

3.1 FPXRF -- Field portable x-ray fluorescence.

3.2 MCA -- Multichannel analyzer for measuring pulse amplitude.

3.3 SSCS -- Site-specific calibration standards.

3.4 FP -- Fundamental parameter.

3.5 ROI -- Region of interest.

3.6 SRM -- Standard reference material; a standard containing certified amounts of metals in soil or sediment.

3.7 eV -- Electron volt; a unit of energy equivalent to the amount of energy gained by an electron passing through a potential difference of one volt.

3.8 Refer to Chapter One, Chapter Three, and the manufacturer's instructions for other definitions that may be relevant to this procedure.

4.0 INTERFERENCES

4.1 The total method error for FPXRF analysis is defined as the square root of the sum of squares of both instrument precision and user- or application-related error. Generally, instrument precision is the least significant source of error in FPXRF analysis. User- or application-related error is generally more significant and varies with each site and method used. Some sources of interference can be minimized or controlled by the instrument operator, but others cannot. Common sources of user- or application-related error are discussed below.

4.2 Physical matrix effects result from variations in the physical character of the sample. These variations may include such parameters as particle size, uniformity, homogeneity, and surface condition. For example, if any analyte exists in the form of very fine particles in a coarser-grained matrix, the analyte’s concentration measured by the FPXRF will vary depending on how fine particles are distributed within the coarser-grained matrix. If the fine particles "settle" to the bottom of the sample cup (i.e., against the cup window), the analyte concentration measurement will be higher than if the fine particles are not mixed in well and stay on top of the coarser-grained particles in the sample cup. One way to reduce such error is to grind and sieve all soil samples to a uniform particle size thus reducing sample-to-sample particle size variability. Homogeneity is always a concern when dealing with soil samples. Every effort should be made to thoroughly mix and homogenize soil samples before analysis. Field studies have shown heterogeneity of the sample generally has the largest impact on comparability with confirmatory samples.

4.3 Moisture content may affect the accuracy of analysis of soil and sediment sample analyses. When the moisture content is between 5 and 20 percent, the overall error from moisture may be minimal. However, moisture content may be a major source of error when analyzing samples of surface soil or sediment that are saturated with water. This error can be minimized by drying the samples in a convection or toaster oven. Microwave drying is not recommended because field studies have shown that microwave drying can increase variability between FPXRF data and confirmatory analysis and because metal fragments in the sample can cause arcing to occur in a microwave.

4.4 Inconsistent positioning of samples in front of the probe window is a potential source of error because the x-ray signal decreases as the distance from the radioactive source increases. This error is minimized by maintaining the same distance between the window and each sample. For the best results, the window of the probe should be in direct contact with the sample, which means that the sample should be flat and smooth to provide a good contact surface.

4.5 Chemical matrix effects result from differences in the concentrations of interfering elements. These effects occur as either spectral interferences (peak overlaps) or as x-ray absorption and enhancement phenomena. Both effects are common in soils contaminated with heavy metals. As examples of absorption and enhancement effects; iron (Fe) tends to absorb copper (Cu) x-rays, reducing the intensity of the Cu measured by the detector, while chromium (Cr) will be enhanced at the expense of Fe because the absorption edge of Cr is slightly lower in energy than the fluorescent peak of iron. The effects can be corrected mathematically through the use of fundamental parameter (FP) coefficients. The effects also can be compensated for using SSCS, which contain all the elements present on site that can interfere with one another.

4.6 When present in a sample, certain x-ray lines from different elements can be very close in energy and, therefore, can cause interference by producing a severely overlapped spectrum. The degree to which a detector can resolve the two different peaks depends on the energy resolution of the detector. If the energy difference between the two peaks in electron volts is less than the resolution of the detector in electron volts, then the detector will not be able to fully resolve the peaks.

The most common spectrum overlaps involve the K_β line of element Z-1 with the K_α line of element Z. This is called the K_α/K_β interference. Because the $K_\alpha:K_\beta$ intensity ratio for a given element usually is about 7:1, the interfering element, Z-1, must be present at large concentrations to cause a problem. Two examples of this type of spectral interference involve the presence of large concentrations of vanadium (V) when attempting to measure Cr or the presence of large concentrations of Fe when attempting to measure cobalt (Co). The V K_α and K_β energies are 4.95 and 5.43 keV, respectively, and the Cr K_α energy is 5.41 keV. The Fe K_α and K_β energies are 6.40 and 7.06 keV, respectively, and the Co K_α energy is 6.92 keV. The difference between the V K_β and Cr K_α energies is 20 eV, and the difference between the Fe K_β and the Co K_α energies is 140 eV. The resolution of the highest-resolution detectors in FPXRF instruments is 170 eV. Therefore, large amounts of V and Fe will interfere with quantitation of Cr or Co, respectively. The presence of Fe is a frequent problem because it is often found in soils at tens of thousands of parts per million (ppm).

4.7 Other interferences can arise from K/L, K/M, and L/M line overlaps, although these overlaps are less common. Examples of such overlap involve arsenic (As) K_α/lead (Pb) L_α and sulfur (S) K_α/Pb M_α. In the As/Pb case, Pb can be measured from the Pb L_β line, and As can be measured from either the As K_α or the As K_β line; in this way the interference can be corrected. If the As K_β line is used, sensitivity will be decreased by a factor of two to five times because it is a less intense line than the As K_α line. If the As K_α line is used in the presence of Pb, mathematical corrections within the instrument software can be used to subtract out the Pb interference. However, because of the limits of mathematical corrections, As concentrations cannot be efficiently calculated for samples with Pb:As ratios of 10:1 or more. This high ratio of Pb to As may result in reporting of a "nondetect" or a "less than" value (e.g., <300 ppm) for As, regardless of the actual concentration present.

No instrument can fully compensate for this interference. It is important for an operator to understand this limitation of FPXRF instruments and consult with the manufacturer of the FPXRF instrument to evaluate options to minimize this limitation. The operator's decision will be based on action levels for metals in soil established for the site, matrix effects, capabilities of the instrument, data quality objectives, and the ratio of lead to arsenic known to be present at the site. If a site is encountered that contains lead at concentrations greater than ten times the concentration of arsenic it is advisable that all critical soil samples be sent off site for confirmatory analysis using other techniques (e.g., flame atomic absorption spectrometry (FLAA), graphite furnance atomic absorption spectrometry (GFAA), inductively coupled plasma-atomic emission spectrometry, (ICP-AES), or inductively coupled plasma-mass spectrometry, (ICP-MS)).

4.8 If SSCS are used to calibrate an FPXRF instrument, the samples collected must be representative of the site under investigation. Representative soil sampling ensures that a sample or group of samples accurately reflects the concentrations of the contaminants of concern at a given time and location. Analytical results for representative samples reflect variations in the presence and concentration ranges of contaminants throughout a site. Variables affecting sample representativeness include differences in soil type, contaminant concentration variability, sample collection and preparation variability, and analytical variability, all of which should be minimized as much as possible.

4.9 Soil physical and chemical effects may be corrected using SSCS that have been analyzed by inductively coupled plasma (ICP) or atomic absorption (AA) methods. However, a major source of error can be introduced if these samples are not representative of the site or if the analytical error is large. Another concern is the type of digestion procedure used to prepare the soil samples for the reference analysis. Analytical results for the confirmatory method will vary depending on whether a partial digestion procedure, such as Method 3050, or a total digestion procedure, such as Method 3052, is used. It is known that depending on the nature of the soil or sediment, Method 3050 will achieve differing extraction efficiencies for different analytes of interest. The confirmatory method should meet the project-specific data quality objectives (DQOs).

XRF measures the total concentration of an element; therefore, to achieve the greatest comparability of this method with the reference method (reduced bias), a total digestion procedure should be used for sample preparation. However, in the study used to generate the performance data for this method (see Table 8), the confirmatory method used was Method 3050, and the FPXRF data compared very well with regression correlation coefficients (r often exceeding 0.95, except for barium and chromium). The critical factor is that the digestion procedure and analytical reference method used should meet the DQOs of the project and match the method used for confirmation analysis.

4.10 Ambient temperature changes can affect the gain of the amplifiers producing instrument drift. Gain or drift is primarily a function of the electronics (amplifier or preamplifier) and not the detector as most instrument detectors are cooled to a constant temperature. Most FPXRF instruments have a built-in automatic gain control. If the automatic gain control is allowed to make periodic adjustments, the instrument will compensate for the influence of temperature changes on its energy scale. If the FPXRF instrument has an automatic gain control function, the operator will not have to adjust the instrument's gain unless an error message appears. If an error message appears, the operator should follow the manufacturer's procedures for troubleshooting the problem. Often, this involves performing a new energy calibration. The performance of an energy calibration check to assess drift is a quality control measure discussed in Sec. 9.2.

If the operator is instructed by the manufacturer to manually conduct a gain check because of increasing or decreasing ambient temperature, it is standard to perform a gain check after every 10 to 20 sample measurements or once an hour whichever is more frequent. It is also suggested that a gain check be performed if the temperature fluctuates more than 10° F. The operator should follow the manufacturer's recommendations for gain check frequency.

5.0 SAFETY

5.1 This method does not address all safety issues associated with its use. The user is responsible for maintaining a safe work environment and a current awareness file of OSHA regulations regarding the safe handling of the chemicals listed in this method. A reference file of material safety data sheets (MSDSs) should be available to all personnel involved in these analyses.

NOTE: No MSDS applies directly to the radiation-producing instrument because that is covered under the Nuclear Regulatory Commission (NRC) or applicable state regulations.

5.2 Proper training for the safe operation of the instrument and radiation training should be completed by the analyst prior to analysis. Radiation safety for each specific instrument can be found in the operator's manual. Protective shielding should never be removed by the analyst or any personnel other than the manufacturer. The analyst should be aware of the local state and national regulations that pertain to the use of radiation-producing equipment and radioactive materials with which compliance is required. There should be a person appointed within the organization that is solely responsible for properly instructing all personnel, maintaining inspection records, and monitoring x-ray equipment at regular intervals.

Licenses for radioactive materials are of two types, specifically: (1) a general license which is usually initiated by the manufacturer for receiving, acquiring, owning, possessing, using, and transferring radioactive material incorporated in a device or equipment, and (2) a specific license which is issued to named persons for the operation of radioactive instruments as required by local, state, or federal agencies. A copy of the radioactive material license (for specific licenses only) and leak tests should be present with the instrument at all times and available to local and national authorities upon request.

X-ray tubes do not require radioactive material licenses or leak tests, but do require approvals and licenses which vary from state to state. In addition, fail-safe x-ray warning lights should be illuminated whenever an x-ray tube is energized. Provisions listed above concerning radiation safety regulations, shielding, training, and responsible personnel apply to x-ray tubes just as to radioactive sources. In addition, a log of the times and operating conditions should be kept whenever an x-ray tube is energized. An additional hazard present with x-ray tubes is the danger of electric shock from the high voltage supply, however, if the tube is properly positioned within the instrument, this is only a negligible risk. Any instrument (x-ray tube or radioisotope based) is capable of delivering an electric shock from the basic circuitry when the system is inappropriately opened.

5.3 Radiation monitoring equipment should be used with the handling and operation of the instrument. The operator and the surrounding environment should be monitored continually for analyst exposure to radiation. Thermal luminescent detectors (TLD) in the form of badges and rings are used to monitor operator radiation exposure. The TLDs or badges should be worn in the area of maximum exposure. The maximum permissible whole-body dose from occupational exposure is 5 Roentgen Equivalent Man (REM) per year. Possible exposure pathways for radiation to enter the body are ingestion, inhaling, and absorption. The best precaution to prevent radiation exposure is distance and shielding.

6.0 EQUIPMENT AND SUPPLIES

The mention of trade names or commercial products in this manual is for illustrative purposes only, and does not constitute an EPA endorsement or exclusive recommendation for use. The products and instrument settings cited in SW-846 methods represent those products and settings used during method development or subsequently evaluated by the Agency. Glassware, reagents, supplies, equipment, and settings other than those listed in this manual may be employed provided that method performance appropriate for the intended application has been demonstrated and documented.

6.1 FPXRF spectrometer -- An FPXRF spectrometer consists of four major components: (1) a source that provides x-rays; (2) a sample presentation device; (3) a detector that converts x-ray-generated photons emitted from the sample into measurable electronic signals; and (4) a data processing unit that contains an emission or fluorescence energy analyzer, such as an MCA, that processes the signals into an x-ray energy spectrum from which elemental concentrations in the sample may be calculated, and a data display and storage system. These components and additional, optional items, are discussed below.

6.1.1 Excitation sources -- FPXRF instruments use either a sealed radioisotope source or an x-ray tube to provide the excitation source. Many FPXRF instruments use sealed radioisotope sources to produce x-rays in order to irradiate samples. The FPXRF instrument may contain between one and three radioisotope sources. Common radioisotope sources used for analysis for metals in soils are iron Fe-55 (^{55}Fe), cadmium Cd-109 (^{109}Cd), americium Am-241 (^{241}Am), and curium Cm-244 (^{244}Cm). These sources may be contained in a probe along with a window and the detector; the probe may be connected to a data reduction and handling system by means of a flexible cable. Alternatively, the sources, window, and detector may be included in the same unit as the data reduction and handling system.

The relative strength of the radioisotope sources is measured in units of millicuries (mCi). All other components of the FPXRF system being equal, the stronger the source, the greater the sensitivity and precision of a given instrument. Radioisotope sources undergo constant decay. In fact, it is this decay process that emits the primary x-rays used to excite samples for FPXRF analysis. The decay of radioisotopes is measured in "half-lives." The half-life of a radioisotope is defined as the length of time required to reduce the radioisotopes strength or activity by half. Developers of FPXRF technologies recommend source replacement at regular intervals based on the source's half-life. This is due to the ever increasing time required for the analysis rather than a decrease in instrument performance. The characteristic x-rays emitted from each of the different sources have energies capable of exciting a certain range of analytes in a sample. Table 2 summarizes the characteristics of four common radioisotope sources.

X-ray tubes have higher radiation output, no intrinsic lifetime limit, produce constant output over their lifetime, and do not have the disposal problems of radioactive sources but are just now appearing in FPXRF instruments. An electrically-excited x-ray tube operates by bombarding an anode with electrons accelerated by a high voltage. The electrons gain an energy in electron volts equal to the accelerating voltage and can excite atomic transitions in the anode, which then produces characteristic x-rays. These characteristic x-rays are emitted through a window which contains the vacuum necessary for the electron acceleration. An important difference between x-ray tubes and radioactive sources is that the electrons which bombard the anode also produce a continuum of x-rays across a broad range of energies in addition to the characteristic x-rays. This continuum is weak compared to the characteristic x-rays but can provide substantial excitation since it covers a broad energy range. It has the undesired property of producing background in the spectrum near the analyte x-ray lines when it is scattered by the sample. For this reason a filter is often used between the x-ray tube and the sample to suppress the continuum radiation while passing the characteristic x-rays from the anode. This filter is sometimes incorporated into the window of the x-ray tube. The choice of accelerating voltage is governed both by the anode material, since the electrons must have sufficient energy to excite the anode, which requires a voltage greater than the absorption edge of the anode material and by the instrument's ability to cool the x-ray tube. The anode is most efficiently excited by voltages 2 to 2.5 times the edge energy (most x-rays per unit power to the tube), although voltages as low as 1.5 times the absorption edge energy will work. The characteristic x-rays emitted by the anode are capable of exciting a range of elements in the sample just as with a radioactive source. Table 3 gives the recommended operating voltages and the sample elements excited for some common anodes.

6.1.2 Sample presentation device -- FPXRF instruments can be operated in two modes: in situ and intrusive. If operated in the in situ mode, the probe window is placed in direct contact with the soil surface to be analyzed. When an FPXRF instrument is operated in the intrusive mode, a soil or sediment sample must be collected, prepared, and placed in a sample cup. For FPXRF instruments operated in the intrusive mode, the probe may be rotated so that the window faces either upward or downward. A protective sample cover is placed over the window, and the sample cup is placed on top of the window inside the protective sample cover for analysis.

6.1.3 Detectors -- The detectors in the FPXRF instruments can be either solid-state detectors or gas-filled, proportional counter detectors. Common solid-state detectors include mercuric iodide (HgI_2), silicon pin diode and lithium-drifted silicon Si(Li). The HgI_2 detector is operated at a moderately subambient temperature controlled by a low power thermoelectric cooler. The silicon pin diode detector also is cooled via the thermoelectric Peltier effect. The Si(Li) detector must be cooled to at least -90 °C either with liquid nitrogen or by thermoelectric cooling via the Peltier effect. Instruments with a Si(Li) detector have an internal liquid nitrogen dewar with a capacity of 0.5 to 1.0 L. Proportional counter detectors are rugged and lightweight, which are important features of a field portable detector. However, the resolution of a proportional counter detector is not as good as that of a solid-state detector. The energy resolution of a detector for characteristic x-rays is usually expressed in terms of full width at half-maximum (FWHM) height of the manganese K_α peak at 5.89 keV. The typical resolutions of the above mentioned detectors are as follows: HgI_2-270 eV; silicon pin diode-250 eV; Si(Li)–170 eV; and gas-filled, proportional counter-750 eV.

During operation of a solid-state detector, an x-ray photon strikes a biased, solid-state crystal and loses energy in the crystal by producing electron-hole pairs. The electric charge produced is collected and provides a current pulse that is directly proportional to the energy of the x-ray photon absorbed by the crystal of the detector. A gas-filled, proportional counter detector is an ionization chamber filled with a mixture of noble and other gases. An x-ray photon entering the chamber ionizes the gas atoms. The electric charge produced is collected and provides an electric signal that is directly proportional to the energy of the x-ray photon absorbed by the gas in the detector.

6.1.4 Data processing units -- The key component in the data processing unit of an FPXRF instrument is the MCA. The MCA receives pulses from the detector and sorts them by their amplitudes (energy level). The MCA counts pulses per second to determine the height of the peak in a spectrum, which is indicative of the target analyte's concentration. The spectrum of element peaks are built on the MCA. The MCAs in FPXRF instruments have from 256 to 2,048 channels. The concentrations of target analytes are usually shown in ppm on a liquid crystal display (LCD) in the instrument. FPXRF instruments can store both spectra and from 3,000 to 5,000 sets of numerical analytical results. Most FPXRF instruments are menu-driven from software built into the units or from PCs. Once the data–storage memory of an FPXRF unit is full or at any other time, data can be downloaded by means of an RS-232 port and cable to a PC.

6.2 Spare battery and battery charger.

6.3 Polyethylene sample cups -- 31 to 40 mm in diameter with collar, or equivalent (appropriate for FPXRF instrument).

6.4 X-ray window film -- Mylar™, Kapton™, Spectrolene™, polypropylene, or equivalent; 2.5 to 6.0 µm thick.

6.5 Mortar and pestle -- Glass, agate, or aluminum oxide; for grinding soil and sediment samples.

6.6 Containers -- Glass or plastic to store samples.

6.7 Sieves -- 60-mesh (0.25 mm), stainless-steel, Nylon, or equivalent for preparing soil and sediment samples.

6.8 Trowels -- For smoothing soil surfaces and collecting soil samples.

6.9 Plastic bags -- Used for collection and homogenization of soil samples.

6.10 Drying oven -- Standard convection or toaster oven, for soil and sediment samples that require drying.

7.0 REAGENTS AND STANDARDS

7.1 Reagent grade chemicals must be used in all tests. Unless otherwise indicated, it is intended that all reagents conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.2 Pure element standards -- Each pure, single-element standard is intended to produce strong characteristic x-ray peaks of the element of interest only. Other elements present must not contribute to the fluorescence spectrum. A set of pure element standards for commonly sought analytes is supplied by the instrument manufacturer, if designated for the instrument; not all instruments require the pure element standards. The standards are used to set the region of interest (ROI) for each element. They also can be used as energy calibration and resolution check samples.

7.3 Site-specific calibration standards -- Instruments that employ fundamental parameters (FP) or similar mathematical models in minimizing matrix effects may not require SSCS. If the FP calibration model is to be optimized or if empirical calibration is necessary, then SSCSs must be collected, prepared, and analyzed.

7.3.1 The SSCS must be representative of the matrix to be analyzed by FPXRF. These samples must be well homogenized. A minimum of 10 samples spanning the concentration ranges of the analytes of interest and of the interfering elements must be obtained from the site. A sample size of 4 to 8 ounces is recommended, and standard glass sampling jars should be used.

7.3.2 Each sample should be oven-dried for 2 to 4 hr at a temperature of less than 150 °C. If mercury is to be analyzed, a separate sample portion should be dried at ambient temperature as heating may volatilize the mercury. When the sample is dry, all large, organic debris and nonrepresentative material, such as twigs, leaves, roots, insects, asphalt, and rock should be removed. The sample should be homogenized (see Sec. 7.3.3) and then a representative portion ground with a mortar and pestle or other mechanical means, prior to passing through a 60-mesh sieve. Only the coarse rock fraction should remain on the screen.

7.3.3 The sample should be homogenized by using a riffle splitter or by placing 150 to 200 g of the dried, sieved sample on a piece of kraft or butcher paper about 1.5 by 1.5 feet in size. Each corner of the paper should be lifted alternately, rolling the soil over on itself and toward the opposite corner. The soil should be rolled on itself 20 times. Approximately 5 g of the sample should then be removed and placed in a sample cup for FPXRF analysis. The rest of the prepared sample should be sent off site for ICP or AA analysis. The method use for confirmatory analysis should meet the data quality objectives of the project.

7.4 Blank samples -- The blank samples should be from a "clean" quartz or silicon dioxide matrix that is free of any analytes at concentrations above the established lower limit of detection. These samples are used to monitor for cross-contamination and laboratory-induced contaminants or interferences.

7.5 Standard reference materials -- Standard reference materials (SRMs) are standards containing certified amounts of metals in soil or sediment. These standards are used for accuracy and performance checks of FPXRF analyses. SRMs can be obtained from the National Institute of Standards and Technology (NIST), the U.S. Geological Survey (USGS), the Canadian National Research Council, and the national bureau of standards in foreign nations. Pertinent NIST SRMs for FPXRF analysis include 2704, Buffalo River Sediment; 2709, San Joaquin Soil; and 2710 and 2711, Montana Soil. These SRMs contain soil or sediment from actual sites that has been analyzed using independent inorganic analytical methods by many different laboratories. When these SRMs are unavailable, alternate standards may be used (e.g., NIST 2702).

8.0 SAMPLE COLLECTION, PRESERVATION, AND STORAGE

Sample handling and preservation procedures used in FPXRF analyses should follow the guidelines in Chapter Three, "Inorganic Analytes."

9.0 QUALITY CONTROL

9.1 Follow the manufacturer’s instructions for the quality control procedures specific to use of the testing product. Refer to Chapter One for additional guidance on quality assurance (QA) and quality control (QC) protocols. Any effort involving the collection of analytical data should include development of a structured and systematic planning document, such as a Quality Assurance Project Plan (QAPP) or a Sampling and Analysis Plan (SAP), which translates project objectives and specifications into directions for those that will implement the project and assess the results.

9.2 Energy calibration check -- To determine whether an FPXRF instrument is operating within resolution and stability tolerances, an energy calibration check should be run. The energy calibration check determines whether the characteristic x-ray lines are shifting, which would indicate drift within the instrument. As discussed in Sec. 4.10, this check also serves as a gain check in the event that ambient temperatures are fluctuating greatly (more than 10 °F).

9.2.1 The energy calibration check should be run at a frequency consistent with manufacturer's recommendations. Generally, this would be at the beginning of each working day, after the batteries are changed or the instrument is shut off, at the end of each working day, and at any other time when the instrument operator believes that drift is occurring during analysis. A pure element such as iron, manganese, copper, or lead is often used for the energy calibration check. A manufacturer-recommended count time per source should be used for the check.

9.2.2 The instrument manufacturer's manual specifies the channel or kiloelectron volt level at which a pure element peak should appear and the expected intensity of the peak. The intensity and channel number of the pure element as measured using the source should be checked and compared to the manufacturer's recommendation. If the energy calibration check does not meet the manufacturer's criteria, then the pure element sample should be repositioned and reanalyzed. If the criteria are still not met, then an energy calibration should be performed as described in the manufacturer's manual. With some FPXRF instruments, once a spectrum is acquired from the energy calibration check, the peak can be optimized and realigned to the manufacturer's specifications using their software.

9.3 Blank samples -- Two types of blank samples should be analyzed for FPXRF analysis, specifically, instrument blanks and method blanks.

9.3.1 An instrument blank is used to verify that no contamination exists in the spectrometer or on the probe window. The instrument blank can be silicon dioxide, a polytetraflurorethylene (PTFE) block, a quartz block, "clean" sand, or lithium carbonate. This instrument blank should be analyzed on each working day before and after analyses are conducted and once per every twenty samples. An instrument blank should also be analyzed whenever contamination is suspected by the analyst. The frequency of analysis will vary with the data quality objectives of the project. A manufacturer-recommended count time per source should be used for the blank analysis. No element concentrations above the established lower limit of detection should be found in the instrument blank. If concentrations exceed these limits, then the probe window and the check sample should be checked for contamination. If contamination is not a problem, then the instrument must be "zeroed" by following the manufacturer's instructions.

9.3.2 A method blank is used to monitor for laboratory-induced contaminants or interferences. The method blank can be "clean" silica sand or lithium carbonate that undergoes the same preparation procedure as the samples. A method blank must be analyzed at least daily. The frequency of analysis will depend on the data quality objectives of the project. If the method blank does not contain the target analyte at a level that interferes with the project-specific data quality objectives then the method blank would be considered acceptable. In the absence of project-specific data quality objectives, if the blank is less than the lowest level of detection or less than 10% of the lowest sample concentration for the analyte, whichever is greater, then the method blank would be considered acceptable. If the method blank cannot be considered acceptable, the cause of the problem must be identified, and all samples analyzed with the method blank must be reanalyzed.

9.4 Calibration verification checks -- A calibration verification check sample is used to check the accuracy of the instrument and to assess the stability and consistency of the analysis for the analytes of interest. A check sample should be analyzed at the beginning of each working day, during active sample analyses, and at the end of each working day. The frequency of calibration checks during active analysis will depend on the data quality objectives of the project. The check sample should be a well characterized soil sample from the site that is representative of site samples in terms of particle size and degree of homogeneity and that contains contaminants at concentrations near the action levels. If a site-specific sample is not available, then an NIST or other SRM that contains the analytes of interest can be used to verify the accuracy of the instrument. The measured value for each target analyte should be within ±20 percent (%D) of the true value for the calibration verification check to be acceptable. If a measured value falls outside this range, then the check sample should be reanalyzed. If the value continues to fall outside the acceptance range, the instrument should be recalibrated, and the batch of samples analyzed before the unacceptable calibration verification check must be reanalyzed.

9.5 Precision measurements -- The precision of the method is monitored by analyzing a sample with low, moderate, or high concentrations of target analytes. The frequency of precision measurements will depend on the data quality objectives for the data. A minimum of one precision sample should be run per day. Each precision sample should be analyzed 7 times in replicate. It is recommended that precision measurements be obtained for samples with varying concentration ranges to assess the effect of concentration on method precision. Determining method precision for analytes at concentrations near the site action levels can be extremely important if the FPXRF results are to be used in an enforcement action; therefore, selection of at least one sample with target analyte concentrations at or near the site action levels or levels of concern is recommended. A precision sample is analyzed by the instrument for the same field analysis time as used for other project samples. The relative standard deviation (RSD) of the sample mean is used to assess method precision. For FPXRF data to be considered adequately precise, the RSD should not be greater than 20 percent with the exception of chromium. RSD values for chromium should not be greater than 30 percent. If both in situ and intrusive analytical techniques are used during the course of one day, it is recommended that separate precision calculations be performed for each analysis type.

The equation for calculating RSD is as follows:

$$\mathrm{RSD} = (\mathrm{SD}/\text{Mean Concentration}) \times 100$$

where:

RSD = Relative standard deviation for the precision measurement for the analyte
SD = Standard deviation of the concentration for the analyte
Mean concentration = Mean concentration for the analyte

The precision or reproducibility of a measurement will improve with increasing count time, however, increasing the count time by a factor of 4 will provide only 2 times better precision, so there is a point of diminishing return. Increasing the count time also improves the sensitivity, but decreases sample throughput.

9.6 The lower limits of detection should be established from actual measured performance based on spike recoveries in the matrix of concern or from acceptable method performance on a certified reference material of the appropriate matrix and within the appropriate calibration range for the application. This is considered the best estimate of the true method sensitivity as opposed to a statistical determination based on the standard deviation of replicate analyses of a low-concentration sample. While the statistical approach demonstrates the potential data variability for a given sample matrix at one point in time, it does not represent what can be detected or most importantly the lowest concentration that can be calibrated. For this reason the sensitivity should be established as the lowest point of detection based on acceptable target analyte recovery in the desired sample matrix.

9.7 Confirmatory samples -- The comparability of the FPXRF analysis is determined by submitting FPXRF-analyzed samples for analysis at a laboratory. The method of confirmatory analysis must meet the project and XRF measurement data quality objectives. The confirmatory samples must be splits of the well homogenized sample material. In some cases the prepared sample cups can be submitted. A minimum of 1 sample for each 20 FPXRF-analyzed samples should be submitted for confirmatory analysis. This frequency will depend on project-specific data quality objectives. The confirmatory analyses can also be used to verify the quality of the FPXRF data. The confirmatory samples should be selected from the lower, middle, and upper range of concentrations measured by the FPXRF. They should also include samples with analyte concentrations at or near the site action levels. The results of the confirmatory analysis and FPXRF analyses should be evaluated with a least squares linear regression analysis. If the measured concentrations span more than one order of magnitude, the data should be log-transformed to standardize variance which is proportional to the magnitude of measurement. The correlation coefficient (r) for the results should be 0.7 or greater for the FPXRF data to be considered screening level data. If the r is 0.9 or greater and inferential statistics indicate the FPXRF data and the confirmatory data are statistically equivalent at a 99 percent confidence level, the data could potentially meet definitive level data criteria.

10.0 CALIBRATION AND STANDARDIZATION

10.1 Instrument calibration -- Instrument calibration procedures vary among FPXRF instruments. Users of this method should follow the calibration procedures outlined in the operator's manual for each specific FPXRF instrument. Generally, however, three types of calibration procedures exist for FPXRF instruments, namely: FP calibration, empirical calibration, and the Compton peak ratio or normalization method. These three types of calibration are discussed below.

10.2 Fundamental parameters calibration -- FP calibration procedures are extremely variable. An FP calibration provides the analyst with a "standardless" calibration. The advantages of FP calibrations over empirical calibrations include the following:

- No previously collected site-specific samples are necessary, although site-specific samples with confirmed and validated analytical results for all elements present could be used.

- Cost is reduced because fewer confirmatory laboratory results or calibration standards are necessary.

However, the analyst should be aware of the limitations imposed on FP calibration by particle size and matrix effects. These limitations can be minimized by adhering to the preparation procedure described in Sec. 7.3. The two FP calibration processes discussed below are based on an effective energy FP routine and a back scatter with FP (BFP) routine. Each FPXRF FP calibration process is based on a different iterative algorithmic method. The calibration procedure for each routine is explained in detail in the manufacturer's user manual for each FPXRF instrument; in addition, training courses are offered for each instrument.

10.2.1 Effective energy FP calibration -- The effective energy FP calibration is performed by the manufacturer before an instrument is sent to the analyst. Although SSCS can be used, the calibration relies on pure element standards or SRMs such as those obtained from NIST for the FP calibration. The effective energy routine relies on the spectrometer response to pure elements and FP iterative algorithms to compensate for various matrix effects.

Alpha coefficients are calculated using a variation of the Sherman equation, which calculates theoretical intensities from the measurement of pure element samples. These coefficients indicate the quantitative effect of each matrix element on an analyte's measured x-ray intensity. Next, the Lachance Traill algorithm is solved as a set of simultaneous equations based on the theoretical intensities. The alpha coefficients are then downloaded into the specific instrument.

The working effective energy FP calibration curve must be verified before sample analysis begins on each working day, after every 20 samples are analyzed, and at the end of sampling. This verification is performed by analyzing either an NIST SRM or an SSCS that is representative of the site-specific samples. This SRM or SSCS serves as a calibration check. A manufacturer-recommended count time per source should be used for the calibration check. The analyst must then adjust the y-intercept and slope of the calibration curve to best fit the known concentrations of target analytes in the SRM or SSCS.

A percent difference (%D) is then calculated for each target analyte. The %D should be within ±20 percent of the certified value for each analyte. If the %D falls outside this acceptance range, then the calibration curve should be adjusted by varying the slope of the line or the y-intercept value for the analyte. The SRM or SSCS is reanalyzed until the %D falls within ±20 percent. The group of 20 samples analyzed before an out-of-control calibration check should be reanalyzed.

The equation to calibrate %D is as follows:

$$\%D = ((C_s - C_k) / C_k) \times 100$$

where:

$\%D$ = Percent difference
C_k = Certified concentration of standard sample
C_s = Measured concentration of standard sample

10.2.2 BFP calibration -- BFP calibration relies on the ability of the liquid nitrogen-cooled, Si(Li) solid-state detector to separate the coherent (Compton) and incoherent (Rayleigh) backscatter peaks of primary radiation. These peak intensities are known to be a function of sample composition, and the ratio of the Compton to Rayleigh peak is a function of the mass absorption of the sample. The calibration procedure is explained in detail in the instrument manufacturer's manual. Following is a general description of the BFP calibration procedure.

The concentrations of all detected and quantified elements are entered into the computer software system. Certified element results for an NIST SRM or confirmed and validated results for an SSCS can be used. In addition, the concentrations of oxygen and silicon must be entered; these two concentrations are not found in standard metals analyses. The manufacturer provides silicon and oxygen concentrations for typical soil types. Pure element standards are then analyzed using a manufacturer-recommended count time per source. The results are used to calculate correction factors in order to adjust for spectrum overlap of elements.

The working BFP calibration curve must be verified before sample analysis begins on each working day, after every 20 samples are analyzed, and at the end of the analysis. This verification is performed by analyzing either an NIST SRM or an SSCS that is representative of the site-specific samples. This SRM or SSCS serves as a calibration check. The standard sample is analyzed using a manufacturer-recommended count time per source to check the calibration curve. The analyst must then adjust the y-intercept and slope of the calibration curve to best fit the known concentrations of target analytes in the SRM or SSCS.

A %D is then calculated for each target analyte. The %D should fall within ±20 percent of the certified value for each analyte. If the %D falls outside this acceptance range, then the calibration curve should be adjusted by varying the slope of the line the y-intercept value for the analyte. The standard sample is reanalyzed until the %D falls within ±20 percent. The group of 20 samples analyzed before an out-of-control calibration check should be reanalyzed.

10.3 Empirical calibration -- An empirical calibration can be performed with SSCS, site-typical standards, or standards prepared from metal oxides. A discussion of SSCS is included in Sec. 7.3; if no previously characterized samples exist for a specific site, site-typical standards can be used. Site-typical standards may be selected from commercially available characterized soils or from SSCS prepared for another site. The site-typical standards should closely approximate the site's soil matrix with respect to particle size distribution, mineralogy, and contaminant analytes. If neither SSCS nor site-typical standards are available, it is possible to make gravimetric standards by adding metal oxides to a "clean" sand or silicon dioxide matrix that simulates soil. Metal oxides can be purchased from various chemical vendors. If standards are made on site, a balance capable of weighing items to at least two decimal places is necessary. Concentrated ICP or AA standard solutions can also be used to make standards. These solutions are available in concentrations of 10,000 parts per million, thus only small volumes have to be added to the soil.

An empirical calibration using SSCS involves analysis of SSCS by the FPXRF instrument and by a conventional analytical method such as ICP or AA. A total acid digestion procedure should be used by the laboratory for sample preparation. Generally, a minimum of 10 and a maximum of 30 well characterized SSCS, site-typical standards, or prepared metal oxide standards are necessary to perform an adequate empirical calibration. The exact number of standards depends on the number of analytes of interest and interfering elements. Theoretically, an empirical calibration with SSCS should provide the most accurate data for a site because the calibration compensates for site-specific matrix effects.

The first step in an empirical calibration is to analyze the pure element standards for the elements of interest. This enables the instrument to set channel limits for each element for spectral deconvolution. Next the SSCS, site-typical standards, or prepared metal oxide standards are analyzed using a count time of 200 seconds per source or a count time recommended by the manufacturer. This will produce a spectrum and net intensity of each analyte in each standard. The analyte concentrations for each standard are then entered into the instrument software; these concentrations are those obtained from the laboratory, the certified results, or the gravimetrically determined concentrations of the prepared standards. This gives the instrument analyte values to regress against corresponding intensities during the modeling stage. The regression equation correlates the concentrations of an analyte with its net intensity.

The calibration equation is developed using a least squares fit regression analysis. After the regression terms to be used in the equation are defined, a mathematical equation can be developed to calculate the analyte concentration in an unknown sample. In some FPXRF instruments, the software of the instrument calculates the regression equation. The software uses calculated intercept and slope values to form a multiterm equation. In conjunction with the software in the instrument, the operator can adjust the multiterm equation to minimize interelement interferences and optimize the intensity calibration curve.

It is possible to define up to six linear or nonlinear terms in the regression equation. Terms can be added and deleted to optimize the equation. The goal is to produce an equation with the smallest regression error and the highest correlation coefficient. These values are automatically computed by the software as the regression terms are added, deleted, or modified. It is also possible to delete data points from the regression line if these points are significant outliers or if they are heavily weighing the data. Once the regression equation has been selected for an analyte, the equation can be entered into the software for quantitation of analytes in subsequent samples. For an empirical calibration to be acceptable, the regression equation for a specific analyte should have a correlation coefficient of 0.98 or greater or meet the DQOs of the project.

In an empirical calibration, one must apply the DQOs of the project and ascertain critical or action levels for the analytes of interest. It is within these concentration ranges or around these action levels that the FPXRF instrument should be calibrated most accurately. It may not be possible to develop a good regression equation over several orders of analyte concentration.

10.4 Compton normalization method -- The Compton normalization method is based on analysis of a single, certified standard and normalization for the Compton peak. The Compton peak is produced from incoherent backscattering of x-ray radiation from the excitation source and is present in the spectrum of every sample. The Compton peak intensity changes with differing matrices. Generally, matrices dominated by lighter elements produce a larger Compton peak, and those dominated by heavier elements produce a smaller Compton peak. Normalizing to the Compton peak can reduce problems with varying matrix effects among samples. Compton normalization is similar to the use of internal standards in organics analysis. The Compton normalization method may not be effective when analyte concentrations exceed a few percent.

The certified standard used for this type of calibration could be an NIST SRM such as 2710 or 2711. The SRM must be a matrix similar to the samples and must contain the analytes of interests at concentrations near those expected in the samples. First, a response factor has to be determined for each analyte. This factor is calculated by dividing the net peak intensity by the analyte concentration. The net peak intensity is gross intensity corrected for baseline reading. Concentrations of analytes in samples are then determined by multiplying the baseline corrected analyte signal intensity by the normalization factor and by the response factor. The normalization factor is the quotient of the baseline corrected Compton K_α peak intensity of the SRM divided by that of the samples. Depending on the FPXRF instrument used, these calculations may be done manually or by the instrument software.

11.0 PROCEDURE

11.1 Operation of the various FPXRF instruments will vary according to the manufacturers' protocols. Before operating any FPXRF instrument, one should consult the manufacturer's manual. Most manufacturers recommend that their instruments be allowed to warm up for 15 to 30 minutes before analysis of samples. This will help alleviate drift or energy calibration problems later during analysis.

11.2 Each FPXRF instrument should be operated according to the manufacturer's recommendations. There are two modes in which FPXRF instruments can be operated: in situ and intrusive. The in situ mode involves analysis of an undisturbed soil sediment or sample. Intrusive analysis involves collection and preparation of a soil or sediment sample before analysis. Some FPXRF instruments can operate in both modes of analysis, while others are designed to operate in only one mode. The two modes of analysis are discussed below.

11.3 For in situ analysis, remove any large or nonrepresentative debris from the soil surface before analysis. This debris includes rocks, pebbles, leaves, vegetation, roots, and concrete. Also, the soil surface must be as smooth as possible so that the probe window will have good contact with the surface. This may require some leveling of the surface with a stainless-steel trowel. During the study conducted to provide example performance data for this method, this modest amount of sample preparation was found to take less than 5 min per sample location. The last requirement is that the soil or sediment not be saturated with water. Manufacturers state that their FPXRF instruments will perform adequately for soils with moisture contents of 5 to 20 percent but will not perform well for saturated soils, especially if ponded water exists on the surface. Another recommended technique for in situ analysis is to tamp the soil to increase soil density and compactness for better repeatability and representativeness. This condition is especially important for heavy element analysis, such as barium. Source count times for in situ analysis usually range from 30 to 120 seconds, but source count times will vary among instruments and depending on the desired method sensitivity. Due to the heterogeneous nature of the soil sample, in situ analysis can provide only “screening” type data.

11.4 For intrusive analysis of surface or sediment, it is recommended that a sample be collected from a 4- by 4-inch square that is 1 inch deep. This will produce a soil sample of approximately 375 g or 250 cm^3, which is enough soil to fill an 8-ounce jar. However, the exact dimensions and sample depth should take into consideration the heterogeneous deposition of contaminants and will ultimately depend on the desired project-specific data quality objectives. The sample should be homogenized, dried, and ground before analysis. The sample can be homogenized before or after drying. The homogenization technique to be used after drying is discussed in Sec. 4.2. If the sample is homogenized before drying, it should be thoroughly mixed in a beaker or similar container, or if the sample is moist and has a high clay content, it can be kneaded in a plastic bag. One way to monitor homogenization when the sample is kneaded in a plastic bag is to add sodium fluorescein dye to the sample. After the moist sample has been homogenized, it is examined under an ultraviolet light to assess the distribution of sodium fluorescein throughout the sample. If the fluorescent dye is evenly distributed in the sample, homogenization is considered complete; if the dye is not evenly distributed, mixing should continue until the sample has been thoroughly homogenized. During the study conducted to provide data for this method, the time necessary for homogenization procedure using the fluorescein dye ranged from 3 to 5 min per sample. As demonstrated in Secs. 13.5 and 13.7, homogenization has the greatest impact on the reduction of sampling variability. It produces little or no contamination. Often, the direct analysis through the plastic bag is possible without the more labor intensive steps of drying, grinding, and sieving given in Secs. 11.5 and 11.6. Of course, to achieve the best data quality possible all four steps should be followed.

11.5 Once the soil or sediment sample has been homogenized, it should be dried. This can be accomplished with a toaster oven or convection oven. A small aliquot of the sample (20 to 50 g) is placed in a suitable container for drying. The sample should be dried for 2 to 4 hr in the convection or toaster oven at a temperature not greater than 150 °C. Samples may also be air dried under ambient temperature conditions using a 10- to 20-g portion. Regardless of what drying mechanism is used, the drying process is considered complete when a constant sample weight can be obtained. Care should be taken to avoid sample cross-contamination and these measures can be evaluated by including an appropriate method blank sample along with any sample preparation process.

CAUTION: Microwave drying is not a recommended procedure. Field studies have shown that microwave drying can increase variability between the FPXRF data and confirmatory analysis. High levels of metals in a sample can cause arcing in the microwave oven, and sometimes slag forms in the sample. Microwave oven drying can also melt plastic containers used to hold the sample.

11.6 The homogenized dried sample material should be ground with a mortar and pestle and passed through a 60-mesh sieve to achieve a uniform particle size. Sample grinding should continue until at least 90 percent of the original sample passes through the sieve. The grinding step normally takes an average of 10 min per sample. An aliquot of the sieved sample should then be placed in a 31.0-mm polyethylene sample cup (or equivalent) for analysis. The sample cup should be one-half to three-quarters full at a minimum. The sample cup should be covered with a 2.5 µm Mylar (or equivalent) film for analysis. The rest of the soil sample should be placed in a jar, labeled, and archived for possible confirmation analysis. All equipment including the mortar, pestle, and sieves must be thoroughly cleaned so that any cross-contamination is below the established lower limit of detection of the procedure or DQOs of the analysis. If all recommended sample preparation steps are followed, there is a high probability the desired laboratory data quality may be obtained.

12.0 DATA ANALYSIS AND CALCULATIONS

Most FPXRF instruments have software capable of storing all analytical results and spectra. The results are displayed in ppm and can be downloaded to a personal computer, which can be used to provide a hard copy printout. Individual measurements that are smaller than three times their associated SD should not be used for quantitation. See the manufacturer's instructions regarding data analysis and calculations.

13.0 METHOD PERFORMANCE

13.1 Performance data and related information are provided in SW-846 methods only as examples and guidance. The data do not represent required performance criteria for users of the methods. Instead, performance criteria should be developed on a project-specific basis, and the laboratory should establish in-house QC performance criteria for the application of this method. These performance data are not intended to be and must not be used as absolute QC acceptance criteria for purposes of laboratory accreditation.

13.2 The sections to follow discuss three performance evaluation factors; namely, precision, accuracy, and comparability. The example data presented in Tables 4 through 8 were generated from results obtained from six FPXRF instruments (see Sec. 13.3). The soil samples analyzed by the six FPXRF instruments were collected from two sites in the United States. The soil samples contained several of the target analytes at concentrations ranging from "nondetect" to tens of thousands of mg/kg. These data are provided for guidance purposes only.

13.3 The six FPXRF instruments included the TN 9000 and TN Lead Analyzer manufactured by TN Spectrace; the X-MET 920 with a SiLi detector and X-MET 920 with a gas-filled proportional detector manufactured by Metorex, Inc.; the XL Spectrum Analyzer manufactured by Niton; and the MAP Spectrum Analyzer manufactured by Scitec. The TN 9000 and TN Lead Analyzer both have a HgI_2 detector. The TN 9000 utilized an Fe-55, Cd-109, and Am-241 source. The TN Lead Analyzer had only a Cd-109 source. The X-Met 920 with the SiLi detector had a Cd-109 and Am-241 source. The X-MET 920 with the gas-filled proportional detector had only a Cd-109 source. The XL Spectrum Analyzer utilized a silicon pin-diode detector and a Cd-109 source. The MAP Spectrum Analyzer utilized a solid-state silicon detector and a Cd-109 source.

13.4 All example data presented in Tables 4 through 8 were generated using the following calibrations and source count times. The TN 9000 and TN Lead Analyzer were calibrated using fundamental parameters using NIST SRM 2710 as a calibration check sample. The TN 9000 was operated using 100, 60, and 60 second count times for the Cd-109, Fe-55, and Am-241 sources, respectively. The TN Lead analyzer was operated using a 60 second count time for the Cd-109 source. The X-MET 920 with the Si(Li) detector was calibrated using fundamental parameters and one well characterized site-specific soil standard as a calibration check. It used 140 and 100 second count times for the Cd-109 and Am-241 sources, respectively. The X-MET 920 with the gas-filled proportional detector was calibrated empirically using between 10 and 20 well characterized site-specific soil standards. It used 120 second times for the Cd-109 source. The XL Spectrum Analyzer utilized NIST SRM 2710 for calibration and the Compton peak normalization procedure for quantitation based on 60 second count times for the Cd-109 source. The MAP Spectrum Analyzer was internally calibrated by the manufacturer. The calibration was checked using a well-characterized site-specific soil standard. It used 240 second times for the Cd-109 source.

13.5 Precision measurements -- The example precision data are presented in Table 4. These data are provided for guidance purposes only. Each of the six FPXRF instruments performed 10 replicate measurements on 12 soil samples that had analyte concentrations ranging from "nondetects" to thousands of mg/kg. Each of the 12 soil samples underwent 4 different preparation techniques from in situ (no preparation) to dried and ground in a sample cup. Therefore, there were 48 precision data points for five of the instruments and 24 precision points for the MAP Spectrum Analyzer. The replicate measurements were taken using the source count times discussed at the beginning of this section.

For each detectable analyte in each precision sample a mean concentration, standard deviation, and RSD was calculated for each analyte. The data presented in Table 4 is an average RSD for the precision samples that had analyte concentrations at 5 to 10 times the lower limit of detection for that analyte for each instrument. Some analytes such as mercury, selenium, silver, and thorium were not detected in any of the precision samples so these analytes are not listed in Table 4. Some analytes such as cadmium, nickel, and tin were only detected at concentrations near the lower limit of detection so that an RSD value calculated at 5 to 10 times this limit was not possible.

One FPXRF instrument collected replicate measurements on an additional nine soil samples to provide a better assessment of the effect of sample preparation on precision. Table 5 shows these results. These data are provided for guidance purposes only. The additional nine soil samples were comprised of three from each texture and had analyte concentrations ranging from near the lower limit of detection for the FPXRF analyzer to thousands of mg/kg. The FPXRF analyzer only collected replicate measurements from three of the preparation methods; no measurements were collected from the in situ homogenized samples. The FPXRF analyzer conducted five replicate measurements of the in situ field samples by taking measurements at five different points within the 4-inch by 4-inch sample square. Ten replicate measurements were collected for both the intrusive undried and unground and intrusive dried and ground samples contained in cups. The cups were shaken between each replicate measurement.

Table 5 shows that the precision dramatically improved from the in situ to the intrusive measurements. In general there was a slight improvement in precision when the sample was dried and ground. Two factors caused the precision for the in situ measurements to be poorer. The major factor is soil heterogeneity. By moving the probe within the 4-inch by 4-inch square, measurements of different soil samples were actually taking place within the square. Table 5 illustrates the dominant effect of soil heterogeneity. It overwhelmed instrument precision when the FPXRF analyzer was used in this mode. The second factor that caused the RSD values to be higher for the in situ measurements is the fact that only five instead of ten replicates were taken. A lesser number of measurements caused the standard deviation to be larger which in turn elevated the RSD values.

13.6 Accuracy measurements -- Five of the FPXRF instruments (not including the MAP Spectrum Analyzer) analyzed 18 SRMs using the source count times and calibration methods given at the beginning of this section. The 18 SRMs included 9 soil SRMs, 4 stream or river sediment SRMs, 2 sludge SRMs, and 3 ash SRMs. Each of the SRMs contained known concentrations of certain target analytes. A percent recovery was calculated for each analyte in each SRM for each FPXRF instrument. Table 6 presents a summary of this data. With the exception of cadmium, chromium, and nickel, the values presented in Table 6 were generated from the 13 soil and sediment SRMs only. The 2 sludge and 3 ash SRMs were included for cadmium, chromium, and nickel because of the low or nondetectable concentrations of these three analytes in the soil and sediment SRMs.

Only 12 analytes are presented in Table 6. These are the analytes that are of environmental concern and provided a significant number of detections in the SRMs for an accuracy assessment. No data is presented for the X-MET 920 with the gas-filled proportional detector. This FPXRF instrument was calibrated empirically using site-specific soil samples. The percent recovery values from this instrument were very sporadic and the data did not lend itself to presentation in Table 6.

Table 7 provides a more detailed summary of accuracy data for one particular FPXRF instrument (TN 9000) for the 9 soil SRMs and 4 sediment SRMs. These data are provided for guidance purposes only. Table 7 shows the certified value, measured value, and percent recovery for five analytes. These analytes were chosen because they are of environmental concern and were most prevalently certified for in the SRM and detected by the FPXRF instrument. The first nine SRMs are soil and the last 4 SRMs are sediment. Percent recoveries for the four NIST SRMs were often between 90 and 110 percent for all analytes.

13.7 Comparability -- Comparability refers to the confidence with which one data set can be compared to another. In this case, FPXRF data generated from a large study of six FPXRF instruments was compared to SW-846 Methods 3050 and 6010 which are the standard soil extraction for metals and analysis by inductively coupled plasma. An evaluation of comparability was conducted by using linear regression analysis. Three factors were determined using the linear regression. These factors were the y-intercept, the slope of the line, and the coefficient of determination (r^2).

As part of the comparability assessment, the effects of soil type and preparation methods were studied. Three soil types (textures) and four preparation methods were examined during the study. The preparation methods evaluated the cumulative effect of particle size, moisture, and homogenization on comparability. Due to the large volume of data produced during this study, linear regression data for six analytes from only one FPXRF instrument is presented in Table 8. Similar trends in the data were seen for all instruments. These data are provided for guidance purposes only.

Table 8 shows the regression parameters for the whole data set, broken out by soil type, and by preparation method. These data are provided for guidance purposes only. The soil types are as follows: soil 1--sand; soil 2--loam; and soil 3--silty clay. The preparation methods are as follows: preparation 1--in situ in the field; preparation 2--intrusive, sample collected and homogenized; preparation 3--intrusive, with sample in a sample cup but sample still wet and not ground; and preparation 4–intrusive, with sample dried, ground, passed through a 40-mesh sieve, and placed in sample cup.

For arsenic, copper, lead, and zinc, the comparability to the confirmatory laboratory was excellent with r^2 values ranging from 0.80 to 0.99 for all six FPXRF instruments. The slopes of the regression lines for arsenic, copper, lead, and zinc, were generally between 0.90 and 1.00 indicating the data would need to be corrected very little or not at all to match the confirmatory laboratory data. The r^2 values and slopes of the regression lines for barium and chromium were not as good as for the other for analytes, indicating the data would have to be corrected to match the confirmatory laboratory.

Table 8 demonstrates that there was little effect of soil type on the regression parameters for any of the six analytes. The only exceptions were for barium in soil 1 and copper in soil 3. In both of these cases, however, it is actually a concentration effect and not a soil effect causing the poorer comparability. All barium and copper concentrations in soil 1 and 3, respectively, were less than 350 mg/kg.

Table 8 shows there was a preparation effect on the regression parameters for all six analytes. With the exception of chromium, the regression parameters were primarily improved going from preparation 1 to preparation 2. In this step, the sample was removed from the soil surface, all large debris was removed, and the sample was thoroughly homogenized. The additional two preparation methods did little to improve the regression parameters. This data indicates that homogenization is the most critical factor when comparing the results. It is essential that the sample sent to the confirmatory laboratory match the FPXRF sample as closely as possible.

Sec. 11.0 of this method discusses the time necessary for each of the sample preparation techniques. Based on the data quality objectives for the project, an analyst must decide if it is worth the extra time necessary to dry and grind the sample for small improvements in comparability. Homogenization requires 3 to 5 min. Drying the sample requires one to two hours. Grinding and sieving requires another 10 to 15 min per sample. Lastly, when grinding and sieving is conducted, time has to be allotted to decontaminate the mortars, pestles, and sieves. Drying and grinding the samples and decontamination procedures will often dictate that an extra person be on site so that the analyst can keep up with the sample collection crew. The cost of requiring an extra person on site to prepare samples must be balanced with the gain in data quality and sample throughput.

13.8 The following documents may provide additional guidance and insight on this method and technique:

13.8.1 A. D. Hewitt, "Screening for Metals by X-ray Fluorescence Spectrometry/Response Factor/Compton K_α Peak Normalization Analysis," American Environmental Laboratory, pp 24-32, 1994.

13.8.2 S. Piorek and J. R. Pasmore, "Standardless, In Situ Analysis of Metallic Contaminants in the Natural Environment With a PC-Based, High Resolution Portable X-Ray Analyzer," Third International Symposium on Field Screening Methods for Hazardous Waste and Toxic Chemicals, Las Vegas, Nevada, February 24-26, 1993, Vol 2, pp 1135-1151, 1993.

13.8.3 S. Shefsky, "Sample Handling Strategies for Accurate Lead-in-soil Measurements in the Field and Laboratory," *International Symposium of Field Screening Methods for Hazardous Waste and Toxic Chemicals*, Las Vegas, NV, January 29-31, 1997.

14.0 POLLUTION PREVENTION

14.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity and/or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in laboratory operation. The EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address their waste generation. When wastes cannot be feasibly reduced at the source, the Agency recommends recycling as the next best option.

14.2 For information about pollution prevention that may be applicable to laboratories and research institutions consult *Less is Better: Laboratory Chemical Management for Waste Reduction* available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th St., N.W. Washington, D.C. 20036, http://www.acs.org.

15.0 WASTE MANAGEMENT

The Environmental Protection Agency requires that laboratory waste management practices be conducted consistent with all applicable rules and regulations. The Agency urges laboratories to protect the air, water, and land by minimizing and controlling all releases from hoods and bench operations, complying with the letter and spirit of any sewer discharge permits and regulations, and by complying with all solid and hazardous waste regulations, particularly the hazardous waste identification rules and land disposal restrictions. For further information on waste management, consult *The Waste Management Manual for Laboratory Personnel* available from the American Chemical Society at the address listed in Sec. 14.2.

16.0 REFERENCES

1. Metorex, X-MET 920 User's Manual.

2. Spectrace Instruments, "Energy Dispersive X-ray Fluorescence Spectrometry: An Introduction," 1994.

3. TN Spectrace, Spectrace 9000 Field Portable/Benchtop XRF Training and Applications Manual.

4. Unpublished SITE data, received from PRC Environment Management, Inc.

17.0 TABLES, DIAGRAMS, FLOWCHARTS, AND VALIDATION DATA

The following pages contain the tables referenced by this method. A flow diagram of the procedure follows the tables.

TABLE 1

EXAMPLE INTERFERENCE FREE LOWER LIMITS OF DETECTION

Analyte	Chemical Abstract Series Number	Lower Limit of Detection in Quartz Sand (milligrams per kilogram)
Antimony (Sb)	7440-36-0	40
Arsenic (As)	7440-38-0	40
Barium (Ba)	7440-39-3	20
Cadmium (Cd)	7440-43-9	100
Calcium (Ca)	7440-70-2	70
Chromium (Cr)	7440-47-3	150
Cobalt (Co)	7440-48-4	60
Copper (Cu)	7440-50-8	50
Iron (Fe)	7439-89-6	60
Lead (Pb)	7439-92-1	20
Manganese (Mn)	7439-96-5	70
Mercury (Hg)	7439-97-6	30
Molybdenum (Mo)	7439-93-7	10
Nickel (Ni)	7440-02-0	50
Potassium (K)	7440-09-7	200
Rubidium (Rb)	7440-17-7	10
Selenium (Se)	7782-49-2	40
Silver (Ag)	7440-22-4	70
Strontium (Sr)	7440-24-6	10
Thallium (Tl)	7440-28-0	20
Thorium (Th)	7440-29-1	10
Tin (Sn)	7440-31-5	60
Titanium (Ti)	7440-32-6	50
Vanadium (V)	7440-62-2	50
Zinc (Zn)	7440-66-6	50
Zirconium (Zr)	7440-67-7	10

Source: Refs. 1, 2, and 3
These data are provided for guidance purposes only.

TABLE 2

SUMMARY OF RADIOISOTOPE SOURCE CHARACTERISTICS

Source	Activity (mCi)	Half-Life (Years)	Excitation Energy (keV)	Elemental Analysis Range	
Fe-55	20-50	2.7	5.9	Sulfur to Chromium	K Lines
				Molybdenum to Barium	L Lines
Cd-109	5-30	1.3	22.1 and 87.9	Calcium to Rhodium	K Lines
				Tantalum to Lead	K Lines
				Barium to Uranium	L Lines
Am-241	5-30	432	26.4 and 59.6	Copper to Thulium	K Lines
				Tungsten to Uranium	L Lines
Cm-244	60-100	17.8	14.2	Titanium to Selenium	K Lines
				Lanthanum to Lead	L Lines

Source: Refs. 1, 2, and 3

TABLE 3

SUMMARY OF X-RAY TUBE SOURCE CHARACTERISTICS

Anode Material	Recommended Voltage Range (kV)	K-alpha Emission (keV)	Elemental Analysis Range	
Cu	18-22	8.04	Potassium to Cobalt	K Lines
			Silver to Gadolinium	L Lines
Mo	40-50	17.4	Cobalt to Yttrium	K Lines
			Europium to Radon	L Lines
Ag	50-65	22.1	Zinc to Technicium	K Lines
			Ytterbium to Neptunium	L Lines

Source: Ref. 4

Notes: The sample elements excited are chosen by taking as the lower limit the same ratio of excitation line energy to element absorption edge as in Table 2 (approximately 0.45) and the requirement that the excitation line energy be above the element absorption edge as the upper limit (L2 edges used for L lines). K-beta excitation lines were ignored.

TABLE 4

EXAMPLE PRECISION VALUES

Analyte	Average Relative Standard Deviation for Each Instrument at 5 to 10 Times the Lower Limit of Detection					
	TN 9000	TN Lead Analyzer	X-MET 920 (SiLi Detector)	X-MET 920 (Gas-Filled Detector)	XL Spectrum Analyzer	MAP Spectrum Analyzer
Antimony	6.54	NR	NR	NR	NR	NR
Arsenic	5.33	4.11	3.23	1.91	12.47	6.68
Barium	4.02	NR	3.31	5.91	NR	NR
Cadmium	29.84[a]	NR	24.80[a]	NR	NR	NR
Calcium	2.16	NR	NR	NR	NR	NR
Chromium	22.25	25.78	22.72	3.91	30.25	NR
Cobalt	33.90	NR	NR	NR	NR	NR
Copper	7.03	9.11	8.49	9.12	12.77	14.86
Iron	1.78	1.67	1.55	NR	2.30	NR
Lead	6.45	5.93	5.05	7.56	6.97	12.16
Manganese	27.04	24.75	NR	NR	NR	NR
Molybdenum	6.95	NR	NR	NR	12.60	NR
Nickel	30.85[a]	NR	24.92[a]	20.92[a]	NA	NR
Potassium	3.90	NR	NR	NR	NR	NR
Rubidium	13.06	NR	NR	NR	32.69[a]	NR
Strontium	4.28	NR	NR	NR	8.86	NR
Tin	24.32[a]	NR	NR	NR	NR	NR
Titanium	4.87	NR	NR	NR	NR	NR
Zinc	7.27	7.48	4.26	2.28	10.95	0.83
Zirconium	3.58	NR	NR	NR	6.49	NR

These data are provided for guidance purposes only.

Source: Ref. 4

[a] These values are biased high because the concentration of these analytes in the soil samples was near the lower limit of detection for that particular FPXRF instrument.

NR Not reported.

NA Not applicable; analyte was reported but was below the established lower limit detection.

TABLE 5

EXAMPLES OF PRECISION AS AFFECTED BY SAMPLE PREPARATION

Analyte	Average Relative Standard Deviation for Each Preparation Method		
	In Situ-Field	Intrusive-Undried and Unground	Intrusive-Dried and Ground
Antimony	30.1	15.0	14.4
Arsenic	22.5	5.36	3.76
Barium	17.3	3.38	2.90
Cadmium[a]	41.2	30.8	28.3
Calcium	17.5	1.68	1.24
Chromium	17.6	28.5	21.9
Cobalt	28.4	31.1	28.4
Copper	26.4	10.2	7.90
Iron	10.3	1.67	1.57
Lead	25.1	8.55	6.03
Manganese	40.5	12.3	13.0
Mercury	ND	ND	ND
Molybdenum	21.6	20.1	19.2
Nickel[a]	29.8	20.4	18.2
Potassium	18.6	3.04	2.57
Rubidium	29.8	16.2	18.9
Selenium	ND	20.2	19.5
Silver[a]	31.9	31.0	29.2
Strontium	15.2	3.38	3.98
Thallium	39.0	16.0	19.5
Thorium	NR	NR	NR
Tin	ND	14.1	15.3
Titanium	13.3	4.15	3.74
Vanadium	NR	NR	NR
Zinc	26.6	13.3	11.1
Zirconium	20.2	5.63	5.18

These data are provided for guidance purposes only.
Source: Ref. 4

[a] These values may be biased high because the concentration of these analytes in the soil samples was near the lower limit of detection.

ND Not detected.
NR Not reported.

TABLE 6

EXAMPLE ACCURACY VALUES

Analyte	Instrument															
	TN 9000				TN Lead Analyzer				X-MET 920 (SiLi Detector)				XL Spectrum Analyzer			
	n	Range of % Rec.	Mean % Rec.	SD	n	Range of % Rec.	Mean % Rec.	SD	n	Range of % Rec.	Mean % Rec	SD	n	Range of % Rec.	Mean % Rec.	SD
Sb	2	100-149	124.3	NA	--	--	--	--	--	--	--	--	--	--	--	--
As	5	68-115	92.8	17.3	5	44-105	83.4	23.2	4	9.7-91	47.7	39.7	5	38-535	189.8	206
Ba	9	98-198	135.3	36.9	--	--	--	--	9	18-848	168.2	262	--	--	--	--
Cd	2	99-129	114.3	NA	--	--	--	--	6	81-202	110.5	45.7	--	--	--	--
Cr	2	99-178	138.4	NA	--	--	--	--	7	22-273	143.1	93.8	3	98-625	279.2	300
Cu	8	61-140	95.0	28.8	6	38-107	79.1	27.0	11	10-210	111.8	72.1	8	95-480	203.0	147
Fe	6	78-155	103.7	26.1	6	89-159	102.3	28.6	6	48-94	80.4	16.2	6	26-187	108.6	52.9
Pb	11	66-138	98.9	19.2	11	68-131	97.4	18.4	12	23-94	72.7	20.9	13	80-234	107.3	39.9
Mn	4	81-104	93.1	9.70	3	92-152	113.1	33.8	--	--	--	--	--	--	--	--
Ni	3	99-122	109.8	12.0	--	--	--	--	--	--	--	--	3	57-123	87.5	33.5
Sr	8	110-178	132.6	23.8	--	--	--	--	--	--	--	--	7	86-209	125.1	39.5
Zn	11	41-130	94.3	24.0	10	81-133	100.0	19.7	12	46-181	106.6	34.7	11	31-199	94.6	42.5

Source: Ref. 4. These data are provided for guidance purposes only.

n:	Number of samples that contained a certified value for the analyte and produced a detectable concentration from the FPXRF instrument.
SD:	Standard deviation; NA: Not applicable; only two data points, therefore, a SD was not calculated.
%Rec.:	Percent recovery.
--	No data.

TABLE 7

EXAMPLE ACCURACY FOR TN 9000[a]

Standard Reference Material	Arsenic			Barium			Copper			Lead			Zinc		
	Cert. Conc.	Meas. Conc.	%Rec.	Cert. Conc.	Meas. Conc.	%Rec.	Cert. Conc.	Meas. Conc.	%Rec.	Cert. Conc.	Meas. Conc.	%Rec.	Cert. Conc.	Meas. Conc.	%Rec.
RTC CRM-021	24.8	ND	NA	586	1135	193.5	4792	2908	60.7	144742	149947	103.6	546	224	40.9
RTC CRM-020	397	429	92.5	22.3	ND	NA	753	583	77.4	5195	3444	66.3	3022	3916	129.6
BCR CRM 143R	--	--	--	--	--	--	131	105	80.5	180	206	114.8	1055	1043	99.0
BCR CRM 141	--	--	--	--	--	--	32.6	ND	NA	29.4	ND	NA	81.3	ND	NA
USGS GXR-2	25.0	ND	NA	2240	2946	131.5	76.0	106	140.2	690	742	107.6	530	596	112.4
USGS GXR-6	330	294	88.9	1300	2581	198.5	66.0	ND	NA	101	80.9	80.1	118	ND	NA
NIST 2711	105	104	99.3	726	801	110.3	114	ND	NA	1162	1172	100.9	350	333	94.9
NIST 2710	626	722	115.4	707	782	110.6	2950	2834	96.1	5532	5420	98.0	6952	6476	93.2
NIST 2709	17.7	ND	NA	968	950	98.1	34.6	ND	NA	18.9	ND	NA	106	98.5	93.0
NIST 2704	23.4	ND	NA	414	443	107.0	98.6	105	106.2	161	167	103.5	438	427	97.4
CNRC PACS-1	211	143	67.7	--	772	NA	452	302	66.9	404	332	82.3	824	611	74.2
SARM-51	--	--	--	335	466	139.1	268	373	139.2	5200	7199	138.4	2200	2676	121.6
SARM-52	--	--	--	410	527	128.5	219	193	88.1	1200	1107	92.2	264	215	81.4

Source: Ref. 4. These data are provided for guidance purposes only.

[a] All concentrations in milligrams per kilogram.

%Rec.: Percent recovery; ND: Not detected; NA: Not applicable.

-- No data.

TABLE 8

EXAMPLE REGRESSION PARAMETERS FOR COMPARABILITY[1]

	Arsenic				Barium				Copper			
	n	r^2	Int.	Slope	n	r^2	Int.	Slope	n	r^2	Int.	Slope
All Data	824	0.94	1.62	0.94	1255	0.71	60.3	0.54	984	0.93	2.19	0.93
Soil 1	368	0.96	1.41	0.95	393	0.05	42.6	0.11	385	0.94	1.26	0.99
Soil 2	453	0.94	1.51	0.96	462	0.56	30.2	0.66	463	0.92	2.09	0.95
Soil 3	—	—	—	—	400	0.85	44.7	0.59	136	0.46	16.60	0.57
Prep 1	207	0.87	2.69	0.85	312	0.64	53.7	0.55	256	0.87	3.89	0.87
Prep 2	208	0.97	1.38	0.95	315	0.67	64.6	0.52	246	0.96	2.04	0.93
Prep 3	204	0.96	1.20	0.99	315	0.78	64.6	0.53	236	0.97	1.45	0.99
Prep 4	205	0.96	1.45	0.98	313	0.81	58.9	0.55	246	0.96	1.99	0.96

	Lead				Zinc				Chromium			
	n	r^2	Int.	Slope	n	r^2	Int.	Slope	n	r^2	Int.	Slope
All Data	1205	0.92	1.66	0.95	1103	0.89	1.86	0.95	280	0.70	64.6	0.42
Soil 1	357	0.94	1.41	0.96	329	0.93	1.78	0.93	—	—	—	—
Soil 2	451	0.93	1.62	0.97	423	0.85	2.57	0.90	—	—	—	—
Soil 3	397	0.90	2.40	0.90	351	0.90	1.70	0.98	186	0.66	38.9	0.50
Prep 1	305	0.80	2.88	0.86	286	0.79	3.16	0.87	105	0.80	66.1	0.43
Prep 2	298	0.97	1.41	0.96	272	0.95	1.86	0.93	77	0.51	81.3	0.36
Prep 3	302	0.98	1.26	0.99	274	0.93	1.32	1.00	49	0.73	53.7	0.45
Prep 4	300	0.96	1.38	1.00	271	0.94	1.41	1.01	49	0.75	31.6	0.56

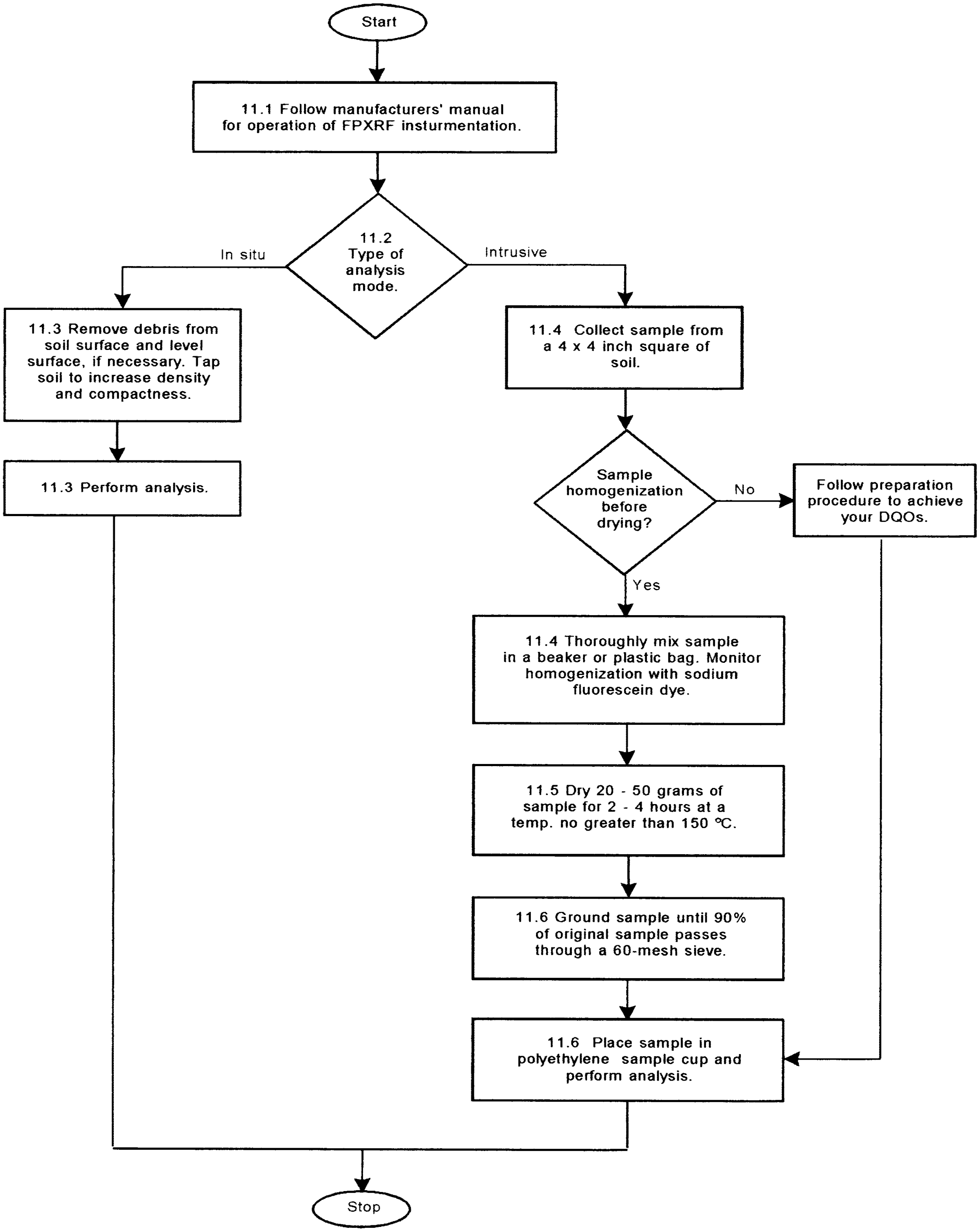
Source: Ref. 4. These data are provided for guidance purposes only.

[1] Log-transformed data

n: Number of data points; r^2: Coefficient of determination; Int.: Y-intercept

— No applicable data

FIELD PORTABLE X-RAY FLUORESCENCE SPECTROMETRY FOR THE DETERMINATION OF ELEMENTAL CONCENTRATIONS IN SOIL AND SEDIMENT



LEAD by Flame AAS

7082

Pb	MW:	207.19 (Pb) 223.19 (PbO)	CAS:	7439-92-1 (Pb) 1317-36-8 (PbO)	RTECS:	OF7525000 (Pb) OG1750000 (PbO)

METHOD: 7082, Issue 2

EVALUATION: FULL

Issue 1: 15 February 1984 Issue 2: 15 August 1994

OSHA : 0.05 mg/m^3
NIOSH: <0.1 mg/m^3; blood Pb $\leq$60 µg/100 g
ACGIH: 0.05 mg/m^3

PROPERTIES: soft metal;
d 11.3 g/cm^3; MP 327.5 °C
valences +2, +4 in salts

SYNONYMS: elemental lead and lead compounds except alkyl lead

SAMPLING

SAMPLER:	FILTER (0.8-µm cellulose ester membrane)
FLOW RATE:	1 to 4 L/min
VOL-MIN: **-MAX:**	200 L @ 0.05 mg/m^3 1500 L
SHIPMENT:	routine
SAMPLE STABILITY:	stable
BLANKS:	2 to 10 field blanks per set

ACCURACY

RANGE STUDIED:	0.13 to 0.4 mg/m^3 [1]; 0.15 to 1.7 mg/m^3 (fume) [2]
BIAS:	− 3.1%
OVERALL PRECISION($\hat{S}_{rT}$):	0.072 [1]; 0.068 (fume) [2]
ACCURACY:	± 17.6%

MEASUREMENT

TECHNIQUE:	ATOMIC ABSORPTION SPECTROPHOTOMETER, FLAME
ANALYTE:	lead
ASHING:	conc. HNO_3, 6 mL + 30% H_2O_2, 1 mL; 140 °C
FINAL SOLUTION:	10% HNO_3, 10 mL
FLAME:	air-acetylene, oxidizing
WAVELENGTH:	283.3 nm
BACKGROUND CORRECTION:	D_2 or H_2 lamp, or Zeeman
CALIBRATION:	Pb^{2+} in 10% HNO_3
RANGE	10 to 200 µg per sample [2,3]
ESTIMATED LOD:	2.6 µg per sample [4]
PRECISION ($\bar{S}_r$):	0.03 [1]

APPLICABILITY: The working range is 0.05 to >1 mg/m^3 for a 200-L air sample. The method is applicable to elemental lead, including Pb fume, and all other aerosols containing lead. This is an elemental analysis, not compound specific. Aliquots of the samples can be analyzed separately for additional elements.

INTERFERENCES: Use D_2 or H_2 continuum or Zeeman background correction to control flame or molecular absorption. High concentrations of calcium, sulfate, carbonate, phosphate, iodide, fluoride, or acetate can be corrected.

OTHER METHODS: This method combines and replaces P&CAM 173 [3] and S341 [4,5] for lead. Method 7300 (ICP-AES) and 7105 (AAS/GF) are alternate analytical methods. Method 7505 is specific for lead sulfide. The following have not been revised: the dithizone method, which appears in P&CAM 102 [5] and the lead criteria document [6]; and P&CAM 191 (ASV) [7].

REAGENTS:

1. Nitric acid, conc.*
2. Nitric acid, 10% (v/v). Add 100 mL conc. HNO_3 to 500 mL water; dilute to 1 L.
3. Hydrogen peroxide, 30% H_2O_2 (w/w), reagent grade.*
4. Calibration stock solution, 1000 µg/mL Pb. Commercial standard or dissolve 1.00 g Pb metal in minimum volume of (1+1) HCl and dilute to 1 L with 1% (v/v) HCl. Store in a polyethylene bottle. Stable ≥ one year.
5. Air, compressed, filtered.
6. Acetylene
7. Distilled or deionized water.

* See SPECIAL PRECAUTIONS.

EQUIPMENT:

1. Sampler: Cellulose ester filter, 0.8-µm pore size, 37-mm diameter, in cassette filter holder.
2. Personal sampling pump, 1 to 4 L/min, with flexible connecting tubing.
3. Atomic Absorption Spectrophotometer with an air-acetylene burner head and background correction.
4. Lead hollow cathode lamp or electrode dischargeless lamp.
5. Regulators, two-stage, for air and acetylene.
6. Beakers, Phillips, 125-mL, or Griffin, 50-mL with watchglass covers.**
7. Volumetric flasks, 10- and 100-mL.**
8. Assorted volumetric pipets as needed.**
9. Hotplate, surface temperature 140°C.
10. Bottles, polyethylene, 100-mL.

** Clean all glassware with conc. nitric acid and rinse thoroughly with distilled or deionized water before use.

SPECIAL PRECAUTIONS: Concentrated nitric acid is an irritant and may burn skin. Perform all acid digestions in a fume hood. Hydrogen peroxide is a strong oxidizing agent, a strong irritant, and corrosive to the skin. Wear gloves and eye protection.

SAMPLING:

1. Calibrate each personal sampling pump with a representative sampler in line.
2. Sample at an accurately known flow rate between 1 and 4 L/min for up to 8 h for a total sample size of 200 to 1500 L for TWA measurements. Do not exceed a filter loading of ca. 2 mg total dust.

SAMPLE PREPARATION:

NOTE 1: The following sample preparation gave quantitative recovery (see EVALUATION OF METHOD) [4]. Steps 4 through 9 of Method 7300 or other quantitative ashing techniques may be substituted, especially if several metals are to be determined on a single filter.

NOTE 2: The Appendix gives a microwave digestion procedure which may be necessary for complete recovery of lead from some matrices, especially epoxy-based paint.

3. Open the cassette filter holders and transfer the samples and blanks to clean beakers.
4. Add 3 mL conc. HNO_3, and 1 mL 30% H_2O_2 and cover with a watchglass. Start reagent blanks at this step.
   NOTE: If PbO_2 is not present in the sample, the 30% H_2O_2 need not be added [2,4].
5. Heat on 140 °C hotplate until volume is reduced to about 0.5 mL.
6. Repeat two more times using 2 mL conc. HNO_3 and 1 mL 30% H_2O_2 each time.
7. Heat on 140 °C hotplate until ca. 0.5 mL liquid remains.
8. When sample is dry, rinse the watchglass and walls of the beaker with 3 to 5 mL 10% HNO_3 Allow the solution to evaporate to dryness.
9. Cool each beaker and dissolve the residues in 1 mL conc. HNO_3
10. Transfer the solution quantitatively to a 10-mL volumetric flask and dilute to volume with distilled water.

NOTE: If the concentration (M) of any of the following is expected to exceed the lead concentration (M) by 10-fold or more, add 1 mL 1 M Na_2EDTA to each flask before dilution to volume: CO_3^{2-}, PO_4^{3-}, I^-, F^-, CH_3COO^-. If Ca^{2+} or SO_4^{2-} are present in 10-fold or greater excess, make all standards and samples 1% (w/w) in La^{2+} [3].

CALIBRATION AND QUALITY CONTROL:

11. Prepare a series of working standards covering the range 0.25 to 20 µg/mL Pb (2.5 to 200 µg Pb per sample).
    a. Add aliquots of calibration stock solution to 100-mL volumetric flasks. Dilute to volume with 10% HNO_3. Store the working standards in polyethylene bottles and prepare fresh weekly.
    b. Analyze the working standards together with the blanks and samples (steps 14 and 15).
    c. Prepare a calibration graph of absorbance vs. solution concentration (µg/mL).
12. Aspirate a standard for every 10 samples to check for instrument drift.
13. Check recoveries with at least one spiked media blank per 10 samples. Use method of standard additions occasionally to check for interferences.

MEASUREMENT:

14. Set spectrophotometer as specified by the manufacturer and to conditions on page 7082-1.
    NOTE: An alternate wavelength is 217.0 nm [8]. Analyses at 217.0 nm have slightly greater sensitivity, but poorer signal-to-noise ratio compared to 283.3 nm. Also, non-atomic absorption is significantly greater at 217.0 nm, making the use of D_2 or H_2 continuum, or Zeeman background correction mandatory at that wavelength.
15. Aspirate standards, samples, and blanks. Record absorbance readings.
    NOTE: If the absorbance values for the samples are above the linear range of the standards, dilute with 10% HNO_3, reanalyze, and apply the appropriate dilution factor in the calculations.

CALCULATIONS:

16. Using the measured absorbances, calculate the corresponding concentrations (µg/mL) of lead in the sample, C_s, and average media blank, C_b, from the calibration graph.
17. Using the solution volumes (mL) of the sample, V_s, and media blanks, V_b, calculate the concentration, C (mg/m^3), of lead in the air volume sampled, V (L):

$$C = \frac{C_sV_s - C_bV_b}{V}, \text{ mg/m}^3.$$

NOTE: µg/mL ≡ mg/m

EVALUATION OF METHOD:

Method S341 [9] was issued on October 24, 1975, and validated over the range 0.13 to 0.4 mg/m^3 for a 180-L air sample, using generated atmospheres of lead nitrate [1]. Recovery in the range 18 to 72 µg Pb per sample was 98%, and collection efficiency of 0.8-µm mixed cellulose ester filters (Millipore Type AA) was 100% for the aerosols. Subsequent studies on analytical recovery of 200 µg Pb per sample gave the following results [2,4]:

Species	Digestion Method	Analytical Recovery, %
Pb metal	HNO_3 only	92 ± 4
Pb metal	$HNO_3 + H_2O_2$	103 ± 3
PbO	HNO_3 only	93 ± 4
PbS	HNO_3 only	93 ± 5
PbO_2	HNO_3 only	82 ± 3
PbO_2	$HNO_3 + H_2O_2$	100 ± 1
Pb in paint*	HNO_3 only	95 ± 6
Pb in paint*	$HNO_3 + H_2O_2$	95 ± 6

*Standard Reference Material #1579, U.S. National Institute of Standards and Technology.

Additional collection efficiency studies were also done using Gelman GN-4 filters for the collection of Pb fume, which had geometric mean diameter of 0.1 µm [2]. Mean collection efficiency for 24 sampling runs at flow rates between 0.15 and 4.0 L/min was > 97 ± 2%. Overall precision, $\hat{S}_{rT}$, was 0.072 for lead nitrate aerosol [1,9] and 0.068 for Pb fume [2,4].

REFERENCES:

[1] Documentation of the NIOSH Validation Tests, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-185 (1977).
[2] Heavy Metal Aerosols: Collection and Dissolution Efficiencies, Final Report of NIOSH Contract 210-79-0058, W. F. Gutknecht, M. H. Ranade, P. M. Grohse, A. Damle, and D. O'Neal, Research Triangle Institute; available as Order No. PB 83-106740 from NTIS, Springfield, VA 22161 (1981).
[3] NIOSH Manual of Analytical Methods, 2nd ed., V. 5, P&CAM 173, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-157-A (1979).
[4] NIOSH Manual of Analytical Methods, 2nd ed., V. 7, S341 (revised 3/25/81), U.S. Department of Health and Human Services, Publ. (NIOSH) 82-100 (1982).
[5] NIOSH Manual of Analytical Methods, 2nd. ed., V. 1, P&CAM 102, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-157-A (1977).
[6] Criteria for a Recommended Standard...Occupational Exposure to Inorganic Lead (Revised Criteria), U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 78-158 (1978).
[7] NIOSH Manual of Analytical Methods, 2nd ed., P&CAM 191.
[8] Analytical Methods for Atomic Absorption Spectrophotometry, Perkin-Elmer (1976).
[9] NIOSH Manual of Analytical Methods, 2nd ed., V. 3, S341, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-157-C (1977).
[10] DataChem Laboratories in-house procedure for microwave sample digestion.
[11] Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, 3rd Ed; U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response. U.S. Government Printing Office: Washington, DC, SW-846 (1986).
[12] Kingston, H.M. and L.B. Jassie, "Safety Guidelines for Microwave Systems in the Analytical Laboratory." Introduction to Microwave Acid Decomposition: Theory and Practice; Kingston, H.M. and Jassie, L.B., Eds.; ACS Professional Reference Book Series; American Chemical Society: Washington, DC, (1988).
[13] 1985 Annual Book of ASTM Standards, Vol. 11.01; "Standard Specification for Reagent Water; ASTM, Philadelphia, PA, D1193 – 77 (1985).
[14] Introduction to Microwave Sample Preparation: Theory and Practice; Kingston, H.M. and Jassie, L.B., Eds.; ACS Professional Reference Book Series; American Chemical Society: Washington DC (1988).
[15] Kingston, H.M. EPA IAG #DW1-393254-01-0 January 1 – March 31, 1988, Quarterly Report.
[16] Binstock, D.A., Yeager, W.M., Grohse, P.M. and Gaskill, A. Validation of a Method for Determining Elements in Solid Waste by Microwave Digestion, Research Triangle Institute Technical Report Draft, RTI Project Number 321U-3579-24, prepared for the Office of Solid Waste, U.S. Environmental Protection Agency, Washington, DC 20460 (November, 1989).

METHOD REVISED BY:

Mark Millson, NIOSH/DPSE and R. DeLon Hull, Ph.D., NIOSH/DBBS; S341 originally validated under NIOSH Contract CDC-94-74-45; additional studies under NIOSH Contract 210-79-0058.

James B. Perkins, David L. Wheeler, and Keith Nicholson, Ph.D., DataChem Laboratories, Salt Lake City, UT, prepared the microwave digestion procedure in the Appendix.

APPENDIX - MICROWAVE DIGESTION FOR LEAD IN PAINT CHIPS (AND OTHER MATRICES)

This procedure is an alternative to the procedure presented in the Sample Preparation section of this method. It provides a rapid, complete acid digestion prior to analysis by flame atomic absorption (FAA), heated graphite furnace atomic absorption (HGFAA), and inductively coupled plasma spectroscopy (ICP) [10].

Apparatus and Material [11-16]

1. Microwave apparatus requirements
   a. The microwave unit provides programmable power with a minimum of 574 W and can be programmed to within ± 10 W of the required power.
   b. The microwave unit cavity is corrosion resistant as well as ventilated. All electronics are protected against corrosion for safe operation.
   c. The system requires Teflon PFA digestion vessels (120-mL capacity) capable of withstanding pressures up to 7.5 ± 0.7 atm (110 ± 10 psi) and capable of controlled pressure relief at pressures exceeding 7.5 ± 0.7 atm (110 ± 10 psi).
   d. A rotating turntable is employed to ensure homogeneous distribution of microwave radiation within the unit. The speed of the turntable should be a minimum of 3 rpm.
   e. A safety concern relates to the use of sealed containers without pressure relief valves in the unit. Temperature is the important variable controlling the reaction. Pressure is needed to attain elevated temperatures but must be safely contained [12].
   f. Polymeric volumetric ware in plastic (Teflon or polyethylene), 50- or 100-mL capacity.
   g. Disposable polypropylene filter funnel.
   h. Analytical balance, 300-g capacity, and minimum ± 0.001 g.

Reagents

1. Nitric acid, concentrated, spectroscopy grade.
2. Reagent Water. Reagent water shall be interference free. All references to water in the method refer to reagent water that meets the ASTM Type 2 standard.

Procedure

1. Calibration of Microwave Equipment
   Calibrate microwave equipment in accordance with manufacturer's instructions. If calibration instructions are not available, see EPA Method 3051 [11].
2. All digestion vessels and volumetric ware must be carefully acid washed and rinsed with reagent water. All digestion vessels should be cleaned by leaching with hot (1:1) nitric acid for a minimum of fifteen minutes, rinsed with reagent water, and dried in a clean environment.
3. Sample Digestion
   a. Tare the Teflon PFA digestion vessel.
   b. Weigh out 0.1 g paint chip sample to the nearest 0.001 g into the tared Teflon PFA sample vessel. With large paint chip samples, measure out a 2 cm^2 piece, weigh to the nearest 0.001 g, and quantitatively transfer it to the vessel.
   c. Add 5.0 ± 0.1 mL concentrated nitric acid to the sample vessel in a fume hood. If a vigorous reaction occurs, allow the reaction to stop before capping the vessel. Cap the vessel and torque the cap to 12 ft-lb (16 N-m) according to the manufacturer's directions. The sample vessel may be connected to an overflow vessel using Teflon PFA connecting tubes. Place the vessels in the microwave carrousel. Connect the overflow vessels to the center well of the unit.
   d. Place the vessels evenly distributed in the turntable of the microwave unit using groups of two, six,

or 12 sample vessels. Any vessels containing 5 mL of nitric acid for reagent blank purposes are counted as sample vessels. When fewer than the recommended number of samples are to be digested, i.e., three samples plus one blank, the remaining vessels should be filled with 5 mL of nitric acid to achieve the full complement of vessels. This provides an energy balance since the microwave power absorbed is proportional to the total mass in the cavity [14]. Irradiate each group of samples to achieve a temperature of 180 °C in five minutes at a pressure of 50 psi. Continue to irradiate to achieve a temperature of 180 °C at 100 psi after 25 minutes. Continue digestion for five minutes. A sample digestion program for 12 samples is presented in the following table.

PROGRAM VARIABLES FOR PAINT CHIPS SAMPLE DIGESTION WITH NITRIC ACID

Stage	(1)	(2)	(3)
Power	90%	90%	0%
Pressure, psi	50	100	0
Run Time, min	10:00	20:00	05:00
Time @ P, min	05:00	15:00	00:00
Temperature	180°C	180°C	0°C
Fan Speed	100%	100%	100%
Number of Vessels:	12		
Liquid Volume per Vessel:	5 mL		
Sample Weight:	0.1 g		

If the analyst wishes to digest other than two, six, or 12 samples at a time, use different values of power as long as they result in the same time and temperature conditions.

e. At the end of the microwave program, allow the vessels to cool for a minimum of five minutes before removing them from the microwave unit. If a loss of sample is detected (e.g., material in overflow collection vessel, liquid outside liner), determine the reason for the loss (e.g., loss of vessel seal integrity, use of a digestion time longer than 30 minutes, too large a sample, or improper heating conditions). Once the source of the loss has been corrected, prepare a new sample beginning at Section 2. If insufficient material is available for reanalysis, dilute remaining digestate and note that some sample loss may have occurred.

f. Uncap and vent each vessel in a fume hood. Add 20 mL reagent water, then reseal vessels and shake to mix thoroughly. Transfer the sample to an acid-cleaned polyethylene bottle. If the digested sample contains particulates which may clog nebulizers or interfere with injection of the sample into the instrument, allow the sample to settle or filter it:

Settling: Allow the sample to stand until the supernatant is clear (usually, overnight is sufficient). If it does not clear, filter the sample.

Filtering: The filtering apparatus must be thoroughly precleaned and rinsed with dilute nitric acid. Filter the sample through quantitative filter paper into a second acid-cleaned container.

The digestate is now ready for analysis for elements of interest using the appropriate method.

4. Calculations: Report the concentrations based on the actual weight of the original sample.

APPENDIX B

FIELD RECORDS

Parameters	SW-01	SW-02	SW-03	SW-04	SW-05	SW-06
Temperature (°C)	15.9	15.9	16	16	18.25	19.85
pH	7.92	7.99	7.99	8.02	6.33	7.62
Specific Conductivity (mS/cm)	32,450	28,007	28,506	28,999	0.312	0.085
Oxidation-Reduction Potential (mV)	108.9	114.4	113.1	113.5	41.7	68.8
Dissolved Oxygen (mg/L)	7.2	7.92	7.39	7.23	4.02	3.27

°C = degrees Celcius
pH = log hydrogen ion concentration
mS/cm =microSiemens/centimeter
mV = millivolts
mg/L = milligrams per liter (parts per million)

WESTON SOLUTIONS

Test Pit: ZA-1

Page 1 of 1

Project Name: Jewett White Lead Co.	
Client: EPA	
Date: 10/04/10	
Contractor: SET	
Logged By: A. Daniels	
Excavation Method: Excavator	
Ground Surf. Elev.:	
Total Depth: 8'	
Depth of Fill: ~3.5'	
Remarks:	

Stratigraphic Unit	Sample Number	Depth (ft)	Material Description
	S-ZA1-0001	00-01 ft	Brown-Black, fine to medium Silty Sand Some ~~cobble/stone~~ Gravel and brick fill
	S-ZA1-0102	01-02 ft	Yellow brown silty ~~Sand~~ Clay fine some black Silty Clay
	S-ZA1-0203	02-03 ft	fine yellow brown silty clay
	S-ZA1-0304	03-04 ft.	fine yellow brown silty sand some Clay
	S-ZA1-0405	04-05 ft.	fine yellow brown silty Clay, Some fine grey silty sand.
	S-ZA1-0506	05-06 ft	fine yellow brown silty Clay and fine grey silty sand.
	S-ZA1-0607	06-07 ft.	fine yellow brown Silty Clay, Some fine grey silty sand, and Reddish-brown silty-sand
	S-ZA1-0708	07-08 ft.	fine to medium Redish brown Silty sand some cobblea. litth yellow brown fine silty sand.

Project Name: Jewett White Lead Co.	**Test Pit:** ZA-3.5
Client: EPA	Page 1 of 1
Date: ~~10/04/10~~ 10/06/10	
Contractor: SET	
Logged By: A. Daniels	
Excavation Method: Excavator	
Ground Surf. Elev.:	
Total Depth:	
Depth of Fill:	
Remarks:	

Stratigraphic Unit	Sample Number	Depth (ft)	Material Description
	S-ZA3.5-0001	00-01 ft.	light brown medium silty sand and pebbles/gravel dark-brown silty sand and gravel (medium-coarse)
	S-ZA3.5-0102	01-02 ft.	layer of yellow brown fine silty sand. dark brown fine sandy silt; some pebbles
	S-ZA3.5-0203	02-03 ft.	very fine dark brown-black sandy silt; little pebbles.
	S-ZA3.5-0304	03-04 ft.	dark brown-black organic material and rubble mix. Brick, wood and dark brown silty sand.
	S-ZA3.5-0405	04-05 ft.	dark brown-black organic material (low dens. light wt.) Some light brown fine sand.
	S-ZA3.5-0506	05-06 ft.	very fine grey and light brown silty sand. dry.
	S-ZA3.5-0607	06-07 ft	SAA.
	S-ZA3.5-0708	07-08 ft.	SAA and Brick.

WESTON SOLUTIONS

Test Pit: ~~[illegible]~~ ZA-4

Page 1 of 1

Project Name: Jewett White Lead Co.
Client: EPA
Date: ~~10/07/10~~ AD 10/06/10
Contractor: SET
Logged By: A. Daniels
Excavation Method: Excavator
Ground Surf. Elev.:
Total Depth: ~~[illegible]~~ 8 ft.
Depth of Fill: UNK.
Remarks:

Stratigraphic Unit	Sample Number	Depth (ft)	Material Description
	S-ZA4-0001	00-01 ft.	Brown silty sand (medium-coarse); Rocks Red Sandy Clay fine dark brown ~~Sand Silt~~ silty sand and gravel
	S-ZA4-0102	01-02 ft.	dark brown silty sand and gravel
	S-ZA4-0203	02-03 ft.	dark brown silty sand and gravel.
	S-ZA4-0304	03-04 ft.	Dark black organic material (low density light weight) (mulch-like) staining.
	S-ZA4-0405	04-05 ft.	Dark black organic material and brown silt (fine); yellow-brown fine silt.
	S-ZA4-0506	05-06 ft.	Very fine grey silty sand and very fine light brown silty sand.
	S-ZA4-0607	06-07 ft.	~~Very~~ fine light brown Sand (moist)
	S-ZA4-0708	07-08 ft.	* fine light brown Sand (moist)

WESTON SOLUTIONS

Test Pit: A-1.5

Page 1 of 1

Project Name: Jewett White Lead Co.
Client: EPA
Date: 10/08/10
Contractor: SET
Logged By: A. Daniels
Excavation Method: Back ho
Ground Surf. Elev.:
Total Depth: 5 ft.
Depth of Fill: UNK.
Remarks:

Stratigraphic Unit	Sample Number	Depth (ft)	Material Description
	S-A1.5-0001	00-01 ft.	Moist, medium grain, dark brown silty sand, and gravel moist medium light brown silty sand.
	S-A1.5-0102	01-02 ft.	moist dark brown medium grain silty sand. layer of coal moist dark brown medium grain silty sand
	S-A1.5-0203	02-03 ft.	SA.A. medium to fine light brown silty sand, little mica.
	S-A1.5-0304	03-04 ft.	Medium to fine light brown silty sand.
	S-A1.5-0405	04-05 ft.	fine light brown, grey-brown, orange brown silty sand layering
			END OF PIT

WESTON SOLUTIONS

Test Pit: A.2.5

Page 1 of 1

Project Name: Jewett White Lead Co.
Client: EPA
Date: 10/08/10
Contractor: SET
Logged By: A. Daniels
Excavation Method: Back Ho
Ground Surf. Elev.:
Total Depth: 6 ft.
Depth of Fill: UNK.
Remarks:

Stratigraphic Unit	Sample Number	Depth (ft)	Material Description
	S-A2.5-0001	00-01 ft.	medium grain, light brown silty sand and gravel fine, yellow-brown silty sand
	S-A2.5-0102	01-02 ft	fine dark brown-black sandy silt layer of coal fine, dark brown-black sandy silt
	S-A2.5-0203	02-03 ft.	fine dark brown-black sandy silt, with some layers of light brown fine silty sand.
	S-A2.5-0304	03-04 ft	fine-medium dark brown moist silty sand and organic material.
	S-A2.5-0405	04-05 ft.	dry, fine light brown sand, little light brown silty-sand, Trace mica.
	S-A2.5-0506	05-06 ft.	dry, fine, yellow brown silty sand.
			END OF PIT

WESTON SOLUTIONS

Test Pit: ~~[illegible]~~ A-5.5

Page 1 of 1

Project Name: Jewett White Lead Co.

Client: EPA

Date: ~~10/07/10~~ (AD) 10/06/10

Contractor: SET

Logged By: A. Daniels

Excavation Method:

Ground Surf. Elev.:

Total Depth: 5 ft.

Depth of Fill: unknown.

Remarks:

Stratigraphic Unit	Sample Number	Depth (ft)	Material Description
	S-A5.5-0001	00-01 ft.	Medium to coarse brown/dark silty sand; some gravel and brick
	S-A5.5-0102	01-02 ft.	brown silty sand and gravel.
	S-A5.5-0203	02-03 ft.	orange-brown, grey, dark-brown fine silty sand banding.
	S-A5.5-0304	03-04 ft.	light brown fine sand; some fine grey silty sand.
	SA5.5-0405	04-05 ft.	very fine grey silty sand; some fine orange-brown silty sand.

WESTON SOLUTIONS

Test Pit: AB-1

Page 1 of 1

Project Name: Jewett White Lead Co.
Client: EPA
Date: 10/04/10
Contractor: SET
Logged By: A. Daniels
Excavation Method: Excavator
Ground Surf. Elev.:
Total Depth: 8'
Depth of Fill: ~ 4'
Remarks:

Stratigraphic Unit	Sample Number	Depth (ft)	Material Description
	S-AB1-0001	00-01 ft	medium Brown silty sand with gravel
	S-AB1-0102	01-02	coarse Sand with some Red-Brown fine Silty-Sand bands
	S-~~AB1-02~~ AB1-0203	02-03	coarse sand
	S-AB1-0304	03-04	fine red-grey-brown Silty Sand with some layers of yellow brown and black-brown silty sand ~~some~~
	S-AB1-0405	04-05	Very fine grey brown silty sand.
	S-AB1-0506	05-06	Very fine grey brown silty sand and very fine Red brown silty sand.
	S AB1-0607	06-07	Very fine reddish-grey silty sand layers of black-brown very fine silty sand
	S AB1-0708	07-08	Very fine Reddish-yellow-grey silty sand some Reddish fine-medium sand.

WESTON SOLUTIONS

Test Pit: AB-1.5

Page 1 of 1

Project Name: Jewett White Lead Co.
Client: EPA
Date: ~~10/07/10~~ AD 10/06/10
Contractor: SET
Logged By: A. Daniels
Excavation Method: Excavator
Ground Surf. Elev.:
Total Depth: 5 ft.
Depth of Fill: UNK.
Remarks:

Stratigraphic Unit	Sample Number	Depth (ft)	Material Description
	S-AB1.5-0001	00-01 ft. ~~00-10~~	Medium-Coarse brown silty sand and rocks
	S-AB1.5-0102	01-02 ft.	black-brown sandy silt; layering of light brown silty sand
	S-AB1.5-0203	02-03 ft.	S.A.A.
	S-AB1.5-0304	03-04 ft.	~~Fine light brown sand; some silt~~. SA A. fine light brown silty Sand.
	S-AB1.5-0405	04-05 ft.	SA.A.

WESTON SOLUTIONS

Test Pit: AB - 2.5

Page 1 of 1

Project Name: Jewett White Lead Co.
Client: EPA
Date: 10/08/10
Contractor: SET
Logged By: A. Daniels
Excavation Method: Back Ho
Ground Surf. Elev.:
Total Depth: 6'
Depth of Fill: UNK.
Remarks:

Stratigraphic Unit	Sample Number	Depth (ft)	Material Description
	S-AB2.5-0001	00-01 ft.	Red-brown medium Sand, some silty, And gravel. dark brown-black medium silty sand, and ~~gravel and brick Rubble~~
	S-AB2.5-0102	01-02 ft.	S.A.A; organic woody debris.
	S-AB2.5-0203	02-03 ft.	Medium grain - fine grain black silty sand, Some fine grain light brown silty sand; woody organic debris and brick Rubble.
	S-AB2.5-0304	03-04 ft.	MOIST, medium - fine dark brown-black Silty Sand; and decomposing woody organic materiel
	S-AB2.5-0405	04-05 ft.	medium to fine dark brown-black moist Silty Sand, mixed with broken ceramic pots and Rubble building debris.
	S-AB2.5-0506	05-06 ft.	fine, dry, light gray silty Sand.
	~~S-AB2.5-0607~~	~~06-07 ft.~~	END OF TEST PIT

WESTON SOLUTIONS

Test Pit: AB-3.5

Page 1 of 1

Project Name: Jewett White Lead Co.
Client: EPA
Date: 10/08/10
Contractor: SET
Logged By: A. Daniels
Excavation Method: Back Ho.
Ground Surf. Elev.:
Total Depth: 5'
Depth of Fill: UNKNOWN
Remarks:

Stratigraphic Unit	Sample Number	Depth (ft)	Material Description
	S-AB3.5-0001	00-01 ft.	Medium to fine grain light brown silty sand and gravel.
	S-AB3.5-0102	01-02 ft.	fine grain black sandy silt, moist.
	S-AB3.5-0203	02-03 ft.	S.A.A.; some layering of light brown sand. light brown-grey fine silty sand; lots of ROCKS.
	S-AB3.5-0304	03-04 ft.	light brown-grey fine sand; little silt, Trace mica.
	S-AB3.5-0405	04-05 ft.	Very fine grey silty sand; and fine light brown silty sand; Trace mica.
			END OF TEST PIT

Test Pit: AB-4

Page 1 of 1

Project Name: Jewett White Lead Co.
Client: EPA
Date: 10/08/10
Contractor: SET
Logged By: A. Daniels
Excavation Method: Back Ho
Ground Surf. Elev.:
Total Depth: 6'
Depth of Fill: UNKNOWN
Remarks:

Stratigraphic Unit	Sample Number	Depth (ft)	Material Description
	S-AB4-0001	00-01 ft.	fine to medium light brown silty sand, some coarse dark brown silty sand. Some ROCKS and gravel; some organic matter.
	S-AB4-0102	01-02 ft.	medium grain dark brown-black silty sand; Some light brown medium-fine silty sand; Coal, gravel, building debris, Rubble.
	S-AB4-0203	02-03 ft.	light brown fine to medium silty sand; Some fine dark-brown-black silty Sand.
	S-AB4-0304	03-04 ft.	dark, moist, black medium to fine silt; Some Organic matter.
	S-AB4-0405	04-05 ft.	S.A.A.; some light brown silty Sand.
	S-AB4-0506	05-06 ft.	fine grain light grey Silty-Sand.

NOTE - HEAVY PETROLEUM ODOR.

END ~~BOR~~ TEST PIT.

WESTON SOLUTIONS

Test Pit: AB-5.5

Page 1 of 1

Project Name: Jewett White Lead Co.
Client: EPA
Date: 10/07/10
Contractor: SET
Logged By: A. Daniels
Excavation Method: Back Ho
Ground Surf. Elev.:
Total Depth: 5'
Depth of Fill: UNK.
Remarks:

Stratigraphic Unit	Sample Number	Depth (ft)	Material Description
	S-AB5.5-0001	00-01 ft.	light brown fine Sand, little silty; some dark brown-black silty fine sand, some gravel and brick Rubble.
	S-AB5.5-0102	01-02 ft.	Very fine yellow-brown silty sand.
	S-AB5.5-0203	02-03 ft.	very fine yellow-brown silty sand, and very fine grey silty sand. DRY.
	S-AB5.5-0304	03-04 ft	S.A.A.
	S-AB5.5-0405	04-05 ft.	S.A.A.
			END OF TEST PIT

WESTON SOLUTIONS

Test Pit: BC-1

Page 1 of 1

Project Name: Jewett White Lead Co.
Client: EPA
Date: 10/04/10
Contractor: SET
Logged By: A Daniels
Excavation Method: Excavator
Ground Surf. Elev.:
Total Depth: 8'
Depth of Fill: 3-4'
Remarks:

Stratigraphic Unit	Sample Number	Depth (ft)	Material Description
	S-BC1-0001	00-01 ft.	fine to medium Brown-black ~~silty sand~~ silty sand. with brick and gravel
	S-BC1-0102	01-02 ft.	fine to medium Brownblack silty sand with bands of yellow brown silty clay
	S-BC1-0203	02-03ft	fine yellow-brown silty clay. some fine yellow-brown sand.
	S-BC1-0304	03-04 ft.	fine yellow-brown silty sand; some fine red-brown silty sand; little mica.
	S-BC1-0405	04-05 ft.	fine Redish-brown silty sand; ~~little~~ Trace mica.
	S-BC1-0506	05-06 ft.	Very fine Red-brown silty sand; Trace mica.
	S-BC1-0607	06-07 ft.	Very fine yellow-brown silty sand and very fine red-brown silty sand; Trace mica.
	S-BC1-0708	07-08 ft.	fine Red brown silty sand; some very fine yellowbrown silty sand; some very fine brown sand; Trace mica

WESTON SOLUTIONS

Test Pit: BC-1.5

Page 1 of 1

Project Name: Jewett White Lead Co.
Client: EPA
Date: ~~10/05/10~~ ~~10/07/10~~ 10/06/10
Contractor: SET
Logged By: A. Daniels
Excavation Method: Excavator
Ground Surf. Elev.:
Total Depth: ~~8~~ 5 ft.
Depth of Fill: UNK.
Remarks:

Stratigraphic Unit	Sample Number	Depth (ft)	Material Description
	S-BC1.5-0001	00-01 ft.	Medium to coarse dark brown silty sand; some pebbles and organic debris
	S-BC1.5-0102	01-02 ft.	fine to medium dark brown silty sand, some building debris/Rubble (ie: pieces of brick and ceramic pipe)
	S-BC1.5-0203	02-03 ft.	fine to medium dark brown silty sand fine redbrown silty sand, some pebbles. light brown silty sand layers.
	S-BC1.5-0304	03-04 ft.	fine light brown Sand, some silt, Trace mica.
	S-BC1.5-0405	04-05 ft.	fine Red-brown and Orange brown silty sand, some layering of dark brown silty sand.

WESTON SOLUTIONS

Test Pit: BC-2.5

Page 1 of 1

Project Name: Jewett White Lead Co.
Client: EPA
Date: 10 | 07 | 10
Contractor: SET
Logged By: A. Daniels
Excavation Method: Excavator
Ground Surf. Elev.:
Total Depth: 5'
Depth of Fill:
Remarks:

Stratigraphic Unit	Sample Number	Depth (ft)	Material Description
	S-BC2.5-0001	00-01 ft.	Medium light-dark brown mix silty sand And concrete, brick rubble debris.
	S-BC2.5-0102	01-02 ft.	medium dark brown silty sand and brick and gravel Rubble.
	S-BC2.5-0203	02-03 ft.	S.A.A. with Ceramic pipe (Teracotta).
	S-BC2.5-0304	03-04 ft	fine, dry, orange-brown silty sand; some grey fine silty sand.
	S-BC2.5-0405	04-05 ft.	S.A.A.
			END OF TEST PIT

WESTON SOLUTIONS

Test Pit: BC-4

Page 1 of 1

Project Name: Jewett White Lead Co.
Client: EPA
Date: 10/07/10
Contractor: SET
Logged By: A. Daniels
Excavation Method: Back Ho
Ground Surf. Elev.:
Total Depth: 8'
Depth of Fill: unk.
Remarks:

Stratigraphic Unit	Sample Number	Depth (ft)	Material Description
	S-BC4-0001	00-01 ft.	medium light brown, moist, silty Sand; little gravel moist dark brown organic material and gravel.
	S-BC4-0102	01-02 ft.	moist fine dark brown silty Sand, ~~and~~ some gravel light brown silty Sand layer dark brown, silty sand and coal/ash
	S-BC4-0203	02-03 ft.	moist fine dark brown silty Sand.
	S-BC4-0304	03-04 ft,	black-brown, medium silty Sand; and woody building material, ceramic pots and piping,
	S-BC4-0405	04-05 ft.	Black and brown medium grain silty sand; some pieces of broken ceramic material and brick.
	S-BC4-0506	05-06 ft	Moist, fine grey-redish-grey silty sand mixed among full brick wall structure.
	S-BC4-0607	06-07 ft.	moist, fine grey Sand, some silt, layered with yellow-brown fine silty sand; TRACE mica
	S-BC4-0708	07-08 ft.	S.A.A.

WESTON SOLUTIONS

Test Pit: CD1.5

Page 1 of 1

Project Name: Jewett White Lead Co.
Client: EPA
Date: 10/05/10
Contractor: SET
Logged By: A. Daniels
Excavation Method: Excavator
Ground Surf. Elev.:
Total Depth: 6'
Depth of Fill: UNK.
Remarks:

Stratigraphic Unit	Sample Number	Depth (ft)	Material Description
	S-CD1.5-0001	00-01 ft.	Medium brown silty sand, moist; CONCRETE gravel, brick, brown silty sand
	S-CD1.5-0102	01-02 ft.	dark brown silty sand; some gravel coal and organic debris
	S-CD1.5-0203	02-03 ft.	orange-brown fine silty sand, moist
	S-CD1.5-0304	03-04 ft.	Very fine grey-silty-sand; some charcoal; little brick.
	S-CD1.5-0405	04-05 ft.	Very fine grey sand; some fine yellow-brown, orange brown, Red brown layering. Silty Sand, dry.
	S-CD1.5-0506	05-06 ft	very fine yellow brown Silty Sand, some Red brown Silty Sand, some grey sand. dry.

WESTON SOLUTIONS

Test Pit: C-4

Page 1 of 1

Project Name: Jewett White Lead Co.
Client: EPA
Date: 10/07/10
Contractor: SET
Logged By: A. Daniels
Excavation Method: Back Ho
Ground Surf. Elev.:
Total Depth: 6'
Depth of Fill: UNK
Remarks:

Stratigraphic Unit	Sample Number	Depth (ft)	Material Description
	S-C4-0001	00-01 ft.	light-dark brown Sand mixed with brick and gravel Rubble. (medium grain size)
	S-C4-0102	01-02 ft.	Orange-brown, fine silty Sand mixed with brick dark brown-black fine silty sand; Some light brown fine silty SAND.
	S-C4-0203	02-03 ft.	dark brown-black fine silty Sand (lots and lots of broken ceramic pots at this depth)
	S-C4-0304	03-04 ft.	S.A.A.
	S-C4-0405	04-05 ft.	fine, dry, light brown Sand; and fine, dry grey Sand.
	S-C4-0506	05-06 ft	S.A.A.
			END OF TEST PIT

Test Pit: CD-1

Page 1 of 1

Project Name: Jewett White Lead Co.
Client: EPA
Date: 10/05/10
Contractor: SET
Logged By: A. Daniels
Excavation Method: Excavator
Ground Surf. Elev.:
Total Depth: 8'
Depth of Fill: ~ 3.5'
Remarks:

Stratigraphic Unit	Sample Number	Depth (ft)	Material Description
	S-CD1-0001	00-01 ft.	fine to medium orange brown silty sand; some medium brown-black silty sand
	S-CD1-0102	01-02 ft.	fine orange-brown silty sand, some medium-fine brown black sand; Trace mica
	S-CD1-0203	02-03 ft.	fine orange-brown silty sand, layering black silty sand (fine); Trace mica.
	S-CD1-0304	03-04 ft.	fine orange-brown silty sand; layering of black silty sand and grey-brown silty sand (fine); Trace mica
	S-CD1-0405	04-05 ft.	fine grey-brown silty sand; some fine yellow-brown silty sand; some orange brown silty sand.
	S-CD1-0506	05-06 ft.	fine Red-brown silty sand; some fine yellow-brown sand; little pebbles; Trace mica.
	S-CD1-0607	06-07 ft.	fine Red-Brown silty-sand; some pebbles and cobles; Trace fine yellow brown silty-sand.
	S-CD1-0708	07-08 ft.	fine Red-brown silty sand; and pebbles.

WESTON SOLUTIONS

Test Pit: CD-3

Page 1 of 1

Project Name: Jewett White Lead Co.
Client: EPA
Date: 10/07/10
Contractor: SET
Logged By: A. Daniels
Excavation Method: Excavator.
Ground Surf. Elev.:
Total Depth: 8'
Depth of Fill: UNK.
Remarks:

Stratigraphic Unit	Sample Number	Depth (ft)	Material Description
	S-CD3-0001	00-01 ft.	Medium-coarse, moist, dark brown silty sand, Organic debris and gravel. orange-brown and brown fine silty sand
	S-CD3-0102	01-02 ft.	Orange-brown fine silty sand with some layering of fine brown silty sand. Dry.
	S-CD3-0203	02-03 ft.	medium to fine, mix of brown, orange-brown, grey silty sand; Trace mica.
	S-CD3-0304	03-04 ft.	SAA.
	S-CD3-0405	04-05 ft.	Medium to fine, moist, grey silty sand and Red-brown silty sand, some orange silty sand
	S-CD3-0506	05-06 ft.	medium to fine, moist orange-brown silty sand some medium to fine, moist, grey silty sand.
	S-CD3-0607	06-07 ft.	Medium to fine, moist grey silty sand with layers of medium to fine, moist Red-brown silty sand.
	S-CD3-0708	07-08 ft.	S.A.A. - with orange, fine silty sand layering.

WESTON SOLUTIONS

Test Pit: D-4

Page 1 of 1

Project Name: Jewett White Lead Co.
Client: EPA
Date: 10/07/10
Contractor: SET
Logged By: A. Daniels
Excavation Method: Excavator
Ground Surf. Elev.:
Total Depth: 8 ft.
Depth of Fill: UNK.
Remarks:

Stratigraphic Unit	Sample Number	Depth (ft)	Material Description
	S-D4-0001	00-01 ft.	Medium, brown silty sand; Organic debris, large gravel. light brown, dry, Silty sand
	S-D4-0102	01-02 ft	Orange-brown, silty sand - fine grain. Dry Some light brown silty sand DRY-moist.
	S-D4-0203	02-03 ft.	fine grey-brown silty sand, some fine orange-brown silty sand, little black, fine silty sand layers. DRY
	S-D4-0304	03-04 ft.	fine, orange-brown silty sand and grey-brown fine silty sand and light brown fine silty sand DRY
	S-D4-0405	04-05 ft.	S.A.A.; Dry.
	S-D4-0506	05-06 ft.	S.A.A; Dry-moist
	S-D4-0607	06-07 ft.	moist, fine, orange brown silty sand, some moist, fine, grey silty sand.
	S-D4-0708	07-08 ft.	Dry, fine, light brown-grey silty sand; Some fine orange-brown silty sand.

Test Pit: DE-1

Page 1 of 1

Project Name: Jewett White Lead Co.
Client: EPA
Date: 10/05/10
Contractor: SET
Logged By: A. Daniels
Excavation Method:
Ground Surf. Elev.:
Total Depth: 8'
Depth of Fill: UNK.
Remarks:

Stratigraphic Unit	Sample Number	Depth (ft)	Material Description
	S-DE1-0001	00-01' ft.	medium brown-black silty sand; some pebbles; some rubble (brick); ~~some~~ layer of black charcoal at roughly 9" bgs.
	S-DE1-0102	01-02' ft.	fine orange brown silty sand; Trace mica
	S-DE1-0203	02-03' ft.	fine orange brown silty sand, some fine yellow-brown silty-sand; Trace mica.
	S-DE1-0304	03-04 ft.	very fine red brown silty sand; some very fine yellow-brown silty sand; some ~~grey~~ orange-brown silty-sand; Trace mica.
	S-DE1-0405	04-05 ft.	Very fine grey-brown (almost a pink hue) silty sand; some yellow-brown silty sand; Trace mica.
	S-DE1-0506	05-06 ft.	very fine light brown silty-sand; some yellow-brown silty sand; Trace mica.
	S-DE1-0607	06-07 ft.	Very fine yellow-brown silty sand; some Red-brown silty sand; some light brown silty sand; trace mica moist.
	S-DE1-0708	07-08 ft.	fine Red-brown silty sand; some pebbles; moist.

WESTON SOLUTIONS

Test Pit: DE-2

Page 1 of 1

Project Name: Jewett White Lead Co.
Client: EPA
Date: 10/05/10
Contractor: SET
Logged By: A. Daniels
Excavation Method: Excavator
Ground Surf. Elev.:
Total Depth: 5'
Depth of Fill: UNknown
Remarks:

Stratigraphic Unit	Sample Number	Depth (ft)	Material Description
	S-DE2-0001	00-01 ft.	fine to medium brown-black Sand; some silt; Some pebbles, brick, organic debris.
	S-DE2-0102	01-02 ft.	fine to medium brown silty sand; layers black charcoal Fine orange brown silty sand, moist
	S-DE2-0203	02-03 ft.	fine orange brown silty sand, layers of brown-black silty sand, moist.
	S-DE2-0304	03-04 ft.	very fine orange-brown silty sand, dry.
	S-DE2-0405	04-05 ft.	Very fine orange brown Sand; little silt, Some red brown sand; some yellow-brown sand, little mica.

WESTON SOLUTIONS

Test Pit: EF-2.5

Page 1 of 1

Project Name: Jewett White Lead Co.
Client: EPA
Date: 10/05/10
Contractor: SET
Logged By: A. Daniels
Excavation Method: Excavator
Ground Surf. Elev.:
Total Depth: 5
Depth of Fill: ~ UNK.
Remarks:

Stratigraphic Unit	Sample Number	Depth (ft)	Material Description
	S-EF2.5-0001	00-01 ft.	Medium brown - dark brown Silty sand; some organic debris; little pebbles.
	S-EF2.50102	01 - 02 ft.	Very fine orange brown silty sand; Some very fine brown silty-sand
	S-EF2.5.0203	02-03 ft.	S.A.A.
	S-EF2.5-0304	03-04 ft.	Very fine orange brown silty sand; And very fine Red brown silty Sand; some layering very fine grey-brown / light brown silty sand.
	S-EF2.5-0405	04-05 ft.	S.A.A.

WESTON SOLUTIONS

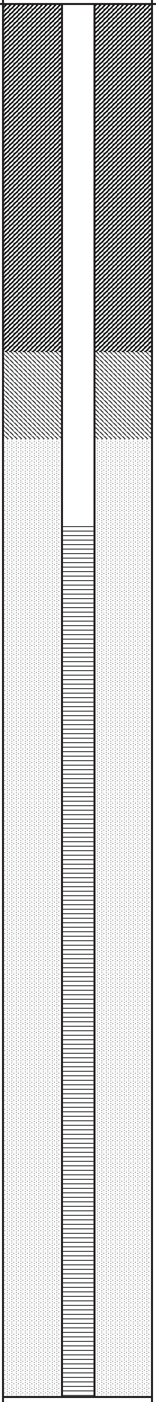
Test Pit: F-1

Page 1 of 1

Project Name: Jewett White Lead Co.
Client: EPA
Date: 10/05/10
Contractor: SET
Logged By: A. Daniels.
Excavation Method: Excavator
Ground Surf. Elev.:
Total Depth: 5'
Depth of Fill: ~ 2'
Remarks:

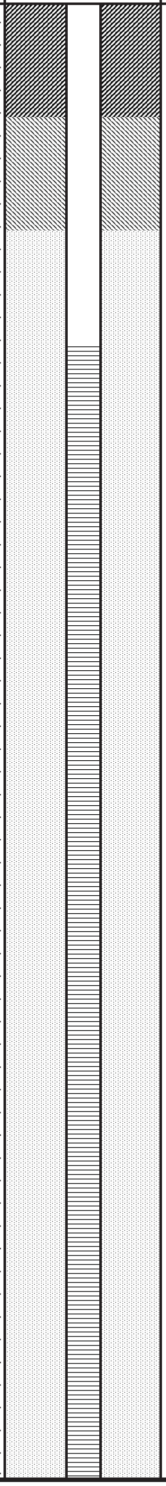
Stratigraphic Unit	Sample Number	Depth (ft)	Material Description
	S-F1-0001	00-01 ft.	medium brown silty sand; some cobbles and organic debris; some charcoal fine to medium ligh brown sand; some fine yellow-brown silty sand.
	S-F1-0102	01-02 ft.	fine yellow-brown silty sand; layer of Charcoal mixed with ceramic pipe; brick, organic debris
	S-F1-0203	02-03 ft	very fine orange brown Silty sand.
	S-F1-0304	03-04 ft.	very fine light brown silty sand; layers of orange-brown, yellow-brown fine silty sand Trace mica; ~~Some~~ red-brown fine siltsand.
	S-F1-0405	04-05 ft.	very fine light brown silty sand; layer of orange-brown, Red-brown fine silty sand; Trace mica.

WESTON SOLUTIONS	**WELL CONSTRUCTION LOG**	Sheet 1 of 1	**Well ID: PO-1**
	Project: Jewett White Lead Company	Drilling Method: Hollow-stem Augers/5-ft MacroSampler	
Client: USEPA Region 2 (RST 2)		Total Well Depth: 16 ft bgs	
Date(s) Drilled: 7 October 2010		Ground Elevation:	
Drilling Contractor: SET, Inc.		Overburden Thickness: >16 ft	
Drill Rig: Dietrich D50		Well Construction: 2-inch diameter, 10-ft long, 0.01-inch slot PVC screen; #0 silica sand to 5 ft bgs, PVC riser, granular bentonite and cement surface seal, flush-mounted in road box.	
Drill Foreman: Brian Sicker			
Logged by: Julissa Morales		Depth to Groundwater: 6.5 ft bgs	

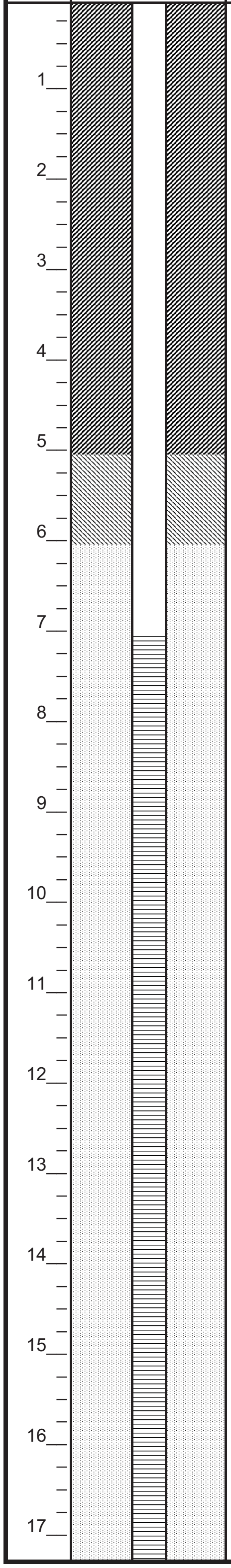


Depth (ft bgs)	Graphic Well Log	Graphic Soil Log	Descriptive Log	Blow Count	Remarks
1			Dark medium brown silty sand, dry. Contains concrete fragments.		
2			Dark medium brown silty sand, dry. Contains concrete fragments.		
3			Dark medium brown silty sand, dry. Contains concrete fragments and some organic matter.		
4					
5			Medium brown fine silty sandy clay, moist.		
6			Light brown fine silty sandy clay, moist.		
7			Light brown fine silty sandy clay, moist, wet at 6.5 ft bgs.		
8			Light brownish gray fine silty sandy clay, wet.		
9			Light grayish brown fine silty sandy clay, wet.		
10			Light grayish brown fine silty sandy clay, wet.		
11					
12					
13					
14					
15					
16			End of boring.		
17					

WESTON SOLUTIONS	**WELL CONSTRUCTION LOG**	Sheet 1 of 1	**Well ID: PO-2**
	Project: Jewett White Lead Company	Drilling Method: Hollow-stem Augers/2-inch Split Spoon	
Client: USEPA Region 2 (RST 2)		Total Well Depth: 13 ft bgs	
Date(s) Drilled: 7 to 8 October 2010		Ground Elevation:	
Drilling Contractor: SET, Inc.		Overburden Thickness: >13 ft	
Drill Rig: Dietrich D50		Well Construction: 2-inch diameter, 10-ft long, 0.01-inch slot PVC screen; #0 silica sand to 2 ft bgs, PVC riser, granular bentonite and cement surface seal, flush-mounted in road box.	
Drill Foreman: Brian Sicker			
Logged by: Julissa Morales		Depth to Groundwater: 6 ft bgs (perched)	

Depth (ft bgs)	Graphic Well Log	Graphic Soil Log	Descriptive Log	Blow Count	Remarks
1			Light medium brown fine to medium silty sand, dry. Contains concrete fragments.		
2			Dark brown, flecked with white, fine to medium silty sand, dry. Contains red brick fragments.		
3			Very dark brown fine silty clayey sand, dry. Contains red brick fragments.		
4			Very dark brown fine silty clayey sand, dry. Contains red brick fragments.		
5			Dark brownish gray medium to coarse silty sand, moist. Contains concrete fragments.		
6			Medium brown fine to medium silty sandy clay, wet.		
7					
8					
9					
10					
11					
12					
13			End of boring.		

WESTON SOLUTIONS	**WELL CONSTRUCTION LOG**	Sheet 1 of 1	**Well ID: PO-3**
	Project: Jewett White Lead Company	Drilling Method: Hollow-stem Augers/2-inch Split Spoon	
Client: USEPA Region 2 (RST 2)		Total Well Depth: 17 ft bgs	
Date(s) Drilled: 7 October 2010		Ground Elevation:	
Drilling Contractor: SET, Inc.		Overburden Thickness: 17 ft	
Drill Rig: Dietrich D50		Well Construction: 2-inch diameter, 10-ft long, 0.01-inch slot PVC screen; #0 silica sand to 6 ft bgs, PVC riser, granular bentonite and cement surface seal, flush-mounted in road box.	
Drill Foreman: Brian Sicker			
Logged by: Julissa Morales		Depth to Groundwater: 8 ft bgs	



Graphic Soil Log	Descriptive Log	Blow Count/ Penetration/Recovery	Remarks
	Reddish brown fine to medium silty sand, dry. Reddish brown fine to coarse silty sand, dry.	2-8-11-11 24/12	
	Dark brown fine to medium silty sand, dry. Contains concrete fragments. Dark reddish brown, with white mottles, fine to medium silty sand, dry. Contains concrete fragments. Obstruction noted at 4 ft bgs.	9-8-21-25 24/6	
	Reddish brown fine silty sand, moist. Reddish brown fine silty sand, moist.	4-4-6-7 24/20	
	Reddish brown fine silty sand, moist.	6-6-7-19 24/	
	Brown silty sand, wet. Contains brick fragments. Reddish brown fine silty sand, wet.	11-9-9-8 24/	
	Bedrock reported at 17 ft bgs. End of boring.		

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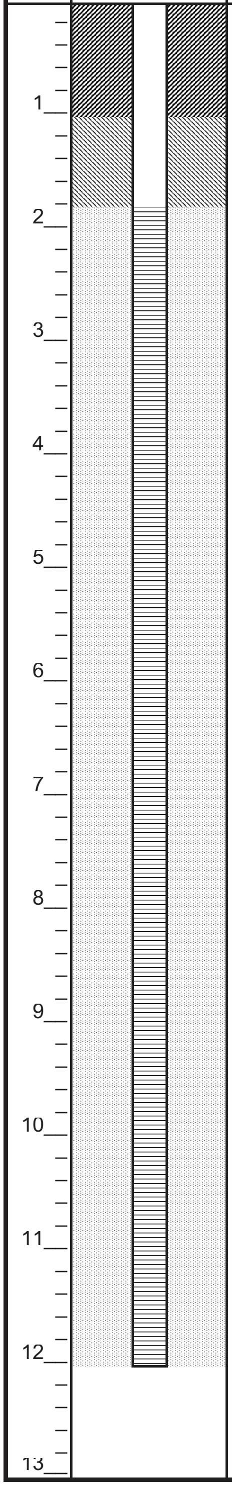
WESTON SOLUTIONS	**WELL CONSTRUCTION LOG**	Sheet 1 of 1	**Well ID: MSC-1**
	Project: Jewett White Lead Company	Drilling Method: Hollow-stem Augers/2-inch MacroSampler	

Client: USEPA Region 2 (RST 2)	Total Well Depth: 12 ft bgs
Date(s) Drilled: 14 October 2010	Ground Elevation:
Drilling Contractor: SET, Inc.	Overburden Thickness: >12 ft
Drill Rig: Geoprobe 6610	Well Construction: 2-inch diameter, 10-ft long, 0.01-inch slot PVC screen; #0 silica sand to 2 ft bgs, PVC riser, granular bentonite and cement surface seal, flush-mounted in road box.
Drill Foreman: Darwin Reid	
Logged by: Anthony Daniels	Depth to Groundwater: 8 ft bgs

Depth (ft bgs) | Graphic Well Log



Graphic Soil Log	Descriptive Log	Blow Count/ Penetration/Recovery	Remarks
	Asphalt.	Background	
		Background	
	Light brown sand and white silty sand, dry.		
	Light brown sand and white silty sand, dry.	Background	
	Brown medium to coarse silty sand. Contains brick fragments.	Background	
	Brown silty sand and reddish brown silty sand, moist to wet.	Background	
	White, black, red, and orange fine silty sand, dry. Contains mica.	Background	
	Light brown clay, saturated.		
	White, black, red, orange, and brown fine silty sand.	Background	
	Brown clay, saturated.	Background	
	End of boring.		

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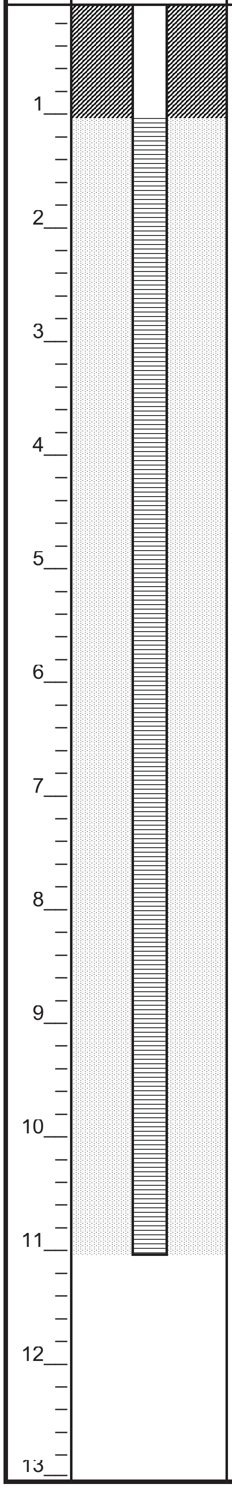
WELL CONSTRUCTION LOG		Sheet 1 of 1	**Well ID: MSC-2**
Project: Jewett White Lead Company		Drilling Method: Hollow-stem Augers/2-inch MacroSampler	
Client: USEPA Region 2 (RST 2)		Total Well Depth: 11 ft bgs	
Date(s) Drilled: 14 October 2010		Ground Elevation:	
Drilling Contractor: SET, Inc.		Overburden Thickness: >11 ft	
Drill Rig: Geoprobe 6610		Well Construction: 2-inch diameter, 10-ft long, 0.01-inch slot PVC screen; #0 silica sand to 1 ft bgs, PVC riser, cement surface seal, flush-mounted in road box.	
Drill Foreman: Darwin Reid			
Logged by: Anthony Daniels		Depth to Groundwater: 7.5 ft bgs	

Depth (ft bgs) | Graphic Well Log | Graphic Soil Log



Descriptive Log	Headspace Readings (ppm, in isobutylene-equivalents)	Remarks
Gravel and asphalt. Black fine silty sand. White fine sand.	Background	
White fine to medium gravelly, silty sand, dry.	Background	
Dark brown silty sand, moist.	Background	
Black silty sand, interbedded with grayish brown silty sand, wet. Contains brick fragments.	Background	
Black silty sand, interbedded with brown silty clay, wet. Contains brick fragments.	Background	
Strong reddish brown sand. Contains brick fragments.	Background	
Brown silty clay, dense, with some brown gravelly, silty sand, wet.	Background	
Brown silty clay, saturated.	Background	
End of boring.		

2015 Richmond Terrace

LOW-FLOW GROUNDWATER SAMPLING FIELD SHEET

Location (Site/Facility Name): Jewett White Lead Company
Well Number MSC-TR (5) Date 10/28/2010
Field Personnel J. Schmidl
Initial Depth to Water (FT BMP) 3.11 TD = 6.50

Sampling Organization WESTON
Identify MP inner casing
Purging Device; (pump type) Peristaltic
Pump/Tubing Intake (FT BGS) 6 ft BTK

Clock Time (24 HR)	Water Depth Below MP (ft)	Pump Dial[1]	Purge Rate (ml/min)	Cum. Volume Purged (liters)	Temp (C) (3%)	Specific Conduc.[2] (uS/cm°) (3%)	pH (+/-0.1)	ORP/ Eh[3] (mv) (+/-10)	DO (mg/L) (10%)	Turbidity (NTU) (10%)	Comments
1153	3.11	②	~~8~~ 500	4							
1158	3.11	①	~~400~~ 200	5	18.61	27.58	6.84	-314.1	1.46	4.6	one well volume
1203	3.11			6	18.16	27.06	6.83	-334.7	1.15	-0.8	
1208	3.11			7	17.99	27.08	6.82	-344.2	-2.08	-2.4	2 well volumes
1213	3.11			8	17.96	27.21	6.81	-344.2	-19.2	-2.9	~~all~~ sample w/ latex
1218											
											Maximum drawdown 3.11 ft = none
											Final Alkalinity (mg/L):

1. Pump dial setting (for example: hertz, cycles/min, etc)
2. uSiemens per cm (same as umhos/cm) at 25C

LOW-FLOW GROUNDWATER SAMPLING FIELD SHEET

Location (Site/Facility Name): Jewett White Lead Company
Well Number MSC-2 Date 10/28/2010
Field Personnel J. Schmidl
Initial Depth to Water (FT BMP) 7.91 TD = 11.25

Sampling Organization, WESTON
Identify MP inner casing
Purging Device; (pump type) Peristaltic
Pump/Tubing intake (FT BGS) 11

Clock Time (24 HR)	Water Depth Below MP (ft)	Pump Dial[1]	Purge Rate (ml/min)	Cum. Volume Purged (liters)	Temp (C) (3%)	Specific Conduc.[2] (uS/cm°) (3%)	pH (+/-0.1)	ORP/ Eh[3] (mv) (+/-10)	DO (mg/L) (10%)	Turbidity (NTU) (10%)	Comments
11:10	7.91		200	1							
11:15	8.20		100	1.2	20.20	1.027	6.99	60.5	0.90	0.8	One well volume
11:20	8.42		100	1.4	20.04	1.022	6.98	24.2	0.93	0.0	
11:25	8.66		1	1.6	19.89	1.007	6.99	1.2	0.98	-0.5	Sample collected
											Final drawdown 8.93
											Final Alkalinity (mg/L):

1. Pump dial setting (for example: hertz, cycles/min, etc)
2. uSiemens per cm (same as umhos/cm) at 25C

LOW-FLOW GROUNDWATER SAMPLING FIELD SHEET

Location (Site/Facility Name): Jewett White Lead Company
Well Number PO-3 Date 10/28/2010
Field Personnel J. Schmidl
Initial Depth to Water (FT BMP) 9.61 TD 16.90 ft

Sampling Organization WESTON
Identify MP inner casing
Purging Device; (pump type) Peristaltic
Pump/Tubing intake (FT BGS) 15

Clock Time (24 HR)	Water Depth Below MP (ft)	Pump Dial[1]	Purge Rate (ml/min)	Cum. Volume Purged (liters)	Temp (C) (3%)	Specific Conduc.[2] (uS/cm°) (3%)	pH (+/-0.1)	ORP/ Eh[3] (mv) (+/-10)	DO (mg/L) (10%)	Turbidity (NTU) (10%)	Comments
0900	9.61	w/a	500	1.5							
0903	9.87		|	3	17.82	0.739	6.75	65.0	6.43	10.2	
0908	10.05			4.5	17.66	0.733	6.66	74.5	3.87	10.6	
0913	10.21		100	4.6	17.60	0.726	6.70	80.1	4.60	2.0	
0918	10.30		↓	4.7	17.59	0.717	6.74	86.2	4.29	5.4	
0923	10.82			4.8	17.58	0.716	6.74	90.3	3.89	0.1	
0928	10.98			4.9	17.53	0.723	6.74	92.3	3.69	13.5	one well volume purged
											Sample collected.
											Final Drawdown 11.95 ft

Final Alkalinity (mg/L)

1. Pump dial setting (for example: hertz, cycles/min, etc)
2. uSiemens per cm (same as umhos/cm) at 25C

LOW-FLOW GROUNDWATER SAMPLING FIELD SHEET

Location (Site/Facility Name): Jewett White Lead Company
Well Number PO-1 Date 10/28/2010
Field Personnel J. Schmidl
Initial Depth to Water (FT BMP) 11.75 TD 15.92

Sampling Organization WESTON
Identify MP
Purging Device; (pump type) Peristaltic
Pump/Tubing intake (FT BGS) 15 ft

Clock Time (24 HR)	Water Depth Below MP (ft)	Pump Dial[1]	Purge Rate (ml/min)	Cum. Volume Purged (liters)	Temp (C) (3%)	Specific Conduc.[2] (uS/cm°) (3%)	pH (+/-0.1)	ORP/ Eh[3] (mv) (+/-10)	DO (mg/L) (10%)	Turbidity (NTU) (10%)	Comments
0955	11.75		500	1.5							
1000	11.90		100	2	17.82	1.348	6.56	-44.0	2.63	32.3	
1005	12.09			2.2	17.49	1.346	6.56	-48.2	1.57	25.2	
1010	12.22			2.4	17.38	1.374	6.62	-52.7	1.35	29.2	
1015	12.31			2.6	17.40	1.375	6.60	-54.3	1.36	38.9	one well volume
1020	12.42			2.8	17.53	1.369	6.60	-56.0	.31	-1.7	sample collected
										← failed	
											Max drawdown 12.62 ft.

Final Alkalinity (mg/L):

1. Pump dial setting (for example: hertz, cycles/min, etc)
2. uSiemens per cm (same as umhos/cm) at 25C

LOW-FLOW GROUNDWATER SAMPLING FIELD SHEET

Location (Site/Facility Name): Jewett White Lead Company
Well Number PO-~~3~~2 JS Date 10/28/2010
Field Personnel J. Schmidl
Initial Depth to Water (FT BMP) dry TD 12.2 ft

Sampling Organization WESTON
Identify MP
Purging Device; (pump type) Peristaltic
Pump/Tubing intake (FT BGS)

Clock Time (24 HR)	Water Depth Below MP (ft)	Pump Dial[1]	Purge Rate (ml/min)	Cum. Volume Purged (liters)	Temp (C) (3%)	Specific Conduc.[2] (uS/cm°) (3%)	pH (+/-0.1)	ORP/ Eh[3] (mv) (+/-10)	DO (mg/L) (10%)	Turbidity (NTU) (10%)	Comments
											Final Alkalinity (mg/L):

1. Pump dial setting (for example: hertz, cycles/min, etc)
2. uSiemens per cm (same as umhos/cm) at 25C

APPENDIX C

DATA VALIDATION DOCUMENTATION

WO # 20401.122.018.4003

DATA REVIEW CHECKLIST

SITE: Jewette White Lead
LAB NUMBER: # 10100024
WESTON SAMPLE IDs:

✱ ~~Note: Make sure rinsate blank contamination was~~ reviewed ✱

Data Reviewed	Fraction	Comments
	metals	
Chain of Custody	Only field dup data/samples were reviewed	per Joe S. reques
Percent Solids/RLs		
Preservation/Log Sheet		
Holding Time		
Field Blanks (Trip/Equip.)	RB-01 ~~Iron = 110ug/L or 11mg/kg x2 = 22mg/kg~~ ? Lead = 36ug/L or 3.6mg/kg x2 = 7.2mg/kg	
Instrument/Method Blanks (Soils/Solids)	RB-03 Iron = 180ug/L or 18mg/kg x2 = 36mg/kg	
Instrument/Method Blanks (Aqueous)	Several other rinsates were not reviewed per PMs.	
MS/MSD (Soil/Solids)		
MS/MSD (Aqueous)		
LCS/LCSD		
Blank Spikes (BS/BSD)		
Lab Duplicates	J1 - Estimate pos lead TCLP, lead SPLP and total lead in S-P02-0506 + S-P02-0506 due to non-compliant field dup RPD (>50%) ✓	
Field Duplicates	Estimate pos ~~lead~~ total ~~lead~~ IRON (JS) in GW-P02-1010 and GW-P02-1010-E ✓	
Surrogate Recoveries	and lead SD-05 and SD-05-E. ✓	

Note:
Data reviewed but not commented on is considered acceptable.
√ = Data Reviewed
NA = Not Applicable

Qualifiers Used:

J2 - Estimate pos Hg results in SP02-0506 + SP02-0506-E due to non-compliant field dup RPD. ✓

J3 - Estimate pos magnesium, calcium and arseni in SD-05 and SD-05-E due to non-compliant field dup RPD.

See Notes on Pages
26, 27, 46, 47, 49, 50, 51

Data Reviewer Initials: DFG
Date: 12/7/10

G:\HOME\QUIGLEYD\DATA REVIEW CHECKLIST.doc

Case Narrative:
Jewett White Lead #10100024

The National Environmental Laboratory Accreditation Conference (NELAC) is a voluntary environmental laboratory accreditation association of State and Federal agencies. NELAC established and promoted a national accreditation program that provides a uniform set of standards for the generation of environmental data that are of known and defensible quality. The EPA Region 2 Laboratory is NELAC accredited. The Laboratory tests that are accredited have met all the requirements established under the NELAC Standards.

Comment(s):

- *Total Analysis:* The solid samples for this project were prepared and analyzed on a Total basis for Lead. The Total Analysis results are reported in "mg/kg" units.

  Toxicity Characteristic Leaching Procedure (TCLP) and *Synthetic Precipitation Leaching Procedure (SPLP) Analysis:* The solid samples for this project were prepared using the both the TCLP procedure and SPLP procedure. The TCLP and SPLP extracts were digested and analyzed for Lead. The extract results were reported in "mg/L" units.

  Samples S-MSCB5-0001 (Laboratory ID AM04710), S-MSCB5-0001-E (Laboratory ID AM04711), and S-MSCF5-0304 (Laboratory ID AM04720), received on 10/20/10, only have TAL Metals and Mercury results reported. The TCLP and SPLP results for Lead could not be provided due to insufficient sample mass.

Data Qualifier(s):

U- The analyte was not detected at or above the Reporting Limit.
J- The identification of the analyte is acceptable; the reported value is an estimate.
K- The identification of the analyte is acceptable; the reported value may be biased high.
L- The identification of the analyte is acceptable; the reported value may be biased low.
NJ-There is presumptive evidence that the analyte is present; the analyte is reported as a tentative identification. The reported value is an estimate.

Reporting Limit(s):

The Laboratory was able to achieve the appropriate limits for each analyte requested.

Method(s):

All methods that are NELAC accredited in the Laboratory are noted with "NELAC" at the end of the method reference.

- TCLP Analysis (Lead): 1) Extraction - EPA SW-846 Method 1311 (TCLP Extraction) (NELAC); Analysis (Lead), EPA Method 200.7 (SOP C-109; ICP/AES Method) (NELAC)

- SPLP Analysis (Lead): 1) Extraction: EPA SW-846 Method 1312 (SPLP Extraction); Analysis (Lead), EPA Method 200.7 (SOP C-109; ICP/AES Method) (NELAC)
- TAL Metals Analysis, EPA SOP C-109 (ICP/AES Method)
- Mercury Analysis, EPA SOP C-110 (CVAAS Method)

Approval: ______________ Date: 11-10-10

U.S. Environmental Protection Agency
Region 2 Laboratory
2890 Woodbridge Avenue
Edison, NJ 08837

Data Report: JEWETT WHITE LEAD

Project Number: 10100024

Program: Y206

Project Leader: SMITA SUMBALY

Remark Codes	Explanation
U	THE ANALYTE WAS NOT DETECTED AT OR ABOVE THE REPORTING LIMIT.
J	THE IDENTIFICATION OF THE ANALYTE IS ACCEPTABLE; THE REPORTED VALUE IS AN ESTIMATE.
UJ	THE ANALYTE WAS NOT DETECTED AT OR ABOVE THE REPORTING LIMIT. THE REPORTING LIMIT IS AN ESTIMATE.
N	THERE IS PRESUMPTIVE EVIDENCE THAT THE ANALYTE IS PRESENT; THE ANALYTE IS REPORTED AS A TENTATIVE IDENTIFICATION.
NJ	THERE IS PRESUMPTIVE EVIDENCE THAT THE ANALYTE IS PRESENT; THE ANALYTE IS REPORTED AS A TENTATIVE IDENTIFICATION. THE REPORTED VALUE IS AN ESTIMATE.
R	THE PRESENCE OR ABSENCE OF THE ANALYTE CANNOT BE DETERMINED FROM THE DATA DUE TO SEVERE QUALITY CONTROL PROBLEMS. THE DATA ARE REJECTED AND CONSIDERED UNUSABLE.
K	THE IDENTIFICATION OF THE ANALYTE IS ACCEPTABLE; THE REPORTED VALUE MAY BE BIASED HIGH. THE ACTUAL VALUE IS EXPECTED TO BE LESS THAN THE REPORTED VALUE.
L	THE IDENTIFICATION OF THE ANALYTE IS ACCEPTABLE; THE REPORTED VALUE MAY BE BIASED LOW. THE ACTUAL VALUE IS EXPECTED TO BE GREATER THAN THE REPORTED VALUE.
NV	NOT VALIDATED
INC	RESULT NOT ENTERED

U.S. EPA Region 2 Laboratory
Data Report

Survey Name: JEWETT WHITE LEAD

Project Number: 10100024

*Sorted By Sample ID

AM04485 Field/Station ID: RB-01
Matrix: Aqueous

Date Received: 10/13/2010

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	---	0.20U	ug/L

Analysis Type: METALS TAL ICP AQUEOUS

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	5.0U	ug/L
7429-90-5	ALUMINUM	---	100U	ug/L
7440-38-2	ARSENIC	---	8.0U	ug/L
7440-39-3	BARIUM	---	100U	ug/L
7440-41-7	BERYLLIUM	---	3.0U	ug/L
7440-70-2	CALCIUM	---	500U	ug/L
7440-43-9	CADMIUM	---	3.0U	ug/L
7440-48-4	COBALT	---	20U	ug/L
7440-47-3	CHROMIUM	---	5.0U	ug/L
7440-50-8	COPPER	---	10U	ug/L
7439-89-6	IRON	110		ug/L
7440-09-7	POTASSIUM	---	1,000U	ug/L
7439-95-4	MAGNESIUM	---	500U	ug/L
7439-96-5	MANGANESE	---	5.0U	ug/L
7440-23-5	SODIUM	---	1,000U	ug/L
7440-02-0	NICKEL	---	20U	ug/L
7439-92-1	LEAD	36		ug/L
7440-36-0	ANTIMONY	---	20U	ug/L
7782-49-2	SELENIUM	---	20U	ug/L
7440-28-0	THALLIUM	---	20U	ug/L
7440-62-2	VANADIUM	---	20U	ug/L
7440-66-6	ZINC	---	20U	ug/L

AM04486 Field/Station ID: S-AB1.5-0405
Matrix: Soil

Date Received: 10/13/2010

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, TCLP	---	0.080U	mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, SPLP	---	0.080U	mg/L

efer to Page 1 for an explanation of Remark Codes

AM04486 Field/Station ID: S-AB1.5-0405 Date Received: 10/13/2010
Matrix: Soil

Sample Description:

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark Codes	Units
7440-22-4	SILVER	---	0.57U	mg/Kg
7429-90-5	ALUMINUM	8,200		mg/Kg
7440-38-2	ARSENIC	4.7		mg/Kg
7440-39-3	BARIUM	21		mg/Kg
7440-41-7	BERYLLIUM	0.45		mg/Kg
7440-70-2	CALCIUM	970		mg/Kg
7440-43-9	CADMIUM	---	0.34U	mg/Kg
7440-48-4	COBALT	4.9		mg/Kg
7440-47-3	CHROMIUM	14		mg/Kg
7440-50-8	COPPER	16		mg/Kg
7439-89-6	IRON	16,000		mg/Kg
7440-09-7	POTASSIUM	640		mg/Kg
7439-95-4	MAGNESIUM	3,900		mg/Kg
7439-96-5	MANGANESE	210		mg/Kg
7440-23-5	SODIUM	---	110U	mg/Kg
7440-02-0	NICKEL	10		mg/Kg
7439-92-1	LEAD	9.9		mg/Kg
7440-36-0	ANTIMONY	---	2.3U	mg/Kg
7782-49-2	SELENIUM	---	2.3U	mg/Kg
7440-28-0	THALLIUM	---	2.3U	mg/Kg
7440-62-2	VANADIUM	20		mg/Kg
7440-66-6	ZINC	31		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-97-6	MERCURY	0.013	L	mg/Kg

AM04487 Field/Station ID: S-AB1-0708 Date Received: 10/13/2010
Matrix: Soil

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-92-1	LEAD, TCLP	---	0.080U	mg/L

AM04487 Field/Station ID: S-AB1-0708 Date Received: 10/13/2010
Matrix: Soil

Sample Description:

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, SPLP	---	0.080U	mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	0.60U	mg/Kg
7429-90-5	ALUMINUM	6,500		mg/Kg
7440-38-2	ARSENIC	8.7		mg/Kg
7440-39-3	BARIUM	21		mg/Kg
7440-41-7	BERYLLIUM	0.37		mg/Kg
7440-70-2	CALCIUM	1,200		mg/Kg
7440-43-9	CADMIUM	---	0.36U	mg/Kg
7440-48-4	COBALT	5.0		mg/Kg
7440-47-3	CHROMIUM	12		mg/Kg
7440-50-8	COPPER	13		mg/Kg
7439-89-6	IRON	18,000		mg/Kg
7440-09-7	POTASSIUM	570		mg/Kg
7439-95-4	MAGNESIUM	2,100		mg/Kg
7439-96-5	MANGANESE	450		mg/Kg
7440-23-5	SODIUM	---	120U	mg/Kg
7440-02-0	NICKEL	9.4		mg/Kg
7439-92-1	LEAD	8.1		mg/Kg
7440-36-0	ANTIMONY	---	2.4U	mg/Kg
7782-49-2	SELENIUM	---	2.4U	mg/Kg
7440-28-0	THALLIUM	---	2.4U	mg/Kg
7440-62-2	VANADIUM	17		mg/Kg
7440-66-6	ZINC	27		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	0.019		mg/Kg

AM04488 Field/Station ID: S-AB2.5-0102 Date Received: 10/13/2010
Matrix: Soil

Sample Description:

Survey Name: JEWETT WHITE LEAD

Project Number: 10100024

*Sorted By Sample ID

AM04488 Field/Station ID: S-AB2.5-0102 Date Received: 10/13/2010
Matrix: Soil

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-92-1	LEAD, TCLP	20		mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-92-1	LEAD, SPLP	18		mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark Codes	Units
7440-22-4	SILVER	1.0		mg/Kg
7429-90-5	ALUMINUM	1,900		mg/Kg
7440-38-2	ARSENIC	6.8		mg/Kg
7440-39-3	BARIUM	670		mg/Kg
7440-41-7	BERYLLIUM	---	0.49U	mg/Kg
7440-70-2	CALCIUM	51,000		mg/Kg
7440-43-9	CADMIUM	1.5		mg/Kg
7440-48-4	COBALT	---	3.3U	mg/Kg
7440-47-3	CHROMIUM	9.4		mg/Kg
7440-50-8	COPPER	120		mg/Kg
7439-89-6	IRON	12,000		mg/Kg
7440-09-7	POTASSIUM	260		mg/Kg
7439-95-4	MAGNESIUM	2,500		mg/Kg
7439-96-5	MANGANESE	3,300		mg/Kg
7440-23-5	SODIUM	170		mg/Kg
7440-02-0	NICKEL	64		mg/Kg
7439-92-1	LEAD	75,000		mg/Kg
7440-36-0	ANTIMONY	3.8		mg/Kg
7782-49-2	SELENIUM	3.4		mg/Kg
7440-28-0	THALLIUM	---	3.3U	mg/Kg
7440-62-2	VANADIUM	8.3		mg/Kg
7440-66-6	ZINC	100		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-97-6	MERCURY	0.56		mg/Kg

AM04489 Field/Station ID: S-AB2.5-0304
Matrix: Soil

Date Received: 10/13/2010

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, TCLP	3.3		mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, SPLP	4.6		mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	0.94U	mg/Kg
7429-90-5	ALUMINUM	2,700		mg/Kg
7440-38-2	ARSENIC	---	1.5U	mg/Kg
7440-39-3	BARIUM	520		mg/Kg
7440-41-7	BERYLLIUM	---	0.57U	mg/Kg
7440-70-2	CALCIUM	41,000		mg/Kg
7440-43-9	CADMIUM	---	0.57U	mg/Kg
7440-48-4	COBALT	---	3.8U	mg/Kg
7440-47-3	CHROMIUM	5.7		mg/Kg
7440-50-8	COPPER	32		mg/Kg
7439-89-6	IRON	4,900		mg/Kg
7440-09-7	POTASSIUM	300		mg/Kg
7439-95-4	MAGNESIUM	1,900		mg/Kg
7439-96-5	MANGANESE	550		mg/Kg
7440-23-5	SODIUM	---	190U	mg/Kg
7440-02-0	NICKEL	4.2		mg/Kg
7439-92-1	LEAD	17,000		mg/Kg
7440-36-0	ANTIMONY	---	3.8U	mg/Kg
7782-49-2	SELENIUM	---	3.8U	mg/Kg
7440-28-0	THALLIUM	---	3.8U	mg/Kg
7440-62-2	VANADIUM	4.2		mg/Kg
7440-66-6	ZINC	54		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	1.3		mg/Kg

AM04490 Field/Station ID: S-AB3.5-0001 Date Received: 10/13/2010
Matrix: Soil

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-92-1	LEAD, TCLP	9.8		mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-92-1	LEAD, SPLP	7.0		mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark Codes	Units
7440-22-4	SILVER	---	0.56U	mg/Kg
7429-90-5	ALUMINUM	6,000		mg/Kg
7440-38-2	ARSENIC	8.6		mg/Kg
7440-39-3	BARIUM	140		mg/Kg
7440-41-7	BERYLLIUM	0.41		mg/Kg
7440-70-2	CALCIUM	37,000		mg/Kg
7440-43-9	CADMIUM	1.4		mg/Kg
7440-48-4	COBALT	8.1		mg/Kg
7440-47-3	CHROMIUM	25		mg/Kg
7440-50-8	COPPER	140		mg/Kg
7439-89-6	IRON	15,000		mg/Kg
7440-09-7	POTASSIUM	620		mg/Kg
7439-95-4	MAGNESIUM	9,800		mg/Kg
7439-96-5	MANGANESE	410		mg/Kg
7440-23-5	SODIUM	200		mg/Kg
7440-02-0	NICKEL	87		mg/Kg
7439-92-1	LEAD	7,500		mg/Kg
7440-36-0	ANTIMONY	---	2.2U	mg/Kg
7782-49-2	SELENIUM	---	2.2U	mg/Kg
7440-28-0	THALLIUM	---	2.2U	mg/Kg
7440-62-2	VANADIUM	24		mg/Kg
7440-66-6	ZINC	230		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-97-6	MERCURY	0.42		mg/Kg

Survey Name: JEWETT WHITE LEAD

Project Number: 10100024

*Sorted By Sample ID

AM04491 Field/Station ID: S-BC1-0001
Matrix: Soil

Date Received: 10/13/2010

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, TCLP	8.7		mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, SPLP	7.7		mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	0.62U	mg/Kg
7429-90-5	ALUMINUM	5,900		mg/Kg
7440-38-2	ARSENIC	8.2		mg/Kg
7440-39-3	BARIUM	120		mg/Kg
7440-41-7	BERYLLIUM	0.41		mg/Kg
7440-70-2	CALCIUM	18,000		mg/Kg
7440-43-9	CADMIUM	0.60		mg/Kg
7440-48-4	COBALT	5.8		mg/Kg
7440-47-3	CHROMIUM	15		mg/Kg
7440-50-8	COPPER	100		mg/Kg
7439-89-6	IRON	15,000		mg/Kg
7440-09-7	POTASSIUM	600		mg/Kg
7439-95-4	MAGNESIUM	6,900		mg/Kg
7439-96-5	MANGANESE	400		mg/Kg
7440-23-5	SODIUM	---	120U	mg/Kg
7440-02-0	NICKEL	23		mg/Kg
7439-92-1	LEAD	7,000		mg/Kg
7440-36-0	ANTIMONY	---	2.5U	mg/Kg
7782-49-2	SELENIUM	---	2.5U	mg/Kg
7440-28-0	THALLIUM	---	2.5U	mg/Kg
7440-62-2	VANADIUM	22		mg/Kg
7440-66-6	ZINC	200		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	0.20		mg/Kg

Survey Name: JEWETT WHITE LEAD

Project Number: 10100024

*Sorted By Sample ID

AM04492 Field/Station ID: S-C4-0102 Date Received: 10/13/2010
Matrix: Soil

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-92-1	LEAD, TCLP	28		mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-92-1	LEAD, SPLP	28		mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark Codes	Units
7440-22-4	SILVER	0.90		mg/Kg
7429-90-5	ALUMINUM	2,800		mg/Kg
7440-38-2	ARSENIC	6.7		mg/Kg
7440-39-3	BARIUM	650		mg/Kg
7440-41-7	BERYLLIUM	---	0.45U	mg/Kg
7440-70-2	CALCIUM	45,000		mg/Kg
7440-43-9	CADMIUM	2.1		mg/Kg
7440-48-4	COBALT	12		mg/Kg
7440-47-3	CHROMIUM	15		mg/Kg
7440-50-8	COPPER	140		mg/Kg
7439-89-6	IRON	13,000		mg/Kg
7440-09-7	POTASSIUM	330		mg/Kg
7439-95-4	MAGNESIUM	1,700		mg/Kg
7439-96-5	MANGANESE	1,800		mg/Kg
7440-23-5	SODIUM	200		mg/Kg
7440-02-0	NICKEL	84		mg/Kg
7439-92-1	LEAD	78,000		mg/Kg
7440-36-0	ANTIMONY	3.8		mg/Kg
7782-49-2	SELENIUM	---	3.0U	mg/Kg
7440-28-0	THALLIUM	---	3.0U	mg/Kg
7440-62-2	VANADIUM	12		mg/Kg
7440-66-6	ZINC	270		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-97-6	MERCURY	0.42		mg/Kg

Survey Name: JEWETT WHITE LEAD

Project Number: 10100024

*Sorted By Sample ID

AM04493 Field/Station ID: S-CD1.5-0405 Date Received: 10/13/2010
Matrix: Soil

Sample Description: MS/MSD

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, TCLP	---	0.080U	mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, SPLP	---	0.080U	mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	0.60U	mg/Kg
7429-90-5	ALUMINUM	6,700		mg/Kg
7440-38-2	ARSENIC	5.9		mg/Kg
7440-39-3	BARIUM	25		mg/Kg
7440-41-7	BERYLLIUM	---	0.36U	mg/Kg
7440-70-2	CALCIUM	760		mg/Kg
7440-43-9	CADMIUM	---	0.36U	mg/Kg
7440-48-4	COBALT	4.2		mg/Kg
7440-47-3	CHROMIUM	12		mg/Kg
7440-50-8	COPPER	8.7		mg/Kg
7439-89-6	IRON	14,000		mg/Kg
7440-09-7	POTASSIUM	510		mg/Kg
7439-95-4	MAGNESIUM	2,200		mg/Kg
7439-96-5	MANGANESE	160		mg/Kg
7440-23-5	SODIUM	---	120U	mg/Kg
7440-02-0	NICKEL	10		mg/Kg
7439-92-1	LEAD	8.3		mg/Kg
7440-36-0	ANTIMONY	---	2.4U L	mg/Kg
7782-49-2	SELENIUM	---	2.4U	mg/Kg
7440-28-0	THALLIUM	---	2.4U	mg/Kg
7440-62-2	VANADIUM	18		mg/Kg
7440-66-6	ZINC	30		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	0.017		mg/Kg

Survey Name: JEWETT WHITE LEAD

Project Number: 10100024

*Sorted By Sample ID

AM04494 Field/Station ID: S-CD3-0001 Date Received: 10/13/2010
Matrix: Soil

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-92-1	LEAD TCLP	2.1		mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-92-1	LEAD, SPLP	0.19		mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark Codes	Units
7440-22-4	SILVER	---	0.53U	mg/Kg
7429-90-5	ALUMINUM	7,400		mg/Kg
7440-38-2	ARSENIC	5.9		mg/Kg
7440-39-3	BARIUM	130		mg/Kg
7440-41-7	BERYLLIUM	0.51		mg/Kg
7440-70-2	CALCIUM	13,000		mg/Kg
7440-43-9	CADMIUM	0.56		mg/Kg
7440-48-4	COBALT	5.4		mg/Kg
7440-47-3	CHROMIUM	15		mg/Kg
7440-50-8	COPPER	60		mg/Kg
7439-89-6	IRON	15,000		mg/Kg
7440-09-7	POTASSIUM	720		mg/Kg
7439-95-4	MAGNESIUM	3,800		mg/Kg
7439-96-5	MANGANESE	360		mg/Kg
7440-23-5	SODIUM	---	110U	mg/Kg
7440-02-0	NICKEL	19		mg/Kg
7439-92-1	LEAD	2,100		mg/Kg
7440-36-0	ANTIMONY	---	2.1U	mg/Kg
7782-49-2	SELENIUM	---	2.1U	mg/Kg
7440-28-0	THALLIUM	---	2.1U	mg/Kg
7440-62-2	VANADIUM	19		mg/Kg
7440-66-6	ZINC	230		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-97-6	MERCURY	0.45		mg/Kg

AM04495 Field/Station ID: S-CD3-0001-E Date Received: 10/13/2010
Matrix: Soil

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, TCLP	22		mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, SPLP	1.2		mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	0.54U	mg/Kg
7429-90-5	ALUMINUM	7,000		mg/Kg
7440-38-2	ARSENIC	5.9		mg/Kg
7440-39-3	BARIUM	130		mg/Kg
7440-41-7	BERYLLIUM	0.53		mg/Kg
7440-70-2	CALCIUM	12,000		mg/Kg
7440-43-9	CADMIUM	0.56		mg/Kg
7440-48-4	COBALT	5.8		mg/Kg
7440-47-3	CHROMIUM	15		mg/Kg
7440-50-8	COPPER	54		mg/Kg
7439-89-6	IRON	15,000		mg/Kg
7440-09-7	POTASSIUM	700		mg/Kg
7439-95-4	MAGNESIUM	3,300		mg/Kg
7439-96-5	MANGANESE	390		mg/Kg
7440-23-5	SODIUM	---	110U	mg/Kg
7440-02-0	NICKEL	19		mg/Kg
7439-92-1	LEAD	2,300		mg/Kg
7440-36-0	ANTIMONY	---	2.1U	mg/Kg
7782-49-2	SELENIUM	---	2.1U	mg/Kg
7440-28-0	THALLIUM	---	2.1U	mg/Kg
7440-62-2	VANADIUM	20		mg/Kg
7440-66-6	ZINC	190		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	0.36		mg/Kg

AM04496 Field/Station ID: S-CD3-0102 Date Received: 10/13/2010
Matrix: Soil

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-92-1	LEAD, TCLP	0.86		mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-92-1	LEAD, SPLP	0.16		mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark Codes	Units
7440-22-4	SILVER	---	0.54U	mg/Kg
7429-90-5	ALUMINUM	8,900		mg/Kg
7440-38-2	ARSENIC	6.8		mg/Kg
7440-39-3	BARIUM	76		mg/Kg
7440-41-7	BERYLLIUM	0.48		mg/Kg
7440-70-2	CALCIUM	6,700		mg/Kg
7440-43-9	CADMIUM	---	0.33U	mg/Kg
7440-48-4	COBALT	5.3		mg/Kg
7440-47-3	CHROMIUM	16		mg/Kg
7440-50-8	COPPER	20		mg/Kg
7439-89-6	IRON	19,000		mg/Kg
7440-09-7	POTASSIUM	830		mg/Kg
7439-95-4	MAGNESIUM	2,200		mg/Kg
7439-96-5	MANGANESE	320		mg/Kg
7440-23-5	SODIUM	---	110U	mg/Kg
7440-02-0	NICKEL	10		mg/Kg
7439-92-1	LEAD	370		mg/Kg
7440-36-0	ANTIMONY	---	2.2U	mg/Kg
7782-49-2	SELENIUM	---	2.2U	mg/Kg
7440-28-0	THALLIUM	---	2.2U	mg/Kg
7440-62-2	VANADIUM	24		mg/Kg
7440-66-6	ZINC	74		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-97-6	MERCURY	0.093		mg/Kg

AM04497 Field/Station ID: S-CD3-0203 Date Received: 10/13/2010
Matrix: Soil

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, TCLP	---	0.080U	mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, SPLP	0.25		mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	0.51U	mg/Kg
7429-90-5	ALUMINUM	5,300		mg/Kg
7440-38-2	ARSENIC	5.0		mg/Kg
7440-39-3	BARIUM	26		mg/Kg
7440-41-7	BERYLLIUM	0.39		mg/Kg
7440-70-2	CALCIUM	860		mg/Kg
7440-43-9	CADMIUM	---	0.31U	mg/Kg
7440-48-4	COBALT	6.7		mg/Kg
7440-47-3	CHROMIUM	9.6		mg/Kg
7440-50-8	COPPER	8.2		mg/Kg
7439-89-6	IRON	15,000		mg/Kg
7440-09-7	POTASSIUM	520		mg/Kg
7439-95-4	MAGNESIUM	1,500		mg/Kg
7439-96-5	MANGANESE	360		mg/Kg
7440-23-5	SODIUM	---	100U	mg/Kg
7440-02-0	NICKEL	8.0		mg/Kg
7439-92-1	LEAD	38		mg/Kg
7440-36-0	ANTIMONY	---	2.1U	mg/Kg
7782-49-2	SELENIUM	---	2.1U	mg/Kg
7440-28-0	THALLIUM	---	2.1U	mg/Kg
7440-62-2	VANADIUM	16		mg/Kg
7440-66-6	ZINC	27		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	0.055		mg/Kg

U.S. EPA Region 2 Laboratory
Data Report

Survey Name: JEWETT WHITE LEAD

Project Number: 10100024

*Sorted By Sample ID

AM04498 Field/Station ID: S-DE1-0506 Date Received: 10/13/2010
Matrix: Soil

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, TCLP	---	0.080U	mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, SPLP	---	0.080U	mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	0.63U	mg/Kg
7429-90-5	ALUMINUM	5,400		mg/Kg
7440-38-2	ARSENIC	1.9		mg/Kg
7440-39-3	BARIUM	15		mg/Kg
7440-41-7	BERYLLIUM	---	0.38U	mg/Kg
7440-70-2	CALCIUM	400		mg/Kg
7440-43-9	CADMIUM	---	0.38U	mg/Kg
7440-48-4	COBALT	5.9		mg/Kg
7440-47-3	CHROMIUM	8.4		mg/Kg
7440-50-8	COPPER	8.8		mg/Kg
7439-89-6	IRON	12,000		mg/Kg
7440-09-7	POTASSIUM	320		mg/Kg
7439-95-4	MAGNESIUM	2,000		mg/Kg
7439-96-5	MANGANESE	530		mg/Kg
7440-23-5	SODIUM	---	130U	mg/Kg
7440-02-0	NICKEL	9.8		mg/Kg
7439-92-1	LEAD	8.6		mg/Kg
7440-36-0	ANTIMONY	---	2.5U	mg/Kg
7782-49-2	SELENIUM	---	2.5U	mg/Kg
7440-28-0	THALLIUM	---	2.5U	mg/Kg
7440-62-2	VANADIUM	9.0		mg/Kg
7440-66-6	ZINC	38		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
439-97-6	MERCURY	0.014		mg/Kg

Survey Name: JEWETT WHITE LEAD

Project Number: 10100024

*Sorted By Sample ID

AM04499 Field/Station ID: S-DE1-0607 Date Received: 10/13/2010
Matrix: Soil

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-92-1	LEAD, TCLP	---	0.080U	mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-92-1	LEAD, SPLP	---	0.080U	mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark Codes	Units
7440-22-4	SILVER	---	0.60U	mg/Kg
7429-90-5	ALUMINUM	5,700		mg/Kg
7440-38-2	ARSENIC	6.5		mg/Kg
7440-39-3	BARIUM	18		mg/Kg
7440-41-7	BERYLLIUM	0.38		mg/Kg
7440-70-2	CALCIUM	810		mg/Kg
7440-43-9	CADMIUM	---	0.36U	mg/Kg
7440-48-4	COBALT	7.9		mg/Kg
7440-47-3	CHROMIUM	12		mg/Kg
7440-50-8	COPPER	18		mg/Kg
7439-89-6	IRON	20,000		mg/Kg
7440-09-7	POTASSIUM	470		mg/Kg
7439-95-4	MAGNESIUM	1,700		mg/Kg
7439-96-5	MANGANESE	460		mg/Kg
7440-23-5	SODIUM	---	120U	mg/Kg
7440-02-0	NICKEL	8.8		mg/Kg
7439-92-1	LEAD	43		mg/Kg
7440-36-0	ANTIMONY	---	2.4U	mg/Kg
7782-49-2	SELENIUM	---	2.4U	mg/Kg
7440-28-0	THALLIUM	---	2.4U	mg/Kg
7440-62-2	VANADIUM	14		mg/Kg
7440-66-6	ZINC	38		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-97-6	MERCURY	0.026		mg/Kg

AM04500 Field/Station ID: S-ZA1-0304 Date Received: 10/13/2010
Matrix: Soil

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-92-1	LEAD, TCLP	---	0.080U	mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-92-1	LEAD, SPLP	---	0.080U	mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark Codes	Units
7440-22-4	SILVER	---	0.62U	mg/Kg
7429-90-5	ALUMINUM	6,000		mg/Kg
7440-38-2	ARSENIC	2.3		mg/Kg
7440-39-3	BARIUM	16		mg/Kg
7440-41-7	BERYLLIUM	---	0.37U	mg/Kg
7440-70-2	CALCIUM	590		mg/Kg
7440-43-9	CADMIUM	---	0.37U	mg/Kg
7440-48-4	COBALT	4.1		mg/Kg
7440-47-3	CHROMIUM	10		mg/Kg
7440-50-8	COPPER	7.3		mg/Kg
7439-89-6	IRON	13,000		mg/Kg
7440-09-7	POTASSIUM	370		mg/Kg
7439-95-4	MAGNESIUM	2,100		mg/Kg
7439-96-5	MANGANESE	120		mg/Kg
7440-23-5	SODIUM	---	120U	mg/Kg
7440-02-0	NICKEL	9.8		mg/Kg
7439-92-1	LEAD	10		mg/Kg
7440-36-0	ANTIMONY	---	2.5U	mg/Kg
7782-49-2	SELENIUM	---	2.5U	mg/Kg
7440-28-0	THALLIUM	---	2.5U	mg/Kg
7440-62-2	VANADIUM	12		mg/Kg
7440-66-6	ZINC	28		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-97-6	MERCURY	0.015		mg/Kg

Survey Name: JEWETT WHITE LEAD

Project Number: 10100024

*Sorted By Sample ID

AM04501 Field/Station ID: S-ZA3.5-0405 Date Received: 10/13/2010
Matrix: Soil

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, TCLP	6.6		mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, SPLP	14		mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	1.1U	mg/Kg
7429-90-5	ALUMINUM	1,200		mg/Kg
7440-38-2	ARSENIC	---	1.8U	mg/Kg
7440-39-3	BARIUM	890		mg/Kg
7440-41-7	BERYLLIUM	---	0.68U	mg/Kg
7440-70-2	CALCIUM	110,000		mg/Kg
7440-43-9	CADMIUM	2.4		mg/Kg
7440-48-4	COBALT	---	4.6U	mg/Kg
7440-47-3	CHROMIUM	5.8		mg/Kg
7440-50-8	COPPER	86		mg/Kg
7439-89-6	IRON	3,700		mg/Kg
7440-09-7	POTASSIUM	260		mg/Kg
7439-95-4	MAGNESIUM	1,700		mg/Kg
7439-96-5	MANGANESE	2,200		mg/Kg
7440-23-5	SODIUM	280		mg/Kg
7440-02-0	NICKEL	7.1		mg/Kg
7439-92-1	LEAD	66,000		mg/Kg
7440-36-0	ANTIMONY	---	4.6U	mg/Kg
7782-49-2	SELENIUM	---	4.6U	mg/Kg
7440-28-0	THALLIUM	---	4.6U	mg/Kg
7440-62-2	VANADIUM	---	4.6U	mg/Kg
7440-66-6	ZINC	160		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	1.1		mg/Kg

Survey Name: JEWETT WHITE LEAD

Project Number: 10100024

*Sorted By Sample ID

AM04502 Field/Station ID: S-ZA3.5-0708 Date Received: 10/13/2010
Matrix: Soil

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, TCLP	---	0.080U	mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, SPLP	---	0.080U	mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	0.55U	mg/Kg
7429-90-5	ALUMINUM	5,800		mg/Kg
7440-38-2	ARSENIC	1.5		mg/Kg
7440-39-3	BARIUM	44		mg/Kg
7440-41-7	BERYLLIUM	---	0.33U	mg/Kg
7440-70-2	CALCIUM	1,000		mg/Kg
7440-43-9	CADMIUM	---	0.33U	mg/Kg
7440-48-4	COBALT	4.5		mg/Kg
7440-47-3	CHROMIUM	12		mg/Kg
7440-50-8	COPPER	7.5		mg/Kg
7439-89-6	IRON	11,000		mg/Kg
7440-09-7	POTASSIUM	480		mg/Kg
7439-95-4	MAGNESIUM	2,200		mg/Kg
7439-96-5	MANGANESE	140		mg/Kg
7440-23-5	SODIUM	---	110U	mg/Kg
7440-02-0	NICKEL	11		mg/Kg
7439-92-1	LEAD	32		mg/Kg
7440-36-0	ANTIMONY	---	2.2U	mg/Kg
7782-49-2	SELENIUM	---	2.2U	mg/Kg
7440-28-0	THALLIUM	---	2.2U	mg/Kg
7440-62-2	VANADIUM	11		mg/Kg
7440-66-6	ZINC	29		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	0.016		mg/Kg

AM04503 Field/Station ID: S-ZA4-0607 Date Received: 10/13/2010
Matrix: Soil

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, TCLP	1.7		mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, SPLP	0.51		mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	0.55U	mg/Kg
7429-90-5	ALUMINUM	6,400		mg/Kg
7440-38-2	ARSENIC	3.4		mg/Kg
7440-39-3	BARIUM	36		mg/Kg
7440-41-7	BERYLLIUM	0.40		mg/Kg
7440-70-2	CALCIUM	1,900		mg/Kg
7440-43-9	CADMIUM	---	0.33U	mg/Kg
7440-48-4	COBALT	6.4		mg/Kg
7440-47-3	CHROMIUM	9.9		mg/Kg
7440-50-8	COPPER	12		mg/Kg
7439-89-6	IRON	12,000		mg/Kg
7440-09-7	POTASSIUM	600		mg/Kg
7439-95-4	MAGNESIUM	2,200		mg/Kg
7439-96-5	MANGANESE	270		mg/Kg
7440-23-5	SODIUM	---	110U	mg/Kg
7440-02-0	NICKEL	8.9		mg/Kg
7439-92-1	LEAD	120		mg/Kg
7440-36-0	ANTIMONY	---	2.2U	mg/Kg
7782-49-2	SELENIUM	---	2.2U	mg/Kg
7440-28-0	THALLIUM	---	2.2U	mg/Kg
7440-62-2	VANADIUM	15		mg/Kg
7440-66-6	ZINC	28		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	0.015		mg/Kg

AM04699 Field/Station ID: RB-02 Date Received: 10/20/2010
Matrix: Aqueous

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	---	0.20U	ug/L

Analysis Type: METALS TAL ICP AQUEOUS

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	5.0U	ug/L
7429-90-5	ALUMINUM	---	100U	ug/L
7440-38-2	ARSENIC	---	8.0U	ug/L
7440-39-3	BARIUM	---	100U	ug/L
7440-41-7	BERYLLIUM	---	3.0U	ug/L
7440-70-2	CALCIUM	---	500U	ug/L
7440-43-9	CADMIUM	---	3.0U	ug/L
7440-48-4	COBALT	---	20U	ug/L
7440-47-3	CHROMIUM	---	5.0U	ug/L
7440-50-8	COPPER	---	10U	ug/L
7439-89-6	IRON	---	50U	ug/L
7440-09-7	POTASSIUM	---	1,000U J	ug/L
7439-95-4	MAGNESIUM	---	500U	ug/L
7439-96-5	MANGANESE	---	5.0U	ug/L
7440-23-5	SODIUM	---	1,000U	ug/L
7440-02-0	NICKEL	---	20U	ug/L
7439-92-1	LEAD	---	8.0U	ug/L
7440-36-0	ANTIMONY	---	20U	ug/L
7782-49-2	SELENIUM	---	20U	ug/L
7440-28-0	THALLIUM	---	20U	ug/L
7440-62-2	VANADIUM	---	20U	ug/L
7440-66-6	ZINC	---	20U	ug/L

AM04700 Field/Station ID: RB-04 Date Received: 10/20/2010
Matrix: Aqueous

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	---	0.20U	ug/L

AM04700 Field/Station ID: RB-04 Date Received: 10/20/2010
Matrix: Aqueous

Sample Description:

Analysis Type: METALS TAL ICP AQUEOUS

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	5.0U	ug/L
7429-90-5	ALUMINUM	---	100U	ug/L
7440-38-2	ARSENIC	---	8.0U	ug/L
7440-39-3	BARIUM	---	100U	ug/L
7440-41-7	BERYLLIUM	---	3.0U	ug/L
7440-70-2	CALCIUM	---	500U	ug/L
7440-43-9	CADMIUM	---	3.0U	ug/L
7440-48-4	COBALT	---	20U	ug/L
7440-47-3	CHROMIUM	---	5.0U	ug/L
7440-50-8	COPPER	---	10U	ug/L
7439-89-6	IRON	200		ug/L
7440-09-7	POTASSIUM	---	1,000U	ug/L
7439-95-4	MAGNESIUM	---	500U	ug/L
7439-96-5	MANGANESE	---	5.0U	ug/L
7440-23-5	SODIUM	---	1,000U	ug/L
7440-02-0	NICKEL	---	20U	ug/L
7439-92-1	LEAD	27		ug/L
7440-36-0	ANTIMONY	---	20U	ug/L
7782-49-2	SELENIUM	---	20U	ug/L
7440-28-0	THALLIUM	---	20U	ug/L
7440-62-2	VANADIUM	---	20U	ug/L
7440-66-6	ZINC	---	20U	ug/L

AM04701 Field/Station ID: S-MSC1-0708 Date Received: 10/20/2010
Matrix: Soil

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, TCLP	4.5		mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, SPLP	0.62		mg/L

Survey Name: JEWETT WHITE LEAD

Project Number: 10100024

*Sorted By Sample ID

AM04701 Field/Station ID: S-MSC1-0708
Matrix: Soil

Date Received: 10/20/2010

Sample Description:

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	0.47U	mg/Kg
7429-90-5	ALUMINUM	14,000		mg/Kg
7440-38-2	ARSENIC	21		mg/Kg
7440-39-3	BARIUM	190		mg/Kg
7440-41-7	BERYLLIUM	---	0.28U	mg/Kg
7440-70-2	CALCIUM	1,400		mg/Kg
7440-43-9	CADMIUM	0.33		mg/Kg
7440-48-4	COBALT	10		mg/Kg
7440-47-3	CHROMIUM	49		mg/Kg
7440-50-8	COPPER	40		mg/Kg
7439-89-6	IRON	26,000		mg/Kg
7440-09-7	POTASSIUM	8,100		mg/Kg
7439-95-4	MAGNESIUM	6,500		mg/Kg
7439-96-5	MANGANESE	280		mg/Kg
7440-23-5	SODIUM	2,200		mg/Kg
7440-02-0	NICKEL	23		mg/Kg
7439-92-1	LEAD	1,600		mg/Kg
7440-36-0	ANTIMONY	---	1.9U	mg/Kg
7782-49-2	SELENIUM	---	1.9U	mg/Kg
7440-28-0	THALLIUM	---	1.9U	mg/Kg
7440-62-2	VANADIUM	53		mg/Kg
7440-66-6	ZINC	79		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	1.1		mg/Kg

AM04702 Field/Station ID: S-MSC2-0708
Matrix: Soil

Date Received: 10/20/2010

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, TCLP	220		mg/L

AM04702 Field/Station ID: S-MSC2-0708 Date Received: 10/20/2010
Matrix: Soil

Sample Description:

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, SPLP	0.92		mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	0.52U	mg/Kg
7429-90-5	ALUMINUM	7,500		mg/Kg
7440-38-2	ARSENIC	4.2		mg/Kg
7440-39-3	BARIUM	110		mg/Kg
7440-41-7	BERYLLIUM	0.46		mg/Kg
7440-70-2	CALCIUM	1,700		mg/Kg
7440-43-9	CADMIUM	3.1		mg/Kg
7440-48-4	COBALT	4.7		mg/Kg
7440-47-3	CHROMIUM	20		mg/Kg
7440-50-8	COPPER	450		mg/Kg
7439-89-6	IRON	12,000		mg/Kg
7440-09-7	POTASSIUM	670		mg/Kg
7439-95-4	MAGNESIUM	1,600		mg/Kg
7439-96-5	MANGANESE	96		mg/Kg
7440-23-5	SODIUM	---	100U	mg/Kg
7440-02-0	NICKEL	42		mg/Kg
7439-92-1	LEAD	20,000		mg/Kg
7440-36-0	ANTIMONY	2.7		mg/Kg
7782-49-2	SELENIUM	---	2.1U	mg/Kg
7440-28-0	THALLIUM	---	2.1U	mg/Kg
7440-62-2	VANADIUM	17		mg/Kg
7440-66-6	ZINC	58		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	0.070		mg/Kg

AM04703 Field/Station ID: S-PO1-0607 Date Received: 10/20/2010
Matrix: Soil

Sample Description: MS/MSD

AM04703 Field/Station ID: S-PO1-0607 Date Received: 10/20/2010
Matrix: Soil

Sample Description: MS/MSD

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, TCLP	---	0.080U	mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, SPLP	---	0.16U	mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	0.54U	mg/Kg
7429-90-5	ALUMINUM	6,600		mg/Kg
7440-38-2	ARSENIC	8.9		mg/Kg
7440-39-3	BARIUM	43		mg/Kg
7440-41-7	BERYLLIUM	---	0.32U	mg/Kg
7440-70-2	CALCIUM	2,600		mg/Kg
7440-43-9	CADMIUM	---	0.32U	mg/Kg
7440-48-4	COBALT	7.5		mg/Kg
7440-47-3	CHROMIUM	14		mg/Kg
7440-50-8	COPPER	18		mg/Kg
7439-89-6	IRON	26,000		mg/Kg
7440-09-7	POTASSIUM	570		mg/Kg
7439-95-4	MAGNESIUM	1,800		mg/Kg
7439-96-5	MANGANESE	370		mg/Kg
7440-23-5	SODIUM	---	110U	mg/Kg
7440-02-0	NICKEL	9.4		mg/Kg
7439-92-1	LEAD	11		mg/Kg
7440-36-0	ANTIMONY	---	2.1U	mg/Kg
7782-49-2	SELENIUM	---	2.1U	mg/Kg
7440-28-0	THALLIUM	---	2.1U	mg/Kg
7440-62-2	VANADIUM	17		mg/Kg
7440-66-6	ZINC	33		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	0.022		mg/Kg

Survey Name: JEWETT WHITE LEAD

Project Number: 10100024

*Sorted By Sample ID

AM04704 Field/Station ID: S-PO2-0506 Date Received: 10/20/2010
Matrix: Soil

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, TCLP	0.53	J1	mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, SPLP	0.38	J1	mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	0.52U	mg/Kg
7429-90-5	ALUMINUM	6,700		mg/Kg
7440-38-2	ARSENIC	2.6		mg/Kg
7440-39-3	BARIUM	37		mg/Kg
7440-41-7	BERYLLIUM	---	0.31U	mg/Kg
7440-70-2	CALCIUM	1,200		mg/Kg
7440-43-9	CADMIUM	---	0.31U	mg/Kg
7440-48-4	COBALT	3.8		mg/Kg
7440-47-3	CHROMIUM	11		mg/Kg
7440-50-8	COPPER	13		mg/Kg
7439-89-6	IRON	13,000		mg/Kg
7440-09-7	POTASSIUM	590		mg/Kg
7439-95-4	MAGNESIUM	2,000		mg/Kg
7439-96-5	MANGANESE	140		mg/Kg
7440-23-5	SODIUM	---	100U	mg/Kg
7440-02-0	NICKEL	9.0		mg/Kg
7439-92-1	LEAD	88	J	mg/Kg
7440-36-0	ANTIMONY	---	2.1U	mg/Kg
7782-49-2	SELENIUM	---	2.1U	mg/Kg
7440-28-0	THALLIUM	---	2.1U	mg/Kg
7440-62-2	VANADIUM	15		mg/Kg
7440-66-6	ZINC	29		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	0.011	J2	mg/Kg

Survey Name: JEWETT WHITE LEAD

Project Number: 10100024

*Sorted By Sample ID

AM04705 Field/Station ID: S-PO2-0506-E
Matrix: Soil

Date Received: 10/20/2010

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-92-1	LEAD, TCLP	1.7	J^1	mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-92-1	LEAD, SPLP	1.0	J^1	mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark Codes	Units
7440-22-4	SILVER	---	0.54U	mg/Kg
7429-90-5	ALUMINUM	7,300		mg/Kg
7440-38-2	ARSENIC	3.4		mg/Kg
7440-39-3	BARIUM	37		mg/Kg
7440-41-7	BERYLLIUM	---	0.32U	mg/Kg
7440-70-2	CALCIUM	1,200		mg/Kg
7440-43-9	CADMIUM	---	0.32U	mg/Kg
7440-48-4	COBALT	4.0		mg/Kg
7440-47-3	CHROMIUM	12		mg/Kg
7440-50-8	COPPER	13		mg/Kg
7439-89-6	IRON	13,000		mg/Kg
7440-09-7	POTASSIUM	590		mg/Kg
7439-95-4	MAGNESIUM	2,100		mg/Kg
7439-96-5	MANGANESE	140		mg/Kg
7440-23-5	SODIUM	---	110U	mg/Kg
7440-02-0	NICKEL	9.7		mg/Kg
7439-92-1	LEAD	200	J	mg/Kg
7440-36-0	ANTIMONY	---	2.2U	mg/Kg
7782-49-2	SELENIUM	---	2.2U	mg/Kg
7440-28-0	THALLIUM	---	2.2U	mg/Kg
7440-62-2	VANADIUM	15		mg/Kg
7440-66-6	ZINC	32		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-97-6	MERCURY	0.020	J^2	mg/Kg

$\frac{.009}{.0155} \times 100 = 58\%$

Survey Name: JEWETT WHITE LEAD

Project Number: 10100024

*Sorted By Sample ID

AM04706 Field/Station ID: S-PO3-0910 Date Received: 10/20/2010
Matrix: Soil

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, TCLP	---	0.080U	mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, SPLP	---	0.16U	mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	0.49U	mg/Kg
7429-90-5	ALUMINUM	11,000		mg/Kg
7440-38-2	ARSENIC	5.4		mg/Kg
7440-39-3	BARIUM	45		mg/Kg
7440-41-7	BERYLLIUM	0.58		mg/Kg
7440-70-2	CALCIUM	1,100		mg/Kg
7440-43-9	CADMIUM	---	0.29U	mg/Kg
7440-48-4	COBALT	8.2		mg/Kg
7440-47-3	CHROMIUM	22		mg/Kg
7440-50-8	COPPER	18		mg/Kg
7439-89-6	IRON	21,000		mg/Kg
7440-09-7	POTASSIUM	1,900		mg/Kg
7439-95-4	MAGNESIUM	4,600		mg/Kg
7439-96-5	MANGANESE	260		mg/Kg
7440-23-5	SODIUM	---	98U	mg/Kg
7440-02-0	NICKEL	18		mg/Kg
7439-92-1	LEAD	23		mg/Kg
7440-36-0	ANTIMONY	---	2.0U	mg/Kg
7782-49-2	SELENIUM	---	2.0U	mg/Kg
7440-28-0	THALLIUM	---	2.0U	mg/Kg
7440-62-2	VANADIUM	32		mg/Kg
7440-66-6	ZINC	80		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	---	0.0033U	mg/Kg

Refer to Page 1 for an explanation of Remark Codes

AM04707 Field/Station ID: RB-03 Date Received: 10/20/2010
Matrix: Aqueous

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	---	0.20U	ug/L

Analysis Type: METALS TAL ICP AQUEOUS

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	5.0U	ug/L
7429-90-5	ALUMINUM	---	100U	ug/L
7440-38-2	ARSENIC	---	8.0U	ug/L
7440-39-3	BARIUM	---	100U	ug/L
7440-41-7	BERYLLIUM	---	3.0U	ug/L
7440-70-2	CALCIUM	---	500U	ug/L
7440-43-9	CADMIUM	---	3.0U	ug/L
7440-48-4	COBALT	---	20U	ug/L
7440-47-3	CHROMIUM	---	5.0U	ug/L
7440-50-8	COPPER	---	10U	ug/L
7439-89-6	IRON	180		ug/L
7440-09-7	POTASSIUM	---	1,000U	ug/L
7439-95-4	MAGNESIUM	---	500U	ug/L
7439-96-5	MANGANESE	---	5.0U	ug/L
7440-23-5	SODIUM	---	1,000U	ug/L
7440-02-0	NICKEL	---	20U	ug/L
7439-92-1	LEAD	---	8.0U	ug/L
7440-36-0	ANTIMONY	---	20U	ug/L
7782-49-2	SELENIUM	---	20U	ug/L
7440-28-0	THALLIUM	---	20U	ug/L
7440-62-2	VANADIUM	---	20U	ug/L
7440-66-6	ZINC	---	20U	ug/L

AM04708 Field/Station ID: S-MSCB1-0102 Date Received: 10/20/2010
Matrix: Soil

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, TCLP	0.28		mg/L

AM04708 Field/Station ID: S-MSCB1-0102 Date Received: 10/20/2010
Matrix: Soil

Sample Description:

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, SPLP	---	0.080U	mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	0.45U	mg/Kg
7429-90-5	ALUMINUM	910		mg/Kg
7440-38-2	ARSENIC	4.4		mg/Kg
7440-39-3	BARIUM	26		mg/Kg
7440-41-7	BERYLLIUM	---	0.27U	mg/Kg
7440-70-2	CALCIUM	120,000	J	mg/Kg
7440-43-9	CADMIUM	---	0.27U	mg/Kg
7440-48-4	COBALT	2.5		mg/Kg
7440-47-3	CHROMIUM	4.1		mg/Kg
7440-50-8	COPPER	24		mg/Kg
7439-89-6	IRON	5,600		mg/Kg
7440-09-7	POTASSIUM	320		mg/Kg
7439-95-4	MAGNESIUM	70,000		mg/Kg
7439-96-5	MANGANESE	160		mg/Kg
7440-23-5	SODIUM	500		mg/Kg
7440-02-0	NICKEL	6.7		mg/Kg
7439-92-1	LEAD	390		mg/Kg
7440-36-0	ANTIMONY	---	1.8U	mg/Kg
7782-49-2	SELENIUM	---	1.8U	mg/Kg
7440-28-0	THALLIUM	---	1.8U	mg/Kg
7440-62-2	VANADIUM	6.3		mg/Kg
7440-66-6	ZINC	43		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	0.048		mg/Kg

AM04709 Field/Station ID: S-MSCB1-0304 Date Received: 10/20/2010
Matrix: Soil

Sample Description:

AM04709 Field/Station ID: S-MSCB1-0304 Date Received: 10/20/2010
Matrix: Soil

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-92-1	LEAD, TCLP	310		mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-92-1	LEAD, SPLP	12		mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark Codes	Units
7440-22-4	SILVER	---	0.68U	mg/Kg
7429-90-5	ALUMINUM	1,300		mg/Kg
7440-38-2	ARSENIC	2.0		mg/Kg
7440-39-3	BARIUM	240		mg/Kg
7440-41-7	BERYLLIUM	---	0.41U	mg/Kg
7440-70-2	CALCIUM	12,000		mg/Kg
7440-43-9	CADMIUM	2.0		mg/Kg
7440-48-4	COBALT	---	2.7U	mg/Kg
7440-47-3	CHROMIUM	3.5		mg/Kg
7440-50-8	COPPER	70		mg/Kg
7439-89-6	IRON	2,800		mg/Kg
7440-09-7	POTASSIUM	570		mg/Kg
7439-95-4	MAGNESIUM	4,500		mg/Kg
7439-96-5	MANGANESE	250		mg/Kg
7440-23-5	SODIUM	8,400		mg/Kg
7440-02-0	NICKEL	6.2		mg/Kg
7439-92-1	LEAD	36,000		mg/Kg
7440-36-0	ANTIMONY	3.1		mg/Kg
7782-49-2	SELENIUM	---	2.7U	mg/Kg
7440-28-0	THALLIUM	---	2.7U	mg/Kg
7440-62-2	VANADIUM	6.0		mg/Kg
7440-66-6	ZINC	55		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-97-6	MERCURY	0.69		mg/Kg

AM04710 Field/Station ID: S-MSCB5-0001 Date Received: 10/20/2010
Matrix: Soil

Sample Description:

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	0.54U	mg/Kg
7429-90-5	ALUMINUM	10,000		mg/Kg
7440-38-2	ARSENIC	5.4		mg/Kg
7440-39-3	BARIUM	170		mg/Kg
7440-41-7	BERYLLIUM	---	0.32U	mg/Kg
7440-70-2	CALCIUM	80,000	J	mg/Kg
7440-43-9	CADMIUM	0.87		mg/Kg
7440-48-4	COBALT	4.9		mg/Kg
7440-47-3	CHROMIUM	33		mg/Kg
7440-50-8	COPPER	42		mg/Kg
7439-89-6	IRON	12,000		mg/Kg
7440-09-7	POTASSIUM	1,000		mg/Kg
7439-95-4	MAGNESIUM	6,200		mg/Kg
7439-96-5	MANGANESE	580		mg/Kg
7440-23-5	SODIUM	130		mg/Kg
7440-02-0	NICKEL	17		mg/Kg
7439-92-1	LEAD	2,400		mg/Kg
7440-36-0	ANTIMONY	---	2.1U	mg/Kg
7782-49-2	SELENIUM	---	2.1U	mg/Kg
7440-28-0	THALLIUM	---	2.1U	mg/Kg
7440-62-2	VANADIUM	22		mg/Kg
7440-66-6	ZINC	340		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	0.054		mg/Kg

AM04711 Field/Station ID: S-MSCB5-0001-E Date Received: 10/20/2010
Matrix: Soil

Sample Description:

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	0.53U	mg/Kg

Survey Name: JEWETT WHITE LEAD

Project Number: 10100024

*Sorted By Sample ID

AM04711 Field/Station ID: S-MSCB5-0001-E Date Received: 10/20/2010
Matrix: Soil

Sample Description:

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark Codes	Units
7429-90-5	ALUMINUM	12,000		mg/Kg
7440-38-2	ARSENIC	4.6		mg/Kg
7440-39-3	BARIUM	160		mg/Kg
7440-41-7	BERYLLIUM	0.44		mg/Kg
7440-70-2	CALCIUM	82,000	J	mg/Kg
7440-43-9	CADMIUM	1.3		mg/Kg
7440-48-4	COBALT	7.4		mg/Kg
7440-47-3	CHROMIUM	27		mg/Kg
7440-50-8	COPPER	48		mg/Kg
7439-89-6	IRON	18,000		mg/Kg
7440-09-7	POTASSIUM	1,300		mg/Kg
7439-95-4	MAGNESIUM	5,900		mg/Kg
7439-96-5	MANGANESE	660		mg/Kg
7440-23-5	SODIUM	150		mg/Kg
7440-02-0	NICKEL	28		mg/Kg
7439-92-1	LEAD	1,600		mg/Kg
7440-36-0	ANTIMONY	---	2.1U	mg/Kg
7782-49-2	SELENIUM	---	2.1U	mg/Kg
7440-28-0	THALLIUM	---	2.1U	mg/Kg
7440-62-2	VANADIUM	25		mg/Kg
7440-66-6	ZINC	470		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-97-6	MERCURY	0.066		mg/Kg

AM04712 Field/Station ID: S-MSCC1-0102 Date Received: 10/20/2010
Matrix: Soil

Sample Description: MS/MSD

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-92-1	LEAD, TCLP	---	0.080U	mg/L

Survey Name: JEWETT WHITE LEAD

Project Number: 10100024

*Sorted By Sample ID

AM04712 Field/Station ID: S-MSCC1-0102 Date Received: 10/20/2010
Matrix: Soil

Sample Description: MS/MSD

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, SPLP	0.088		mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	0.47U	mg/Kg
7429-90-5	ALUMINUM	540		mg/Kg
7440-38-2	ARSENIC	4.0		mg/Kg
7440-39-3	BARIUM	---	9.4U	mg/Kg
7440-41-7	BERYLLIUM	---	0.28U	mg/Kg
7440-70-2	CALCIUM	160,000	J	mg/Kg
7440-43-9	CADMIUM	---	0.28U	mg/Kg
7440-48-4	COBALT	2.0		mg/Kg
7440-47-3	CHROMIUM	3.2		mg/Kg
7440-50-8	COPPER	4.1		mg/Kg
7439-89-6	IRON	4,800		mg/Kg
7440-09-7	POTASSIUM	260		mg/Kg
7439-95-4	MAGNESIUM	98,000	J	mg/Kg
7439-96-5	MANGANESE	190		mg/Kg
7440-23-5	SODIUM	370		mg/Kg
7440-02-0	NICKEL	4.2		mg/Kg
7439-92-1	LEAD	7.9		mg/Kg
7440-36-0	ANTIMONY	---	1.9U	mg/Kg
7782-49-2	SELENIUM	---	1.9U	mg/Kg
7440-28-0	THALLIUM	---	1.9U	mg/Kg
7440-62-2	VANADIUM	6.5		mg/Kg
7440-66-6	ZINC	10		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	---	0.0078U	mg/Kg

AM04713 Field/Station ID: S-MSCC1-0203 Date Received: 10/20/2010
Matrix: Soil

Sample Description:

Survey Name: JEWETT WHITE LEAD

Project Number: 10100024

*Sorted By Sample ID

AM04713 Field/Station ID: S-MSCC1-0203 Date Received: 10/20/2010
Matrix: Soil

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-92-1	LEAD, TCLP	34		mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-92-1	LEAD, SPLP	1.4		mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark Codes	Units
7440-22-4	SILVER	---	0.42U	mg/Kg
7429-90-5	ALUMINUM	760		mg/Kg
7440-38-2	ARSENIC	4.3		mg/Kg
7440-39-3	BARIUM	45		mg/Kg
7440-41-7	BERYLLIUM	---	0.25U	mg/Kg
7440-70-2	CALCIUM	150,000	J	mg/Kg
7440-43-9	CADMIUM	0.40		mg/Kg
7440-48-4	COBALT	2.3		mg/Kg
7440-47-3	CHROMIUM	6.2		mg/Kg
7440-50-8	COPPER	27		mg/Kg
7439-89-6	IRON	7,600		mg/Kg
7440-09-7	POTASSIUM	290		mg/Kg
7439-95-4	MAGNESIUM	88,000	J	mg/Kg
7439-96-5	MANGANESE	220		mg/Kg
7440-23-5	SODIUM	570		mg/Kg
7440-02-0	NICKEL	6.5		mg/Kg
7439-92-1	LEAD	1,900		mg/Kg
7440-36-0	ANTIMONY	---	1.7U	mg/Kg
7782-49-2	SELENIUM	---	1.7U	mg/Kg
7440-28-0	THALLIUM	---	1.7U	mg/Kg
7440-62-2	VANADIUM	5.5		mg/Kg
7440-66-6	ZINC	79		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-97-6	MERCURY	0.098		mg/Kg

Refer to Page 1 for an explanation of Remark Codes

AM04714 Field/Station ID: S-MSCC5-0102 Date Received: 10/20/2010
Matrix: Soil

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, TCLP	2.5		mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, SPLP	0.58		mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	0.43U	mg/Kg
7429-90-5	ALUMINUM	1,200		mg/Kg
7440-38-2	ARSENIC	8.7		mg/Kg
7440-39-3	BARIUM	49		mg/Kg
7440-41-7	BERYLLIUM	---	0.26U	mg/Kg
7440-70-2	CALCIUM	130,000	J	mg/Kg
7440-43-9	CADMIUM	0.64		mg/Kg
7440-48-4	COBALT	3.7		mg/Kg
7440-47-3	CHROMIUM	9.3		mg/Kg
7440-50-8	COPPER	99		mg/Kg
7439-89-6	IRON	9,600		mg/Kg
7440-09-7	POTASSIUM	420		mg/Kg
7439-95-4	MAGNESIUM	84,000	J	mg/Kg
7439-96-5	MANGANESE	170		mg/Kg
7440-23-5	SODIUM	190		mg/Kg
7440-02-0	NICKEL	14		mg/Kg
7439-92-1	LEAD	1,100		mg/Kg
7440-36-0	ANTIMONY	---	1.7U	mg/Kg
7782-49-2	SELENIUM	---	1.7U	mg/Kg
7440-28-0	THALLIUM	---	1.7U	mg/Kg
7440-62-2	VANADIUM	15		mg/Kg
7440-66-6	ZINC	150		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	0.058		mg/Kg

*Sorted By Sample ID

AM04715 Field/Station ID: S-MSCC5-0506 Date Received: 10/20/2010
Matrix: Soil

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, TCLP	---	0.080U	mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, SPLP	0.24		mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	0.48U	mg/Kg
7429-90-5	ALUMINUM	9,100		mg/Kg
7440-38-2	ARSENIC	5.3		mg/Kg
7440-39-3	BARIUM	77		mg/Kg
7440-41-7	BERYLLIUM	0.32		mg/Kg
7440-70-2	CALCIUM	54,000	J	mg/Kg
7440-43-9	CADMIUM	0.43		mg/Kg
7440-48-4	COBALT	4.2		mg/Kg
7440-47-3	CHROMIUM	13		mg/Kg
7440-50-8	COPPER	19		mg/Kg
7439-89-6	IRON	13,000		mg/Kg
7440-09-7	POTASSIUM	1,100		mg/Kg
7439-95-4	MAGNESIUM	2,900		mg/Kg
7439-96-5	MANGANESE	200		mg/Kg
7440-23-5	SODIUM	1,000		mg/Kg
7440-02-0	NICKEL	9.6		mg/Kg
7439-92-1	LEAD	710		mg/Kg
7440-36-0	ANTIMONY	---	1.9U	mg/Kg
7782-49-2	SELENIUM	---	1.9U	mg/Kg
7440-28-0	THALLIUM	---	1.9U	mg/Kg
7440-62-2	VANADIUM	28		mg/Kg
7440-66-6	ZINC	86		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	0.13		mg/Kg

Survey Name: JEWETT WHITE LEAD

Project Number: 10100024

*Sorted By Sample ID

AM04716 Field/Station ID: S-MSCD1-0102 Date Received: 10/20/2010
Matrix: Soil

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-92-1	LEAD, TCLP	1.2		mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-92-1	LEAD, SPLP	---	0.16U	mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark Codes	Units
7440-22-4	SILVER	---	0.44U	mg/Kg
7429-90-5	ALUMINUM	750		mg/Kg
7440-38-2	ARSENIC	3.4		mg/Kg
7440-39-3	BARIUM	17		mg/Kg
7440-41-7	BERYLLIUM	---	0.26U	mg/Kg
7440-70-2	CALCIUM	140,000	J	mg/Kg
7440-43-9	CADMIUM	---	0.26U	mg/Kg
7440-48-4	COBALT	2.2		mg/Kg
7440-47-3	CHROMIUM	4.0		mg/Kg
7440-50-8	COPPER	10		mg/Kg
7439-89-6	IRON	5,200		mg/Kg
7440-09-7	POTASSIUM	360		mg/Kg
7439-95-4	MAGNESIUM	87,000	J	mg/Kg
7439-96-5	MANGANESE	190		mg/Kg
7440-23-5	SODIUM	350		mg/Kg
7440-02-0	NICKEL	5.6		mg/Kg
7439-92-1	LEAD	530		mg/Kg
7440-36-0	ANTIMONY	---	1.8U	mg/Kg
7782-49-2	SELENIUM	---	1.8U	mg/Kg
7440-28-0	THALLIUM	---	1.8U	mg/Kg
7440-62-2	VANADIUM	10		mg/Kg
7440-66-6	ZINC	31		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-97-6	MERCURY	---	0.038U	mg/Kg

Survey Name: JEWETT WHITE LEAD

Project Number: 10100024

*Sorted By Sample ID

AM04717 Field/Station ID: S-MSCD4-0304 Date Received: 10/20/2010
Matrix: Soil

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, TCLP	4.0		mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, SPLP	3.3		mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	1.1U	mg/Kg
7429-90-5	ALUMINUM	590		mg/Kg
7440-38-2	ARSENIC	---	1.8U	mg/Kg
7440-39-3	BARIUM	430		mg/Kg
7440-41-7	BERYLLIUM	---	0.66U	mg/Kg
7440-70-2	CALCIUM	58,000		mg/Kg
7440-43-9	CADMIUM	1.4		mg/Kg
7440-48-4	COBALT	---	4.4U	mg/Kg
7440-47-3	CHROMIUM	4.5		mg/Kg
7440-50-8	COPPER	62		mg/Kg
7439-89-6	IRON	2,000		mg/Kg
7440-09-7	POTASSIUM	---	220U	mg/Kg
7439-95-4	MAGNESIUM	1,500		mg/Kg
7439-96-5	MANGANESE	1,300		mg/Kg
7440-23-5	SODIUM	1,100		mg/Kg
7440-02-0	NICKEL	---	4.4U	mg/Kg
7439-92-1	LEAD	54,000		mg/Kg
7440-36-0	ANTIMONY	---	4.4U	mg/Kg
7782-49-2	SELENIUM	9.5		mg/Kg
7440-28-0	THALLIUM	---	4.4U	mg/Kg
7440-62-2	VANADIUM	---	4.4U	mg/Kg
7440-66-6	ZINC	77		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	0.54		mg/Kg

AM04718 Field/Station ID: S-MSCD5-0506 Date Received: 10/20/2010
Matrix: Soil

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, TCLP	100		mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, SPLP	5.7		mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	0.53U	mg/Kg
7429-90-5	ALUMINUM	4,100		mg/Kg
7440-38-2	ARSENIC	3.0		mg/Kg
7440-39-3	BARIUM	41		mg/Kg
7440-41-7	BERYLLIUM	---	0.32U	mg/Kg
7440-70-2	CALCIUM	9,000		mg/Kg
7440-43-9	CADMIUM	1.3		mg/Kg
7440-48-4	COBALT	3.3		mg/Kg
7440-47-3	CHROMIUM	7.5		mg/Kg
7440-50-8	COPPER	51		mg/Kg
7439-89-6	IRON	7,800		mg/Kg
7440-09-7	POTASSIUM	490		mg/Kg
7439-95-4	MAGNESIUM	960		mg/Kg
7439-96-5	MANGANESE	190		mg/Kg
7440-23-5	SODIUM	170		mg/Kg
7440-02-0	NICKEL	10		mg/Kg
7439-92-1	LEAD	110,000		mg/Kg
7440-36-0	ANTIMONY	---	2.1U	mg/Kg
7782-49-2	SELENIUM	---	2.1U	mg/Kg
7440-28-0	THALLIUM	---	2.1U	mg/Kg
7440-62-2	VANADIUM	17		mg/Kg
7440-66-6	ZINC	21		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	0.25		mg/Kg

Survey Name: JEWETT WHITE LEAD

Project Number: 10100024

*Sorted By Sample ID

AM04719 Field/Station ID: S-MSCF4-0405 Date Received: 10/20/2010
Matrix: Soil

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-92-1	LEAD, TCLP	870		mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-92-1	LEAD, SPLP	34		mg/L

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark Codes	Units
7440-22-4	SILVER	1.6		mg/Kg
7429-90-5	ALUMINUM	4,900		mg/Kg
7440-38-2	ARSENIC	18		mg/Kg
7440-39-3	BARIUM	240		mg/Kg
7440-41-7	BERYLLIUM	0.40		mg/Kg
7440-70-2	CALCIUM	20,000		mg/Kg
7440-43-9	CADMIUM	52		mg/Kg
7440-48-4	COBALT	6.6		mg/Kg
7440-47-3	CHROMIUM	13		mg/Kg
7440-50-8	COPPER	440		mg/Kg
7439-89-6	IRON	17,000		mg/Kg
7440-09-7	POTASSIUM	360		mg/Kg
7439-95-4	MAGNESIUM	7,200		mg/Kg
7439-96-5	MANGANESE	240		mg/Kg
7440-23-5	SODIUM	200		mg/Kg
7440-02-0	NICKEL	29		mg/Kg
7439-92-1	LEAD	130,000		mg/Kg
7440-36-0	ANTIMONY	15		mg/Kg
7782-49-2	SELENIUM	---	2.1U	mg/Kg
7440-28-0	THALLIUM	---	5.3U	mg/Kg
7440-62-2	VANADIUM	67		mg/Kg
7440-66-6	ZINC	1,700		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-97-6	MERCURY	0.39		mg/Kg

AM04720 Field/Station ID: S-MSCF5-0304 Date Received: 10/20/2010
Matrix: Soil

Sample Description:

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark Codes	Units
7440-22-4	SILVER	---	0.56U	mg/Kg
7429-90-5	ALUMINUM	7,300		mg/Kg
7440-38-2	ARSENIC	4.4		mg/Kg
7440-39-3	BARIUM	150		mg/Kg
7440-41-7	BERYLLIUM	---	0.34U	mg/Kg
7440-70-2	CALCIUM	53,000	J	mg/Kg
7440-43-9	CADMIUM	0.48		mg/Kg
7440-48-4	COBALT	3.8		mg/Kg
7440-47-3	CHROMIUM	13		mg/Kg
7440-50-8	COPPER	94		mg/Kg
7439-89-6	IRON	11,000		mg/Kg
7440-09-7	POTASSIUM	750		mg/Kg
7439-95-4	MAGNESIUM	3,400		mg/Kg
7439-96-5	MANGANESE	200		mg/Kg
7440-23-5	SODIUM	370		mg/Kg
7440-02-0	NICKEL	15		mg/Kg
7439-92-1	LEAD	5,100		mg/Kg
7440-36-0	ANTIMONY	---	2.2U	mg/Kg
7782-49-2	SELENIUM	---	2.2U	mg/Kg
7440-28-0	THALLIUM	---	2.2U	mg/Kg
7440-62-2	VANADIUM	30		mg/Kg
7440-66-6	ZINC	93		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-97-6	MERCURY	0.39		mg/Kg

AM04885 Field/Station ID: GW-MSC1-1010 Date Received: 10/29/2010
Matrix: Aqueous

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-97-6	MERCURY	---	0.20U J	ug/L

AM04885 Field/Station ID: GW-MSC1-1010 Date Received: 10/29/2010
Matrix: Aqueous

Sample Description:

Analysis Type: METALS TAL ICP AQUEOUS

CAS Number	Analyte Name	Result	Remark Codes	Units
7440-22-4	SILVER	---	5.0U	ug/L
7429-90-5	ALUMINUM	---	100U	ug/L
7440-38-2	ARSENIC	12		ug/L
7440-39-3	BARIUM	110		ug/L
7440-41-7	BERYLLIUM	---	3.0U	ug/L
7440-70-2	CALCIUM	240,000		ug/L
7440-43-9	CADMIUM	---	3.0U	ug/L
7440-48-4	COBALT	---	20U	ug/L
7440-47-3	CHROMIUM	---	5.0U	ug/L
7440-50-8	COPPER	---	10U	ug/L
7439-89-6	IRON	280		ug/L
7440-09-7	POTASSIUM	260,000		ug/L
7439-95-4	MAGNESIUM	670,000		ug/L
7439-96-5	MANGANESE	460		ug/L
7440-23-5	SODIUM	1,100,000	J	ug/L
7440-02-0	NICKEL	---	20U	ug/L
7439-92-1	LEAD	39		ug/L
7440-36-0	ANTIMONY	---	20U	ug/L
7782-49-2	SELENIUM	---	20U	ug/L
7440-28-0	THALLIUM	---	20U	ug/L
7440-62-2	VANADIUM	---	20U	ug/L
7440-66-6	ZINC	---	20U	ug/L

AM04886 Field/Station ID: GW-MSC2-1010 Date Received: 10/29/2010
Matrix: Aqueous

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-97-6	MERCURY	---	0.20U J	ug/L

Analysis Type: METALS TAL ICP AQUEOUS

CAS Number	Analyte Name	Result	Remark Codes	Units
7440-22-4	SILVER	---	5.0U	ug/L

AM04886 Field/Station ID: GW-MSC2-1010 Date Received: 10/29/2010
Matrix: Aqueous

Sample Description:

Analysis Type: METALS TAL ICP AQUEOUS

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7429-90-5	ALUMINUM	---	100U	ug/L
7440-38-2	ARSENIC	---	8.0U	ug/L
7440-39-3	BARIUM	350		ug/L
7440-41-7	BERYLLIUM	---	3.0U	ug/L
7440-70-2	CALCIUM	140,000		ug/L
7440-43-9	CADMIUM	---	3.0U	ug/L
7440-48-4	COBALT	---	20U	ug/L
7440-47-3	CHROMIUM	---	5.0U	ug/L
7440-50-8	COPPER	---	10U	ug/L
7439-89-6	IRON	860		ug/L
7440-09-7	POTASSIUM	28,000		ug/L
7439-95-4	MAGNESIUM	26,000		ug/L
7439-96-5	MANGANESE	1,200		ug/L
7440-23-5	SODIUM	36,000		ug/L
7440-02-0	NICKEL	---	20U	ug/L
7439-92-1	LEAD	---	8.0U	ug/L
7440-36-0	ANTIMONY	---	20U	ug/L
7782-49-2	SELENIUM	---	20U	ug/L
7440-28-0	THALLIUM	---	20U	ug/L
7440-62-2	VANADIUM	---	20U	ug/L
7440-66-6	ZINC	---	20U	ug/L

AM04887 Field/Station ID: GW-PO1-1010 Date Received: 10/29/2010
Matrix: Aqueous

Sample Description: MS/MSD

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	---	0.20U J	ug/L

Analysis Type: METALS TAL ICP AQUEOUS

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	5.0U	ug/L
7429-90-5	ALUMINUM	---	100U	ug/L

AM04887 Field/Station ID: GW-PO1-1010 Date Received: 10/29/2010
Matrix: Aqueous

Sample Description: MS/MSD

Analysis Type: METALS TAL ICP AQUEOUS

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-38-2	ARSENIC	73		ug/L
7440-39-3	BARIUM	170		ug/L
7440-41-7	BERYLLIUM	---	3.0U	ug/L
7440-70-2	CALCIUM	280,000		ug/L
7440-43-9	CADMIUM	---	3.0U	ug/L
7440-48-4	COBALT	---	20U	ug/L
7440-47-3	CHROMIUM	---	5.0U	ug/L
7440-50-8	COPPER	---	10U	ug/L
7439-89-6	IRON	24,000		ug/L
7440-09-7	POTASSIUM	11,000		ug/L
7439-95-4	MAGNESIUM	28,000		ug/L
7439-96-5	MANGANESE	4,400		ug/L
7440-23-5	SODIUM	17,000		ug/L
7440-02-0	NICKEL	---	20U	ug/L
7439-92-1	LEAD	---	8.0U	ug/L
7440-36-0	ANTIMONY	---	20U	ug/L
7782-49-2	SELENIUM	---	20U	ug/L
7440-28-0	THALLIUM	---	20U	ug/L
7440-62-2	VANADIUM	---	20U	ug/L
7440-66-6	ZINC	---	20U	ug/L

AM04888 Field/Station ID: GW-PO2-1010 Date Received: 10/29/2010
Matrix: Aqueous

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	---	0.20U J	ug/L

Analysis Type: METALS TAL ICP AQUEOUS

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	5.0U	ug/L
7429-90-5	ALUMINUM	---	100U	ug/L
7440-38-2	ARSENIC	---	8.0U	ug/L

AM04888 Field/Station ID: GW-PO2-1010
Matrix: Aqueous
Date Received: 10/29/2010

Sample Description:

Analysis Type: METALS TAL ICP AQUEOUS

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-39-3	BARIUM	220		ug/L
7440-41-7	BERYLLIUM	---	3.0U	ug/L
7440-70-2	CALCIUM	110,000		ug/L
7440-43-9	CADMIUM	---	3.0U	ug/L
7440-48-4	COBALT	---	20U	ug/L
7440-47-3	CHROMIUM	---	5.0U	ug/L
7440-50-8	COPPER	---	10U	ug/L
7439-89-6	IRON	56	J	ug/L
7440-09-7	POTASSIUM	14,000		ug/L
7439-95-4	MAGNESIUM	26,000		ug/L
7439-96-5	MANGANESE	4,700		ug/L
7440-23-5	SODIUM	35,000		ug/L
7440-02-0	NICKEL	---	20U	ug/L
7439-92-1	LEAD	---	8.0U	ug/L
7440-36-0	ANTIMONY	---	20U	ug/L
7782-49-2	SELENIUM	---	20U	ug/L
7440-28-0	THALLIUM	---	20U	ug/L
7440-62-2	VANADIUM	---	20U	ug/L
7440-66-6	ZINC	---	20U	ug/L

AM04889 Field/Station ID: GW-PO2-1010-E
Matrix: Aqueous
Date Received: 10/29/2010

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	---	0.20U J	ug/L

Analysis Type: METALS TAL ICP AQUEOUS

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	5.0U	ug/L
7429-90-5	ALUMINUM	130		ug/L
7440-38-2	ARSENIC	---	8.0U	ug/L
7440-39-3	BARIUM	240		ug/L

AM04889 Field/Station ID: GW-PO2-1010-E Date Received: 10/29/2010
Matrix: Aqueous

Sample Description:

Analysis Type: METALS TAL ICP AQUEOUS

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-41-7	BERYLLIUM	---	3.0U	ug/L
7440-70-2	CALCIUM	110,000		ug/L
7440-43-9	CADMIUM	---	3.0U	ug/L
7440-48-4	COBALT	---	20U	ug/L
7440-47-3	CHROMIUM	---	5.0U	ug/L
7440-50-8	COPPER	---	10U	ug/L
7439-89-6	IRON	120	J	ug/L
7440-09-7	POTASSIUM	14,000		ug/L
7439-95-4	MAGNESIUM	27,000		ug/L
7439-96-5	MANGANESE	5,000		ug/L
7440-23-5	SODIUM	35,000		ug/L
7440-02-0	NICKEL	---	20U	ug/L
7439-92-1	LEAD	---	8.0U	ug/L
7440-36-0	ANTIMONY	---	20U	ug/L
7782-49-2	SELENIUM	---	20U	ug/L
7440-28-0	THALLIUM	---	20U	ug/L
7440-62-2	VANADIUM	---	20U	ug/L
7440-66-6	ZINC	---	20U	ug/L

AM04890 Field/Station ID: RB-06 Date Received: 10/29/2010
Matrix: Aqueous

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	---	0.20U	ug/L

Analysis Type: METALS TAL ICP AQUEOUS

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	5.0U	ug/L
7429-90-5	ALUMINUM	---	100U	ug/L
7440-38-2	ARSENIC	---	8.0U	ug/L
7440-39-3	BARIUM	---	100U	ug/L
7440-41-7	BERYLLIUM	---	3.0U	ug/L

AM04890 Field/Station ID: RB-06 Date Received: 10/29/2010
Matrix: Aqueous

Sample Description:

Analysis Type: METALS TAL ICP AQUEOUS

CAS Number	Analyte Name	Result	Remark Codes	Units
7440-70-2	CALCIUM	---	500U	ug/L
7440-43-9	CADMIUM	---	3.0U	ug/L
7440-48-4	COBALT	---	20U	ug/L
7440-47-3	CHROMIUM	---	5.0U	ug/L
7440-50-8	COPPER	---	10U	ug/L
7439-89-6	IRON	---	50U	ug/L
7440-09-7	POTASSIUM	---	1,000U	ug/L
7439-95-4	MAGNESIUM	---	500U	ug/L
7439-96-5	MANGANESE	---	5.0U	ug/L
7440-23-5	SODIUM	---	1,000U	ug/L
7440-02-0	NICKEL	---	20U	ug/L
7439-92-1	LEAD	---	8.0U	ug/L
7440-36-0	ANTIMONY	---	20U	ug/L
7782-49-2	SELENIUM	---	20U	ug/L
7440-28-0	THALLIUM	---	20U	ug/L
7440-62-2	VANADIUM	---	20U	ug/L
7440-66-6	ZINC	---	20U	ug/L

AM04891 Field/Station ID: RB-07 Date Received: 10/29/2010
Matrix: Aqueous

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-97-6	MERCURY	---	0.20U	ug/L

Analysis Type: METALS TAL ICP AQUEOUS

CAS Number	Analyte Name	Result	Remark Codes	Units
7440-22-4	SILVER	---	5.0U	ug/L
7429-90-5	ALUMINUM	---	100U	ug/L
7440-38-2	ARSENIC	---	8.0U	ug/L
7440-39-3	BARIUM	---	100U	ug/L
7440-41-7	BERYLLIUM	---	3.0U	ug/L
7440-70-2	CALCIUM	---	500U	ug/L

Survey Name: JEWETT WHITE LEAD

Project Number: 10100024

*Sorted By Sample ID

AM04891 Field/Station ID: RB-07 Date Received: 10/29/2010
Matrix: Aqueous

Sample Description:

Analysis Type: METALS TAL ICP AQUEOUS

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-43-9	CADMIUM	---	3.0U	ug/L
7440-48-4	COBALT	---	20U	ug/L
7440-47-3	CHROMIUM	---	5.0U	ug/L
7440-50-8	COPPER	---	10U	ug/L
7439-89-6	IRON	---	50U	ug/L
7440-09-7	POTASSIUM	---	1,000U	ug/L
7439-95-4	MAGNESIUM	---	500U	ug/L
7439-96-5	MANGANESE	---	5.0U	ug/L
7440-23-5	SODIUM	---	1,000U	ug/L
7440-02-0	NICKEL	---	20U	ug/L
7439-92-1	LEAD	---	8.0U	ug/L
7440-36-0	ANTIMONY	---	20U	ug/L
7782-49-2	SELENIUM	---	20U	ug/L
7440-28-0	THALLIUM	---	20U	ug/L
7440-62-2	VANADIUM	---	20U	ug/L
7440-66-6	ZINC	---	20U	ug/L

AM04892 Field/Station ID: SD-05 Date Received: 10/29/2010
Matrix: Sediment

Sample Description: MS/MSD

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	0.44U	mg/Kg
7429-90-5	ALUMINUM	3,400		mg/Kg
7440-38-2	ARSENIC	3.2 ✓	J 3	mg/Kg
7 0-39-3	BARIUM	43 ✓		mg/Kg
7440-41-7	BERYLLIUM	---	0.27U	mg/Kg
7440-70-2	CALCIUM	J3 49,000 ~~49,000~~	J	mg/Kg
7440-43-9	CADMIUM	~~[illegible]~~		mg/Kg
7440-48-4	COBALT	4.3 ✓		mg/Kg
7440-47-3	CHROMIUM	13 ✓		mg/Kg
7440-50-8	COPPER	36 ✓		mg/Kg
7439-89-6	IRON	9,400		mg/Kg

Refer to Page 1 for an explanation of Remark Codes

Survey Name: JEWETT WHITE LEAD

Project Number: 10100024

*Sorted By Sample ID

AM04892 Field/Station ID: SD-05 Date Received: 10/29/2010
Matrix: Sediment

Sample Description: MS/MSD

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-09-7	POTASSIUM	470		mg/Kg
7439-95-4	MAGNESIUM	22,000	J^3	mg/Kg
7439-96-5	MANGANESE	120		mg/Kg
7440-23-5	SODIUM	450		mg/Kg
7440-02-0	NICKEL	11		mg/Kg
7439-92-1	LEAD	61	J^1	mg/Kg
7440-36-0	ANTIMONY	---	1.8U	mg/Kg
7782-49-2	SELENIUM	---	1.8U	mg/Kg
7440-28-0	THALLIUM	---	1.8U J	mg/Kg
7440-62-2	VANADIUM	19		mg/Kg
7440-66-6	ZINC	130		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	0.032		mg/Kg

AM04893 Field/Station ID: SD-05-E Date Received: 10/29/2010
Matrix: Sediment

Sample Description:

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	0.40U	mg/Kg
7429-90-5	ALUMINUM	2,500		mg/Kg
7440-38-2	ARSENIC	1.7	J^3	mg/Kg
7440-39-3	BARIUM	32		mg/Kg
7440-41-7	BERYLLIUM	---	0.24U	mg/Kg
7440-70-2	CALCIUM	26,000	J^3	mg/Kg
7440-43-9	CADMIUM	---	0.24U	mg/Kg
7440-48-4	COBALT	3.7		mg/Kg
7440-47-3	CHROMIUM	8.4		mg/Kg
7440-50-8	COPPER	41		mg/Kg
7439-89-6	IRON	9,400		mg/Kg
7440-09-7	POTASSIUM	450		mg/Kg

Refer to Page 1 for an explanation of Remark Codes

AM04893 Field/Station ID: SD-05-E
Matrix: Sediment
Date Received: 10/29/2010

Sample Description:

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-95-4	MAGNESIUM	9,200	J3	mg/Kg
7439-96-5	MANGANESE	90 ✓		mg/Kg
7440-23-5	SODIUM	470 ✓		mg/Kg
7440-02-0	NICKEL	8.3 ✓		mg/Kg
7439-92-1	LEAD	130	J1	mg/Kg
7440-36-0	ANTIMONY	---	1.6U ✓	mg/Kg
7782-49-2	SELENIUM	---	1.6U	mg/Kg
7440-28-0	THALLIUM	---	1.6U	mg/Kg
7440-62-2	VANADIUM	27 ✓		mg/Kg
7440-66-6	ZINC	120 ✓		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	---	0.069U	mg/Kg

AM04894 Field/Station ID: SD-06
Matrix: Sediment
Date Received: 10/29/2010

Sample Description:

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	0.50U	mg/Kg
7429-90-5	ALUMINUM	3,300		mg/Kg
7440-38-2	ARSENIC	2.3		mg/Kg
7440-39-3	BARIUM	51		mg/Kg
7440-41-7	BERYLLIUM	---	0.30U	mg/Kg
7440-70-2	CALCIUM	13,000		mg/Kg
7440-43-9	CADMIUM	0.38		mg/Kg
7440-48-4	COBALT	5.3		mg/Kg
7440-47-3	CHROMIUM	42		mg/Kg
7440-50-8	COPPER	88		mg/Kg
7439-89-6	IRON	15,000		mg/Kg
7440-09-7	POTASSIUM	910		mg/Kg
7439-95-4	MAGNESIUM	6,700		mg/Kg

AM04894 Field/Station ID: SD-06 Date Received: 10/29/2010
Matrix: Sediment

Sample Description:

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-96-5	MANGANESE	120		mg/Kg
7440-23-5	SODIUM	200		mg/Kg
7440-02-0	NICKEL	19		mg/Kg
7439-92-1	LEAD	89		mg/Kg
7440-36-0	ANTIMONY	2.4		mg/Kg
7782-49-2	SELENIUM	---	2.0U	mg/Kg
7440-28-0	THALLIUM	---	2.0U	mg/Kg
7440-62-2	VANADIUM	29		mg/Kg
7440-66-6	ZINC	290		mg/Kg

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-97-6	MERCURY	0.037		mg/Kg

AM04895 Field/Station ID: SW-05 Date Received: 10/29/2010
Matrix: Aqueous

Sample Description: MS/MSD

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-97-6	MERCURY	---	0.20U J	ug/L

Analysis Type: METALS TAL ICP AQUEOUS

CAS Number	Analyte Name	Result	Remark Codes	Units
7440-22-4	SILVER	---	5.0U	ug/L
7429-90-5	ALUMINUM	120		ug/L
7440-38-2	ARSENIC	---	8.0U	ug/L
7440-39-3	BARIUM	---	100U	ug/L
7440-41-7	BERYLLIUM	---	3.0U	ug/L
7440-70-2	CALCIUM	21,000		ug/L
7440-43-9	CADMIUM	---	3.0U	ug/L
7440-48-4	COBALT	---	20U	ug/L
7440-47-3	CHROMIUM	---	5.0U	ug/L
7440-50-8	COPPER	29		ug/L

AM04895 Field/Station ID: SW-05 Date Received: 10/29/2010
Matrix: Aqueous

Sample Description: MS/MSD

Analysis Type: METALS TAL ICP AQUEOUS

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-89-6	IRON	1,700	✓	ug/L
7440-09-7	POTASSIUM	13,000	✓	ug/L
7439-95-4	MAGNESIUM	2,500	✓	ug/L
7439-96-5	MANGANESE	130	✓	ug/L
7440-23-5	SODIUM	14,000	✓	ug/L
7440-02-0	NICKEL	---	20U	ug/L
7439-92-1	LEAD	15	✓	ug/L
7440-36-0	ANTIMONY	---	20U	ug/L
7782-49-2	SELENIUM	---	20U	ug/L
7440-28-0	THALLIUM	---	20U	ug/L
7440-62-2	VANADIUM	---	20U	ug/L
7440-66-6	ZINC	150	✓	ug/L

AM04896 Field/Station ID: SW-05-E Date Received: 10/29/2010
Matrix: Aqueous

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	---	0.20U	ug/L

Analysis Type: METALS TAL ICP AQUEOUS

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	---	5.0U ✓	ug/L
7429-90-5	ALUMINUM	130	✓	ug/L
7440-38-2	ARSENIC	---	8.0U ✓	ug/L
7440-39-3	BARIUM	---	100U ✓	ug/L
7440-41-7	BERYLLIUM	---	3.0U ✓	ug/L
7440-70-2	CALCIUM	20,000	✓	ug/L
7440-43-9	CADMIUM	---	3.0U ✓	ug/L
7440-48-4	COBALT	---	20U ✓	ug/L
7440-47-3	CHROMIUM	---	5.0U ✓	ug/L
7440-50-8	COPPER	28	✓	ug/L
7439-89-6	IRON	1,600	✓	ug/L

U.S. EPA Region 2 Laboratory
Data Report

Survey Name: JEWETT WHITE LEAD

Project Number: 10100024

***Sorted By Sample ID**

AM04896 Field/Station ID: SW-05-E
Matrix: Aqueous
Date Received: 10/29/2010

Sample Description:

Analysis Type: METALS TAL ICP AQUEOUS

CAS Number	Analyte Name	Result	Remark Codes	Units
7440-09-7	POTASSIUM	13,000		ug/L
7439-95-4	MAGNESIUM	2,400		ug/L
7439-96-5	MANGANESE	130		ug/L
7440-23-5	SODIUM	14,000		ug/L
7440-02-0	NICKEL	---	20U	ug/L
7439-92-1	LEAD	15		ug/L
7440-36-0	ANTIMONY	---	20U	ug/L
7782-49-2	SELENIUM	---	20U	ug/L
7440-28-0	THALLIUM	---	20U	ug/L
7440-62-2	VANADIUM	---	20U	ug/L
7440-66-6	ZINC	140		ug/L

AM04897 Field/Station ID: SW-06
Matrix: Aqueous
Date Received: 10/29/2010

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark Codes	Units
7439-97-6	MERCURY	---	0.20U	ug/L

Analysis Type: METALS TAL ICP AQUEOUS

CAS Number	Analyte Name	Result	Remark Codes	Units
7440-22-4	SILVER	---	5.0U	ug/L
7429-90-5	ALUMINUM	310		ug/L
7440-38-2	ARSENIC	---	8.0U	ug/L
7440-39-3	BARIUM	---	00U	ug/L
7440-41-7	BERYLLIUM	---	3.0U	ug/L
7440-70-2	CALCIUM	10,000		ug/L
7440-43-9	CADMIUM	---	3.0U	ug/L
7440-48-4	COBALT	---	20U	ug/L
7440-47-3	CHROMIUM	---	5.0U	ug/L
7440-50-8	COPPER	11		ug/L
7439-89-6	IRON	2,500		ug/L
7440-09-7	POTASSIUM	3,000		ug/L

AM04897 Field/Station ID: SW-06 Date Received: 10/29/2010
Matrix: Aqueous

Sample Description:

Analysis Type: METALS TAL ICP AQUEOUS

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-95-4	MAGNESIUM	1,300		ug/L
7439-96-5	MANGANESE	89		ug/L
7440-23-5	SODIUM	7,000		ug/L
7440-02-0	NICKEL	---	20U	ug/L
7439-92-1	LEAD	22		ug/L
7440-36-0	ANTIMONY	---	20U	ug/L
7782-49-2	SELENIUM	---	20U	ug/L
7440-28-0	THALLIUM	---	20U	ug/L
7440-62-2	VANADIUM	---	20U	ug/L
7440-66-6	ZINC	92		ug/L

AM04917 Field/Station ID: S-MSCF4-0102 Date Received: 11/2/2010
Matrix: Soil

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, TCLP	290		mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, SPLP	180		mg/L

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	1.4		mg/Kg

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-22-4	SILVER	0.87		mg/Kg
7429-90-5	ALUMINUM	7,500		mg/Kg
7440-38-2	ARSENIC	26		mg/Kg
7440-39-3	BARIUM	400		mg/Kg
7440-41-7	BERYLLIUM	5.5		mg/Kg

AM04917 Field/Station ID: S-MSCF4-0102 Date Received: 11/2/2010
Matrix: Soil

Sample Description:

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7440-70-2	CALCIUM	13,000		mg/Kg
7440-43-9	CADMIUM	5.2		mg/Kg
7440-48-4	COBALT	79		mg/Kg
7440-47-3	CHROMIUM	88		mg/Kg
7440-50-8	COPPER	2,800		mg/Kg
7439-89-6	IRON	57,000		mg/Kg
7440-09-7	POTASSIUM	700		mg/Kg
7439-95-4	MAGNESIUM	5,700		mg/Kg
7439-96-5	MANGANESE	930		mg/Kg
7440-23-5	SODIUM	850		mg/Kg
7440-02-0	NICKEL	370		mg/Kg
7439-92-1	LEAD	41,000		mg/Kg
7782-49-2	SELENIUM	6.5		mg/Kg
7440-36-0	ANTIMONY	14		mg/Kg
7440-28-0	THALLIUM	---	7.0U	mg/Kg
7440-62-2	VANADIUM	1,400		mg/Kg
7440-66-6	ZINC	11,000		mg/Kg

AM04918 Field/Station ID: S-MSCF1-0405 Date Received: 11/2/2010
Matrix: Soil

Sample Description:

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, TCLP	26		mg/L

Analysis Type: METALS, SPLP ICP SPLP EXTRACT

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-92-1	LEAD, SPLP	0.53		mg/L

Single Component Analyses

CAS Number	Analyte Name	Result	Remark_ Codes	Units
7439-97-6	MERCURY	1.2		mg/Kg

Survey Name: JEWETT WHITE LEAD

Project Number: 10100024

*Sorted By Sample ID

AM04918 Field/Station ID: S-MSCF1-0405 Date Received: 11/2/2010
Matrix: Soil

Sample Description:

Analysis Type: METALS TAL ICP SOLID

CAS Number	Analyte Name	Result	Remark Codes	Units
7440-22-4	SILVER	6.2		mg/Kg
7429-90-5	ALUMINUM	6,500		mg/Kg
7440-38-2	ARSENIC	19		mg/Kg
7440-39-3	BARIUM	190		mg/Kg
7440-41-7	BERYLLIUM	1.1		mg/Kg
7440-70-2	CALCIUM	22,000		mg/Kg
7440-43-9	CADMIUM	3.7		mg/Kg
7440-48-4	COBALT	9.2		mg/Kg
7440-47-3	CHROMIUM	57		mg/Kg
7440-50-8	COPPER	340		mg/Kg
7439-89-6	IRON	23,000		mg/Kg
7440-09-7	POTASSIUM	1,700		mg/Kg
7439-95-4	MAGNESIUM	6,500		mg/Kg
7439-96-5	MANGANESE	310		mg/Kg
7440-23-5	SODIUM	8,700		mg/Kg
7440-02-0	NICKEL	64		mg/Kg
7439-92-1	LEAD	4,300		mg/Kg
7782-49-2	SELENIUM	---	3.3U	mg/Kg
7440-36-0	ANTIMONY	6.4		mg/Kg
7440-28-0	THALLIUM	---	3.3U	mg/Kg
7440-62-2	VANADIUM	75		mg/Kg
7440-66-6	ZINC	1,800		mg/Kg

Project Approval: ______________________ **Date:** 11-10-10

USEPA
DateShipped: 10/12/2010
CarrierName: FedEx
AirbillNo:

CHAIN OF CUSTODY RECORD
Jewett White Lead Company
Contact Name: Joseph Schmidl
Contact Phone: 603-656-5461

No: 2-101110-202320-0001
Cooler #: 1
Lab: EPA Region 2 Laboratory
Lab Phone: 732-906-6886

Lab #	Sample #	Location	Analyses	Matrix	Collected	Numb Cont	Container	Preservative	MS/MSD
	RB-01	AB-2.5	Lead	Blank	10/8/2010	1	1 L poly	HNO3 pH<2	
	S-AB1.5-0405	AB-1.5	Lead, SPLP Lead, TCLP Lead	Soil	10/6/2010	1	8 oz glass	Wet ice	
	S-AB1-0708	AB-1	Lead, SPLP Lead, TCLP Lead	Soil	10/4/2010	1	8 oz glass	Wet ice	
	S-AB2.5-0102	AB-2.5	Lead, SPLP Lead, TCLP Lead	Soil	10/8/2010	1	8 oz glass	Wet ice	
	S-AB2.5-0304	AB-2.5	Lead, SPLP Lead, TCLP Lead	Soil	10/8/2010	1	8 oz glass	Wet ice	
	S-AB3.5-0001	AB-3.5	Lead, SPLP Lead, TCLP Lead	Soil	10/8/2010	1	8 oz glass	Wet ice	
	S-BC1-0001	BC-1	Lead, SPLP Lead, TCLP Lead	Soil	10/4/2010	1	8 oz glass	Wet ice	
	S-C4-0102	C-4	Lead, SPLP Lead, TCLP Lead	Soil	10/7/2010	1	8 oz glass	Wet ice	
	S-CD1.5-0405	CD-1	Lead, SPLP Lead, TCLP Lead	Soil	10/5/2010	2	8 oz glass	Wet ice	Y
	S-CD3-0001	CD-3	Lead, SPLP Lead, TCLP Lead	Soil	10/7/2010	1	8 oz glass	Wet ice	
	S-CD3-0001-E	ZA-3.5	Lead, SPLP Lead, TCLP Lead	Soil	10/7/2010	1	8 oz glass	Wet ice	
	S-CD3-0102	CD-3	Lead, SPLP Lead, TCLP Lead	Soil	10/7/2010	1	8 oz glass	Wet ice	
	S-CD3-0203	CD-3	Lead, SPLP Lead, TCLP Lead	Soil	10/7/2010	1	8 oz glass	Wet ice	
	S-DE1-0506	DE-1	Lead, SPLP Lead, TCLP Lead	Soil	10/5/2010	1	8 oz glass	Wet ice	
	S-DE1-0607	DE-1	Lead, SPLP Lead, TCLP Lead	Soil	10/5/2010	1	8 oz glass	Wet ice	
	S-ZA1-0304	ZA-1	Lead, SPLP Lead, TCLP Lead	Soil	10/4/2010	1	8 oz glass	Wet ice	
	S-ZA3.5-0405	ZA-3.5	Lead, SPLP Lead, TCLP Lead	Soil	10/6/2010	1	8 oz glass	Wet ice	
	S-ZA3.5-0708	ZA-3.5	Lead, SPLP Lead, TCLP Lead	Soil	10/6/2010	1	8 oz glass	Wet ice	
	S-ZA4-0607	ZA-4	Lead, SPLP Lead, TCLP Lead	Soil	10/6/2010	1	8 oz glass	Wet ice	

Special Instructions: Hold excess samples for possible, future analyses.

SAMPLES TRANSFERRED FROM
CHAIN OF CUSTODY #

Items/Reason	Relinquished by	Date	Received by	Date	Time	Items/Reason	Relinquished By	Date	Received by	Date	Time

Page 1 of 1

USEPA
DateShipped: 10/19/10
CarrierName: FedEx
AirbillNo: 8715 6304 5590

CHAIN OF CUSTODY RECORD
Jewett White Lead Company
Contact Name:
Contact Phone:

No: 2-101810-062300-0002
Cooler #: 1 of 1
Lab: EPA Region 2 Laboratory
Lab Phone: 732-906-6886

Lab #	Sample #	Location	Analyses	Matrix	Collected	Sample Time	Numb Cont	Container	Preservative	MS/MSD
	RB-02	Decon	Lead	Blank	10/8/2010	09:00	1	1 L poly	HNO3 pH<2	N
	RB-04	Decon	Lead	Blank	10/14/2020	09:20	1	1 L poly	HNO3 pH<2	N
	S-MSC1-0708	MSC-01	Lead, SPLP Lead, TCLP Lead	Soil	10/14/2010	10:10	1	4 oz glass jar	4 C	N
	S-MSC2-0708	MSC-02	Lead, SPLP Lead, TCLP Lead	Soil	10/14/2010	11:00	1	4 oz glass jar	4 C	N
	S-PO1-0607	PO-01	Lead, SPLP Lead, TCLP Lead	Soil	10/7/2010	14:47	1	4 oz glass jar	4 C	Y
	S-PO2-0506	PO-02	Lead, SPLP Lead, TCLP Lead	Soil	10/7 ~~10/8~~/2010 SS	15:17	1	4 oz glass jar	4 C	N
	S-PO2-0506-E	PO-02	Lead, SPLP Lead, TCLP Lead	Soil	10/7 ~~10/8~~/2010 SS	15:17	1	4 oz glass jar	4 C	N
	S-PO3-0910	PO-03	Lead, SPLP Lead, TCLP Lead	Soil	10/7/2010	10:42	1	4 oz glass jar	4 C	N

Special Instructions: Hold excess sample volume for possible further analysis.

SAMPLES TRANSFERRED FROM CHAIN OF CUSTODY #

Items/Reason	Relinquished by	Date	Received by	Date	Time	Items/Reason	Relinquished By	Date	Received by	Date	Time
		10/19/10	FedEx	10/19/10	1400						

USEPA
DateShipped: 10/15/10
CarrierName: FedEx
AirbillNo: 8715 6304 5580

CHAIN OF CUSTODY RECORD

Jewett White Lead Company
Contact Name: Joseph Schmidl
Contact Phone: 603-656-5461

No: 2-101810-145000-0003
Cooler #: 1 of 1
Lab: EPA Region 2 Laboratory
Lab Phone: 732-906-6886

Lab #	Sample #	Location	Analyses	Matrix	Collected	Sample Time	Numb Cont	Container	Preservative	MS/MSD
	RB-03	Decon	Lead	Blank	10/12/2010	08:35	1	1 L poly	HNO3 pH<2	
	S-MSCB1-0102	MSCB-1	Lead, SPLP Lead, TCLP Lead	Soil	10/12/2010	10:10	2	4 oz glass jar	4 C	N
	S-MSCB1-0304	MSCB-1	Lead, SPLP Lead, TCLP Lead	Soil	10/12/2010	10:14	2	4 oz glass jar	4 C	N
	S-MSCB5-0001	MSCB-5	Lead, SPLP Lead, TCLP Lead	Soil	10/14/2010	09:16	2	4 oz glass jar	4 C	N
	S-MSCB5-0001-E	MSCB-5	Lead, SPLP Lead, TCLP Lead	Soil	10/14/2010	09:16	2	4 oz glass jar	4 C	N
	S-MSCC1-0102	MSCC-1	Lead, SPLP Lead, TCLP Lead	Soil	10/12/2010	11:20	2	4 oz glass jar	4 C	Y
	S-MSCC1-0203	MSCC-1	Lead, SPLP Lead, TCLP Lead	Soil	10/12/2010	11:22	2	4 oz glass jar	4 C	N
	S-MSCC5-0102	MSCC-5	Lead, SPLP Lead, TCLP Lead	Soil	10/13/2010	13:30	2	4 oz glass jar	4 C	N
	S-MSCC5-0506	MSCC-5	Lead, SPLP Lead, TCLP Lead	Soil	10/13/2010	13:42	2	4 oz glass jar	4 C	N
	S-MSCD1-0102	MSCD-1	Lead, SPLP Lead, TCLP Lead	Soil	10/12/2010	11:46	2	4 oz glass jar	4 C	N
	S-MSCD4-0304	MSCD-4	Lead, SPLP Lead, TCLP Lead	Soil	10/13/2010	11:56	2	4 oz glass jar	4 C	N
	S-MSCD5-0506	MSCD-5	Lead, SPLP Lead, TCLP Lead	Soil	10/13/2010	13:20	2	4 oz glass jar	4 C	N
	S-MSCF4-0405	MSCF-4	Lead, SPLP Lead, TCLP Lead	Soil	10/13/2010	10:28	2	4 oz glass jar	4 C	N
	S-MSCF5-0304	MSCF-5	Lead, SPLP Lead, TCLP Lead	Soil	10/13/2010	09:46	2	4 oz glass jar	4 C	N

Special Instructions: Hold remaining sample for possible future analyses.

SAMPLES TRANSFERRED FROM CHAIN OF CUSTODY #

Items/Reason	Relinquished by	Date	Received by	Date	Time	Items/Reason	Relinquished By	Date	Received by	Date	Time
		10/15/10	FedEx	10/15/10	1400						

USEPA

DateShipped: 10/28/2010
CarrierName: ~~FedEx~~ Delivered by Hand
AirbillNo:

CHAIN OF CUSTODY RECORD

Jewett White Lead Company
Contact Name: Joseph Schmidt
Contact Phone: 603-656-5461

No: 2-102710-113546-0006
Cooler #:
Lab: EPA Region 2 Laboratory
Lab Phone: 732-906-6886

Lab #	Sample #	Location	Analyses	Matrix	Collected	Sample Time	Numb Cont	Container	Preservative	MS/MSD
	GW-MSC1-1010	MSC-01	Lead	Ground Water	10/28/2010	12:13	1	1 L poly	HNO3 pH<2	N
	GW-MSC2-1010	MSC-02	Lead	Ground Water	10/28/2010	11:25	1	1 L poly	HNO3 pH<2	N
	GW-PC1-1010	PO-01	Lead	Ground Water	10/28/2010	10:20	2	1 L poly	HNO3 pH<2	Y
	GW-PC2-1010	PO-02	Lead	Ground Water	10/28/2010	09:28	1	1 L poly	HNO3 pH<2	N
	GW-PC2-1010-E	PO-02	Lead	Ground Water	10/28/2010	09:28	1	1 L poly	HNO3 pH<2	N
	RB-06	Decon	Lead	Blank	10/28/2010	13:00	1	1 L poly	HNO3 pH<2	N
	RB-07	Decon	Lead	Blank	10/28/2010	13:10	1	1 L poly	HNO3 pH<2	N
	SD-05	SW/SD-05	Lead	Sediment	10/28/2010	08:50	2	4 oz glass jar	4 C	Y
	SD-05-E	SW/SD-05	Lead	Sediment	10/28/2010	08:55	1	4 oz glass jar	4 C	N
	SD-06	SW/SD-06	Lead	Sediment	10/28/2010	11:05	1	4 oz glass jar	4 C	N
	SW-05	SW/SD-05	Lead	Surface Water	10/28/2010	08:35	2	1L poly bottle	HNO3 pH<2	Y
	SW-05-E	SW/SD-05	Lead	Surface Water	10/28/2010	08:40	1	1L poly bottle	HNO3 pH<2	N
	SW-06	SW/SD-06	Lead	Surface Water	10/28/2010	11:00	1	1L poly bottle	HNO3 pH<2	N

Special Instructions: Hold excess solid sample for possible future analysis.

SAMPLES TRANSFERRED FROM
CHAIN OF CUSTODY #

Items/Reason	Relinquished by	Date	Received by	Date	Time	Items/Reason	Relinquished By	Date	Received by	Date	Time
		10/28/10	M. Pena	10/28/10	17:05						

APPENDIX D

HUMAN HEALTH RISK ASSESSMENT AND ENVIRONMENTAL RISK ASSESSMENT

STREAMLINED HUMAN HEALTH RISK ASSESSMENT

Jewett White Lead Site
2000-2012 Richmond Terrace Property
Staten Island, New York

January 4, 2011

Introduction

This streamlined risk assessment (SRA) has been prepared to support the EE/CA for the 2000-2012 Richmond Terrace portion of the Site.

The study area and the sample locations assessed in this SRA are presented on the site location map, Figure 1-2 of the Removal Action Alternatives Report (RAAR), included in Attachment I. The objective of the streamlined risk assessment is to provide an evaluation of potential risks to human receptors assuming no removal or cleanup actions are taken at the site.

Data Collection

Surface soil, subsurface soil and groundwater samples were collected in October 2010. Soil samples (166) were collected from the surface to the water table and analyzed for lead using a field instrument (XRF). The samples were collected in 1 foot increments. Additional soil samples (22) were collected for confirmatory analysis. These samples were analyzed for full TAL metals. The sampling interval was also collected in 1 foot increments.

Groundwater samples were collected at three sampling locations on the property. These groundwater samples were collected at the water table and analyzed for full TAL metals.

Human Health Screening – Constituents of Potential Concern

The current land use is zoned commercial/industrial. The future land use is not expected to change. However, this assessment included screening against the residential screening criteria, as a conservative measure to provide a range of the risks associated with each exposure scenario.

The screening process is a conservative step in the streamlined risk assessment process. To evaluate the potential risks posed to current and future receptors, a conservative screening process was applied to identify Constituents of Potential Concern (COPC) in the surface soil, subsurface soil and groundwater at the site.

In order to develop a list of COPCs for each medium, the maximum detected concentrations of the site related constituents were compared to their respective regional screening levels (RSLs) from the Regional Screening Levels for Contaminants at Superfund Sites (November, 2010). The screening levels utilized in this streamlined risk evaluation correspond to either a cancer risk of 1×10^{-6} or a hazard quotient of 0.1. The non-cancer hazard RSLs have been adjusted to 0.1 to take into account potential exposures to multiple chemicals.

If the maximum detected concentration of the constituent exceeded its respective RSL, the constituent is identified as a COPC. If the maximum detected concentration of a constituent did not exceed its respective RSL, it was determined that the constituent does not represent an unacceptable risk to human health. Group A Carcinogens (Known Human Carcinogens) that were detected were also selected as COPCs regardless of the level at which they were detected.

Results

Tables 1, 2 and 3 summarize human health COPCs identified for surface soil, subsurface soil and groundwater.

The samples collected and analyzed using the XRF (Table 1), indicate that the maximum detected concentration of lead (97,921 mg/kg) exceeded its respective screening criteria for the child (400 mg/kg) and adult receptor (880 mg/kg). The average lead concentration at the surface (0-2ft) is 27,443 mg/kg and is much higher when compared to the total soil (surface and subsurface) lead concentration throughout the site (11,245 mg/kg).

For comparison purposes, the average lead concentration using the XRF data versus the lab analyzed data was evaluated. The average lead concentration generated using the lab data is 11,630 mg/kg which is fairly consistent with the average lead concentration calculated using only the XRF data (11,245 mg/kg).

The maximum detected concentrations of the constituents detected (lab data) were compared to their respective screening levels. In soil, 8 detected chemicals exceeded their respective residential screening criteria (Table 2). When compared to their respective screening criteria, a cancer risk and non-cancer hazard was generated for each chemical based upon the maximum detected concentration (Table 4). For carcinogens, cancer risks are generally expressed as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the carcinogen. This evaluation was conducted for all constituents in Table 2 with the exception of lead. These risks are probabilities that usually are expressed in scientific notation. An excess lifetime cancer risk of 1×10^{-6} indicates that an individual experiencing the reasonable maximum exposure estimated has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. The NCP defines the acceptable risk range for site related exposures as one in 10,000 (1×10^{-4}) to one in a million (1×10^{-6}). The ratio of exposure to toxicity is called a hazard quotient (HQ). An HQ<1.0 indicates that a receptor’s dose of a single contaminant is less than the reference dose (RfD), and that toxic non-carcinogenic effects from that chemical are highly unlikely.

Lead is evaluated differently than other constituents and will be discussed later in the evaluation. The maximum detected concentrations of COPCs (individually) are below the HI = 1 or within the cancer risk range, with the exception of manganese. The maximum detected concentration of manganese corresponds to a hazard index of 1.8, which slightly exceeds the non cancer hazard threshold.

Three detected chemicals in groundwater samples exceeded their respective tap water screening criteria. The maximum detected concentration for Iron corresponds to 0.9 HI, which is below EPAs threshold of 1. The maximum detected concentration for Manganese corresponds to a 5.6 HI, which slightly exceeds EPAs threshold of 1. The maximum detected concentration of Arsenic corresponds to a cancer risk of 1.6 x 10^{-3}, which exceeds EPA cancer risk range. It should be noted that Arsenic was detected only in one of the three monitoring wells sampled at the site.

Lead is evaluated differently. The screening criteria included in this evaluation do not correspond to either a cancer risk or non-cancer hazard. The CDC has identified a blood lead concentration level of 10 µg/dL as the level of concern above which significant health risks occur. For lead, the toxicity assessment is based on exceeding the 10 µg/dL blood lead concentration.

Development of the residential screening level in this interim directive required two important Office of Solid Waste and Emergency Response (OSWER) decisions. 1) OSWER determined that it would seek to achieve a specific level of protectiveness in site cleanups; generally, OSWER will attempt to limit exposure to soil lead levels such that a typical (or hypothetical) child or group of similarly exposed children would have an estimated risk of no more than 5% exceeding the 10 µg lead/dl blood lead level. This 10 µg/dl blood lead level is based upon analyses conducted by the Centers for Disease Control and EPA that associate blood lead levels of 10 µg/dl and higher with health effects in children; however, this blood lead level is below a level that would trigger medical intervention. 2) In developing the residential screening level, OSWER has decided to apply the EPA's IEUBK model on a site-specific basis. This model has been designed specifically to evaluate exposures for children in a residential setting. Current research indicates that young children are particularly sensitive to the effects of lead and require specific attention in the development of a soil screening level for lead. A screening level that is protective for young children is expected to be protective for older population subgroups.

The identification of lead exposures from other sources (due to air, water, diet, paint, etc.) is an essential part of characterizing the appropriate blood lead distribution for a specific neighborhood or site. For the purpose of deriving a residential screening level, the background lead exposure inputs to the IEUBK model were determined using national averages, where suitable, or typical values. Thus, the estimated screening level of 400 ppm is associated with an expected "typical" response to these exposures, and should not be taken to indicate that a certain level of risk (e.g., exactly 5% of children exceeding 10 µg/dl blood) will be observed in specific community, e.g., in a blood lead survey.

The lead results indicate that the average concentration on the site (surface and subsurface) presents an unacceptable risk to the current industrial/commercial receptor and the potential future resident.

Table 1 - Lead XRF data – Soils

Contaminant of Potential Concern	Maximum Detected Concentration (mg/kg)	Residential Screening Criteria (mg/kg)	Industrial Screening Criteria (mg/kg) (1)	Average Surface Soil Concentration (0-2 feet) (mg/kg)	Average Total Soil Concentration (surface and subsurface) (mg/kg)
Lead	97,921	400	800	27,443	11,245

Footnote:

(1) An updated screening level for soil lead at commercial/industrial sites of 800 mg/kg is based on a recent analysis of the combined phases of the National Nutrition Examination Survey (NHANES III) that choose a cleanup goal protective for all subpopulations.

Table 2 - Confirmatory Sampling Data – Soils

Contaminant of Potential Concern	Maximum Detected Concentration (mg/kg)	RSL Screening Toxicity Value – Residential (mg/kg) (1)	RSL Screening Toxicity Value – Industrial (mg/kg) (2)	Rational for Selection or Deletion (3)	Contaminant of Potential Concern Flag (Y or N) (4)
Silver	1	39 (N)	510 (N)	BSL	No
Aluminum	11,000	7700 (N)	99,000 (N)	ASL - (R)	Yes
Arsenic	8.9	0.39 (C)	1.6 (C)	GAC, ASL - (R) (NR)	Yes
Barium	890	1500 (N)	19,000(N)	BSL	No
Beryllium	0.58	16 (N)	200 (N)	BSL	No
Cadmium	2.4	7 (N)	81 (N)	BSL	No
Cobalt	12	2.3 (N)	30 (N)	BSL	No
Chromium	25	28 (C)	140 (C)	BSL	No
Copper	140	31 (N)	4,100 (N)	ASL - (R)	Yes
Iron	26,000	5,500 (N)	72,000 (N)	ASL - (R)	Yes
Manganese	3,300	180 (N)	2,300 (N)	ASL - (R) (NR)	Yes
Nickel	87	160 (N)	2,000 (N)	BSL	No
Lead	78,000	400 (N)	800	ASL - (R) (NR)	Yes
Antimony	3.8	3.1 (N)	41 (N)	ASL - (R)	Yes
Selenium	3.4	39 (N)	510 (N)	BSL	No
Thallium	ND	0.51 (N)	6.6 (N)	BSL	No
Vanadium	32	55 (N)	720 (N)	BSL	No
Zinc	270	2,300 (N)	31,000 (N)	BSL	No
Mercury	1.3	0.67 (N)	28 (N)	ASL - (R)	Yes

Footnote:

(1) Screening values are for residential soil and represent a cancer benchmark of $1x10^{-6}$ or a HQ = 0.1 (USEPA November 2010 RSL Screening Toxicity Values)
  (C) Most sensitive Health Endpoint is Cancer
  (N) Most Sensitive Health Point is Non-Cancer

(2) Screening values are for industrial soil and represent a cancer benchmark of $1x10^{-6}$ or a HQ = 0.1 (USEPA November 2010 RSL Screening Toxicity Values)
  (C) Most sensitive Health Endpoint is Cancer
  (N) Most Sensitive Health Point is Non-Cancer

(3) Selection Rationale:
  ASL – Above Screening Criteria
  BSL – Below Screening Criteria
  GAC – Group A Carcinogen
  (R) – Exceedence Based on the Residential Screening Criteria
  (NR) – Exceedence Based on the Industrial Screening Criteria

(4) Constituents selected as constituents of Potential Concern if the constituent exceeds its respective screening value, if there is no selected screening value or if a constituent is a Group A carcinogen.

(5) ND: Not detected

(6) Highlighted in RED: Constituents that have exceeded their respective RSL

Table 3 – Groundwater Sampling Data

COPC	Maximum Detected Concentration (µg/L)	RSL Screening Toxicity Value – Tap Water (µg/L) [1]	Rationale for Selection or Deletion [2]	Contaminant of Potential Concern Flag (Y or N) [3]	Cancer Risk or Non-Cancer Hazard[4]
Aluminum	130	3,700 (N)	BSL	No	0.004 (N)
Arsenic	73	0.045 (C)	ASL, GAC	Yes	1.6 x 10-3 (C)
Barium	240	730 (N)	BSL	No	0.03 (N)
Beryllium	0.58	7.3 (N)	BSL	No	0.008 (N)
Iron	24,000	2,600 (N)	ASL	Yes	0.9 (N)
Manganese	5,000	88 (N)	ASL	Yes	5.6 (N)

Footnote:

(1) Screening values for tap water represent a cancer benchmark of $1x10^{-6}$ or a HQ = 0.1 (USEPA November 2010 RSL Screening Toxicity Values)

(C) Most sensitive Health Endpoint is Cancer
(N) Most Sensitive Health Point is Non-Cancer

(2) Selection Rationale:

ASL – Above Screening Criteria
BSL – Below Screening Criteria
GAC – Group A Carcinogen

(3) Constituents selected as constituents of Potential Concern if the constituent exceeds its respective screening value, if there is no selected screening value or if a constituent is a Group A carcinogen.

(4) The NCP defines the acceptable risk range for site related exposures as one in 10,000 ($1x10^{-4}$) to one in a million ($1x10^{-6}$). The ratio of exposure to toxicity is called a hazard quotient (HQ). An HQ<1.0 indicates that a receptor's dose of a single contaminant is less than the reference dose (RfD), and that toxic non-carcinogenic effects from that chemical are highly unlikely..

(5) Highlighted in RED: Constituents that have exceeded their respective RSL.

Table 4 – Cancer Risk or Non-Cancer Hazard for COPCs in Soil*

COPC	Maximum Detected Concentration (mg/kg)	Residential Cancer Risk or Non Cancer Hazard	Non Residential Cancer Risk or Non Cancer Hazard
Aluminum	11,000	0.14 (N)	
Arsenic	8.9	2.3×10^{-5} (C)	5.6×10^{-6} (C)
Copper	140	0.45 (N)	
Iron	26,000	0.47 (N)	
Manganese	3,300	1.8 (N)	0.14 (N)
Antimony	3.8	0.12 (N)	
Mercury	1.3	0.19 (N)	

Footnote:

*** excluding lead. See Table 1 for lead evaluation**

(1) The NCP defines the acceptable risk range for site related exposures as one in 10,000 (1×10^{-4}) to one in a million (1×10^{-6}). The ratio of exposure to toxicity is called a hazard quotient (HQ). An HQ<1.0 indicates that a receptor's dose of a single contaminant is less than the reference dose (RfD), and that toxic non-carcinogenic effects from that chemical are highly unlikely.

(C) Most sensitive Health Endpoint is Cancer

(N) Most Sensitive Health Point is Non-Cancer

STREAMLINED
SCREENING LEVEL
ECOLOGICAL
RISK ASSESSMENT

Jewett White Lead Site
2000-2012 Richmond Terrace Property
Staten Island, New York

Prepared for
U.S. Environmental Protection Agency
2890 Woodbridge Avenue
Edison, NJ 08818

Prepared by
Alion Science and Technology
2890 Woodbridge Avenue
Edison, New Jersey 08818

Acronyms

BAF	bioaccumulation factor
BERA	baseline ecological risk assessment
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liabilities Act
COPC	contaminant of potential concern
CSM	conceptual site model
EC	effects concentration
EcoSSL	Ecological Soil Screening Level
EPA	Environmental Protection Agency
ERAGS	Ecological Risk Assessment Guidance for Superfund
ER-L	effects range-low
ESL	ecological screening level
HQ	hazard quotient
IRM	interim removal action
LOAEL	lowest observable adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
NOAEL	no observable adverse effect level
NYSDEC	New York State Department of Environmental Protection
PCB	polychlorinated biphenyl
PRC	Perfetto Realty Company
PRG	preliminary remediation goal
RI	remedial investigation
SLERA	streamlined screening level ecological risk assessment
TAL	target analyte list
TRV	toxicity reference value
µg/L	micrograms per liter
>	greater than
<	less than
%	percent

1. Introduction

A streamlined Screening Level Ecological Risk Assessment (SLERA) was performed for the 2000-2012 Richmond Terrace portion (property) of the Jewett White Lead Site (Site) in the Borough of Staten Island, Richmond County, New York. The Site consists of the historic footprint of the former Jewett White Lead Company facility and the related extent of contamination, which includes the 1.07-acre parcel of land at 2000-2012 Richmond Terrace and the approximately 2.25-acre parcel of land at 2015 Richmond Terrace. Historically, John Jewett & Sons White Lead Company operated a white lead manufacturing facility at the 2015 Richmond Terrace property from 1839 until April 3, 1890, when National Lead & Oil Company of New York ("National Lead") acquired the property. National Lead continued the manufacture of white lead at the Site and extended the operations across the street to include the 2000 Richmond Terrace property. National Lead owned and operated at both properties until approximately 1943. Operations included the manufacture of white lead, an additive found in lead-based paint and ceramics.

In 1943, the property at 2015 Richmond Terrace was acquired by the Moran Towing Corporation, which currently owns and operates an active tug boat facility at the property. Because this property is nearly entirely paved and does not represent potential wildlife habitat, it is not evaluated in this SLERA.

Between 1949 and 1990, various businesses, including Sedutto's Ice Cream Factory, operated at the 2000-2012 Richmond Terrace property. After several fires occurred at the Factory, the buildings and remaining debris were razed and cleared in 2000 and the property was sold. It is currently owned by Perfetto Realty Co., Inc. (PRC), which used the property as a staging area for materials and equipment being brought to and removed from a construction project conducted elsewhere on Staten Island. The property consists of fenced vacant land that has historically been disturbed by heavy machinery and vehicles related to nearby construction work. Presently, the land is covered with weedy grass, and EPA has received assurances from the owner that the property will not be used until a final cleanup has been completed.

1.1 Objectives

This report was prepared in accordance with EPA guidance for ecological risk assessment (EPA 1997, 1998). The SLERA consists of Steps 1 and 2 of the eight step process presented in EPA (1997). The objective of this SLERA is to evaluate the potential ecological impact of contaminants at the 2000-2012 Richmond Terrace property. In particular, this streamlined assessment is being performed to provide evidence as to whether a non-time critical removal action at the Site is justified and to identify what current or potential exposures should be prevented. The streamlined risk evaluation is intermediate in scope between a risk evaluation performed for emergency response activities and a baseline assessment typically performed for remedial actions (EPA 1993). The evaluation uses site-specific data to identify the contaminants of concern, the affected media, the contaminant concentrations, and the potential toxicity associated with those contaminant concentrations, to focus the assessment on specific site problems. Where standards for a given medium are clearly exceeded, further quantitative assessment is not generally needed (EPA 1993).

Like a regular SLERA, a streamlined evaluation uses conservative assumptions to identify exposure pathways and, where possible, quantify potential ecological risks. In Step 1, descriptions are developed of the environmental setting, contaminants known or suspected to exist at the property and the maximum concentrations present in each medium, contaminant fate and transport mechanisms that might exist, mechanisms of ecotoxicity associated with contaminants, receptors that may be affected, potentially complete exposure pathways, and screening ecotoxicity values. In Step 2, risk is estimated by comparing maximum documented exposure concentrations with the ecotoxicity screening values identified in Step 1.

2. Problem Formulation

The problem formulation for this SLERA presents the environmental setting, nature and extent of contamination, potential sources of contamination, assessment endpoints evaluated, potential exposure pathways, and the process for identifying COPCs.

2.1 Environmental Setting

The Site is located in the Port Richmond section of the Borough of Staten Island. The area is primarily residential with heavy concentrations of industrial and manufacturing use along the waterfront. Located along the North Shore of Staten Island, the neighborhood is defined by the Kill Van Kull to the north, the Bayonne Bridge and Martin Luther King Expressway to the west, Forest Avenue to the south and Broadway to the east. Port Richmond is an economically distressed community, with the Borough's second-lowest median household income, the second-highest poverty rate, and the highest concentration of older housing in Staten Island.

2.2 Site History

In 2006, the New York State Department of Environmental Conservation (NYSDEC) awarded an environmental justice community impact grant to the North Shore Waterfront Conservancy of Staten Island. The grant resulted in a report that identified potential environmental impacts from 21 properties positioned along the North Shore of Staten Island. One of these was the portion of the Jewett Lead Site located at 2000 Richmond Terrace. At the request of the Council of the City of New York, EPA Region 2 evaluated the property in 2008 for a removal action under the authority of the Comprehensive Environmental Response, Compensation, and Liabilities Act (CERCLA). Soil samples were collected from 16 test pits excavated to a depth of approximately four feet below ground surface (bgs). The analyses for soil samples collected from the test pits included Target Analyte List (TAL) metals and polychlorinated biphenyls (PCBs). The results revealed elevated levels of lead throughout most of the property, both laterally and with depth.

At EPAs request, an interim removal action (IRA) was undertaken in April 2009 by the current property owner to prevent the migration of lead-contaminated soils from the 2000-2012 Richmond Terrace property. The IRA included improving the existing fencing, installing a silt fence and hay bales around the fence line, spreading grass seed and mulch to hold the lead-contaminated soils in place, posting "lead hazard" signs, and removing the lead-contaminated soils and sediments from the sidewalks and near curb line adjacent the property. The ground surface is now mostly covered with grass, and a fabric windscreen has been placed along the entire fence line.

2.3 Conceptual Model

The potential for ecological risk from contamination in surface soil is being evaluated in this SLERA. In addition, although surface water or sediments are not present on the property, an assessment of these media in catch basins adjacent to the property is being performed to evaluate the potential for risk from surface run-off of contaminated soils. Marine sediments and surface waters at outfalls located in the nearby Kill van Kull are being evaluated as well. Risks due to exposure to groundwater are not being assessed, because exposure of ecological receptors to groundwater or deeper soils at the property is unlikely.

2.3.1 Potential Contaminants of Concern

The Site was historically used for the manufacture of white lead, an additive found in lead-based paint and ceramics. Samples taken from the 2000-2012 Richmond Terrace property in 2008 and 2010 showed elevated levels of lead throughout most of the property, both laterally and with depth. Surface soil samples taken in 2008 had lead concentrations ranging from 80 milligrams per kilogram (mg/kg) to 148,000 mg/kg, with an average value of 16,663 mg/kg. Surface soil samples taken in 2010 had lead concentrations ranging from 2,100 mg/kg to 7,500 mg/kg, with an average value of 5,280 mg/kg. Other heavy metals including antimony, arsenic, chromium, cobalt, copper, iron, manganese, mercury, nickel, silver, vanadium, and zinc were also detected in test pits at the property.

2.3.2. Potential Ecological Receptors

The Site is located in an area characterized by residential, industrial, and manufacturing activities. The only potential habitat consists of grassy vegetation planted in the one-acre fenced area that historically was disturbed by vehicular and heavy machinery use. While it appears unlikely that ecological receptors would use the 2000-2012 Richmond Terrace portion of the Site, the potential risk from exposure to contaminants at the property was evaluated for ecological receptors including soil invertebrates and soil heterotrophic processes, plants, terrestrial birds, terrestrial mammals, benthic invertebrates, and fish.

2.3.3. Exposure Pathways and Exposure Routes

Ecological receptors using the property may be exposed to contaminants through direct contact with or incidental ingestion of surface soil. Receptors may also be exposed to Site-related contaminants through dietary transfer. Additionally, receptors may potentially be at risk from contaminated surface water and sediments formed via storm-water run-off from storm drains into the Kill van Kull.

2.4 Exposure Parameters

2.4.1 Soil Exposure

Soil exposure was evaluated using data from samples collected in 2008 from 16 test pits excavated to a depth of approximately four feet below grade. Surface soil samples evaluated in the SLERA included 34 samples taken from a depth of 0 to 3 inches or 0 to 1 foot bgs at each test pit location. Additional soil samples were collected from test pits in 2010. Samples from this collection event used to characterize surface soils consist of four samples (including one duplicate) taken at a depth of 0 to 1 foot bgs. All soil samples were analyzed for TAL metals.

2.4.2 Surface Water and Sediment Sampling

Collocated surface water and sediment samples were collected in 2010 at two catch basins located near the 2000-2012 Richmond Terrace property and analyzed for TAL metals. The catch basins are part of the municipal storm water drainage system. Because samples were collected through catch basin grates, ecological receptors are unlikely to be exposed to surface water or sediment at these locations. However, they may reveal the potential for transport of Site-related contaminants via storm water run-off.

Two additional collocated sediment and surface water samples were taken near outfalls discharging from the property into the Kill van Kull, located to the north of the Site. These samples were also analyzed for TAL metals.

2.5 Assessment Endpoints and Measures of Effects

In SLERAs, assessment endpoints are usually considered to be any adverse effects from site contaminants to any ecological receptors at the site. Assessment endpoints used to evaluate ecological risk from exposure to contaminants in soil at the 2000-2012 Richmond Terrace portion of the Jewett White Lead Site include terrestrial plants, terrestrial invertebrates, and terrestrial animals including birds and mammals (Table 1). Measures of effects to these assessment endpoints were based initially on comparisons of site-specific contaminant concentrations to conservative screening level benchmarks. Contaminants with concentrations exceeding screening benchmarks were further assessed using food chain models to evaluate potential impacts to terrestrial birds and mammals via dietary transfer. In addition, potential impacts to benthic invertebrates and fish via exposure to surface water runoff were evaluated by comparing contaminant concentrations in water and sediment in catch basins to freshwater and freshwater sediment benchmarks. Potential impacts to benthic invertebrates and fish at outfalls in the Kill van Kull were evaluated by comparing contaminant concentrations in sediments and saltwater at those locations to conservative screening benchmarks for marine sediment and saline surface water.

3. Ecological Effects Assessment

The effects assessment in a SLERA presents media- and chemical-specific screening levels that serve as conservative effect concentrations for evaluating risk. Site-specific data from 2008 and

2010 were compared to selected screening levels to assess the potential for ecological effects to the assessment endpoints being evaluated. Maximum contaminant concentrations for each chemical were used in the evaluation, as required for a screening level assessment (EPA 1997). If a contaminant was measured at a concentration exceeding its respective screening level, it was concluded that the potential exists for adverse ecological effects to occur at the property from exposure to that contaminant.

3.1. Selection of Screening Benchmarks

The selection of COPCs involves comparing the maximum contaminant concentrations measured at the property to screening benchmarks (Table 2). This allows further evaluations to focus on those chemicals that pose the greatest potential risks to ecological receptors, thereby providing guidance that can be used in additional risk evaluations and remediation decisions. Ecotoxicological screening benchmarks are concentrations of chemicals that are reasonably considered to be the highest acceptable concentration, at or below which there should be no adverse environmental effects.

Screening values were applied in a hierarchical fashion to the maximum site-specific COPC concentrations. The selection of screening benchmarks for each medium is described in the following sections.

3.1.1 Soil Screening Benchmarks

Soil screening benchmarks were applied in the following order.

- New York State Department of Environmental Conservation Soil Clean Up Objectives for the Protection of Ecological Resources (NYSDEC 2006);
- The lowest available benchmark from EPA Ecological Soil Screening Levels (EcoSSLs) values for plants, soil invertebrates, birds, or mammals (EPA 2003);
- Preliminary Remediation Goals (PRGs) for Ecological Endpoints from Efroymson *et al.* 1997a;
- The lowest values among Oak Ridge National Laboratories values for plants, soil and litter invertebrates, and soil heterotrophic processes (Efroymson *et al.* 1997b, 1997c).

Thus, the NYSDEC values were applied first, when available. If no value was available, the next source listed was examined for a screening value, and so on. If a selected screening level was exceeded, contaminants were retained for further evaluation using food chain models.

3.1.2 Freshwater Sediment Screening Benchmarks

Freshwater sediment screening benchmarks represent conservative values (e.g., Lowest Effects Levels [LELs]) whenever possible (Table 3). Freshwater sediment screening benchmarks were taken from the sources below, in the order listed.

- New York State Technical Guidance Values (NYSDEC 1999)
- Ontario Ministry of the Environment Guidelines (Persaud *et al.* 1993)
- EPA toxicity values for the amphipod and midge (EPA 1996)

- EPA Region 3 Ecological Screening Values (EPA Region 3 2010).

3.1.3 Freshwater Surface Water Screening Benchmarks

Surface water screening values represent conservative values (e.g., chronic criteria) whenever possible (Table 4). Surface water screening benchmarks were taken from the sources below, in the order listed.

- NYSDEC Ambient Water Quality Standards and Guidance Values (NYSDEC 1998).
- Region 3 EPA Ecological Risk Assessment Freshwater Screening Benchmarks (EPA Region 3 2010).

EPA Ambient Water Quality Criteria (EPA 2009) were reviewed as a possible benchmark source, but the only compound for which NYSDEC (1998) did not have a screening value was manganese. EPA (2009) did not have a screening value for manganese; therefore, the value from EPA Region 3 (2010) was used.

3.1.4 Marine Sediment Screening Benchmarks

Marine sediment screening benchmarks represent conservative values (e.g., effects range-low [ER-L] or chronic criteria) whenever possible (Table 5). Marine sediment screening benchmarks were taken from the sources below, in the order listed.

- New York State Technical Guidance Values (NYSDEC 1999)
- EPA toxicity values for the amphipod and midge (EPA 1996)
- Field *et al.* (2002)
- If a marine sediment benchmark could not be found for a particular contaminant, a freshwater sediment benchmark from Ontario Ministry of the Environment (Persaud *et al.* 1993) was applied.

3.1.5 Saline Surface Water Screening Benchmarks

Benchmark sources reviewed for screening benchmarks for saline surface water include NYSDEC Ambient Water Quality Standards and Guidance Values (NYSDEC 1998), EPA National Water Quality Criteria (EPA 2009), New Jersey Department of Environmental Protection Ecological Screening Criteria (NJDEP 2010), Ontario Ministry of the Environment Water Quality Guidelines (OMOE 2010), and Washington State Department of Ecology Surface Water Quality Criteria (WSD0E 2010). No applicable screening benchmarks could be found for contaminants detected in saline surface water (iron and manganese).

3.2 Calculation of Hazard Quotients

The hazard quotient (HQ) method was used to estimate risk of exposure to each COPC. This method compares the maximum exposure concentration (EC) to the ecological screening level (ESL) and is expressed as a ratio per the following formula:

$$HQ = EC / ESL.$$

A calculated HQ > 1 indicates there is the potential for risk from a particular contaminant to the assessment endpoint being evaluated. An HQ ≤ 1 suggests that there is a high degree of confidence that minimal risk exists for the given COPC, since conservative benchmarks were applied to protect the most sensitive organisms. Therefore, only contaminants for which the HQ was > 1 were retained as COPCs for further evaluation using food chain models.

Analytes for which benchmark values were not available were also retained as COPCs. Calcium, magnesium potassium, and sodium were removed from further consideration as COPCs because they are ubiquitous, occur naturally in high concentrations, are essential nutrients, and they are unlikely to be risk drivers. Additionally, tissue concentrations of these compounds are regulated by living organisms; even at relatively high levels of exposure, internal concentrations generally do not become sufficiently high to cause toxic effects.

3.3 Assumptions

Assumptions made during this analysis that contribute to the uncertainty associated with this SLERA include:

- An HQ > 1 indicates there is insufficient information to conclude negligible risk from exposure to contaminants at concentrations measured on-site. An HQ of ≤ 1 does not indicate a lack of risk, but suggests that there is a high degree of confidence that minimal risk exists for the given contaminant.
- The exposure value for each contaminant used in risk estimations was assumed to be present throughout the property at the measured concentration all of the time.
- Maximum concentrations of contaminants were used for the risk calculations. The bioavailability of each contaminant was assumed to be 100 percent (%). No assumptions were considered regarding ionic species present.
- Background concentrations were not considered.

3.4 Identification of Contaminants of Potential Concern

Chemicals with maximum detected values above their selected ESLs were retained as COPCs, as were detected contaminants for which screening level benchmarks could not be identified.

3.4.1 Soil

The following compounds were identified as COPCs in surface soil because maximum detected concentrations exceeded screening benchmarks.

- Aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, silver, vanadium, and zinc. The greatest calculated HQ was for lead (2,349), followed by aluminum (1,776), iron (181), and chromium (108) (Table 2).

The only compounds measured at concentrations lower than screening benchmarks were beryllium, selenium, and thallium.

3.4.2 Freshwater Sediment

The following compounds were identified as COPCs in freshwater sediment because maximum detected concentrations exceeded screening benchmarks.

- Chromium, copper, lead, nickel, selenium, and zinc. The greatest calculated HQ was from copper (5.5), followed by lead (4.2) and zinc (2.4). Hazard quotients for chromium, nickel, and selenium were less than 2 (Table 3).

In addition, barium and vanadium were retained as COPCs because no screening value could be identified for these compounds.

3.4.3 Freshwater Surface Water

The following compounds were identified as COPCs in freshwater surface water because maximum detected concentrations exceeded screening benchmarks.

- Aluminum, copper, iron, lead, manganese, and zinc. The greatest calculated HQ was for iron (8.3), followed by lead (5.8), copper (3.2), and aluminum (3.1). Hazard quotients for manganese and zinc were less than 2 (Table 4).

3.4.3 Marine Sediment

The following compounds were identified as COPCs in sediment from the outfalls in the Kill van Kull because maximum detected concentrations exceeded screening benchmarks.

- Antimony, arsenic, copper, iron, lead, manganese, mercury, nickel, silver, and zinc. The greatest calculated HQ was from nickel (12.4), followed by silver (7.8) and antimony (7.6). Hazard quotients for arsenic, iron, manganese, and zinc were less than two (Table 5).

In addition, barium and vanadium were retained as COPCs because no screening values could be found for these compounds.

3.4.4 Saline Surface Water

Two contaminants (iron and manganese) were detected in surface water near the outfalls in the Kill van Kull. Saltwater screening benchmarks could not be identified for these compounds. The maximum measured concentrations of iron and manganese were 280 µg/L and 42 µg/L, respectively.

3. 5 Assessment of Ecological Risk via Dietary Transfer and Incidental Soil Ingestion Using Food Chain Models

To better evaluate the potential risk to ecological receptors from exposure to contaminants at the property via dietary transfer and incidental soil ingestion, food chain models were developed for compounds measured at concentrations exceeding screening benchmarks. A variety of assessment endpoints were used to evaluate the potential for risk to the terrestrial avian and mammalian communities from exposure to Site contaminants.

3.5.1 Assessment Endpoints and Estimates of Contaminant Intake

Terrestrial assessment endpoints evaluated included herbivorous birds and mammals, soil invertebrate feeding (invertivorous) birds and mammals, and carnivorous birds and mammals. For each assessment endpoint, a representative (receptor) species was evaluated. Selected receptor species were as follows.

- Herbivorous birds – northern bobwhite (*Colinus virginianus*)
- Invertivorous birds – American woodcock (*Scolopax minor*)
- Carnivorous birds – American kestrel (*Falco sparverius*)
- Herbivorous mammals – meadow vole (*Microtus pennsylvanicus*)
- Invertivorous mammals – short-tailed shrew (*Blarina brevicauda*)
- Carnivorous mammals – red fox (*Vulpes vulpes*)

For each receptor species, dietary inputs were used to calculate the amount of each contaminant expected to be consumed via the diet. Dietary concentrations of contaminants were calculated by applying bioaccumulation factors (BAFs), which represent transfer from soil to various dietary components. The assumed dietary composition for each receptor species and the application of BAFs used to calculate dietary concentrations of each contaminant are presented in Table 6, and are described below.

- Northern bobwhite: The diet of the northern bobwhite consists primarily of plant material including seeds and fruit. Insects typically comprise a small proportion of their diet as well (EPA 2003). For the food chain models, the dietary composition of the northern bobwhite was assumed to be 50% seeds and 50% fruit. The concentrations of contaminants in the diet of the northern bobwhite were calculated using the 90th percentile BAFs for soil to above ground plant tissues presented in Bechtel Jacobs (1998).
- American woodcock: The diet of the American woodcock consists primarily of earthworms, supplemented by various insects (EPA 1993). For the food chain models, the diet of the American woodcock was assumed to consist solely of earthworms. The concentrations of contaminants in the diet of the American woodcock were calculated using the 90th percentile BAFs for soil to earthworms presented in Sample *et al.* (1998a). A BAF for antimony could not be found in the published literature; a default BAF of 1.0 was used for this compound.
- American kestrel: The diet of the American kestrel consists primarily of small mammals, birds, and insects. For the food chain models, the diet of the American kestrel was assumed to consist solely of small mammals. The concentrations of contaminants in the diet of the American kestrel were calculated using 90th percentile BAFs for soil to generalized (i.e., no specific trophic group) small mammals presented in Sample *et al.* (1998b). Values for aluminum and antimony were not presented in Sample *et al.* (1998b).

The BAF for antimony was taken from Baes 1984. A soil to small mammal BAF for aluminum could not be found, so a default value of 1.0 was used for this compound.

- Meadow vole: the diet of the meadow vole consists primarily of plant material including seeds, fruit, and shoots (EPA 1993). Fungi and insects are consumed occasionally as well. For the food chain models, the dietary composition of the meadow vole was assumed to be 50% fresh (green) shoots, 25% seeds, and 25% fruit. The dietary concentrations of contaminants in the diet of the meadow vole were calculated using the 90^{th} percentile BAFs for soil to above ground plant tissues presented in Bechtel Jacobs (1998).
- Short-tailed shrew: The diet of the short-tailed shrew consists of primarily of earthworms and insects (EPA 1993). For the food chain models, the diet of the short-tailed shrew was assumed to consist solely of earthworms. The concentrations of contaminants in the diet of the short-tailed shrew were calculated using the 90^{th} percentile BAFs for soil to earthworms presented in Sample *et al*. (1998a). A soil to earthworm BAF for antimony could not be found in the published literature; therefore, a default value of 1.0 was used for this compound.
- Red fox: The diet of the red fox consists primarily of small mammals and birds, supplemented by insects and plant material (EPA 1993). For the food chain models, the diet of the red fox was assumed to consist solely of small mammals. The concentrations of contaminants in the diet of the red fox were calculated using 90^{th} percentile BAFs for soil to generalized (i.e., no specific trophic group) small mammals presented in Sample *et al.* (1998b). Values for aluminum and antimony were not presented in Sample *et al.* (1998b). The BAF for antimony was taken from Baes (1984). A soil to small mammal BAF for aluminum could not be found, so a default value of 1.0 was used for this compound.

The expected intake of each contaminant via incidental soil ingestion was calculated using soil ingestion rates obtained from the published literature (EPA 1993, Beyer *et al.* 1994, Conor 1993, and Wood *et al.* 1996; Table 7). Because soil ingestion rates were reported as percent of the diet in dry weight and food ingestion rates were reported in grams per day wet weight, food ingestion rates were converted to dry weight measures using the moisture content of the diet, as reported in EPA (1993). The percent soil ingestion was then applied to the dry weight food ingestion rate to obtain a soil ingestion rate in units of grams per day (Table 8).

3.5.2 Dose Calculation

The intake of contaminants via the diet and via incidental soil ingestion were used along with body weights (taken from EPA 1993) to calculate a daily dose of each contaminant ingested per unit body weight per day. Conservative values were used for all inputs, including maximum contaminant concentrations measured at the property, minimum body weights, and maximum food ingestion rates, to obtain the highest (most conservative) estimates of exposure (Tables 7 and 8). No inputs were included for surface water, since there is no readily available source of drinking water at the property.

For each contaminant, the total dose was calculated using the following equations.

$$TIx = ((SIR*S_{cx}) + ((S_{cx} * BAFx) * FIR)) / BW$$

Where: TIx = total intake of contaminant x (milligrams per kilogram per day)
SIR = soil ingestion rate (grams per day)
S_{cx} = soil concentration of contaminant x
$BAFx$ = bioaccumulation factor for contaminant x
FIR = food ingestion rate (grams per day)
BW = body weight (grams)

3.5.3 Effects Assessment

The calculated daily doses were compared to toxicity reference values (TRVs) obtained from the published literature (Table 9). The TRVs selected represent the no observable adverse effects level (NOAEL), which is the highest dose shown not to cause toxic effects, for effects on growth, reproduction, or survival. Toxicity reference values were taken from the sources below, in the order listed.

- EcoSSL documents (EPA 2003)
- Sample et al. 1996
- Sobotka *et al.* 1996

Hazard quotients for each contaminant and receptor species were calculated as follows:

$$HQx = TIx / NOAELx$$

Where: HQx = hazard quotient for contaminant x (unitless)
TIx = total intake of contaminant x (milligrams per kilogram per day)
$NOAELx$ = NOAEL for contaminant x (milligrams per kilogram per day)

NOAEL HQs less than 1 provide a high degree of confidence that minimal risk exits to an ecological receptor from ingestion of the COPC in diet and soil. For contaminants with NOAEL HQs greater than 1, further investigation would be required to conclusively demonstrate that risk does or does not exist.

3.5.4 Model Assumptions

Assumptions of the models include:

- The area use factor (AUF), which is the foraging area used by the receptor for the exposure model, was assumed to be 1.0, indicating that all foraging was done on the property.
- Bioavailability of contaminants in soil was assumed to be 100%. Speciation of COPCs was not considered.
- Food items were assumed to exhibit 100% absorption efficiency and were assumed not to be excreted during the life of the receptor. That is, the risk estimated from dietary exposure was based on administered dose, not the absorbed dose.

- Food and soil ingestion rates were assumed to be representative of the true ingestion rates for the receptor species being evaluated.
- The diet for each receptor was assumed to consist of a single food item.
- BAFs taken from the published literature were assumed to be representative of the actual accumulation rates of contaminants at the property.
- For contaminants without available BAFs, an accumulation factor of 1.0 was applied.
- Toxicity reference values taken from the published literature were assumed to be representative of TRVs for wildlife receptors at the property.

4. Screening Level Risk Characterization

Results of food chain models indicate the potential for risk to all terrestrial assessment endpoints evaluated from incidental soil ingestion and dietary transfer of contaminants at the property. Model-calculated risks to each assessment endpoint were found for the following contaminants.

4.1 Risk to the Terrestrial Community

The comparison of maximum contaminant concentrations at the property to conservative screening benchmarks indicated that the terrestrial assessment endpoints including soil invertebrates, soil heterotrophic processes, plants, birds, and mammals may potentially be at risk from exposure to contaminants at the property. Evaluations of birds and mammals via food chain models provide another line of evidence that ecological receptors may be at risk from exposure to property contaminants.

4.2 Risk to the Terrestrial Avian Community

4.2.1 Risk to Herbivorous Birds

Using the northern bobwhite as the receptor (model) species, herbivorous birds may be at risk from exposure to the following contaminants at the property.

- Aluminum, arsenic, barium, copper, lead, manganese, mercury, nickel, and zinc (Table 10). Lead had the highest calculated HQ (4,217). The HQ for lead was approximately 175 times that of the nickel, which had the next highest HQ (24). Risk to herbivorous birds from exposure to antimony and iron could not be evaluated because avian NOAELs were not available for these compounds.

4.2.2 Risk to Invertivorous Birds

Using the American woodcock as the receptor (model) species, invertivorous birds may be at risk from exposure to the following contaminants at the property.

- Aluminum, arsenic, barium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, silver, vanadium, and zinc (Table 11). Lead had the highest calculated HQ (107,573), followed by nickel (665). The HQ for lead was approximately 160 times that of the HQ for nickel. Risk to invertivorous birds from exposure to antimony and iron could not be evaluated because avian NOAELs were not available for these compounds.

4.2.3 Risk to Carnivorous Birds

Using the American kestrel as the receptor (model) species, carnivorous birds may be at risk from exposure to the following contaminants at the property.

- Aluminum, barium, cadmium, chromium, copper, lead, manganese, nickel, and zinc (Table 12). Lead had the highest calculated HQ (8,061), followed by aluminum (251). Risk to carnivorous birds from exposure to antimony and iron could not be evaluated because avian NOAELs were not available for these compounds.

4.3 Risk to the Terrestrial Mammalian Community

4.3.1 Risk to Herbivorous Mammals

Using the meadow vole as the receptor (model) species, herbivorous mammals may be at risk from exposure to the following contaminants at the property.

- Aluminum, antimony, arsenic, barium, cadmium, chromium, copper, lead, manganese, mercury, nickel, and zinc (Table 13). Lead had the highest calculated HQ (5,256), followed by nickel (357) and aluminum (224).

4.3.2 Risk to Invertivorous Mammals

Using the short-tailed shrew as the receptor (model) species, invertivorous mammals may be at risk from exposure to the following contaminants at the property.

- Aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, silver, and zinc (Table 14). Lead had the highest calculated HQ (29,877), followed by aluminum (3,604) and nickel (2,108).

4.3.3 Risk to Carnivorous Mammals

Using the red fox as the receptor (model) species, carnivorous mammals may be at risk from exposure to the following contaminants at the property.

- Aluminum, cadmium, chromium, copper, lead, manganese, nickel, and zinc (Table 15). Aluminum had the highest calculated HQ (6,442), followed by lead (1,263).

4.4 Risk from Exposure to Sediment in Catch Basins

As demonstrated in the comparison to conservative screening benchmarks, there may be risk to ecological receptors at the property from exposure to contaminants in sediments formed via run-off of storm water, as evidenced by contaminant concentrations in sediments from the catch basins (Table 3). Compounds retained as COPCs due to exceedances of freshwater screening benchmarks include chromium, copper, lead, nickel, selenium, and zinc. Risk from barium and vanadium could not be evaluated because no screening values could be identified for these compounds. However, given that sediment screening benchmarks are typically based on impacts to benthic macroinvertebrates and there are unlikely to be viable communities of these organisms inhabiting the sediment in the catch basins, the relevance of these exceedances to the ecological community is unclear.

4.5 Risk from Exposure to Water in Catch Basins

As demonstrated in the comparison to conservative screening benchmarks, there may be risk to ecological receptors at the property from exposure to contaminants in storm water run-off, as evidenced by contaminant concentrations in water from the catch basins (Table 4). Compounds retained as COPCs due to exceedances of freshwater benchmarks include aluminum, copper, iron, lead, manganese, and zinc. However, given that freshwater screening benchmarks are typically based on impacts to fish and there are unlikely to be viable communities of these organisms inhabiting the water in the catch basins, the relevance of these exceedances to the ecological community is unclear.

4.6 Risk from Exposure to Sediment at Kill van Kull Outfalls

As demonstrated in the comparison to conservative screening benchmarks, there may be risk to ecological receptors at the property from exposure to contaminants in sediments at the outfalls in the Kill van Kull (Table 5). Compounds retained as COPCs due to exceedances of marine sediment screening benchmarks include antimony, arsenic, copper, iron, lead, manganese, mercury, nickel, silver, and zinc. In addition, barium and vanadium were retained as COPCs because no screening values could be found for these compounds. It should be noted that the source of these contaminants in the Kill van Kull, a tidal waterbody, is unknown. Therefore, it is not clear whether the benthic marine community in the Kill van Kull is at risk from exposure to Site-related contaminants.

4.7 Risk from Exposure to Water at Kill van Kull Outfalls

Only two compounds, iron and manganese, were detected in samples taken from the Kill van Kull. However, no screening benchmarks could be found for these compounds in saltwater. Thus it cannot be concluded that there is no risk to ecological receptors at the property from exposure to contaminants in water near the outfalls of the Kill van Kull. It should be noted that the source of these contaminants in the Kill van Kull, a tidal waterbody, is unknown. Therefore, it is not clear whether the saltwater fish community in the Kill van Kull is at risk from exposure to Site-related contaminants.

5. Sources of Uncertainty

There are several sources of uncertainty in the risk assessment process. The potential sources or uncertainty for this SLERA are outlined below.

5.1 Assumptions and Uncertainty Associated with Problem Formulation

The selection of assessment endpoints at the property was intended to address all potentially exposed species; in reality, however, few ecological receptors are likely to use the 2000-2012 Richmond Terrace property because of the limited amount of habitat. Standing water and sediment are not present; contamination in sediments and surface water in the Kill van Kull may not be from the Site itself. In addition, the terrestrial habitat consists of approximately 1 acre of weedy vegetation characteristic of disturbed areas. Thus, the habitat quality appears sufficiently poor that complete exposure pathways are few. Thus it is likely that the ecological risk identified in this SLERA is overestimated. However, if additional pathways or assessment endpoints exist beyond those evaluated, risk may be underestimated.

5.2 Assumptions and Uncertainty Associated with Exposure Assessment

Maximum concentrations measured onsite were used in exposure calculations, and it was assumed this concentration was present site-wide, all the time. This assumption likely overestimates ecological risk.

Information regarding life history parameters was taken from the published literature and may not be accurate for populations at the property. Body weights and food and soil ingestion rates vary with age, sex, nutritional condition, and environmental conditions. For the SLERA, conservative assumptions including minimum reported adult body weights and maximum food ingestion rates were used. This likely overestimates ecological risk.

For all receptors, dietary composition was assumed to consist of a single food item (i.e., plants, earthworms, or small mammals). In reality, organisms are likely to consume a variety of food items, depending upon availability, nutritional needs, reproductive status, and other factors. In addition, dietary intake rates were converted from wet weights to dry weights based on published water contents; the actual dry weight intake will differ from calculated intakes if the food items consumed (and therefore water contents) are different from those assumed for the models. These assumptions may result in an assessment that over- or under-estimates risk.

Bioaccumulation factors from the published literature were used in the SLERA. Bioaccumulation factors are extremely variable and dependent on numerous site-specific factors such as grain size, organic carbon content, pH, and more. It is not known whether the BAFs used are a good approximation of those that would occur at the property, and the values used may over-or under-estimate risk. For some contaminants, BAFs could not be found in the literature, and a default value of 1.0 was applied. For metals, this likely represents a conservative assumption that overestimates risk from dietary transfer.

For all compounds, bioavailability was assumed to be 100%. This is likely to be an unrealistic assumption, since some fraction of metals will sorb to soil particles, decreasing the potential for environmental transport and bioabsorption. For some contaminants (e.g., aluminum and iron), pH in particular has significant impacts on bioavailability, to the extent that in alkaline, neutral or slightly acidic (pH>5.5) soils, the compounds are typically unavailable and unlikely to induce toxic effects. While pH was not measured in soils at the property, the location and natural history of the area indicate that the pH of the soil is likely to be neutral or nearly neutral. Thus, some identified COPCs, particularly aluminum and iron, could potentially be excluded from consideration if measures of soil pH were available.

5.3 Assumptions and Uncertainty Associated with Effects Assessment

Uncertainties associated with effects assessment relate to estimations of TRVs, the use of conservative assumptions, and the degree of interaction between site contaminants.

Not all benchmarks and TRVs have the same degree of confidence. For some COPCs, information on toxicity is limited or not available. Additionally, many benchmarks and TRVs were derived from laboratory animal studies that evaluated exposure to a single chemical under controlled conditions. Wildlife species may be exposed to a mixture of COPCs under sometimes stressful environmental conditions, which may impact the toxic impact of a contaminant. Additionally, extrapolation of a benchmark derived from populations or species different from those at the property may introduce error because of differences in pharmacokinetics or population and species variability. Further, where benchmark values were statistically determined, they do not represent absolute thresholds; they are reflective of the experimental design. Finally, benchmark values incorporate error contributed by the use of results from many studies incorporating different methods of sample collection, preparation, and analysis. These factors may result in over- or underestimating ecological risk.

Error can be introduced by use of invalid assumptions in the conceptual model. In SLERAs, conservative assumptions are generally made in light of the uncertainty associated with the risk assessment process. This minimizes the possibility of concluding that no risk is present when a threat actually does exist (i.e., false negatives). However, the accuracy with which risk was predicted is not known. The use of conservative assumptions likely overestimates potential risk.

Risk estimates were determined for each COPC individually. Hazard indices (HIs), which are the summation of HQs, were not calculated in this SLERA. It is the general practice within risk assessments to use HI calculations when it is known that several contaminants interact; however, interactions between contaminants may be additive, antagonistic or synergistic. Because the degree to which interactions between contaminants may affect risk to ecological receptors at the property is not known, this assumption may over- or underestimate risk.

There is also the potential of magnified effects from exposure due to additional stressors (e.g., habitat degradation); however, this was not evaluated within this SLERA. If other stressors exist at the property, and if the effects of those stressors and the effects of exposure to site related contaminants are cumulative, ecological risks at the property may be underestimated.

6. Summary and Conclusions

There appears to be the potential for risk to ecological receptors at the 2000-2012 Richmond Terrace portion of the Site. Contaminant concentrations measured at the property exceeded screening benchmarks for many contaminants in soil, in catch basin water and sediments, and in sediment and surface water at the outfalls in the Kill van Kull. Hazard quotients for surface water and sediment (both freshwater and marine) were generally low, but still exceeded threshold values. Concentrations of contaminants in soil were very high for some contaminants, particularly lead, aluminum, iron, nickel, and chromium. In addition, food chain models indicated the potential for risk to all assessment endpoints evaluated (herbivorous birds and mammals, invertivorous birds and mammals, and carnivorous birds and mammals). For all assessment endpoints except carnivorous mammals, lead was the primary contaminant of concern, with HQs reaching 107,573 for the American woodcock. For carnivorous mammals, the highest HQ was calculated for aluminum. This is likely due to using the default BAF of 1.0, which was applied because soil to small mammal values could not be found in the published literature. This BAF is likely to be overly conservative and may cause aluminum to appear to be a disproportionately important COPC.

The SLERA clearly indicates that concentrations of lead and other metals at the property are sufficiently high to present risk to ecological receptors. The fact that little viable habitat exists at the property may represent a mitigating factor by reducing the possibility of ecological exposure.

7. Literature Cited

Baes, C.F., III, R.D. Sharp, A.L. Sjoreen, and R.W. Shor. 1984. A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture, ORNL-5786, Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, TN. 150pp.

Bechtel Jacobs Co. 1998. Empirical Models for the Uptake of Inorganic Chemicals from Soil by Plants. Oak Ridge, TN: Bechtel Jacobs Co. BJC/OR-133.

British Columbia Ministry of the Environment. 2009. Water Quality Guidelines (Criteria). Available at http://www.env.gov.bc.ca/wat/wq/.

Efroymson, R.A., G.W. Suter II, B.E. Sample, and D.S. Jones. 1997a. Preliminary Remediation Goals for Ecological Endpoints. ES/ER/TM-162/R2. Oak Ridge National Laboratory, Oak Ridge, TN.

Efroymson, R.A., M. E. Will, G.W. Suter, and A.C. Wooten. 1997b. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision. Oak Ridge National Laboratory, Oak Ridge, TN.

Efroymson, R.A., M.E. Will, and G.W. Suter II. 1997c. Toxicological benchmarks for contaminants of potential concern for effects on soil and litter invertebrates and heterotrophic processes. ES/ER/TM-126/R2.

EPA. 2009. National Recommended Water Quality Criteria. Office of Water and Office of Science and Technology. Available at http://water.epa.gov/scitech/swguidance/waterquality/standards/current/index.cfm.

EPA. 2003. Guidance for Developing Ecological Soil Screening Levels. Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285-7-55.

EPA. 1998. Guidelines for Ecological Risk Assessment. EPA/630-R-95/002F.

EPA. 1997. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments. EPA 540-R-97-006.

EPA. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod *Hyalella azteca* and the midge *Chironomus riparius*. EPA 905-R96-008, Great Lakes National Program Office, Chicago, IL.

EPA. 1993. Wildlife Exposure Factors Handbook, Volume I of II. Washington, DC. EPA/600/4-93/187a.: United States Environmental Protection Agency, Office of Research and Development.

EPA Region 3. 2010. Ecological Risk Assessment Freshwater Screening Benchmarks. Available at http://www.epa.gov/reg3hwmd/risk/eco/btag/sbv/fw/screenbench.htm#notes. March.

Field, L.J., D.D. MacDonald, S.B. Norton, C.G. Ingersoll, C.G. Severn, D.S. Morong, and R. Lindskoog. 2002. Predicting amphipod toxicity from sediment chemistry using logistic regression models. Environmental Toxicology and Chemistry 21(9):1993–2005.

Lemley, A.D. 2002. Selenium assessment in aquatic ecosystems. U.S. Forest Service, Blacksburg, VA.

NJDEP. 2010. Ecological Screening Criteria. Site Remediation Program, August. Available at http://www.nj.gov/dep/srp/guidance/ecoscreening.

NYSDEC. 2006. Environmental Conservation Law (ECL) Subpart 375-6: Remedial Program Soil Cleanup Objectives. Available at http://www.dec.ny.gov/regs/15507.html.

NYSDEC. 1999. Technical Guidance for Screening Contaminated Sediments. Division of Fish, Wildlife, and Marine Resources. Available at http://www.dec.ny.gov/docs/wildlife_pdf/seddoc.pdf.

NYSDEC. 1993. Technical and Operational Guidance Series (1.1.1). Ambient Water Quality Standards and Guidance. Division of Water. June. Available at http://www.dec.ny.gov/docs/water_pdf/togs111.pdf.

Persaud Ontario Ministry of the Environment. August 1993. Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. ISBN 0-7729-9248-7. August.

Sample, B. E., G. W. Suter, J. J. Beauchamp and R. A. Efroymson. 1999. Literature-derived bioaccumulation models for earthworms: Development and validation. Environmental Toxicology and Chemistry 18: 2110-2120.

Sample, B. E., J. J. Beauchamp, R. A. Efroymson, G. W. Suter and T. L. Ashwood. 1998a. Development and Validation of Bioaccumulation Models for Earthworms. Oak Ridge, TN: Lockheed Martin Corp. ES/ER/TM-220. February 1998.

Sample, B. E., J. J. Beauchamp, R. A. Efroymson and G. W. Suter II. 1998b. Development and Validation of Bioaccumulation Models for Small Mammals. Lockheed Martin Energy Systems, Oak Ridge National Laboratories. ES/ER/TM-219.

Sample, B.E., D.M. Opresko, and G.W Suter II. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. Oak Ridge National Laboratory, Oak Ridge, TN. 227 pp. ES/ER/TM-86/R3.

Sobotka, T.J., P. Whittaker, J.M. Sobotka, R.E. Brodie, D.Y. Quander, M. Robi, M. Bryant, and C.N. Barton. 1996. Neurobehavioral dysfunctions associated with dietary iron overload. Physiology and Behavior. 59(2):213-219.

WSDOE. 2010. Surface Water Quality Standards. Available at http://www.ecy.wa.gov/programs/wq/swqs/index.html.

Table 1. Assessment Endpoints and Measures of Effects Evaluated in SLERA
Jewett White Lead Site
Staten Island, New York

Assessment Endpoint	Risk Question	Measurement Endpoint	Receptor
Terrestrial Habitats			
Survival, growth, and reproduction of the soil invertebrate and heterotrophic communities	Are site-related chemical concentrations in surface soil sufficiently high to adversely affect soil invertebrate and heterotrophic communities?	Comparison of maximum contaminant concentrations in soil to soil screening values	Soil invertebrates and soil hetertrophic processes
Survival, growth, and reproduction of the plant community	Are site-related chemical concentrations in surface soil sufficiently high to adversely affect the plant community?	Comparison of maximum contaminant concentrations in soil to soil screening values	Terrestrial plants
Survival, growth, and reproduction of the avian herbivore community	Are site-related chemical concentrations in surface soil sufficiently high to adversely affect the avian herbivore community?	Comparison of maximum contaminant concentrations in soil to soil screening values Comparison of estimated daily contaminant intake to NOAEL-based TRVs; HQs > 1 indicate the potential for risk	Northern bobwhite
Survival, growth, and reproduction of the avian invertivore community	Are site-related chemical concentrations in surface soil sufficiently high to adversely affect the avian invertivore community?	Comparison of maximum contaminant concentrations in soil to soil screening values Comparison of estimated daily contaminant intake to NOAEL-based TRVs; HQs > 1 indicate the potential for risk	American woodcock
Survival, growth, and reproduction of the avian carnivore community	Are site-related chemical concentrations in surface soil sufficiently high to adversely affect the avian carnivore community?	Comparison of maximum contaminant concentrations in soil to soil screening values Comparison of estimated daily contaminant intake to NOAEL-based TRVs; HQs > 1 indicate the potential for risk	American kestrel
Survival, growth, and reproduction of the mammalian herbivore community	Are site-related chemical concentrations in surface soil sufficiently high to adversely affect the mammalian herbivore community?	Comparison of maximum contaminant concentrations in soil to soil screening values Comparison of estimated daily contaminant intake to NOAEL-based TRVs; HQs > 1 indicate the potential for risk	Meadow vole
Survival, growth, and reproduction of the mammalian invertivore community	Are site-related chemical concentrations in surface soil sufficiently high to adversely affect the mammalian invertivore community?	Comparison of maximum contaminant concentrations in soil to soil screening values Comparison of estimated daily contaminant intake to NOAEL-based TRVs; HQs > 1 indicate the potential for risk	Short-tailed shrew
Survival, growth, and reproduction of the mammalian carnivore community	Are site-related chemical concentrations in surface soil sufficiently high to adversely affect the mammalian carnivore community?	Comparison of maximum contaminant concentrations in soil to soil screening values Comparison of estimated daily contaminant intake to NOAEL-based TRVs; HQs > 1 indicate the potential for risk	Red fox
Freshwater Aquatic Habitats			
Survival, growth, and reproduction of benthic macroinvertebrates exposed to stormwater runoff	Are site-related chemical concentrations in sediments from the catch basins sufficiently high to adversely affect the benthic macroinvertebrate community?	Comparison of maximum contaminant concentrations in sediments from the catch basins to freshwater sediment screening values	Freshwater benthic macroinvertebrates
Survival, growth, and reproduction of fish exposed to stormwater runoff	Are site-related chemical concentrations in water from the catch basins sufficiently high to adversely affect the fish community?	Comparison of maximum contaminant concentrations in water from the catch basins to freshwater screening values	Freshwater fish
Saline Aquatic Habitats			
Survival, growth, and reproduction of the benthic macroinvertebrate community	Are site-related chemical concentrations in saline sediments sufficiently high to adversely affect the benthic macroinvertebrate community?	Comparison of maximum contaminant concentrations in marine sediments to marine sediment screening values	Marine benthic macroinvertebrates
Survival, growth, and reproduction of the fish community	Are site-related chemical concentrations in saline surface water sufficiently high to adversely affect the fish community?	Comparison of maximum contaminant concentrations in saline waters to saltwater screening values	Saltwater fish

Table 2. Soil Screening Results for 2000 Richmond Terrace Property
Jewett White Lead Site
Staten Island, New York

Analyte	Screening Benchmark mg/kg	Source	Maximum Value mg/kg	Maximum HQ
ALUMINUM	50	c	88804.0	**1776.1**
ANTIMONY	0.27	b	13.3	**49.3**
ARSENIC	13	a	33.4	**2.6**
BARIUM	433	a	1610.0	**3.7**
BERYLLIUM	10	a	3.1	0.3
CADMIUM	4	a	4.8	**1.2**
CHROMIUM	1	a	108.0	**108.0**
COBALT	13	b	74.6	**5.7**
COPPER	50	a	1130.0	**22.6**
IRON	200	c	36300.0	**181.5**
LEAD	63	a	148000.0	**2349.2**
MANGANESE	1600	a	11900.0	**7.4**
MERCURY	0.18	a	1.2	**6.6**
NICKEL	30	a	1220.0	**40.7**
SELENIUM	3.9	a	1.4	0.4
SILVER	2	a	7.7	**3.9**
THALLIUM	1	d	0.5	0.5
VANADIUM	7.8	b	31.7	**4.1**
ZINC	109	a	2180.0	**20.0**

Benchmark Sources:

a = NYS Clean up Goals for Ecological Endpoints (NYSDEC 2006)

b = lowest among EcoSSLs for plants, invertebrates, birds, and mammals (U.S. EPA 2003)

c = lowest value among toxicological benchmarks for plants, soi and litter invertebrates, and soil hetertrophic processes (Efroymson et al. 1997a,b)

d = Preliminary remediation goal (based on plants as an endpoint) (Efroymson *et al.* 1997)

mg/kg = milligrams per kilogram

HQ = hazard quotient

Table 3. Freshwater Sediment Screening Results for Storm Sewers
Jewett White Lead Site
Staten Island, New York

Analyte	Screening Benchmark mg/kg	Source	MAX value mg/kg	Maximum HQ
ALUMINUM	25,500	a	3400.0	0.1
ARSENIC	6	b,c	3.2	0.5
BARIUM	NV	NV	51.0	NC
CADMIUM	0.6	b,d	0.380	0.6
CHROMIUM	26	b,d	42.0	**1.6**
COBALT	50	e	5.3	0.1
COPPER	16	b,d	88.0	**5.5**
IRON	20,000	b,d	15000.0	0.8
LEAD	31	b,d	130.0	**4.2**
MANGANESE	460	b,d	120.0	0.3
MERCURY	0.15	b,c	0.037	0.2
NICKEL	16	b,d	19.0	**1.2**
SELENIUM	2	f	2.4	**1.2**
VANADIUM	NV	NV	29.0	NC
ZINC	120	b,c,d	290.0	**2.4**

a = U.S EPA (1996) Effects Range-Low (ER-L)
b = NYSDEC (1999)
c = Long and Morgan (1990) ER-L
d = Persaud et al. (1993) Lowest Effect Level (LEL)
e = Persaud et al. (1993) additional parameters
f = U.S. EPA Region 3 (1999) Screening Values, taken from Lemley
mg/kg = milligrams per kilogram
HQ = hazard quotient
NV = no value could be found
NC = not calculated

Table 4. Surface Water Screening Results for Storm Sewers
Jewett White Lead Site
Staten Island, New York

Analyte	Screening Benchmark µg/L	Source	Maximum Value µg/L	Maximum HQ
ALUMINUM	100	a	310	**3.1**
COPPER	8.956	a	29	**3.2**
IRON	300	a	2500	**8.3**
LEAD	3.7845	a	22	**5.8**
MANGANESE	120	b	130	**1.1**
ZINC	82.632	a	150	**1.8**

a NYSDEC Ambient Water Quality Standards and Guidance Values (NYSDEC 1998).

b Region 3 EPA Ecological Risk Assessment Freshwater Screening Benchmarks (U.S.EPA Region 3 2010).

µg/L = micrograms per liter

HQ = hazard quotient

Table 5. Marine Sediment Screening Results for Outfalls in Kill van Kull
Jewett White Lead Site
Staten Island, New York

Analyte	Screening Benchmark mg/kg	Source	Outfall Maximum Concentration (mg/kg)	Outfall Maximum HQ
ALUMINUM	25,500	a,b	11000.0	0.4
ANTIMONY	0.63	c	4.8	**7.6**
ARSENIC	8.2	d,e	11.0	**1.3**
BARIUM	NV	NV	68.0	NC
CHROMIUM	81	d,e	70.0	0.9
COBALT	50	a,f	19.0	0.4
COPPER	34	d,e	80.0	**2.4**
IRON	20,000	a,g	28000.0	**1.4**
LEAD	46.7	d,e	130.0	**2.8**
MANGANESE	460	a,g	470.0	**1.02**
MERCURY	0.15	d,e	1.1	**7.3**
NICKEL	20.9	d,e	260.0	**12.4**
SILVER	1	d,e	7.8	**7.8**
VANADIUM	NV	NV	32.0	NC
ZINC	150	d,e	180.0	**1.2**

a = Freshwater sediment applied because value for marine sediment could not be found
b = U.S EPA (1996) Effects Range-Low (ER-L)
c = Field *et al.* (2002) T20 value (concentration resulted in mortality of 20% of test population)
d = NYSDEC (1999)
e = Long *et al.* (1995) Effects Range-Low (ER-L)
f = Persaud *et al.* (1993) additional parameters
g = Persaud *et al.* (1993) Lowest Effects Level (LEL)
mg/kg = milligrams per kilogram
HQ = hazard quotient
NV = no screening value could be located
NA = not applicable
ND = not detected
NC = not calculated

Table 6. Bioaccumulation Factors and Calculated Tissue Concentrations
Jewett White Lead Site
Staten Island, New York

Analyte	Soil to Plants	Tissue	Source	Soil to Earthworms	Source	Small to Small Mammals	Source
ALUMINUM	0.005	above ground	a	0.118	b	1	c
ANTIMONY	0.0114	above ground	a	1	c	0.001	d
ARSENIC	1.103	above ground	a	0.523	b	0.0149	e
BARIUM	0.477	above ground	a	0.16	b	0.1121	e
CADMIUM	3.25	above ground	a	40.69	b	3.9905	e
CHROMIUM	0.0839	above ground	a	3.162	b	0.3333	e
COBALT	0.0248	above ground	a	0.291	b	0.1	e
COPPER	0.625	above ground	a	1.531	b	1.045	e
IRON	0.01	above ground	a	0.078	b	0.0171	e
LEAD	0.468	above ground	a	1.522	b	0.2864	e
MANGANESE	0.234	above ground	a	0.124	b	0.0587	e
MERCURY	5	above ground	a	20.63	b	0.192	e
NICKEL	1.411	above ground	a	4.73	b	0.5891	e
SILVER	0.0367	above ground	a	15.338	b	0.5013	e
VANADIUM	0.0097	above ground	a	0.088	b	0.0179	e
ZINC	1.82	above ground	a	12.88	b	2.6878	e

a = 90th percentile value from Bechtel Jacobs 1998
b = 90th percentile value from Sample et al. 1998a
c = BAF could not be found; default value of 1.0 applied
d = Baes *et al.* 1984
e = 90th percentile value from Sample *et al.* 1998b

Table 7. Life History Parameters Used in Food Chain Models
Jewett White Lead Site
Staten Island, New York

Species	Receptor Group	Diet	Body weight (g)	Food Ingestion Rate (g/g/d)[1]	Soil Ingestion Rate(%)[2]	Source
Birds:						
Northern bobwhite	Avian herbivore	100% plant material (50% seeds; 50% fruit)	154	0.093	5.5	d
American woodcock	Avian invertivore	100% earthworms	133.8	0.77	10.4	b
American kestrel	Avian carnivore	100% small mammals	103	0.31	0	NA
Mammals:						
Meadow vole	Mammalian herbivore	100% plant material (50% fresh shoots, 25% seeds; 25% fruit)	17	0.35	2.4	b
Short-tailed shrew	Mammalian invertivore	100% earthworms	15	0.62	5.2	c
Red fox	Mammalian carnivore	100% small mammals	3940	0.14	0	NA

[1] wet weight measure from EPA 1996

[2] dry weight measure

b Beyer *et al.* 1994

c Connor 1993

d maximum grit ingestion rate from Wood *et al.* (1986)

% = percent

NA = not applicable

Table 8. Calculation of Soil Ingestion Input Parameters for Food Chain Models
Jewett White Lead Site
Staten Island, New York

Species	Body size (g)	Food Ingestion Rate (g/g/d)[1]	Food Ingestion Rate (g/d)[1]	Food moisture content (%)[2]	Food Ingestion Rate (g/d)[3]	Soil Ingestion Rate (%)[4]	Soil Ingestion Rate (g/d)
Birds:							
Northern bobwhite	154	0.093	14.322	43	8.16354	5.5	0.4489947
American woodcock	133.8	0.77	103.026	84	16.48416	10.4	1.71435264
American kestrel	103	0.31	31.93	68	10.2176	0	0
Mammals:							
Meadow vole	17	0.35	5.95	63	2.2015	2.4	0.052836
Short-tailed shrew	15	0.62	9.3	84	1.488	5.2	0.077376
Red fox	3940	0.14	551.6	68	176.512	0	0

[1] wet weight

[2] from EPA 1996

[3] dry weight; converted from wet weight using average moisture content of diet (EPA 1996). Diet of bobwhite assumed to be 50% seeds and 50% fruit. Diet of meadow vole assumed to be 50% fresh shoots, 25% seeds, and 25% fruit.

[4] dry weight

g = grams
g/g/d = grams per gram per day
g/d = grams per day
% = percent

Table 9. Toxicity Reference Values
Jewett White Lead
Staten Island, New York

Analyte	Birds		Mammals	
	NOAEL	Source	NOAEL	Source
Aluminum	109.7	b	1.93	b
Antimony	NV	NV	0.059	a
Arsenic	2.24	a	1.04	a
Barium	20.8	b	51.8	a
Cadmium	1.47	a	0.77	a
Chromium	2.66	a	2.4	a
Cobalt	7.61	a	7.33	a
Copper	4.05	a	5.6	a
Iron	NV	NV	301.5	c
Lead	1.63	a	4.7	a
Manganese	179	a	51.5	a
Mercury	0.45	b	0.032	b
Nickel	6.71	a	1.7	a
Silver	2.02	a	6.02	a
Vanadium	0.344	a	4.16	a
Zinc	66.1	a	75.4	a

a = EcoSSL documents (EPA 2003)
b = Sample *et al.* 1996
c = Sobotka *et al.* 1996
NOAEL = no observable adverse effect level
NV = no toxicity reference value could be found

TABLE 10. Hazard Quotient Calculations for Northern Bobwhite
Jewett Lead Site
Staten Island, New York

Input Parameters:

Body Weight	Food IR	Food IR	Soil IR
154	14.322	8.16354	0.4489947

Analyte	Conc. in soil (mg/kg)	BAF	Conc. in Diet (mg/kg)	Body Weight (g)	Food Ingestion rate (g/day w.w.)	Food Ingestion rate (g/day d.w.)	Soil Ingestion rate (g/day d.w.)	Total intake from soil (mg/day)	Total intake from diet (mg/day)	Dose soil (mg/kg/day)	Dose Diet (mg/kg/day)	Total Dose (mg/kg/day)	TRV NOAEL (mg/kg/day)	HQ NOAEL soil	HQ NOAEL diet	TOTAL HQ NOAEL
Aluminum	88804	0.005	444.02	154	14.322	8.16354	0.4489947	39.87252534	6.35925444	258.9125022	41.29386	300.2063622	109.7	**2.36**	0.38	**2.74**
Antimony	13.30	0.0114	0.15162	154	14.322	8.16354	0.4489947	0.00597163	0.002171502	0.038776815	0.01410066	0.052877475	NV	**NC**	**NC**	NC
Arsenic	33.40	1.103	36.8402	154	14.322	8.16354	0.4489947	0.014996423	0.527625344	0.09737937	3.4261386	3.52351797	2.24	0.04	**1.53**	**1.57**
Barium	1610	0.477	767.97	154	14.322	8.16354	0.4489947	0.722881467	10.99886634	4.6940355	71.42121	76.1152455	20.8	0.23	**3.43**	**3.66**
Cadmium	4.80	3.25	15.6	154	14.322	8.16354	0.4489947	0.002155175	0.2234232	0.01399464	1.4508	1.46479464	1.47	0.01	**0.99**	**1.00**
Chromium	108	0.0839	9.0612	154	14.322	8.16354	0.4489947	0.048491428	0.129774506	0.3148794	0.8426916	1.157571	2.66	0.12	0.32	0.44
Cobalt	74.60	0.0248	1.85008	154	14.322	8.16354	0.4489947	0.033495005	0.026496846	0.21750003	0.17205744	0.38955747	7.61	0.03	0.02	0.05
Copper	1130	0.625	706.25	154	14.322	8.16354	0.4489947	0.507364011	10.1149125	3.2945715	65.68125	68.9758215	4.05	0.81	**16.22**	**17.03**
Iron	36300	0.01	363	154	14.322	8.16354	0.4489947	16.29850761	5.198886	105.834465	33.759	139.593465	NV	**NC**	**NC**	NC
Lead	148000	0.468	69264	154	14.322	8.16354	0.4489947	66.4512156	991.999008	431.5014	6441.552	6873.0534	1.63	**264.72**	**3951.87**	**4216.60**
Manganese	11900	0.234	2784.6	154	14.322	8.16354	0.4489947	5.34303693	39.8810412	34.695045	258.9678	293.662845	179	0.19	**1.45**	**1.64**
Mercury	1.18	5	5.9	154	14.322	8.16354	0.4489947	0.000529814	0.0844998	0.003440349	0.5487	0.552140349	0.45	0.01	**1.22**	**1.23**
Nickel	1220	1.411	1721.42	154	14.322	8.16354	0.4489947	0.547773534	24.65417724	3.556971	160.09206	163.649031	6.71	0.53	**23.86**	**24.39**
Silver	7.74	0.0367	0.284058	154	14.322	8.16354	0.4489947	0.003475219	0.004068279	0.022566357	0.026417394	0.048983751	2.02	0.01	0.01	0.02
Vanadium	31.70	0.0097	0.30749	154	14.322	8.16354	0.4489947	0.014233132	0.004403872	0.092422935	0.02859657	0.121019505	0.344	0.27	0.08	0.35
Zinc	2180	1.82	3967.6	154	14.322	8.16354	0.4489947	0.978808446	56.8239672	6.355899	368.9868	375.342699	66.1	0.10	**5.58**	**5.68**

COPC = contaminant of potential concern
IR = ingestion rate
mg/kg = milligrams per kilogram
BAF = bioaccumulation factor
g = grams
g/day = grams per day
d.w = dry weight
mg/day = milligrams per day
mg/kg/day = milligrams per kilogram per day
kg = kilograms
TRV = toxicity reference value
NOAEL = no observable adverse effect level
Conc. = concentration
HQ = hazard quotient
NV = no value could be found for this compound
NC = not calculated

TABLE 11. Hazard Quotient Calculations for American Woodcock
Jewett Lead Site
Staten Island, New York

Input Parameters:

Body Weight	Food IR	Food IR	Soil IR
133.8	103.026	16.48416	1.71435264

Analyte	Conc. in soil (mg/kg)	BAF	Conc. in Diet (mg/kg)	Body Weight (g)	Food Ingestion rate (g/day w.w.)	Food Ingestion rate (g/day d.w.)	Soil Ingestion rate (g/day d.w.)	Total intake from soil (mg/day)	Total intake from diet (mg/day)	Dose soil (mg/kg/day)	Dose Diet (mg/kg/day)	Total Dose (mg/kg/day)	TRV NOAEL (mg/kg/day)	HQ NOAEL soil	HQ NOAEL diet	TOTAL HQ NOAEL
Aluminum	88804	0.118	10478.872	133.8	103.026	16.48416	1.71435264	152.2413718	1079.596267	1137.827891	8068.73144	9206.559331	109.7	**10.37**	**73.55**	**83.92**
Antimony	13.30	1	13.3	133.8	103.026	16.48416	1.71435264	0.02280089	1.3702458	0.17041024	10.241	10.41141024	NV	**NC**	**NC**	NC
Arsenic	33.40	0.523	17.4682	133.8	103.026	16.48416	1.71435264	0.057259378	1.799678773	0.42794752	13.450514	13.87846152	2.24	0.19	**6.00**	**6.20**
Barium	1610	0.16	257.6	133.8	103.026	16.48416	1.71435264	2.76010775	26.5394976	20.628608	198.352	218.980608	20.8	**0.99**	**9.54**	**10.53**
Cadmium	4.80	40.69	195.312	133.8	103.026	16.48416	1.71435264	0.008228893	20.12221411	0.06150144	150.39024	150.4517414	1.47	0.04	**102.31**	**102.35**
Chromium	108	3.162	341.496	133.8	103.026	16.48416	1.71435264	0.185150085	35.1829669	1.3837824	262.95192	264.3357024	2.66	0.52	**98.85**	**99.37**
Cobalt	74.60	0.291	21.7086	133.8	103.026	16.48416	1.71435264	0.127890707	2.236550224	0.95583488	16.715622	17.67145688	7.61	0.13	**2.20**	**2.32**
Copper	1130	1.531	1730.03	133.8	103.026	16.48416	1.71435264	1.937218483	178.2380708	14.478464	1332.1231	1346.601564	4.05	**3.57**	**328.92**	**332.49**
Iron	36300	0.078	2831.4	133.8	103.026	16.48416	1.71435264	62.23100083	291.7078164	465.10464	2180.178	2645.28264	NV	**NC**	**NC**	NC
Lead	148000	1.522	225256	133.8	103.026	16.48416	1.71435264	253.7241907	23207.22466	1896.2944	173447.12	175343.4144	1.63	**1163.37**	**106409.28**	**107572.65**
Manganese	11900	0.124	1475.6	133.8	103.026	16.48416	1.71435264	20.40079642	152.0251656	152.47232	1136.212	1288.68432	179	0.85	**6.35**	**7.20**
Mercury	1.18	20.63	24.3434	133.8	103.026	16.48416	1.71435264	0.002022936	2.508003128	0.015119104	18.744418	18.7595371	0.45	0.03	**41.65**	**41.69**
Nickel	1220	4.73	5770.6	133.8	103.026	16.48416	1.71435264	2.091510221	594.5218356	15.631616	4443.362	4458.993616	6.71	**2.33**	**662.20**	**664.53**
Silver	7.74	15.338	118.71612	133.8	103.026	16.48416	1.71435264	0.013269089	12.23084698	0.099171072	91.4114124	91.51058347	2.02	0.05	**45.25**	**45.30**
Vanadium	31.70	0.088	2.7896	133.8	103.026	16.48416	1.71435264	0.054344979	0.28740133	0.40616576	2.147992	2.55415776	0.344	**1.18**	**6.24**	**7.42**
Zinc	2180	12.88	28078.4	133.8	103.026	16.48416	1.71435264	3.737288755	2892.805238	27.931904	21620.368	21648.2999	66.1	0.42	**327.09**	**327.51**

COPC = cont Contaminant of potential concern
IR = ingestio Ingestion rate
mg/kg = milli Milligrams per kilogram
BAF = bioacc Bioaccumulation factor
g = grams grams
g/day = gram grams per day
w.w. = wet weight
d.w = dry wei dry weight
mg/day = mill milligrams per day
mg/kg/day = Milligrams per kilogram per day
kg = kilogram Kilograms
TRV = toxicit Toxicity reference value
NOAEL = no No observable adverse effect level
Conc. = conc Concentration
HQ = hazard Hazard quotient
NV = no value could be found for this compound
NC = not calculated

TABLE 12. Hazard Quotient Calculations for American Kestrel
Jewett Lead Site
Staten Island, New York

Input Parameters:

Body Weight	Food IR	Food IR	Soil IR
103	31.93	10.2176	0

Analyte	Conc. in soil (mg/kg)	BAF	Conc. in Diet (mg/kg)	Body Weight (g)	Food Ingestion rate (g/day w.w.)	Food Ingestion rate (g/day d.w.)	Soil Ingestion rate (g/day d.w.)	Total intake from soil (mg/day)	Total intake from diet (mg/day)	Dose soil (mg/kg/day)	Dose Diet (mg/kg/day)	Total Dose (mg/kg/day)	TRV NOAEL (mg/kg/day)	HQ NOAEL soil	HQ NOAEL diet	TOTAL HQ NOAEL
Aluminum	88804	1	88804	103	31.93	10.2176	0	0	2835.51172	0	27529.24	27529.24	109.7	0.00	**250.95**	**250.95**
Antimony	13.30	0.001	0.0133	103	31.93	10.2176	0	0	0.000424669	0	0.004123	0.004123	NV	**NC**	**NC**	NC
Arsenic	33.40	0.0149	0.49766	103	31.93	10.2176	0	0	0.015890284	0	0.1542746	0.1542746	2.24	0.00	0.07	0.07
Barium	1610	0.1121	180.481	103	31.93	10.2176	0	0	5.76275833	0	55.94911	55.94911	20.8	0.00	**2.69**	**2.69**
Cadmium	4.80	3.9905	19.1544	103	31.93	10.2176	0	0	0.611599992	0	5.937864	5.937864	1.47	0.00	**4.04**	**4.04**
Chromium	108	0.3333	35.9964	103	31.93	10.2176	0	0	1.149365052	0	11.158884	11.158884	2.66	0.00	**4.20**	**4.20**
Cobalt	74.60	0.1	7.46	103	31.93	10.2176	0	0	0.2381978	0	2.3126	2.3126	7.61	0.00	0.30	0.30
Copper	1130	1.045	1180.85	103	31.93	10.2176	0	0	37.7045405	0	366.0635	366.0635	4.05	0.00	**90.39**	**90.39**
Iron	36300	0.0171	620.73	103	31.93	10.2176	0	0	19.8199089	0	192.4263	192.4263	NV	**NC**	**NC**	NC
Lead	148000	0.2864	42387.2	103	31.93	10.2176	0	0	1353.423296	0	13140.032	13140.032	1.63	0.00	**8061.37**	**8061.37**
Manganese	11900	0.0587	698.53	103	31.93	10.2176	0	0	22.3040629	0	216.5443	216.5443	179	0.00	**1.21**	**1.21**
Mercury	1.18	0.192	0.22656	103	31.93	10.2176	0	0	0.007234061	0	0.0702336	0.0702336	0.45	0.00	0.16	0.16
Nickel	1220	0.5891	718.702	103	31.93	10.2176	0	0	22.94815486	0	222.79762	222.79762	6.71	0.00	**33.20**	**33.20**
Silver	7.74	0.5013	3.880062	103	31.93	10.2176	0	0	0.12389038	0	1.20281922	1.20281922	2.02	0.00	0.60	0.60
Vanadium	31.70	0.0179	0.56743	103	31.93	10.2176	0	0	0.01811804	0	0.1759033	0.1759033	0.344	0.00	0.51	0.51
Zinc	2180	2.6878	5859.404	103	31.93	10.2176	0	0	187.0907697	0	1816.41524	1816.41524	66.1	0.00	**27.48**	**27.48**

COPC = conta Contaminant of potential concern
IR = ingestior Ingestion rate
mg/kg = milli Milligrams per kilogram
BAF = bioacc Bioaccumulation factor
g = grams grams
g/day = grams grams per day
d.w = dry wei dry weight
mg/day = mill milligrams per day
mg/kg/day = r Milligrams per kilogram per day
kg = kilogram Kilograms
TRV = toxicit Toxicity reference value
NOAEL = no No observable adverse effect level
Conc. = conce Concentration
HQ = hazard c Hazard quotient
NV = no value could be found for this compound
NC = not calculated

TABLE 13. Hazard Quotient Calculations for Meadow Vole
Jewett Lead Site
Staten Island, New York

Input Parameters:	Body Weight	Food IR	Food IR	Soil IR
	17	5.95	2.2015	0.052836

Analyte	Conc. in soil (mg/kg)	BAF	Conc. in Diet (mg/kg)	Body Weight (g)	Food Ingestion rate (g/day w.w.)	Food Ingestion rate (g/day d.w.)	Soil Ingestion rate (g/day d.w.)	Total intake from soil (mg/day)	Total intake from diet (mg/day)	Dose soil (mg/kg/day)	Dose Diet (mg/kg/day)	Total Dose (mg/kg/day)	TRV NOAEL (mg/kg/day)	HQ NOAEL soil	HQ NOAEL diet	TOTAL HQ NOAEL
Aluminum	88804	0.005	444.02	17	5.95	2.2015	0.052836	4.692048144	2.641919	276.002832	155.407	431.409832	1.93	**143.01**	**80.52**	**223.53**
Antimony	13.30	0.0114	0.15162	17	5.95	2.2015	0.052836	0.000702719	0.000902139	0.0413364	0.053067	0.0944034	0.059	0.70	0.90	**1.60**
Arsenic	33.40	1.103	36.8402	17	5.95	2.2015	0.052836	0.001764722	0.21919919	0.1038072	12.89407	12.9978772	1.04	0.10	**12.40**	**12.50**
Barium	1610	0.477	767.97	17	5.95	2.2015	0.052836	0.08506596	4.5694215	5.00388	268.7895	273.79338	51.8	0.10	**5.19**	**5.29**
Cadmium	4.80	3.25	15.6	17	5.95	2.2015	0.052836	0.000253613	0.09282	0.0149184	5.46	5.4749184	0.77	0.02	**7.09**	**7.11**
Chromium	108	0.0839	9.0612	17	5.95	2.2015	0.052836	0.005706288	0.05391414	0.335664	3.17142	3.507084	2.4	0.14	**1.32**	**1.46**
Cobalt	74.60	0.0248	1.85008	17	5.95	2.2015	0.052836	0.003941566	0.011007976	0.2318568	0.647528	0.8793848	7.33	0.03	0.09	0.12
Copper	1130	0.625	706.25	17	5.95	2.2015	0.052836	0.05970468	4.2021875	3.51204	247.1875	250.69954	5.6	0.63	**44.14**	**44.77**
Iron	36300	0.01	363	17	5.95	2.2015	0.052836	1.9179468	2.15985	112.8204	127.05	239.8704	301.5	0.37	0.42	0.80
Lead	148000	0.468	69264	17	5.95	2.2015	0.052836	7.819728	412.1208	459.984	24242.4	24702.384	4.7	**97.87**	**5157.96**	**5255.83**
Manganese	11900	0.234	2784.6	17	5.95	2.2015	0.052836	0.6287484	16.56837	36.9852	974.61	1011.5952	51.5	0.72	**18.92**	**19.64**
Mercury	1.18	5	5.9	17	5.95	2.2015	0.052836	6.23465E-05	0.035105	0.00366744	2.065	2.06866744	0.032	0.11	**64.53**	**64.65**
Nickel	1220	1.411	1721.42	17	5.95	2.2015	0.052836	0.06445992	10.242449	3.79176	602.497	606.28876	1.7	**2.23**	**354.41**	**356.64**
Silver	7.74	0.0367	0.284058	17	5.95	2.2015	0.052836	0.000408951	0.001690145	0.02405592	0.0994203	0.12347622	6.02	0.00	0.02	0.02
Vanadium	31.70	0.0097	0.30749	17	5.95	2.2015	0.052836	0.001674901	0.001829566	0.0985236	0.1076215	0.2061451	4.16	0.02	0.03	0.05
Zinc	2180	1.82	3967.6	17	5.95	2.2015	0.052836	0.11518248	23.60722	6.77544	1388.66	1395.43544	75.4	0.09	**18.42**	**18.51**

COPC = contaminant of potential concern
IR = ingestion rate
mg/kg = milligrams per kilogram
BAF = bioaccumulation factor
g = grams
g/day = grams per day
d.w = dry weight
mg/day = milligrams per day
mg/kg/day = milligrams per kilogram per day
kg = kilograms
TRV = toxicity reference value
NOAEL = no observable adverse effect level
Conc. = concentration
HQ = hazard quotient

TABLE 14. Hazard Quotient Calculations for Short-tailed Shrew
Jewett Lead Site
Staten Island, New York

Input Parameters:	Body Weight	Food IR	Food IR	Soil IR
	15	9.3	1.488	0.077376

Analyte	Conc. in soil (mg/kg)	BAF	Conc. in Diet (mg/kg)	Body Weight (g)	Food Ingestion rate (g/day w.w.)	Food Ingestion rate (g/day d.w.)	Soil Ingestion rate (g/day d.w.)	Total intake from soil (mg/day)	Total intake from diet (mg/day)	Dose soil (mg/kg/day)	Dose Diet (mg/kg/day)	Total Dose (mg/kg/day)	TRV NOAEL (mg/kg/day)	HQ NOAEL soil	HQ NOAEL diet	TOTAL HQ NOAEL
Aluminum	88804	0.118	10478.872	15	9.3	1.488	0.077376	6.871298304	97.4535096	458.0865536	6496.90064	6954.987194	1.93	**237.35**	**3366.27**	**3603.62**
Antimony	13.30	1	13.3	15	9.3	1.488	0.077376	0.001029101	0.12369	0.06860672	8.246	8.31460672	0.059	**1.16**	**139.76**	**140.93**
Arsenic	33.40	0.523	17.4682	15	9.3	1.488	0.077376	0.002584358	0.16245426	0.17229056	10.830284	11.00257456	1.04	0.17	**10.41**	**10.58**
Barium	1610	0.16	257.6	15	9.3	1.488	0.077376	0.12457536	2.39568	8.305024	159.712	168.017024	51.8	0.16	**3.08**	**3.24**
Cadmium	4.80	40.69	195.312	15	9.3	1.488	0.077376	0.000371405	1.8164016	0.02476032	121.09344	121.1182003	0.77	0.03	**157.26**	**157.30**
Chromium	108	3.162	341.496	15	9.3	1.488	0.077376	0.008356608	3.1759128	0.5571072	211.72752	212.2846272	2.4	0.23	**88.22**	**88.45**
Cobalt	74.60	0.291	21.7086	15	9.3	1.488	0.077376	0.00577225	0.20188998	0.38481664	13.459332	13.84414864	7.33	0.05	**1.84**	**1.89**
Copper	1130	1.531	1730.03	15	9.3	1.488	0.077376	0.08743488	16.089279	5.828992	1072.6186	1078.447592	5.6	**1.04**	**191.54**	**192.58**
Iron	36300	0.078	2831.4	15	9.3	1.488	0.077376	2.8087488	26.33202	187.24992	1755.468	1942.71792	301.5	0.62	**5.82**	**6.44**
Lead	148000	1.522	225256	15	9.3	1.488	0.077376	11.451648	2094.8808	763.4432	139658.72	140422.1632	4.7	**162.43**	**29714.62**	**29877.06**
Manganese	11900	0.124	1475.6	15	9.3	1.488	0.077376	0.9207744	13.72308	61.38496	914.872	976.25696	51.5	**1.19**	**17.76**	**18.96**
Mercury	1.18	20.63	24.3434	15	9.3	1.488	0.077376	9.13037E-05	0.22639362	0.006086912	15.092908	15.09899491	0.032	0.19	**471.65**	**471.84**
Nickel	1220	4.73	5770.6	15	9.3	1.488	0.077376	0.09439872	53.66658	6.293248	3577.772	3584.065248	1.7	**3.70**	**2104.57**	**2108.27**
Silver	7.74	15.338	118.71612	15	9.3	1.488	0.077376	0.00059889	1.104059916	0.039926016	73.6039944	73.64392042	6.02	0.01	**12.23**	**12.23**
Vanadium	31.70	0.088	2.7896	15	9.3	1.488	0.077376	0.002452819	0.02594328	0.16352128	1.729552	1.89307328	4.16	0.04	0.42	0.46
Zinc	2180	12.88	28078.4	15	9.3	1.488	0.077376	0.16867968	261.12912	11.245312	17408.608	17419.85331	75.4	0.15	**230.88**	**231.03**

COPC = contaminant of potential concern
IR = ingestion rate
mg/kg = milligrams per kilogram
BAF = bioaccumulation factor
g = grams
g/day = grams per day
d.w = dry weight
mg/day = milligrams per day
mg/kg/day = milligrams per kilogram per day
kg = kilograms
TRV = toxicity reference value
NOAEL = no observable adverse effect level
Conc. = concentration
HQ = hazard quotient

TABLE 15. Hazard Quotient Calculations for Red Fox
Jewett Lead Site
Staten Island, New York

Input Parameters:	Body Weight	Food IR	Food IR	Soil IR
	3940	551.6	176.512	0

Analyte	Conc. in soil (mg/kg)	BAF	Conc. in Diet (mg/kg)	Body Weight (g)	Food Ingestion rate (g/day w.w.)	Food Ingestion rate (g/day d.w.)	Soil Ingestion rate (g/day d.w.)	Total intake from soil (mg/day)	Total intake from diet (mg/day)	Dose soil (mg/kg/day)	Dose Diet (mg/kg/day)	Total Dose (mg/kg/day)	TRV NOAEL (mg/kg/day)	HQ NOAEL soil	HQ NOAEL diet	TOTAL HQ NOAEL
Aluminum	88804	1	88804	3940	551.6	176.512	0	0	48984.2864	0	12432.56	12432.56	1.93	0.00	**6441.74**	**6441.74**
Antimony	13.30	0.001	0.0133	3940	551.6	176.512	0	0	0.00733628	0	0.001862	0.001862	0.059	0.00	0.03	0.03
Arsenic	33.40	0.0149	0.49766	3940	551.6	176.512	0	0	0.274509256	0	0.0696724	0.0696724	1.04	0.00	0.07	0.07
Barium	1610	0.1121	180.481	3940	551.6	176.512	0	0	99.5533196	0	25.26734	25.26734	51.8	0.00	0.49	0.49
Cadmium	4.80	3.9905	19.1544	3940	551.6	176.512	0	0	10.56556704	0	2.681616	2.681616	0.77	0.00	**3.48**	**3.48**
Chromium	108	0.3333	35.9964	3940	551.6	176.512	0	0	19.85561424	0	5.039496	5.039496	2.4	0.00	**2.10**	**2.10**
Cobalt	74.60	0.1	7.46	3940	551.6	176.512	0	0	4.114936	0	1.0444	1.0444	7.33	0.00	0.14	0.14
Copper	1130	1.045	1180.85	3940	551.6	176.512	0	0	651.35686	0	165.319	165.319	5.6	0.00	**29.52**	**29.52**
Iron	36300	0.0171	620.73	3940	551.6	176.512	0	0	342.394668	0	86.9022	86.9022	301.5	0.00	0.29	0.29
Lead	148000	0.2864	42387.2	3940	551.6	176.512	0	0	23380.77952	0	5934.208	5934.208	4.7	0.00	**1262.60**	**1262.60**
Manganese	11900	0.0587	698.53	3940	551.6	176.512	0	0	385.309148	0	97.7942	97.7942	51.5	0.00	**1.90**	**1.90**
Mercury	1.18	0.192	0.22656	3940	551.6	176.512	0	0	0.124970496	0	0.0317184	0.0317184	0.032	0.00	**0.99**	**0.99**
Nickel	1220	0.5891	718.702	3940	551.6	176.512	0	0	396.4360232	0	100.61828	100.61828	1.7	0.00	**59.19**	**59.19**
Silver	7.74	0.5013	3.880062	3940	551.6	176.512	0	0	2.140242199	0	0.54320868	0.54320868	6.02	0.00	0.09	0.09
Vanadium	31.70	0.0179	0.56743	3940	551.6	176.512	0	0	0.312994388	0	0.0794402	0.0794402	4.16	0.00	0.02	0.02
Zinc	2180	2.6878	5859.404	3940	551.6	176.512	0	0	3232.047246	0	820.31656	820.31656	75.4	0.00	**10.88**	**10.88**

COPC = contaminant of potential concern
IR = ingestion rate
mg/kg = milligrams per kilogram
BAF = bioaccumulation factor
g = grams
g/day = grams per day
d.w = dry weight
mg/day = milligrams per day
mg/kg/day = milligrams per kilogram per day
kg = kilograms
TRV = toxicity reference value
NOAEL = no observable adverse effect level
Conc. = concentration
HQ = hazard quotient

APPENDIX E

RESPONSE ACTION ALTERNATIVES COST SUMMARIES

Table E-1

Cost Estimate for Alternative 1: No Action

Jewett White Lead Company Site

2000-2012 Richmond Terrace, Staten Island, New York

Removal Action Assessment Report

Item/Description	Units	Estimated Quantity	Estimated Unit Price	Estimated Cost
Capital Costs				
			Subtotal Capital Costs	$ -
Transportation and Disposal Costs				
			Subtotal Transportation and Disposal Costs	$ -
Operation and Maintenance Costs				
			Subtotal Operation and Maintenance Costs	$ -
Indirect Costs				
Pubic Site Information Repository	LS	1	$ 5,000.00	$ 5,000.00
Legal Fees (Land Use Restrictions)	LS	1	$ 5,000.00	$ 5,000.00
Contractor Work Plans	LS	1	$ 50.00	$ 50.00
			Subtotal Indirect Costs	$ 10,050.00
Total				
Direct Costs				$ -
Transportation and Disposal Costs				$ -
Operation and Maintenance Costs				$ -
Indirect Costs				$ 10,050.00
			Total	$ 10,050.00

LS - Lump Sum

% - Price based on a percentage of Subtotal Captial and Transportation & Disposal Costs.

Table E-2
Cost Estimate for Alternative 2: Soil Excavation, Off-Site Treatment/Disposal
Jewett White Lead Company Site
2000-2012 Richmond Terrace, Staten Island, New York
Removal Action Assessment Report

Item/Description	Units	Estimated Quantity	Estimated Unit Price	Estimated Cost
Capital Costs				
Property Lease	DAY	8	$ 1,000.00	$ 8,000.00
Site Preparation				
Clearing and grubbing	LS	1	$ 6,000.00	$ 5,000.00
Temporary facilities	WK	2	$ 1,000.00	$ 2,000.00
Decontamination Area	LS	1	$ 4,000.00	$ 4,000.00
Utility Identification	LS	1	$ 5,000.00	$ 5,000.00
Material Handling				
Soil Removal	DAY	13	$ 3,000.00	$ 39,000.00
Foundation Work	DAY	2	$ 4,000.00	$ 8,000.00
Placement of Backfill	DAY	15	$ 3,000.00	$ 45,000.00
Backfill	CY	4,242	$ 13.00	$ 55,146.00
			Subtotal Capital Costs	$ 171,146.00
Transportation and Disposal Costs				
Subtitle D Transportation and Disposal	TON	3,264	$ 60.00	$ 195,853.14
Subtitle C Transportation and Disposal	TON	2,462	$ 175.00	$ 430,934.18
			Subtotal Transportation and Disposal Costs	$ 626,787.32
Operation and Maintenance Costs				
Semi-Annual Monitoring (Present Value)	YR	2	$ 7,500.00	$ 14,509.35
			Subtotal Operation and Maintenance Costs	$ 14,509.35
Indirect Costs				
Remedial Design	%	10%	$ 79,793.33	$ 79,793.33
Confirmatory Sampling	%	3%	$ 5,134.38	$ 23,938.00
Contractor Work Plans	%	1%	$ 7,979.33	$ 7,979.33
			Subtotal Indirect Costs	$ 111,710.66
Total				
Direct Costs				$ 171,146.00
Transportation and Disposal Costs				$ 626,787.32
Operation and Maintenance Costs				$ 14,509.35
Indirect Costs				$ 111,710.66
			Total	$ 924,153.33

LS - Lump Sum

WK - Week

CY - Cubic Yard

% - Price based on a percentage of Subtotal Captial and Transportation & Disposal Costs.

Present Value based on annual payments and 7% interest.

Table E-3
Cost Estimate for Alternative 3: Capping

Jewett White Lead Company Site
2000-2012 Richmond Terrace, Staten Island, New York
Removal Action Assessment Report

Item/Description	Units	Estimated Quantity	Estimated Unit Price	Estimated Cost
Capital Costs				
Property Lease	DAY	8	$ 1,000.00	$ 8,000.00
Site Preparation				
Clearing and grubbing	LS	1	$ 6,000.00	$ 5,000.00
Temporary facilities	WK	2	$ 1,000.00	$ 2,000.00
Decontamination Area	LS	1	$ 4,000.00	$ 4,000.00
Utility Identification	LS	1	$ 5,000.00	$ 5,000.00
Cap Installation				
Excavation of 3-ft Anchor Trench	DAY	2	$ 3,000.00	$ 6,000.00
Excavation of 2-ft of Soil Site-Wide	DAY	4	$ 3,000.00	$ 12,000.00
40-mil HDPE Liner	SF	48,000	$ 0.25	$ 12,000.00
Liner Installation/Seaming	SF	45,000	$ 0.25	$ 11,250.00
Placement of Backfill/Cushion Layer	DAY	6	$ 3,000.00	$ 18,000.00
Material Handling	DAY	5	$ 1,000.00	$ 5,000.00
Backfill	CY	2,400	$ 13.00	$ 31,200.00
			Subtotal Capital Costs	$ 119,450.00
Transportation and Disposal Costs				
Subtitle D Transportation and Disposal	TON	1,847	$ 60.00	$ 110,808.00
Subtitle C Transportation and Disposal	TON	1,393	$ 175.00	$ 243,810.00
			Subtotal Transportation and Disposal Costs	$ 354,618.00
Operation and Maintenance Costs				
Semi-Annual Monitoring (Present Value)	YR	30	$ 7,500.00	$ 99,582.56
Cap Maintenance (Present Value)	YR	30	$ 1,000.00	$ 13,277.67
			Subtotal Operation and Maintenance Costs	$ 112,860.23
Indirect Costs				
Remedial Design	%	10%	$ 47,406.80	$ 47,406.80
Legal Fees (Land Use Restrictions)	LS	1	$ 5,000.00	$ 5,000.00
Contractor Work Plans	%	1%	$ 4,740.68	$ 4,740.68
			Subtotal Indirect Costs	$ 57,147.48
Total				
Direct Costs				$ 119,450.00
Transportation and Disposal Costs				$ 354,618.00
Operation and Maintenance Costs				$ 112,860.23
Indirect Costs				$ 57,147.48
			Total	$ 644,075.71

LS - Lump Sum

WK - Week

YR - Year

CY - Cubic Yard

SF - Square Foot

% - Price based on a percentage of Subtotal Captial and Transportation & Disposal Costs.

Present Value based on annual payments and 7% interest.

Table E-4
Cost Estimate for Alternative 4: Paving
Jewett White Lead Company Site
2000-2012 Richmond Terrace, Staten Island, New York
Removal Action Assessment Report

Item/Description	Units	Estimated Quantity	Estimated Unit Price	Estimated Cost
Capital Costs				
Property Lease	DAY	8	$ 1,000.00	$ 8,000.00
Site Preparation				
Clearing and grubbing	LS	1	$ 6,000.00	$ 5,000.00
Temporary facilities	WK	2	$ 1,000.00	$ 2,000.00
Decontamination Area	LS	1	$ 4,000.00	$ 4,000.00
Utility Identification	LS	1	$ 5,000.00	$ 5,000.00
Pavement Installation				
Site Grading, including construction debris removal	DAY	5	$ 3,000.00	$ 15,000.00
Pavement Installation	SF	43,000	$ 2.00	$ 86,000.00
Material Handling	DAY	8	$ 1,000.00	$ 8,000.00
Backfill	CY	500	$ 13.00	$ 6,500.00
	Subtotal Capital Costs			$ 139,500.00
Transportation and Disposal Costs				
Subtitle D Transportation and Disposal	TON	385	$ 60.00	$ 23,085.00
Subtitle C Transportation and Disposal	TON	290	$ 175.00	$ 50,793.75
	Subtotal Transportation and Disposal Costs			$ 73,878.75
Operation and Maintenance Costs				
Semi-Annual Monitoring (Present Value)	YR	30	$ 7,500.00	$ 99,582.56
Cap Maintenance (Present Value)	YR	30	$ 1,000.00	$ 13,277.67
	Subtotal Operation and Maintenance Costs			$ 112,860.23
Indirect Costs				
Remedial Design	%	10%	$ 21,337.88	$ 21,337.88
Legal Fees (Land Use Restrictions)	LS	1	$ 5,000.00	$ 5,000.00
Contractor Work Plans	%	1%	$ 2,133.79	$ 2,133.79
	Subtotal Indirect Costs			$ 28,471.66
Total				
Direct Costs				$ 139,500.00
Transportation and Disposal Costs				$ 73,878.75
Operation and Maintenance Costs				$ 112,860.23
Indirect Costs				$ 28,471.66
Total				$ 354,710.64

LS - Lump Sum

WK - Week

YR - Year

CY - Cubic Yard

SF - Square Foot

% - Price based on a percentage of Subtotal Captial and Transportation & Disposal Costs.

Present Value based on annual payments and 7% interest.

Table E-5
Cost Estimate for Alternative 5: Immobilization
Jewett White Lead Company Site
2000-2012 Richmond Terrace, Staten Island, New York
Removal Action Assessment Report

Item/Description	Units	Estimated Quantity	Estimated Unit Price	Estimated Cost
Capital Costs				
Property Lease	DAY	8	$ 1,000.00	$ 8,000.00
Site Preparation				
Clearing and grubbing	LS	1	$ 6,000.00	$ 5,000.00
Temporary facilities	WK	2	$ 1,000.00	$ 2,000.00
Decontamination Area	LS	1	$ 4,000.00	$ 4,000.00
Utility Identification	LS	1	$ 5,000.00	$ 5,000.00
Soil Treatment				
Site Grading, including construction debris emplacement	DAY	6	$ 3,000.00	$ 18,000.00
Treatment of top 2 ft of soil	TON	4,355	$ 12.00	$ 52,260.00
Soil Treatment Additive	TON	4,355	$ 9.00	$ 39,195.00
Material Handling	DAY	12	$ 1,000.00	$ 12,000.00
	Subtotal Capital Costs			$ 145,455.00
Transportation and Disposal Costs				
	Subtotal Transportation and Disposal Costs			$ -
Operation and Maintenance Costs				
Semi-Annual Monitoring (Present Value)	YR	30	$ 7,500.00	$ 99,582.56
Cap Maintenance (Present Value)	YR	30	$ 1,000.00	$ 13,277.67
	Subtotal Operation and Maintenance Costs			$ 112,860.23
Indirect Costs				
Remedial Design	%	10%	$ 14,545.50	$ 14,545.50
Legal Fees (Land Use Restrictions)	LS	1	$ 5,000.00	$ 5,000.00
Contractor Work Plans	%	1%	$ 1,454.55	$ 1,454.55
	Subtotal Indirect Costs			$ 21,000.05
Total				
Direct Costs				$ 145,455.00
Transportation and Disposal Costs				$ -
Operation and Maintenance Costs				$ 112,860.23
Indirect Costs				$ 21,000.05
			Total	$ 279,315.28

LS - Lump Sum

WK - Week

YR - Year

% - Price based on a percentage of Subtotal Captial and Transportation & Disposal Costs.

Present Value based on annual payments and 7% interest.