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JACOBS SMELTER SITE
OPERABLE UNIT 2
STOCKTON, UTAH

FINAL
UPDATED REVISED

FEASIBILITY STUDY REPORT

State of Utah

Department of Environmental Quality
Division of Environmental Response and Remediation

Contract No. 146237 / WA# 01

June 2014

URS

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FINAL
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Prepared for

STATE OF UTAH
DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF ENVIRONMENTAL RESPONSE AND REMEDIATION

SALT LAKE CITY, UTAH

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June 2014

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LIST OF ACRONYMS

<	less than
>	greater than
%	percent
µg/dL	micrograms per deciliter
1E-4	1 in 10,000
1E-6	1 in 1,000,000
ac	acres
AFCEE	Air Force Center for Engineering and the Environment
ALM	Adult Lead Methodology
AOC	Area of Contamination
ARARs	Applicable or Relevant and Appropriate Requirements
ATV	All-Terrain Vehicle
AWAL	America West Analytical Laboratories
bgs	below ground surface
BLM	Bureau of Land Management
CADD	computer-aided design drafting
CDC	Centers for Disease Control
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
COC	contaminant of concern
CQA	Construction Quality Assurance
CSM	conceptual site model
CSS	Contaminant Screening Study
cu ft	cubic feet
cu yd	cubic yard
DERR	Division of Environmental Response and Remediation
DQO	data quality objectives
ECCS	Environmental Chemistry Consulting Services
EPC	exposure point concentration
ERA	ecological risk assessment
ETAG	Ecological Technical Advisory Group
FIELDS	Field Environmental Decision Support Team
ft	foot
FML	flexible membrane liner
FS	Feasibility Study
FFS	Focused Feasibility Study
GCL	geosynthetic clay liner
GIS	geographical information system
HHRA	Human Health Risk Assessment
HQ	hazard quotient

IEUBK	Integrated Exposure Uptake Biokinetic
KUCC	Kennecott Utah Copper Corporation, LLC
lb	pound
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
O&M	operation and maintenance
ODC	other direct charges
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
oz.	ounce
PRG	preliminary remediation goal
QA/QC	quality assurance/quality control
RACER	Remedial Action Cost Engineering and Requirements
RAO	remedial action objective
RAT	Rapid Assessment Tool
RCRA	Resource Conservation and Recovery Act
REDOX	reduction/oxidation
RI	Remedial Investigation
ROD	Record of Decision
Sq ft	square feet
Sq yd	square yard
S/S	stabilization/solidification
TBC	to be considered
TCLP	toxicity characteristic leaching procedure
UAC	Utah Administrative Code
UDEQ	Utah Department of Environmental Quality
UOS	URS Operating Services
URS	URS Corporation
USEPA	United States Environmental Protection Agency
XRF	X-ray fluorescence

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EXECUTIVE SUMMARY

The Utah Department of Environmental Quality (UDEQ), in cooperation with the United States Environmental Protection Agency (USEPA), Region 8, has tasked URS Corporation (URS) with preparing this Draft Final Updated Revised Feasibility Study Report (FS) for Operable Unit 2 (OU2) of the Jacob Smelter Superfund Site (Site), near Stockton, Utah (Figure 1-1). The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site activities are being performed under Contract No. 086217 for UDEQ.

In 2009, additional soil sampling performed by the Utah Division of Environmental Response and Remediation (DERR) at the request of a resident in the Rawhide Ranchette subdivision showed contamination levels in excess of the clean-up standards established for the Removal Action conducted in 2001 (described in further detail in Section 1.2 of this report). This prompted DERR to commission an update to the Final Revised FS in order to collect additional data to address community concerns regarding lead and arsenic contaminated soils in residential areas of OU2 as well as document changes that have taken place within the Site since the issuing of the 2004 Proposed Plan.

As part of this Draft Final Updated Revised FS, additional data was collected for 29 of the 30 Rawhide Ranchette properties (access was not obtained for one of the properties), all 10 of the B&B subdivision properties, and the undeveloped area that lies between them. The sampling indicated that five lots within the Rawhide Ranchette subdivision still contained soil with lead concentrations exceeding site criteria. These properties have been addressed by a Time-Critical Removal Action initiated in 2010 and completed in the spring of 2011. Thus, these properties will not be addressed further in this document. The sampling also indicated that four lots within the B&B subdivision have soils that exceed site criteria and confirmed that soils in the undeveloped Waterman Smelter and all-terrain vehicle (ATV) areas that lie between the two subdivisions are highly impacted. In August of 2011, an additional sampling event was conducted by USEPA in the Waterman Smelter and ATV areas to evaluate the current spatial distribution of metals contamination; this sampling event confirmed and refined understanding of soil contamination in a 25-acre area within the Waterman Smelter and ATV areas. This data has been incorporated into the alternatives evaluated as part of this Draft Final Updated Revised FS.

The National Oil and Hazardous Substances Contingency Plan (NCP) requires that each of the remedial alternatives be evaluated using nine criteria developed to address the CERCLA requirements. These nine criteria are divided into three categories—threshold criteria, balancing criteria, and modifying criteria. Each alternative must meet the two threshold criteria because these criteria relate directly to statutory findings that must ultimately be made in the Record of Decision (ROD). The five balancing criteria represent primary principles upon which the analysis is based (e.g., long-term effectiveness and permanence). The two modifying criteria, state acceptance and community acceptance, are not addressed during the FS process, but are determined through the review and public comment periods during the Proposed Plan and ROD development process. Therefore, a total of seven criteria, two threshold criteria and five balancing criteria, were evaluated as part of this Draft Final Updated Revised FS. The objectives of this Draft Final Updated Revised FS are to:

- Identify Applicable or Relevant and Appropriate Requirements (ARARs),
- Review risk management decisions,
- Screen potential remedial technologies,
- Develop remedial alternatives,
- Analyze and compare remedial alternatives, and
- Rank each alternative on the basis of the seven CERCLA criteria evaluated during this FS process.

The human health and ecological risk assessments summarized in the Remedial Investigation (URS, 2003a) for the Jacobs Smelter OU2 site were used to develop action levels for lead contaminated soil and remedial action objectives for both residential and non-residential areas. The residential action levels for soil are 500 milligrams per kilograms (mg/kg) lead for surface soils [0-2 inches below ground surface (bgs)] and 800 mg/kg lead for subsurface soils (2-12 inches bgs) over an exposure area. An exposure area is defined as an area with consistent land use, where receptors can be exposed to contamination, across which an exposure point concentration can be calculated and compared to an action level. The action level for the non-residential, recreational area is 3,000 mg/kg lead for surface and subsurface soils over an exposure area. The May 14, 2013 risk memo included in Appendix E, determined that this action level for non-residential areas would also be protective of ecological receptors. Based on these action levels and the screening of potential technologies, six remedial alternatives were developed for the OU2 Jacobs Smelter Site. In the 2004 Final Revised FS alternatives were developed for residential and non-residential areas separately, however, subsequent to that document it has been decided to address both residential and non-residential areas together. Therefore, only one set of alternatives will be evaluated in this Draft Final Updated Revised FS.

The alternatives were first evaluated against the two threshold criteria. Those alternatives that met these criteria were then ranked on the basis of the alternatives relative standing in each sub-section to the other alternatives being considered. Neither an overall ranking nor a preferred alternative was selected. The preferred alternative will be presented by UDEQ and USEPA in the Proposed Plan, and the alternative selection will occur after the public comment period and will be published in the ROD. Table ES-1 details each alternative and their present worth.

TABLE ES-1.
Remedial Alternatives with Present Worth

Alternative	Description	Present Worth
Alternative 1	No action.	$0
Alternative 2	Excavate material in excess of site action levels* to a depth of **18 inches**, backfill with clean soil, dispose of excavated material **off-site**.	$9,647,000
Alternative 3	Cover material in excess of site action levels* with clean soil.	$5,278,000
Alternative 4	Excavate material in excess of site action levels* to a depth of **18 inches**, backfill all areas with clean soil, dispose of excavated material in **on-site repository with a RCRA Subtitle C cap**.	$8,065,000
Alternative 5	Excavate all material in excess of site action levels* to the **depth of contamination**, backfill residential areas with clean soil, regrade non-residential areas, dispose of excavated material in **on-site repository with a RCRA Subtitle C cap**.	$8,326,000
Alternative 6	Excavate all material in excess of site action levels* to the **depth of contamination**, backfill residential areas with clean soil, regrade non-residential areas, dispose of excavated material in an **on-site repository with a soil cover**.	$7,664,000

* = Site actions levels are as follows:
Residential – 500 mg/kg lead in surface soils (0-2 inches) within an exposure area.
800 mg/kg lead in subsurface soils (2-12 inches) within an exposure area.
Non-residential, Recreational – 3,000 mg/kg lead in both surface and subsurface soils.
mg/kg – milligrams per kilogram
RCRA – Resources Conservation and Recovery Act

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1.0 INTRODUCTION

The UDEQ, in cooperation with the USEPA, Region 8, has tasked URS with preparing this Updated Revised FS for OU2 of the Jacob Smelter Superfund Site (Site), near Stockton, Utah (Figure 1-1). The Jacobs Smelter Superfund Site consists of six operable units (OUs): OU1, the residential soils in the town of Stockton; OU2, the undeveloped and residential areas that are the subject of this study; OU3, the impacted soils within the Union Pacific railroad right-of-way; OU4, impacted soils owned by Kennecott; OU5, impacted soils owned by Bureau of Land Management (BLM); and OU6, impacted soils associated with the Chicago and Carson Buzzo Smelters.

The original Final Revised FS Report for OU2 was completed in July of 2004. A Proposed Plan was prepared for OU2 in July 2004. Since that time a characterization investigation of a parcel owned by Kennecott Utah Copper Corporation, LLC (KUCC) located to the immediate northeast of the town of Stockton suggested that the lead and arsenic contamination on the parcel could be from up-gradient mining waste rock piles eroding and depositing contaminated material on the property. Based on the results of this additional characterization, USEPA Region 8 along with DERR concurred that the contamination on the KUCC property was not associated with smelter wastes from the Jacobs Smelter Superfund Site. Based on this concurrence, an Administrative Order on Consent was issued that requires KUCC to address the Kennecott Northeast Parcel through a Removal Action as a non-National Priority List (NPL) Site, effectively removing it from OU2.

An additional parcel owned by Kennecott, located near the Stockton Railyard and adjacent to the Rawhide Ranchette subdivision was designated as OU4 (Figure 1-1). OU4 was the subject of a Non-Time-Critical Removal Action that was performed during the fall of 2008.

Screening level data generated during the Remedial Investigation (RI) (URS, 2003a) identified an area to the northeast of the town of Stockton, on BLM property. This area was designated as OU5 in 2010 and is currently being addressed by the BLM (Figure 1-1).

In 2009, additional soil sampling performed by DERR at the request of a resident in the Rawhide Ranchette subdivision showed contamination levels in excess of the clean-up standards established for the Removal Action conducted in 2001 (described in further detail in Section 1.2). This prompted DERR to commission an Update to the Final Revised FS in 2009 in order to collect additional data to address community concerns regarding lead and arsenic contaminated soils in residential areas of OU2 as well as document changes that took place within the Site between the 2004 Proposed Plan and the 2009 sampling event. The alternatives presented in the 2004 Final Revised FS and 2004 Proposed Plan have been reevaluated as part of this Draft Final Updated Revised FS. The reevaluation occurred because of: the amount of time elapsed since the 2004 Proposed Plan, the changes that were made in the Site boundaries, the creation of OUs 4 and 5, and the subsequent clean-up of OU4.

As a result of the data collected during 2009 and 2010 as part of the Updated Final Revised FS, a Time-Critical Removal Action was initiated at four residential lots in the Rawhide Ranchettes subdivision that

had surface lead levels exceeding the residential action level. Two of the lots were also part of the 2001 removal. Removal and restoration of the lots was completed in the spring of 2011 (USEPA, 2011). Also as a result of data collected during the 2009/2010 sampling, USEPA decided to perform additional sampling (which occurred in August 2011, see Appendix D) in the area of the Waterman Smelter to evaluate the current spatial distribution of metals contamination.

This Draft Final Updated Revised FS incorporates newly collected data, as well as changes in site conditions, into the analysis of the remedial alternatives to provide an updated and accurate analysis of remedial alternatives that reflect current site conditions.

The RI report (URS, 2003a), the 2010 Additional Sampling Report (summarized in Section 1.3 and included in Appendix C), and the 2011 Draft Sampling Activities Report (summarized in Section 1.3 and included in Appendix D) provide analysis of field and laboratory data collected within OU2 during six field-sampling events conducted from 1998 to 2011. This Draft Final Updated Revised FS report synthesizes that data and provides an evaluation and comparison of possible remedial technologies for the site, followed by a detailed analysis of alternatives using the nine CERCLA criteria.

1.1 Site Background

The Jacobs Smelter OU2 site is located within Rush Valley, Tooele County, Utah. The only significant population in the valley resides in the town of Stockton (Figure 1-1), located approximately 38 miles southwest of Salt Lake City via Interstate 80 and Utah Highway 36 and five miles southwest of the city of Tooele. The population of Tooele County in 2000 was 40,735 (Tooele Valley, 2003). The population in the city of Stockton in 2000 was estimated at 443 (Tooele Valley, 2003). The Stockton area was the center of a silver- and base metal-mining, milling, and smelting district from the 1860s until 1970; no industries and very few retail/commercial businesses currently exist in Stockton. Although the mainline of the Union Pacific Railroad between Salt Lake City and Los Angeles runs through the town of Stockton, the former train station and rail sidings have been removed. In general, land surrounding the town of Stockton is used for agricultural and recreational purposes.

In April 1864, members of a volunteer cavalry with gold mining experience in California discovered silver ore in a limestone ledge east of Stockton and organized the first mining district (Guilluly, 1932) in the foothills of the Oquirrh Mountains, one to two miles east of Stockton. The Stockton area immediately began to be used for smelting of gold, silver, and base metals. Although several furnaces were built by 1866, these smelters apparently operated only for a few years, then shut down. The exact locations of these smelters are unknown, but several areas are suspected due to the presence of elevated concentrations of heavy metals detected in site soils (URS, 2003a) (Figure 1-1). In 1872, the Jacobs Smelter went into operation within the town limits of Stockton (Guilluly, 1932). In 1879, the Great Basin concentrator was constructed in a building adjacent to the Jacobs Smelter and by 1880 was milling 100 tons of ore and producing 20 tons of concentrates and 80 tons of mill tailings per day. The Jacobs Smelter and Great Basin concentrator were both located within the OU1 boundaries.

The Chicago Smelter opened on the eastern shore of Rush Lake, two miles south of Stockton, in August 1873 (Guilluly, 1932) and operated until the fall of 1880. The Carson Buzzo Smelter was located about 0.5 miles south of the Chicago Smelter and opened two vertical blast furnaces in March 1873. The company later moved to West Jordan and opened a much larger reduction works. The largest smelter in the Stockton area was the Waterman Smelting Works, which opened in 1871 and operated continuously until 1886. Between 1874 and 1878, this works smelted 26,270 tons of ore to produce 8,312 tons of bullion and 3,300 tons of silver-lead-containing flue dust. The remainder, 14,658 tons, would have been wasted, probably as smelter slag. All three smelters were originally located within OU2 boundaries; however, the Chicago and Carson Buzzo Smelters were removed from OU2 and will be addressed as their own OU.

There was also mining activity further east in the Oquirrh Mountains. The largest contributor to mining activities in this area was the Honerine Mine. Founded around 1900, the mine also had a stamp mill on site and an extensive tunnel system, which drained westward into the existing gullies just east of Stockton. In addition to the large smelters in the area, there were numerous small smelters and stamp mills in the areas surrounding Stockton.

The topography of OU2 is dominated by the Rush Valley floor, which is generally smooth, at an elevation of approximately 5,000 feet. The boundaries of OU2 are shown in Figure 1-1. These boundaries have changed since the original 2004 Final Revised FS to account for the removal of the OU4 and OU5 areas and the removal of the Chicago and Carson Buzzo Smelters. Within the northern extent of Rush Valley lies Rush Lake, which is located in a closed drainage basin. Because of this, the lake level and size fluctuate over time, with its highest water level recorded in 1877 (Gilbert, 1890) and its lowest water level reached in the summer of 2002 with virtually no standing water. For a more detailed description of the OU2 site see the *Final Remedial Investigation for Operable Unit 2 Jacobs Smelter Site* (URS, 2003a).

1.2 Site Regulatory History

The Jacobs Smelter Superfund Site was originally identified in 1997. Contamination at the Jacobs Smelter Site resulted from the operation of several historic smelters in the area including the Jacobs Smelter, the Chicago Smelter, the Carson Buzzo Smelter, and the Waterman Smelter. In 1998, the site was divided into three operable units, OU1, OU2 and OU3 (Figure 1-1). OU1 generally includes the residential soils within the town limits of Stockton. OU2 was originally the portion of the Jacobs Smelter Site outside the general town limits of Stockton, with the exception of OU3, which is the impacted soils within the Union Pacific railroad right-of-way. Subsequently, portions of OU2 have been reallocated into OU4, OU5, and OU6, as described further below and shown in Figure 1-1.

After the 1998 designation of OU1, OU2, and OU3 for the Jacobs Smelter Site, the USEPA conducted sampling focused on the town of Stockton (OU1). This sampling was conducted in 1998 and was part of the USEPA Emergency Removal Action investigation (UOS, 1999). The sampling centered on the former Jacobs Smelter Site and resulted in a Time-Critical Removal Action at approximately 30 residences within Stockton and the listing of the site on the NPL. As part of the 1998 sampling event,

URS Operating Services (UOS) collected soil samples in OU2 along the western boundary of OU1 on property number J251. The locations sampled within the OU2 boundary as part of this UOS sample event are shown in Figure 1-2. This sampling in OU2 identified areas with elevated surface soil lead concentrations and the need for further investigation.

Three additional OUs have been designated since the site was originally divided into operable units. OU4, originally part of OU2, is on KUCC property and includes the soils directly north of OU3 and adjacent to the Rawhide Ranchette subdivision. OU5, originally part of OU2, is located on BLM land in the northeast corner of the site. This area was identified by screening level data generated during the RI (URS, 2003a). OU6, which was created in 2014 (see memorandum in Appendix E), includes contamination associated with the Chicago Smelter and the Carson Buzzo Smelter.

The current OU2 area consists of undeveloped land used for agricultural purposes, including the grazing of cattle, and recreational purposes and two residential developments, the Rawhide Ranchette subdivision and the B&B subdivision. The Rawhide Ranchettes subdivision was remediated under the 2010 Time-Critical Removal Action, as discussed below. Four residential properties within the B&B subdivision will be remediated as part of OU2. The locations of these subdivisions and the affected properties are discussed further in Section 3.0.

Remediation of approximately 125 contaminated residences in OU1 was completed by URS Corporation in 2001 (URS, 2001a). The OU1 residential soil lead action levels established for this work are as follows: 500 mg/kg for surface soil (up to 2 inches bgs) and 800 mg/kg for subsurface soil (between 2 inches and 18 inches bgs) concentrations (URSG, 1999).

Contaminated soils in OU3 were remediated by Union Pacific in the summer/fall of 1999. The site investigation included approximately 9 acres; 1,625 feet in length and between 50 feet to 450 feet in width. An active mainline railroad bisects the site from north to south. Soil cover was selected as the preferred alternative with an action level, set by USEPA, of 1,200 mg/kg total lead. The area above the action level included approximately 3.6 acres to the east side of the railroad tracks and approximately 0.70 acres on the west side of the railroad tracks (AGI, 2000).

Contaminated soils in OU4 were remediated by KUCC in fall 2008. Excavation was selected as the preferred alternative, with an action level, set by USEPA of 500 mg/kg total lead. Approximately 10,760 cubic yards of soil were removed (KUCC, 2009).

Investigation and remediation at OU5 are being conducted by the BLM and are currently ongoing. Investigation of contamination associated with OU6 was begun as part of OU2 investigation activities; however, completion of OU6 remedial activities will be conducted by UDEQ in the future.

Remedial Investigation activities for OU2 began in 1999. Due to the large geographic extent of OU2 and the relatively small amount of data available, UDEQ elected to first perform a Contaminant Screening Study (CSS) prior to conducting a comprehensive RI. The CSS was primarily intended to identify the

general areas of contamination in OU2 and establish a geographic boundary for future study. Sample locations for the CSS are shown in Figure 1-2. During the CSS investigation, elevated levels of metals were found in the soils of the developing Rawhide Ranchette subdivision. This resulted in a focused investigation of the subdivision in May 2000 (see sample locations on Figure 1-2). Analytical results of the soil sampling indicated that five of the 30 lots within the subdivision exceeded residential lead-screening levels (500 mg/kg of lead for surface material and 800 mg/kg of lead for subsurface material). A Non-Time-Critical Removal Action for the five contaminated lots was performed by the developer and completed by August 31, 2001. The details of the work performed at Rawhide Ranchette subdivision are described in the Rawhide Ranchette Investigation Report (URS, 2000). Subsequent activities at the site identified remaining contamination in the Rawhide Ranchette subdivision, which led to the additional sampling performed in 2009, which is summarized below in Section 1.3.1. A Time-Critical Removal Action was initiated in 2010 at four residential lots in the Rawhide Ranchette subdivision. Two of the lots were part of the 2001 removal, but surface and subsurface soils were found to have lead concentrations exceeding the residential clean-up levels. The Removal Action was completed in the spring of 2011 (USEPA, 2011).

Review of the data from the CSS and Rawhide Ranchette subdivision identified several data gaps relative to the overall RI effort, so a Pre-RI study was conducted in early 2001 to fill these specific data gaps and further focus the RI activities (see sample locations on Figure 1-2). Several other tasks were also conducted during this time period, as part of the data quality objectives (DQO) process, including preparation of the Human Health Risk Assessment (HHRA) Technical Memorandum (URS, 2001b), and the *Ecological Risk Assessment: Jacobs Smelter Site, Stockton, Utah* (Lockheed Martin REAC, 2003).

The USEPA finalized a land reuse assessment in 2001 (USEPA, 2001), which looked at current land use and habitat types as well as reasonably anticipated future land use for the OU2 area. This study was designed to aid the USEPA in risk management decisions, remediation technology and alternative evaluation, and remedial action objective (RAO) development, as presented in this Updated Draft Revised FS.

Focused RI activities commenced in early 2002 and included the collection of samples for chemical analyses to support the data needs identified through the DQO and Ecological Technical Advisory Group (ETAG) processes for human health and ecological risk scenarios. RI sampling was conducted in two phases. The first phase, which took place in April and May of 2002, included soil and groundwater sampling and constitutes the majority of the RI samples.

Two ground water monitoring wells were installed at locations up-gradient and down-gradient of the Waterman Smelter from April 29 to May2, 2002. The up-gradient well was installed to a depth of 100 feet bgs and the down-gradient well was installed to a depth of 47 feet bgs. Groundwater was not encountered during the drilling of the up-gradient well. Groundwater was initially found at a depth of 35 feet bgs in the down-gradient well, however further development of the well did not yield enough groundwater to sample. Saturated conditions in the Waterman Smelter area are greater than 100 feet bgs, therefore it is unlikely that leaching of surficial soil contamination could impact any deeper aquifers in the

area. Based on the lack of groundwater at the Waterman Smelter, and the depth to groundwater in the Rush Valley, USEPA and UDEQ have determined that the groundwater pathway is incomplete and no further groundwater investigations are required.

Based on the soil sampling results of the first phase of RI sampling, it was determined that additional sampling was required on a number of the residential properties included in OU2. This second phase of sampling took place in February of 2003 and only included soil sampling (URS, 2003a). Sample locations for the focused RI activities are shown in Figure 1-2. Based on analysis of data collected during all phases of the RI, lead concentrations were measured above the established human health and ecological action levels in both recreational and residential soils within the Jacobs Smelter OU2 area. Although metals other than lead (primarily arsenic) were shown to exist in site soils above preliminary human health remediation goals, it was determined that remediation of lead contaminated soils to specified action levels would result in a decrease in risk to acceptable levels from all other metals. Metals concentrations in surface water and groundwater were not shown to pose a significant risk to human or ecological receptors at the site. Elevated soil lead concentrations were identified to occur primarily in the areas near the former Waterman Smelter, the Carson-Buzzo Smelter (no longer part of OU2), the Chicago Smelter (no longer part of OU2), as well as to the northeast of the town of Stockton, which is now OU5.

The RI and additional sampling data coverage and quality provide a sound basis for risk management of both residential and recreational areas within OU2. The HHRA and the ecological risk assessment (ERA) were performed to develop risk-based criteria for at-risk populations in the Jacobs Smelter OU2 area. The areas within OU2 that exceed these risk-based criteria are the focus of this FS.

1.3 Summary of Additional Sampling Activities

Two additional sampling events have occurred subsequent to the RI, as described below.

1.3.1 FS Addendum Sampling Event

In 2009, as part of oversight of a remedial action conducted by KUCC in OU4 adjacent to the Rawhide Ranchette subdivision, lead concentrations exceeding residential action levels were observed in one of the Rawhide Ranchettes subdivision properties that had been remediated as part of the 2001 Non-Time-Critical Removal Action. This instigated a review of the sampling protocol previously implemented at the Rawhide Ranchettes and B&B subdivisions. Although the sampling protocol used at the time was consistent with industry standards, USEPA guidance (USEPA, 2003a) has been published since that time that recommends a sampling protocol where properties are subdivided into smaller sample areas. In an effort to assess the contamination remaining at the site and in accordance with current USEPA guidance, an additional sampling event occurred from September 2009 through January 2010. This section summarizes this sampling event. The full report detailing the field effort and results is included as Appendix C of this report.

The sampling performed as part of the additional investigation occurred between August 2009 and February 2010 in the Rawhide Rachette and B&B subdivisions, as well as in the undeveloped area between them (see sample locations on Figure 1-2).

The original scope of this additional sampling effort was to collect soil samples from the 40 residential properties within OU2, located in the Rawhide Ranchettes and B&B subdivisions, and analyze them for lead and arsenic. These properties range in size from two acres to seven acres, with the majority of properties being approximately two acres. The properties were divided into composite sample size areas that meet current standards (i.e., ¼ of an acre; USEPA, 2003a). After sampling activities commenced in the residential subdivisions, the scope of the sampling effort was expanded to include additional sampling in the primarily recreational areas of the former Waterman Smelter and the ATV area, both of which are located in between the Rawhide Ranchettes and B&B subdivisions. The main reason for expanding the scope to include the former Waterman Smelter and ATV area was concern for potential cross-contamination between these recreational areas and the residential subdivisions.

Different field sampling techniques were used for the residential properties (Rawhide Ranchettes and B&B subdivisions) than were used for the recreational properties (former Waterman Smelter and ATV area). The residential properties were divided into ¼ acre decision units, per guidance found in the *Superfund Lead-Contaminated Residential Sites Handbook* (USEPA, 2003a), for a total of 225 decision units in the Rawhide Ranchette subdivision and 208 decision units in the B&B subdivision. One composite surface sample and three subsurface samples were collected from each decision unit. The subsurface samples were collected at three different intervals: 0-6 inches bgs, 6-12 inches bgs, and 12-18 inches bgs. A total of 900 samples were collected in the Rawhide Ranchette subdivision and 832 samples in the B&B subdivision. At the Environmental Chemistry Consulting Services (ECCS) laboratory, these samples were dried, sieved (using a No. 60 sieve), and analyzed for total lead and arsenic at a fixed-base laboratory via USEPA Method 6200, which uses the innov-X 440XT X-Ray Fluorescence (XRF) analyzer. Five percent of the primary samples that were sent to ECCS for fixed-base XRF analysis were analyzed by a second laboratory by ICP instrumentation. Evaluation of the two data sets indicated a near perfect correlation for the lead data (R^2=0.9875), with a less robust correlation for the arsenic data (R^2=0.6705), as discussed in Appendix C.

Eleven of the 900 samples collected in the Rawhide Ranchettes subdivision exceeded the lead action levels of 500 mg/kg and 800 mg/kg for surface and subsurface soils, respectively. Nine of the exceedances were surface samples (0-2 inches bgs) and two were subsurface (0-6, 6-12, or 12-18 inches bgs), as shown in Appendix C. These exceedances triggered a Time-Critical Removal Action at four residential lots in the Rawhide Ranchette subdivision. The Removal Action was initiated in 2010 and was completed in the spring of 2011 (USEPA, 2011).

Fifty-four of the 832 samples collected in the B&B subdivision exceeded the lead action levels of 500 mg/kg and 800 mg/kg for surface and subsurface soils, respectively. Fifteen of the exceedances were surface samples and 39 were subsurface samples. All of the exceedances were in the lots in the northern portion of the B&B subdivision (Lots 1, 2, 3, and 4), as shown in Appendix C.

In the Waterman Smelter area 124 field XRF readings were recorded and ten discrete surface grab samples were collected and analyzed via fixed-base laboratory (EPA Method 6200). In the ATV area 53 field XRF readings were recorded and 14 grab samples (11 surface and 3 subsurface) soil samples were collected and analyzed via laboratory-based XRF. The highest lead value found in the Waterman area was 154,887 mg/kg and was measured in one of the grab samples collected at the assumed location of the former smelter. The highest lead concentration found at the ATV area was a field-based XRF value of 51,319 mg/kg measured in the center of the ATV track located in this area. More details on this field effort and the analytical data for this sample event can be found in Appendix C of this report.

1.3.2 Waterman Smelter Sampling Event

In August 2011, an additional sample event was conducted in the area of the Waterman Smelter and ATV areas to evaluate the current spatial distribution of metals contamination. The sample locations were selected based on a pre-determined grid established using USEPA's Field Environmental Decision Support Team (FIELDS) Rapid Assessment Tool (RAT) software and are shown in Figure 1-2. Samples from each location were collected from three different depth intervals: 0-6 inches bgs, 6-12 inches bgs, and 12-18 inches bgs. Soil samples were collected with either a hand auger or gas powered drill auger/Teflon scoop depending on soil conditions (USEPA, 2011). The soil samples were analyzed for total recoverable metals using method C200.7 at a Region 8 USEPA Laboratory. The full report detailing the field effort and results is included as Appendix D of this report.

Samples were collected from a total of 97 locations at three different depths, for a total of 291 samples. Lead was found to exceed the action level of 3,000 mg/kg in 53 of the 291 samples collected and at 31 of the 97 locations sampled.

1.4 Feasibility Study Objectives and Organization

The objectives of this Draft Final Updated Revised FS are to identify and screen potential remedial technologies, select and analyze a reasonable number of remedial alternatives, and present a comparative analysis of alternatives using the CERCLA nine-criteria methodology (USEPA, 1988). The goal of the FS is to provide sufficient information for UDEQ and USEPA to select an acceptable alternative that, once implemented, will reduce soil concentrations of lead to below risk-based concentrations.

The Draft Final Updated Revised FS report is organized as follows:

- Section 1 Introduction. The introduction section includes details on the scope and organization of the report, background information on the Jacob Smelter OU2 site, and objectives of the FS.

- Section 2 Preliminary Evaluation of ARARs. This section defines the preliminary ARARs, which are those local, state, and federal regulations that guide the selection of remedial alternatives.
- Section 3 Risk Management. The risk management section applies the conclusions of the HHRA and ERA along with specific risk management decisions to define preliminary remediation goals (PRGs) and preliminary action levels for soil remediation, although final action levels will be set in the Record of Decision (ROD).
- Section 4 Identification and Screening of Technologies. This section identifies a range of technologies then uses preliminary screening criteria (effectiveness, implementability, and cost) to evaluate various potential technologies. The results of the evaluation will eliminate inappropriate remedial technologies and select applicable remedial technologies for use in remedial alternative development.
- Section 5 Detailed Analysis of Alternatives. This section identifies the remedial alternatives selected using the technologies that passed preliminary screening in Section 4 and then uses the seven CERCLA analysis criteria to evaluate those alternatives along with the mandatory “no action” alternative.
- Section 6 Comparative Analysis of Alternatives. This section compares the alternatives for both residential and non-residential (recreational) areas.
- Section 7 References. This section provides a complete list of references cited throughout this report.

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2.0 PRELIMINARY EVALUATION OF ARARs

To assist with the selection of remedial alternatives at Jacobs Smelter OU2, a preliminary evaluation of state and federal requirements was conducted to identify the preliminary ARARs for OU2. The ARAR evaluation is a two-part process to determine (1) whether a given requirement is applicable and, if it is not applicable, then (2) whether it is both relevant and appropriate.

1. Applicable Requirements are clean-up standards and environmental protection regulations per federal or state law that specifically address a hazardous substance, contaminant, remedial action, location, or other circumstances at a CERCLA site.
2. Relevant and Appropriate Requirements are clean-up standards and environmental protection regulations per federal or state law that do not directly and fully address a specific hazardous substance, contaminant, remedial action, location, or other circumstance at a CERCLA site, but address problems or situations similar to those encountered at the CERCLA site.

CERCLA actions may have to comply with several different types of requirements. For this reason, ARARs are typically divided into three categories, which are defined below, then discussed in more detail in the following sections:

1. Chemical-specific ARARs are regulatory health- or risk-associated, numerical values that govern acceptable concentrations of a chemical in environmental media such as soil, groundwater, or air. The most stringent chemical-specific standard should be used in the case of a chemical having more than one requirement, or, in the case of a mixture of chemicals, several chemical-specific requirements.
2. Action-specific ARARs are determined according to the specific technologies or activities taking place under each alternative. Each alternative has an individual, distinct list of action-specific ARARs depending on the technologies and activities being implemented.
3. Location-specific ARARs are determined according to site-related characteristics such as geology, floodplains, wetlands, sensitive ecosystems and habitats, and historic places.

In addition to the three types of ARARs, “To Be Considered” (TBC) criteria have also been evaluated. TBC criteria are proposed standards, advisories, and guidance developed by federal and state environmental and health programs that are not legally enforceable but provide helpful information for determining levels of protection and selecting remediation technologies.

2.1 Preliminary Chemical-Specific ARARs

Preliminary chemical-specific ARARs for OU2 are listed in Table 2-1. Depending on the alternative, regulations that may apply include standards for ambient air, surface water, and groundwater protection. Because the waste at OU2 is similar to hazardous waste, some Resource Conservation and Recovery Act (RCRA) hazardous waste requirements are also listed as relevant and appropriate.

2.2 Preliminary Action-Specific ARARs

Preliminary action-specific ARARs for OU2 are shown in Table 2-2 and may include, depending on the alternative, regulations governing such activities as excavation, waste treatment, construction and maintenance, management of containers, transportation of hazardous materials, emergency response, and contingency procedures. Of specific interest is the action-specific ARAR that deals with the Bevill exempt status of the materials associated with this site, as described below.

Bevill Exempt Status

Mining, milling, and processing operations involve generation and handling of overburden, waste rock, tailings, spent ore, and other wastes. RCRA is the source of federal regulations guiding the disposal of the solid waste associated with Subtitle D regulations. RCRA also imposes additional requirements on the subcategory of solid wastes that are "hazardous wastes" with Subtitle C regulations.

Congress excluded mining wastes from the RCRA Subtitle C regulations with the Bevill Amendment of 1980. The Bevill Amendment of 1980 directed the USEPA to study these wastes and determine which ones should remain exempt from the RCRA Subtitle C regulations. On December 31, 1985, USEPA published the required report to Congress, which determined that regulation of certain mining wastes under Subtitle C of RCRA was not warranted, primarily because traditional hazardous waste controls applied to large volume mining wastes may be technically infeasible or economically impractical. This legislation was codified by 40 CFR 261.4(b)(7), which states that solid waste from the extraction, beneficiation, and processing of ores and minerals are not considered hazardous wastes.

On this basis, the USEPA has categorized the waste generated from any Removal Action at Jacobs Smelter OU2 as Bevill Exempt. This categorization allows for the disposal of any waste generated at the site as a solid waste in accordance with Subtitle D regulations and not as a hazardous waste under Subtitle C regulations (see the March 23, 2004 email from Katherine Bradford included in Appendix E). UDEQ, in conjunction with the USEPA, determined that since some of the wastes are similar to hazardous waste, certain RCRA hazardous waste requirements may be considered relevant and appropriate.

2.3 Preliminary Location-Specific ARARs

Preliminary location-specific ARARs for OU2 are shown in Table 2-3. Applicable regulations include general facility location standards, Protection of Floodplains, the Fish and Wildlife Coordination Act, the National Historic Preservation Act, and the Clean Water Act.

2.4 Other Criteria To Be Considered

The TBC criteria are most often evaluated in conjunction with ARARs to assist in setting clean-up level targets, but may also be used to set standards in the absence of ARARs. Two TBC criteria have been identified for OU2 and are presented below and shown in Table 2-4.

- Establishing risk-based soil clean-up levels at lead sites
- Soil lead levels for children

3.0 REMEDIATION GOALS AND REMEDIAL ACTION OBJECTIVES

The Jacobs Smelter Superfund Site originally consisted of three Operable Units, OU1, OU2 and OU3. At that time OU2 consisted of undeveloped and underdeveloped land surrounding the Waterman Smelter west of Stockton, the majority of the Rush Lake Valley, and the Chicago and Carson Buzzo Smelters south of the Town of Stockton.

In 2010, two additional Operable Units were created, OU4 and OU5. OU4 consists of land owned by Kennecott LLC and is located east of the Rawhide Ranchettes subdivision. OU5 consists of land owned and managed by the Bureau of Land Management (BLM). In addition, areas that sampling efforts had shown were not impacted by smelter related contamination were removed from the Site boundaries. The boundaries of OU2 were modified to include the Waterman Smelter, the Rawhide Ranchettes and B&B subdivisions and the Chicago and Carson Buzzo Smelters.

It has been observed that the Chicago and Carson Buzzo Smelter areas are used mainly for agricultural purposes. Thus, in 2013 the agencies re-examined the exposure scenarios associated with the Chicago and Carson Buzzo Smelters. Based on the differences in use and the location of the Chicago and Carson Buzzo Smelters in relation to the town of Stockton, it was determined that the risk assumptions used for the Waterman Smelter are not applicable to the Chicago and Carson Buzzo Smelters. Therefore, the boundaries of OU2 have been changed to only address contamination associated with the Waterman Smelter and another Operable Unit, OU6, has been created to address contamination from the Chicago and Carson Buzzo Smelters (see UDEQ memo regarding creation of OU6 in Appendix E). Additional investigations, including a risk assessment based on the current and likely future land use will be performed for OU6.

Surface and subsurface soil, sediment, surface water, and groundwater samples were collected and analyzed for heavy metals during previous investigations performed at the Jacobs Smelter OU2 site, as discussed in detail in Sections 1 and 4 of the RI report (URS, 2003a). An HHRA was prepared based on previous sampling to characterize potential exposure of residential, industrial/commercial, and recreational users to metals in the environment at OU2 (URS, 2001b and URS, 2003b). An ERA was also conducted to characterize potential exposure of sensitive species to metals in soil, surface water, and sediment (Lockheed Martin REAC, 2003). The ERA was based on samples collected specifically for the ERA. These assessments suggest excessive risks to both human and ecological receptors from surface soils contaminated with lead and arsenic.

Due to fluctuation in Rush Lake water levels (there was water present at the time of sampling [1999 to 2002], however, in subsequent years, the lake has been dry), sediment is considered to be included in the soil classification for remediation purposes. This is a conservative approach, as the soil screening numbers are lower than the sediment screening numbers.

There is no surface water within the current OU2 boundary. As stated in the RI report (URS, 2003a), wells were installed up-gradient and down-gradient of the Waterman smelter, but groundwater was not

encountered. USEPA and UDEQ have determined that the groundwater pathway is incomplete and risk is not anticipated.

Remedial actions in residential areas will be focused on minimizing risk to human receptors. Remedial actions in non-residential areas will be focused on minimizing risk to avian and terrestrial wildlife as well as minimizing risk to humans under a recreational exposure scenario.

This section presents the RAOs for Jacobs Smelter OU2 and the process for developing them. Important components of the process include: the risk assessments and conceptual site models (CSMs) used, the PRGs, the preliminary action levels selected for soil remediation, and the risk management decisions developed by UDEQ and USEPA for this site.

3.1 Conceptual Site Models and Derivation of Preliminary Remediation Goals and Action Levels

RAOs are developed by considering the results of the HHRA and ERA along with risk management decisions made by regulators. Specifically, they are formulated from CSMs generated in the risk assessments along with PRGs and action levels.

The HHRA was completed in several phases culminating in two CSMs for the site. The first CSM is based on potential residential exposures whereas the second CSM is based on potential commercial, industrial, and recreational exposures for human receptors. A concise review of the HHRA is given followed by a review of the ecological risks and their potential exposures at the site. PRGs and soil action levels for both human and ecological receptors are also identified in this section.

3.1.1 Human Exposures

The HHRA was conducted to evaluate threats to human receptors from exposure to site contaminants at Jacobs Smelter OU2 (URS, 2001b and URS, 2003b). Data for samples collected from 0 to 2 inches bgs during all previous investigations were used in a three-phased assessment process. Phase 1 compared measured concentrations for contaminants at the site with USEPA Region 3 risk-based concentrations to select contaminants of concern (COCs). Phase 2 developed site-specific risk-based screening levels specific to the various media at Jacobs Smelter OU2, and compared these levels with measured concentrations at the site. Phase 3 of the HHRA defined exposure areas within OU2, statistically determined exposure point concentrations (EPCs) for each Phase 2 COC in each exposure area, and then compared those EPCs to the screening levels developed for Phase 2.

The HHRA provided a CSM, identified the COCs, and identified remediation goals based on screening levels for industrial/commercial and recreational land uses. Due to the strong similarity between Jacobs Smelter OU1 (ISSI, 1999) and the residential areas of OU2, remediation goals selected for residential areas in OU2 were based on the Jacobs Smelter OU1 ROD (USEPA, 1999).

Initially, a set of CSMs, which identify exposure pathways for contaminants based on the potentially exposed populations, site characteristics, and land use scenarios, was developed for Jacobs Smelter OU2. The CSM for residential exposure was presented in the HHRA (URS, 2001b) and is reproduced in this section as Figure 3-1. The CSM for industrial/commercial and recreational exposure was also presented in the HHRA (URS, 2001b) and is reproduced here as Figure 3-2.

Figure 3-1 illustrates that potential residential human receptors at the Jacobs Smelter OU2 site include current and future children and adults. The inhalation and dermal contact exposure pathways were considered minimal and the ingestion of homegrown vegetables pathway was not evaluated in the HHRA because of limited site-specific data due to limited vegetable gardening within OU2 (ISSI, 1999). Exposure pathways associated with soil contamination below a depth of 12 inches are considered to be incomplete and were not evaluated. Based on the conclusions of the OU1 HHRA (ISSI, 1999), contamination of drinking water is not suspected to be of concern because residents of Stockton and the surrounding areas (including the residents at the Rawhide Ranchettes and B & B subdivisions within OU2) are supplied with drinking water through a municipal water supply system. This drinking water was tested in 1997 and found to be free of lead and arsenic contamination.

Figure 3-2 illustrates that potential non-residential human receptors at the site include current and future industrial/commercial adults and recreational children and adults. Risk to the receptors from the groundwater was considered minimal and exposure pathways associated with soil contamination below a depth of 2 inches (subsurface) are considered to be incomplete.

Therefore, exposure pathways identified in the CSMs as potentially complete for human exposure and quantitatively evaluated in the HHRA include:

<u>Residential</u>

- Oral—incidental ingestion of indoor dust
- Oral—incidental ingestion of outdoor soil
- Oral—direct ingestion of discrete waste piles

<u>Commercial/Industrial and Recreational</u>

- Oral—inhalation of outdoor dust
- Oral—ingestion of surface soil
- Dermal—contact with surface soil
- Oral—ingestion of surface water
- Dermal—contact with surface water
- Oral—ingestion of sediment
- Dermal—contact with sediment

The final phase (Phase 3) of the HHRA was conducted to evaluate if removal of "hot spots" in surface and subsurface soils would result in an acceptable decrease of risk (URS, 2003b). This was done by identifying exposure areas and then calculating EPCs for each area. Highly contaminated areas were then removed from the data set and new EPCs were calculated and compared to the Phase 2 screening levels. This approach was used in the original Final Revised FS to determine a site action level for the recreational areas of the site. However, since that time, as a result of changed use in areas of the site, specifically the ATV track to the east of the Waterman Smelter, a new risk management approach has been adopted and is presented in the June 17, 2010 UDEQ Risk Management Memo (UDEQ, 2013) included in Appendix E.

3.1.2 Ecological Exposures

The ERA was conducted to evaluate potential threats to ecological receptors in the terrestrial and aquatic systems of Rush Lake and the surrounding area from exposure to site contaminants (Lockheed Martin REAC, 2003). Samples of soil, terrestrial plants, terrestrial invertebrates, small mammals, surface water, sediment, aquatic plants, aquatic invertebrates, and fish tissue were studied. Based on these samples collected for the ERA, using the hazard quotient (HQ) method, the ERA concluded that both aquatic and terrestrial biota are at risk from the contaminants at OU2 including lead, arsenic, cadmium, and selenium but that the primary threat to ecological receptors is from exposure to lead. Surface soil samples collected for the ERA included soil from 0 to 3 inches bgs. No clean-up goals were established in the ERA.

The complete ecological exposure pathways identified and quantitatively evaluated for unacceptable risk in the ERA (Lockheed Martin REAC, 2003) are listed in Table 3-1.

3.1.3 Preliminary Remediation Goals and Action Levels

USEPA Region 8, in consultation with UDEQ, used results of the HHRA, ERA, and newly identified use patterns at the site to establish PRGs for the site and to develop preliminary action levels to meet these goals. Final action levels will be established in the ROD.

The USEPA and UDEQ selected soil PRGs for human receptors (see the June 17, 2010 memo included in Appendix E), as shown in Table 3-2. These PRGs are based on the HHRA and newly identified use patterns at the site, with consideration for data quality and some uncertainty associated with soil contaminant concentrations in some parts of the site. Specifically, residential goals are based on the Jacobs Smelter OU1 ROD (USEPA, 1999), whereas the industrial/commercial and recreational use area goals of 2,200 and 3,000 mg/kg lead, respectively, represent approximately the arithmetic mean of the low and high risk ranges.

Action levels of 500 and 800 mg/kg lead were established for surface and sub-surface soils, respectively, over an exposure area within residential areas (Appendix E). An action level of 3,000 mg/kg lead for recreational exposure was established for surface and subsurface soils over an exposure area (Appendix E). An action level of 2,200 mg/kg lead for commercial/industrial exposure for surface and subsurface

soils over an exposure area is being established as a part of this FS. An exposure area is defined as an area with consistent land use, where receptors can be exposed to contamination, across which an exposure point concentration can be calculated and compared to an action level. These action levels are presented in Table 3-3. An action level for arsenic is not proposed because the arsenic contamination is co-located with the lead contamination and is, therefore, anticipated to be addressed by remediation of the lead contaminated soil (Appendix E).

USEPA developed ecological PRGs for Jacobs Smelter OU2 based on the ERA and under "…the assumption that protection of ecological receptors from deleterious levels of lead will also be protective from other heavy metal contaminants" (USEPA, 2003b). While the ERA demonstrated potential threats based on pathways from sediments and surface water, clean-up goals for both soil and sediment are all based on soil concentrations. Cleanup goals were not established specific to sediments because of confounding factors in the ERA test results and significant fluctuations in the water level of Rush Lake. Goals were not established for surface water because no viable fish population existed in Rush Lake during the sampling for the ERA due to high salinity from extended drought conditions. Also, ERA sampling results indicate low levels of metals in both the lake and inflow seeps. Consequently, the lowest protective concentration in soil was estimated for potential terrestrial and avian wildlife receptors and lead remediation goals (for both soil and sediment) of 574 and 1,148 mg/kg were established based on HQs of one and two for the most sensitive species, the northern flicker, a member of the insectivorous avian community.

In 2012, USEPA used ArcGIS 10.0 software, in conjunction with soil data in the area up to and including the 2011 sample data, to conduct a moving window analysis to evaluate remediation scenarios and identify any potential areas across the Waterman Smelter portion of the site which had an average lead soil concentration above the ecological PRG for lead of 1,148 mg/kg (corresponding to an HQ of two) after each scenario (see the May 14, 2013 memo included in Appendix E). The scenarios were run for three soil horizons (0-6 inches bgs, 6-12 inches bgs, and 12-18 inches bgs) and assumed that all soils with concentrations of lead above 3,000, 5,000 and 10,000 mg/kg were removed and replaced with soils containing 3,000 mg/kg of lead. The analysis concluded that the remediation of surface soils (0-6 inches bgs) to 5,000 mg/kg and subsurface soils to 10,000 mg/kg will be protective (Appendix E).

Based on this analysis, it has been determined that remediating the site to the human health recreational action level of 3,000 mg/kg lead in soil over an exposure area will also be protective of ecological receptors.

3.2 Remedial Action Objectives

A RAO was developed to protect human health from the COCs—lead and arsenic in soils—at residences and in the industrial/commercial and recreational areas of Jacobs Smelter OU2. An additional RAO was developed to protect ecological receptors from lead in soils. These RAOs were developed by considering the results of the HHRA and the ERA (COCs, exposure routes, receptors) and the risk management decisions by USEPA Region 8, in consultation with UDEQ, including PRGs. Final RAOs may be

modified to have specific action levels associated with them, therefore, preliminary action levels are identified for each RAO.

To achieve protection of human health and the environment, based on the results of the HHRA and ERA, at Jacobs Smelter OU2, the RAOs are:

RAO 1

Reduce risks from exposure to lead- and arsenic-contaminated soil such that no person has greater than a 1E-4 increased risk of contracting cancer, the potential to exceed toxicity exposure thresholds for noncancer health effects (HQ = 1), and such that no more than 5 percent (%) of children exposed to site contaminants will have a blood lead concentration exceeding 10 micrograms per deciliter (µg/dL). This objective can be achieved by:

a. Preventing ingestion of lead-contaminated soils in excess of 500 mg/kg lead in surface soils (0 to 2 inches bgs) and 800 mg/kg lead in sub-surface soils (2 to 12 inches bgs) in residential areas
b. Preventing ingestion of arsenic-contaminated soils in excess of 100 mg/kg arsenic in surface and subsurface soil (0 to 12 inches bgs) in residential areas.
c. Preventing ingestion of and direct contact with lead-contaminated soils that would result in a representative exposure in excess of 3,000 mg/kg lead in recreational areas.

A representative exposure is determined by a statistical assessment (URS, 2003b and USEPA, 2002a) of measured concentrations within specific areas across the Jacobs Smelter OU2 site.

The preliminary action levels to meet RAO 1 are:

- Lead concentrations of 500 mg/kg for surface (0 to 2 inches bgs) and 800 mg/kg for subsurface soils (2 to 12 inches bgs) over an exposure area within residential areas, and
- Lead concentrations of 3,000 mg/kg for surface soils over an exposure area within recreational areas.

Since arsenic contamination is co-located with lead contamination, an action level for arsenic is not specified.

RAO 2

Reduce risks from exposure to lead-contaminated soil such that no ecological receptor has the potential to exceed 2 times the toxicity exposure thresholds for noncancer health effects. This objective can be achieved by preventing ingestion of lead-contaminated soils by ecological receptors that would result in a representative effective exposure in excess of 1,148 mg/kg lead. A representative effective exposure is determined by a statistical assessment (USEPA, 2003b) of measured concentrations within specific areas across the Jacobs Smelter OU2 site.

The preliminary action level of 3,000 mg/kg lead over an exposure area identified to meet RAO 1 will also meet RAO 2, as identified above and in Appendix E.

These RAOs address contaminated soil and sediment located within OU2, Surface water and groundwater located within OU2 boundaries have been investigated and it has been determined that the pathways are incomplete. The non-residential areas of OU2 included in this FS are used for recreational purposes and are not used for industrial commercial uses.

3.3 Anticipated Extent of Clean-up

Figure 3-3 illustrates the properties in the B&B subdivision with soil lead concentrations above the 500 and 800 mg/kg action levels for surface and sub-surface soils. The extent of clean-up at the B&B subdivision is estimated to be 5.4 acres and is shown in Figure 3-4. The majority clean-up areas within the residential properties are located in the northern half of the B&B subdivision and are not near buildings or homes.

Figures 3-5, 3-6, and 3-7 illustrate the soil lead concentrations in the non-residential (recreational) land use areas of Jacobs Smelter OU2 (i.e., Waterman Smelter and ATV areas). The areas shown in these figures were found to have soil lead concentrations greater than 3,000 mg/kg. Figure 3-5 shows the extent of lead contaminated soil in the 0-6 inch depth interval; Figure 3-6 shows the extent of lead contaminated soil in the 6-12 inch depth interval; and Figure 3-7 shows the extent of lead contaminated soil in the 12-18 inch depth interval. The extent of clean-up of the Waterman Smelter and ATV areas is estimated as 26.7 acres and is shown in Figure 3-8. The vertical extent of contamination was investigated to a depth of 18 inches with the following results: approximately 14.6 acres of the contaminated area only extend down to 6 inches, 3.6 acres extend down to 12 inches, and 8.5 acres extend down to 18 inches.

The excavation areas and contours were primarily based on results of the 2011 Waterman Smelter sampling event, which were laboratory data. Historical data were used to supplement the 2011 data. Field measurements (such as field XRF data for the CSS sampling event [SOP 1713]) were superseded by laboratory data in areas where both laboratory and field measurements were available. In certain areas, such as northeast of the ATV area, the CSS field XRF measurements found lead concentrations above site action levels but these concentrations were not confirmed by laboratory data. These areas were not included in the excavation areas, but should be reevaluated during the pre-design phase of the project.

The maximum depth of sample collection was defined as 18 inches by UDEQ and USEPA. However, data indicates that contamination in areas of greater than 3,000 mg/kg lead extends down to at least 18 inches in some areas. If excavation is identified as the preferred method of clean-up for any target area, either backfilling with clean soil (if excavation only extends to 18 inches) or additional excavation to remove the entire vertical extent of contamination would be required to prevent any exposure to contaminated soil below 18 inches. Additional pre-design sampling will also be used to define the final clean-up area.

The Rawhide Ranchettes subdivision is no longer included in this Draft Final Updated Revised FS because it was remediated as part of the 2010 Time-Critical Removal Action (USEPA, 2011).

4.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

As recommended in USEPA guidance (USEPA, 1988), three criteria—effectiveness, implementability, and cost—are used to screen relevant remedial technologies to formulate appropriate remedial alternatives for analysis. The available information from a literature search is used to identify and distinguish any differences among the technologies. A comparison of these technologies, using the three criteria, is then completed to determine which technologies are carried forward to the detailed analysis of alternatives (Section 5.0). Within the detailed analysis of alternatives, technologies may be combined into alternatives to obtain the optimal mix of technologies to most cost effectively reduce the risk posed by the affected areas. A brief description of the three criteria used to screen each technology is described below.

EFFECTIVENESS

The evaluation of technologies under this criterion broadly addresses both short-term and long-term effectiveness. Short-term effectiveness addresses the effects of the alternative during the construction and implementation phase until remedial response objectives are met. Long-term effectiveness addresses the results of a remedial action in terms of the risk remaining at the site after response objectives have been met (USEPA, 1988).

IMPLEMENTABILITY

The implementability criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation. Technical feasibility focuses on construction and operation, reliability of the technology, the ease of undertaking additional remedial action, and monitoring considerations. The administrative feasibility determination is concentrated on the activities needed to coordinate with other offices and agencies (e.g., obtaining permits for offsite activities or rights-of-way for construction) (USEPA, 1988).

COST

Capital costs consist of direct (construction) and indirect (non-construction and overhead) costs. Direct costs include expenditures for the equipment, labor, and materials necessary to complete the remedial actions. Indirect costs include expenditures for administrative, engineering, financial, and other services that are not part of actual installation activities but are required to complete the installation of remedial alternatives. Operation and maintenance (O&M) costs are post-construction costs necessary to ensure the continued effectiveness of a remedial action. Operating labor costs, maintenance materials, auxiliary materials and energy, disposal of residues, sampling and laboratory fees, administrative costs, and insurance, taxes, and licensing costs are all considered when determining the O&M costs for a proposed technology (USEPA, 1988). Appendix A contains detailed cost estimates for the technologies presented in this section that are retained for detailed analysis and incorporated into the alternatives presented in Section 5.

A total of ten technologies, six *in-situ* (in-place) technologies and four ex-situ (not in-place, or excavated) technologies, have been selected for screening for the Jacobs Smelter OU2 site. A summary of the rating for each of the three criteria for all technologies discussed in this section is presented in Table 4-1. Table 4-1 also identifies which technologies are retained for detailed analysis in Section 5.0.

Two of the ex-situ treatment technologies identified within this section (excavation, removal, and backfill; and excavation, removal, and regrading) require disposal of excavated material as part of the process. Several alternative disposal alternatives are evaluated at the end of this section to determine the optimal disposal option and location, if this technology is retained. Table 4-2 is developed for disposal options similar to the table developed for technologies and is based on the same three criteria: effectiveness, implementability, and cost.

4.1 ***In-Situ* Technologies**

The *in-situ* remedial technologies reviewed are:

- Soil Cover
- Soil Cap
- Phytoremediation
- Tilling with Amendments
- *In-situ* Stabilization/Solidification
- Phosphate Amendment

4.1.1 Soil Cover

Soil cover is an *in-situ* waste containment technology that involves placing a layer of clean soil (below the lead action levels for the Jacobs Smelter OU2 site) over contaminated soil. A 9-inch lift of uncompacted backfill covered by a 9-inch lift of uncompacted topsoil is suggested for this site. Backfill and topsoil layers will be compacted to a 12-inch soil cover. The clean fill may be placed directly over existing contaminated soil or over a geotextile fabric used to separate contaminated soil from clean cover soil and provide a visible barrier during digging or excavation. Geotextile fabric is a type of non-woven fabric that is used extensively in landfill caps and to separate road subgrades from the base course. The geotextile does not prevent against excavation or infiltration of precipitation through the contaminated soil zone. The clean topsoil cover would be revegetated and an erosion control blanket would be installed to reduce the potential for soil erosion. Institutional controls to restrict excavation in affected areas would be required with this technology at OU2.

Soil Cover - Applicability

Soil cover technology reduces the potential for direct contact with the contaminated soil and reduces contaminant mobility from airborne transport of particulates. In both the non-residential areas and the residential properties at OU2, geotextile fabric is suggested to prevent soil mixing as well as provide a visible barrier to increase resident and user awareness of contaminated soil exposure.

Soil Cover - Limitations

Factors that may limit the effectiveness of this technology include:

- The soil cover must remain intact to be effective. Soil erosion, burrowing animals, or excavation may jeopardize the soil cover and expose contaminated materials, resulting in potential human and ecological health risks.
- Erosion control features, such as drainage ditches and swales, must be used to divert runoff from areas with high erosion potential. Vegetation will need to be replaced as necessary to minimize erosion of the cover material.
- Some areas of OU2 have steep slopes making both soil cover implementation and erosion control measures difficult.
- Use of the area by recreational vehicles may disrupt the cover material resulting in exposure of the contaminated soil.
- Grazing animals in portions of the OU2 site may impact vegetation and erosion prevention measures.
- Restrictions on excavation below the soil cover must be implemented to prevent human exposure to contaminated soil and routine inspections and maintenance must be conducted to identify and repair any breaches in the soil cover.
- Controlled land use and institutional controls to limit disturbance of the soil cover may be difficult to administratively implement and enforce at OU2 due to the relatively large acreage of land impacted.
- Contaminant mobility decreases, but volume of contaminated media and toxicity are not reduced; therefore, the potential for future exposure remains.
- Maintenance would be required.

Soil Cover - Effectiveness and Implementability

Soil cover is less effective than most ex-situ technologies since the volume of contaminated media and toxicity are not reduced and the possibility of future exposure remains. In addition, this technology has only a limited history as a remedial technique for residential properties. Therefore, the effectiveness of this technology was ranked as moderate. Soil cover would be relatively easy to implement technically, but would require monitoring and maintenance to ensure proper revegetation occurs and unacceptable erosion is prevented. Soil cover would be difficult to maintain administratively due to the problems associated with the enforcement of controlled land use and institutional controls because of the relatively large acreage of impacted land, the present uses of areas within OU2, and the remoteness of some areas.

Soil Cover - Cost

The soil cover costs include the purchase and installation of the geotextile fabric, hauling, applying, and compacting clean fill, establishment of vegetation, and monitoring. The capital construction cost for a soil cover is relatively low, but the O&M cost is higher than many ex-situ techniques due to the need for periodic monitoring and repairs.

The cost for geotextile fabric (assuming Typar® 4-ounce [oz] non-woven fabric) is approximately $0.48 per square yard. Installation and equipment costs for large areas of geotextile are approximately $0.50 per square yard. The estimated material and hauling cost for delivering clean fill (bank run) and topsoil to OU2 is $14 per ton and $23 per ton, respectively. Placing and grading of the cover material is estimated at $9 per ton. The estimated cost for seeding the soil cover is $300 per acre. References for the quoted costs are presented in Appendix A, Table A-5.

The capital costs for this technology are ranked as low and the O&M costs are ranked as moderate (see Table 4-1).

Soil Cover - Recommendations

Soil cover is a viable alternative for both commercial/industrial properties and residential properties (see Table 4-1). A geotextile fabric is suggested at both non-residential areas and residential properties to create a barrier to soil mixing and provide a visible reminder to residents and other users that contaminated soil resides below the fabric. Institutional controls will be required with this technology to prevent unauthorized excavation and/or removal of materials from the site. This technology is reviewed in the detailed analysis of alternatives as a stand-alone technology for both undeveloped and residential areas. It is also considered in conjunction with other remediation technologies to develop an effective treatment alternative for Jacobs Smelter OU2 (Section 5.0).

4.1.2 Soil Cap

A soil cap is an *in-situ* technology that involves placing either a flexible membrane liner (FML) or a geosynthetic clay liner (GCL) and a soil layer over the contaminated soil. A soil cap differs from a soil cover in that it includes an impermeable membrane over the contaminated soil below the layer of clean soil. A 9-inch lift of uncompacted backfill covered by a 9-inch lift of uncompacted topsoil is suggested for the Jacobs Smelter OU2. The membrane would minimize the potential for contaminated soil to mix with the clean soil and would minimize the infiltration of precipitation through the contaminated soil zone. As discussed in Section 4.1.1, revegetation and an erosion control blanket would be required to minimize soil erosion on and around the cap. Institutional controls to restrict excavation in affected areas would be required with this technology.

Soil Cap - Applicability

Soil cap technology, like soil cover technology, reduces the potential for direct contact with the contaminated soil and also reduces contaminant mobility from airborne transport of particulates. However, unlike the soil cover, the soil cap also minimizes leaching of contaminants and migration to greater depths.

Soil Cap - Limitations

Factors that may limit the applicability and effectiveness of the technology include:

- Future excavation may damage the cap (i.e., membrane and topsoil layer), resulting in potential exposure of human and ecological receptors to the underlying contaminated soil.
- Controlled land use and institutional controls to limit disturbance of the soil cover may be difficult to implement and enforce because of the relatively large acreage of impacted land and the remoteness of some areas.
- Some areas of OU2 have steep slopes making both soil cap implementation and erosion control measures difficult.
- Use of the area by recreational vehicles may disrupt the cover material resulting in exposure of the FML or GCL.
- Grazing animals in portions of the OU2 site may impact vegetation and erosion prevention measures.
- Contaminant mobility decreases, but volume of contaminated media and toxicity are not reduced; therefore, the potential for future exposure remains.
- Maintenance would be required.

Soil Cap - Effectiveness and Implementability

Soil capping is less effective than most ex-situ technologies since the volume of contaminated media and toxicity are not reduced and the possibility of future exposure remains. Due to these factors, the effectiveness of this technology was ranked as moderate. The technical implementability is ranked as moderate due to the increase in construction complexity over the soil cover technology. Soil capping is not well adapted to residential use because the impermeable membrane inhibits growth of a wide variety of landscaping vegetation. It would be difficult to implement administratively due to the problems associated with the enforcement of controlled land use and institutional controls due to the relatively large acreage of land impacted and the remoteness of some areas. Maintaining the appropriate cover in all non-residential areas to protect the integrity of the FML or GCL will likely be difficult and will therefore increase O&M costs.

Soil Cap - Cost

Soil capping costs include the purchase and installation of the membrane, hauling, applying, and compacting clean fill, and establishing and maintaining vegetation. Although the capital construction cost for a soil cap is moderate (higher than soil cover), the O&M cost is much higher than many ex-situ techniques due to the need for frequent repairs and periodic monitoring. The estimated cost for GCL is $4.50 per square yard, and installation of GCL is estimated at $2.25 per square yard. The estimated material and hauling cost for delivering clean fill (bank run) and topsoil to OU2 is $14 per ton and $23 per ton, respectively. Placing and grading of the cover material is estimated at $9 per ton. The estimated cost for seeding the soil cap is $300 per acre.

The capital costs for this technology are ranked as moderate and the O&M costs are ranked as moderate (see Table 4-1).

Soil Cap - Recommendations

Since the historical contamination was shown to have no impact to deep groundwater, residual contamination following remediation would similarly not be expected to impact deep groundwater (USEPA, 2004) and a soil cap is more expensive and harder to implement than soil cover, this technology is not retained for detailed analysis in Section 5.0.

4.1.3 Phytoremediation

Phytoremediation is a process that uses plants to remove, transfer, stabilize, or destroy either organic or inorganic contaminants in soil and sediment. The mechanisms of phytoremediation include enhanced rhizosphere biodegradation, phyto-extraction (also called phyto-accumulation), phyto-degradation, and phyto-stabilization. Some plant species have the ability to store metals in their roots. As the roots become saturated with metal contaminants, they can be harvested and either incinerated or composted.

Phytoremediation - Applicability

Phytoremediation may be applicable for the remediation of metals, pesticides, solvents, explosives, crude oil, polycyclic aromatic hydrocarbons, and landfill leachate. Generally, the use of phytoremediation is limited to sites with low to medium contaminant concentrations and contamination in shallow soils, streams, and groundwater. Water movement, oxygen concentrations, root growth, and root structure all affect the growth of plants and should be considered when implementing phytoremediation.

Phytoremediation - Limitations

There are a number of limitations to phytoremediation of soil.

- High concentrations of hazardous materials can be toxic to plants; therefore, proper plant selection is critical.
- Phytoremediation involves the same mass transfer limitations as other biotreatments.
- Phytoremediation is seasonal.
- Maintenance of vegetation on steep slopes is difficult.
- Arid conditions at the site make establishment of plants difficult.
- Phytoremediation would not prevent exposure to either ecological or human receptors.
- The toxicity and bioavailability of biodegradation products are not always known.
- Products may bioaccumulate in animals feeding on the bioaccumulating plants.
- Phytoremediation is unfamiliar to most state and federal regulators.

Phytoremediation - Effectiveness and Implementability

Due to number and severity of limitations listed above, the effectiveness of phytoremediation is rated as low. Phytoremediation would be difficult to implement technically, since the reliability of this technology is in question and monitoring for lead uptake and reduction of lead in the soils is difficult. In

addition, it would be more difficult to obtain administrative approval than for other techniques because phytoremediation does not remove the exposure route to human or ecological receptors.

Phytoremediation - Cost

According to the Air Force Center for Engineering and the Environment (AFCEE) Remedial Action Cost Engineering and Requirements (RACER) software the cost for phytoremediation ranges between $112 to $1,775 per cubic yard of soil over for the life of the project, depending on the complexity and size of the site (FRTR, 2013a). The $112 cost is based on a large site (62 acres or 10,000 cubic yards) requiring O&M monitoring for five years. The $1,775 cost is based on a small site (3 acres or 500 cubic yards) requiring O&M monitoring for 20 years. The area requiring treatment at the Jacobs Smelter OU2 site is approximately 30 acres or 43,000 cubic yards. The capital costs for this technology are ranked as high and the O&M costs are ranked as high (see Table 4-1).

Phytoremediation - Recommendations

The effectiveness of this technique for lead contaminated soils has not been determined and it may be technically and administratively difficult to implement (see Table 4-1). Furthermore, selection of phytoremediation as a preferred alternative would not prevent pathway completion to either ecological or human receptors; therefore, this technique is not retained for detailed analysis in Section 5.0.

4.1.4 Tilling with Amendments

A disc plow or rotary mixer can be used to till soil at depths up to three feet to dilute the metals concentrations in the area of interest (ground surface to 18 inches bgs for the Jacobs Smelter OU2). Adequate mixing with a disc plow requires approximately three passes, each at right angles to one another at a speed of approximately two miles per hour. A rotary mixer can achieve adequate mixing in one pass but can only achieve mixing to depths of approximately 24 inches and is slower than a disc plow (Compton, 2002 and Dollhopf, 2003). Fertilizer would be added during tilling to enhance vegetative growth after reseeding of the affected areas. Revegetation and an erosion control blanket would be required.

Tilling with Amendments - Applicability

The success of tilling is dependent on adequate mixing of contaminated soils with “clean” soils below. For example, tilling to a 50% reduction in concentration assumes complete mixing with clean soil of at least the same thickness as the contaminated layer. Therefore, tilling is appropriate at sites where underlying soils have been tested and have relatively low contaminant concentrations to ensure mixing of these materials will achieve the desired target soil concentrations. A feasibility demonstration project is usually recommended to determine if this technology will work at a site (Dollhopf, 2003).

Tilling with Amendments - Limitations

The limitations for the tilling with amendment technology include:

- The rotary mixer is not suited to soils with rocks 4 inches or greater in diameter.
- Soil contamination must be limited to the upper 6 inches to 12 inches for tilling to be an effective remediation technique.
- Achieving uniform mixing below 24 inches has not been demonstrated.
- A specialized plow would be required.
- Only one contractor has been identified with the required expertise and the specialized equipment.
- Analytical data are not currently available below 18 inches at the Jacobs Smelter OU2 site. Additional sampling would be required to determine if this technology can be successfully implemented.
- Complete mixing would require verification.
- A feasibility demonstration project is required, which would result in additional expenditures and may lengthen the duration of the remediation.
- The technology would be difficult to implement in areas with steep slopes.
- Generation of fugitive dust may be an issue during tilling operations.

Tilling with Amendments - Effectiveness and Implementability

The USEPA has utilized this technology at the East Helena, Montana site with acceptable results. However, contaminant concentrations were lower than at the Jacobs Smelter OU2 site with surface concentrations of less than or equal to 3,000 mg/kg lead and "clean" soil with concentrations of 100 mg/kg lead at depths greater than 6 inches bgs. No data are available to determine the efficacy of this technology at a site with the higher contamination levels found at the Jacobs Smelter OU2 site (>10,000 mg/kg lead); therefore, the effectiveness was rated as low. Evaluating the technical feasibility of this technology at the Jacobs Smelter OU2 site requires information that is not available at this time, namely contaminant concentrations below 18 inches bgs. Additional sampling at depths greater than 18 inches throughout the proposed tilling areas would be required to determine if tilling would achieve the target reduction in concentration. The soil types found at the Jacobs Smelter OU2 site are amenable to this type of technology (Dollhopf, 2003); however, a feasibility demonstration project is required prior to full-scale application. Due to all of these factors, the technical implementability of this technology is difficult. Also, this technology would be difficult to implement administratively because the overall volume and extent of the contamination would actually be increased due to the mixing of the more concentrated soils to a greater depth.

Tilling with Amendments - Costs

Costs include tilling, amendments, and establishment and maintenance of vegetation. The sole-source contractor, located in Montana, could not be reached to provide costs for mobilization or tilling of the proposed areas. There are no cost data available through other sources because the sites where it has been used are enforcement-lead projects. The capital construction cost for this technology would likely be high

due to mobilization of the required equipment from Montana, the need for a demonstration project, and the non-competitive nature of using a sole-source contractor. The estimated cost for seeding the tilled areas is $300 per acre.

The capital costs for this technology are ranked as high and the O&M costs are ranked as low (see Table 4-1).

Tilling with Amendments - Recommendations

Based on several factors, this technology has not been selected for use in a treatment alternative. First, the data available for tilling with amendments are limited. Second, the projects that employed this technology were ideal with relatively low surface concentrations (3,000 mg/kg lead) and relatively clean material (100 mg/kg lead) at depths in excess of 6 inches. Third, it is possible that tilling would increase the amount of contaminated material at the site by mixing contaminated soils to a greater depth. Forth, this is a sole source technology and this contractor could not be reached to determine costs for implementation. Fifth, the contamination below 18 inches bgs is unknown, so additional sampling at depths greater than 18 inches throughout the proposed tilling areas would be required prior to a proper evaluation of this technology. Finally, a demonstration project would be required to ensure effectiveness of the technology prior to site wide implementation, which would increase the overall cost and duration of the project. This technology is not retained for detailed analysis in Section 5.0.

4.1.5 *In-Situ* Stabilization/Solidification

In-situ stabilization/solidification (S/S) is a site stabilization technique in which amendments are applied to soils to alter the soil contaminant chemistry, making contaminants less soluble, less mobile, and less bioavailable. *In-situ* S/S does not affect the total contaminant concentration, but seeks to reduce the risk of harm to human and ecological receptors by reducing biological activity, leachability, and exposure. *In-situ* S/S is based on fundamental soil chemistry, agricultural practices, and experience with restoration of disturbed mine and roadside lands and construction sites (ITRC, 1997). The parameters required to assess the technical feasibility of this technology include soil particle size, Atterberg limits, moisture content, metals concentrations, sulfate content, organic content, density, permeability, unconfined compressive strength, pH, and microstructure analysis. This information is not currently available for the Jacobs Smelter OU2 site.

Unlike other remedial technologies, *in-situ* S/S seeks to trap or immobilize contaminants within their "host" medium (i.e., the soil, sand, or building materials that contain them), instead of removing them through chemical or physical means. Revegetation and an erosion control blanket would be required after *in-situ* S/S is employed.

***In-Situ* Stabilization/Solidification - Applicability**

The target contaminant group for *in-situ* S/S is generally inorganics. *In-situ* S/S technologies are well demonstrated, can be applied to the most common site and waste types, require agricultural plowing/spreading and conventional materials handling equipment, and are available competitively from

a number of vendors. Most reagents and additives are also widely available and relatively inexpensive industrial commodities.

***In-Situ* Stabilization/Solidification - Limitations**

Factors that may limit the applicability and effectiveness of the process include:

- Generally accepted percentages for the reduction of bioavailability due to *in-situ* S/S range from 12% to 33% (USEPA, 2002b and Barthel, 2004).
- Future usage of the site may weather the materials and affect ability to maintain immobilization and reduction in bioavailability of the contaminants.
- Some future land uses may be incompatible with stabilized or solidified soil.
- Contaminant mobility decreases, but volume of contaminated media is not reduced; therefore, the potential for future exposure remains.
- S/S processes result in an increase in volume of media (up to 10% above the original volume).
- Certain wastes are incompatible with reagent and/or additive variations of this process. Bench-scale or treatability studies are required to determine the proper stabilization mixture.
- Like all *in-situ* treatments, confirmatory sampling can be more difficult than for ex-situ treatments.
- Delivering reagents to the subsurface and achieving uniform mixing and treatment *in-situ* to a depth of 18 inches may be difficult.

***In-Situ* Stabilization/Solidification - Effectiveness and Implementability**

In-situ S/S processes are highly effective and can reduce the leachability of contaminated waste by greater than 95%. Since the historical contamination was shown to have no impact to groundwater, residual contamination following remediation would similarly not be expected to impact groundwater (USEPA, 2004). Due to this, coupled with the Bevill Exemption, treatment of the contaminated material to reduce leachability is not a requirement at the Jacobs Smelter OU2 site and therefore would not be the goal of this technology. A reduction in lead bioavailability for human and ecological receptors would be the goal and generally accepted percentages for the reduction of lead bioavailability through the use of this technology range from 12% to 33% (USEPA, 2002a and Barthel, 2004). Therefore, the effectiveness of this technology for the situation at Jacobs Smelter OU2 is ranked as low.

Long term effects of weathering (e.g., freeze-thaw cycles, acid precipitation, and wind erosion), groundwater infiltration, and physical disturbance associated with uncontrolled land use may affect the integrity of the stabilized mass and contaminant mobility in ways that cannot be predicted by laboratory tests. Site data including soil particle size, Atterberg limits, moisture content, metals concentrations, sulfate content, organic content, density, permeability, unconfined compressive strength, leachability, pH, and microstructure analysis are not available to adequately determine the predicted effectiveness of this technology. *In-situ* S/S processes require large volumes of bulk reagents and additives. The availability of suitable reagents is not likely to be an issue for the Jacobs Smelter OU2 site.

In-situ S/S would be moderately difficult to implement technically due to the lack of site data. Administrative implementability is ranked as moderately difficult due to the variable nature of lead bioavailability reduction through the use of this technology.

***In-Situ* Stabilization/Solidification - Cost**

Costs for the *in-situ* S/S techniques include reagent and application, transportation, and establishing and maintaining vegetation. Applications, such as those required at OU2, average $40 to $60 per cubic yard of treated soil (FRTR, 2013b). Transportation costs can dominate project economics, which can quickly become unfavorable in cases where local or regional material sources are unavailable. The estimated cost for seeding is $300 per acre. The capital construction costs for *in-situ* S/S are moderate due to the large volume of soil to be treated and the O&M cost are low due to the need for infrequent monitoring (see Table 4-1).

***In-Situ* Stabilization/Solidification - Recommendations**

This technique is not retained for detailed analysis in Section 5.0 (see Table 4-1) due to the relatively small and uncertain reduction of lead bioavailability after implementation of this technology.

4.1.6 Phosphate Amendment

Amending lead contaminated soil with a phosphate-based agent is a remedial technique which is often used to decrease the leachability of the lead for disposal purposes; however, recently this approach has also been evaluated for use in decreasing the bioavailability of the lead in soil, thereby reducing the risk of harm to human and ecological receptors. Phosphate amendment agents, in general, act through ionic substitution and replacement of calcium by lead in its crystalline structures, making a pyromorphite type mineral (USEPA, 2012). Phosphate amendment agents include: triple super phosphate, rock phosphate, phosphoric acid, and hydroxyapatite (e.g., fish bones).

Phosphate amendment does not affect the total contaminant concentration, but instead changes the chemical composition of the contaminant to make it less bioavailable. However, the decrease in bioavailability is limited and dependent on site conditions and waste type. A review of the literature indicates that the decrease in bioavailability, as measured by *in vivo* (a direct measurement in live organisms) tests, is in the range of 30% and that phosphate treatment may not be effective for decreasing bioavailability of soils impacted by mill waste (USEPA, 2012). Adding phosphate amendments to lead contaminated soils may decrease the bioavailability of lead; however, it may also increase the mobility of lead and other soil contaminants. Revegetation and an erosion control blanket would be required after phosphate amendment is applied.

Phosphate Amendment - Applicability

Application of phosphate amendments is a well proven process and requires agricultural plowing/spreading and conventional materials handling equipment, which are available competitively from a number of vendors. The successful application of phosphate amendments depends on adequate mixing of contaminated soil with the amendment reagent. Most reagents and additives are also widely

available and relatively inexpensive industrial commodities. Hydroxyapatite from fish bones is actually a processed waste product of the fishery industries (available commercially through PIMS NW Inc.), making it an environmentally friendly "green" product.

Phosphate Amendment - Limitations

Factors that may limit the applicability and effectiveness of the process include:

- Field studies show that the change in bioavailability of lead due to phosphate amendment ranges from a 5% increase to a 69% decrease, with the average being approximately 32% (USEPA, 2012).
- The ability of phosphate to reduce the bioavailability of lead in mill related wastes is not proven (USEPA, 2012).
- Phosphate amendments may increase the mobility of lead and other contaminants.
- Future usage of the site may weather the materials and affect ability to maintain immobilization and reduction in bioavailability of the contaminants.
- Some future land uses may be incompatible with amended soil.
- Contaminant mobility decreases, but volume of contaminated media is not reduced; therefore, the potential for future exposure remains.
- Phosphate amendment results in an increase in volume of media (up to 10% above the original volume).
- Like all *in-situ* treatments, confirmatory sampling can be more difficult than for ex-situ treatments.
- Delivering reagents to the subsurface and achieving uniform mixing and treatment *in-situ* to a depth of 18 inches may be difficult.

Phosphate Amendment - Effectiveness and Implementability

The application of phosphate amendments is well demonstrated for decreasing the leachability of contaminants. However, based on the current state of the science, the application of phosphate for decreasing bioavailability, such that no other remedy (i.e., soil cover) would be required to address risk, is not well demonstrated, especially for mill related wastes. Based on the Integrated Exposure Uptake Biokinetic (IEUBK) Adult Lead Methodology (ALM) and the parameters presented in the June 17, 2010 risk memo included in Appendix E, a greater than to 80% reduction in lead bioavailability for human receptors would be necessary at the site for phosphate amendment to be an effective remedy, on its own, for human exposure. The required decrease in bioavailability for ecological receptors is unclear. Field case studies show the maximum percent reduction of lead bioavailability through the use of this technology to be 69%, with an average of 32% and the potential for a 5% increase in lead bioavailability (USEPA. 2012). Additionally, long term effects of weathering (e.g., freeze-thaw cycles, acid precipitation, and wind erosion), groundwater infiltration, and physical disturbance associated with uncontrolled land use may affect the integrity of the amended mass and contaminant mobility and bioavailability. No good data exists demonstrating the long term effectiveness of this technology for decreasing bioavailability. Therefore, the effectiveness of this technology for the situation at Jacobs Smelter OU2 is ranked as low.

Phosphate amendment would be moderately difficult to implement technically due to the lack of site-specific data. Administrative implementability is ranked as highly difficult to due to the variable nature of lead bioavailability reduction through the use of this technology.

Phosphate Amendment - Cost

Costs for the *in-situ* soil mixing techniques include reagent and application, transportation, and establishing and maintaining vegetation. The cost for phosphate amendment with hydroxyapatite from fish bone, the most environmentally favorable amendment, would cost approximately $22 per cubic yard of treated soil based on case studies (ESTCP, 2006). The estimated cost for seeding is $300 per acre. The capital construction costs and the O&M cost for phosphate amendment are low based on the low cost of reagent and the need for infrequent monitoring (see Table 4-1).

Phosphate Amendment - Recommendations

This technique is not retained for detailed analysis in Section 5 (see Table 4-1) due to the relatively small and uncertain reduction of lead bioavailability after implementation of this technology.

4.2 Ex-Situ Technologies

The ex-situ remedial technologies are:

- Excavation, removal, and backfill
- Excavation, removal, and regrading
- Excavation and soil washing
- Excavation and chemical separation

4.2.1 Excavation to 18-Inch Depth, Removal, and Backfill

The excavation, removal, and backfill technology involves removing up to 18 inches of contaminated material and transporting it to a disposal area (the disposal options are discussed in Section 4.3). A geotextile layer is suggested for demarcation purposes in the areas excavated to 18 inches because of the potential contamination remaining in the soil at depths greater than 18 inches. Backfilling involves placing a layer of clean soil, over the excavated areas and the geotextile layer. An 18-inch lift of uncompacted fill material covered by a 9-inch lift of uncompacted topsoil is suggested for the Jacobs Smelter OU2 site. After compaction of the backfill and topsoil, the pre-existing grade would be returned. The clean topsoil would be revegetated and an erosion control blanket would be installed to reduce the potential for soil erosion.

Excavation, Removal, and Backfill - Applicability

The excavation, removal, and backfill technology is applicable for the complete range of contaminant groups. Although excavation and removal alleviates the contaminant problem at a site, it does not treat the contaminated soils to reduce the volume of contaminated media or the toxicity. Due to the Bevill

Exemption of the excavated soils, treatment of the soils would not be required prior to disposal. This technology was implemented at Jacobs Smelter OU1 as well as two Removal Actions at Jacobs Smelter.

Excavation, Removal, and Backfill - Limitations

Factors that may limit the applicability and effectiveness of the process include:

- Generation of fugitive dust emissions may be a problem during excavation and removal.
- Excavation and backfilling on steep slopes is difficult.
- Transportation of the soil through populated areas may affect community acceptance.
- If only partial excavation is planned, communities may be concerned with future safety, long-term monitoring and stewardship, and long-term ecological health.
- CERCLA includes a statutory preference for treatment of contaminants; therefore excavation and removal, especially with off-site disposal, may be less administratively desirable than other technologies.

Excavation, Removal, and Backfill - Effectiveness and Implementability

Excavation and removal is the most common method for cleaning up residential hazardous waste sites containing heavy metals. It is also highly effective in reducing the toxicity and mobility of contaminants at the excavation site. Excavation and removal followed by backfilling would remove the exposure pathway for both human and ecological receptors at the OU2 site. Technically, excavation and removal is a well-proven and readily implementable technology. The technical implementation of excavation at the OU2 sites is therefore ranked as easy. Due to previous implementation of this technology at Jacobs Smelter OU1 and two USEPA Removal Actions at Jacobs Smelter, the administrative implementability of this technology is ranked as easy even though a statutory preference for treatment of contaminants exists. Excavation and removal are the initial components in all ex-situ treatments, and, therefore, the regulatory community is familiar with this option.

The factors that could affect implementability of this technology are the presence of steep slopes at OU2 making excavation, backfilling, erosion control, and revegetation measures difficult.

Excavation, Removal, and Backfill - Cost

Cost estimates for excavation at OU2 is $10 per ton. The estimated material and hauling cost for delivering clean fill (bank run) and topsoil to OU2 is $14 per ton and $23 per ton, respectively. Placing and grading of the cover material is estimated at $9 per ton. The estimated cost for seeding the backfilled material is $300 per acre. The O&M costs for excavation are lower than those for the *in-situ* technologies due to reduced monitoring requirements. References for the quoted costs are presented in Appendix A, in Tables A-4 and A-6. Transportation costs range between $12.50 and $35 for transportation by truck. Disposal costs range between $19 and $35 per ton. Transportation and disposal costs are discussed in more detail in Section 4.3.

The capital costs for this technology are ranked as moderate and the O&M costs are ranked as low (see Table 4-1).

Excavation, Removal, and Backfill - Recommendations

This technique is recommended for detailed analysis at OU2 (see Table 4-1) due to its high effectiveness, relatively easy implementation, moderate capital costs, and low O&M costs. Disposal options are discussed in more detail in Section 4.3.

4.2.2 Excavation to Depth of Contamination, Removal, and Regrading

The excavation, removal, and regrading technology involves removing contaminated material and transporting it to a disposal area (the disposal options are discussed in Section 4.3). Instead of backfilling the excavated areas, this technology involves regrading the excavated areas to match the surrounding grade. After regrading is completed, a 9-inch lift of uncompacted topsoil is suggested to encourage revegetation and reduce the potential for soil erosion. The clean topsoil would be revegetated and an erosion control blanket would be installed to reduce the potential for soil erosion. Since excavation will not be followed by a layer of clean backfill, all contaminated material would be removed under this technology to reduce the potential of exposure to contaminated soils. Thus, excavation would involve chasing the vertical and horizontal extents of contaminated soil.

Excavation to Depth of Contamination, Removal, and Regrading - Applicability

The excavation, removal, and regrading technology is applicable for the complete range of contaminant groups. Although excavation and removal alleviates the contaminant problem at a site, it does not treat the contaminated soils to reduce the volume of contaminated media or the toxicity. Due to the Bevill Exemption of the excavated soils, treatment of the soils would not be required prior to disposal.

Excavation to Depth of Contamination, Removal, and Regrading - Limitations

Factors that may limit the applicability and effectiveness of the process include:

- Generation of fugitive dust emissions may be a problem during excavation, regrading, and removal.
- Excavation and regrading on steep slopes is difficult.
- This technology would change the current topography of the land, which may be unacceptable to the community.
- Transportation of the soil through populated areas may affect community acceptance.
- Since this technology would not return the excavated areas to pre-existing grades, it would only be implemented in the non-residential areas.
- CERCLA includes a statutory preference for treatment of contaminants; therefore excavation and removal, especially with off-site disposal, may be less administratively desirable than other technologies.

Excavation to Depth of Contamination, Removal, and Regrading - Effectiveness and Implementability

Excavation and removal is the most common method for cleaning up residential hazardous waste sites containing heavy metals. It is also highly effective in reducing the toxicity and mobility of contaminants at the excavation site. This technology is effective for completely removing the exposure pathway for both human and ecological receptors because all contaminated soils would be required to be removed, since backfill would not be used.

Technically, excavation, removal, and regrading is a well-proven and readily implementable technology. The technical implementation of excavation at the OU2 site is therefore ranked as easy. The administrative implementability of this technology is ranked as moderate because the previous Removal Actions at the Site included backfilling to return the site to the original grade, which this one does not, and because a statutory preference for treatment of contaminants exists.

The factors that could affect implementability of this technology are the presence of steep slopes at OU2 making excavation, regrading, erosion control, and revegetation measures difficult, as well as the fact that the topography of the site would be altered, which could be unacceptable to the public.

Excavation to Depth of Contamination, Removal, and Regrading - Cost

Cost estimates for excavation at OU2 is $10 per ton. The estimated cost for regrading the excavated areas is $3 per square yard. The estimated material and hauling cost for delivering topsoil to OU2 is $23 per ton and the cost of placing and grading the topsoil is estimated at $9 per ton. The estimated cost for seeding the topsoil material is $300 per acre. References for the quoted costs are presented in Appendix A, in Tables A-7 and A-8. Transportation costs range between $12.50 and $35 for transportation by truck. Disposal costs range between $19 and $35 per ton. Transportation and disposal costs are discussed in more detail in Section 4.3.

The capital and the O&M costs for this technology are ranked as low (see Table 4-1).

Excavation to Depth of Contamination, Removal, and Regrading - Recommendations

This technique is recommended for detailed analysis at OU2 (see Table 4-1) due to its high effectiveness, relatively easy implementation, low capital costs, and low O&M costs. Disposal options are discussed in more detail in Section 4.3.

4.2.3 Excavation and Soil Washing

Soil washing is an ex-situ, water-based process for scrubbing soils to remove contaminants that is generally performed on site after excavation of the affected soils. Soil washing incorporates methods from established mining, mineral processing, ore beneficiation, and wastewater treatment technologies, especially for full-scale systems. The process removes contaminants in one of two ways—by dissolving or suspending contaminants in the wash solution or by concentrating the contaminants into a smaller volume of soil through particle size separation, gravity separation, and attrition scrubbing. Generally, soil

washing is not a stand-alone technology but is commonly used with chemical separation and stabilization/solidification.

After excavation of up to 18 inches of compacted material and soil washing, backfilling with the washed material would be required. In order for the washed material to be used as backfill, confirmation sampling would be required to ensure the soil lead concentrations are below the action levels. An 18-inch lift of uncompacted, washed material covered by a 9-inch lift of uncompacted, imported topsoil was evaluated for this site. The clean topsoil would be revegetated and an erosion control blanket would be installed to reduce the potential for soil erosion.

Excavation and Soil Washing - Applicability

The target contaminants for soil washing are heavy metals, semi-volatile organic compounds, and fuels. Potential applications for the technology include metals recovery and inorganic contaminant extraction from coarse-grained soils. In general, soil washing is most effective on coarse sand and with reactive contaminants. Soil washing provides an environmentally proactive alternative to stabilization and landfilling.

Excavation and Soil Washing - Limitations

Soil washing alone may have the following disadvantages:

- Soils containing large amounts of clay and silt typically do not respond well to soil washing, especially if it is applied as a stand-alone technology.
- High humic content in soil may require pretreatment.
- Additional treatment of residues may involve the use of potentially hazardous chemicals (e.g., chelating solutions, acidic leaching agents, and pyrometallurgical processing) and effluents.
- The availability of water in Rush Valley to soil wash large volumes of soil may be difficult to acquire.
- The aqueous stream may require treatment at demobilization.
- The infrastructure required to implement this technology is significant.

Excavation and Soil Washing - Effectiveness and Implementability

Soil washing has been used extensively in Europe but has had limited use in the United States. Soil washing is highly effective in reducing the toxicity and mobility of contaminants at the excavation site and reducing the volume of contaminants to be treated further or transported to a disposal site. For other sites where the washed soil is not required to reach action levels, soil washing is moderately difficult to implement technically. However, at the Jacobs Smelter OU2 site, soil washing is rated as difficult to implement technically due to the remote area of the site and the infrastructure required for this technology. Administratively, soil washing would be difficult to implement, due to the limited use in the United States.

Excavation and Soil Washing - Cost

The average cost of soil washing, including excavation, ranges from $53 to $142 per cubic yard, depending on site-specific conditions, and the target waste quantity and concentration (FRTR, 2013c). The $53 per cubic yard cost is based on a large site (200,000 cubic yards), and the cost of $142 per cubic yard is based on a small site (10,000 cubic yards). The volume requiring treatment at the Jacobs Smelter OU2 site may be in excess of 43,000 cubic yards. Analytical costs for confirmation of lead concentration are $30 per soil sample. Assuming one sample for every 1,000 tons of washed soil, the analytical costs would be approximately $2,000. The estimated material and hauling cost for delivering clean topsoil to OU2 is $23 per ton. Placing and grading of the backfill and cover material is estimated at $9 per ton. The estimated cost for re-seeding the area is $300 per acre. The O&M costs for soil washing are lower than those for the *in-situ* technologies due to reduced monitoring requirements.

The capital costs for this technology are ranked as high and the O&M costs are ranked as low.

Excavation and Soil Washing - Recommendations

The cost for implementation of this technology is significantly higher than other technologies evaluated in this section, both *in-situ* and ex-situ. Furthermore, it is uncertain if soil washing could reduce the soil concentrations to below the lead action levels for use as backfill material. The technical implementability is therefore ranked as difficult. The complexity of the soil washing technology would be higher than other technologies due to the additional liquid waste stream and associated disposal difficulties. Therefore, this technology is not retained for detailed analysis in Section 5.0.

4.2.4 Excavation and Chemical Separation

Reduction/oxidation (REDOX) reactions chemically convert hazardous contaminants to non-hazardous or less toxic compounds that are more stable, less mobile, or inert. REDOX reactions involve the transfer of electrons from one compound to another. Specifically, one reactant is oxidized (loses electrons) and one is reduced (gains electrons). The oxidizing agents most commonly used for treatment of hazardous contaminants are ozone, hydrogen peroxide, hypochlorites, chlorine, and chlorine dioxide.

After excavation and chemical treatment, backfilling with the treated material would be required. In order for the treated material to be used as backfill, confirmation sampling would be required to ensure the soil lead concentration is less than the action levels. An 18-inch lift of uncompacted, treated material covered by a 9-inch lift of uncompacted, imported topsoil is suggested for this site. The clean topsoil would be revegetated and an erosion control blanket would be installed to reduce the potential for soil erosion.

Excavation and Chemical Separation - Applicability

The target contaminant group for chemical REDOX is inorganics, including metals. Enhanced systems are now being used more frequently to treat hazardous wastes in soils. A technology for removing heavy metals and organic contaminants from contaminated soil and sediment has been evaluated in pilot-scale tests. The process uses physical scouring and chemical leaching to remove contaminants from the soil.

Prior to chemical processing, treatability tests should be conducted to identify parameters such as water, alkaline metals, and humus content that could affect processing time and cost.

Excavation and Chemical Separation - Limitations

Factors that may limit the applicability and effectiveness of the process include:

- Incomplete oxidation or formation of intermediate contaminants may occur, depending upon the contaminants and oxidizing agents used.
- The process is not cost effective for high contaminant concentrations, because of the large amounts of oxidizing agent required.
- The process has not been shown to effectively treat lead and arsenic.

Excavation and Chemical Separation - Effectiveness and Implementability

The chemical separation technology has not been shown to be an effective treatment for lead and arsenic contaminated soil therefore, the effectiveness for this technology is rated as low. For heavy metals, chemical REDOX is difficult to implement technically and, as a treatment technique, moderately difficult to implement administratively.

Excavation and Chemical Separation - Cost

Estimated treatment costs range from $150 to $500 per cubic yard for this technology (FRTR, 2013d). Analytical costs for conformation of lead concentration are $30 per soil sample. Assuming one sample for every 1,000 tons of treated soil, the analytical costs would be approximately $2,000. The estimated material and hauling cost for delivering topsoil to OU2 is $23 per ton. Placing and grading of the backfill and cover material is estimated at $9 per ton. The estimated cost for seeding the backfilled material is $300 per acre. Although treatment costs are high, the O&M costs for chemical separation are lower than those for the *in-situ* technologies due to reduced monitoring requirements.

The capital costs for this technology are ranked as high and the O&M costs are ranked as low.

Excavation and Chemical Separation - Recommendations

This technique is not retained for detailed analysis in Section 5 due to the relatively unproven full-scale effectiveness in treating lead and arsenic contaminated soils.

4.3 Disposal Options

In this subsection, several options are evaluated for disposal of soils removed using the excavation, removal and backfill technology or the excavation, removal and regrading technology. The other technologies discussed above would not require disposal of soil. EPA has determined that waste generated from any removal or remedial action at Jacobs Smelter OU2 is Bevill-Exempt mining-related waste which allows for off-site disposal to the extent permitted by the regulations without RCRA Subtitle C compliance. However, some of the soils within OU2 contain leachable levels of lead above

5 milligrams per liter (mg/L) based on the Toxicity Characteristic Leachate Procedure (TCLP) and as such, many of the Subtitle C requirements are relevant and appropriate as described in Section 2.

This determination allows for soils that do not contain leachable levels of lead above 5 mg/L based on TCLP to be disposed of at any solid waste disposal facility in accordance with RCRA Subtitle D regulations. Therefore, both Class I and Class V Subtitle D landfills are an option for off-site disposal of soil containing concentrations that do not exceed TCLP limits.

Soils that contain leachable levels of lead above 5 mg/L based on TCLP are required to be disposed at a Subtitle C facility or within an on-site repository that meets the relevant and appropriate Subtitle C standards.

Off-site disposal options include transport to one of three Subtitle D landfills, including three Class V commercial landfills, as well as transport to a RCRA Subtitle C hazardous waste landfill. The original 2004 Final Revised FS also considered disposal in a Class I Municipal landfill (Tooele County Landfill), however, that landfill has since indicated that they are no longer a disposal option and will not be evaluated in this report.

Some advantages to off-site disposal include:

- Removal and off-site disposal of the materials permanently eliminates contaminated material from the site.
- This technology is applicable to all potential COCs.
- Disposal is a well-proven technology that is highly effective and fairly easy to implement and has been used at the Jacobs Smelter Site for the OU1 Remedial Action as well as two USEPA Removal Actions at OU2.

Some disadvantages to off-site disposal include:

- Disposal options for Bevill Exempt wastes may be limited and acceptance is dependent on landfill waste acceptance policies.
- CERCLA includes a statutory preference of treatment of contaminants and excavation and off-site disposal may be less administratively acceptable than other technologies.
- Transportation from the site to an appropriate disposal facility will affect remediation costs. The Jacobs Smelter Site is within approximately 80 miles of both a Subtitle C and a Subtitle D landfill.

4.3.1 Disposal of "Unleachable" Bevill Exempt Waste in a Subtitle D Class V Commercial Landfill

Under State of Utah solid waste rules (Utah Administrative Code [UAC] R315-301-2), a Class V landfill is a commercial landfill, which receives any non-hazardous solid waste for disposal. The advantage of a

Class V commercial landfill over a Class I municipal landfill is that a commercial facility is not restricted to accepting waste from a specific jurisdictional region. There are a number of Class V commercial facility options available for waste disposal.

The estimated cost for disposal at a Subtitle D commercial facility is $30.30 per ton. Transportations costs range from $12.50 to $35 per ton depending on distance and transportation mode (truck vs. rail).

This disposal option could be easily implemented technically and administratively for the soils that do not contain leachable levels of lead above 5 mg/l at OU2 and is retained for detailed analysis.

4.3.2 Disposal of "Leachable" Bevill Exempt Waste in a Subtitle C Hazardous Waste Landfill

Disposal of soil that contains leachable (i.e., has concentrations that exceed TCLP limits) levels of soil in a hazardous waste (Subtitle C) landfill is another disposal option. While disposal at any Subtitle C facility is possible, the Grassy Mountain facility located approximately 80 miles northwest of OU2 was contacted and that pricing was used as the basis for cost estimating. This facility has sufficient capacity to accept the volume of soil excavated from OU2 and was utilized for disposal of contaminated soil excavated during the OU1 Removal Action. Excavated soil would be transported via truck. The estimated cost for disposal of "leachable" Bevill Exempt soil is approximately $35 per ton of soil. Transportation by truck would be approximately $12.50 per ton of soil.

This disposal option could be easily implemented technically and would be moderately easy to implement administratively. This option is also retained for detailed analysis.

4.3.3 Disposal of Bevill Exempt Waste in an On-Site Repository

An additional option for disposal of the Bevill Exempt waste is the generation of an on-site repository. In an effort to evaluate the efficacy of an on-site repository, a preliminary design and cost estimate were completed (see Tables A-19 through A-22 of Appendix A and Appendix B for more details). Numerous preliminary design decisions were made in concert with the USEPA and UDEQ, as follows. The repository location was tentatively defined in Figure 3-9 and would reside on the former Waterman Smelter site. The area of the repository ranges between 2 and 2.5 acres, depending on the storage volume required for the waste generated by the anticipated clean-up.

Two options were considered for completing the on-site repository. The first option is an engineered cap design that complies with RCRA Subtitle C cap requirements for minimization of infiltration. As part of this option, a gravel armor layer would be installed as the top layer of the cap to prevent erosion and deter burrowing animals. The second option is a soil cover consisting of backfill and topsoil, as described in Section 4.1.1. As part of this option, an erosion control mat would be placed over the cover material after seeding with a native seed mix to encourage seed growth and prevent erosion. The final grading of both the RCRA Subtitle C cap and soil cover would be sloped to encourage run-off. A drainage ditch would be constructed around the repository to handle run-on flows from the mountains to the east. The drainage

ditch would be lined with rip-rap to prevent erosion. The repository area would be fenced in an effort to prevent unauthorized access. Upgradient and downgradient groundwater monitoring wells will be required if the regulatory agencies deem groundwater monitoring is necessary. For costing purposes it was assumed that groundwater monitoring would be conducted for both the RCRA Subtitle C cap and the soil cover options. It was assumed for the purposes of design and costing that the top 18 inches of soil within the proposed repository boundary is contaminated and would require placement in the repository. Furthermore, it was assumed that the soil at depths greater than 2 ½ feet could be used as clean backfill for constructing both the RCRA Subtitle C cap and soil cover repository options. A geotechnical investigation as well as additional sampling would be required before design could commence.

This disposal option is moderately effective, both short-term and long-term. The technical implementability is rated as difficult due to the lack of geotechnical and sampling information. A moderate rating for administrative implementability of the RCRA Subtitle C cap is given due to increased coordination within regulatory and state agencies as well as potential public opinion concerns (Table 4-2).

The on-site repository with soil cover could be more difficult to implement administratively because the soil cover does not meet the Subtitle C cap requirements for minimization of infiltration. The unit costs per ton of excavated soil ranges between $19 per ton for the soil cover option and $27 per ton for the RCRA Subtitle C cap option. Therefore the cost for the RCRA Subtitle C cap on-site repository disposal option is considered moderate and the cost for the soil cover on-site repository disposal option is considered low.

The on-site repositories with both RCRA Subtitle C cap and soil cover options are retained for detailed analysis due to their effectiveness and favorable cost

4.4 Technologies Retained for Detailed Analysis

Based on the discussions in Sections 4.1, 4.2, and 4.3, summary tables are provided in Tables 4-1 and 4-2 for the remedial technologies and disposal options. Three remedial technologies were retained for further analysis due to a combination of their effectiveness, implementability, and cost:

- Soil cover
- Excavation, removal, and backfill
- Excavation, removal, and regrading

The excavation, removal, and backfill technology and the excavation, removal, and regrading technology require disposal of the excavated soil. The soil cover technology does not require any disposal. Three disposal options were retained for analysis due to a combination of their effectiveness, implementability, and cost:

- Off-site disposal at Subtitle D Class V municipal landfill or Subtitle C landfill (to be conservative, the Subtitle C disposal costs are used in alternative analysis)
- On-site repository with a RCRA Subtitle C cap
- On-site repository with a soil cover

Section 5.0 evaluates alternatives, which may be a combination of technologies, and the associated disposal options in closer detail.

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5.0 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

Six alternatives have been developed for clean-up of the residential and non-residential (recreational) areas of Jacobs Smelter OU2 based on the screening of technologies reported in Section 4.0. One remedial alternative developed is the "no action" alternative, which is required by the National Oil and Hazardous Substances Contingency Plan (NCP). All of the alternatives, with the exception of the "no action" alternative, include institutional controls such as building permit restrictions, deed restrictions, or public awareness.

Following are the six remedial alternatives developed for Jacobs Smelter OU2. Each alternative applies to soils that exceed the site actions levels of 3,000 mg/kg lead for all soils in non-residential (recreational) areas, 500 mg/kg lead for surface soils (0-2 inches bgs) in residential areas, and 800 mg/kg for subsurface soils (2-12 inches bgs) in residential areas.

- Alternative 1 No action.
- Alternative 2 Excavate material in excess of site action levels to a depth of 18 inches, backfill with clean soil, and dispose of excavated materials off-site.
- Alternative 3 Cover material in excess of site action levels with clean soil.
- Alternative 4 Excavate material in excess of site action levels to a depth of 18 inches, backfill all areas with clean soil, and dispose of excavated materials in an on-site repository with a RCRA Subtitle C cap.
- Alternative 5 Excavate all material in excess of site action levels to the depth of contamination, backfill residential areas with clean soil, regrade non-residential areas, and dispose of excavated materials in an on-site repository with a RCRA Subtitle C cap.
- Alternative 6 Excavate all material in excess of site action levels to the depth of contamination, backfill residential areas with clean soil, regrade non-residential areas, and dispose of excavated materials in an on-site repository with a soil cover.

This section describes each alternative with respect to the volumes or areas of contaminated media to be addressed, the technologies to be used, and the performance requirements associated with the technologies. An assessment of each alternative against the CERCLA evaluation criteria is also presented. Section 6.0 compares the alternatives to assess the relative performance of each alternative with respect to seven of the nine CERCLA evaluation criteria.

5.1 Evaluation Criteria

The NCP requires that each of the remedial alternatives be evaluated using nine criteria developed to address the CERCLA requirements. These nine criteria are divided into three categories—threshold criteria, balancing criteria, and modifying criteria. Each alternative must meet the two threshold criteria

because these criteria relate directly to statutory findings that must ultimately be made in the ROD. The five balancing criteria represent primary principles upon which the analysis is based (e.g., long-term effectiveness and permanence). The two modifying criteria, state acceptance and community acceptance, are not determined during the FS process, but are determined through the review and public comment periods during the Proposed Plan and ROD development process. Therefore, a total of seven criteria, two threshold criteria and five balancing criteria, are evaluated as part of this detailed analysis of remedial alternatives.

The two threshold criteria are described below:

- Overall protection of human health and the environment—addresses whether the remedy provides adequate protection to human health and the environment and describes the methods for eliminating, reducing, or controlling the risks posed by each pathway through treatment, removal, engineering controls, or institutional controls.
- Compliance with ARARs—addresses compliance of the alternative with ARARs and other TBC state and federal environmental laws.

The five balancing criteria are described below:

- Long-term effectiveness and permanence—addresses the ability of the alternative to maintain reliable, permanent risk reduction to human health and the environment once the clean-up goals have been met.
- Reduction of toxicity, mobility, or volume through treatment—addresses the capability of the alternative to permanently and significantly reduce toxicity, mobility or volume of the hazardous substances. There is a statutory preference for treatments that reduce toxicity, mobility, or volume and against containment, cover, and excavation with off-site disposal of untreated waste (40CFR300.430(f)(1)(ii)(E)).
- Short-term effectiveness—addresses the effectiveness of alternatives in protecting human health and the environment during the construction and implementation of a remedy until response objectives are met.
- Implementability—addresses the technical and administrative feasibility of the remedy, including the availability of trained personnel, materials, equipment, and services required and any potential legal or administrative obstacles that may block implementation of the remedy.
- Cost—addresses not only the capital costs involved in construction/implementation of the remedy, but also the short- and long-term operations and maintenance costs calculated on a present-worth basis.

The two modifying criteria are described below:

- State acceptance—indicates the state's preferences among or concerns about the analyzed alternatives. The most common form of state acceptance of the selected remedial alternative is indicated by signature of the ROD.
- Community acceptance—reflects the community's apparent preference among or concerns about alternatives presented in the Proposed Plan. The responses to the public comments on the proposed alternatives are addressed in the Responsiveness Summary portion of the ROD.

The following sections discuss the remedial alternatives relative to the seven threshold and balancing criteria. As discussed in Section 3.0 (Table 3-2), the action level for residential soils is 500 mg/kg for surface lead concentrations and 800 mg/kg for subsurface lead concentrations over an exposure area and non-residential areas have an action level of 3,000 mg/kg lead over an exposure area. All alternatives, other than the "no action" alternative, involve the remediation of soils in excess of these action levels.

5.2 Remedial Alternatives

Six remedial alternatives were evaluated for implementation at the Jacobs Smelter OU2 site.

Figures 3-3 through 3-6 illustrate the areas with lead concentrations greater than the associated action levels in the B&B subdivision and the Waterman Smelter and ATV areas. The extent of clean-up of the residential B&B subdivision area is estimated as 5.4 acres, as shown in Figure 3-7. The extent of clean-up of the Waterman Smelter and ATV areas is estimated as 26.7 acres, as shown in Figure 3-8. Therefore, the total area with lead concentrations that exceed site action levels is estimated as 32.1 acres. Table 5-1 and Figure 5-1 summarize the six remedial alternatives for Jacobs Smelter OU2. Table 5-2 presents a comparison of the alternatives based on the NCP nine evaluation criteria.

5.2.1 Alternative 1 – No Action

According to CERCLA and the NCP, a "no action" alternative must be developed for all Superfund sites in order to provide a comparison between potential remedial alternatives and current conditions at a site. The "no action" alternative does not include any remedial action, any institutional controls on land-use, or other actions that incur costs.

5.2.1.1 Alternative 1 - Overall Protection of Human Health and the Environment

If Alternative 1 is implemented, the risk to human health and ecological receptors will remain unchanged for all properties. The human health and ecological risk/hazard for the properties containing soil contamination greater than associated action levels will not be mitigated or eliminated. Consequently, spread of and exposure to contaminated soils would still be of concern. Therefore, Alternative 1 does not meet the threshold criteria for protection of human health and the environment.

5.2.1.2 Alternative 1 - Compliance with ARARs

If Alternative 1 is implemented, the chemical-specific ARARs and TBC criteria discussed in Section 2.0 (Tables 2-1 and 2-4) will not be met because all of the contaminated soil will remain in place and there will be no reduction to exposure or contaminant transport. In addition, the action-specific ARARs (Table 2-2) will not be met. Rules pertaining to closure of a site (UAC R315-101 [Cleanup Action and Risk-Based Closure Standards], UAC R315-8-7 [Closure and Post Closure], and UAC 315-302-3 [General Closure and Post-Closure Requirements]) require that certain actions be taken to manage risks. No closure activities will occur as part of Alternative 1. Therefore, Alternative 1 will not meet the threshold criteria for compliance with ARARs. Location-specific ARARs (Table 2-3) are not applicable because no remedial action is involved.

5.2.1.3 Alternative 1 - Long-term Effectiveness and Permanence

The source is not removed in Alternative 1 and human health and ecological risk analyses have demonstrated that excess risk exists at Jacobs Smelter OU2 due to current site conditions. Therefore, none of the risk to human health or the environment will be mitigated. Alternative 1 provides no controls for the existing contamination and, therefore, is both inadequate and unreliable.

5.3.1.4 Alternative 1 - Reduction of Toxicity, Mobility, or Volume Through Treatment

In the no action alternative, no treatment process is used and, therefore, the composition of contamination is not altered. This alternative does not comply with the statutory preference for treatment. Alternative 1 also provides no reduction of toxicity, mobility, or volume.

5.2.1.5 Alternative 1 - Short-term Effectiveness

Current site conditions pose human health and ecological risks. Alternative 1 does not provide any controls or change site conditions. Therefore, short-term risks to human health and the environment are not mitigated under this alternative.

5.2.1.6 Alternative 1 - Implementability

No construction or operation is required to implement Alternative 1. Because monitoring effectiveness is also not required, it is not necessary to obtain approval from other agencies, and no equipment, specialists, materials, technologies, services, or capacities are required. Therefore, Alternative 1 is very easy to implement because there is no change from the current status.

5.2.1.7 Alternative 1 - Cost

There are, by definition, no capital or O&M costs associated with the Alternative 1. Therefore, the costs in Table 5-2 for Alternative 1 are $0 for capital cost and $0 for O&M.

5.2.2 Alternative 2 – Excavate Material in Excess of Site Action Levels to a Depth of 18 Inches, Backfill with Clean Soil, and Dispose of Excavated Materials Off-Site

The second remedial alternative for residential and non-residential areas involves a remedial action to meet ARARs for soils and decrease human health and ecological risks at OU2. A total of 32.1 acres of

contaminated soil would be addressed with this alternative. However, due to potentially impacted areas with only screening level data within the Jacobs Smelter OU2 boundaries, the affected non-residential acreage requiring remedial action may increase based on the results of further sampling in these areas performed during the pre-design phase of the project.

The components of Alternative 2 include clearing and grubbing all areas with soil concentrations exceeding 3,000 mg/kg lead in non-residential areas and 500 and 800 mg/kg in surface and subsurface soils in residential areas, followed by the excavation of up to 18 inches of contaminated soils (69,558 tons) and transporting all excavated soils to either a Subtitle D or Subtitle C landfill for disposal, depending on TCLP concentrations (Table 5-1). Because the TCLP concentration of all excavated soils is unknown and to be conservative, Subtitle C disposal pricing is used for costing purposes.

After excavation, a geotextile fabric will be placed on the areas excavated to 18 inches prior to backfill placement because of the potential for residual soil contamination at depths greater than 18 inches. The areas where soil is excavated to a depth of 6 inches will be filled with 9 inches of clean topsoil, allowing for 33% compaction to bring the fill material to grade. The areas where soil is excavated to a depth of 12 inches will be filled with 9 inches of un-contaminated backfill followed by 9 inches of clean topsoil, allowing for 33% compaction to bring the fill material to grade. The areas where soil is excavated to a depth of 18 inches will be filled with 18 inches of un-contaminated backfill followed by 9 inches of clean topsoil, allowing for 33% compaction to bring the fill material to grade. Approximately 44,555 tons of clean backfill will be placed over the excavated surfaces at Jacobs OU2. Approximately 52,419 tons of clean topsoil will be placed over the backfill at Jacobs OU2. The approximate land surface contour after machine roll compaction will be at the original grade. The affected areas of approximately 32.1 acres will be re-seeded with a native grass mix through a broadcast method followed by tilling and an erosion control blanket will be installed. Implementation of institutional controls may be required for areas where contamination remains beneath a depth of 18 inches. Annual O&M will be required as part of this alternative. O&M costs will include one annual site visit to ensure that institutional controls, such as fencing, signs, and erosion control, are in place and effective and to perform any necessary repairs. Annual O&M will also include a monitoring summary report to document the O&M activities performed during the reporting year.

5.2.2.1 Alternative 2 – Overall Protection of Human Health and the Environment

Excavation and disposal of up to 18 inches of soil followed by cover with clean backfill reduces the risk of direct contact, inhalation, or ingestion of the contaminated soil and, therefore, reduces human health and ecological risk to Jacobs Smelter OU2 receptors (Table 5-2). Landfill disposal further reduces the migration potential and the potential for future direct contact, ingestion, and inhalation of the contaminants because the material is collocated with a protective cover. Upgradient and downgradient groundwater monitoring performed by the landfill management helps ensure contamination from the disposal location is not adversely impacting the underlying groundwater. The clean backfill, vegetation, and the erosion control blanket also reduce the spread of contamination into the environment through wind and water erosion of any contaminated soil remaining at depth after excavation. However, the contamination that is left in-place beneath imported material may become exposed if the cover is

breached through excavation, erosion, or construction below the geotextile fabric. Therefore, Alternative 2 is partially dependent on institutional controls to meet the threshold criteria for protection of human health and the environment.

5.2.2.2 Alternative 2 – Compliance with ARARs

Excavation and disposal of the contaminated soil in a RCRA-approved landfill reduces the risk of direct contact to humans and protects against environmental exposure to soil with lead levels greater than 3,000 mg/kg in non-residential areas and 500 and 800 mg/kg in surface and subsurface soils in residential areas. Therefore, Alternative 2 will meet the Centers for Disease Control (CDC) TBC criteria (Table 2-4). However, potential contamination remaining in the soil below a depth of 18 inches will require special institutional controls governing use of properties in the remediated area of Jacobs Smelter OU2. By incorporating institutional controls, Alternative 2 meets all action-specific ARARs. Assuming control of fugitive dust is maintained during excavation and backfill operations, Alternative 2 meets all chemical-specific ARARs. Alternative 2 will not impact wetlands, floodplains, and historic properties, so the Jacobs Smelter OU2 location-specific ARARs will be met. Therefore, by controlling fugitive dust, avoiding location impacts, and implementing institutional controls, Alternative 2 meets the threshold criteria for compliance with ARARs.

5.2.2.3 Alternative 2 – Long-term Effectiveness and Permanence

In excavated areas, the threat posed by the top 18 inches of contaminated soil is permanently eliminated. However, residual risk would remain from lead-contaminated soil located below the clean backfilled soil in unexcavated subsoil at a depth beneath 18 inches. If additional earthmoving activities were required after implementation of Alternative 2 is complete, these activities could impact the protectiveness of the remedy. Institutional controls, such as environmental easements, local ordinances, and deed restrictions will be implemented and are designed to prevent exposure to contamination below the existing barrier of clean, imported backfill soils. However, the reliability of institutional controls is dependent on a proper monitoring and maintenance program and residents notifying proper authorities when disturbing remaining contaminated soil. A CERCLA five-year review would be required to evaluate long-term effectiveness because contaminants above action levels will remain on-site.

5.2.2.4 Alternative 2 – Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternative 2 provides no reduction of toxicity or volume for any of the excavated soils, but does reduce the mobility of the contaminants through disposal in a RCRA-permitted landfill, which will be managed to minimize contaminant transportation via erosion and leaching. This alternative does not comply with the statutory preference for treatment. The volume of residual contamination remaining after remediation will be low, as all soils above action levels in the top 18 inches will be removed. However, residual contamination below the excavated depth of 18 inches may remain.

5.2.2.5 Alternative 2 – Short-term Effectiveness

There will be no relocation of residents required during implementation of Alternative 2 to maintain protection of human health during implementation of this remedial alternative. Modified Level D personal protection (Tyvek suits, protective gloves, and protective boots) will be required for construction

workers. In conditions of excessive dust, Level C protection (respirators) for construction workers will be required to prevent inhalation or ingestion of lead-contaminated soil and dust. Dust generated during construction is a health and environmental concern, but state and Occupational Safety and Health Administration (OSHA) regulations governing dust suppression will be implemented (see chemical-specific ARARs in Table 2-1) to minimize impacts. The time required to complete the remedial action is approximately 12 months.

5.2.2.6 Alternative 2 – Implementability

Excavation and off-site disposal are relatively simple processes with proven procedures. It would be applicable for use in all areas of Jacobs Smelter OU2, should additional contamination be discovered in the future. However, if additional earthmoving activities were required after implementation of Alternative 2 is complete, these activities could impact the protectiveness of the remedy. It requires labor-intensive activities with little potential for automation. Standard clearing and grubbing as well as soil excavating, hauling, backfilling, and grading techniques are used in Alternative 2. The construction equipment, specialists, materials, technologies, services, and capacities needed are readily available from several Utah vendors. Significant coordination with local, state, and federal agencies will be required to obtain approval of a landfill suitable for disposal of the lead- and arsenic-contaminated soil. Coordination with local agencies will also be required during construction and to provide the necessary institutional controls as well as conduct long-term monitoring.

5.2.2.7 Alternative 2 – Cost

Site preparation to clear and grub the area prior to excavation is estimated at $550 per acre. The unit cost estimate for the excavation is $10 per ton, $12.50 per ton for transportation of excavated soil to the Subtitle C Landfill, and $35 per ton for disposal at the Subtitle C Landfill. Geotextile fabric procurement and installation is estimated at $0.98 per square yard. The costs for imported, clean backfill material and topsoil, including transportation and placement, are $23 and $32 per ton, respectively. Re-vegetation with a native grass seed mixture via a broadcast and harrow method is approximately $300 per acre. The cost for the erosion control blanket (material and installation) is estimated at $10,890 per acre. Additional details regarding the expenses incurred through implementation of this alternative or the sources for the cost estimates are included in Appendix A.

As indicated in Table 5-2, capital costs for Alternative 2 are $9,443,000 and 30 years of O&M will require a commitment of the present worth equivalent of $204,000 (see Appendix A for a detailed capital and O&M cost estimate). The total annual O&M cost for this alternative is $16,622 and includes annual inspection and maintenance of the clean cover material (to include clean soil placement, regrading, and reseeding if necessary) at $8,339 per year and the generation of an annual report by the O&M contractor at approximately $8,283 per year. The annual report documents the annual inspection and maintenance activities and reports the degree of success achieved implementing institutional controls for the site. These capital and O&M costs combine for a net present worth for Alternative 2 of $9,647,000.

5.2.3 Alternative 3 – Cover Material in Excess of Site Action Levels with Clean Soil

The third remedial alternative involves a remedial action to meet ARARs for soils and decrease human health and ecological risks at OU2. A total of 32.1 acres would be addressed with this alternative. However, due to potentially impacted areas with only screening level data within the Jacobs Smelter OU2 boundaries, the affected non-residential acreage requiring remedial action may increase based on the results of further sampling in these areas performed during the pre-design phase of the project.

The components of Alternative 3 include clearing and grubbing the 32.1 acres with contamination above 3,000 mg/kg lead in non-residential areas and 500 and 800 mg/kg lead in surface and subsurface soils in residential areas. The grubbed area would then be covered with a geotextile fabric followed by placing 9 inches of un-compacted clean backfill (55,040 tons) under 9 inches of un-compacted clean topsoil (52,419 tons). The geotextile fabric will serve to minimize mixing of the contaminated soil with the clean backfill and will also provide a visible layer to indicate the bottom of the soil cover. After machine roll compaction, the land surface contour will be approximately 12 to 14 inches above original grade. The affected areas will be re-seeded with a native grass mix through a broadcast method followed by tilling and an erosion control blanket will be installed. Implementation of annual O&M and institutional controls will be required as part of this alternative. O&M costs will include one annual site visit to ensure that institutional controls, such as fencing and erosion control, are in place and effective and to perform any necessary repairs. Annual O&M will also include a monitoring summary report to document the O&M activities performed during the reporting year.

5.2.3.1 Alternative 3 – Overall Protection of Human Health and the Environment

Placing a soil cover over contaminated soils reduces the risk of direct contact, inhalation, or ingestion of the contaminated soil and therefore, reduces human health and ecological risk by providing a barrier to accessible contamination (Table 5-2). The clean soil cover, vegetation, and the erosion control blanket also reduce the spread of contamination into the environment through wind and water erosion. However, the contaminated soil left in-place may become exposed if the cover is breached through excavation, erosion, or construction below the geotextile fabric. Additionally, conditions at OU2 are not conducive to robust re-vegetation, making erosion a real potential at the site. Therefore, Alternative 3 is dependent on the successful implementation of institutional controls in order to meet the threshold criteria for protection of human health and the environment.

5.2.3.2 Alternative 3 – Compliance with ARARs

With soil cover, there is the possibility of creating an exposure pathway if the cover is removed or the geotextile fabric is damaged. Therefore, special institutional controls to govern the use of properties in the remediated areas of Jacobs Smelter OU2 will be required to avoid air quality violations or exposure for residents and for children playing or adults working in the non-residential areas. A clean soil barrier compacted to 12 to 14 inches over all areas of concern allows Alternative 3 to meet the TBC criteria (Table 2-4). Assuming control of fugitive dust is maintained during remedy implementation, Alternative 3 meets all chemical-specific ARARs (Table 2-1). If appropriate institutional controls are implemented, Alternative 3 will meet all action-specific ARARs. Alternative 3 will not impact wetlands,

floodplains, and historic properties and will therefore meet the Jacobs Smelter OU2 location-specific ARARs. Therefore, by implementing institutional controls and avoiding location impacts, Alternative 3 meets the threshold criteria for compliance with ARARs.

5.2.3.3 Alternative 3 – Long-term Effectiveness and Permanence

The soil cover provides a barrier between the potential receptors and the existing lead- and arsenic-contaminated soil. However, the original lead- and arsenic-contaminated soil remains in place under the soil cover. If additional remediation were required after implementation of Alternative 3 is complete, the new remedial action would destroy the original soil cover remedy. The soil cover could also be breached during excavation or by animal activities such as burrowing. Institutional controls, such as environmental easements, local ordinances, and deed restrictions will be implemented to reduce exposure potential to contamination below the clean soil cover. However, the reliability of institutional controls is dependent on a proper monitoring and maintenance program and residents notifying proper authorities when disturbing remaining contaminated soil. If contaminated subsoil is exposed in an excavation, the property owner may be responsible for its disposal. Because contaminants above action levels would remain on-site, a CERCLA five-year review would be required to evaluate long-term effectiveness.

5.2.3.4 Alternative 3 – Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternative 3 uses no treatment process; therefore, the composition of contamination is not altered. Furthermore, this alternative does not comply with the statutory preference for treatment. Soil cover provides no reduction of either toxicity or volume, but does reduce the mobility of the contaminants via wind and water erosion. There will be residual contamination at Jacobs Smelter OU2 because no contaminated soils are removed or treated.

5.2.3.5 Alternative 3 – Short-term Effectiveness

There will be no relocation of residents required during implementation of Alternative 3 to maintain protection of human health during implementation of this remedial alternative. Modified Level D personal protection (Tyvek suits, protective gloves, and protective boots) will be required for construction workers. In conditions of excessive dust, Level C protection (respirators) for construction workers will be required to prevent inhalation or ingestion of lead-contaminated soil and dust. Dust generated during construction is a human health and environmental concern, but state and OSHA regulations governing dust suppression will be implemented (see chemical-specific ARARs in Table 2-1) to minimize impacts. The time required to complete the remedial action is approximately nine to 12 months.

5.2.3.6 Alternative 3 – Implementability

The placement of a soil cover is a relatively simple process with proven procedures. It would be implementable at all areas of OU2, should additional contamination be discovered in the future. Standard clearing and grubbing as well as soil hauling, placement, and grading techniques are used in Alternative 3. The construction equipment, specialists, materials, technologies, services, and capacities needed are readily available from several Utah vendors. Coordination with local agencies will be required during construction.

Routine monitoring of the soil cover will be required to identify issues that may lead to exposure of contaminated soil below the soil cover. Coordination with local agencies will be required during construction and to implement the necessary institutional controls and long-term monitoring.

5.2.3.7 Alternative 3 – Cost

Site preparation to clear and grub the area is $550 per acre. Geotextile fabric procurement and installation is estimated at $0.98 per square yard. The costs for imported, clean backfill material and topsoil including transportation and placement are $23 and $32 per ton, respectively. Re-vegetation with a native grass seed mixture via a broadcast and harrow method is approximately $300 per acre. The cost for the erosion control blanket (material and installation) is estimated at $10,890 per acre. Additional details regrading the expenses incurred through implementation of this alternative or the sources for the cost estimates are included in Appendix A.

As indicated in Table 5-2, capital costs for Alternative 3 are $5,056,000 and 30 years of O&M will require a commitment of the present worth equivalent of $222,000 (see Appendix A for a detailed capital and O&M cost estimate). The annual O&M cost for this alternative is $18,052 and includes annual inspection and maintenance of the clean cover material (to include clean soil placement, regrading, and reseeding if necessary) at $9,769 per year and the generation of an annual report by the O&M contractor at approximately $8,283 per year. The annual report documents the annual inspection and maintenance activities for the site and assesses success of institutional controls. These capital and O&M costs combine for a net present worth for Alternative 3 of $5,278,000.

5.2.4 Alternative 4 – Excavate Material in Excess of Site Action Levels to a Depth of 18 Inches, Backfill All Areas with Clean Soil, and Dispose of Excavated Materials in an On-Site Repository with a RCRA Subtitle C Cap

The fourth remedial alternative involves a remedial action to meet ARARs for soils and decrease human health and ecological risks at OU2. A total of 32.1 acres would be addressed with this alternative, including the area for the on-site repository. However, due to potentially impacted areas with only screening level data within the Jacobs Smelter OU2 boundaries, the affected acreage requiring remedial action may increase based on the results of further sampling in these areas performed during the pre-design phase of the project. Due to the lack of geotechnical information in the area proposed for the on-site repository, investigational activities will be required in the pre-design phase of the project to validate the feasibility of the on-site repository approach presented in this alternative.

The components of Alternative 4 include clearing and grubbing all areas with soil concentrations exceeding 3,000 mg/kg lead in non-residential areas and 500 and 800 mg/kg in surface and subsurface soils in residential areas, followed by the excavation of up to 18 inches of contaminated soils (63,067 tons) and transporting all excavated soils to the on-site repository (see Table 5-1). A geotextile fabric will be placed on the areas excavated to 18 inches prior to backfill placement because of the potential for residual soil contamination to be present at depths greater than 18 inches. The areas where soil is excavated to a depth of 6 inches will be filled with 9 inches of clean topsoil, allowing for

33% compaction to bring the fill material to grade. The areas where soil is excavated to a depth of 12 inches will be filled with 9 inches of un-contaminated backfill followed by 9 inches of clean topsoil, allowing for 33% compaction to bring the fill material to grade. The areas where soil was excavated to a depth of 18 inches will be filled with 18 inches of un-contaminated backfill followed by 9 inches of clean topsoil, allowing for 33% compaction to bring the fill material to grade. Approximately 38,693 tons of un-contaminated backfill will be placed over the excavated surfaces at Jacobs OU2. Approximately 49,151 tons of clean topsoil will be placed over the backfill at Jacobs OU2. The approximate land surface contour after machine roll compaction will be at the original grade. The affected areas will be re-seeded with a native grass mix through a broadcast method followed by tilling and an erosion control blanket will be installed.

The proposed on-site repository would be situated on the slope of the former Waterman Smelter property, as shown in Figure 3-9, and would be completed with a RCRA Subtitle C cap. The preliminary design of the on-site repository is described in Appendix B. The on-site repository construction would disturb an area of 2 acres. An additional 2 acres of work area is estimated to stockpile soil and efficiently move heavy equipment into and out of the area. Assuming that soil excavated for repository construction from below the top 2½ feet is clean, more than sufficient volume of material would be generated from the excavation of the repository to use as backfill in construction of the RCRA Subtitle C cap. For cost estimating purposes, it is assumed that the excess clean soils generated by the excavation of the on-site repository will only be used for the backfill layer of the RCRA Subtitle C cap and will not be used to backfill the excavated areas outside of the on-site repository. The repository RCRA Subtitle C cap design used to develop the cost estimate includes the following layers from top to bottom: 6 inches of gravel armor, 18 inches of common backfill, 4-ounce geotextile fabric, 12 inches of drainage material, 4-ounce geotextile fabric, and a geosynthetic clay liner. The repository design will include a drainage ditch, fencing around the repository, and five monitoring wells. Two upgradient and three downgradient monitoring wells are proposed to ensure that contamination from the on-site repository is not adversely impacting the underlying groundwater. The cost of the on-site repository is provided in Appendix A.

Implementation of annual O&M and institutional controls for areas where contamination remains beneath a depth of 18 inches will be required as part of this alternative. O&M costs will include one annual site visit to ensure that institutional controls, such as fencing and erosion control, are in place and effective and to perform any necessary repairs. The annual O&M visits will also include groundwater sampling of the monitoring wells. The first year of groundwater monitoring will consist of sampling the two upgradient wells on eight separate events and the three downgradient wells on four separate events, as per UDEQ UAC R315-308-2(5)(a). After the first year, groundwater monitoring will consist of sampling the two upgradient wells and three downgradient wells on a semi-annual basis, as per UDEQ UAC R315-308-2(5)(b). Annual O&M will also include a monitoring summary report to document the O&M activities performed during the reporting year.

5.2.4.1 Alternative 4 – Overall Protection of Human Health and the Environment

Excavation and disposal of up to the top 18 inches of soil followed by cover with clean backfill reduces the risk of direct contact, inhalation, or ingestion of the contaminated soil and, therefore, reduces human

health and ecological risk to Jacobs Smelter OU2 receptors (see Table 5-2). Disposal in the on-site repository further reduces the migration potential and the potential for future direct contact, ingestion, and inhalation of the contaminants because the material is collocated with a protective cover. Upgradient and downgradient groundwater monitoring helps ensure contamination from the disposal location is not adversely impacting the underlying groundwater. The clean backfill, vegetation, and the erosion control blanket also reduce the spread of contamination into the environment through wind and water erosion of any contaminated soil remaining at depth after excavation. However, the contaminated material left in the on-site repository and in-place beneath imported material may become exposed if the RCRA Subtitle C cap is breached through excavation, erosion, or construction below the geotextile fabric. Therefore, Alternative 4 is partially dependent on institutional controls to meet the threshold criteria for protection of human health and the environment.

5.2.4.2 Alternative 4 – Compliance with ARARs

Excavation and disposal of the contaminated soil in an on-site repository reduces the risk of direct contact to humans and protects against environmental exposure to soil with lead levels greater than 3,000 mg/kg in non-residential areas and 500 and 800 mg/kg in surface and subsurface soils in residential areas. Therefore, Alternative 4 will meet the CDC TBC criteria (Table 2-4). However, potential contamination remaining in the soil below a depth of 18 inches will require special institutional controls governing use of properties in the remediated area of Jacobs Smelter OU2. In addition, potential exposure to contaminated soil in the on-site repository will require annual O&M and institutional controls. By incorporating institutional controls and annual O&M, Alternative 4 meets all action-specific ARARs. Assuming control of fugitive dust is maintained during remedy implementation, Alternative 4 meets all chemical-specific ARARs. Alternative 4 will not impact wetlands, floodplains, and historic properties, so the Jacobs Smelter OU2 location-specific ARARs will be met. Therefore, by controlling fugitive dust, avoiding location impacts, and implementing institutional controls and long-term monitoring, Alternative 4 meets the threshold criteria for compliance with ARARs.

5.2.4.3 Alternative 4 – Long-term Effectiveness and Permanence

In excavated areas, the threat posed by the top 18 inches of contaminated soil is removed and consolidated on site to minimize exposure to Jacobs Smelter OU2 receptors. However, residual risk would remain from lead-contaminated soil located in the on-site repository and below the clean backfilled soil in unexcavated subsoil at a depth beneath 18 inches. If additional earthmoving activities were required after implementation of Alternative 4 is complete, these activities could impact the protectiveness of the remedy. Institutional controls, such as environmental easements, local ordinances, and deed restrictions will be implemented and are designed to prevent exposure to contamination below the existing barrier of clean, imported backfill soils. However, the reliability of institutional controls is dependent on a proper monitoring and maintenance program and residents notifying proper authorities when disturbing remaining contaminated soil. A CERCLA five-year review would be required to evaluate long-term effectiveness because contaminants above action levels will remain on-site.

5.2.4.4 Alternative 4 – Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternative 4 provides no reduction of toxicity or volume for any of the excavated soils, but does reduce the mobility of the contaminants through disposal in the on-site repository with a RCRA Subtitle C cap, which will be managed to minimize contaminant transportation via erosion and leaching. This alternative does not comply with the statutory preference for treatment. Alternative 4 provides no reduction of toxicity or volume for any of the excavated soils. The volume of residual contamination remaining after remediation will be low, because all soils above action levels in the top 18 inches will be removed and the on-site repository will be covered with a RCRA Subtitle C cap. However, residual contamination may remain below the excavated depth of 18 inches outside the area of the on-site repository.

5.2.4.5 Alternative 4 – Short-term Effectiveness

There will be no relocation of residents required during implementation of Alternative 4 to maintain protection of human health during implementation of this remedial alternative. Modified Level D personal protection (Tyvek suits, protective gloves, and protective boots) will be required for construction workers. In conditions of excessive dust, Level C protection (respirators) for construction workers will be required to prevent inhalation or ingestion of lead-contaminated soil and dust. Dust generated during construction would be greater than Alternatives 1 through 3 due to the generation of an on-site repository and is a human health and environmental concern, but state and OSHA regulations governing dust suppression will be implemented (see chemical-specific ARARs in Table 2-1) to minimize impacts. The time required to complete the remedial action is approximately 21 to 24 months.

5.2.4.6 Alternative 4 – Implementability

Excavation and on-site disposal are relatively simple processes with proven procedures. It would be applicable for use in all areas of Jacobs Smelter OU2. Excavation requires labor-intensive activities with little potential for automation. Standard clearing and grubbing as well as soil excavating, hauling, backfilling, and grading techniques are used in Alternative 4. The construction equipment, specialists, materials, technologies, services, and capacities needed are readily available from several Utah vendors. Construction of the on-site repository is rated as difficult to implement technically due to the lack of geotechnical and analytical data in the area and at the proposed repository depth.

The on-site repository will be closed after implementation of Alternative 4. Thus, if additional contamination is discovered and additional excavation is required in the future, the excavated material would have to be transported to an off-site facility for disposal.

Significant coordination with local, state, and federal agencies will be required to obtain approval for a suitable repository location for the disposal of the lead-contaminated soil. Coordination with local agencies will also be required during construction and to provide the necessary institutional controls as well as conduct long-term monitoring.

5.2.4.7 Alternative 4 – Cost

Site preparation to clear and grub the area prior to excavation is estimated at $550 per acre. The cost for generation of the on-site repository is $1,698,450, which includes the installation of monitoring wells.

The unit cost estimate for the excavation is $10 per ton and the unit cost for transporting contaminated soil to the on-site repository is $4 per ton. The costs for imported, clean backfill material and topsoil, including transportation and placement, are $23 and $32 per ton, respectively. Geotextile fabric procurement and installation is estimated at $0.98 per square yard. Re-vegetation with a native grass seed mixture via a broadcast and harrow method is approximately $300 per acre. The cost for the erosion control blanket (material and installation) is estimated at $10,890 per acre. Additional details regrading the expenses incurred through implementation of this alternative or the sources for the cost estimates are included in Appendix A.

As indicated in Table 5-2, capital costs for Alternative 4 are $7,647,000 and 30 years of O&M will require a commitment of the present worth equivalent of $417,000 (see Appendix A for a detailed capital and O&M cost estimate). The first year of groundwater monitoring includes eight samples from each of two upgradient wells and four samples from each of three downgradient wells (per Utah Administative Code [UAC] R315-308-2). The groundwater samples will be analyzed for lead and arsenic. The total expenditure for this initial sampling is $49,988. In the years that follow, semi-annual groundwater monitoring is required for all five wells totaling $10,979 per year. The O&M cost for the first year of this alternative is $70,042; for each following year the annual O&M is $31,033. O&M includes: annual inspection of the backfilled areas and the RCRA Subtitle C cap repository; eight groundwater sampling events for the first year and semi-annual events thereafter; maintenance of the RCRA Subtitle C cap repository and backfill material (to include clean soil placement, regrading, and reseeding if necessary); and production of an annual report. The annual report documents the analytical results from the groundwater sampling, annual inspection and maintenance activities, and reports the degree of success achieved implementing institutional controls for the site. These capital and O&M costs combine for net present worth for Alternative 4 of $8,065,000.

5.2.5 Alternative 5 – Excavate All Material in Excess of Site Action Levels to the Depth of Contamination, Backfill Residential Areas with Clean Soil, Regrade Non-Residential Areas, and Dispose of Excavated Material in On-Site Repository with a RCRA Subtitle C cap

The fifth remedial alternative involves a remedial action to meet ARARs for soils and decrease human health and ecological risks at OU2. A total of 32.1 acres would be addressed with this alternative, including the area for the on-site repository. However, due to potentially impacted areas with only screening level data within the Jacobs Smelter OU2 boundaries, the affected acreage requiring remedial action may increase based on the results of further sampling in these areas performed during the pre-design phase of the project. Due to the lack of geotechnical information in the area proposed for the on-site repository, investigational activities will be required in the pre-design phase of the project to validate the feasibility of the on-site repository approach presented in this alternative.

The components of Alternative 5 include clearing and grubbing all areas with soil concentrations exceeding 3,000 mg/kg lead in non-residential areas and 500 and 800 mg/kg in surface and subsurface soils in residential areas, followed by the excavation of contaminated soils and transporting all excavated soils to the on-site repository (see Table 5-1). Excavation in the residential areas will be conducted to a

depth of 18 inches bgs and will be backfilled as described in Alternatives 2 and 4. The non-residential excavated areas will be regraded to match the surrounding grade. Since the non-residential areas will not be backfilled, excavation will remove all contaminated soils to reduce the potential for exposure. The vertical extent of contamination in the non-residential areas would be determined based on the results of further sampling during the pre-design phase of the project. However, for cost estimating purposes, it is assumed that an additional 12 inches will be excavated in the non-residential areas where the vertical extent of contamination has not been fully defined (i.e., areas with soil contamination found at 18 inches bgs). The excavation volume for this alternative is estimated at 78,271 tons and includes 61,943 tons of contaminated soil in the top 18 inches and 16,327 tons for removing additional 12-inches of contamination below 18 inches bgs.

A 9-inch layer of clean topsoil will be placed on the excavated non-residential areas following regrading. Approximately 39,632 tons of clean topsoil will be placed in the non-residential areas and will be compacted to bring the fill material to grade. The residential areas will be backfilled with 9,121 tons of clean backfill and 8,791 tons of topsoil. The affected areas will be re-seeded with a native grass mix through a broadcast method followed by tilling and an erosion control blanket will be installed.

The proposed on-site repository would be situated on the slope of the former Waterman Smelter property, as shown in Figure 3-9. The on-site repository construction would disturb an area of 2.4 acres. An additional 2 acres of work area is estimated to stockpile soil and efficiently move heavy equipment into and out of the area. Assuming that soil excavated for repository construction from below the top 2½ feet is clean, more than sufficient volume of material would be generated from the excavation of the repository to use as backfill in construction of the RCRA Subtitle C cap. For cost estimating purposes, it is assumed that the excess clean soils generated by the excavation of the on-site repository will only be used for the backfill layer of the RCRA Subtitle C cap and will not be used to backfill the excavated areas outside of the on-site repository. The repository RCRA Subtitle C cap design used to develop the cost estimate includes the following layers from top to bottom: 6 inches of gravel armor, 18 inches of common backfill, 4-ounce geotextile fabric, 12 inches of drainage material, 4-ounce geotextile fabric, and a geosynthetic clay liner. The repository design will include a drainage system, fencing around the repository, and five monitoring wells. Two upgradient and three downgradient monitoring wells are proposed to ensure that contamination from the on-site repository is not adversely impacting the underlying groundwater. The cost of the on-site repository is provided in Appendix A.

Implementation of annual O&M and institutional controls for areas where contamination remains beneath a depth of 18 inches will be required as part of this alternative, such as residential areas and the on-site repository. O&M costs will include one annual site visit to ensure that institutional controls, such as fencing and erosion control, are in place and effective and to perform any necessary repairs. The annual O&M visits will also include groundwater sampling of the monitoring wells. The first year of groundwater monitoring will consist of sampling the two upgradient wells on eight separate events and the three downgradient wells on four separate events, as per UDEQ UAC R315-308-2(5)(a). After the first year, groundwater monitoring will consist of sampling the two upgradient wells and three downgradient wells on a semi-annual basis, as per UDEQ UAC R315-308-2(5)(b). Annual O&M will

also include a monitoring summary Report to document the O&M activities performed during the reporting year.

5.2.5.1 Alternative 5 – Overall Protection of Human Health and the Environment

In the non-residential areas, the complete removal of contaminated soil eliminates the risk of direct contact, inhalation, or ingestion of the contaminated soil and, therefore, eliminates the human health and ecological risk to Jacobs Smelter OU2 receptors. In the residential areas, excavation and disposal of up 18 inches of contaminated soil followed by cover with clean backfill reduces the human health and ecological risk, but does not eliminate risk in those areas (see Table 5-2). The clean backfill, vegetation, and the erosion control blanket in the residential areas reduce the spread of contamination into the environment through wind and water erosion of any contaminated soil remaining at depths greater than 18 inches. Disposal in the on-site repository also reduces the migration potential and the potential for future direct contact, ingestion, and inhalation of the contaminants because the material is collocated with a protective cover. Upgradient and downgradient groundwater monitoring helps ensure that contamination from the disposal location is not adversely impacting the underlying groundwater. However, the contaminated material left in the on-site repository and in the residential areas may become exposed if the protective covers are breached through excavation, erosion, or construction below the geotextile fabric. Therefore, Alternative 5 is partially dependent on institutional controls to meet the threshold criteria for protection of human health and the environment.

5.2.5.2 Alternative 5 – Compliance with ARARs

Excavation and disposal of the contaminated soil in an on-site repository reduces the risk of direct contact to humans and protects against environmental exposure to soil with lead levels greater than 3,000 mg/kg in non-residential areas and 500 and 800 mg/kg in surface and subsurface soils in residential areas. Therefore, Alternative 5 will meet the CDC TBC criteria (Table 2-4). However, potential contamination remaining in the soil below a depth of 18 inches in the residential areas will require special institutional controls governing use of the remediated residential properties of Jacobs Smelter OU2. In addition, potential exposure to contaminated soil in the on-site repository will require annual O&M and institutional controls. By incorporating institutional controls and annual O&M, Alternative 5 meets all action-specific ARARs. Assuming control of fugitive dust is maintained during remedy implementation, Alternative 5 meets all chemical-specific ARARs. Alternative 5 will not impact wetlands, floodplains, and historic properties, so the Jacobs Smelter OU2 location-specific ARARs will be met. Therefore, by controlling fugitive dust, avoiding location impacts, and implementing institutional controls and long-term monitoring, Alternative 5 meets the threshold criteria for compliance with ARARs.

5.2.5.3 Alternative 5 – Long-term Effectiveness and Permanence

The top 18 inches of contaminated soil in residential areas and all the contaminated soil in the non-residential areas are removed and consolidated on site to minimize exposure to Jacobs Smelter OU2 receptors. However, residual risk would remain from lead-contaminated soil located in the on-site repository and in the residential areas with unexcavated subsoil beneath 18 inches bgs. Institutional controls, such as environmental easements, local ordinances, and deed restrictions, will be implemented in those areas and are designed to prevent exposure to contamination left on site. However, the reliability

of institutional controls is dependent on a proper monitoring and maintenance program and residents notifying proper authorities when disturbing remaining contaminated soil. A CERCLA five-year review would be required to evaluate long-term effectiveness because contaminants above action levels will remain on-site.

5.2.5.4 Alternative 5 – Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternative 5 provides no reduction of toxicity or volume for any of the excavated soils, but does reduce the mobility of the contaminants through disposal in the on-site repository, which will be managed to minimize contaminant transportation via erosion and leaching. This alternative does not comply with the statutory preference for treatment. Alternative 5 provides no reduction of toxicity or volume for any of the excavated soils. The volume of residual contamination remaining after remediation will be low, because all soils above action levels will be removed from the non-residential areas and from the top 18 inches in the residential areas. The removed soils will be consolidated in the on-site repository, which will be capped with a RCRA Subtitle C cap designed to minimize infiltration.

5.2.5.5 Alternative 5 – Short-term Effectiveness

There will be no relocation of residents required during implementation of Alternative 5 to maintain protection of human health during implementation of this remedial alternative. Modified Level D personal protection (Tyvek suits, protective gloves, and protective boots) will be required for construction workers. In conditions of excessive dust, Level C protection (respirators) for construction workers will be required to prevent inhalation or ingestion of lead-contaminated soil and dust. Dust generated during construction would be greater than Alternatives 1 through 3 due to the generation of an on-site repository and is a human health and environmental concern, but state and OSHA regulations governing dust suppression will be implemented (see chemical-specific ARARs in Table 2-1) to minimize impacts. The time required to complete the remedial action is approximately 24 months.

5.2.5.6 Alternative 5 – Implementability

Excavation and on-site disposal are relatively simple processes with proven procedures that are applicable for use in all areas of Jacobs Smelter OU2. Regrading is only applicable in the non-residential areas because it will not bring excavated areas to pre-existing grades. In the residential areas, where regrading is not applicable, the excavated areas will be backfilled and returned to the original grade. Excavation and regrading require labor-intensive activities with little potential for automation. Standard clearing and grubbing as well as soil excavating, hauling, backfilling, and grading techniques are used in Alternative 5. The construction equipment, specialists, materials, technologies, services, and capacities needed are readily available from several Utah vendors. Construction of the on-site repository is rated as difficult to implement technically due to the lack of geotechnical and analytical data in the area and at the proposed repository depth.

The on-site repository will be closed after implementation of Alternative 5. Thus, if additional contamination is discovered and additional excavation is required in the future, the excavated material would have to be transported to an off-site facility for disposal.

Significant coordination with local, state, and federal agencies will be required to obtain approval for a suitable repository location for the disposal of the lead-contaminated soil. Coordination with local agencies will also be required during construction and to provide the necessary institutional controls as well as conduct long-term monitoring.

5.2.5.7 Alternative 5 – Cost

Site preparation to clear and grub the area prior to excavation is estimated at $550 per acre. The cost for generation of the on-site repository with a RCRA Subtitle C cap is $2,052,466, which includes the installation of monitoring wells. The unit cost estimate for the excavation is $10 per ton and the unit cost for transporting contaminated soil to the on-site repository is $4 per ton. The costs for regrading the excavated non-residential areas is $3 per square yard. The costs for imported, clean backfill material and topsoil, including transportation and placement, are $23 and $32 per ton, respectively. Geotextile fabric procurement and installation is estimated at $0.98 per square yard. Re-vegetation with a native grass seed mixture via a broadcast and harrow method is approximately $300 per acre. The cost for the erosion control blanket (material and installation) is estimated at $10,890 per acre. Additional details regrading the expenses incurred through implementation of this alternative or the sources for the cost estimates are included in Appendix A.

As indicated in Table 5-2, capital costs for Alternative 5 are $7,956,000 and 30 years of O&M will require a commitment of the present worth equivalent of $371,000 (see Appendix A for a detailed capital and O&M cost estimate). The first year of groundwater monitoring includes eight samples from each of two upgradient wells and four samples from each of three downgradient wells (per UAC R315-308-2). The groundwater samples will be analyzed for lead and arsenic. The total expenditure for this initial sampling is $49,988. In the years that follow, semi-annual groundwater monitoring is required for all five wells totaling $10,979 per year. The O&M cost for the first year of this alternative is $66,241; for each following year the annual O&M is $27,232. O&M includes: annual inspection of the excavated areas and RCRA Subtitle C cap repository; eight groundwater sampling events in the first year and semi-annual events thereafter; maintenance of the RCRA Subtitle C cap repository and topsoil material (to include clean topsoil placement and reseeding if necessary); and production of an annual report. The annual report documents the analytical results from the groundwater sampling, annual inspection and maintenance activities, and reports the degree of success achieved implementing institutional controls for the site. These capital and O&M costs combine for net present worth for Alternative 5 of $8,326,000.

5.2.6 Alternative 6 – Excavate All Material in Excess of Site Action Levels to the Depth of Contamination, Backfill Residential Areas with Clean Soil, Regrade Non-Residential Areas, and Dispose of Excavated Material in an On-Site Repository with a Soil Cover

The sixth remedial alternative involves a remedial action to meet ARARs for soils and decrease human health and ecological risks at OU2. A total of 32.1 acres would be addressed with this alternative, including the area for the on-site repository. However, due to potentially impacted areas with only screening level data within the Jacobs Smelter OU2 boundaries, the affected acreage requiring remedial action may increase based on the results of further sampling in these areas performed during the

pre-design phase of the project. Due to the lack of geotechnical information in the area proposed for the on-site repository, investigational activities will be required in the pre-design phase of the project to validate the feasibility of the on-site repository approach presented in this alternative.

The components of Alternative 6 are the same components described for Alternative 5 in Section 5.2.5. The only difference between Alternatives 5 and 6 is the on-site repository design. The on-site repository for Alternative 6 would be completed with a soil cover consisting of a 9-inch lift of uncompacted backfill overlaid by a 9-inch lift of uncompacted topsoil. The cover would be placed over a 4-oz geotextile fabric and will be compacted to a 12-inch soil cover. The proposed on-site repository in Alternative 6 would be situated on the slope of the former Waterman Smelter property, as shown in Figure 3-9. The on-site repository construction would disturb an area of 2.3 acres. An additional 2 acres of work area is estimated to stockpile soil and efficiently move heavy equipment into and out of the area. Assuming that soil excavated for repository construction from below the top 2 ½ feet is clean, more than sufficient volume of material would be generated from the excavation of the repository to use as backfill in construction of the soil cover. For cost estimating purposes, it is assumed that the excess clean soils generated by the excavation of the on-site repository will only be used for the backfill layer of the soil cover and will not be used to backfill the excavated areas outside of the on-site repository. As in Alternative 5, the repository design will include a drainage system, fencing around the repository, and five monitoring wells. The cost of the on-site repository is provided in Appendix A.

The O&M assumptions for Alternative 6 are the same described in Alternative 5.

5.2.6.1 Alternative 6 – Overall Protection of Human Health and the Environment

In the non-residential areas, the complete removal of contaminated soil eliminates the risk of direct contact, inhalation, or ingestion of the contaminated soil and, therefore, eliminates the human health and ecological risk to Jacobs Smelter OU2 receptors. In the residential areas, excavation and disposal of up to 18 inches of contaminated soil followed by cover with clean backfill reduces the human health and ecological risk, but does not eliminate risk in those areas. The clean backfill,vegetation, and the erosion control blanket in the residential areas reduce the spread of contamination into the environment through wind and water erosion of any contaminated soil remaining at depths greater than 18 inches. Disposal in the on-site repository also reduces the migration potential and the potential for future direct contact, ingestion, and inhalation of the contaminants because the material is collocated with a protective cover. While the soil cover in Alternative 6 will reduce the potential for future direct contact, ingestion, and inhalation, it will only partly reduce the migration potential because it is not designed to minimize infiltration. Upgradient and downgradient groundwater monitoring will be conducted to evaluate the impact of contamination from the disposal location to the underlying groundwater. The contaminated material left in the on-site repository and in-place in the residential areas may become exposed if the cover is breached through excavation, erosion, or construction below the geotextile fabric. Therefore, Alternative 6 is partially dependent on institutional controls to meet the threshold criteria for protection of human health and the environment.

5.2.6.2 Alternative 6 – Compliance with ARARs

Excavation and disposal of the contaminated soil in an on-site repository reduces the risk of direct contact to humans and protects against environmental exposure to soil with lead levels greater than 3,000 mg/kg in non-residential areas and 500 and 800 mg/kg in surface and subsurface soils in residential areas. Therefore, Alternative 6 will meet the CDC TBC criteria (Table 2-4). However, potential contamination remaining in the soil below a depth of 18 inches in the residential areas will require special institutional controls governing use of the remediated residential properties of Jacobs Smelter OU2. In addition, potential exposure to contaminated soil left on-site in the on-site repository will require post closure care, annual O&M, and institutional controls. Because soils are moved and contained within an area of contamination (AOC), hazardous waste ARARs are not triggered; and by incorporating institutional controls, post closure care, and annual O&M, Alternative 6 meets all action-specific ARARs. Assuming control of fugitive dust is maintained during remedy implementation, Alternative 6 meets all chemical-specific ARARs. Alternative 6 will not impact wetlands, floodplains, and historic properties, so the Jacobs Smelter OU2 location-specific ARARs will be met. Therefore, by controlling fugitive dust, avoiding location impacts, and implementing institutional controls and long-term monitoring, Alternative 6 meets the threshold criteria for compliance with ARARs.

5.2.6.3 Alternative 6 – Long-term Effectiveness and Permanence

The top 18 inches of contaminated soil in residential areas and all the contaminated soil in the non-residential areas are removed and consolidated on site to minimize exposure to Jacobs Smelter OU2 receptors. However, residual risk would remain from lead-contaminated soil located in the on-site repository and in the residential areas with unexcavated subsoil beneath 18 inches bgs. Institutional controls, such as environmental easements, local ordinances, and deed restrictions, will be implemented in those areas and are designed to prevent exposure to contamination left on site. However, the reliability of institutional controls is dependent on a proper monitoring and maintenance program and residents notifying proper authorities when disturbing remaining contaminated soil. A CERCLA five-year review would be required to evaluate long-term effectiveness because contaminants above action levels will remain on-site.

5.2.6.4 Alternative 6 – Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternative 6 provides no reduction of toxicity or volume for any of the excavated soils, but does reduce the mobility of the contaminants through disposal in the on-site repository, which will be managed to minimize contaminant transportation via erosion. However, the soil cover in Alternative 6 does not minimize mobility of the contaminants via leaching. This alternative does not comply with the statutory preference for treatment. Alternative 6 provides no reduction of toxicity or volume for any of the excavated soils. The volume of residual contamination remaining after remediation will be low, because all soils above action levels will be removed from the non-residential areas and from the top 18 inches in the residential areas.

5.2.6.5 Alternative 6 – Short-term Effectiveness

There will be no relocation of residents required during implementation of Alternative 6 to maintain protection of human health during implementation of this remedial alternative. Modified Level D

personal protection (Tyvek suits, protective gloves, and protective boots) will be required for construction workers. In conditions of excessive dust, Level C protection (respirators) for construction workers will be required to prevent inhalation or ingestion of lead-contaminated soil and dust. Dust generated during construction would be greater than Alternatives 1 through 3 due to the generation of an on-site repository and is a human health and environmental concern, but state and OSHA regulations governing dust suppression will be implemented (see chemical-specific ARARs in Table 2-1) to minimize impacts. The time required to complete the remedial action is approximately 18 to 21 months.

5.2.6.6 Alternative 6 – Implementability

Excavation and on-site disposal are relatively simple processes with proven procedures that are applicable for use in all areas of Jacobs Smelter OU2. Regrading is only applicable in the non-residential areas because it will change the topography of the residential lot, which is deemed unacceptable. In the residential areas, where regrading is not applicable, the excavated areas will be backfilled and returned to the original grade. Excavation and regrading require labor-intensive activities with little potential for automation. Standard clearing and grubbing as well as soil excavating, hauling, backfilling, and grading techniques are used in Alternative 6. The construction equipment, specialists, materials, technologies, services, and capacities needed are readily available from several Utah vendors. Construction of the on-site repository is rated as difficult to implement technically due to the lack of geotechnical and analytical data in the area and at the proposed repository depth.

The on-site repository will be closed after implementation of Alternative 6. Thus, if additional contamination is discovered and additional excavation is required in the future, the excavated material would have to be transported to an off-site facility for disposal.

Significant coordination with local, state, and federal agencies will be required to obtain approval for a suitable repository location for the disposal of the lead-contaminated soil. Coordination with local agencies will also be required during construction and to provide the necessary institutional controls as well as conduct long-term monitoring.

5.2.6.7 Alternative 6 – Cost

Site preparation to clear and grub the area prior to excavation is estimated at $550 per acre. The cost for generation of the on-site repository with a soil cover is $1,532,022, which includes the installation of monitoring wells. The unit cost estimate for the excavation is $10 per ton and the unit cost for transporting contaminated soil to the on-site repository is $4 per ton. The cost for regrading the excavated non-residential areas is $4 per square yard. The costs for imported, clean backfill material and topsoil, including transportation and placement, are $23 and $32 per ton, respectively. Geotextile fabric procurement and installation is estimated at $0.98 per square yard. Re-vegetation with a native grass seed mixture via a broadcast and harrow method is approximately $300 per acre. The cost for the erosion control blanket (material and installation) is estimated at $10,890 per acre. Additional details regarding the expenses incurred through implementation of this alternative or the sources for the cost estimates are included in Appendix A.

As indicated in Table 5-2, capital cost for Alternative 6 is $7,293,000 and 30 years of O&M will require a commitment of the present worth equivalent of $371,000 (see Appendix A for a detailed capital and O&M cost estimate). The first year of groundwater monitoring includes eight samples from each of two upgradient wells and four samples from each of three downgradient wells (per UAC R315-308-2). The groundwater samples will be analyzed for lead and arsenic. The total expenditure for this initial sampling is $49,988. In the years that follow, semi-annual groundwater monitoring is required for all five wells totaling $10,979 per year. The O&M cost for the first year of this alternative is $66,241; for each following year the annual O&M is $27,232. O&M includes: annual inspection of the excavated areas and on-site soil cover repository; eight groundwater sampling events in the first year and semi-annual events thereafter; maintenance of the soil cover repository and topsoil material (to include topsoil replacement and reseeding if necessary); and production of an annual report. The annual report documents the analytical results from the groundwater sampling, annual inspection and maintenance activities, and reports the degree of success achieved implementing institutional controls for the site. These capital and O&M costs combine for net present worth for Alternative 6 of $7,664,000.

6.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

This section compares and ranks the alternatives described in Section 5.0. Section 5.0 explained, in detail, the compliance of each alternative with seven of the nine CERCLA evaluation criteria. In an effort to provide a ranking for the alternatives, a methodology has been developed and is described in Section 6.1. Sections 6.2 and 6.3 provide a description of the comparison and ranking methodology for each of the seven threshold and balancing criteria for the alternatives, which are summarized in Table 6-1. Section 6.4 presents the conclusions from the comparisons and an overview of the ranking presented in Sections 6.2 and 6.3.

6.1 Comparison Methodology

Table 6-1 compares the seven threshold and balancing criteria for the alternatives. For the two threshold criteria, the table identifies whether or not the alternatives provide overall protectiveness and if they comply with the ARARs described in Section 2.0. If an alternative does not meet either of the threshold criteria, it does not receive a ranking for the remaining balancing criteria. For the remaining five balancing criteria, with the exception of cost, each alternative is ranked (as described below) on the basis of its relative standing in each sub-section to the other alternatives being considered. A detailed description of this ranking procedure is provided below.

6.2 Ranking of Sub-Sections and Criteria

A ranking system from 1 to 5 was developed for comparison of the alternatives. A rank of “1” represents the most compliant alternative and a rank of “5” represents the least compliant alternative for each criteria sub-section.

6.3 Remedial Alternatives

The six alternatives include the following.

- Alternative 1 No action.
- Alternative 2 Excavate material in excess of site action levels to a depth of 18 inches, backfill with clean soil, and dispose of excavated materials off-site.
- Alternative 3 Cover material in excess of site action levels with clean soil.
- Alternative 4 Excavate material in excess of site action levels to a depth of 18 inches, backfill all areas with clean soil, and dispose of excavated materials in an on-site repository with a RCRA Subtitle C cap.
- Alternative 5 Excavate all material in excess of site action levels to the depth of contamination, backfill residential areas with clean soil, regrade non-residential areas, and dispose of excavated materials in an on-site repository with a RCRA Subtitle C cap.

- Alternative 6 Excavate all material in excess of site action levels to the depth of contamination, backfill residential areas with clean soil, regrade non-residential areas, and dispose of excavated materials in an on-site repository with a soil cover.

6.3.1 Overall Protection of Human Health and the Environment

Alternative 1 provides no human health or environmental protection and does not address any contamination in OU2. Alternatives 2 and 4 provide protection because they excavate up to the top 18 inches of contaminated soil, dispose of the excavated soil in a RCRA-approved landfill or the on-site repository, and then backfill all excavated areas with clean soil. Similarly, Alternative 3, while providing sufficient protection does not provide the same magnitude of protection as Alternatives 2, 4, 5, and 6. In Alternatives 5 and 6, residual contamination will only be present in the residential areas and in the on-site repository and contaminated soil will be completely removed from the non-residential areas. Therefore, residual contamination may be present in certain areas below the excavated depth of 18 inches in all four excavation alternatives, Alternatives 2, 4, 5, and 6. Alternatives 5 and 6 are the most protective because they completely remove contaminated soil from the non-residential areas while Alternatives 2 and 4 only removes the top 18 inches. However, Alternative 2 is more protective than Alternative 4, because the excavated soils are taken off-site for disposal. Institutional controls to control use are necessary for all alternatives.

6.3.2 Compliance with ARARs

Alternative 1 takes no action to remediate the contaminated soil and therefore does not comply with the risk-based standards for closure or the CDC directive. Alternatives 2 through 6 all comply with chemical-specific, location-specific, and action-specific ARARs and TBC criteria.

Since Alternative 1 meets neither threshold criteria, it is not evaluated further with respect to the remaining five balancing criteria.

6.3.3 Long-term Effectiveness and Permanence

Alternative 2 (excavation and off-site disposal followed by backfill with clean soil) is the most effective and permanent alternative. Alternative 2 removes up to the top 18 inches of soil in all areas where there is surface or subsurface lead contamination greater than site action levels and disposes of the material off-site. The same volume of material is excavated for Alternative 4, however the material is disposed in the on-site repository. Similarly, while Alternatives 5 and 6 excavate more material than Alternative 2, the excavated material remains in the on-site repository. After disposal, both Alternatives 2 and 4 involve backfilling of all excavated areas with clean soil and Alternatives 5 and 6 only involve backfilling the excavated residential areas. Alternatives 4, 5, and 6 receive a lower ranking than Alternative 2, where soils are disposed off-site, because a greater volume of contaminated soil is left within the OU2 boundaries.

The effectiveness of Alternative 3 involves soil cover and depends upon the effectiveness of a long-term monitoring program because contaminated soils remain at the site. Alternative 3 leaves all contaminated soils on-site and covers them with clean soil and is therefore the least effective and permanent alternative. Alternatives 2, 4, 5, and 6 are more effective than Alternative 3 because all of the contaminated soil is left in place with Alternative 3.

The long-term effectiveness and permanence of all remaining alternatives are dependent on the adequacy and reliability of institutional controls. When ranked, Alternative 2 is the least reliant on the adequacy and reliability of institutional controls due to the removal of the contaminant mass and off-site disposal. Alternatives 5 and 6 are more effective than Alternative 4 because contaminated soil is completely removed from the non-residential areas, so the long-term effectiveness of these alternatives are reliant on institutional controls for the residential and on-site repository areas. Alternative 3 is most reliant on institutional controls because none of the known mass is removed and all of the impacted material is covered with soil.

The magnitude of residual risk is lowest with Alternative 2 due to the removal of contaminated soil and off-site disposal and highest with Alternative 3 (soil cover). Alternatives 4, 5, and 6 are ranked lower than Alternative 2 because the material remains on-site and the resulting magnitude of residual risk is higher.

6.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

CERCLA Section 121(b)(1) establishes a statutory preference for remedial actions that permanently and significantly reduce the volume, toxicity, or mobility of a hazardous substance through treatment. None of the alternatives proposed at OU2 meet this statutory preference, as the contaminated material is not treated or destroyed in any of the proposed alternatives. However, a reduction in toxicity and volume is achieved if Alternative 2, 4, 5, or 6 is implemented. Alternative 2 provides the highest local reduction in toxicity and volume due to the removal of the top 18 inches of contaminated material to an off-site landfill. Alternatives 4, 5, and 6 also reduce toxicity and volume, however disposal of the material is on-site rather than off-site. Alternatives 5 and 6 provide a higher reduction of toxicity and volume than Alternative 4 because they remove all contaminated soil from the non-residential areas whereas Alternative 4 only removes contaminated material to a depth of 18 inches.

Alternative 2, followed by Alternative 5, 6, and 4, achieve the highest reduction of mobility because they involve disposing of the entire excavated volume in a permitted landfill or at the on-site repository. Alternative 6 provides a lower reduction of mobility than Alternative 5 because the on-site repository soil cover is less effective at minimizing infiltration than the RCRA Subtitle C cap in Alternative 5. Alternative 3 provides a reduction in mobility through the soil cover, which reduces the erosion potential by wind and water. However, Alternative 3 does not remove any of the contamination or collocate the wastes and therefore, achieves less reduction in mobility. The overall ranking for reduction of toxicity, mobility, and volume for the alternatives is shown in Table 6-1.

6.3.5 Short-term Effectiveness

Of the six remedial alternatives, Alternative 3 generates the fewest impacts to the community, workers, and the environment because it only involves soil cover and therefore involves no excavation or handling of contaminated soil. Due to the large amount of additional soil handling required for the on-site repository, Alternatives 4, 5, and 6 have the most short-term impacts. Alternatives 5 and 6 have less short-term impact than Alternative 4 because they require importing less backfill material. Alternative 6 has less short-term impact than Alternative 5 because construction of the soil cover requires less material than a RCRA Subtitle C cap. Therefore, Alternative 3 has the greatest short-term effectiveness (i.e., has less of an impact in the short-term) followed by Alternatives 2, 6, 5, and 4, respectively. The time until action is complete for Alternatives 2 and 3 range between 9 to 12 months. Due to the creation of an on-site repository, the time until action is complete for Alternatives 4, 5, and 6 is longer, ranging between 18 to 24 months.

6.3.6 Implementability

Alternative 3 is ranked highest for constructability. Alternative 3 is easily constructed because it involves the least amount of excavation and no contaminated soil handling. Alternative 2 follows Alternative 3, due to the handling of contaminated soil. Alternatives 4, 5, and 6 are the most difficult to construct due to the lack of geotechnical and analytical data in the area and at the proposed repository depth. Alternatives 4, 5, and 6 would also be more difficult to operate due to the state's obligation to perform additional maintenance and monitoring required for the on-site repository.

If additional remediation is necessary, the soil cover alternative (Alternative 3) will be the most impacted, since breaching of the soil cover would be required and all of the impacted material utilizes soil cover as the remedy. The remedies implemented by Alternatives 2, 4, 5, and 6 would be less impacted by additional remediation activities. Alternatives 4, 5, and 6 are ranked lower than Alternative 2 because it would be more difficult to dispose of additional wastes in the on-site repository since it will be closed, whereas the off-site facility will likely remain open for a period of time to accept additional wastes.

The ability to monitor effectiveness is also contingent upon the amount of soil cover used and which disposal option is utilized. Therefore, Alternative 3 would be the most difficult to monitor due to the increased amount of soil cover, followed by Alternatives 4, 5, 6, and 2, with Alternative 2 being the least difficult to monitor.

Of the remedial alternatives, Alternative 3 is ranked highest with respect to agency approval, long-term monitoring, and compliance since neither an on-site nor an off-site disposal location is required for implementation. Alternative 2 ranks next because all of the excavated soils would be disposed off-site at a permitted facility. Alternatives 4, 5, and 6 are ranked as more difficult due to the high level of agency coordination for approval of the on-site repository and additional O&M requirements. The availability of the equipment, materials, specialists and technologies necessary for all of the remedial alternatives are equal.

6.3.7 Cost

The total present worth (capital cost plus O&M cost calculated for 30 years including a discount factor) for Alternative 2 is the most expensive, approximately $9,647,000, followed by Alternative 5 at approximately $8,326,000, Alternative 4 at approximately $8,065,000, Alternative 6 at approximately $7,664,000, and Alternative 3 at approximately $5,278,000.

The uncertainty in the present worth estimates described above is most significant for Alternatives 5 and 6. As mentioned in Sections 5.2.5 and 5.2.6, the excavation quantities for Alternatives 5 and 6 are assumed because the vertical extent of contamination in the non-residential areas has not been fully characterized. For cost estimating purposes, it is assumed that an additional 12 inches will be excavated in the non-residential areas where the vertical extent of contamination has not been fully defined (i.e., areas with soil contamination found at 18 inches bgs). Because of this assumption, the capital costs associated with Alternatives 5 and 6 have the greatest degree of uncertainty.

6.4 Conclusions

All alternatives, with the exception of the 'No Action' alternative, meet the CERCLA threshold criteria for 'overall protectiveness' and 'compliance with ARARs'. Therefore, Alternatives 2 through 6 were ranked based on their relative compliance with 4 of the 5 CERCLA balancing criteria (described in previous subsections). Cost, the remaining balancing criterion, was not included in the ranking process, but was presented as the net present worth in order to reflect the true financial impact. The following paragraphs summarize the ranking of alternatives as shown in Table 6-1.

Alternatives 2 through 6 met the threshold criteria for overall protectiveness and compliance with ARARs. Alternative 2 received the highest ranking for long-term effectiveness and permanence and reduction of toxicity, mobility, and volume, followed by Alternatives 5, 6, 4, and 3. The ranking for the short-term effectiveness criteria had Alternative 3 as most effective followed by Alternatives 2, 6, 5, and 4. The ranking for the sub-categories of the implementability criterion was mixed among the alternatives with Alternative 3 receiving the highest ranking for the ability to construct and operate and the ability to obtain approval from other agencies. Alternative 2 received the highest ranking for the ease of additional remediation and the ability to monitor effectiveness. All other sub-categories were either ranked as not applicable or no difference. The total present worth for Alternative 2 is the most expensive, approximately $9,647,000, followed by Alternative 5 at approximately $8,326,000, Alternative 4 at approximately $8,065,000, Alternative 6 at approximately $7,664,000, and Alternative 3 at approximately $5,278,000. Alternatives 5 and 6 have the greatest degree of uncertainty associated with present worth because of the unknown depths of excavation.

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TABLES

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TABLE 2-1
Preliminary Chemical-Specific ARARs

Requirement	Citation	ARAR	Comment
FEDERAL:			
National Ambient Air Quality Standards (NAAQS)	40 CFR Part 50	Applicable	All alternatives must meet the emission standards of this regulation.
Criteria for Identification and Listing of Hazardous Waste	40 CFR Part 261	Relevant and Appropriate	Wastes generated during the remedial actions must be identified and listed as hazardous wastes, as appropriate. Wastes at this site were created from beneficiation and smelting of metal ores and are not hazardous waste per 40 CFR 261.4(b)(7)(ii)(B) and 40 CFR 261.4(b)(7)(i). However, because some of the wastes are similar to hazardous waste, certain RCRA hazardous waste requirements are considered relevant and appropriate.
STATE:			
Emission Standards: Visible Emissions	UAC R307-201-1(1)	Applicable	Emissions from the excavation and disposal operations must meet the standards of this regulation. Remedial actions are not expected to cause significant visible emissions.
Emission Standards: Fugitive Emissions and Fugitive Dust	UAC R307-309	Applicable	Fugitive dust must be controlled during ground disturbing activities such as excavation, disposal, and soil covering.
Corrective Action Cleanup	UAC R311-211	Applicable	The remedial alternatives must employ appropriate measures to control or remove contaminant sources and must utilize soil cleanup standards that are protective of public health and the environment.
Identification and Listing of Hazardous Waste	UAC R315-2	Relevant and Appropriate	Wastes generated during the remedial actions must be identified and listed as hazardous wastes, as appropriate. Wastes at this site were created from beneficiation and smelting of metal ores and are not hazardous wastes per UAC R315-2-4(b)(7). However, because some of the wastes are similar to hazardous waste, certain RCRA hazardous waste requirements are considered relevant and appropriate.
Cleanup Action and Risk Based Closure Standards	UAC R315-101	Applicable	The standards establish requirements for managing sites contaminated with hazardous waste or hazardous constituents where cleanup to background will not be achieved. Site management depends on risks identified for the site and may include corrective action, post-closure care, monitoring, and institutional controls.
Run-On/Run-Off Controls	UAC R317-2	Applicable	All alternatives must comply with storm water runoff requirements to protect surface water bodies, including Rush Lake.

TABLE 2-2
Preliminary Action-Specific ARARs

Action	Citation	ARAR	Comment
FEDERAL:			
Criteria for Classification of Solid Waste Disposal and Practices	40 CFR 257.3	Applicable	Alternatives which involve the generation and on-site disposal of solid wastes must comply with these requirements.
Bevill Exempt Status of Mining Wastes	40 CFR 261.4(b)(7)	Applicable	Any solid waste generated as a result of the extraction, benefication, or processing of ores and minerals are not considered hazardous wastes and are not subject to RCRA Subtitle C regulations.
Generation of Hazardous Waste	40 CFR Part 262	Relevant and Appropriate	Standards are relevant and appropriate to alternatives that generate remediation wastes that are similar to hazardous waste.
Closure and Post Closure	40 CFR 264 Subpart G	Relevant and Appropriate	The requirements are relevant and appropriate to site closure activities due to the presence of contaminated wastes that are similar to hazardous waste. This is not triggered when soils are moved within an Area of Contamination (AOC).
Construction Quality Assurance (CQA) Program	40 CFR 264.19	Relevant and Appropriate	A CQA program is required for most surface impoundment, waste pile, and landfill units. Alternatives leaving contaminated soil in place and covering with soil or alternatives using staging piles may need a CQA.
Landfill Closure and Post Closure	40 CFR 264.310	Relevant and Appropriate	The requirements are relevant and appropriate to alternatives that involve the placement of a cover over contaminated materials. Post-closure care of such covers is necessary.
Surface Water Control	40 CFR 264.554(d)	Relevant and Appropriate	All remedial alternatives using staging piles must operate run-on/run-off controls to protect human health and the environment.
Staging Piles	40 CFR 264.554	Relevant and Appropriate	All remedial alternatives using staging piles must address temporary storage of remediation wastes in piles during remedial activities.
STATE:			
Air Pollutant Emissions	UAC R307-102-1	Applicable	All alternatives must prevent emissions of air contaminants in significant quantities. All alternatives must meet applicable emission requirements of R307 and the Utah State Implementation Plan.
Production of Fugitive Emissions and/or Fugitive Dust	UAC R307-205	Applicable	All alternatives must be designed to minimize fugitive dust and emissions.
Non-Attainment and Maintenance Areas for PM 10 and PM2.5: Fugitive Dust and Fugitive Emissions	UAC-R307-309	Applicable	All alternative must be designed to minimize fugitive dust and emissions.
Corrective Action Cleanup	UAC R311-211	Applicable	The remedial alternatives must employ appropriate measures to control or remove contaminant sources and must utilize soil cleanup standards that are protective of public health and the environment.
Hazardous Waste Generator	UAC R315-5	Relevant and Appropriate	Standards are relevant and appropriate to alternatives that generate remediation wastes that are similar to hazardous waste.

TABLE 2-2
Preliminary Action-Specific ARARs
(Continued)

Action	Citation	ARAR	Comment
Closure and Post Closure	UAC R315-8-7	Relevant and Appropriate	The requirements are relevant and appropriate to site closure activities due to the presence of contaminated wastes that are similar to hazardous waste. This is not triggered by movement of material within an AOC.
Surface Water Control	UAC R315-8-14.2 (g), (h), & (i)	Relevant and Appropriate	All alternatives leaving contaminated soil in place and covering with soil must maintain run-on and run-off systems to protect soil from water associated with a 24-hour 25-year storm.
Landfill Closure and Post Closure	UAC R315-8-14.5	Relevant and Appropriate	The requirements are relevant and appropriate to alternatives that involve the placement of a cover over contaminated materials. Post-closure care of such covers is necessary.
Cleanup Action and Risk Based Closure Standards	UAC R315-101	Applicable	The standards establish requirements for managing sites contaminated with hazardous waste or hazardous constituents where cleanup to background will not be achieved. Site management depends on risks identified for the site and may include corrective action, post-closure care, monitoring, and institutional controls.
Owner Responsibility for Solid Waste	UAC R315-301-3	Applicable	Solid wastes generated during the remedial activities will be managed and disposed in accordance with the Utah Solid Waste Permitting and Management Rules and the Utah Solid and Hazardous Waste Act.
Closure and Post-Closure	UAC R315-302-3	Applicable	These standards are applicable to alternatives that involve the generation of solid waste and the disposal of that waste in an on-site repository. They are relevant and appropriate to alternatives that involve placement of a cover over contaminated soil that remains in-place. Closure will be performed to minimize maintenance and threats to human health and the environment.
Corrective Action Management Units	UAC R315-8-21	Relevant and Appropriate	A CAMU will be designated if the remedial action involves excavation of contaminated soil followed by on-site storage.
Industrial Solid Waste Facility Requirements and Landfilling Standards	UAC R315-303 UAC R315-304	Applicable	Alternatives that involve the generation of solid waste and the disposal of that waste in an on-site repository must comply with the Class IIIa industrial waste landfill requirements.
Ground Water Monitoring Requirements	UAC R315-308	Applicable	While applicable due to the on-site repository alternatives, ground water monitoring requirements may be waived if it is demonstrated that there is no potential for migration of hazardous constituents to the groundwater.
Piles Used for Storage and Treatment	UAC R315-314	Applicable	All remedial alternatives that store remediation wastes in piles more than 90 days must comply with the applicable requirements of this standard.
Run-on/Run-off Control	UAC R317-8	Applicable	Since construction area exceeds an acre, all alternatives must comply with storm water runoff requirements..

TABLE 2-3
Preliminary Location-Specific ARARs

Location	Citation	ARAR	Comment
FEDERAL:			
Effect on historic properties within project area	National Historical Preservation Act (NHPA) 36 CFR Part 800 16 USC 470	Applicable	Requires federal agency to consider the effect of the project on properties eligible for inclusion on the National Register of Historic Places.
Area inhabited by endangered species or migratory birds.	16 USC 1531 et seq.; 40 CFR 6.302(h) Migratory Bird Treaty Act (16 USC §§ 703 et seq.)	Applicable	Applicable to all alternatives, if endangered species or migratory birds are present at the site.
STATE:			
Location standards for disposal facility	UAC R315-302-1	Applicable	These standards are applicable to alternatives involving the generation and on-site disposal of solid waste. They are relevant and appropriate to alternatives that involve in-place closure of contaminated soil.

TABLE 2-4
Summary of To Be Considered (TBC) Material

Material	Citation	Comment
Clarification to the 1994 Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities	OSWER Directive #9200.4-27P August 1998	Office of Solid Waste and Emergency Response (OSWER) recommends that the integrated exposure uptake and biokinetic (IEUBK) model be used as the primary tool to generate risk-based soil cleanup levels at lead sites for current or future residential land use. In selecting management strategies, it is OSWER's preference to seek early risk reduction with a combination of engineering controls (actions which permanently remove or treat contaminants, or create reliable barriers to mitigate the risk of exposure) and non-engineering response actions (such as education and health intervention programs). As a given project progresses, OSWER recognizes the National Oil and Hazardous Substances Contingency Plan (NCP) preference for permanent remedies and emphasizes selection of engineering over non-engineering remedies for long-term response actions.
Centers for Disease Control and Prevention (CDC) guidance for determining soil lead action levels	"Preventing Lead Poisoning in Young Children: A Statement by the Centers for Disease Control", October 1991	CDC recommends that there should be no more than a 5 percent chance that children aged 1 to 3 have blood levels higher than 10 micrograms per deciliter (µg/dL).

Table 3-1
Complete Exposure Pathways Linking Contaminated Media to Ecological Receptors
(from USEPA, 2003a)

Endpoint	Pathway
I. Terrestrial Plant Community	Direct contact with soil Direct contact with surface water
II. Benthic Invertebrates	Direct contact with interstitial water Direct contact with surface water Direct contact with sediment Ingestion of sediment
III. Herbivorous Birds	Ingestion of surface water Incidental ingestion of soil Incidental ingestion of sediment Ingestion of terrestrial or aquatic vegetation
IV. Insectivorous Birds	Ingestion of surface water Incidental ingestion of soil Ingestion of terrestrial invertebrates
V. Aquatic Invertebrate Eating Birds	Ingestion of surface water Incidental ingestion of sediment Ingestion of aquatic invertebrates
VI. Omnivorous Birds	Ingestion of surface water Incidental ingestion of soil Incidental ingestion of sediment Ingestion of aquatic plants Ingestion of aquatic invertebrates
VII. Piscivorous Birds	Ingestion of surface water Incidental ingestion of sediment Ingestion of aquatic vertebrates
VIII. Carnivorous Birds	Ingestion of surface water Incidental ingestion of soil Ingestion of small mammals
IX. Herbivorous Mammals	Ingestion of surface water Incidental ingestion of soil Ingestion of terrestrial vegetation
X. Insectivorous Mammals	Ingestion of surface water Incidental ingestion of soil Ingestion of terrestrial insects
XI. Omnivorous Mammals	Ingestion of surface water Incidental ingestion of soil Ingestion of terrestrial insects Ingestion of terrestrial vegetation
XII. Carnivorous Mammals	Ingestion of surface water Incidental ingestion of soil Ingestion of small mammals

Table 3-2
Preliminary Soil Remediation Goals for Human Receptors for Jacobs Smelter OU2

	Lead (mg/kg)		
	Low	**High**	**Selected**
Residential (Surface, 0-2 in. bgs)	500	500	500
Residential (Subsurface, 2-12 in. bgs)	800	800	800
Commercial/Industrial	1,671	2,632	2,200
Recreational	2,408	3,792	3000

bgs – below ground surface
in – inches
mg/kg – milligrams per kilogram
Range calculated from regional blood lead levels

Table 3-3
Preliminary Soil Action Levels for Human Receptors within Jacobs Smelter OU2
(UDEQ, 2010)

Preliminary Action Level for Soil	Lead (mg/kg)
Residential Areas (Surface, 0-2 in. bgs)	500
Residential Areas (Subsurface, 2-12 in. bgs)	800
Commercial/Industrial	2,200[a]
Recreational	3,000

UDEQ, 2010. Utah Department of Environmental Quality. *Memorandum: Risk management proposal regarding clean up levels based on human health risk for Operable Unit Two of the Jacobs Smelter Superfund Site*. June 17, 2010.

a – this value was not included in the memorandum referenced above, but has been selected by UDEQ/EPA as a part of this FS process.
bgs – below ground surface
in – inches
mg/kg – milligrams per kilogram

TABLE 4-1
Initial Screening of Remedial Technologies

Technology	Effectiveness	Implementability		Costs		Retained for Detailed Analysis	Comments
		Technical	Administrative	Capital	O&M		
Soil cover [a]	Moderate	Easy	Difficult	Low	Moderate	Yes	This technology is viable for both residential and non-residential areas.
Soil cap [b]	Moderate	Moderate	Difficult	Moderate	Moderate	No	This technology is not feasible for residential properties and the reduction of infiltration from the cap material is not required at the site.
Phytoremediation	Low	Difficult	Difficult	High	High	No	This technology would not prevent pathway completion to either ecological or human receptors. Arid conditions at the site make establishment of plants difficult.
Tilling with amendments	Low	Difficult	Difficult	High	Low	No	Limited data is available for this technology and a feasibility demonstration project is likely required.
In-situ S/S	Low	Moderate	Moderate	Moderate	Low	No	This technology is not retained due to the relatively small and uncertain reduction of lead bioavailability.
Phosphate amendment	Low	Moderate	Difficult	Low	Low	No	This technology is not retained due to the relatively small and uncertain reduction of lead bioavailability which would be required to address risk to human and ecological receptors and due to the uncertain long-term effectiveness of the technology.
Excavation, removal, and backfill [c]	High	Easy	Easy	Moderate	Low	Yes	This technology is highly effective with easy technical and administrative implementability and can be used for both residential and non-residential areas.

TABLE 4-1
Initial Screening of Remedial Technologies
(Continued)

Technology	Effectiveness	Implementability		Costs		Retained for Detailed Analysis	Comments
		Technical	Administrative	Capital	O&M		
Excavation, removal, and regrading [c]	High	Easy	Moderate	Low	Low	Yes	This technology is highly effective with easy technical and moderate administrative implementability and can be used for both residential and non-residential areas.
Excavation and soil washing	High	Difficult	Difficult	High	Low	No	This technology is expensive and difficult to implement, generates an additional liquid waste stream, and is normally used in conjunction with another technology.
Excavation and chemical separation	Low	Difficult	Moderate	High	Low	No	This technology has not been proven effective for treating lead and arsenic contaminated soils at a full scale.

[a] Soil cover technology involves placing a 9-inch lift of uncompacted clean backfill covered by a 9-inch lift of uncompacted clean topsoil over the contaminated soil.
[b] Soil cap technology involves placing an impermeable membrane, a 9-inch lift of uncompacted clean backfill, and a 9-inch lift of uncompacted clean topsoil over the contaminated soil.
[c] See Table 4-2 for disposal options.
S/S – Stabilization/Solidification
O&M – Operations and Maintenance

TABLE 4-2
Initial Screening of Soil Disposal Options

Technology	Effectiveness	Implementability		Cost	Retained for Detailed Analysis	Comments
		Technical	Administrative			
Off-Site Disposal in a Subtitle D, Class V Landfill [a]	High	Easy	Easy	Low	Yes	Due to effectiveness and favorable costs, this option is retained for soils that do not exceed TCLP limits. However, to be conservative, it is **not used for costing**.
Off-Site Disposal in a Subtitle C Hazardous Waste Landfill [b]	High	Easy	Moderate	Moderate	Yes	Due to effectiveness, this option is retained for soils that exceed TCLP limits. Costs are higher than for Subtitle D, Class V disposal. Therefore, to be conservative, this option is **used for costing**.
Disposal in an On-Site Repository with a RCRA Subtitle C Cap	Moderate	Difficult	Moderate	Moderate	Yes	Retained due to effectiveness and favorable costs.
Disposal in an On-Site Repository with a Soil Cover	Moderate	Difficult	Difficult	Low	Yes	Retained due to effectiveness and favorable costs.

Notes:
[a] Wasatch Regional Class V Landfill, Tooele, UT
[b] Clean Harbors Grassy Mountain Landfill, Tooele County, UT
RCRA – Resource Conservation and Recovery Act

TABLE 5-1
Summary of Remedial Alternatives

<u>Alternative 1</u> – No Action.
• No action will be taken to address soil contamination.
<u>Alternative 2</u> – Excavate material in excess of site action levels* to a depth of 18 inches, backfill with clean soil, and dispose of excavated materials off-site.
• Clear and grub brush and vegetation on 32.1 acres. • Excavate up to 18 inches of contaminated soil with soil lead levels in excess of site action levels* • Transport and dispose of all excavated soils at a RCRA-permitted landfill. • Place geotextile fabric over the areas excavated to 18 inches. • In areas with an 18-inch excavation depth, place and compact 9-inches of un-compacted topsoil over 18-inches of un-compacted backfill, allowing for 33 percent compaction to bring the fill material to grade. • In areas with a 12-inch excavation depth, place and compact 9-inches of un-compacted topsoil over 9-inches of un-compacted back fill, allowing for 33 percent compaction to bring the fill material to grade. • In areas with a 6-inch excavation depth, place and compact 9-inches of un-compacted topsoil, allowing for 33 percent compaction to bring the fill material to grade. • Re-vegetate with a native grass mixture through a broadcast method followed by tilling and install an erosion control blanket. • Implement institutional controls for areas where contamination is found at depths greater than 18 inches. • Implement annual operations and maintenance.
<u>Alternative 3</u> – Cover material in excess of site action levels* with clean soil.
• Clear and grub brush and vegetation on 32.1 acres. • Place geotextile fabric over all soil surfaces in excess of action levels (32.1 acres). • Place and compact 9-inches of un-compacted topsoil over 9-inches of un-compacted backfill on all areas where soil lead levels are greater than site action levels. • Re-vegetate with a native grass mixture through a broadcast method followed by tilling and install an erosion control blanket. • Implement institutional controls for areas where contamination is found at depths greater than 18 inches. • Implement annual operations and maintenance.
<u>Alternative 4</u> – Excavate material in excess of site action levels* to a depth of 18 inches, backfill all areas with clean soil, and dispose of excavated materials in an on-site repository with a RCRA Subtitle C cap.
• Construct 2-acre on-site repository in the slope in the former Waterman Smelter area. • Clear and grub brush and vegetation on 32.1 acres. • Excavate up to 18 inches of contaminated soil with soil lead levels in excess of site action levels. • Transport and dispose of all excavated soils at the on-site repository. • Place geotextile fabric over the areas excavated to 18 inches. • In areas with an 18-inch excavation depth, place and compact 9-inches of un-compacted topsoil over 18-inches of un-compacted backfill, allowing for 33 percent compaction to bring the fill material to grade. • In areas with a 12-inch excavation depth, place and compact 9-inches of un-compacted topsoil over 9-inches of un-compacted back fill, allowing for 33 percent compaction to bring the fill material to grade. • In areas with a 6-inch excavation depth, place and compact 9-inches of un-compacted topsoil, allowing for 33 percent compaction to bring the fill material to grade. • Re-vegetate with a native grass mixture through a broadcast method followed by tilling and install an erosion control blanket.

TABLE 5-1
Summary of Remedial Alternatives
(Continued)

<u>Alternative 4</u> – Excavate material in excess of site action levels* to a depth of 18 inches, backfill all areas with clean soil, and dispose of excavated materials in an on-site repository with a RCRA Subtitle C cap. (Cont.)
• Complete the on-site repository with a RCRA cap consisting of (from top to bottom) 6-inches of gravel armor, 18-inches of common fill from the clean excavated material, a 4 oz. geotextile layer; a 12-inch drainage layer (graded material 3/8" minus), a 4 oz. geotextile layer, and a geosynthetic clay liner. • Implement institutional controls for areas where contamination is found at depths greater than 18 inches, including the on-site repository. • Implement annual operations and maintenance.
<u>Alternative 5</u> – Excavate all material in excess of site action levels* to the depth of contamination, backfill residential areas with clean soil, regrade non-residential areas, and dispose of excavated materials in an on-site repository with a RCRA Subtitle C cap.
• Construct 2-acre on-site repository in the slope in the former Waterman Smelter area. • Clear and grub brush and vegetation on 32.1 acres. • In residential areas, excavate up to 18-inches of contaminated soil with lead levels in excess of site action levels. • Place geotextile fabric over the areas excavated to 18 inches in residential areas. • In residential areas with an 18-inch excavation depth, place and compact 9-inches of un-compacted topsoil over 18-inches of un-compacted backfill, allowing for 33 percent compaction to bring the fill material to grade. • In residential areas with a 12-inch excavation depth, place and compact 9-inches of un-compacted topsoil over 9-inches of un-compacted back fill, allowing for 33 percent compaction to bring the fill material to grade. • In residential areas with a 6-inch excavation depth, place and compact 9-inches of un-compacted topsoil, allowing for 33 percent compaction to bring the fill material to grade. • In non-residential areas, excavate all contaminated soil with lead levels in excess of site action levels. • Regrade all non-residential excavated areas to match the surrounding grade. • In non-residential areas, place and compact 9-inches of un-compacted topsoil and bring the fill material to grade. • Transport and dispose of all excavated soils at the on-site repository. • Re-vegetate residential and non-residential areas with a native grass mixture through a broadcast method followed by tilling and install an erosion control blanket. • Complete the on-site repository with a RCRA cap consisting of (from top to bottom) 6-inches of gravel armor, 18-inches of common fill from the clean excavated material, a 4 oz. geotextile layer; a 12-inch drainage layer (graded material 3/8" minus), a 4 oz. geotextile layer, and a geosynthetic clay liner. • Implement institutional controls for all excavated areas and the on-site repository. • Implement annual operations and maintenance.
<u>Alternative 6</u> – Excavate all material in excess of site action levels* to the depth of contamination, backfill residential areas with clean soil, regrade non-residential areas, and dispose excavated materials to an on-site repository with a soil cover.
• Construct 2-acre on-site repository in the slope in the former Waterman Smelter area. • Clear and grub brush and vegetation on 32.1 acres. • In residential areas, excavate up to 18-inches of contaminated soil with lead levels in excess of site action levels. • Place geotextile fabric over the areas excavated to 18 inches in residential areas. • In residential areas with an 18-inch excavation depth, place and compact 9-inches of un-compacted topsoil over 18-inches of un-compacted backfill, allowing for 33 percent compaction to bring the fill material to grade.

TABLE 5-1
Summary of Remedial Alternatives
(Continued)

<u>Alternative 6</u> – Excavate all material in excess of site action levels* to the depth of contamination, backfill residential areas with clean soil, regrade non-residential areas, and dispose excavated materials to an on-site repository with a soil cover. (Cont.)
• In residential areas with a 12-inch excavation depth, place and compact 9-inches of un-compacted topsoil over 9-inches of un-compacted back fill, allowing for 33 percent compaction to bring the fill material to grade. • In residential areas with a 6-inch excavation depth, place and compact 9-inches of un-compacted topsoil, allowing for 33 percent compaction to bring the fill material to grade. • In non-residential areas, excavate all contaminated soil with lead levels in excess of site action levels. • Regrade all non-residential excavated areas to match the surrounding grade. • In non-residential areas, place and compact 9-inches of un-compacted topsoil and bring the fill material to grade. • Transport and dispose of all excavated soils at the on-site repository. • Re-vegetate residential and non-residential areas with a native grass mixture through a broadcast method followed by tilling and install an erosion control blanket. • Complete on-site repository with a soil cover consisting of 9-inches of uncompacted backfill from the clean excavated material, a 4 oz. geotextile layer, and 9-inches of uncompacted topsoil. • Implement institutional controls for all excavated areas and in the on-site repository. • Implement annual operations and maintenance.

Notes:
bgs – below ground surface
mg/kg – milligrams per kilogram
* - Site actions levels are:
1) Residential (applicable to the B&B Subdivision) = 500 mg/kg lead for surface soils (0-2 inches bgs) and 800 mg/kg lead for subsurface soils (greater than 2 inches bgs).
2) Recreational (applicable to all other areas that are currently [2013] undeveloped) = 3,000 mg/kg lead.

TABLE 5-2
Detailed Analysis of Remedial Alternatives

Criteria	**Alternative 1** **No Action**	**Alternative 2** **Excavate contaminated material to a depth of 18 inches, backfill with clean soil, off-site disposal**	**Alternative 3** **Cover contaminated material with clean soil**	**Alternative 4** **Excavate contaminated material to a depth of 18 inches; backfill with clean soil, disposal at on-site repository with RCRA Subtitle C cap**	**Alternative 5** **Excavate all contaminated material to depth of contamination in non-residential areas, backfill residential areas with clean soil, regrade non-residential areas, and disposal at on-site repository with RCRA Subtitle C cap**	**Alternative 6** **Excavate all contaminated material to depth of contamination in non-residential areas, backfill residential areas with clean soil, regrade non-residential areas, and disposal at on-site repository with soil cover**
OVERALL PROTECTIVENESS						
Human health	Does not meet the threshold criterion for protection of human health.	Removal of contaminated soil to a depth of 18 inches and off-site disposal permanently removes the risk of direct contact, inhalation, and ingestion. Residual contamination remains underneath 18 inches of clean soil but backfill reduces the risk of direct contact, inhalation or ingestion. The threshold criterion for protection of human health is met if proper institutional controls limiting use and soil disturbance are implemented and observed.	Soil cover reduces direct contact, inhalation, and ingestion of contaminated soil. Contamination remains underneath 18 inches of clean soil and backfill. The threshold criterion for protection of human health is met if proper institutional controls limiting use and soil disturbance are implemented and observed.	Removal of contaminated soil to a depth of 18 inches eliminates the risk of direct contact, inhalation, and ingestion for excavated material. Disposal in an on-site repository with a Subtitle C cap reduces the risk of direct contact, inhalation and ingestion for material placed within the repository. Residual contamination remains at the site within a repository located near residential and recreational areas that could be breached, and underneath 18 inches of clean soil and backfill elsewhere at the site. Annual monitoring and O&M are needed to assure the integrity of the repository The threshold criterion for protection of human health is met if proper institutional controls limiting use and soil disturbance are implemented and observed.	Removal of all contaminated soil eliminates the risk of direct contact, inhalation and ingestion. Disposal in an on-site repository with a Subtitle C cap reduces the risk of direct contact inhalation and ingestion for material placed within the repository. Residual contamination remains at the site within a repository located near residential and recreational areas that could be breached and underneath 18inches of clean soil and backfill in residential areas. Annual monitoring and O&M are needed to assure the integrity of the repository The threshold criterion for protection of human health is met if proper institutional controls limiting use are implemented and observed.	Removal of all contaminated soil eliminates the risk of direct contact, inhalation and ingestion. Disposal in an on-site repository with a soil cap reduces the risk of direct contact inhalation and ingestion for material placed within the repository. Residual contamination remains at the site within a repository located near residential and recreational areas that could be breached and underneath 18 inches of clean soil and backfill in residential areas.. Annual monitoring and O&M are needed to assure the integrity of the repository The threshold criterion for protection of human health is met if proper institutional controls limiting use are implemented and observed.
Environmental protection	Allows continued spread of and exposure to contamination.	The potential for spread of contamination is minimized due to permanent removal of accessible contamination and backfill over any remaining contamination at depth. The threshold criterion for protection of the environment is met.	The potential for spread of contamination is minimized due to cover of existing contamination. The threshold criterion for protection of the environment is met.	The potential for spread of contamination is minimized due to removal of accessible contamination and backfill over any remaining contamination at depth. The threshold criterion for protection of the environment is met.	The potential for spread of contamination is minimized due to the complete removal of contaminated soil in the non-residential areas and the removal of accessible contamination and backfill over any remaining contamination at depth in the residential areas. The threshold criterion for protection of the environment is met.	The potential for spread of contamination is minimized due to the complete removal of contaminated soil in the non-residential areas and the removal of accessible contamination and backfill over any remaining contamination at depth in the residential areas. The threshold criterion for protection of the environment is met.
COMPLIANCE WITH ARARS						
Chemical-specific ARAR	No action will be taken to ensure compliance with protective levels under R-317-5-4. The risk-based criterion is not met.	Air protection standards will be met by incorporating fugitive dust control during construction. All contamination down to 18 inches will be removed from OU2. As long as institutional controls and annual O&M are effective, the risk-based criterion is met.	Air protection standards will be met by incorporating fugitive dust control during construction. Although all contaminated soils will remain in OU2, if institutional controls are implemented and long-term monitoring is effective, the risk-based criterion is met.	Air protection standards will be met by incorporating fugitive dust control during construction. All contamination down to 18 inches will be removed from OU2 and consolidated at the on-site repository with a RCRA cap. As long as institutional controls and annual O&M are effective, the risk-based criterion is met.	Air protection standards will be met by incorporating fugitive dust control during construction. All accessible contamination will be removed from the non-residential areas and to a depth of 18 inches in residential areas of OU2 and consolidated in an on-site repository with a RCRA cap. As long as institutional controls and annual O&M are effective, the risk-based criterion is met.	Air protection standards will be met by incorporating fugitive dust control during construction. All accessible contamination will be removed from the non-residential areas and to a depth of 18 inches in the residential areas of OU2 and consolidated in an on-site repository. As long as institutional controls and annual O&M are effective, the risk-based criterion is met.
Action-specific ARAR	No action will be taken to manage risk or eliminate sources to ensure compliance with R-315-101. The action-specific	All action-specific ARARs will be met by incorporating institutional controls, annual O&M, and by procedures implemented during construction.	All action-specific ARARs will be met by incorporating institutional controls, annual O&M, and by procedures implemented during construction.	All action-specific ARARs will be met by incorporating institutional controls, annual O&M, and by procedures implemented during construction.	All action-specific ARARs will be met by incorporating institutional controls, annual O&M, and by procedures implemented during construction.	All action-specific ARARs will be met by incorporating institutional controls, annual O&M, and by procedures implemented during construction.

TABLE 5-2
Detailed Analysis of Remedial Alternatives
(Continued)

Criteria	**Alternative 1** **No Action**	**Alternative 2** **Excavate contaminated material to a depth of 18 inches, backfill with clean soil, off-site disposal**	**Alternative 3** **Cover contaminated material with clean soil**	**Alternative 4** **Excavate contaminated material to a depth of 18 inches; backfill with clean soil, disposal at on-site repository with RCRA Subtitle C cap**	**Alternative 5** **Excavate all contaminated material to depth of contamination in non-residential areas, backfill residential areas with clean soil, regrade non-residential areas, and disposal at on-site repository with RCRA Subtitle C cap**	**Alternative 6** **Excavate all contaminated material to depth of contamination in non-residential areas, backfill residential areas with clean soil, regrade non-residential areas, and disposal at on-site repository with soil cover**
	ARARs will not be met.					
Location-specific ARAR	No action will be taken to ensure compliance with location-specific ARARs. The location-specific ARARs will not be met.	All location-specific ARARs will be met.	All location-specific ARARs will be met.	All location-specific ARARs will be met.	All location-specific ARARs will be met.	All location-specific ARARs will be met.
Other criteria/guidance	Does not meet the CDC TBC criteria for blood-lead levels in children.	Meets the CDC TBC criteria for blood-lead levels in children.	Meets the CDC TBC criteria for blood-lead levels in children.	Meets the CDC TBC criteria for blood-lead levels in children.	Meets the CDC TBC criteria for blood-lead levels in children.	Meets the CDC TBC criteria for blood-lead levels in children.
LONG-TERM EFFECTIVENESS AND PERMANENCE						
Magnitude of residual risk	Contaminated soil is not removed or covered. Existing risk will remain.	Risk of exposure is greatly reduced with the removal and off-site disposal of most of the contaminated soil. Some residual risk remains from potential exposure to contaminated soil below 18 inches of clean soil andbackfill.	Some residual risk remains from potential exposure to contaminated soil remaining under the soil cover.	Risk is reduced with the containment of most of the contaminated soil in an on-site repository. Some residual risk remains from potential exposure to contaminated soil in repository and below 18 inches of clean soil and backfill.	Risk is reduced with the containment of all of the non-residential soil in an on-site repository. Some residual risk remains from potential exposure to contaminated soil in repository and below 18 inches of clean soil and backfill in residential areas.	Risk is reduced with the containment of all of the non-residential soil in an on-site repository. Some residual risk remains from potential exposure to contaminated soil in repository and below 18 inches of clean soil and backfill in residential areas.
Adequacy and reliability of controls	No controls will be implemented.	There is a high adequacy and reliability of controls at the off-site disposal location. Institutional controls, annual inspections and O&M are needed to assure protectiveness of the 18 inches of clean backfill placed over residual contamination. The reliability of institutional controls is dependent on landowners and land users notifying proper authorities when remaining contaminated soil is disturbed.	Institutional controls annual inspections and O&M are needed to assure the integrity of the soil cover. The reliability of institutional controls is dependent on land owners and land users notifying proper authorities when contaminated soil is disturbed.	Institutional controls, annual inspections and O&M are needed to assure the integrity of the repository and the 18 inches of clean backfill placed over residual contamination. The reliability of institutional controls is dependent on land owners and land users notifying proper authorities when contaminated soil is disturbed or when the integrity of the repository is compromised.	Institutional controls, annual inspections and O&M are needed to assure the integrity of the repository. The reliability of institutional controls is dependent on landowners and land users notifying proper authorities when the integrity of the repository is compromised.	Institutional controls, annual inspections and O&M are needed to assure the integrity of the repository. The reliability of institutional controls is dependent on landowners and land users notifying proper authorities when the integrity of the repository is compromised.
REDUCTION OF TOXICITY, MOBILITY, VOLUME						
Treatment process used	None used.	None used.	None used.	None used.	None used.	None used.
Amount destroyed or treated	None.	None.	None.	None.	None.	None.
Reduction of toxicity, mobility, or volume	None.	No reduction in volume or toxicity; however mobility is reduced through disposal in a permitted facility.	No reduction in volume or toxicity; however mobility is reduced by cover material.	No reduction in volume or toxicity; however mobility is reduced through disposal in the on-site repository.	No reduction in volume or toxicity; however mobility is reduced through disposal in the on-site repository.	No reduction in volume or toxicity; however mobility is reduced through disposal in the on-site repository.
Irreversible treatment	No treatment used.	No treatment used.	No treatment used.	No treatment used.	No treatment used.	No treatment used.
Type and quantity of residuals remaining after treatment	No soil will be treated or removed. All contaminated soil will be left in place.	No soil will be treated; approximately 70,000 tons of contaminated soil will be removed from the site. Some contamination will remain below 18 inches of clean backfill.	No soil will be treated or removed. All contaminated soil will be left in place.	No soil will be treated; approximately 70,000 tons of contaminated soil will be placed in an on-site repository with a RCRA Subtitle C cap. Contamination will remain within the	No soil will be treated; approximately 80,000 tons of contaminated soil will be placed in an on-site repository with a RCRA Subtitle C cap. Contamination will remain within the repository.	No soil will be treated; approximately 80,000 tons of contaminated soil will be placed in an on-site repository with a RCRA Subtitle C cap. Contamination will remain within the repository

TABLE 5-2
Detailed Analysis of Remedial Alternatives
(Continued)

Criteria	**Alternative 1** **No Action**	**Alternative 2** **Excavate contaminated material to a depth of 18 inches, backfill with clean soil, off-site disposal**	**Alternative 3** **Cover contaminated material with clean soil**	**Alternative 4** **Excavate contaminated material to a depth of 18 inches; backfill with clean soil, disposal at on-site repository with RCRA Subtitle C cap**	**Alternative 5** **Excavate all contaminated material to depth of contamination in non-residential areas, backfill residential areas with clean soil, regrade non-residential areas, and disposal at on-site repository with RCRA Subtitle C cap**	**Alternative 6** **Excavate all contaminated material to depth of contamination in non-residential areas, backfill residential areas with clean soil, regrade non-residential areas, and disposal at on-site repository with soil cover**
				repository and below 18 inches of clean backfill.		
Statutory preference for treatment	Does not meet.	Does not meet.	Does not meet.	Does not meet.	Does not meet.	Does not meet.
SHORT-TERM EFFECTIVENESS						
Community protection	Risk is not increased by remedy implementation as there is no remedy.	Contaminated dust and surface water run-off may be generated during construction and could create a human health impact. Increased traffic on local roads could also create a human health impact. Surface water run-off, traffic issues and fugitive dust will be mitigated during construction.	Contaminated dust and surface water run-off may be generated during construction and could create a human health impact. Increased traffic on local roads could also create a human health impact. Surface water run-off, traffic issues and fugitive dust will be mitigated during construction.	Contaminated dust and surface water run-off may be generated during construction and could create a human health impact. Increased traffic on local roads could also create a human health impact. Surface water run-off, traffic issues and fugitive dust will be mitigated during construction.	Contaminated dust and surface water run-off may be generated during construction and could create a human health impact. Increased traffic on local roads could also create a human health impact. Surface water run-off, traffic issues and fugitive dust will be mitigated during construction.	Contaminated dust and surface water run-off may be generated during construction and could create a human health impact. Increased traffic on local roads could also create a human health impact. Surface water run-off, traffic issues and fugitive dust will be mitigated during construction.
Worker protection	No risk to workers.	Modified Level D protection (Tyvek suits, protective gloves and boots) is required for construction workers.	Modified Level D protection (Tyvek suits, protective gloves and boots) is required for construction workers.	Modified Level D protection (Tyvek suits, protective gloves and boots) is required for construction workers. There is more risk of exposure to workers during construction of the on-site repository due to increased soil handling.	Modified Level D protection (Tyvek suits, protective gloves and boots) is required for construction workers. There is more risk of exposure to workers during construction of the on-site repository due to increased soil handling.	Modified Level D protection (Tyvek suits, protective gloves and boots) is required for construction workers. There is more risk of exposure to workers during construction of the on-site repository due to increased soil handling.
Environmental impacts	Impacts are not increased by remedy implementation.	Dust and surface water run-off generated during construction may cause environmental impacts.	Dust and surface water run-off generated during construction may cause environmental impacts..	Dust and surface water run-off generated during construction may cause environmental impacts.	Dust and surface water run-off generated during construction may cause environmental impacts.	Dust and surface water run-off generated during construction may cause environmental impacts.
Time until action is complete	Not applicable.	12 months	9-12 months	21-24 months	24 months	18-21 months
IMPLEMENTABILITY						
Ability to construct and operate	No construction or operation required.	Standard construction techniques are required to operate and construct. This remedy has been used at several other superfund sites in Utah.	Standard construction techniques are required to operate and construct.	The complexity of the construction project is increased due to on-site repository development and the installation of the Subtitle C cap.	The complexity of the construction project is increased due to on-site repository development and the installation of the Subtitle C cap.	The complexity of the construction project is increased due to on-site repository development.
Ease of additional remediation, if needed	Easy, as no remediation will be done in this alternative.	Applicable to all areas of OU2. Additional remediation may impact original remedy.	Applicable to all areas of OU2. Additional remediation may impact original remedy.	Applicable to all areas of OU2. Additional remediation may impact original remedy.	Applicable to all areas of OU2. Additional remediation may impact original remedy.	Applicable to all areas of OU2. Additional remediation may impact original remedy.
Ability to monitor effectiveness	No monitoring required.	Institutional controls are needed to minimize risk of future excavation below 18 inches in depth. Periodic inspections of areas where contamination remains under 18 inches of clean backfill is needed to assure	Institutional controls are needed to minimize risk of future excavation below soil cover Periodic inspections of soil cover is needed to assure	Institutional controls are needed to minimize risk of future excavation below 18 inches in depth. Periodic inspections of the repository and areas where contamination remains under 18 inches of clean backfill is needed to	Institutional controls, annual inspections and O&M are needed to assure the integrity of the repository.	Institutional controls, annual inspections and O&M are needed to assure the integrity of the repository.

TABLE 5-2
Detailed Analysis of Remedial Alternatives
(Continued)

Criteria	**Alternative 1** **No Action**	**Alternative 2** **Excavate contaminated material to a depth of 18 inches, backfill with clean soil, off-site disposal**	**Alternative 3** **Cover contaminated material with clean soil**	**Alternative 4** **Excavate contaminated material to a depth of 18 inches; backfill with clean soil, disposal at on-site repository with RCRA Subtitle C cap**	**Alternative 5** **Excavate all contaminated material to depth of contamination in non-residential areas, backfill residential areas with clean soil, regrade non-residential areas, and disposal at on-site repository with RCRA Subtitle C cap**	**Alternative 6** **Excavate all contaminated material to depth of contamination in non-residential areas, backfill residential areas with clean soil, regrade non-residential areas, and disposal at on-site repository with soil cover**
		protectiveness.	protectiveness.	assure protectiveness. Groundwater monitoring wells may be needed.		
Ability to obtain approval from other agencies	None required.	Moderate level of coordination with local, state, and federal agencies needed for landfill disposal of soil. Moderate level of coordination with local, state and federal agencies needed for long-term monitoring and compliance.	Coordination with local, state and federal agencies needed for long-term monitoring and compliance.	Significant coordination with local, state, and federal agencies and property owner needed for on-site repository design and siting. Significant level of coordination with local, state and federal agencies needed for long-term monitoring and compliance.	Significant coordination with local, state, and federal agencies and property owner needed for on-site repository design and siting. Significant level of coordination with local, state and federal agencies needed for long-term monitoring and compliance.	Significant coordination with local, state, and federal agencies and property owner needed for on-site repository design and siting. Significant level of coordination with local, state and federal agencies needed for long-term monitoring and compliance.
Availability of services and capacities	No services or capacities required.	Services and capacities available.	Services and capacities available.	Services and capacities available.	Services and capacities available.	Services and capacities available.
Availability of equipment, specialists, materials	None required.	All equipment, specialists, and material available from various sources.	All equipment, specialists, and material available from various sources.	All equipment, specialists, and material available from various sources.	All equipment, specialists, and material available from various sources.	All equipment, specialists, and material available from various sources.
Availability of technology	None required.	Required technology readily available.	Required technology readily available.	Required technology readily available.	Required technology readily available.	Required technology readily available.
COST*						
Capital cost	$0	$9,443,000	$5,056,000	$7,647,000	$7,956,000	$7,293,000
30-year O&M cost	$0	$204,000	$222,000	$417,000	$371,000	$371,000
Present worth cost	$0	$9,647,000	$5,278,000	$8,065,000	$8,326,000	$7,664,000
STATE ACCEPTANCE	See Note A	See Note A	See Note A	See Note A	See Note A	See Note A
COMMUNITY ACCEPTANCE	See Note B	See Note B	See Note B	See Note B	See Note B	See Note B

"Contaminated" refers to concentrations above action levels.
* Refer to Appendix A for detailed cost information.
Note A Will be determined after State review.
Note B Will be evaluated during the CERCLA-required Public Comment Period.
ARAR – Applicable or Relevant and Appropriate Requirement
O&M – Operations and maintenance
CDC – Center for Disease Control
TBC – To be considered

TABLE 6-1
Ranking[a] of Remedial Alternatives

Criteria	Alternative 1 No action	Alternative 2 Excavate impacted material to a depth of 18 inches, backfill, off-site disposal	Alternative 3 Cover material in excess of site action levels with clean soil	Alternative 4 Excavate impacted material to a depth of 18 inches, backfill, disposal at on-site repository with RCRA Subtitle C cap	Alternative 5 Excavate all impacted material to depth of contamination, backfill residential areas, regrade non-residential areas, and disposal at on-site repository with RCRA Subtitle C cap	Alternative 6 Excavate all impacted material to depth of contamination, backfill residential areas, regrade non-residential areas, and disposal at on-site repository with soil cover
Threshold Criteria						
OVERALL PROTECTIVENESS						
Human health	No	Yes	Yes	Yes	Yes	Yes
Environmental protection	No	Yes	Yes	Yes	Yes	Yes
COMPLIANCE WITH ARARS						
Chemical-specific ARARs	No	Yes	Yes	Yes	Yes	Yes
Location-specific ARARs	NA	Yes	Yes	Yes	Yes	Yes
Action-specific ARARs	No	Yes	Yes	Yes	Yes	Yes
Other criteria/guidance (TBC criteria)	No	Yes	Yes	Yes	Yes	Yes
Balancing Criteria						
LONG-TERM EFFECTIVENESS AND PERMANENCE						
Magnitude of residual risk	--	1	5	4	2	3
Adequacy and reliability of controls	--	1	5	4	2	3
REDUCTION OF TOXICITY, MOBILITY, VOLUME						
Treatment process used	--	NA	NA	NA	NA	NA
Amount destroyed or treated	--	NA	NA	NA	NA	NA
Reduction of toxicity, mobility, or volume	--	1	5	4	2	3
Irreversible treatment	--	NA	NA	NA	NA	NA
Type and quantity of residuals remaining after treatment	--	NA	NA	NA	NA	NA
Statutory preference for treatment	--	ND	ND	ND	ND	ND

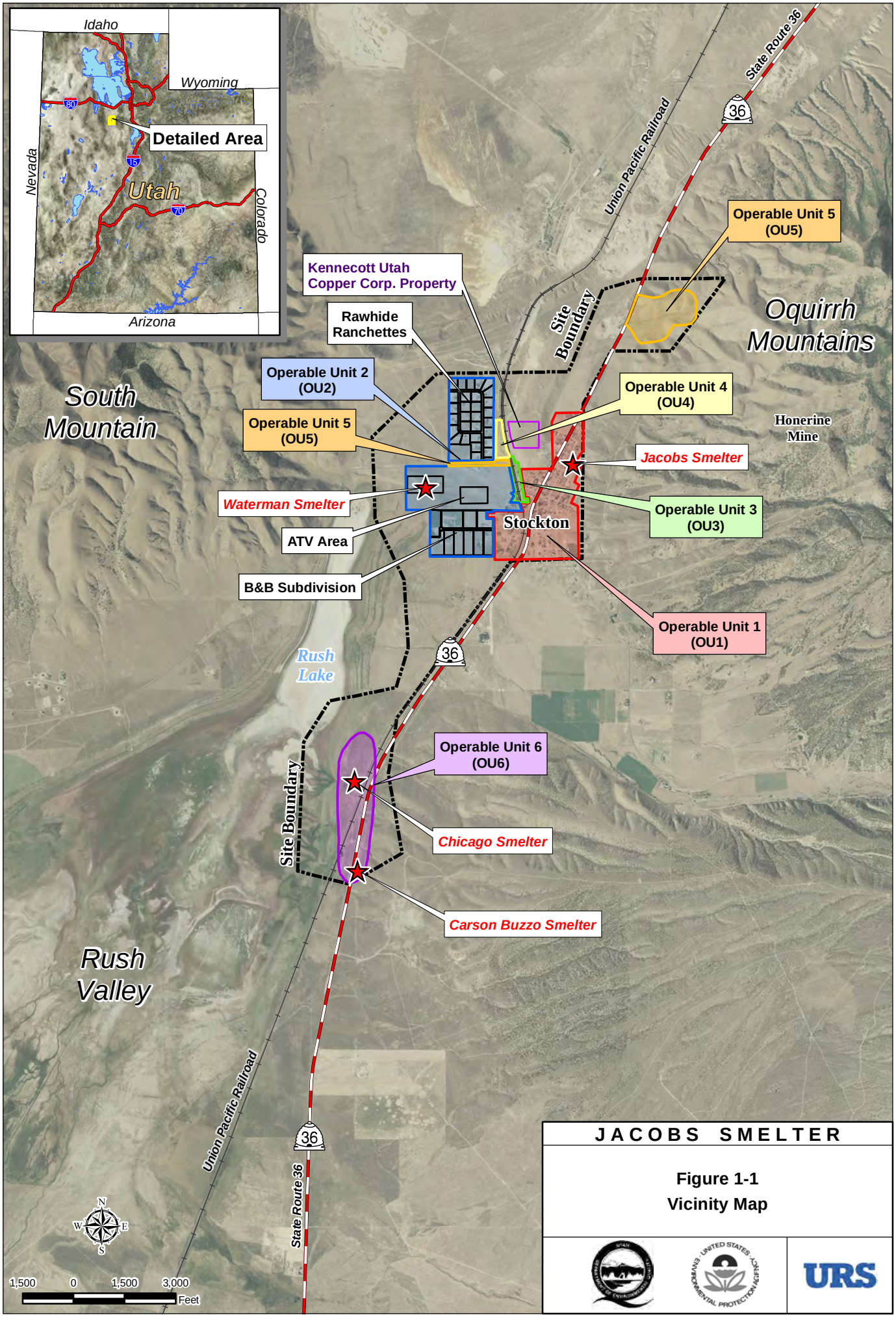
TABLE 6-1
Ranking[a] of Remedial Alternatives
(Continued)

Criteria	Alternative 1 No action	Alternative 2 Excavate impacted material to a depth of 18 inches, backfill, off-site disposal	Alternative 3 Cover material in excess of site action levels with clean soil	Alternative 4 Excavate impacted material to a depth of 18 inches, backfill, disposal at on-site repository with RCRA Subtitle C cap	Alternative 5 Excavate all impacted material to depth of contamination, backfill residential areas, regrade non-residential areas, and disposal at on-site repository with RCRA Subtitle C cap	Alternative 6 Excavate all impacted material to depth of contamination, backfill residential areas, regrade non-residential areas, and disposal at on-site repository with soil cover
SHORT-TERM EFFECTIVENESS						
Community protection	--	2	1	5	4	3
Worker protection	--	2	1	5	4	3
Environmental impacts	--	2	1	5	4	3
Time until action is complete	--	12 months	9-12 months	21-24 months	24 months	18-21 months
IMPLEMENTABILITY						
Ability to construct and operate	--	2	1	5	4	3
Ease of additional remediation, if needed	--	1	5	4	3	2
Ability to monitor effectiveness	--	1	5	4	3	2
Ability to obtain approval from other agencies	--	2	1	3	4	5
Availability of services and capacities	--	ND	ND	ND	ND	ND
Availability of equipment, specialists, materials	--	ND	ND	ND	ND	ND
Availability of technology	--	ND	ND	ND	ND	ND
COST						
Total present worth	--	$9,647,000	$5,278,000	$8,065,000	$8,326,000	$7,664,000

Notes:
AOC – Area of Contamination
ARAR – Applicable or Relevant and Appropriate Requirements
CERCLA – Comprehensive Environmental Response, Compensation and Liability Act
NA – Not Applicable
ND – No difference in ranking between alternatives
RCRA – Resource Conservation and Recovery Act
TBC – To Be Considered
-- – Not evaluated because criteria not met.

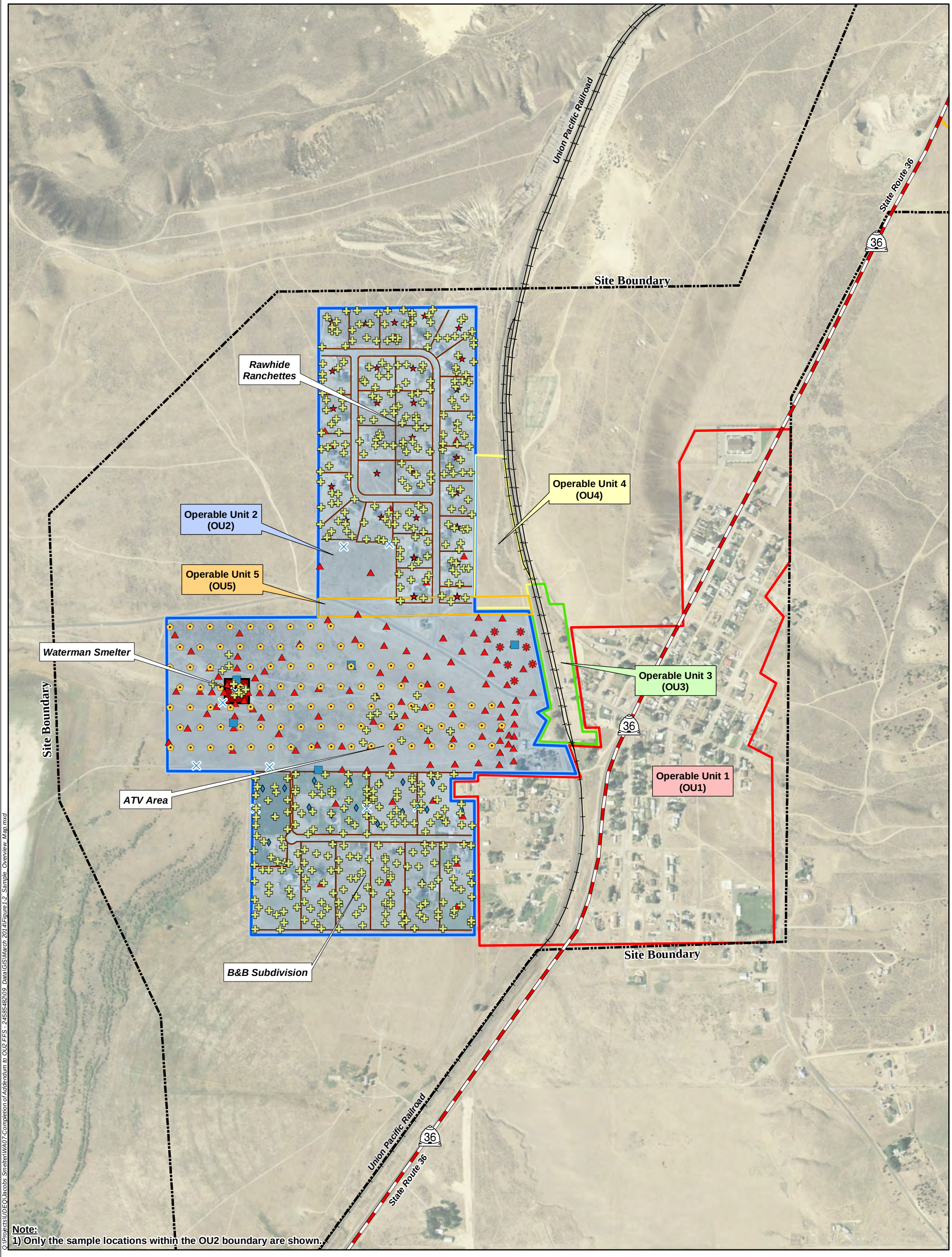
[a] The lower the rank (or number), the more compliant the alternative is with the CERCLA guidelines.

FIGURES



JACOBS SMELTER

Figure 1-1
Vicinity Map



Q:\Projects\UDEQ\Jacobs Smelter\WA07-Completion of Addendum to OU2 FFS - 24585482\09. Data\GIS\March 2014\Figure1-2_Sample_Overview_Map.mxd

LEGEND

Sampling Locations by Event

- UOS (1998)
- CSS (Oct - Dec 1999)
- Rawhide Ranchette Subdivision (May 2000)
- Pre-RI (Dec 2000 - Jan 2001 / Mar - Apr 2001)
- RI - First phase (Apr - May 2002)
- RI - Second phase (Feb 2003)
- FS Addendum (Oct 2009 - Feb 2010)
- Waterman Smelter Sampling (Aug 2011)

Field Measurements

SOP1713 (XRF)

Laboratory Analysis

ICP

C200.7

6200 (XRF)

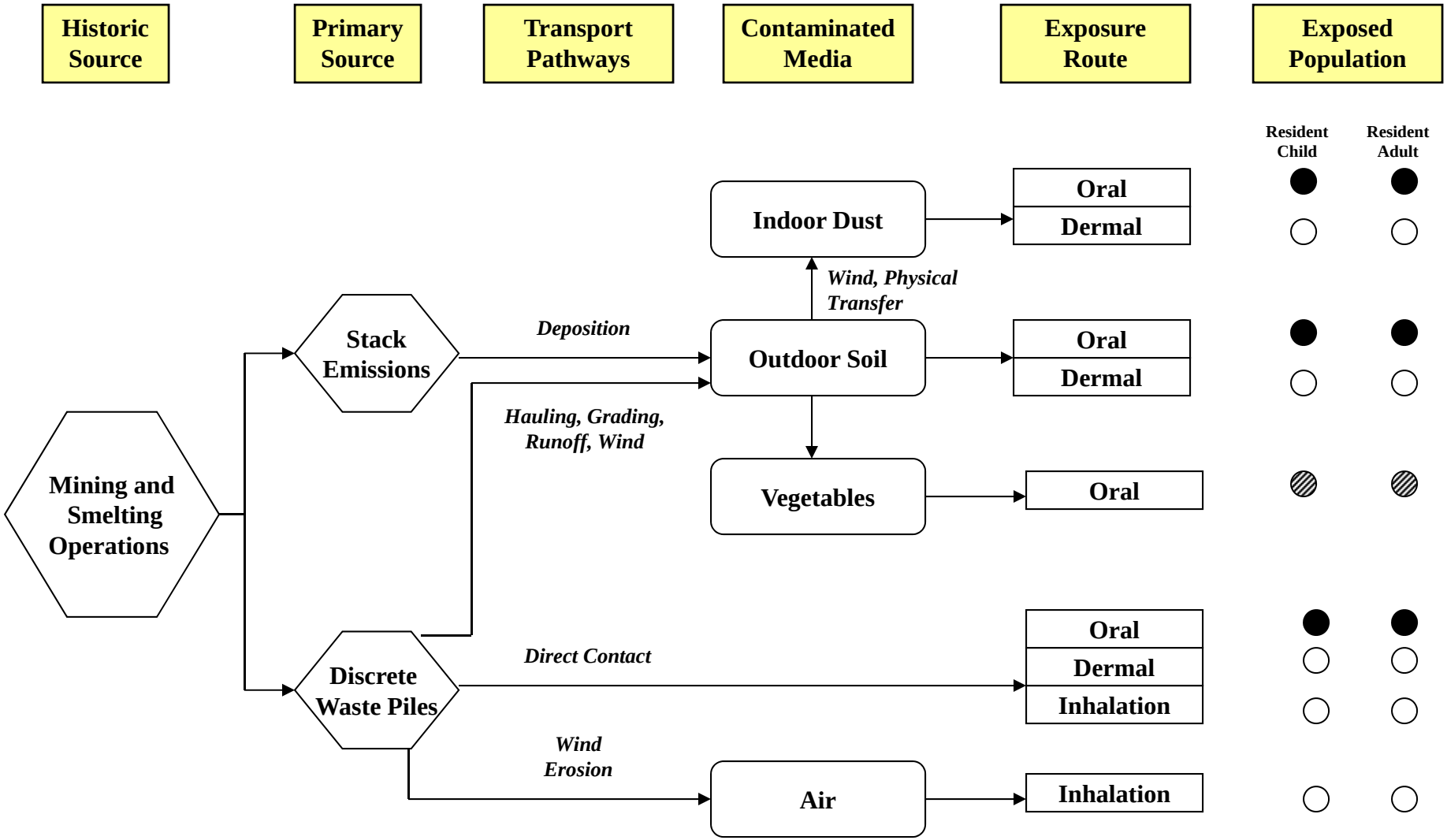
N W E S

0 375 750 Feet

JACOBS SMELTER OU2

Figure 1-2
Overview of Samples Collected Within OU2

URS

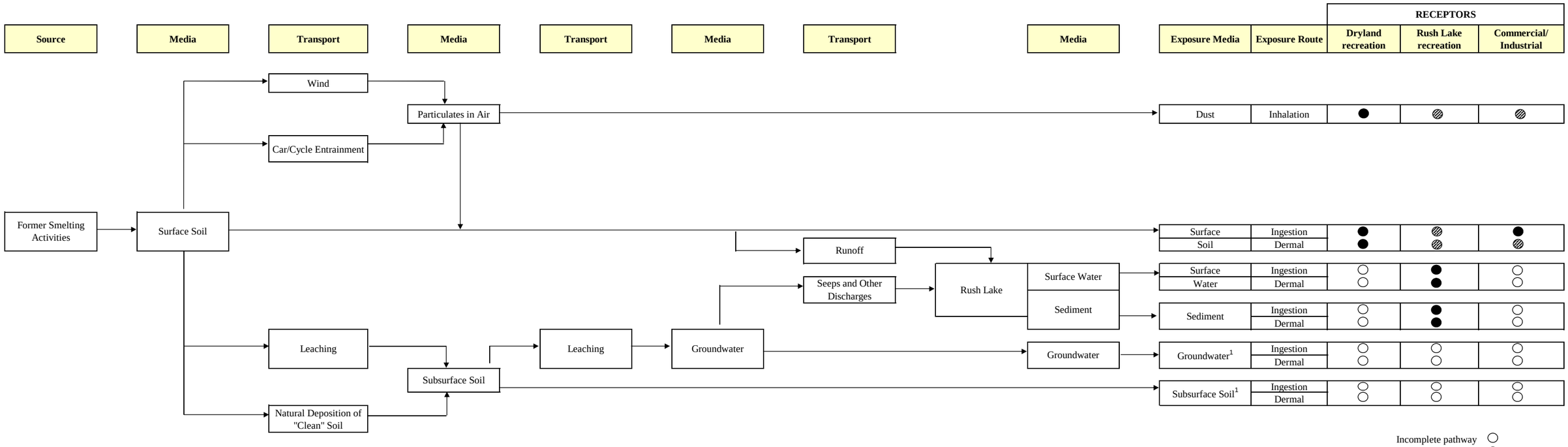


Pathway is not complete; No evaluation necessary.

Pathway is or may be complete; however, risk is low or data are lacking; qualitative evaluation only.

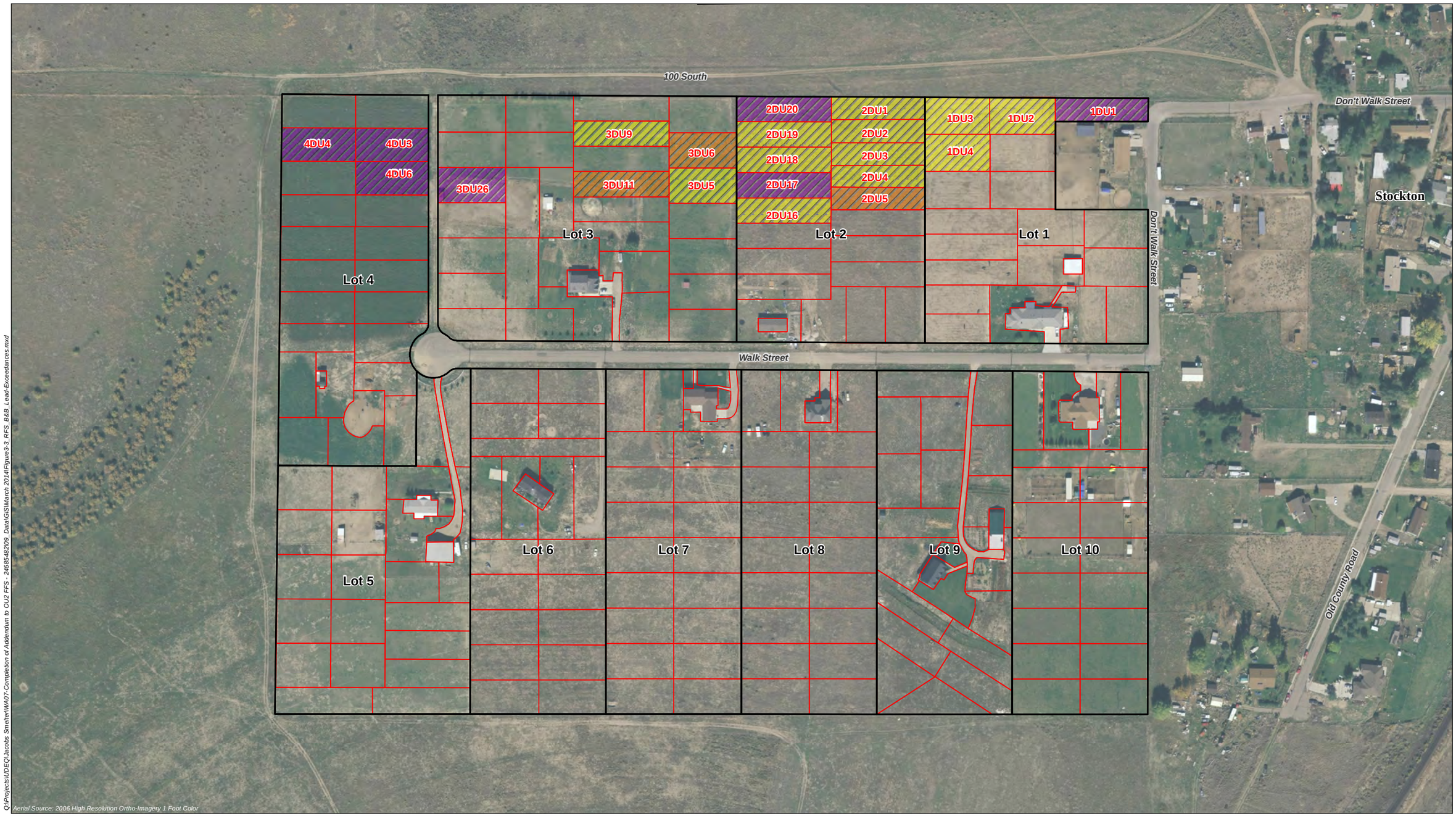
Pathway is or may be complete and may be significant; quantitative evaluation.

Figure 3-1
Conceptual Site Model for Residential Exposure
Jacobs Smelter OU2, Stockton, UT
(from ISSI 1999)



Note 1: This CSM is based on current conditions. There may be potential for future exposure to these media that could require updating of this CSM.

Figure 3-2.
Conceptual Site Model for
Non-Residential Human Exposure
Jacobs Smelter OU2, Stockton, UT
(from URS. 2001)



Q:\Projects\UDEQ\Jacobs Smelter\WA07-Completion of Addendum to OU2 FFS - 24585482/09_Data\GIS\March 2014\Figure3-3_RFS_B&B_Lead-Exceedances.mxd

LEGEND

At least one sample has lead concentration in exceedance of site criteria for:

- *Surface = 500 mg/kg - 0.72 acres*
- *Subsurface = 800 mg/kg - 1.75 acres*
- *Surface = 500 mg/kg and Subsurface = 800 mg/kg - 2.91 acres*

- Decision Unit
- Lot Boundary

N
W E
S

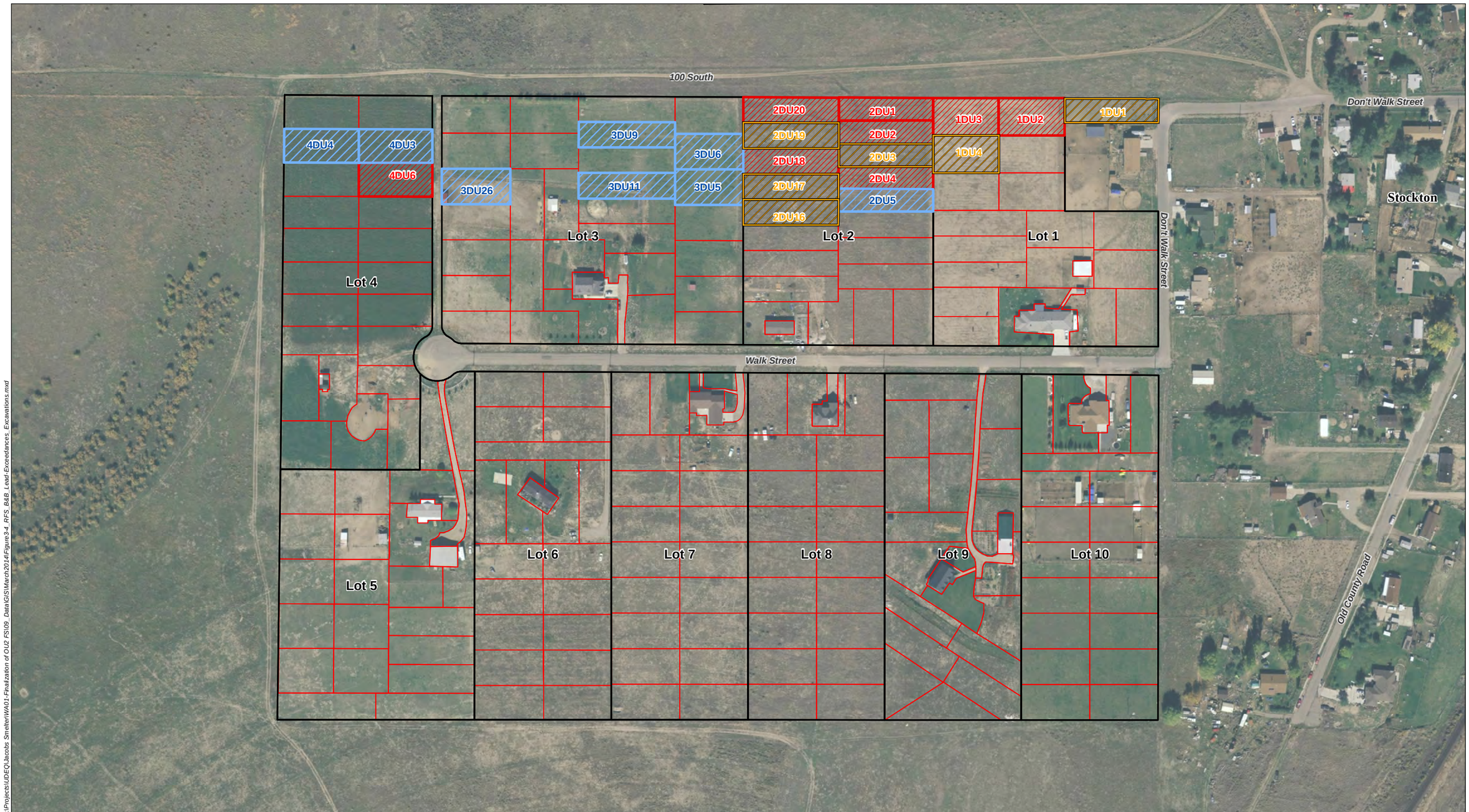
0 100 200 300 Feet

JACOBS SMELTER OU2

Figure 3-3

B&B Subdivision Lead Exceedances

URS



Q:\Projects\UDEQ\Jacobs Smelter\WA01-Finalization of OU2 FS\09_Data\GIS\March2014\Figure3-4_RFS_B&B_Lead-Exceedances_Excavations.mxd

LEGEND

Excavation Areas (Excavation Depth)

- *0-6" bgs (Surface) - 2.0 acres*
- *0-12" bgs (Shallow Subsurface) - 1.5 acres*
- *0-18" bgs (Deep Subsurface) - 1.9 acres*

Decision Unit

Lot Boundary

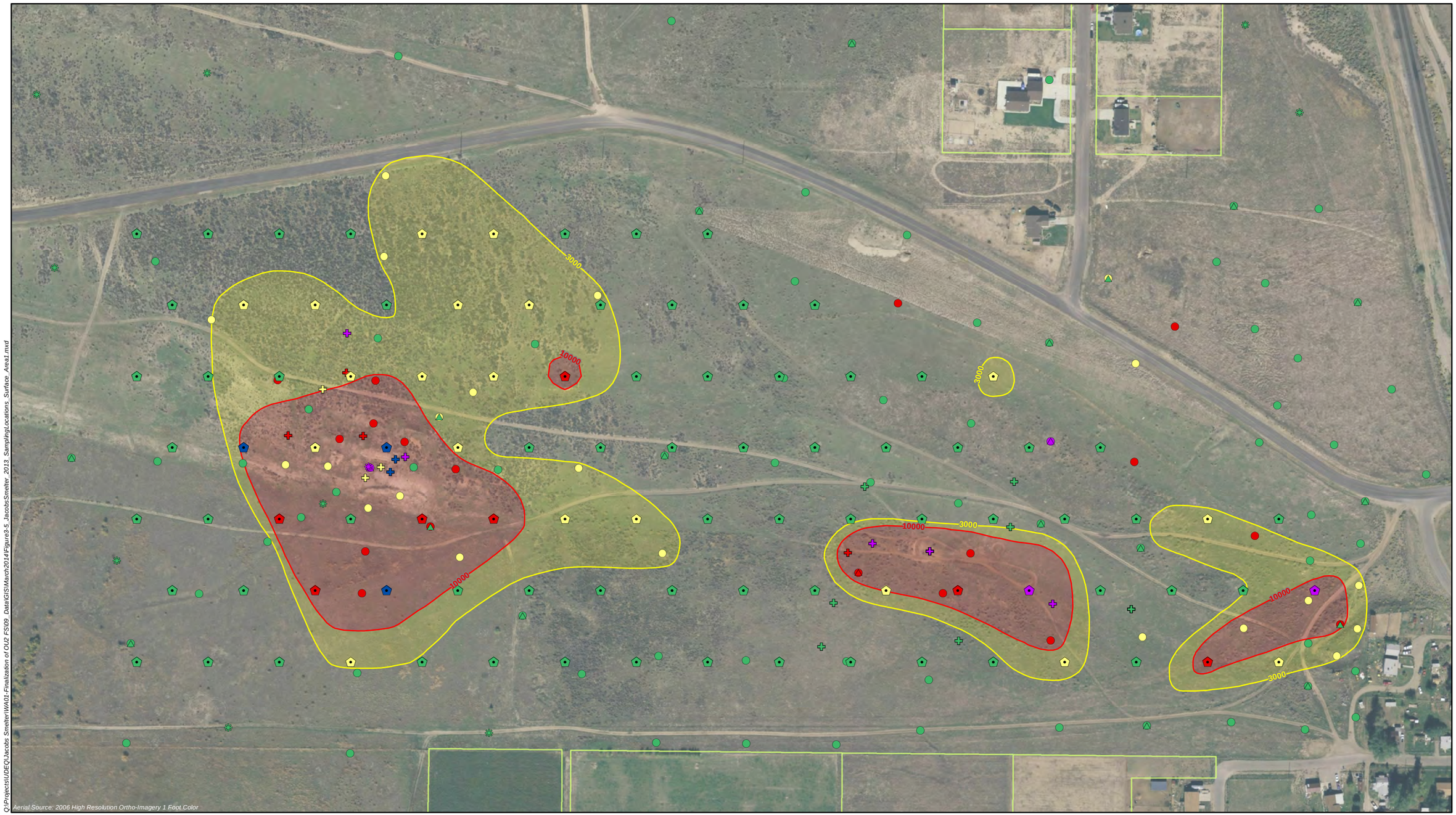
N W E S

0 100 200 300 Feet

JACOBS SMELTER OU2

Figure 3-4
B&B Subdivision
Proposed Excavation Areas
Based on Lead Exceedances

URS



Q:\Projects\UDEQ\Jacobs Smelter\WA01-Finalization of OU2 FS\09_Data\GIS\March2014\Figure3-5_JacobsSmelter_2013_SamplingLocations_Surface_Area1.mxd

LEGEND

Sampling Locations by Event (Analysis Method)

- *Waterman Smelter Sampling (C200.7)*
- *FS Addendum (6200)*
- *RI - First Phase (ICP)*
- *CSS (ICP)*
- *CSS (SOP 1713)*

Sample Concentration (mg/kg)

- *< 3,000*
- *3,000 - 10,000*
- *10,000 - 25,000*
- *25,000 - 50,000*
- *> 50,000*
- Subdivision Lots

Notes:

1) bgs = below ground surface
2) Contours primilary based on results from the 2011 WS Sampling event for the 0-6 inches bgs sample interval. Contours adjusted, where necessary, based on previous sample data.
3) RI and CSS samples collected at 0 inches bgs and 0-2 inches bgs. Additional Sampling Event / FS Addendum samples collected at 0 inches bgs and 0-2 inches bgs. The maximum concentration measured in these intervals is used to check surface and contours.

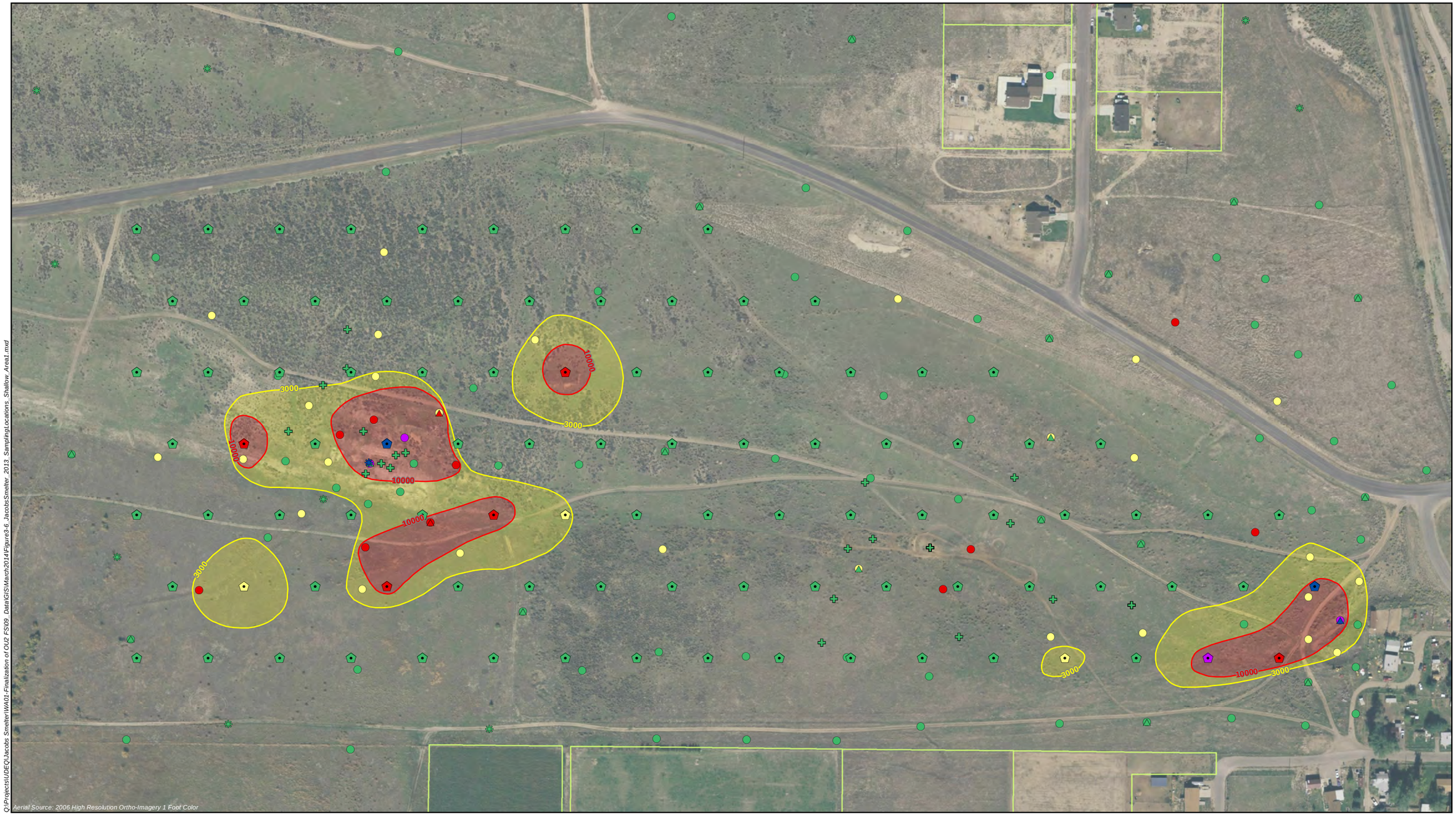
N
W E
S

0 110 220 330 Feet

JACOBS SMELTER OU2

Figure 3-5
Waterman Smelter and ATV Area
Lead Isoconcentration Map
Surface (0-6" bgs)

URS



Q:\Projects\UDEQ\Jacobs Smelter\WA01-Finalization of OU2 FS\09_Data\GIS\March2014\Figure3-6_JacobsSmelter_2013_SamplingLocations_Shallow_Area1.mxd

LEGEND

Sampling Locations by Event (Analysis Method)

- *Waterman Smelter Sampling (C200.7)*
- *FS Addendum (6200)*
- *RI - First Phase (ICP)*
- *CSS (ICP)*
- *CSS (SOP 1713)*

Sample Concentration (mg/kg)

- *< 3,000*
- *3,000 - 10,000*
- *10,000 - 25,000*
- *25,000 - 50,000*
- *> 50,000*
- Subdivision Lots

Notes:
1) bgs = below ground surface
2) Contours primarily based on results from the 2011 WS Sampling event for the 6-12 inches bgs sample interval. Contours adjusted, where necessary, based on previous sample data.
3) RI and CSS samples collected at 2-12 inches bgs. Additional Sampling Event / FS Addendum samples collected at 6-12 inches bgs.

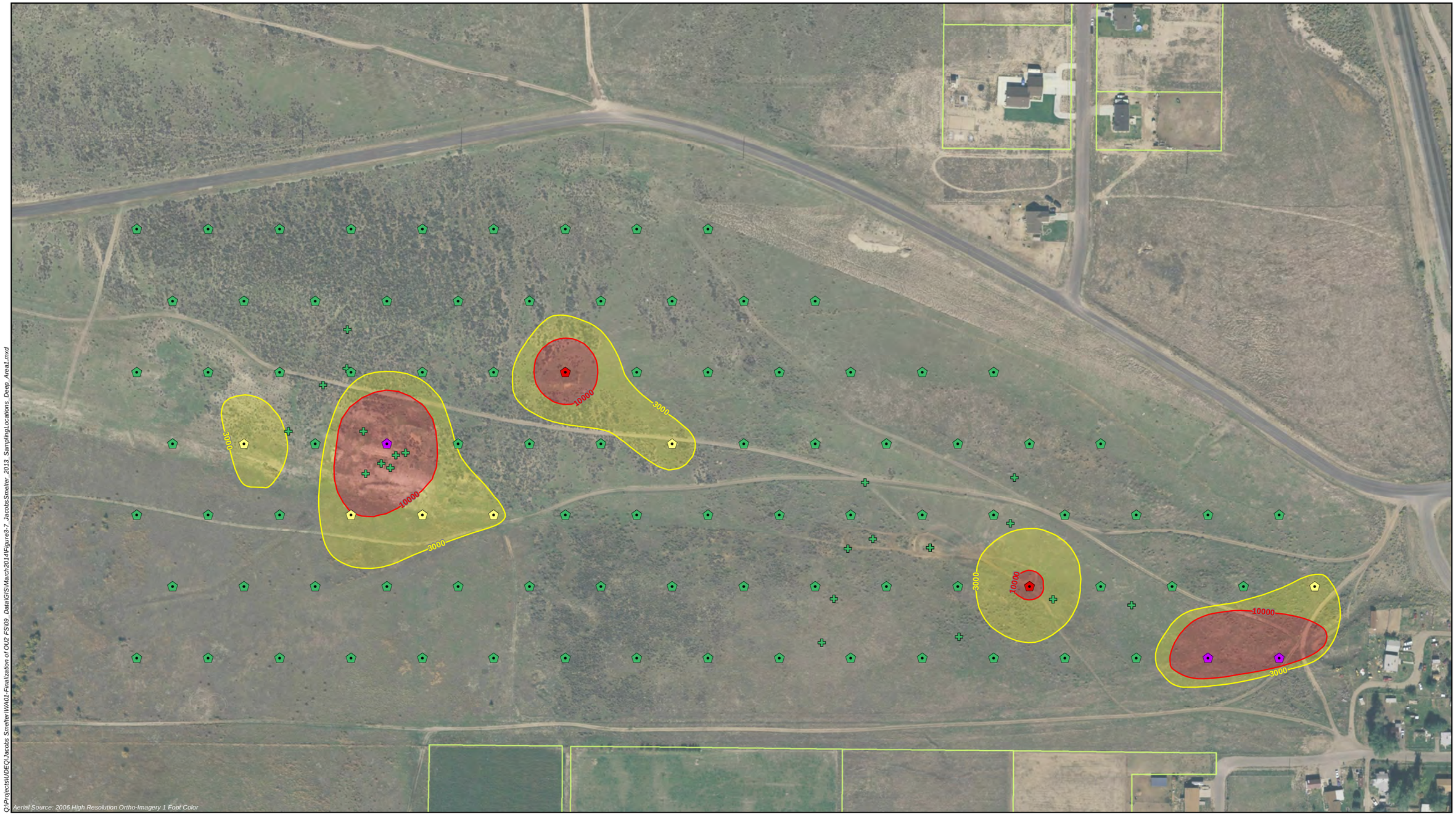
N
W E
S

0 110 220 330 Feet

JACOBS SMELTER OU2

Figure 3-6
Waterman Smelter and ATV Area
Lead Isoconcentration Map
Shallow Subsurface (6-12" bgs)

URS



Q:\Projects\UDEQ\Jacobs Smelter\WA01-Finalization of OU2 FS\09_Data\GIS\March2014\Figure3-7_JacobsSmelter_2013_SamplingLocations_Deep_Area1.mxd

LEGEND

Sampling Locations by Event (Analysis Method)

- *2011 WS Sampling (C200.7)*
- *Additional Sampling Event / FS Addendum (6200)*

Sample Concentration (mg/kg)

- *< 3,000*
- *3,000 - 10,000*
- *10,000 - 25,000*
- *25,000 - 50,000*
- *> 50,000*
- Subdivision Lots

Notes:
1) bgs = below ground surface
2) Contours primilary based on results from the 2011 WS Sampling event for the 12-18 inches bgs sample interval.
3) Additional Sampling Event / FS Addendum samples collected at 12-18 inches bgs are used to check deep subsurface contours.

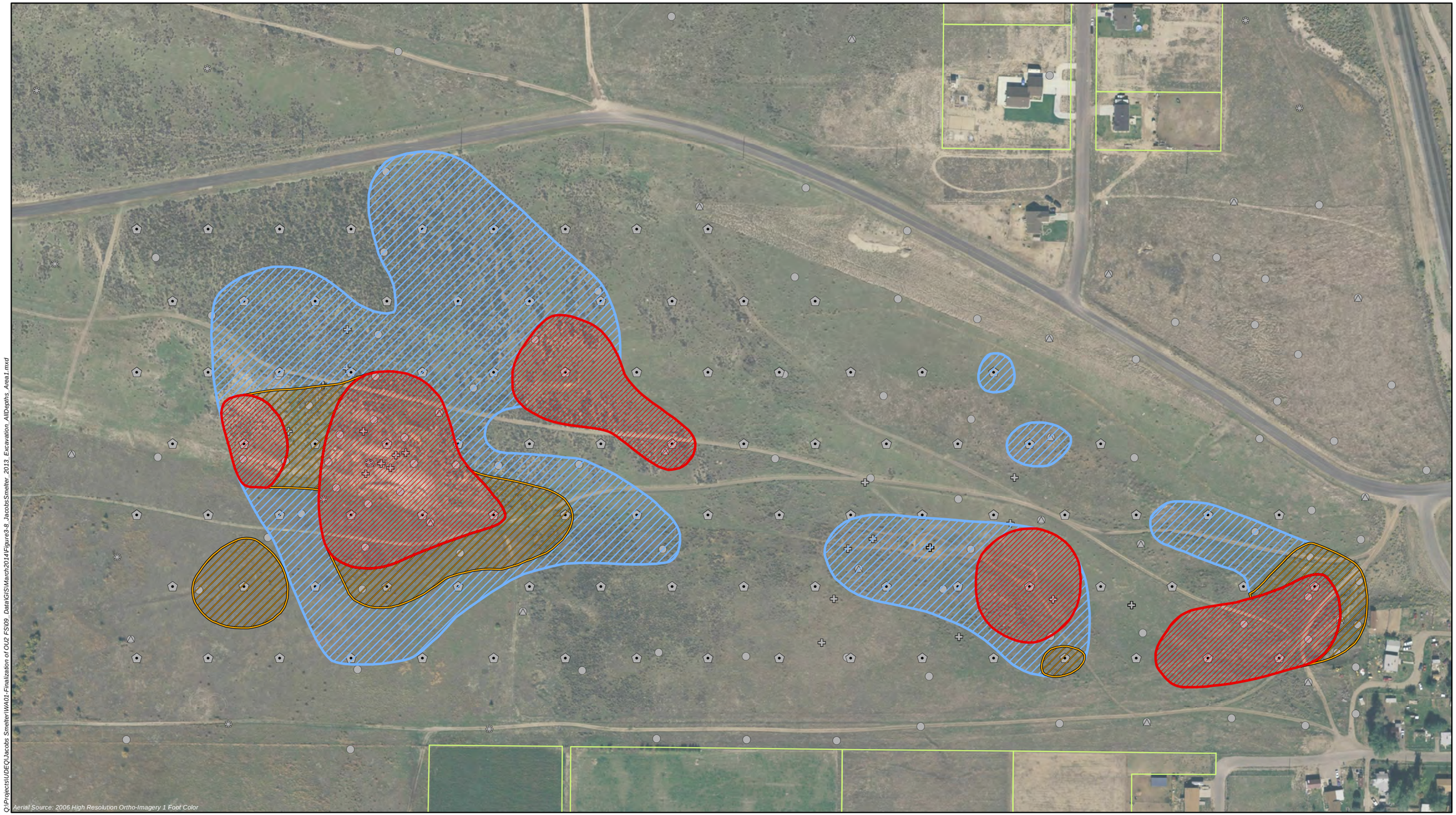
N W E S

0 110 220 330 Feet

JACOBS SMELTER OU2

Figure 3-7
Waterman Smelter and ATV Area
Lead Isoconcentration Map
Deep Subsurface (12-18" bgs)

URS



Q:\Projects\UDEQ\Jacobs Smelter\WA01-Finalization of OU2 FS\09_Data\GIS\March2014\Figure3-8_JacobsSmelter_2013_Excavation_AllDepths_Area1.mxd

LEGEND

Sampling Locations by Event (Analysis Method)

- *Waterman Smelter Sampling (C200.7)*
- *FS Addendum (6200)*
- *RI - First Phase (ICP)*
- *CSS (ICP)*
- *CSS (SOP 1713)*

Excavation Areas (Excavation Depth)

- *0-6" bgs (Surface)* - 14.6 acres
- *0-12" bgs (Shallow Subsurface)* - 3.6 acres
- *0-18" bgs (Deep Subsurface)* - 8.5 acres

Subdivision Lots

Notes:
1) bgs = below ground surface
2) Excavation areas based on contours shown in Figure 3-5, 3-6, and 3-7.

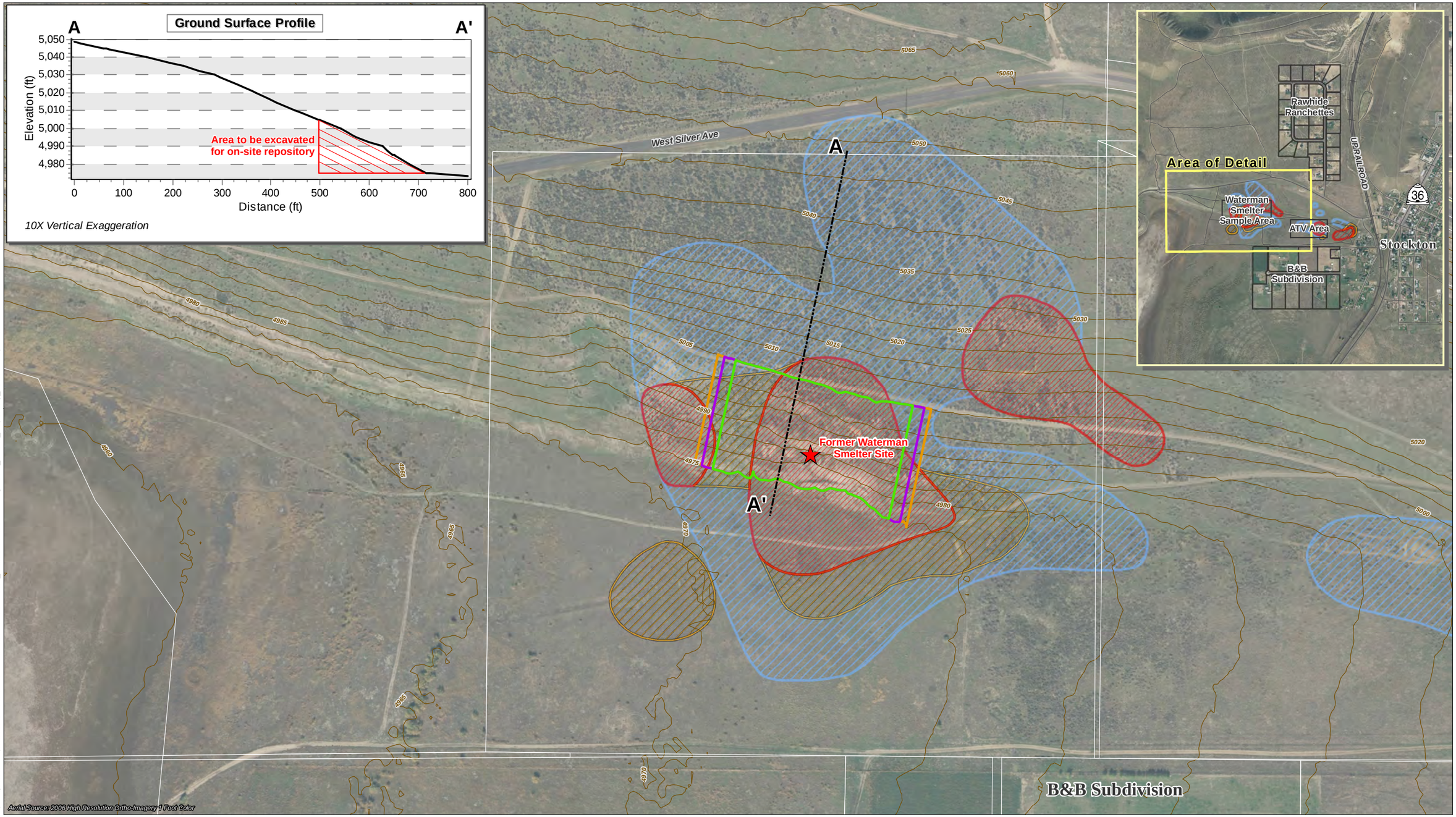
N W E S

0 110 220 330 Feet

JACOBS SMELTER OU2

Figure 3-8
Waterman Smelter and ATV Area
Proposed Excavation Areas
Based on Lead Exceedances

URS



Q:\Projects\UDEQ\Jacobs Smelter\WA01-Finalization of OU2 FS\09_Data\GIS\March2014\Figure3-9_OnSite_Repository_LocationMap.mxd

LEGEND

4975 — 5 ft Surface Contour

A_...A' Cross Section Location

Proposed On-Site Repository Area

- Alternative 4
- Alternative 5
- Alternative 6

Excavation Areas (Excavation Depth)

- *0-6" bgs (Surface)* - 14.6 acres
- *0-12" bgs (Shallow Subsurface)* - 3.6 acres
- *0-18" bgs (Deep Subsurface)* - 8.5 acres

Notes:

1) bgs = below ground surface
2) Excavation areas based on contours shown in Figure 3-5, 3-6 and 3-7.
3) The area of the on-site repository varies for each alternative. The area of proposed on-site repository is 2.0 acres for Alternative 4; 2.4 acres for Alternative 5; and 2.3 acres for Alternative 6.

N W E S

0 100 200 300 Feet

JACOBS SMELTER OU2

Figure 3-9
Waterman Smelter Area
On-Site Repository Location Map

URS

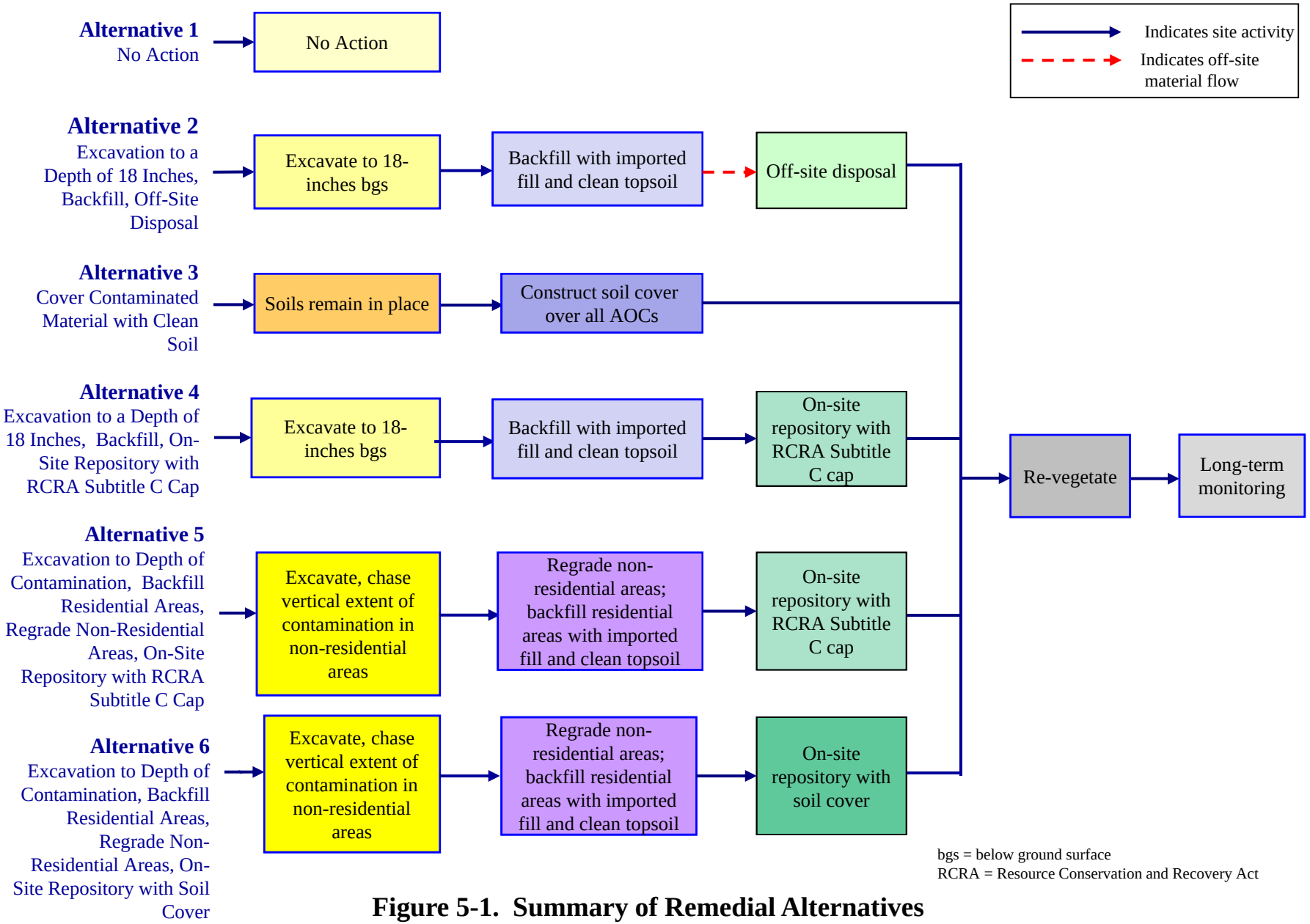


Figure 5-1. Summary of Remedial Alternatives

APPENDIX A

Capital and O&M Cost Estimates

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Table A-1
Jacobs Smelter OU2 Cost Summary

	Capital	Present Worth O&M	Present Worth	Brief Description of Alternative
Alternative 1	$0	$0	$0	No action
Alternative 2	$9,443,000	$204,000	$9,647,000	Excavate material in excess of site action levels to a depth of 18 inches, backfill with clean soil, and dispose of excavated materials **off-site**.
Alternative 3	$5,056,000	$222,000	$5,278,000	Cover material in excess of site action levels with clean soil.
Alternative 4	$7,647,000	$417,000	$8,065,000	Excavate material in excess of site action levels to a depth of 18 inches, backfill all areas with clean soil, and dispose of excavated materials in an **on-site repository with a RCRA Subtitle C cap**.
Alternative 5	$7,956,000	$371,000	$8,326,000	Excavate all material in excess of site action levels to the depth of contamination, backfill residential areas with clean soil, regrade non-residential areas, and dispose of excavated materials in an **on-site repository with a RCRA Subtitle C cap.**
Alternative 6	$7,293,000	$371,000	$7,664,000	Excavate all material in excess of site action levels to the depth of contamination, backfill residential areas with clean soil, regrade non-residential areas, and dispose of excavated materials in an **on-site repository with a soil cover.**

Notes:
O&M = Operations and Maintenance

a) Residential O&M costs for Alternatives 2 through 6 are negligible due to the size of the residential areas compared to the non-residential areas. The O&M for the residential areas will be conducted at the same time as the O&M for the non-residential areas and are therefore reflected in the non-residential O&M costs.
b) All numbers are rounded to the nearest $1000.

Table A-2
Jacobs Smelter OU2 Remedial Quantities

AREA OF CONTAMINATION	AREA (acres)	VOLUME (cu.yd.)	WEIGHT (tons)
RESIDENTIAL PROPERTIES			
SURFACE AND SUBSURFACE LEAD CONTAMINATION			
B&B Subdivision	5.4	8,631	12,818
Sub-Total	**5.4**	**8,631**	**12,818**
NON-RESIDENTIAL AREAS			
SURFACE AND SUBSURFACE LEAD CONTAMINATION			
Waterman Smelter	19.5	27,045	40,162
ATV Area	7.2	11,164	16,579
Sub-Total	26.7	38,209	56,741
TOTAL FOR ALL AREAS	**32.1**	**46,841**	**69,558**

Notes:
a) The above acreages are preliminary.
b) See Table A-3 for detailed remedial quantities.
c) Residential contamination defined as >500 mg/kg lead in surface (0-2 inches bgs) and >800 mg/kg lead in subsurface (2-12 inches bgs)
d) Non-residential contamination defined as >3,000 mg/kg lead in surface (0-6 inches bgs), shallow subsurface (6-12 inches bgs), and deep subsurface (12-18 inches bgs)
e) Acreages in non-residential areas estimated from countours primarily based on results from the 2011 sample event. Contours were adjusted, where necessary, based on previous sample data.

bgs = below ground surface
cu.yd. = cubic yard
mg/kg = milligrams per kilogram

Table A-3
Material Requirements and Waste Generation
Jacobs Smelter OU2

AREA OF CONTAMINATION	AREA[1] (acres)	Excavate DEPTH (inches)	Excavate VOLUME (Cu yd)	Excavate WEIGHT (tons)	Geotextile Fabric[2] AREA (Sq yd)	Backfill[3,4] DEPTH (inches)	Backfill[3,4] WEIGHT (tons)	Topsoil[4] DEPTH (inches)	Topsoil[4] WEIGHT (tons)	Vegetation AREA (acres)
Alternatives 2 - Excavate Material in Excess of Site Action Levels to a Depth of 18 Inches; Backfill with Clean Soil; and Dispose of Excavated Materials Off-Site										
B&B Subdivision										
6 in bgs excavation depth	2.0	6	1,608	2,387	-	--	--	9	3,256	2.0
12 in bgs excavation depth	1.5	12	2,355	3,498	-	9	2,504	9	2,385	1.5
18 in bgs excavation depth	1.9	18	4,668	6,932	9,336	18	6,617	9	3,151	1.9
Subtotal	*5.4*		*8,631*	*12,818*	*9,336*		*9,121*		*8,791*	*5.4*
Waterman Smelter										
6 in bgs excavation depth	11.1	6	8,924	13,252	-	--	--	9	18,071	11.1
12 in bgs excavation depth	2.9	12	4,704	6,986	-	9	5,001	9	4,763	2.9
18 in bgs excavation depth	5.5	18	13,416	19,923	26,833	18	19,018	9	9,056	5.5
Subtotal	*19.5*		*27,045*	*40,162*	*26,833*		*24,019*		*31,891*	*19.5*
ATV Area										
6 in bgs excavation depth	3.5	6	2,822	4,190	-	--	--	9	5,714	3.5
12 in bgs excavation depth	0.7	12	1,160	1,723	-	9	1,233	9	1,174	0.7
18 in bgs excavation depth	3.0	18	7,183	10,666	14,365	18	10,181	9	4,848	3.0
Subtotal	*7.2*		*11,164*	*16,579*	*14,365*		*11,414*		*11,737*	*7.2*
Total	**32.1**		**46,841**	**69,558**	**50,534**		**44,555**		**52,419**	**32.1**
Alternative 3 - Cover Material in Excess of Site Action Levels with Clean Soil										
B&B Subdivision	5.4	-	-	-	26,049	9	9,231	9	8,791	5.4
Waterman Smelter	19.5	-	-	-	94,491	9	33,485	9	31,891	19.5
ATV Area	7.2	-	-	-	34,775	9	12,324	9	11,737	7.2
Total	**32.1**				**155,316**		**55,040**		**52,419**	**32.1**

Notes:
1) The above acreages are preliminary.
2) Geotextile will only be placed in the areas excavated to 18 inches bgs.
3) Backfill and topsoil depths/volumes are based on uncompacted volumes. It is estimated that a 33% reduction in volume will occur during compaction.
4) A 33% compaction factor was estimated for bringing the fill material to grade. Therefore, the areas where soil is excavated to 6 inches will be filled with 9 inches of clean topsoil; the areas where soil is excavated to 12 inches will be filled with 9 inches of un-contaminated backfill followed by 9 inches of clean topsoil; and the areas where soil was excavated to 18 inches will be filled with 18 inches of un-contaminated backfill followed by 9 inches of clean topsoil.
5) The size of the on-site repository was estimated based on the volume of contaminated soil excavated and the selected cover design for each alternative. The material requirements and waste generation associated with the on-site repository are described in Appendix B. In summary, the area of the the on-site repository is 2.0 acres for Alternative 4, 2.4 acres for Alternative 5, and 2.3 acres for Alternative 6.
6) The repository RCRA Subtitle C cap consists of the following layers from top to bottom: 6 inches of gravel armor, 18 inches of common backfill, 4-ounce geotextile fabric, 12 inches of drainage material, 4-ounce geotextile fabric, and a geosynthetic clay liner.
7) The repository soil cover consists of the following layers from top to bottom: 6 inches of uncompacted topsoil, 12 inches of uncompacted backfill, a 4-ounce geotextile fabric.

Conversion Factors:

Average Density of In-Place Material = 110 lb/ft^3 (typical value taken from literature for similar soils)

Average Density of Uncompacted Backfill Material = 105 lb/ft^3

Average Density of Uncompacted Topsoil Material = 100 lb/ft^3

1 acre = 4,840 sq yd
1 acre = 43,560 sq ft
1 cu yd = 27 cu ft

bgs = below ground surface
in = inches
Cu ft = cubic feet
lb/ft^3 = pounds per cubic feet
Cu yd = cubic yard
Sq yd = square yard

Table A-3 (cont'd)
Material Requirements and Waste Generation
Jacobs Smelter OU2

		Excavate			Geotextile Fabric[2]	Backfill[3,4]		Topsoil[4]		Vegetation
AREA OF CONTAMINATION	AREA[1] (acres)	DEPTH (inches)	VOLUME (Cu yd)	WEIGHT (tons)	AREA (Sq yd)	DEPTH (inches)	WEIGHT (tons)	DEPTH (inches)	WEIGHT (tons)	AREA (acres)
Alternative 4 - Excavate Material in Excess of Site Action Levels to a Depth of 18 Inches; Backfill All Areas with Clean Soil; and Dispose of Excavated Materials in an On-Site Repository with a RCRA Subtitle C Cap										
B&B Subdivision										
6 in bgs excavation depth	2.0	6	1,608	2,387	-	--	--	9	3,256	2.0
12 in bgs excavation depth	1.5	12	2,355	3,498	-	9	2,504	9	2,385	1.5
18 in bgs excavation depth	1.9	18	4,668	6,932	9,336	18	6,617	9	3,151	1.9
Subtotal	*5.4*		*8,631*	*12,818*	*9,336*		*9,121*		*8,791*	*5.4*
Waterman Smelter (Area of on-site repository subtracted)[5,6]										
6 in bgs excavation depth	11.0	6	8,853	13,146	-	--	--	9	17,926	11.0
12 in bgs excavation depth	2.5	12	4,049	6,013	-	9	4,305	9	4,100	2.5
18 in bgs excavation depth	4.0	18	9,772	14,511	19,544	18	13,852	9	6,596	4.0
Subtotal	*17.5*		*22,674*	*33,671*	*19,544*		*18,157*		*28,623*	*17.5*
ATV Area										
6 in bgs excavation depth	3.5	6	2,822	4,190	-	--	--	9	5,714	3.5
12 in bgs excavation depth	0.7	12	1,160	1,723	-	9	1,233	9	1,174	0.7
18 in bgs excavation depth	3.0	18	7,183	10,666	14,365	18	10,181	9	4,848	3.0
Subtotal	*7.2*		*11,164*	*16,579*	*14,365*		*11,414*		*11,737*	*7.2*
Total	**30.1**		**42,470**	**63,067**	**43,245**		**38,693**		**49,151**	**30.1**

Notes:
1) The above acreages are preliminary.
2) Geotextile will only be placed in the areas excavated to 18 inches bgs.
3) Backfill and topsoil depths/volumes are based on uncompacted volumes. It is estimated that a 33% reduction in volume will occur during compaction.
4) A 33% compaction factor was estimated for bringing the fill material to grade. Therefore, the areas where soil is excavated to 6 inches will be filled with 9 inches of clean topsoil; the areas where soil is excavated to 12 inches will be filled with 9 inches of un-contaminated backfill followed by 9 inches of clean topsoil; and the areas where soil was excavated to 18 inches will be filled with 18 inches of un-contaminated backfill followed by 9 inches of clean topsoil.
5) The size of the on-site repository was estimated based on the volume of contaminated soil excavated and the selected cover design for each alternative. The material requirements and waste generation associated with the on-site repository are described in Appendix B. In summary, the area of the the on-site repository is 2.0 acres for Alternative 4, 2.4 acres for Alternative 5, and 2.3 acres for Alternative 6.
6) The repository RCRA Subtitle C cap consists of the following layers from top to bottom: 6 inches of gravel armor, 18 inches of common backfill, 4-ounce geotextile fabric, 12 inches of drainage material, 4-ounce geotextile fabric, and a geosynthetic clay liner.
7) The repository soil cover consists of the following layers from top to bottom: 6 inches of uncompacted topsoil, 12 inches of uncompacted backfill, a 4-ounce geotextile fabric.

Conversion Factors:

Average Density of In-Place Material = 110 lb/ft^3 (typical value taken from literature for similar soils)

Average Density of Uncompacted Backfill Material = 105 lb/ft^3

Average Density of Uncompacted Topsoil Material = 100 lb/ft^3

1 acre = 4,840 sq yd
1 acre = 43,560 sq ft
1 cu yd = 27 cu ft

bgs = below ground surface
in = inches
Cu ft = cubic feet
lb/ft^3 = pounds per cubic feet
Cu yd = cubic yard
Sq yd = square yard

Table A-3 (cont'd)
Material Requirements and Waste Generation
Jacobs Smelter OU2

		Excavate			Geotextile Fabric[2]	Backfill[3,4]		Topsoil[4]		Vegetation
AREA OF CONTAMINATION	AREA[1] (acres)	DEPTH (inches)	VOLUME (Cu yd)	WEIGHT (tons)	AREA (Sq yd)	DEPTH (inches)	WEIGHT (tons)	DEPTH (inches)	WEIGHT (tons)	AREA (acres)
Alternative 5 – Excavate All Material in Excess of Site Action Levels to the Depth of Contamination; Backfill Residential Areas with Clean Soil, Regrade Non-Residential Areas, Dispose of Excavated Material in On-Site Repository with a RCRA Subtitle C cap										
B&B Subdivision										
6 in bgs excavation depth	2.0	6	1,608	2,387	-	--	--	9	3,256	2.0
12 in bgs excavation depth	1.5	12	2,355	3,498	-	9	2,504	9	2,385	1.5
18 in bgs excavation depth	1.9	18	4,668	6,932	9,336	18	6,617	9	3,151	1.9
Subtotal	*5.4*		*8,631*	*12,818*	*9,336*		*9,121*		*8,791*	*5.4*
Waterman Smelter (Area of on-site repository subtracted)[5,6]										
6 in bgs excavation depth	10.8	6	8,737	12,974	-	-	-	9	17,692	10.8
12 in bgs excavation depth	2.4	12	3,870	5,748	-	-	-	9	3,919	2.4
18 in bgs excavation depth	3.8	18	9,310	13,825	-	-	-	9	6,284	3.8
Subtotal	*17.1*		*21,917*	*32,547*	*0*		-		*27,895*	*17.1*
ATV Area										
6 in bgs excavation depth	3.5	6	2,822	4,190	-	-	-	9	5,714	3.5
12 in bgs excavation depth	0.7	12	1,160	1,723	-	-	-	9	1,174	0.7
18 in bgs excavation depth	3.0	18	7,183	10,666	-	-	-	9	4,848	3.0
Subtotal	*7.2*		*11,164*	*16,579*	*0*		-		*11,737*	*7.2*
Subtotal (0 to 18 inches bgs)	**29.7**		**41,713**	**61,943**	**9,336**		**9,121**		**48,423**	**29.7**
Quantities for Chasing Contamination (Assuming an additional 12 inches of contamination in areas of 18-inch excavation depth)										
Additional 12 in under 18 in bgs excavation areas	6.8	12	10,995	16,327	-	-	-	-	-	-
Total			**52,708**	**78,271**	**9,336**		**9,121**		**48,423**	**29.7**

Notes:
1) The above acreages are preliminary.
2) Geotextile will only be placed in the areas excavated to 18 inches bgs.
3) Backfill and topsoil depths/volumes are based on uncompacted volumes. It is estimated that a 33% reduction in volume will occur during compaction.
4) A 33% compaction factor was estimated for bringing the fill material to grade. Therefore, the areas where soil is excavated to 6 inches will be filled with 9 inches of clean topsoil; the areas where soil is excavated to 12 inches will be filled with 9 inches of un-contaminated backfill followed by 9 inches of clean topsoil; and the areas where soil was excavated to 18 inches will be filled with 18 inches of un-contaminated backfill followed by 9 inches of clean topsoil.
5) The size of the on-site repository was estimated based on the volume of contaminated soil excavated and the selected cover design for each alternative. The material requirements and waste generation associated with the on-site repository are described in Appendix B. In summary, the area of the the on-site repository is 2.0 acres for Alternative 4, 2.4 acres for Alternative 5, and 2.3 acres for Alternative 6.
6) The repository RCRA Subtitle C cap consists of the following layers from top to bottom: 6 inches of gravel armor, 18 inches of common backfill, 4-ounce geotextile fabric, 12 inches of drainage material, 4-ounce geotextile fabric, and a geosynthetic clay liner.
7) The repository soil cover consists of the following layers from top to bottom: 6 inches of uncompacted topsoil, 12 inches of uncompacted backfill, a 4-ounce geotextile fabric.

Conversion Factors:

Average Density of In-Place Material = 110 lb/ft^3 (typical value taken from literature for similar soils)

Average Density of Uncompacted Backfill Material = 105 lb/ft^3

Average Density of Uncompacted Topsoil Material = 100 lb/ft^3

1 acre = 4,840 sq yd
1 acre = 43,560 sq ft
1 cu yd = 27 cu ft

bgs = below ground surface
in = inches
Cu ft = cubic feet
lb/ft^3 = pounds per cubic feet
Cu yd = cubic yard
Sq yd = square yard

Table A-3 (cont'd)
Material Requirements and Waste Generation
Jacobs Smelter OU2

AREA OF CONTAMINATION	AREA[1] (acres)	Excavate DEPTH (inches)	Excavate VOLUME (Cu yd)	Excavate WEIGHT (tons)	Geotextile Fabric[2] AREA (Sq yd)	Backfill[3,4] DEPTH (inches)	Backfill[3,4] WEIGHT (tons)	Topsoil[4] DEPTH (inches)	Topsoil[4] WEIGHT (tons)	Vegetation AREA (acres)
Alternative 6 – Excavate All Material in Excess of Site Action Levels to the Depth of Contamination; Backfill Residential Areas with Clean Soil, Regrade Non-Residential Areas, Dispose of Excavated Material in an On-Site Repository with a Soil Cover										
B&B Subdivision										
6 in bgs excavation depth	2.0	6	1,608	2,387	-	--	--	9	3,256	2.0
12 in bgs excavation depth	1.5	12	2,355	3,498	-	9	2,504	9	2,385	1.5
18 in bgs excavation depth	1.9	18	4,668	6,932	9,336	18	6,617	9	3,151	1.9
Subtotal	*5.4*		*8,631*	*12,818*	*9,336*		*9,121*		*8,791*	*5.4*
Waterman Smelter (Area of on-site repository subtracted)[5,7]										
6 in bgs excavation depth	10.9	6	8,763	13,013	-	-	-	9	17,745	10.9
12 in bgs excavation depth	2.4	12	3,898	5,788	-	-	-	9	3,947	2.4
18 in bgs excavation depth	3.9	18	9,544	14,174	-	-	-	9	6,443	3.9
Subtotal	*17.2*		*22,205*	*32,975*	*0*		-		*28,134*	*17.2*
ATV Area										
6 in bgs excavation depth	3.5	6	2,822	4,190	-	-	-	9	5,714	3.5
12 in bgs excavation depth	0.7	12	1,160	1,723	-	-	-	9	1,174	0.7
18 in bgs excavation depth	3.0	18	7,183	10,666	-	-	-	9	4,848	3.0
Subtotal	*7.2*		*11,164*	*16,579*	*0*		-		*11,737*	*7.2*
Subtotal (0 to 18 inches bgs)	**29.8**		**42,001**	**62,371**	**9,336**		**9,121**		**48,662**	**29.8**
Quantities for Chasing Contamination (Assuming an additional 12 inches of contamination in areas of 18-inch excavation depth)										
Additional 12 in under 18 in bgs excavation areas	6.9	12	11,151	16,560	-	-	-	-	-	-
Total			**53,152**	**78,931**	**9,336**		**9,121**		**48,662**	**29.8**

Notes:
1) The above acreages are preliminary.
2) Geotextile will only be placed in the areas excavated to 18 inches bgs.
3) Backfill and topsoil depths/volumes are based on uncompacted volumes. It is estimated that a 33% reduction in volume will occur during compaction.
4) A 33% compaction factor was estimated for bringing the fill material to grade. Therefore, the areas where soil is excavated to 6 inches will be filled with 9 inches of clean topsoil; the areas where soil is excavated to 12 inches will be filled with 9 inches of un-contaminated backfill followed by 9 inches of clean topsoil; and the areas where soil was excavated to 18 inches will be filled with 18 inches of un-contaminated backfill followed by 9 inches of clean topsoil.
5) The size of the on-site repository was estimated based on the volume of contaminated soil excavated and the selected cover design for each alternative. The material requirements and waste generation associated with the on-site repository are described in Appendix B. In summary, the area of the the on-site repository is 2.0 acres for Alternative 4, 2.4 acres for Alternative 5, and 2.3 acres for Alternative 6.
6) The repository RCRA Subtitle C cap consists of the following layers from top to bottom: 6 inches of gravel armor, 18 inches of common backfill, 4-ounce geotextile fabric, 12 inches of drainage material, 4-ounce geotextile fabric, and a geosynthetic clay liner.
7) The repository soil cover consists of the following layers from top to bottom: 6 inches of uncompacted topsoil, 12 inches of uncompacted backfill, a 4-ounce geotextile fabric.

Conversion Factors:

Average Density of In-Place Material = 110 lb/ft^3 (typical value taken from literature for similar soils)

Average Density of Uncompacted Backfill Material = 105 lb/ft^3

Average Density of Uncompacted Topsoil Material = 100 lb/ft^3

1 acre = 4,840 sq yd
1 acre = 43,560 sq ft
1 cu yd = 27 cu ft

bgs = below ground surface
in = inches
Cu ft = cubic feet
lb/ft^3 = pounds per cubic feet
Cu yd = cubic yard
Sq yd = square yard

Table A-4
Alternative 2 (Excavate to a depth of 18 inches, backfill, off-site disposal) - Capital Cost Estimate
Jacobs Smelters OU2 Residential and Non-Residential Zone

Item#	Description	Units	Quantity	Unit Cost	Notes	Cost
1	Truck Scale	Each	1	$45,000	1	$45,000
2	Clear and Grub Brush	Acres	32.1	$550	1	$17,655
3	Water Truck - Dust Suppression	Month	12	$15,000	1	$180,000
4	Excavation	Ton	69,558	$10	7	$695,585
5	Backfill - material, haul, and place	Ton	44,555	$23	2	$1,024,767
6	Topsoil - material, haul, and place	Ton	52,419	$32	2	$1,677,408
7	Geotextile Fabric 4 oz.	Sq yd	50,534	$0.98	3	$49,524
8	Revegetation	Acres	32.1	$300	1	$9,630
9	Erosion Control Blankets	Acres	32.1	$10,890	6	$349,569
9	Transport Bevill Exempt Waste to Subtitle C Hazardous Waste Landfill	Ton	69,558	$12.50	1	$869,481
10	Disposal of Bevill Exempt Waste at Subtitle C Hazardous Waste Landfill	Ton	69,558	$35	4	$2,434,546
11	Health & Safety Ambient Air Monitoring	Lump Sum	1	$55,950	5	$55,950
12	Final Site Wide Clean-up	Each	1	$10,000	1	$10,000
		Total Cost				$7,419,115
		Mobilization				$300,000
		Demobilization				$150,000
		Subtotal				$7,869,115
		Unidentified Construction Cost (10%)				$786,911
		Construction Management (10%)				$786,911
		TOTAL				**$9,442,938**

Assumptions:
a) TCLP testing will not be required by regulation based on the Bevill Exemption; however, a particular commercial facility may require TCLP tests based on policy or permit conditions.
b) Geotextile will only installed in the areas excavated to a depth of 18 inches below ground surface.

Notes:
1) Quote received from Environmental Remediation, LLC on 3/20/13.
2) Quote received from AET Environmental on 3/21/13.
3) Quote received from Geodynamics on 3/21/13. Typar non-woven fabric, price includes material and labor.
4) Quote from Steve Simpson with Clean Harbors on 8/8/13.
5) See Table A-23.
6) Quote received from Direct Push Services LLC on 10/25/11 for the Davenport Flagstaff site and includes installation and materials for coconut straw erosion control blankets.

7) Excavation cost based on the quote received from Environmental Remediaion, LLC on 3/20/13 and range of costs in 2014 RS Means.

oz = ounces
sq yd = square yard
TCLP = Toxic Characteristic Leachability Procedure

Table A-5
Alternative 3 (Cover impacted material with clean soil) - Capital Cost Estimate
Jacobs Smelters OU2 Residential and Non-Residential Zone

Item#	Description	Units	Quantity	Unit Cost	Notes	Cost
1	Truck Scale	Each	1	$45,000	1	$45,000
2	Clear and Grub Brush	Acres	32.1	$550	1	$17,655
3	Water Truck - Dust Suppression	Month	12	$15,000	1	$180,000
4	Backfill - material, haul, and place	Ton	55,040	$23	2	$1,265,919
5	Topsoil - material, haul, and place	Ton	52,419	$32	2	$1,677,408
6	Geotextile Fabric 4 oz.	Sq yd	155,316	$0.98	3	$152,209
7	Revegetation	Acres	32.1	$300	1	$9,630
8	Erosion Control Blankets	Acres	32.1	$10,890	5	$349,569
9	Health & Safety Ambient Air Monitoring	Lump Sum	1	$55,950	4	$55,950
10	Final Site Wide Clean-up	Each	1	$10,000	1	$10,000

Total Cost	$3,763,341
Mobilization	$300,000
Demobilization	$150,000
Subtotal	$4,213,341
Unidentified Construction Cost (10%)	$421,334
Construction Management (10%)	$421,334
TOTAL	**$5,056,009**

Notes:
1) Quote received from Environmental Remediation, LLC on 3/20/13.
2) Quote received from AET Environmental on 3/21/13.
3) Quote received from Geodynamics on 3/21/13. Typar non-woven fabric, price includes material and labor.
4) See Table A-23.
5) Quote received from Direct Push Services LLC on 10/25/11 for the Davenport Flagstaff site and includes installation and materials for coconut straw erosion control blankets.

oz = ounces
Sq yd = square yard

Table A-6
Alternative 4 (Excavate to a depth of 18 inches, backfill, disposal at on-site repository with RCRA Subtitle C cap) - Capital Cost Estimate

Jacobs Smelters OU2 Residential and Non-Residential Zone

Item#	Description	Units	Quantity	Unit Cost	Notes	Cost
1	Truck Scale	Each	1	$45,000	1	$45,000
2	Clear and Grub Brush	Acres	30.1	$550	1	$16,555
3	Water Truck - Dust Suppression	Month	24	$15,000	1	$360,000
4	Excavation of Contaminated Soils	Ton	63,067	$10	7	$630,673
5	Backfill - material, haul, and place	Ton	38,693	$23	2	$889,931
6	Topsoil - material, haul, and place	Ton	49,151	$32	2	$1,572,823
7	Geotextile Fabric 4 oz.	Sq yd	43,245	$0.98	3	$42,380
8	Revegetation	Acres	30.1	$300	1	$9,030
9	Erosion Control Blankets	Acres	30.1	$10,890	6	$327,789
10	On-Site Repository Generation	Each	1	$1,698,450	4	$1,698,450
11	Transport Contaminated Soil to On-Site Repository	Ton	63,067	$4	1	$252,269
12	Health & Safety Ambient Air Monitoring	Lump Sum	1	$67,950	5	$67,950
13	Final Site Wide Clean-up	Each	1	$10,000	1	$10,000
		Total Cost				$5,922,850
		Mobilization				$300,000
		Demobilization				$150,000
		Subtotal				$6,372,850
		Unidentified Construction Cost (10%)				$637,285
		Construction Management (10%)				$637,285
		TOTAL				**$7,647,420**

Assumptions:
a) Quantities based on the areas of contamination located within the proposed area for the on-site repository are not included in the estimates for excavation, backfilling, geotextile, and revegetation.
b) Geotextile will only be installed in the areas excavated to a depth of 18 inches below ground surface.
c) The size of the on-site repository was estimated based on the volume of contaminated soil excavated and the selected cover design for each alternative. The material requirements and waste generation associated with the on-site repository are described in Appendix B.
d) The volume of material excavated from the repository, with the exception of the top 18 inches, is of suitable quality and does not have elevated lead concentrations. Therefore, it can be used as clean backfill for the project.
e) For cost estimating purposes, it is assumed that the clean soil generated as part of the on-site repository excavation will not be used to backfill the remedial excavation.
f) Blasting will not be required to develop the on-site repository.

Notes:
1) Quote received from Environmental Remediation, LLC on 3/20/13.
2) Quote received from AET Environmental on 3/21/13.
3) Quote received from Geodynamics on 3/21/13. Typar non-woven fabric, price includes material and labor.
4) See Table A-20.
5) See Table A-23.
6) Quote received from Direct Push Services LLC on 10/25/11 for the Davenport Flagstaff site and includes installation and materials for coconut straw erosion control blankets.
7) Excavation cost based on the quote received from Environmental Remediaion, LLC on 3/20/13 and range of costs in 2014 RS Means.

oz = ounces
Sq yd = square yard

Table A-7
Alternative 5 (Excavate to depth of contamination, backfill residential areas, regrade non-residential areas, and disposal at on-site repository with RCRA Subtitle C cap) - Capital Cost Estimate
Jacobs Smelters OU2 Residential and Non-Residential Zone

Item#	Description	Units	Quantity	Unit Cost	Notes	Cost
1	Truck Scale	Each	1	$45,000	1	$45,000
2	Clear and Grub Brush	Acres	29.7	$550	1	$16,335
3	Water Truck - Dust Suppression	Month	24	$15,000	1	$360,000
4	Excavation of Contaminated Soils	Ton	61,943	$10	7	$619,434
5	Excavation for Chasing Contamination	Ton	16,327	$10	7	$163,274
6	Regrade Excavated Areas	Sq yd	143,748	$3	1	$431,244
7	Backfill - material, haul, and place	Ton	9,121	$23	2	$209,790
8	Topsoil - material, haul, and place	Ton	48,423	$32	2	$1,549,551
9	Geotextile Fabric 4 oz.	Sq yd	9,336	$0.98	3	$9,150
10	Revegetation	Acres	29.7	$300	1	$8,910
11	Erosion Control Blankets	Acres	29.7	$10,890	6	$323,433
12	On-Site Repository Generation	Each	1	$2,052,466	4	$2,052,466
13	Transport Contaminated Soil to On-Site Repository	Ton	78,271	$4	1	$313,083
14	Health & Safety Ambient Air Monitoring	Lump Sum	1	$67,950	5	$67,950
15	Final Site Wide Clean-up	Each	1	$10,000	1	$10,000
		Total Cost				$6,179,619
		Mobilization				$300,000
		Demobilization				$150,000
		Subtotal				$6,629,619
		Unidentified Construction Cost (10%)				$662,962
		Construction Management (10%)				$662,962
		TOTAL				**$7,955,543**

Assumptions:
a) Geotextile will only be installed in the areas excavated to a depth of 18 inches below ground surface in residential areas.
b) The size of the on-site repository was estimated based on the volume of contaminated soil excavated and the selected cover design for each alternative. The material requirements and waste generation associated with the on-site repository are described in Appendix B.
c) The volume of material excavated from the repository, with the exception of the top 18 inches, is of suitable quality and does not have elevated lead concentrations. Therefore, it can be used as clean backfill for the project.
d) For cost estimating purposes, it is assumed that the clean soil generated as part of the on-site repository excavation will not be used to backfill the remedial excavation.
e) Blasting will not be required to develop the on-site repository.

Notes:
1) Quote received from Environmental Remediation, LLC on 3/20/13.
2) Quote received from AET Environmental on 3/21/13.
3) Quote received from Geodynamics on 3/21/13. Typar non-woven fabric, price includes material and labor.
4) See Table A-20.
5) See Table A-23.
6) Quote received from Direct Push Services LLC on 10/25/11 for the Davenport Flagstaff site and includes installation and materials for coconut straw erosion control blankets.
7) Excavation cost based on the quote received from Environmental Remediaion, LLC on 3/20/13 and range of costs in 2014 RS Means.

oz = ounces
Sq yd = square yard

Table A-8
Alternative 6 (Excavate to depth of contamination, backfill residential areas, regrade non-residential areas, and disposal at on-site repository with soil cover) - Capital Cost Estimate
Jacobs Smelters OU2 Residential and Non-Residential Zone

Item#	Description	Units	Quantity	Unit Cost	Notes	Cost
1	Truck Scale	Each	1	$45,000	1	$45,000
2	Clear and Grub Brush	Acres	29.8	$550	1	$16,390
3	Water Truck - Dust Suppression	Month	21	$15,000	1	$315,000
4	Excavation of Contaminated Soils	Ton	62,371	$10	7	$623,711
5	Excavation for Chasing Contamination	Ton	16,560	$10	7	$165,598
6	Regrade Excavated Areas	Sq yd	144,232	$3	1	$432,696
7	Backfill - material, haul, and place	Ton	9,121	$23	2	$209,790
8	Topsoil - material, haul, and place	Ton	48,662	$32	2	$1,557,183
9	Geotextile Fabric 4 oz.	Sq yd	9,336	$0.98	3	$9,150
10	Revegetation	Acres	29.8	$300	1	$8,940
11	Erosion Control Blankets	Acres	29.8	$10,890	6	$324,522
12	On-Site Repository Generation	Each	1	$1,532,022	4	$1,532,022
13	Transport Contaminated Soil to On-Site Repository	Ton	78,931	$4	1	$315,723
14	Health & Safety Ambient Air Monitoring	Lump Sum	1	$61,950	5	$61,950
15	Final Site Wide Clean-up	Each	1	$10,000	1	$10,000
		Total Cost				$5,627,674
		Mobilization				$300,000
		Demobilization				$150,000
		Subtotal				$6,077,674
		Unidentified Construction Cost (10%)				$607,767
		Construction Management (10%)				$607,767
		TOTAL				**$7,293,209**

Assumptions:
a) Geotextile will only be installed in the areas excavated to a depth of 18 inches below ground surface in residential areas.
b) The size of the on-site repository was estimated based on the volume of contaminated soil excavated and the selected cover design for each alternative. The material requirements and waste generation associated with the on-site repository are described in Appendix B.
c) The volume of material excavated from the repository, with the exception of the top 18 inches, is of suitable quality and does not have elevated lead concentrations. Therefore, it can be used as clean backfill for the project.
d) For cost estimating purposes, it is assumed that the clean soil generated as part of the on-site repository excavation will not be used to backfill the remedial excavation.
e) Blasting will not be required to develop the on-site repository.

Notes:
1) Quote received from Environmental Remediation, LLC on 3/20/13.
2) Quote received from AET Environmental on 3/21/13.
3) Quote received from Geodynamics on 3/21/13. Typar non-woven fabric, price includes material and labor.
4) See Table A-20.
5) See Table A-23.
6) Quote received from Direct Push Services LLC on 10/25/11 for the Davenport Flagstaff site and includes installation and materials for coconut straw erosion control blankets.
7) Excavation cost based on the quote received from Environmental Remediaion, LLC on 3/20/13 and range of costs in 2014 RS Means.

oz = ounces
Sq yd = square yard

Table A-9
Alternative 2 (Excavate to a depth of 18 inches, backfill, off-site disposal) - Operation and Maintenance Cost Estimate
Jacobs Smelters OU2

Alternative 2		
Soil Cover	-	acres
Excavation & Backfill	32.1	acres
On-Site Repository Area	-	acres
Total Acreages	32.1	acres

Annual Maintenance

Description	Unit	Quantity per Event	Frequency (Events per Year)	Unit Cost	Total	Source	Notes
Other Direct Charges							
Repair Supplies	Lump Sum	1	1	$1,000	$1,000	Engineer estimate	Drums, clean soil, seeds, hand tools, etc.
Repair Equipment, Rental	Lump Sum	1	1	$1,200	$1,200	Engineer estimate	Bobcat loader, fertilizer spreader, etc.
Travel (Round Trip)	Miles	100	1	$0.56	$56	URS	Based on a 100-mile round trip
ODC Subtotal					**$2,256**		
Labor Charges							
Project Management	Hour	3	1	$120	$360	URS	Project manager labor rate.
Onsite Labor	Hour	32	1	$65	$2,080	URS	Assume ~one hour per acre; field technician labor rate.
Onsite Supervision	Hour	32	1	$85	$2,720	URS	Assume ~one hour per acre; geologist/engineer labor rate.
Offsite Support	Hour	3	1	$55	$165	URS	Office clerical staff labor rate.
Labor Subtotal					**$5,325**		
Contingency Allowance		10%		$7,581	**$758**		
Annual Cost					**$8,339**		

Notes:
a) Maintenance is estimated to occur annually after the first year.
b) Maintenance will include clean soil replacement, erosion control, and reseeding if necessary.

Monitoring Summary Reports - Annual

Description	Unit	Quantity per Event	Frequency (Events per Year)	Unit Cost	Total	Source	Notes
Other Direct Charges							
Reproduction	Page	300	1	$0.10	$30	URS	10 copies, 30 pages per copy
Postage / Packaging	Package	3	1	$20	$60	FedEx	Express Mail / FedEx
ODC Subtotal					**$90**		
Labor Charges							
Project Management	Hour	12	1	$120	$1,440	URS	Project manager labor rate.
Offsite Labor	Hour	48	1	$85	$4,080	URS	Geologist / engineer labor rate.
Offsite Drafting/Graphics	Hour	16	1	$65	$1,040	URS	CADD /GIS technician labor rate.
Offsite Support	Hour	16	1	$55	$880	URS	Office clerical staff labor rate.
Labor Subtotal					**$7,440**		
Contingency Allowance		10%		$7,530	**$753**		
Annual Cost					**$8,283**		

Notes:
CADD = Computer-Aided Design Drafting
GIS = Geographical Information System
ODC = Other Direct Charges

Total Annual O&M Cost:	**$16,622**

Table A-10
Alternative 3 (Cover impacted material with clean soil) - Operation and Maintenance Cost Estimate
Jacobs Smelters OU2

Alternative 3		
Soil Cover	32.1	acres
Excavation & Backfill	-	acres
On-Site Repository Area	-	acres
Total Acreages	32.1	acres

Annual Maintenance

Description	Unit	Quantity per Event	Frequency (Events per Year)	Unit Cost	Total	Source	Notes
Other Direct Charges							
Repair Supplies	Lump Sum	1	1	$1,500	$1,500	Engineer estimate	Drums, clean soil, seeds, hand tools, etc.
Repair Equipment, Rental	Lump Sum	1	1	$2,000	$2,000	Engineer estimate	Bobcat loader, fertilizer spreader, etc.
Travel (Round Trip)	Miles	100	1	$0.56	$56	URS	Based on a 100-mile round trip
ODC Subtotal					**$3,556**		
Labor Charges							
Project Management	Hour	3	1	$120	$360	URS	Project manager labor rate.
Onsite Labor	Hour	32	1	$65	$2,080	URS	Assume ~one hour per acre; field technician labor rate.
Onsite Supervision	Hour	32	1	$85	$2,720	URS	Assume ~one hour per acre; geologist/engineer labor rate.
Offsite Support	Hour	3	1	$55	$165	URS	Office clerical staff labor rate
Labor Subtotal					**$5,325**		
Contingency Allowance		10%		$8,881	**$888**		
Annual Cost					**$9,769**		

Notes:
a) Maintenance is estimated to occur annually after the first year.
b) Maintenance will include clean soil replacement, erosion control, and reseeding if necessary.

Monitoring Summary Reports - Annual

Description	Unit	Quantity per Event	Frequency (Events per Year)	Unit Cost	Total	Source	Notes
Other Direct Charges							
Reproduction	Page	300	1	$0.10	$30	URS	10 copies, 30 pages per copy
Postage / Packaging	Package	3	1	$20	$60	FedEx	Express Mail / FedEx
ODC Subtotal					**$90**		
Labor Charges							
Project Management	Hour	12	1	$120	$1,440	URS	Project manager labor rate.
Offsite Labor	Hour	48	1	$85	$4,080	URS	Geologist / engineer labor rate.
Offsite Drafting/Graphics	Hour	16	1	$65	$1,040	URS	CADD /GIS technician labor rate.
Offsite Support	Hour	16	1	$55	$880	URS	Office clerical staff labor rate.
Labor Subtotal					**$7,440**		
Contingency Allowance		10%		$7,530	**$753**		
Annual Cost					**$8,283**		

Notes:
CADD = Computer-Aided Design Drafting
GIS = Geographical Information System
ODC = Other Direct Charges

Total Annual O&M Cost:	**$18,052**

Table A-11
Alternative 4 (Excavate to a depth of 18 inches, backfill, disposal at on-site repository with RCRA Subtitle C cap) - Operation and Maintenance Cost Estimate
Jacobs Smelters OU2

Alternative 4		
Soil Cover	-	acres
Excavation & Backfill (residential)	5.4	acres
On-Site Repository Area	2	acres
Total Acreages	7.4	acres

Annual Maintenance

Description	Unit	Quantity per Event	Frequency (Events per Year)	Unit Cost	Total	Source	Notes
Other Direct Charges							
Repair Supplies	Lump Sum	1	1	$2,000	$2,000	Engineer estimate	Drums, clean soil, seeds, hand tools, etc.
Repair Equipment, Rental	Lump Sum	1	1	$2,400	$2,400	Engineer estimate	Bobcat loader, fertilizer spreader, etc.
Travel (Round Trip)	Miles	100	1	$0.56	$56	URS	Based on a 100-mile round trip
ODC Subtotal					**$4,456**		
Labor Charges							
Project Management	Hour	1	1	$120	$120	URS	Project manager labor rate.
Onsite Labor	Hour	7	1	$65	$455	URS	Assume ~one hour per acre; field technician labor rate.
Onsite Supervision	Hour	7	1	$85	$595	URS	Assume ~one hour per acre; geologist/engineer labor rate.
Offsite Support	Hour	1	1	$55	$55	URS	Office clerical staff labor rate
Labor Subtotal					**$1,225**		
Contingency Allowance		10%		$5,681	**$568**		
Annual Cost					**$6,249**		

Notes:
a) Maintenance is estimated to occur annually after the first year.
b) Maintenance will include clean soil replacement, erosion control, and reseeding if necessary.

Monitoring Summary Reports - Annual

Description	Unit	Quantity per Event	Frequency (Events per Year)	Unit Cost	Total	Source	Notes
Other Direct Charges							
Reproduction	Page	700	1	$0.10	$70	URS	10 copies, 70 pages per copy
Postage / Packaging	Package	3	1	$20	$60	FedEx	Express Mail / FedEx
ODC Subtotal					**$130**		
Labor Charges							
Project Management	Hour	12	1	$120	$1,440	URS	Project manager labor rate.
Offsite Labor	Hour	24	1	$85	$2,040	URS	Chemist labor rate.
Offsite Labor	Hour	80	1	$85	$6,800	URS	Geologist / engineer labor rate.
Offsite Drafting/Graphics	Hour	16	1	$65	$1,040	URS	CADD /GIS technician labor rate.
Offsite Support	Hour	20	1	$55	$1,100	URS	Office clerical staff labor rate.
Labor Subtotal					**$12,420**		
Contingency Allowance		10%		$12,550	**$1,255**		
Annual Cost					**$13,805**		

Notes:
CADD = Computer-Aided Design Drafting
GIS = Geographical Information System
ODC = Other Direct Charges

Table A-11 (cont.)
Alternative 4 (Excavate to a depth of 18 inches, backfill, disposal at on-site repository with RCRA Subtitle C cap) - Operation and Maintenance Cost Estimate
Jacobs Smelters OU2

First Year of Groundwater Monitoring

Description	Unit	Quantity per Event	Frequency (Events per Year)	Unit Cost	Total	Source	Notes
Other Direct Charges							
Dedicated Pumps and Tubing	Each	5	1	$1,200	$6,000	Engineer estimate	One Grundfos 3" pump with dedicated tubing for the two upgradient wells and the three downgradient wells, for a total of five pumps with dedicated tubing.
Generator Rental	Days	3	8	$125	$3,000	Engineer estimate	Rental of generator for sampling effort.
Upgradient Analytical Costs	Each	3	8	$40	$960	AWAL	One sample from the two upgradient wells with one duplicate sample eight times the first year. Analysis of lead and arsenic only. Analytical costs from America West Analytical Laboratories (AWAL).
Downgradient Analytical Costs	Each	3	4	$40	$480	AWAL	One sample from the three downgradient wells four times the first year. Analysis of lead and arsenic only. Analytical costs from AWAL.
Sampling ODCs	Lump Sum	1	8	$250	$2,000	Engineer estimate	Gloves, bottles, drums, rags, etc.
Travel (Round Trip)	Miles	100	8	$0.56	$444	URS	Based on a 100-mile round trip
ODC Subtotal					**$12,884**		
Labor Charges							
Project Management	Hour	3	8	$120	$2,880	URS	Project manager labor rate
Onsite Labor	Hour	24	8	$65	$12,480	URS	Assume 24 hours per sampling event to travel to site, pick up supplies and generator, sample, pack and ship cooler, return generator, etc. Field technician labor rate.
Onsite Supervision	Hour	24	8	$85	$16,320	URS	Assume 24 hours per sampling event to travel to site, pick up supplies and generator, sample, pack and ship cooler, return generator, etc. Engineer or geologist labor rate.
Offsite Support	Hour	2	8	$55	$880	URS	Office clerical staff rate to support field efforts and order supplies.
Labor Subtotal					**$32,560**		
Contingency Allowance		10%		$45,444	**$4,544**		
Cost for First Year of Monitoring					**$49,988**		

Notes:
a) The first year of groundwater monitoring will consist of sampling the two upgradient wells on eight separate events and the three downgradient wells on four separate events, as per UDEQ UAC R315-308-2(5)(a). Since a quality assurance/quality control (QA/QC) sample is required, it is assumed that three upgradient samples are required and one will be used for QA/QC purposes.

b) A dedicated pump and dedicated tubing for each well is included.
c) It is assumed that each sample event will last three days.

Table A-11 (cont.)
Alternative 4 (Excavate to a depth of 18 inches, backfill, disposal at on-site repository with RCRA Subtitle C cap) - Operation and Maintenance Cost Estimate
Jacobs Smelters OU2

Groundwater Monitoring After the First Year

Description	Unit	Quantity per Event	Frequency (Events per Year)	Unit Cost	Total	Source	Notes
Other Direct Charges							
Generator Rental	Days	3	2	$125	$750	Engineer estimate	Rental of generator for sampling effort.
Upgradient and Downgradient Sampling Costs	Each	6	2	$40	$480	AWAL	One sample from the two upgradient wells and the three downgradient wells with one duplicate sample two times per year after the first year. Analysis of lead and arsenic only. Analytical costs from AWAL.
Sampling ODCs	Lump Sum	1	2	$250	$500	Engineer estimate	Gloves, bottles, drums, rags, etc.
Travel (Round Trip)	Miles	100	2	$0.56	$111	URS	Based on a 100-mile round trip
ODC Subtotal					**$1,841**		
Labor Charges							
Project Management	Hour	3	2	$120	$720	URS	Project manager labor rate.
Onsite Labor	Hour	24	2	$65	$3,120	URS	Assume 24 hours per sampling event to travel to site, pick up supplies and generator, sample, pack and ship cooler, return generator, etc. Field technician labor rate.
Onsite Supervision	Hour	24	2	$85	$4,080	URS	Assume 24 hours per sampling event to travel to site, pick up supplies and generator, sample, pack and ship cooler, return generator, etc. Engineer or geologist labor rate.
Offsite Support	Hour	2	2	$55	$220	URS	Office clerical staff labor rate to support field efforts and order supplies.
Labor Subtotal					**$8,140**		
Contingency Allowance		10%		$9,981	**$998**		
Cost for Groundwater Monitoring After the First Year					**$10,979**		

Notes:
a) Groundwater monitoring after the first year will consist of sampling the two upgradient wells and three downgradient wells on a semi-annual basis as per UDEQ UAC R315-308-2(5)(b). Since a quality assurance/quality control (QA/QC) sample is required, it is assumed that a total of six samples are required per sampling event and one will be used for QA/QC purposes.
b) It is assumed that each sample event will last three days.
c) Redevelopment of the wells is not included in the annual costs because it is not likely needed on an annual basis. Redevelopment of the wells will likely be required every 5-10 years at an approximate cost of $1,500 per well.

O&M Cost for First Year:	**$70,042**
O&M Cost after First Year:	**$31,033**

Table A-12
Alternative 5 (Excavate to depth contamination, backfill residential areas, regrade non-residential areas; and disposal at on-site repository with RCRA Subtitle C cap)
Operation and Maintenance Cost Estimate
Jacobs Smelters OU2

Alternative 5		
Soil Cover	-	acres
Excavation & Backfill (residential)	5.4	acres
On-Site Repository Area	2.4	acres
Total Acreages	7.8	acres

Annual Maintenance

Description	Unit	Quantity per Event	Frequency (Events per Year)	Unit Cost	Total	Source	Notes
Other Direct Charges							
Repair Supplies	Lump Sum	1	1	$500	$500	Engineer estimate	Fertilizer spreader, clean soil, seeds, hand tools, etc.
Travel (Round Trip)	Miles	100	1	$0.56	$56	URS	Based on a 100-mile round trip
ODC Subtotal					**$556**		
Labor Charges							
Project Management	Hour	3	1	$120	$360	URS	Project manager labor rate.
Onsite Labor	Hour	8	1	$65	$520	URS	Assume ~1 hour per acre; field technician labor rate.
Onsite Supervision	Hour	8	1	$85	$680	URS	Assume ~1 hour per acre; geologist/engineer labor rate.
Offsite Support	Hour	2	1	$55	$110	URS	Office clerical staff labor rate
Labor Subtotal					**$1,670**		
Contingency Allowance		10%		$2,226	**$223**		
Annual Cost					**$2,448**		

Notes:
a) Maintenance is estimated to occur annually after the first year.
b) Maintenance will include clean soil replacement, erosion control, and reseeding if necessary.

Monitoring Summary Reports - Annual

Description	Unit	Quantity per Event	Frequency (Events per Year)	Unit Cost	Total	Source	Notes
Other Direct Charges							
Reproduction	Page	700	1	$0.10	$70	URS	10 copies, 70 pages per copy
Postage / Packaging	Package	3	1	$20	$60	FedEx	Express Mail / FedEx
ODC Subtotal					**$130**		
Labor Charges							
Project Management	Hour	12	1	$120	$1,440	URS	Project manager labor rate.
Offsite Labor	Hour	24	1	$85	$2,040	URS	Chemist labor rate.
Offsite Labor	Hour	80	1	$85	$6,800	URS	Geologist / engineer labor rate.
Offsite Drafting/Graphics	Hour	16	1	$65	$1,040	URS	CADD /GIS technician labor rate.
Offsite Support	Hour	20	1	$55	$1,100	URS	Office clerical staff labor rate.
Labor Subtotal					**$12,420**		
Contingency Allowance		10%		$12,550	**$1,255**		
Annual Cost					**$13,805**		

Notes:
CADD = Computer-Aided Design Drafting
GIS = Geographical Information System
ODC = Other Direct Charges

Table A-12 (cont.)
Alternative 5 (Excavate to depth contamination, backfill residential areas, regrade non-residential areas; and disposal at on-site repository with RCRA Subtitle C cap)
Operation and Maintenance Cost Estimate
Jacobs Smelters OU2

First Year of Groundwater Monitoring

Description	Unit	Quantity per Event	Frequency (Events per Year)	Unit Cost	Total	Source	Notes
Other Direct Charges							
Dedicated Pumps and Tubing	Each	5	1	$1,200	$6,000	Engineer estimate	One Grundfos 3" pump with dedicated tubing for the two upgradient wells and the three downgradient wells, for a total of five pumps with dedicated tubing.
Generator Rental	Days	3	8	$125	$3,000	Engineer estimate	Rental of generator for sampling effort.
Upgradient Analytical Costs	Each	3	8	$40	$960	AWAL	One sample from the two upgradient wells with one duplicate sample eight times the first year. Analysis of lead and arsenic only. Analytical costs from America West Analytical Laboratories (AWAL).
Downgradient Analytical Costs	Each	3	4	$40	$480	AWAL	One sample from the three downgradient wells four times the first year. Analysis of lead and arsenic only. Analytical costs from AWAL.
Sampling ODCs	Lump Sum	1	8	$250	$2,000	Engineer estimate	Gloves, bottles, drums, rags, etc.
Travel (Round Trip)	Miles	100	8	$0.56	$444	URS	Based on a 100-mile round trip
ODC Subtotal					**$12,884**		
Labor Charges							
Project Management	Hour	3	8	$120	$2,880	URS	Project Manager labor rate
Onsite Labor	Hour	24	8	$65	$12,480	URS	Assume 24 hours per sampling event to travel to site, pick up supplies and generator, sample, pack and ship cooler, return generator, etc. Field technician rate.
Onsite Supervision	Hour	24	8	$85	$16,320	URS	Assume 24 hours per sampling event to travel to site, pick up supplies and generator, sample, pack and ship cooler, return generator, etc. Engineer or geologist labor rate.
Offsite Support	Hour	2	8	$55	$880	URS	Office clerical staff rate to support field efforts and order supplies.
Labor Subtotal					**$32,560**		
Contingency Allowance		10%		$45,444	**$4,544**		
Cost for First Year of Monitoring					**$49,988**		

Notes:
a) The first year of groundwater monitoring will consist of sampling the two upgradient wells on eight separate events and the three downgradient wells on four separate events, as per UDEQ UAC R315-308-2(5)(a). Since a quality assurance/quality control (QA/QC) sample is required, it is assumed that three upgradient samples are required and one will be used for QA/QC purposes.

b) A dedicated pump and dedicated tubing for each well is included.
c) It is assumed that each sample event will last three days.

Table A-12 (cont.)
Alternative 5 (Excavate to depth contamination, backfill residential areas, regrade non-residential areas; and disposal at on-site repository with RCRA Subtitle C cap)
Operation and Maintenance Cost Estimate
Jacobs Smelters OU2

Groundwater Monitoring After the First Year

Description	Unit	Quantity per Event	Frequency (Events per Year)	Unit Cost	Total	Source	Notes
Other Direct Charges							
Generator Rental	Days	3	2	$125	$750	Engineer estimate	Rental of generator for sampling effort.
Upgradient and Downgradient Sampling Costs	Each	6	2	$40	$480	AWAL	One sample from the two upgradient wells and the three downgradient wells with one duplicate sample two times per year after the first year. Analysis of lead and arsenic only. Analytical costs from AWAL.
Sampling ODCs	Lump Sum	1	2	$250	$500	Engineer estimate	Gloves, bottles, drums, rags, etc.
Travel (Round Trip)	Miles	100	2	$0.56	$111	URS	Based on a 100-mile round trip
ODC Subtotal					**$1,841**		
Labor Charges							
Project Management	Hour	3	2	$120	$720	URS	Project manager labor rate.
Onsite Labor	Hour	24	2	$65	$3,120	URS	Assume 24 hours per sampling event to travel to site, pick up supplies and generator, sample, pack and ship cooler, return generator, etc. Field technician labor rate.
Onsite Supervision	Hour	24	2	$85	$4,080	URS	Assume 24 hours per sampling event to travel to site, pick up supplies and generator, sample, pack and ship cooler, return generator, etc. Engineer or geologist labor rate.
Offsite Support	Hour	2	2	$55	$220	URS	Office clerical staff labor rate to support field efforts and order supplies.
Labor Subtotal					**$8,140**		
Contingency Allowance		10%		$9,981	**$998**		
Cost for Groundwater Monitoring After the First Year					**$10,979**		

Notes:
a) Groundwater monitoring after the first year will consist of sampling the two upgradient wells and three downgradient wells on a semi-annual basis as per UDEQ UAC R315-308-2(5)(b). Since a quality assurance/quality control (QA/QC) sample is required, it is assumed that a total of six samples are required per sampling event and one will be used for QA/QC purposes.

b) It is assumed that each sample event will last three days.
c) Redevelopment of the wells is not included in the annual costs because it is not likely needed on an annual basis. Redevelopment of the wells will likely be required every 5-10 years at an approximate cost of $1,500 per well.

O&M Cost for First Year:	**$66,241**
O&M Cost after First Year:	**$27,232**

Table A-13
Alternative 6 (Excavate to depth contamination, backfill residential areas, regrade non-residential areas, and disposal at on-site repository with soil cover)
Operation and Maintenance Cost Estimate
Jacobs Smelters OU2

Alternative 5		
Soil Cover	-	acres
Excavation & Backfill (residential)	5.4	acres
On-Site Repository Area	2.3	acres
Total Acreages	7.7	acres

Annual Maintenance

Description	Unit	Quantity per Event	Frequency (Events per Year)	Unit Cost	Total	Source	Notes
Other Direct Charges							
Repair Supplies	Lump Sum	1	1	$500	$500	Engineer estimate	Fertilizer spreader, clean soil, seeds, hand tools, etc.
Travel (Round Trip)	Miles	100	1	$0.56	$56	URS	Based on a 100-mile round trip
ODC Subtotal					**$556**		
Labor Charges							
Project Management	Hour	3	1	$120	$360	URS	Project manager labor rate.
Onsite Labor	Hour	8	1	$65	$520	URS	Assume ~1 hour per acre; field technician labor rate.
Onsite Supervision	Hour	8	1	$85	$680	URS	Assume ~1 hour per acre; geologist/engineer labor rate.
Offsite Support	Hour	2	1	$55	$110	URS	Office clerical staff labor rate
Labor Subtotal					**$1,670**		
Contingency Allowance		10%		$2,226	**$223**		
Annual Cost					**$2,448**		

Notes:
a) Maintenance is estimated to occur annually after the first year.
b) Maintenance will include clean soil replacement, erosion control, and reseeding if necessary.

Monitoring Summary Reports - Annual

Description	Unit	Quantity per Event	Frequency (Events per Year)	Unit Cost	Total	Source	Notes
Other Direct Charges							
Reproduction	Page	700	1	$0.10	$70	URS	10 copies, 70 pages per copy
Postage / Packaging	Package	3	1	$20	$60	FedEx	Express Mail / FedEx
ODC Subtotal					**$130**		
Labor Charges							
Project Management	Hour	12	1	$120	$1,440	URS	Project manager labor rate.
Offsite Labor	Hour	24	1	$85	$2,040	URS	Chemist labor rate.
Offsite Labor	Hour	80	1	$85	$6,800	URS	Geologist / engineer labor rate.
Offsite Drafting/Graphics	Hour	16	1	$65	$1,040	URS	CADD /GIS technician labor rate.
Offsite Support	Hour	20	1	$55	$1,100	URS	Office clerical staff labor rate.
Labor Subtotal					**$12,420**		
Contingency Allowance		10%		$12,550	**$1,255**		
Annual Cost					**$13,805**		

Notes:
CADD = Computer-Aided Design Drafting
GIS = Geographical Information System
ODC = Other Direct Charges

Table A-13 (cont.)
Alternative 6 (Excavate to depth contamination, backfill residential areas, regrade non-residential areas, and disposal at on-site repository with soil cover)
Operation and Maintenance Cost Estimate
Jacobs Smelters OU2

First Year of Groundwater Monitoring

Description	Unit	Quantity per Event	Frequency (Events per Year)	Unit Cost	Total	Source	Notes
Other Direct Charges							
Dedicated Pumps and Tubing	Each	5	1	$1,200	$6,000	Engineer estimate	One Grundfos 3" pump with dedicated tubing for the two upgradient wells and the three downgradient wells, for a total of five pumps with dedicated tubing.
Generator Rental	Days	3	8	$125	$3,000	Engineer estimate	Rental of generator for sampling effort.
Upgradient Analytical Costs	Each	3	8	$40	$960	AWAL	One sample from the two upgradient wells with one duplicate sample eight times the first year. Analysis of lead and arsenic only. Analytical costs from America West Analytical Laboratories (AWAL).
Downgradient Analytical Costs	Each	3	4	$40	$480	AWAL	One sample from the three downgradient wells four times the first year. Analysis of lead and arsenic only. Analytical costs from AWAL.
Sampling ODCs	Lump Sum	1	8	$250	$2,000	Engineer estimate	Gloves, bottles, drums, rags, etc.
Travel (Round Trip)	Miles	100	8	$0.56	$444	URS	Based on a 100-mile round trip
ODC Subtotal					**$12,884**		
Labor Charges							
Project Management	Hour	3	8	$120	$2,880	URS	Project Manager labor rate
Onsite Labor	Hour	24	8	$65	$12,480	URS	Assume 24 hours per sampling event to travel to site, pick up supplies and generator, sample, pack and ship cooler, return generator, etc. Field technician rate.
Onsite Supervision	Hour	24	8	$85	$16,320	URS	Assume 24 hours per sampling event to travel to site, pick up supplies and generator, sample, pack and ship cooler, return generator, etc. Engineer or geologist labor rate.
Offsite Support	Hour	2	8	$55	$880	URS	Office clerical staff rate to support field efforts and order supplies.
Labor Subtotal					**$32,560**		
Contingency Allowance		10%		$45,444	**$4,544**		
Cost for First Year of Monitoring					**$49,988**		

Notes:
a) The first year of groundwater monitoring will consist of sampling the two upgradient wells on eight separate events and the three downgradient wells on four separate events, as per UDEQ UAC R315-308-2(5)(a). Since a quality assurance/quality control (QA/QC) sample is required, it is assumed that three upgradient samples are required and one will be used for QA/QC purposes.
b) A dedicated pump and dedicated tubing for each well is included.
c) It is assumed that each sample event will last three days.

Table A-13 (cont.)
Alternative 6 (Excavate to depth contamination, backfill residential areas, regrade non-residential areas, and disposal at on-site repository with soil cover)
Operation and Maintenance Cost Estimate
Jacobs Smelters OU2

Groundwater Monitoring After the First Year

Description	Unit	Quantity per Event	Frequency (Events per Year)	Unit Cost	Total	Source	Notes
Other Direct Charges							
Generator Rental	Days	3	2	$125	$750	Engineer estimate	Rental of generator for sampling effort.
Upgradient and Downgradient Sampling Costs	Each	6	2	$40	$480	AWAL	One sample from the two upgradient wells and the three downgradient wells with one duplicate sample two times per year after the first year. Analysis of lead and arsenic only. Analytical costs from AWAL.
Sampling ODCs	Lump Sum	1	2	$250	$500	Engineer estimate	Gloves, bottles, drums, rags, etc.
Travel (Round Trip)	Miles	100	2	$0.56	$111	URS	Based on a 100-mile round trip
ODC Subtotal					**$1,841**		
Labor Charges							
Project Management	Hour	3	2	$120	$720	URS	Project manager labor rate.
Onsite Labor	Hour	24	2	$65	$3,120	URS	Assume 24 hours per sampling event to travel to site, pick up supplies and generator, sample, pack and ship cooler, return generator, etc. Field technician labor rate.
Onsite Supervision	Hour	24	2	$85	$4,080	URS	Assume 24 hours per sampling event to travel to site, pick up supplies and generator, sample, pack and ship cooler, return generator, etc. Engineer or geologist labor rate.
Offsite Support	Hour	2	2	$55	$220	URS	Office clerical staff labor rate to support field efforts and order supplies.
Labor Subtotal					**$8,140**		
Contingency Allowance		10%		$9,981	**$998**		
Cost for Groundwater Monitoring After the First Year					**$10,979**		

Notes:
a) Groundwater monitoring after the first year will consist of sampling the two upgradient wells and three downgradient wells on a semi-annual basis as per UDEQ UAC R315-308-2(5)(b). Since a quality assurance/quality control (QA/QC) sample is required, it is assumed that a total of six samples are required per sampling event and one will be used for QA/QC purposes.

b) It is assumed that each sample event will last three days.
c) Redevelopment of the wells is not included in the annual costs because it is not likely needed on an annual basis. Redevelopment of the wells will likely be required every 5-10 years at an approximate cost of $1,500 per well.

O&M Cost for First Year:	**$66,241**
O&M Cost after First Year:	**$27,232**

Table A-14
Alternative 2 (Excavate to a depth of 18 inches, backfill, off-site disposal)
Present Cost of Construction, Operation, Maintenance, and Monitoring

Year	Capital Cost	Annual O&M Cost	Subtotal Annual Expenditures	Discount Factor [1] 7%	Present Worth[2]
0	$9,442,938		$9,442,938	1.000	$9,442,938
1		$16,622	$16,622	0.935	$15,534
2		$16,622	$16,622	0.873	$14,518
3		$16,622	$16,622	0.816	$13,568
4		$16,622	$16,622	0.763	$12,681
5		$16,622	$16,622	0.713	$11,851
6		$16,622	$16,622	0.666	$11,076
7		$16,622	$16,622	0.623	$10,351
8		$16,622	$16,622	0.582	$9,674
9		$16,622	$16,622	0.544	$9,041
10		$16,622	$16,622	0.508	$8,450
11		$16,622	$16,622	0.475	$7,897
12		$16,622	$16,622	0.444	$7,380
13		$16,622	$16,622	0.415	$6,897
14		$16,622	$16,622	0.388	$6,446
15		$16,622	$16,622	0.362	$6,024
16		$16,622	$16,622	0.339	$5,630
17		$16,622	$16,622	0.317	$5,262
18		$16,622	$16,622	0.296	$4,918
19		$16,622	$16,622	0.277	$4,596
20		$16,622	$16,622	0.258	$4,295
21		$16,622	$16,622	0.242	$4,014
22		$16,622	$16,622	0.226	$3,752
23		$16,622	$16,622	0.211	$3,506
24		$16,622	$16,622	0.197	$3,277
25		$16,622	$16,622	0.184	$3,063
26		$16,622	$16,622	0.172	$2,862
27		$16,622	$16,622	0.161	$2,675
28		$16,622	$16,622	0.150	$2,500
29		$16,622	$16,622	0.141	$2,336
Present Worth of Capital Cost					$9,443,000
Present Worth of O&M Cost					$204,000
Total Present Worth (30 Years)					$9,647,000

Notes:
1) Discount rate of 7% and inflation rate of 0% were based on guidance from Section 4.0 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", (USEPA. 2000). Discount factor = $1/(1+\text{Discount Rate}^{\text{Year}})$.
2) Present Worth = Annual expenditures x Inflation Factor x Discount Factor. Inflation Factor = 1.

a) Present worth values rounded to the nearest $1000.
b) Assume that Year 0 is the year 2014.

Table A-15
Alternative 3 (Cover impacted material with clean soil)
Present Cost of Construction, Operation, Maintenance, and Monitoring

Year	Capital Cost	Annual O&M Cost	Subtotal Annual Expenditures	Discount Factor [1] 7%	Present Worth[2]
0	$5,056,009		$5,056,009	1.000	$5,056,009
1		$18,052	$18,052	0.935	$16,871
2		$18,052	$18,052	0.873	$15,767
3		$18,052	$18,052	0.816	$14,735
4		$18,052	$18,052	0.763	$13,771
5		$18,052	$18,052	0.713	$12,871
6		$18,052	$18,052	0.666	$12,029
7		$18,052	$18,052	0.623	$11,242
8		$18,052	$18,052	0.582	$10,506
9		$18,052	$18,052	0.544	$9,819
10		$18,052	$18,052	0.508	$9,176
11		$18,052	$18,052	0.475	$8,576
12		$18,052	$18,052	0.444	$8,015
13		$18,052	$18,052	0.415	$7,491
14		$18,052	$18,052	0.388	$7,001
15		$18,052	$18,052	0.362	$6,543
16		$18,052	$18,052	0.339	$6,115
17		$18,052	$18,052	0.317	$5,715
18		$18,052	$18,052	0.296	$5,341
19		$18,052	$18,052	0.277	$4,991
20		$18,052	$18,052	0.258	$4,665
21		$18,052	$18,052	0.242	$4,360
22		$18,052	$18,052	0.226	$4,074
23		$18,052	$18,052	0.211	$3,808
24		$18,052	$18,052	0.197	$3,559
25		$18,052	$18,052	0.184	$3,326
26		$18,052	$18,052	0.172	$3,108
27		$18,052	$18,052	0.161	$2,905
28		$18,052	$18,052	0.150	$2,715
29		$18,052	$18,052	0.141	$2,537

Present Worth of Capital Cost	$5,056,000
Present Worth of O&M Cost	$222,000
Total Present Worth (30 Years)	$5,278,000

Notes:
1) Discount rate of 7% and inflation rate of 0% were based on guidance from Section 4.0 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", (USEPA. 2000). Discount factor = $1/(1+\text{Discount Rate}^{\text{Year}})$.
2) Present Worth = Annual expenditures x Inflation Factor x Discount Factor. Inflation Factor = 1.

a) Present worth values rounded to the nearest $1000.
b) Assume that Year 0 is the year 2014.

Table A-16
Alternative 4 (Excavate to a depth of 18 inches, backfill, disposal at on-site repository with RCRA Subtitle C cap)
Present Cost of Construction, Operation, Maintenance, and Monitoring

Year	Capital Cost	Annual O&M Cost	Subtotal Annual Expenditures	Discount Factor [1] 7%	Present Worth[2]
0	$7,647,420		$7,647,420	1.000	$7,647,420
1		$70,042	$70,042	0.935	$65,460
2		$31,033	$31,033	0.873	$27,105
3		$31,033	$31,033	0.816	$25,332
4		$31,033	$31,033	0.763	$23,675
5		$31,033	$31,033	0.713	$22,126
6		$31,033	$31,033	0.666	$20,678
7		$31,033	$31,033	0.623	$19,326
8		$31,033	$31,033	0.582	$18,061
9		$31,033	$31,033	0.544	$16,880
10		$31,033	$31,033	0.508	$15,775
11		$31,033	$31,033	0.475	$14,743
12		$31,033	$31,033	0.444	$13,779
13		$31,033	$31,033	0.415	$12,877
14		$31,033	$31,033	0.388	$12,035
15		$31,033	$31,033	0.362	$11,248
16		$31,033	$31,033	0.339	$10,512
17		$31,033	$31,033	0.317	$9,824
18		$31,033	$31,033	0.296	$9,181
19		$31,033	$31,033	0.277	$8,581
20		$31,033	$31,033	0.258	$8,019
21		$31,033	$31,033	0.242	$7,495
22		$31,033	$31,033	0.226	$7,004
23		$31,033	$31,033	0.211	$6,546
24		$31,033	$31,033	0.197	$6,118
25		$31,033	$31,033	0.184	$5,718
26		$31,033	$31,033	0.172	$5,344
27		$31,033	$31,033	0.161	$4,994
28		$31,033	$31,033	0.150	$4,667
29		$31,033	$31,033	0.141	$4,362
Present Worth of Capital Cost					$7,647,000
Present Worth of O&M Cost					$417,000
Total Present Worth (30 Years)					$8,065,000

Notes:
1) Discount rate of 7% and inflation rate of 0% were based on guidance from Section 4.0 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", (USEPA. 2000). Discount factor = $1/(1+\text{Discount Rate}^{\text{Year}})$.
2) Present Worth = Annual expenditures x Inflation Factor x Discount Factor. Inflation Factor = 1.

a) Present worth values rounded to the nearest $1000.
b) Assume that Year 0 is the year 2014.

Table A-17
Alternative 5 (Excavate to depth of contamination, backfill residential areas, regrade non-residential areas, and disposal at on-site repository with RCRA Subtitle C cap)
Present Cost of Construction, Operation, Maintenance, and Monitoring

Year	Capital Cost	Annual O&M Cost	Subtotal Annual Expenditures	Discount Factor [1] 7%	Present Worth[2]
0	$7,955,543		$7,955,543	1.000	$7,955,543
1		$66,241	$66,241	0.935	$61,908
2		$27,232	$27,232	0.873	$23,786
3		$27,232	$27,232	0.816	$22,230
4		$27,232	$27,232	0.763	$20,775
5		$27,232	$27,232	0.713	$19,416
6		$27,232	$27,232	0.666	$18,146
7		$27,232	$27,232	0.623	$16,959
8		$27,232	$27,232	0.582	$15,849
9		$27,232	$27,232	0.544	$14,812
10		$27,232	$27,232	0.508	$13,843
11		$27,232	$27,232	0.475	$12,938
12		$27,232	$27,232	0.444	$12,091
13		$27,232	$27,232	0.415	$11,300
14		$27,232	$27,232	0.388	$10,561
15		$27,232	$27,232	0.362	$9,870
16		$27,232	$27,232	0.339	$9,224
17		$27,232	$27,232	0.317	$8,621
18		$27,232	$27,232	0.296	$8,057
19		$27,232	$27,232	0.277	$7,530
20		$27,232	$27,232	0.258	$7,037
21		$27,232	$27,232	0.242	$6,577
22		$27,232	$27,232	0.226	$6,147
23		$27,232	$27,232	0.211	$5,745
24		$27,232	$27,232	0.197	$5,369
25		$27,232	$27,232	0.184	$5,018
26		$27,232	$27,232	0.172	$4,689
27		$27,232	$27,232	0.161	$4,382
28		$27,232	$27,232	0.150	$4,096
29		$27,232	$27,232	0.141	$3,828

Present Worth of Capital Cost	$7,956,000
Present Worth of O&M Cost	$371,000
Total Present Worth (30 Years)	$8,326,000

Notes:
1) Discount rate of 7% and inflation rate of 0% were based on guidance from Section 4.0 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", (USEPA. 2000). Discount factor = $1/(1+\text{Discount Rate}^{\text{Year}})$.
2) Present Worth = Annual expenditures x Inflation Factor x Discount Factor. Inflation Factor = 1.

a) Present worth values rounded to the nearest $1000.
b) Assume that Year 0 is the year 2014.

Table A-18
Alternative 6 (Excavate to depth of contamination, backfill residential areas, regrade non-residential areas, and disposal at on-site repository with soil cover)
Present Cost of Construction, Operation, Maintenance, and Monitoring

Year	Capital Cost	Annual O&M Cost	Subtotal Annual Expenditures	Discount Factor [1] 7%	Present Worth[2]
0	$7,293,209		$7,293,209	1.000	$7,293,209
1		$66,241	$66,241	0.935	$61,908
2		$27,232	$27,232	0.873	$23,786
3		$27,232	$27,232	0.816	$22,230
4		$27,232	$27,232	0.763	$20,775
5		$27,232	$27,232	0.713	$19,416
6		$27,232	$27,232	0.666	$18,146
7		$27,232	$27,232	0.623	$16,959
8		$27,232	$27,232	0.582	$15,849
9		$27,232	$27,232	0.544	$14,812
10		$27,232	$27,232	0.508	$13,843
11		$27,232	$27,232	0.475	$12,938
12		$27,232	$27,232	0.444	$12,091
13		$27,232	$27,232	0.415	$11,300
14		$27,232	$27,232	0.388	$10,561
15		$27,232	$27,232	0.362	$9,870
16		$27,232	$27,232	0.339	$9,224
17		$27,232	$27,232	0.317	$8,621
18		$27,232	$27,232	0.296	$8,057
19		$27,232	$27,232	0.277	$7,530
20		$27,232	$27,232	0.258	$7,037
21		$27,232	$27,232	0.242	$6,577
22		$27,232	$27,232	0.226	$6,147
23		$27,232	$27,232	0.211	$5,745
24		$27,232	$27,232	0.197	$5,369
25		$27,232	$27,232	0.184	$5,018
26		$27,232	$27,232	0.172	$4,689
27		$27,232	$27,232	0.161	$4,382
28		$27,232	$27,232	0.150	$4,096
29		$27,232	$27,232	0.141	$3,828

Present Worth of Capital Cost	$7,293,000
Present Worth of O&M Cost	$371,000
Total Present Worth (30 Years)	$7,664,000

Notes:
1) Discount rate of 7% and inflation rate of 0% were based on guidance from Section 4.0 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", (USEPA. 2000). Discount factor = $1/(1+\text{Discount Rate}^{\text{Year}})$.
2) Present Worth = Annual expenditures x Inflation Factor x Discount Factor. Inflation Factor = 1.

a) Present worth values rounded to the nearest $1000.
b) Assume that Year 0 is the year 2014.

Table A-19
Alternatives 4, 5, & 6 - On-Site Repository Quantities

		Excavate			Cover Material				Geotextile Fabric	Fencing[3]	Drainage Ditch[3]	Vegetation
	AREA (acres)	DEPTH (inches)	VOLUME (cu.yd.)	WEIGHT (tons)	AREA (sq.yd.)	DEPTH (inches)	VOLUME (cu.yd.)	WEIGHT (tons)	AREA (sq.yd.)	LENGTH (ft)	LENGTH (ft)	AREA (acres)
Alternative 4												
Excavation of On-Site Repository (See Appendix B for sizing calculations)[1]	2.0	-	47,188	70,074	--	--	--	--	--	1,171	1,171	--
Excavated Material from Residential and Undeveloped Areas	30.1	--	42,470	63,067	--	--	--	--	--	--	--	--
Work Area[4]	2.0	--	--	--	--	--	--	--	--	--	--	2.0
RCRA Subtitle C cap Material												
Top Layer - 6 in gravel armor[2]	2.0	--	--	--	9,525	6	1,588	2,381	--	--	--	--
Top Layer - 18 in backfill	2.0	--	--	--	9,525	18	4,763	6,751	--	--	--	--
Drainage Layer - 12 in sand or gravel[2]	2.0	--	--	--	9,525	12	3,175	4,763	9,525	--	--	--
Impermeable layer - Geosynthetic Clay Liner	2.0	--	--	--	9,525	--	--	--	9,525	--	--	--
TOTAL					**38,100**	**36**	**9,525**	**13,895**	**19,050**	**1,171**	**1,171**	**2.0**
Alternative 5												
Excavation of On-Site Repository (See Appendix B for sizing calculations)[1]	2.4	-	58,564	86,968	--	--	--	--	--	1,305	1,305	--
Excavated Material from Residential and Undeveloped Areas	29.7	--	52,708	78,271	--	--	--	--	--	--	--	--
Work Area[4]	2.0	--	--	--	--	--	--	--	--	--	--	2.0
RCRA Subtitle C cap Material												
Top Layer - 6 in gravel armor[2]	2.4	--	--	--	11,821	6	1,970	2,955	--	--	--	--
Top Layer - 18 in backfill	2.4	--	--	--	11,821	18	5,911	8,378	--	--	--	--
Drainage Layer - 12 in sand or gravel[2]	2.4	--	--	--	11,821	12	3,940	5,911	11,821	--	--	--
Impermeable layer - Geosynthetic Clay Liner	2.4	--	--	--	11,821	--	--	--	11,821	--	--	--
TOTAL					**47,285**	**36**	**11,821**	**17,244**	**23,643**	**1,305**	**1,305**	**2.0**
Alternative 6												
Excavation of On-Site Repository (See Appendix B for sizing calculations)[1]	2.3	-	54,985	81,653	--	--	--	--	--	1,264	1,264	--
Excavated Material from Residential and Undeveloped Areas	29.8	--	53,152	78,931	--	--	--	--	--	--	--	--
Work Area[4]	2.0	--	--	--	--	--	--	--	--	--	--	2.0
Soil Cover Material												
Topsoil Layer	2.3	--	--	--	11,099	9	2,775	3,746	--	--	--	2.3
Backfill Layer	2.3	--	--	--	11,099	9	2,775	4,120	11,099	--	--	--
TOTAL					**22,198**	**18**	**5,549**	**7,866**	**11,099**	**1,264**	**1,264**	**4.3**

Conversion Factors:

Average Density of In-Place Material = 110 lb/ft^3 (typical value taken from literature for similar soils)

Average Density of Uncompacted Backfill Material = 105 lb/ft^3

Average Density of Uncompacted Topsoil Material = 100 lb/ft^3

1 acre = 4,840 sq yd
1 acre = 43,560 sq ft
1 cu yd = 27 cu ft

1) The provided on-site repository acreage is preliminary and does not include any additional excavation that may be required to maintain slope stability. Acreage was estimated based the volume of excavation required to accommodate contaminated soil, a RCRA Subtitle C cap for Alternatives 4 and 5, and a soil cover for Alternative 6. See Appendix B for volume calculations.

2) Based on estimates from Staker Parson Tooele, the calculated weight for these materials was calculated as: Volume (cu.yd.)*1.5 = Weight (tons)

3) The drainage ditch and fence length is based on the perimeter of the repository.

4) Work area includes area around the repository as well as the area needed to stockpile soil from the repository.

Notes:
Cu yd = cubic yard
ft = foot
in = inch
Sq yd = square yard

Table A-20
Alternative 4 (Excavate to a depth of 18 inches, backfill, disposal at on-site repository with RCRA Subtitle C cap)
On-Site Repository Cost Summary
Jacobs Smelter OU2 FS

Item#	Description	Units	Quantity	Unit Cost	Notes	Cost
1	Clear and Grub Brush	Acres	4	$550	1	$2,182
2	Grade Road to Repository	Sq yd	3,333	$3.00	1	$10,000
3	Excavation of Repository	Ton	70,074	$10.00	8	$700,741
Top Layer						
4	Gravel Armour (D50 3/4") - material and haul	Ton	2,381	$35.00	1	$83,344
5	Backfill - material, haul, and place	Ton	6,751	$0.00	6	$0
Drainage Layer						
6	Geotextile Fabric - 4 oz.	Sq yd	9,525	$0.98	2	$9,335
7	Drainage Layer (Graded material 3/8" minus) - material and haul	Ton	4,763	$35.00	1	$166,688
Low Permeability Layer						
8	Geotextile Fabric - 4 oz.	Sq yd	9,525	$0.98	2	$9,335
9	Geosynthetic Clay Liner	Sq yd	9,525	$4.50	1	$42,863
10	Installation of Geosynthetic Clay Liner	Sq yd	9,525	$2.25	1	$21,431
Installation and Other						
11	Compaction of Contaminated Soil	Cu yd	42,470	$4.00	1	$169,878
12	Spread RCRA Subtitle C cap Material with Front End Loader and Bulldozer	Cu yd	9,525	$5.00	1	$47,625
13	Grade Four Cap Layers	Sq yd	38,100	$3.00	1	$114,300
14	Monitoring Well Installation and Development	Each	5	$30,000	3	$150,000
15	Drainage Ditch Around Repository	Linear Foot	1,171	$1.50	1	$1,757
16	Rock for Drainage Trenches	Cu yd	260	$50.00	1	$13,013
17	Install Fencing	Linear Foot	1,171	$45.00	4	$52,702
18	Site Revegetation	Acres	2	$300.00	1	$600
19	Erosion Control Blankets	Acres	2	$10,890	7	$21,780
		Subtotal				$1,617,572
		On-Site Repository Design Cost (5%)				$80,879
		TOTAL				**$1,698,450**
		Total per ton of soil				**$26.93**

Assumptions:
a) Five groundwater monitoring wells (2 upgradient and 3 downgradient of the repository) drilled to a depth of 200 feet will be required for the on-site repository.

b) The on-site repository will be capped with multilayered, composite system to meet the requirements of a RCRA Subtitle C Cap and includes the following layers (from top to bottom): 6-inch gravel armor; 18-inch common fill; 4 oz. geotextile; 12-inch drainage layer; 4 oz. geotextile; geosynthetic clay liner (GCL). Details on the on-site repository are found in Appendix B.
c) Clean excavated material will be used for the 18-inch common fill layer.
d) Blasting will not be required to develop the on-site repository.
e) Drainange ditch will be approximately six feet wide and one foot deep.
f) Site revegetation will only be required for the 2 acre work area.

Notes:
1) Quote received from Environmental Remediation, LLC on 3/20/13.
2) Quote received from Geodynamics on 3/21/13. Typar non-woven fabric, price includes material and labor.
3) Engineer's estimate.
4) RSMeans Heavy Construction Data 2010; *32 31 23.10 0320* , 6 ft high privacy vinyl fence.
5) See Table A-23.
6) Excess clean material from the construction of the on-site repository will be used as backfill in the top layer of the RCRA Subtitle C cap. Therefore, the material cost for backfill is not included. The costs for compacting and spreading backfill are included in items #11 and 12, respectively.
7) Quote received from Direct Push Services LLC on 10/25/11 for the Davenport Flagstaff site and includes installation and materials for coconut straw erosion control blankets.

8) Excavation cost based on the quote received from Environmental Remediaion, LLC on 3/20/13 and range of costs in 2014 RS Means.

Cu yd = cubic yard
Sq yd = square yard
oz = ounces

Table A-21
Alternative 5 (Excavate to depth of contamination, backfill residential areas, regrade non-residential areas, and disposal at on-site repository with RCRA Subtitle C cap)
On-Site Repository Cost Summary
Jacobs Smelter OU2 FS

Item#	Description	Units	Quantity	Unit Cost	Notes	Cost
1	Clear and Grub Brush	Acres	4	$550	1	$2,443
2	Grade Road to Repository	Sq yd	3,333	$3.00	1	$10,000
3	Excavation of Repository	Ton	86,968	$10.00	8	$869,675
Top Layer						
4	Gravel Armour (D50 3/4") - material and haul	Ton	2,955	$35.00	1	$103,436
5	Backfill - material, haul, and place	Ton	8,378	$0.00	6	$0
Drainage Layer						
6	Geotextile Fabric - 4 oz.	Sq yd	11,821	$0.98	2	$11,585
7	Drainage Layer (Graded material 3/8" minus) - material and haul	Ton	5,911	$35.00	1	$206,873
Low Permeability Layer						
8	Geotextile Fabric - 4 oz.	Sq yd	11,821	$0.98	2	$11,585
9	Geosynthetic Clay Liner	Sq yd	11,821	$4.50	1	$53,196
10	Installation of Geosynthetic Clay Liner	Sq yd	11,821	$2.25	1	$26,598
Installation and Other						
11	Compaction of Contaminated Soil	Cu yd	52,708	$4.00	1	$210,830
12	Spread RCRA Subtitle C cap Material with Front End Loader and Bulldozer	Cu yd	11,821	$5.00	1	$59,106
13	Grade Four Cap Layers	Sq yd	47,285	$3.00	1	$141,855
14	Monitoring Well Installation and Development	Each	5	$30,000	3	$150,000
15	Drainage Ditch Around Repository	Linear Foot	1,305	$1.50	1	$1,957
16	Rock for Drainage Trenches	Cu yd	290	$50.00	1	$14,497
17	Install Fencing	Linear Foot	1,305	$45.00	4	$58,712
18	Site Revegetation	Acres	2	$300	1	$600
19	Erosion Control Blankets	Acres	2	$10,890	7	$21,780
		Subtotal				$1,954,729
		On-Site Repository Design Cost (5%)				$97,736
		TOTAL				**$2,052,466**
		Total per ton of soil				**$26.22**

Assumptions:
a) Five groundwater monitoring wells (2 upgradient and 3 downgradient of the repository) drilled to a depth of 200 feet will be required for the on-site repository.

b) The on-site repository will be capped with multilayered, composite system to meet the requirements of a RCRA Subtitle C Cap and includes the following layers (from top to bottom): 6-inch gravel armor; 18-inch common fill; 4 oz. geotextile; 12-inch drainage layer; 4 oz. geotextile; geosynthetic clay liner (GCL). Details on the on-site repository are found in Appendix B.
c) Clean excavated material will be used for the 18-inch common fill layer.
d) Blasting will not be required to develop the on-site repository.
e) Drainange ditch will be approximately six feet wide and one foot deep.
f) Site revegetation will only be required for the 2 acre work area.

Notes:
1) Quote received from Environmental Remediation, LLC on 3/20/13.
2) Quote received from Geodynamics on 3/21/13. Typar non-woven fabric, price includes material and labor.
3) Engineer's estimate.
4) RSMeans Heavy Construction Data 2010; *32 31 23.10 0320* , 6 ft high privacy vinyl fence.
5) See Table A-23.
6) Excess clean material from the construction of the on-site repository will be used as backfill in the top layer of the RCRA Subtitle C cap. Therefore, the material cost for backfill is not included. The costs for compacting and spreading backfill are included in items #11 and 12, respectively.
7) Quote received from Direct Push Services LLC on 10/25/11 for the Davenport Flagstaff site and includes installation and materials for coconut straw erosion control blankets.
8) Excavation cost based on the quote received from Environmental Remediaion, LLC on 3/20/13 and range of costs in 2014 RS Means.

Cu yd = cubic yard
Sq yd = square yard
oz = ounces

Table A-22
Alternative 6 (Excavate to depth of contamination, backfill residential areas, regrade non-residential areas, and disposal at on-site repository with soil cover)
On-Site Repository Cost Summary
Jacobs Smelter OU2 FS

Item#	Description	Units	Quantity	Unit Cost	Notes	Cost
1	Clear and Grub Brush	Acres	4	$550	1	$2,361
2	Grade Road to Repository	Sq yd	3,333	$3.00	1	$10,000
3	Excavation of Repository	Ton	81,653	$10.00	9	$816,526
Soil Cover						
4	Backfill - material, haul, and place	Ton	4,120	$0.00	7	$0
5	Topsoil - material, haul, and place	Ton	3,746	$32.00	2	$119,867
6	Erosion control mat - material and place	Sq ft	99,890	$0.35	8	$34,961
7	Geotextile Fabric - 4 oz.	Sq yd	11,099	$0.98	3	$10,877
Installation and Other						
8	Compaction of Contaminated Soil	Cu yd	53,152	$4.00	1	$212,608
9	Spread Material with Front End Loader and Bulldozer	Cu yd	5,549	$5.00	1	$27,747
10	Monitoring Well Installation and Development	Each	5	$30,000	4	$150,000
11	Drainage Ditch Around Repository	Linear Foot	1,264	$1.50	1	$1,896
12	Rock for Drainage Trenches	Cu yd	281	$50.00	1	$14,047
13	Install Fencing	Linear Foot	1,264	$45.00	5	$56,890
14	Site Revegetation	Acres	4	$300.00	1	$1,288
15	Erosion Control Blankets	Acres	4	$10,890	7	$46,752
		Subtotal				$1,459,069
		On-Site Repository Design Cost (5%)				$72,953
		TOTAL				**$1,532,022**
		Total per ton of soil				**$19.41**

Assumptions:
a) Five groundwater monitoring wells (2 upgradient and 3 downgradient of the repository) drilled to a depth of 200 feet will be required for the on-site repository.

b) The on-site repository will be capped with 12 inches of uncompacted backfill; 6 inches of uncompacted topsoil; and 4-oz geotextile fabric. The soil cover will be compacted to a 12-inch soil cover. Details on the on-site repository are found in Appendix B.
c) Blasting will not be required to develop the on-site repository.
d) Clean excavated material will be used for the 12-inch backfill layer.
e) Drainange ditch will be approximately six feet wide and one foot deep.
f) Site revegetation will be required for the 2 acre work area and the on-site repository.

Notes:
1) Quote received from Environmental Remediation, LLC on 3/20/13.
2) Quote received from AET Environmental on 3/21/13.
3) Quote received from Geodynamics on 3/21/13. Typar non-woven fabric, price includes material and labor.
4) Engineer's estimate.
5) RSMeans Heavy Construction Data 2010; *32 31 23.10 0320* , 6 ft high privacy vinyl fence
6) See Table A-23.
7) Excess clean material from the construction of the on-site repository will be used as backfill in the soil cover. Therefore, the material cost for backfill is not included. The costs for compacting and spreading backfill are included in items #8 and #9, respectively.
8) Quote received from Direct Push Services LLC on 10/25/11 for the Davenport Flagstaff site and includes installation and materials for coconut straw erosion control blankets.
9) Excavation cost based on the quote received from Environmental Remediaion, LLC on 3/20/13 and range of costs in 2014 RS Means.

Cu yd = cubic yard
Sq ft = square feet
Sq yd = square yard
oz = ounces

Table A-23
Health & Safety Ambient Air Monitoring
Jacobs Smelters OU2

Health & Safety Ambient Air Sampling Costs for 3 Months

Description	Units	Quantity	Unit Cost	Notes	Cost
Data Ram	Per Month	3	$1,000	1	$3,000
Air Pump	Per Day	90	$80	2	$7,200
Analysis	Per Sample	370	$90	3	$33,300
Air Pump Calibrators	Per Month	3	$150		$450
				Total for 3 Months of Monitoring	**$43,950**

Health & Safety Ambient Air Monitoring (Data Ram) Costs for Project Duration

Alternative	Units	Quantity	Unit Cost	Notes	Cost
Data Ram for Alternative 2 (12 months)	Per Month	12	$1,000	4	$12,000
Data Ram for Alternative 3 (9-12 months)	Per Month	12	$1,000	4	$12,000
Data Ram for Alternative 4 (21-24 months)	Per Month	24	$1,000	4	$24,000
Data Ram for Alternative 5 (24 months)	Per Month	24	$1,000	4	$24,000
Data Ram for Alternative 6 (18-21 months)	Per Month	18	$1,000	4	$18,000

Health & Safety Ambient Air Monitoring Total Costs

Alternative	Cost
Alternative 2	$55,950
Alternative 3	$55,950
Alternative 4	$67,950
Alternative 5	$67,950
Alternative 6	$61,950

1) Two Data Ram stations (one upwind and one downwind) at $500 per unit for the duration of the project.
2) Minimum of two air pumps (one upwind and one downwind) at $40 per unit per day for 90 days.
3) Assume four samples will be collected per day (one upwind sample, one downwind sample, one trip blank, and one field duplicate) for three months. Additionally, 10 samples from workers will be collected.
4) The longest project duration is used for cost estimating purposes.

APPENDIX B

Onsite Repository

Appendix B
On-Site Repository Preliminary Design

EPA has characterized the waste generated from any removal action at the Jacobs OU2 site as Bevill Exempt (UDEQ, 2004). One of the options for disposal of the Bevill Exempt waste is the generation of an on-site repository. For cost estimating purposes, a preliminary design of an on-site repository was conducted and is summarized here. The cost resulting from this preliminary design is used in the cost estimate in Appendix A.

Two cover options were considered for completion of the on-site repository: 1) a RCRA cap and 2) a soil cover. Below is a description of each cover option.

RCRA Subtitle C Cap

The RCRA subtitle C cap is an engineered cap designed to comply with Subtitle C Cap requirements for minimization of infiltration as outlined in 40 CFR 264. The RCRA subtitle C cap proposed for the Jacobs OU 2 site consists of the following layers (from top to bottom): 6-inch gravel armor; 18-inch common fill; 4 ounce (oz.) geotextile; 12-inch drainage layer; 4 oz. geotextile; geosynthetic clay liner (GCL).

The top layer of the cap is designed to impede erosion while allowing surface runoff from major storm events. This layer usually consists of a layer of vegetation over topsoil or a layer of gravel armor over a layer of common fill. Since it could be difficult to establish and maintain vegetation at the Jacobs OU 2 site, gravel armor is recommended for the top layer of the cap. The proposed 6-inch layer of gravel armor will provide erosion control while protecting other components of the cap and serving as a barrier to human and burrowing animals. The underlying 18-inch layer of common fill is a protection layer designed to provide sufficient soil thickness to allow for expected long-term erosional losses as well as providing adequate water-storage capacity to attenuate rainfall infiltrations into the underlying layers.

The drainage layer is designed to prevent leachate generation by minimizing the volume and the residence time of water coming into contact with the low permeability layer. This layer usually consists of a 4 oz. geotextile and a 12-inch drainage layer. The proposed 4 oz. geotextile is included as a filter layer. The 12-inch drainage layer is recommended to be constructed of clean sand or gravel.

The low permeability layer is designed to impede infiltration through the cover. This layer usually consists of 4 oz. geotextile and a low permeability barrier/liner. The proposed 4 oz. geotextile is included as a filter layer. The low permeability barrier recommended for the Jacobs OU 2 repository consists of a GCL layer. GCL is a low permeability liner that has been successfully used as a hydraulic barrier and has been shown to be more effective than compacted clay liners.

Soil Cover

The soil cover proposed for the Jacobs OU 2 site consists of the following layers (from top to bottom): 9 inches of uncompacted topsoil; 9 inches of uncompacted backfill; and a 4-oz geotextile fabric. The soil cover will be compacted to a 12-inch soil cover.

On-Site Repository Design

The proposed on-site repository would be situated on the slope of the former Waterman Smelter property, where the highest lead concentrations have been measured, as shown in Figure B-1. This appendix provides a preliminary design of the on-site repository and does not take into account geotechnical and other constructability considerations. The purpose of this preliminary design is to estimate the approximate size and cost of the on-site repository required to store the contaminated soil volume from the remedial excavations at Jacobs OU 2. A geotechnical investigation as well as additional sampling would be required before design could commence. The preliminary design of the on-site repository does not include any additional excavation that may be required to maintain slope stability.

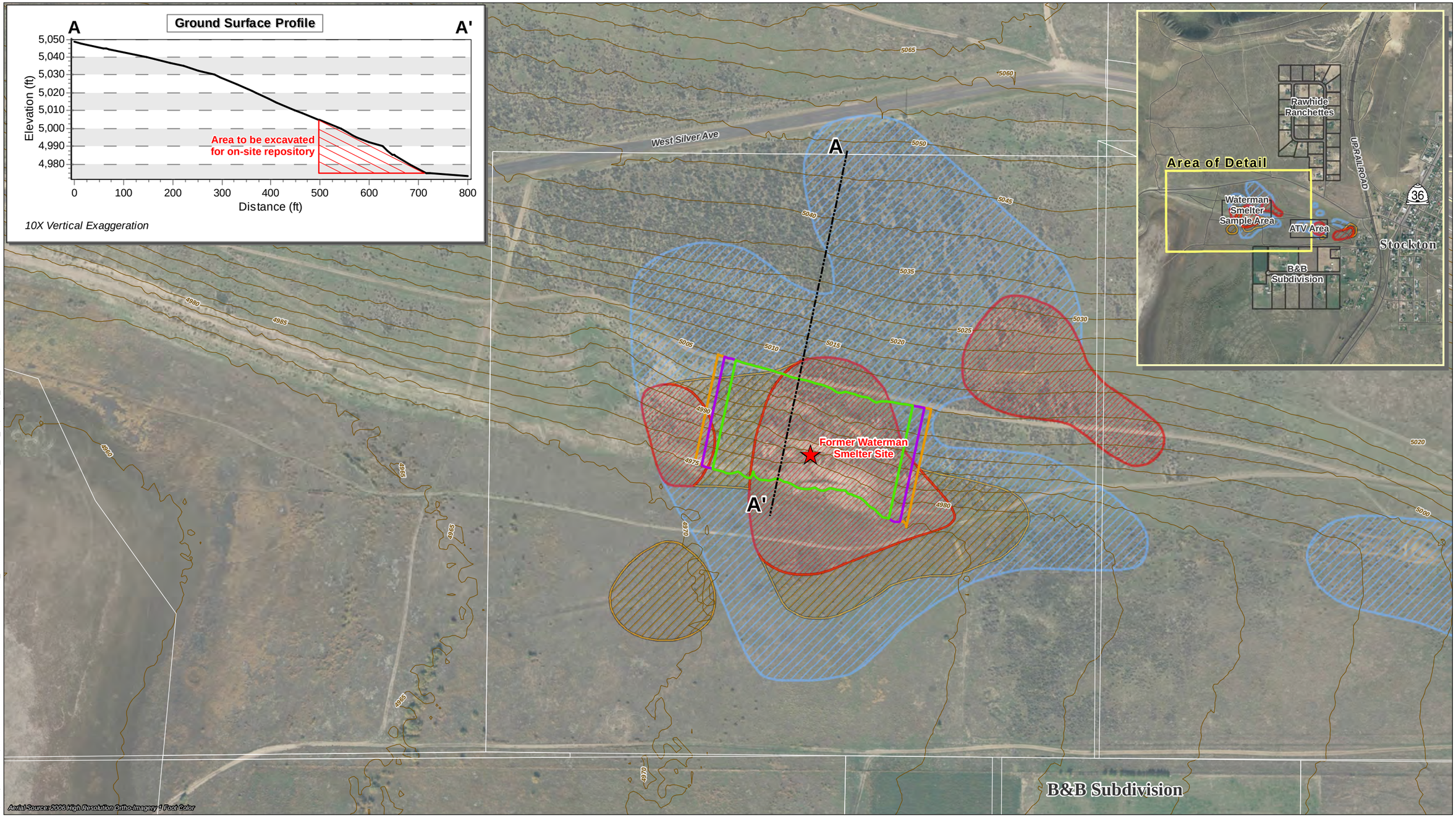
An on-site repository is considered for the following three alternatives:

- Alternative 4 Excavate material in excess of site action levels to a depth of 18 inches, backfill all areas with clean soil, and dispose of excavated materials in an on-site repository with a RCRA Subtitle C cap.
- Alternative 5 Excavate all material in excess of site action levels to the depth of contamination, backfill residential areas with clean soil, regrade non-residential areas, and dispose of excavated materials in an on-site repository with a RCRA Subtitle C cap.
- Alternative 6 Excavate all material in excess of site action levels to the depth of contamination, backfill residential areas with clean soil, regrade non-residential areas, and dispose of excavated materials in an on-site repository with a soil cover.

A preliminary design for an on-site repository for each alternative was developed because, although the remedial area for all three alternatives is the same, the depth of excavation is different for each alternative. The depth of excavation in Alternative 4 is 18 inches bgs in all remedial areas. Alternatives 5 and 6 require that all contaminated material be excavated from the non-residential area. Thus, it is assumed that an additional 12 inches will be excavated in the non-residential areas where the vertical extent of contamination has not been fully defined (i.e. areas with soil contamination found at 18 inches bgs). The size of the on-site repository was estimated based on the volume of excavation required to accommodate the volume of contaminated soil excavated and volume of the selected cover design for each alternative. The estimated quantities related to the construction of each proposed on-site repositories are listed in Tables B-1, B-2, and B-3 for Alternatives 4, 5, and 6, respectively.

The excavation area considered extends from the bottom of the slope at an elevation of 4975 feet above mean sea level (amsl) to the road found at 5005 feet amsl (Figure B-1). The horizontal distance between the bottom of the slope and the road is approximately 220 feet and the slope in this area is estimated at approximately 14%. Assuming that the entire horizontal length of 220 feet is excavated, as shown in Figure B-1, a cross-sectional area of approximately 3,300 square feet will be excavated for the on-site repository. For preliminary design purposes, this cross-sectional area is assumed to be uniform across the proposed area for the on-site repository (this assumption is supported by the elevation contours). The required width of the on-site repository is estimated as 386 feet for Alternative 4, 479 feet for Alternative 5, and 450 feet for Alternative 6. This width was determined based on the volume of contaminated soil to be placed in the repository, the cross-sectional area of the slope, and the area occupied by the selected cover for each alternative. The total area of the on-site repository is estimated at 2.0 acres for Alternative 4, 2.4 acres for Alternative 5, and 2.3 acres for Alternative 6. A drainage ditch and fence should also be installed around the on-site repository.

Contaminated soil is found in the majority of the area proposed for the on-site repository. For preliminary design purposes, it is assumed that the top 30 inches of soil in this area are contaminated and will be stored in the on-site repository. Excavation of the on-site repository will generate excess clean material, as shown in Tables B-1 through B-3. The clean excess excavated material is recommended to be used in the 18-inch common fill layer of the RCRA subtitle C cap and the 12-inch backfill layer of the soil cover. The remaining clean excess excavated material could be used as backfill in the excavated areas of the Jacobs OU 2 site. However, since geotechnical and analytical data for the soils below 18 inches are not available at this time and in the interest of providing a conservative cost estimate, the alternatives using the on-site repository include costs for importing backfill material for the areas outside the on-site repository.



Q:\Projects\UDEQ\Jacobs Smelter\WA01-Finalization of OU2 FS\09_Data\GIS\March2014\FigureB-1_OnSite_Repository_LocationMap.mxd

LEGEND

4975 — 5 ft Surface Contour

A_ _ _A' Cross Section Location

Proposed On-Site Repository Area

- Alternative 4
- Alternative 5
- Alternative 6

Excavation Areas (Excavation Depth)

- *0-6" bgs (Surface)* - 14.6 acres
- *0-12" bgs (Shallow Subsurface)* - 3.6 acres
- *0-18" bgs (Deep Subsurface)* - 8.5 acres

Notes:

1) bgs = below ground surface
2) Excavation areas based on contours shown in Figure 3-5, 3-6 and 3-7.
3) The area of the on-site repository varies for each alternative. The area of proposed on-site repository is 2.0 acres for Alternative 4; 2.4 acres for Alternative 5; and 2.3 acres for Alternative 6.

N W E S

0 100 200 300 Feet

JACOBS SMELTER OU2

Figure B-1
Waterman Smelter Area
On-Site Repository Location Map

URS

Table B-1
Jacobs OU 2 On-Site Repository for Alternative 4 - Excavate All Affected Areas, Backfill, and On-Site Repository with RCRA Subtitle C Cap

	Quantity	Unit	Notes
Dimensions of Slope to Be Excavated for On-Site Repository			
Horizontal length of slope to be excavated	220	ft	See ground surface contours in Figure B-1
Elevation at bottom of slope	4,975	ft	See ground surface contours in Figure B-1
Elevation at top of slope	5,005	ft	See ground surface contours in Figure B-1
Slope height	30	ft	
Surface length of slope to be excavated	222	ft	
Cross-sectional area of slope to be excavated	3,300	sq ft	
Material in Slope			
Depth of contaminated soil on slope to be excavated	2.50	ft	Assume an additional 12 inches of contaminated soil below the top 18-inches.
Clean soil height	27.50	ft	
Cross-sectional area of clean soil available in slope	3,025	sq ft	
Required On-Site Repository Size			
Volume of contaminated soil at Jacobs OU2	42,469.13	cu yd	
	1,146,666.47	cu ft	
Thickness of RCRA subtitle C cap	3	ft	
Cross-sectional area under RCRA subtitle C cap	2,970	sq ft	Area of slope available to be filled with contaminated soil excavated from Jacobs OU2
Required width of excavation in slope	386.08	ft	
Volume of excavation required for on-site repository	1,274,073.86	cu ft	
	47,187.92	cu yd	
Volume of clean soil generated by on-site repository excavation	1,167,901.04	cu ft	
	43,255.59	cu yd	
Disturbed surface area	85,724.33	sq ft	
	2.0	ac	
Backfill material required for RCRA subtitle C cap	4,762.46	cu yd	1.5 feet of clean backfill required for RCRA subtitle C cap
Excess clean material	38,493.13	cu yd	
	57,162.30	ton	

Notes:

1. Size of on-site repository was estimated based the volume of excavation required to accommodate the contaminated soil from the Jacobs OU2 site and 3 ft thick RCRA subtitle C cap.
2. The RCRA subtitle C cap consists of the following layers the following layers (from top to bottom): 6-inch gravel armor; 18-inch common fill; 4 oz. geotextile; 12-inch drainage layer; 4 oz. geotextile; geosynthetic clay liner (GCL).
3. The estimated repository excavation volume is preliminary and does not include any additional excavation that may be required to maintain slope stability.
4. Clean soil excavated during the construction of the on-site repository will be used in the common fill layer of the RCRA subtitle C cap.

Table B-2
Jacobs OU 2 On-Site Repository for Alternative 5 - Excavate and Regrade All Affected Areas, and On-Site Repository with RCRA Subtitle C Cap

	Quantity	Unit	Notes
Dimensions of Slope to Be Excavated for On-Site Repository			
Horizontal length of slope to be excavated	220	ft	See ground surface contours in Figure B-2
Elevation at bottom of slope	4,975	ft	See ground surface contours in Figure B-2
Elevation at top of slope	5,005	ft	See ground surface contours in Figure B-2
Slope height	30	ft	
Surface length of slope to be excavated	222	ft	
Cross-sectional area of slope to be excavated	3,300	sq ft	
Material in Slope			
Depth of contaminated soil on slope to be excavated	2.50	ft	Assume an additional 12 inches of contaminated soil below the top 18-inches.
Clean soil height	27.50	ft	
Cross-sectional area of clean soil available in slope	3,025	sq ft	
Required On-Site Repository Size			
Volume of contaminated soil at Jacobs OU2	52,707.60	cu yd	Includes an assumed 12 inches to chase contamination in the non-residential areas where soil contamination may be present below 18 inches bgs.
	1,423,105.20	cu ft	
Thickness of RCRA subtitle C cap	3	ft	
Cross-sectional area under RCRA subtitle C cap	2,970	sq ft	Area of slope available to be filled with contaminated soil excavated from Jacobs OU2
Required width of excavation in slope	479.16	ft	
Volume of excavation required for on-site repository	1,581,228.00	cu ft	
	58,564.00	cu yd	
Volume of clean soil generated by on-site repository excavation	1,449,459.00	cu ft	
	53,683.67	cu yd	
Disturbed surface area	106,390.79	sq ft	
	2.4	ac	
Backfill material required for RCRA subtitle C cap	5,910.60	cu yd	1.5 feet of clean backfill required for RCRA subtitle C cap
Excess clean material	47,773.07	cu yd	
	70,943.01	ton	

Notes:

1. Size of on-site repository was estimated based the volume of excavation required to accommodate the contaminated soil from the Jacobs OU2 site and 3 ft thick RCRA subtitle C cap.
2. The RCRA subtitle C cap consists of the following layers the following layers (from top to bottom): 6-inch gravel armor; 18-inch common fill; 4 oz. geotextile; 12-inch drainage layer; 4 oz. geotextile; geosynthetic clay liner (GCL).
3. The estimated repository excavation volume is preliminary and does not include any additional excavation that may be required to maintain slope stability.
4. Clean soil excavated during the construction of the on-site repository will be used in the common fill layer of the RCRA subtitle C cap.

Table B-3
Jacobs OU 2 On-Site Repository for Alternative 6 - Excavate and Regrade All Affected Areas, and On-Site Repository with Soil Cover

	Quantity	Unit	Notes
Dimensions of Slope to Be Excavated for On-Site Repository			
Horizontal length of slope to be excavated	220	ft	See ground surface contours in Figure B-3
Elevation at bottom of slope	4,975	ft	See ground surface contours in Figure B-3
Elevation at top of slope	5,005	ft	See ground surface contours in Figure B-3
Slope height	30	ft	
Surface length of slope to be excavated	222	ft	
Cross-sectional area of slope to be excavated	3,300	sq ft	
Material in Slope			
Depth of contaminated soil on slope to be excavated	2.50	ft	Assume an additional 12 inches of contaminated soil below the top 18-inches.
Clean soil height	27.50	ft	
Cross-sectional area of clean soil available in slope	3,025	sq ft	
Required On-Site Repository Size			
Volume of contaminated soil at Jacobs OU2	53,152.07	cu yd	Includes an assumed 12 inches to chase contamination in the non-residential areas where soil contamination may be present below 18 inches bgs.
	1,435,105.98	cu ft	
Thickness of soil cover	1	ft	
Cross-sectional area under soil cover	3,190	sq ft	Area of slope available to be filled with contaminated soil excavated from Jacobs OU2
Required width of excavation in slope	449.88	ft	
Volume of excavation required for on-site repository	1,484,592.39	cu ft	
	54,984.90	cu yd	
Volume of clean soil generated by on-site repository excavation	1,360,876.36	cu ft	
	50,402.83	cu yd	
Disturbed surface area	99,888.79	sq ft	
	2.3	ac	
Backfill material required for soil cover	3,699.58	cu yd	1 feet of clean backfill required for soil cover
Excess clean material	46,703.24	cu yd	
	69,354.32	ton	

Notes:

1. Size of on-site repository was estimated based the volume of excavation required to accommodate the contaminated soil from the Jacobs OU2 site and 1 ft thick soil cover.
2. The soil cover consists of the following layers the following layers (from top to bottom): 12 inches of uncompacted backfill, 4-oz geotextile fabric, and 6 inches of uncompacted topsoil. The soil cover will be compacted to12 inches.
3. The estimated repository excavation volume is preliminary and does not include any additional excavation that may be required to maintain slope stability.
4. Clean soil excavated during the construction of the on-site repository will be used in the backfill layer of the soil cover.

APPENDIX C

Additional Sampling Report

JACOBS SMELTER SITE
OPERABLE UNIT 2
STOCKTON, UTAH

ADDITIONAL SAMPLING REPORT

State of Utah

Department of Environmental Quality
Division of Environmental Response and Remediation

Contract No. 08627 / WA-04

August 2010

URS

ADDITIONAL SAMPLING REPORT

for

Operable Unit 2
Jacobs Smelter Site
Stockton, Utah

Prepared for

UTAH DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF ENVIRONMENTAL RESPONSE AND REMEDIATION

SALT LAKE CITY, UTAH

Prepared by

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August 2010

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LIST OF ACRONYMS

ATV	All-terrain vehicle
AWAL	America West Analytical Laboratories
bgs	below ground surface
CSS	Contaminant Screening Study
DI	deionized
ECCS	Environmental Chemistry Consulting Services
EPA	Environmental Protection Agency
FD	Field Duplicate
FS	Feasibility Study
GIS	Geographical Information System
GPS	Global Positioning System
ICP	inductively coupled plasma
IDW	investigation-derived waste
LCS	laboratory control samples
MS	Matrix Spikes
MSD	Matrix Spike Duplicates
NIST	National Institute of Standards and Technology
OU	Operable Unit
ppm	parts per million
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RB	Rinsate Blanks
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RI/FFS	Remedial Investigation/Focused Feasibility Study
ROD	Record of Decision
RPD	relative percent difference
SD	standard deviation
SOP	standard operation procedure
UDEQ	Utah Department of Environmental Quality
URS	URS Corporation
VSP	Visual Sampling Plan
XRF	X-ray Fluorescence Spectrophotometer

1.0 INTRODUCTION

URS Corporation (URS) was tasked by the Utah Department of Environmental Quality (UDEQ), in cooperation with the U.S. Environmental Protection Agency (EPA), Region VIII, to perform additional sampling within Operable Unit (OU) 2 of the Jacobs Smelter Site (Site), Figure 1-1. The objective of this sampling effort was to collect sufficient data to determine the lead and arsenic concentrations in soil at the residential properties that are part of the Rawhide Ranchettes and B&B Subdivisions, as well as at the former Waterman Smelter and Winegar Property locations, all located within OU2 and shown on Figure 1-2. This report describes the field effort for the additional sampling, and presents the resultant field and laboratory data. Sampling was conducted at the Site from September 2009 through February 2010.

1.1 Site Background

The Jacobs Smelter OU2 site is located within Rush Valley, Tooele County, Utah (Figure 1-1). The only significant population in the valley resides in the town of Stockton, located approximately 38 miles southwest of Salt Lake City via Interstate 80 and Utah Highway 36, and five miles southwest of the city of Tooele, the county seat of Tooele County. In general, land surrounding the town of Stockton is used primarily for agricultural and recreational purposes.

The Jacobs Smelter Superfund Site was originally identified in 1997. Contamination at the Jacobs Smelter Site resulted from the operation of several historic smelters in the area, including the Chicago Smelter, the Carson Buzzo Smelter, and the Waterman Smelter (Figure 1-1). In 1998, the site was divided into three operable units: OU1, OU2 and OU3 (Figure 1-1). OU1 generally includes the residential soils within the town limits of Stockton. OU2 is that portion of the Jacobs Smelter Site outside the general town limits of Stockton and consists primarily of undeveloped land used for agricultural and recreational purposes; however, two residential developments are also a part of OU2: the Rawhide Ranchettes Subdivision, and the B&B Subdivision (Figure 1-2). OU3 includes only the soils within the Union Pacific railroad right-of-way.

Remedial activities within OU1 were completed in 2001 according to the requirements specified in EPA guidance and the OU1 Record of Decision (ROD) (EPA 1999). Contaminated soils in OU3 were remediated by Union Pacific in the summer/fall of 1999. Contaminated soils in OU2 are currently being addressed, and the soils of the two residential developments (Rawhide Ranchettes and B&B Subdivisions), the former Waterman Smelter, and the Winegar Property are the focus of this work.

1.2 Relevant Previous Investigations

Detailed discussions of previous investigations conducted at the Jacobs Smelter site can be found in the *Final Remedial Investigation for Operable Unit 2 Jacobs Smelter Site Stockton, Utah* (URS, 2003), and in the *Final Revised Feasibility Study for Operable Unit 2 Jacobs Smelter Site Stockton, Utah* (URS, 2004). Previous investigations that are particularly relevant to the work discussed in this report include the

following: 1) the OU1 Remedial Investigation/Focused Feasibility Study (RI/FFS) conducted in 1999 (URSG, 1999); 2) a Contaminant Screening Study (CSS) conducted in 1999 at the outset of RI activities for OU2 (URSG, 2000a); 3) a focused investigation of the developing Rawhide Ranchettes subdivision conducted in 2000 (URSG, 2000b); 4) OU2 RI sampling that included the B&B Subdivision conducted in early 2002 (URS, 2003); and 5) sampling conducted for Kennecott Copper Corporation in 2009 that led to this investigation (no official documentation from UDEQ as of the writing of this report). A brief description of each of these relevant previous investigations is presented below.

1.2.1 OU1 Remedial Investigation/Focused Feasibility Study

In February of 1999, as part of the OU1 RI/FFS, UDEQ-contractor URS Greiner performed sampling of open ground along the eastern edge of the residential area of Stockton. The results of this sampling were used to establish the eastern boundary between OU1 and OU2. The sampling locations are now contained in the part of OU2 east of Stockton. The OU1 residential soil lead action levels, established based on the OU1 RI/FFS results and adopted in the OU1 ROD (EPA, 1999), were used as action levels for the additional sampling described in this report, and are as follows: 500 parts per million (ppm) lead for surface soil (up to 2 inches below ground surface [bgs]) and 800 ppm lead for subsurface soil (between 2 inches and 18 inches bgs) concentrations (URSG, 1999).

1.2.2 Contaminant Screening Study

Remedial Investigation activities for OU2 began in 1999. Due to the large geographic extent of OU2 and the relatively small amount of data available, UDEQ elected to first perform a CSS prior to conducting a comprehensive RI. The CSS was primarily intended to identify the general areas of contamination in OU2 and establish a geographic boundary for future study; results are presented in the *Contaminant Screening Study Report for Operable Unit 2 Jacobs Smelter Site, Stockton Utah* (URSG, 2000a). During the CSS investigation, elevated levels of metals were found in the soils of the developing Rawhide Ranchettes Subdivision. This resulted in a focused investigation of the Rawhide Ranchettes subdivision in May 2000.

1.2.3 Rawhide Ranchettes Investigation

A focused investigation of the developing Rawhide Ranchettes subdivision was conducted in 2000 due to elevated levels of metals discovered in the area during CSS sampling (URSG, 2000a). The Rawhide Ranchettes subdivision is composed of 30 lots of approximately 1½-acres. One 5-point composite sample was collected from 25 of the 30 lots. The remaining five lots were divided into four different zones (Zones A, B, C, and D) and a 5-point composite sample was collected from each zone within the lot. Analytical results of the Rawhide Ranchettes soil sampling indicated that five of the 30 lots within the subdivision exceeded residential lead-screening levels (500 ppm of lead for surface material and 800 ppm of lead for subsurface material). A Non-Time-Critical Removal Action for the five contaminated lots was completed by August 31, 2001. The details of the work performed at Rawhide Ranchette Subdivision are described in the *Rawhide Ranchettes Investigation Report* (URSG, 2000b).

1.2.4 2003 OU2 RI Sampling

Remedial Investigation sampling was conducted in 2003. As part of this event, the residential properties along the northern half of the B&B Subdivision were sampled in February 2003. Four properties were sampled by dividing each property into zones based on use and size, for a total of 18 zones. The size of each zone was approximately 1 ½ acres. A five-point composite sample was collected from each zone at depths of 0-2 inches, 2-6 inches, 6-12 inches and 12-18 inches, for a total 72 samples. The samples were analyzed at a fixed-based laboratory for lead and arsenic.

Of the 18 zones, only two properties, and only one zone within each property, had composite soil results that exceeded residential action levels for lead. No properties exceeded the residential action level for arsenic (URS, 2003).

1.2.5 Kennecott Remedial Action

In 2009, as part of oversight of a remedial action being conducted by Kennecott Copper Corporation in OU3, adjacent to the Rawhide Ranchettes subdivision, one of the properties that had been previously remediated was found to have levels of lead that exceeded the residential action level. This instigated a review of the sampling protocol previously implemented at the Rawhide Ranchettes and B&B Subdivisions. Although the sampling protocol used at the time was consistent with industry standards, EPA guidance (EPA, 2003) has been published since that time that recommends a sampling protocol where properties are subdivided into smaller sample sizes (1/4 acre). Therefore, in an effort to assess the contamination remaining at the site and in accordance with current EPA guidance, the investigation described herein was completed.

1.3 SCOPE, OBJECTIVES, AND ORGANIZATION OF REPORT

The scope, objectives and report organization are presented in the following sections.

1.3.1 Scope

Based on results presented in the Baseline Human Health Risk Assessment for OU1 (ISSI, 1999), soil containing elevated concentrations of lead and arsenic is considered the primary threat to human health. The original scope of this additional sampling effort was to collect soil samples from the 40 residential properties within OU2, located in the Rawhide Ranchettes and B&B Subdivisions, and analyze them for lead and arsenic, as outlined in the *Final Residential Re-Sampling Project Plans for Operable Unit 2, Jacobs Smelter Site Stockton, Utah* (URS, 2009). These properties range in size from 2 acres to 7 acres, with the majority of properties being approximately 2 acres, and the properties were divided into composite sample size areas that meet current standards (i.e. ¼ of an acre; EPA, 2003).

After sampling activities commenced in the residential subdivisions, the scope of the sampling effort was expanded to include additional sampling in the primarily recreational areas of the former Waterman Smelter and the Winegar Property, both of which are located in between the Rawhide Ranchettes and B&B Subdivisions. The main impetus for expanding the scope to include the former Waterman Smelter

and Winegar Property was concern regarding the potential for cross-contamination between these recreational areas and the residential subdivisions.

The data obtained from the analysis of all soil samples were used to achieve project objectives, as described below.

1.3.2 Objectives

The project objectives include collecting data to adequately represent human exposures in the residential and recreational properties that are a part of OU2 in order to determine if exposure exceeds the previously determined lead and arsenic action levels, described below. In addition, data were gathered to support volume calculations and the remedial cost evaluation to be made in the updated Revised Final OU2 FS (URS, 2004).

1.3.2.1 Action Levels

The OU2 lead and arsenic action levels will be established in the upcoming OU2 ROD. However, for screening and comparison purposes and due to the strong similarity between OU1 and the residential areas of OU2, the residential values determined in the ROD for OU1 of the Jacobs Smelter site were used for this investigation (EPA, 1999). Those residential values are as follows; 500 ppm lead in surface (0-2 inches) soils, 800 ppm lead in subsurface (2-18 inches) soils, and 100 ppm arsenic in both surface and subsurface soils.

1.3.3 Organization

This report is organized into eight sections. Site background and previous investigations are summarized in section 1.0. Section 2.0 summarizes field investigation methods. Section 3.0 summarizes analytical methods. Section 4.0 discusses quality assurance/quality control (QA/QC) measures. Section 5.0 discusses sample results from the field and laboratory data. Section 6.0 summarizes data validation. Section 7.0 discusses conclusions based on the information presented in Sections 5.0 and 6.0. Section 8.0 includes the references cited in this report.

2.0 FIELD INVESTIGATIONS

An analytical program was conducted to analyze lead and arsenic concentrations in soils using three separate, complementary analytical methods: hand-held X-Ray Fluorescence (XRF) technology; fixed-base laboratory XRF analyses; and inductively coupled plasma (ICP) analyses. Additional information about each analytical method is presented in Section 3.0. This section describes the sampling design and presents the procedures used for collecting and locating samples.

Different field sampling techniques were used for the residential properties (Rawhide Ranchettes and B&B Subdivisions) than were used for the recreational properties (former Waterman Smelter and Winegar Property), as described below in Sections 2.1 and 2.2. Appropriate decontamination and investigation-derived waste (IDW) management procedures were followed for all sampling, as described in Section 2.3.

2.1 Residential Properties

Each lot within the Rawhide Ranchettes and B&B Subdivisions was divided into ¼ acre decision units, per guidance found in the *Superfund Lead-Contaminated Residential Sites Handbook* (EPA, 2003). The Rawhide Ranchettes Subdivision contains 30 lots. Twenty-nine of these lots were sampled during this effort; access to sample Lot 30 was not obtained and was not sampled. The 29 Rawhide Ranchettes lots (Figure 2-1) were divided into a total of 225 decision units. The B&B Subdivision contains 10 lots, which were divided into a total of 208 decision units (Figure 2-2).

Sampled media consisted of surface and subsurface soils collected from residential lots soil. A field team of at least two people conducted all sampling, with support from a third field team member when necessary. One composite surface sample and three subsurface grab samples were collected from each decision unit. The surface (0-2 inches bgs) sample was a composite of separate, evenly distributed aliquots from within each decision unit. The number of aliquots used per decision unit was determined statistically, based on the variability of the in-situ XRF lead concentrations observed in the lot containing the decision unit. This methodology is referred to as Vario-plotting and is described in Section 2.1.1 below. The subsurface grab samples from each decision unit were collected from the aliquot location that exhibited the highest in-situ XRF lead reading, and consisted of three depth intervals (0-6 inches; 6-12 inches; and 12-18 inches bgs) to create a depth profile at that location.

2.1.1 Aliquot Number Determination using Vario-plotting

The number of aliquots used for surface composite samples for each decision unit was statistically determined in the field based on the actual variability of in-situ XRF lead concentrations observed at each lot. The statistical variability was determined by performing vario-plotting at each lot on the site. Vario-plotting was conducted by collecting in-situ XRF lead concentrations from a 12 foot by 12 foot grid within a given lot, and then running a statistical analysis in the field using a laptop computer, as described in the Vario-plotting methodology developed by EPA (EPA, 2009), found in Appendix A. The results of the vario-plotting were used in conjunction with Visual Sampling Plan (VSP) sampling software

(Matzke et al., 2007) to statistically determine the number of aliquots necessary to adequately account for lead variability observed. The number of required aliquots determined during the vario-plotting exercise at each lot was applied for all decision units within that lot, with the exception of lots that had more than one vario-plot performed (see below).

At least one vario-plot was performed at each lot within the Rawhide Ranchettes and the B&B Subdivisions. Properties that were previously remediated (portions of Rawhide Ranchettes Lots 1, 2, 3, 21, and 22) or had areas that historically exceeded the clean up standard of 500 ppm lead (portions of B&B Lots 2 and 3), had at least two vario-plots performed, one in the 'impacted' area and one in a 'non-impacted' area. In those cases, a "worst case scenario" technique was used, where the highest number of aliquots determined via vario-plotting was used for all decision units in that lot, except in the case of Lot 2 in the B&B subdivision (see Appendix G). Table 2-1 presents a summary of the number of aliquots used for each lot in the Rawhide Ranchettes and B&B Subdivisions.

2.1.2 Subdividing Properties into Decision Units and Plotting Aliquot Locations

Each lot was divided into approximately ¼ acre decision units. Land use was the largest consideration when determining decision unit locations (i.e., areas that are surrounding houses were kept in one decision unit if possible, while areas that were previously impacted were kept in their own decision units). The footprint of houses and other impermeable surfaces were not included in the areas over which aliquots were collected.

A geographic information system (GIS) map for each lot was created showing subdivisions of decision units and aliquot locations. The number of aliquots determined during vario-plotting for each decision unit was evenly distributed spatially across the decision unit as shown in Figures 2-1 and 2-2. Each map provided a table of Global Positioning System (GPS) coordinates for aliquot locations. The maps took into account any structures or concrete areas existing on the decision unit, such that aliquot locations were not placed in the footprint of these areas.

2.1.3 Locating Sample Aliquots

Each sample aliquot was located and marked using a Trimble Geo Explorer geographic GPS unit and the pre-determined GPS grid coordinates that were provided on sampling maps for use in the field. In instances where field conditions existed so that it was not practical to use one of the pre-determined GPS coordinates, an alternate location was selected in the field and the new coordinates were recorded in the field notes. Field coordinates of the aliquot with the highest in-situ XRF reading for lead were measured and saved in the GPS unit for later use as the location for the subsurface (depth profile) samples. These locations are shown in Figures 2-1 and 2-2. Coordinates recorded in the GPS unit were differentially corrected in the office daily using GPS Pathfinder® software. The other locations that made up the composite surface soil sample were not recorded unless a major deviation from the aliquot location was required based on field conditions, as described above.

2.1.4 In-Situ XRF Sampling

Aliquot sample locations were cleared of organic material, and imported material where feasible. The hand-held XRF instrument was used to record in-situ lead and arsenic reading at each of the marked aliquot locations. Readings were recorded on the sample log forms included in Appendix B.

2.1.5 Soil Sample Collection Procedures

Once the in-situ XRF measurements were completed, surface and subsurface samples were collected using the procedures described below.

Surface Sample Procedures

Composite surface soil samples were collected by using a disposable stainless steel spoon to remove an equal volume of soil from each aliquot location within each decision unit. Soil from each aliquot was deposited directly into a re-sealable, clear plastic sample bag. Each bag was sealed and prominently labeled with the appropriate sample ID (described in Section 2.1.6). Once sealed, each composite sample was homogenized in the bag by thoroughly, manually mixing the soil together. The hand-held XRF unit was used to measure lead and arsenic concentrations from the bagged sample, by directly analyzing the soil. These measurements were recorded on the sample forms. Each sample was sent to Environmental Chemistry Consulting Services (ECCS) laboratory in Madison, Wisconsin for preparation and fixed-base XRF analysis.

Subsurface Sample Procedure

Subsurface depth profile samples were collected from the surface aliquot location with the highest in-situ XRF lead reading using hand-driven sampling augers. Each auger was labeled with a depth interval, 0-6 inch, 6-12 inch, or 12-18 inch, and dedicated to that depth. Once the 0-6 inch hand-auger was driven down 6 inches, the auger was carefully removed from the borehole. Separate decontaminated augers were then used to obtain the 6-12 inch and 12-18 inch samples by driving the augers down the same borehole to the desired depth. Each depth interval soil sample was placed into a labeled stainless steel bowl, mixed thoroughly, and placed directly into a re-sealable clear plastic sample bag. Each bag was labeled with the appropriate sample ID (described in Section 2.1.6). The hand-held XRF unit was used to measure lead and arsenic concentrations from the bagged sample by directly analyzing the soil. The measurement was recorded on sample forms. Each sample was sent to ECCS laboratory for preparation and fixed-base XRF analysis.

2.1.6 Residential Properties Sample Identification

For the residential soil samples, a total of up to six fields were used to represent the sample identification designation as described below:

1. The first field consists of four characters “JOU2”, which designates the site, Jacobs Smelter Site OU2.

2. The second field consists of two characters. This field designates the residential development that sample originates from, with "RR" representing Rawhide Ranchettes and "BB" representing the B&B Subdivision.
3. The third field consists of up to five alphanumeric characters, which designates the lot number within each residential development. For example if the sample is from Lot 5 of a development this field would be "Lot5".
4. The fourth field consists of up to four alphanumeric characters, which designate the decision unit within each lot that the sample comes from. For example if the sample is from decision unit 6 this field would be "DU6".
5. The fifth field consists of up to four alphanumeric characters, which designate the depth of the sample. The sample is either "surf", "0006", "0612", or "1218". Where "surf" represents the 0-2 inch composite surface sample and the numeric character designations represent the beginning and ending depth of the sample in inches.
6. The sixth field, if required, is comprised of "Y", which designates the sample as a field duplicate.

The following is an example ID for the 6-12 inch depth profile sample collected from decision unit 4 within lot 8 of the Rawhide Ranchettes development, "JOU2-RR-Lot8-DU4-0612. Equipment blanks were designated by "EB" and the date they were collected. For example, the sample ID EB101609 designates the equipment blank collected on October 16th, 2009.

2.2 Recreational Properties

For the recreational properties, decision units were not used, but rather in-situ XRF data were collected along transect lines for use in determining the best locations to collect grab surface soil samples for fixed-base XRF analysis, as described below.

2.2.1 Soil Sample Location

At the former Waterman Smelter, in-situ XRF data were collected along intersecting transect lines; two lines were oriented east-west (approximately one half mile in length) and two lines were oriented north-south (approximately one quarter mile in length). In-situ XRF data were collected approximately every forty feet along the east-west transects, and approximately every twenty feet along the north-south transects, as shown on Figure 2-3. At the Winegar Property, in-situ XRF data were collected primarily along the east-west oriented all-terrain vehicle (ATV) track, but also along several north-west transects radiating outward from the ATV track, as shown in Figure 2-3.

The XRF lead and arsenic measurements and their corresponding coordinates were electronically stored in the GPS unit. Coordinates recorded in the GPS unit were differentially corrected in the office using GPS Pathfinder® software and plotted onto a map. Surfer® contouring software was used to estimate/interpolate likely lead concentrations across the area, and URS chose several grab surface soil

sample locations based on the results of the lead contours. UDEQ approved the sample locations at these recreational properties prior to any sample collection.

2.2.2 Grab Sample Procedure

Grab samples were collected from the Waterman Smelter area and the Winegar Property. Both of these properties are located between the B&B and Rawhide Ranchettes Subdivisions (Figure 1-2).

Waterman Smelter Area

Ten grab sample locations were determined using the information provided by the contoured in-situ XRF data (see Section 2.2.1). Before each sample was collected, an in-situ XRF measurement was taken and recorded on the daily soil sampling log field form (Appendix B). The grab samples were surface samples (0-2 inches bgs), collected with a decontaminated (or disposable) stainless steel spoon. The first two inches of the surface were scraped off and placed into a clear re-sealable plastic sampling bag. The bag was labeled with the appropriate sample ID, the date and time. The hand-held XRF unit was used to measure lead and arsenic concentrations from the bagged sample by directly analyzing the sample. These readings were recorded on the daily soil sampling log field form (Appendix B). Each grab sample was sent to ECCS laboratory for preparation and fixed-base XRF analysis.

Winegar Property

Eleven grab sample locations were chosen for the Winegar Property based on the contoured in-situ XRF data. Grab samples were collected following the same procedures described for the Waterman Smelter area above. Subsurface samples from 0-6 inch, 6-12 inch, and 12-18 inch sample depths were collected from the surface locations with the highest XRF lead analysis. Grab sample collections were recorded on depth profile soil sampling logs (Appendix B). Subsurface sampling at the Winegar Property was conducted following the procedures listed in Section 2.1.5.

2.2.3 Recreational Properties Sample Identification

For the recreational properties, different sample identification designations were used. Samples collected in the former Waterman Smelter area were designated with three fields:

1. The first field consists of two characters “WS”, which designates the Waterman Smelter area of the site.
2. The second field consists of a number in two digit format, such as “01” to designate the number sample collected.
3. The third field consists of the date in MMDDYY format.

The following is an example ID for the third sample collected at the Waterman Smelter area on February 10, 2010: WS-03-021010.

Samples collected from the Winegar Property area of the site were designated with up to five fields:

1. The first field consists of four characters “JOU2”, which designates the site, Jacobs Smelter Site OU2.
2. The second field consists of the word WINEGER to designate that the samples were collected from the Winegar Property.
3. The third field consists of a number in two digit format, such as “01” to designate the number sample collected.
4. The fourth field consists of up to four alphanumeric characters, which designate the depth of the sample. The sample is either “surf”, “0006”, “0612”, or “1218”, where “surf” represents a 0-2 inch surface sample and the numeric character designations represent the beginning and ending depth of the sample in inches.
5. The fifth field, if used, consists of “Y” to designate the sample as a field duplicate.

The following is an example ID for the tenth sample collected at the Winegar Property, collected as a surface sample: JOU2-WINEGER-10-SURF.

2.3 Decontamination and IDW

All non-disposable sampling equipment was decontaminated between each sampling location. This equipment included three hand-driven augers, three stainless steel bowls, and three stainless steel spoons which had all been used for collecting designated sample depths. Decontamination consisted of scrubbing the sampling equipment with Alconox® detergent until the sampling equipment was visibly free of dirt and debris, and triple rinsing with de-ionized water. Decontamination wash and rinse water was disposed of daily in the proximity of the sampling location with the highest observed lead concentration.

Investigation-derived waste was not generated during sampling. All extra soil sample material was placed back into the hole from which the sample was collected.

3.0 ANALYTICAL METHODS

Three different analytical methods were used to collect data for the Jacobs OU2 additional sampling effort. These analytical methods included hand-held XRF analysis (conducted in the field), fixed-base (laboratory) XRF analysis, and laboratory ICP analysis.

Chronologically, the first analysis used for soil samples was done using the hand-held XRF instrument. The hand-held XRF analyses were conducted in the field by field personnel using the Innov-X Alpha series portable XRF instrument, model number A-200AS, as described in Sections 2.1.1 through 2.1.4 above.

The second analytical method used was fixed-base (laboratory) XRF analysis performed by ECCS laboratories. Although chronologically second, fixed-base XRF analysis is considered the primary analytical method used for this study because results of these analyses will be used for deciding alternatives to be discussed in the Feasibility Study for the Jacobs Smelter OU2 site. At ECCS laboratories, soil samples were dried in an oven for approximately four hours or overnight if necessary. The samples were than manually ground with a mortar and pestle in a hood, and passed through a No. 60 sieve, ensuring that at least 90% of the sample passed through the sieve. The portion that passed through the sieve was then placed in an XRF cup and analyzed using the ECCS standard operation procedure (SOP) for Method 6200, which uses the Innov-X 440XT XRF analyzer.

The final analytical method, which serves as a comparison check for samples analyzed by the fixed-base XRF method, was ICP analysis performed by American West Analytical Laboratories (AWAL) in Salt Lake City. After the completion of the fixed-base XRF analysis (which does not alter the sample) at ECCS, five percent of the samples that were already analyzed by XRF were then sent to AWAL to be analyzed by ICP for lead and arsenic using EPA method 6010.

Soil samples collected in the residential properties (Rawhide Ranchettes and B&B Subdivisions) were subject to all three analytical methods listed above. Soil samples collected in the recreational properties (former Waterman Smelter and Winegar Property) were only analyzed by XRF methods (both hand-held and fixed-base), and not by ICP methods. This was because the sample results in those areas were of such a high concentration that ICP comparison would not be useful.

4.0 QUALITY ASSURANCE/QUALITY CONTROL

To ensure overall data quality as specified in the Quality Assurance Project Plan (QAPP) (URS, 2009) the following QA/QC measures were taken.

4.1 Hand-held XRF Controls

QA/QC protocols for checking the accuracy and precision of the hand-held XRF instrument are described below.

4.1.1 Standards

A set of standards, consisting of National Institute of Standards and Technology (NIST) traceable and laboratory prepared standards, was analyzed to verify the XRF was measuring within an expectable range. The standards consisted of a high standard, a low standard, a blank standard, and a Resource Conservation and Recovery Act (RCRA) lead standard and were analyzed three times a day: in the morning before analyzing any soil samples, mid-day, and at the end of the day after all field samples had been analyzed with the hand-held XRF. Similar to laboratory control samples (LCSs), the standards were matrices that had been spiked with a known concentration of metals, including lead and arsenic. XRF measurements of the standards were recorded on field forms (Appendix B) and compared to the known concentrations.

4.1.2 RCRA Standard

A control chart was developed for the specific hand-held XRF instrument used for this work. The control chart was used to monitor whether the instrument was performing within acceptable limits. The control chart was created by analyzing a RCRA lead standard using the hand-held XRF instrument numerous times over numerous days and then drawing lines on a graph that correspond to the mean concentration, plus or minus two standard deviations, and plus or minus three standard deviations. As stated in the Sampling and Analysis Plan for the additional sampling effort (URS, 2009), as long as plus or minus two standard deviations was equal to or less than 10% of the mean and the mean was within 10% of the expected standard concentration, the hand-held XRF was considered adequate for use.

The RCRA lead standard was analyzed about once every twenty field samples analyzed. The concentration measured by the XRF was plotted on a control chart (Appendix C) along with the date, time and XRF run number. Statistically, 95% of these measurements were expected to fall within the plus or minus two standard deviation (2SD) lines and 99% were expected to fall within the three standard deviation (3SD) lines. If a measurement fell outside the 2SD line, the standard was re-analyzed. If more than 5% of the RCRA lead standard measurements fell outside of 2SD lines, field personnel knew there was a problem with either the RCRA standard or the XRF instrument. In most cases, replacing the Mylar film on the RCRA standard corrected the problem. In one instance, the screen on the XRF sampling window was replaced. Once the Mylar and/or the XRF screen was replaced, the readings fell back into the 2SD lines. The RCRA standard was analyzed 219 times throughout the sampling event; 17

measurements fell outside of the 2SD lines (7.7%) and one measurement fell outside of the 3SD lines (0.05%).

4.1.3 Matrix Duplicates

Matrix duplicates (or move duplicates) were also performed, as necessary. A matrix duplicate was indicated when any XRF result seemed out of line with what was reasonably expected. In these cases, the XRF instrument was moved from the location of the first suspect result by a couple of inches or less and another reading was taken. The results of these readings were compared by calculating a relative percent difference (RPD), as described in the Sampling and Analysis Plan for the additional sampling effort (URS, 2009). During field work for this additional sampling effort, move duplicates were only required during the data collection for vario-plotting and the RPD was never outside of the expected range of 50% (see field forms in Appendix B).

4.2 Analytical Laboratory & Field Method Controls

QA/QC protocols for verifying the precision of analytical laboratory methods and the adequacy of field decontamination procedures are described below.

4.2.1 Field Duplicates

Field duplicates were collected at a rate of 5% of the total number of soil samples, to provide estimates of laboratory analytical precision. At least one field duplicate was collected from each lot. Field duplicate samples were collected and sent to ECCS for total lead and arsenic analysis by fixed-base XRF methods. The field duplicate samples were handled and analyzed in the same manner as all environmental samples; the chain-of-custody forms documenting the transfer of the samples to the laboratory can be found in Appendix B, and the data validation report that evaluates the field duplicate results can be found in Appendix D.

4.2.2 Equipment Blanks

Equipment blanks (equipment decontamination rinsate samples) were collected and submitted to a local analytical laboratory in order to assess the adequacy of decontamination procedures to prevent cross-contamination between sampling locations and samples. Equipment blanks were collected at a rate of 5% of samples collected with non-disposable equipment (depth profile samples). Disposable sampling equipment did not require decontamination or collection of an equipment blank.

Equipment blanks were collected after the final decontamination rinse of the hand-held auger by pouring deionized (DI) water over the auger and into a clean stainless steel bowl. The water was then poured from the bowl into appropriate sample bottles. The DI water and sample bottles were provided by AWAL, located in Salt Lake City, UT. Equipment blank samples were analyzed using ICP methodology for total lead and total arsenic by AWAL. Samples were handled in the same manner as all environmental samples; the chain-of-custody forms documenting the transfer of samples to the laboratory can be found in Appendix B, and results of data validation using the equipment blank results are presented in Appendix D.

4.3 Analytical Laboratory Comparison Samples

Five percent of the primary samples that were collected in the residential properties (Rawhide Ranchettes and B&B Subdivisions) and sent to ECCS laboratory for fixed-base XRF analysis were also sent to AWAL for analysis of lead and arsenic by ICP instrumentation. These ICP data were used as comparison data since ICP is a widely-accepted EPA-approved analytical method, and fixed-base XRF analyses are currently not as widely used. There were 1,757 non-duplicate, or primary, samples collected during the additional sampling event; therefore, 88 of the primary samples (5%) were sent to AWAL for comparison ICP analysis.

The samples selected for delivery to AWAL for ICP analysis were chosen by URS, with approval from UDEQ and EPA. These samples were selected from a pool of results with lead concentrations that ranged from 200 ppm to 3500 ppm, such that selected samples had a strong representation near the 500 ppm lead action level, as well as even representation of the rest of the range of meaningful lead concentrations (200 ppm to 3500 ppm). To achieve appropriate representation, 40% of the samples sent for ICP analysis (n=35) were selected from a range as close to 500 ppm lead as possible. The smallest concentration range near the 500 ppm action level that yielded 35 samples was from 438 ppm to 562 ppm; therefore 35 samples with concentrations within this range were sent to AWAL for ICP analysis.

The remaining 60% of samples sent for ICP analysis were selected to represent the rest of the meaningful range of lead concentrations represented by the XRF sample results (200 ppm to 3500 ppm). Therefore, 25% of the samples (n=22) sent for ICP analysis had concentrations ranging from just above 200 ppm to 438 ppm, and the remaining 35% of samples sent (n=31) had concentrations ranging from 562 ppm to 3500 ppm. This method of sample selection resulted in nearly complete ICP analysis representation for all lots within the residential subdivisions; only six lots within the two subdivisions were not represented in these samples, due to very low (<200 ppm) lead concentrations in samples from those lots. As stated in Section 3.0, soil samples from the former Waterman Smelter and Winegar Property were not included in the pool of samples to be sent for ICP analysis. This is because their concentrations were too high to provide a meaningful comparison, as at lead concentrations greater than 10,000 ppm, XRF and ICP results are not expected to correlate.

5.0 SAMPLING RESULTS

This section is a presentation of the results primarily of the laboratory-based (ECCS) XRF results; complete datasets for these results can be found in Appendix F. Datasets for the field-based XRF analyses are presented in Appendix E, and data results for the ICP analyses are found in Appendix I. This section only includes results for primary samples; field duplicate samples are discussed in the data validation report found in Appendix D. Detailed figures with data from each lot and decision unit of the Rawhide Ranchettes and B&B subdivisions are presented in Appendix G.

The results reported by the laboratory included the XRF lead value and the instrument uncertainty associated with that value. For the purposes of this report, sample results were interpreted based on the sum of the reported XRF lead value and the reported instrument uncertainty. Therefore, a surface soil sample was considered to exceed the surface soil residential lead-screening level of 500 ppm if the sum of the reported lead value and the reported uncertainty was greater than or equal to 500 ppm.

5.1 Rawhide Ranchettes Subdivision

A histogram for lead results for 897 samples collected at the Rawhide Ranchettes subdivision is presented in Figure 5-1. These samples consist of both surface soil and subsurface soil samples, and the histogram shows that the majority of the lead results (n = 545) fell within the range of 1 ppm to 100 ppm range. Three hundred thirty-four results fell within the 101 ppm to 500 ppm lead range, and 20 sample results were greater than 500 ppm (which is the surface soil residential lead-screening level, used here for reference only).

Of the 897 sample results shown in Figure 5-1, nine surface soil samples and two subsurface soil samples exceeded their respective soil residential lead-screening levels (500 ppm and 800 ppm, respectively), for a total of 11 samples that exceeded a screening level. Figure 5-2 shows the lots at Rawhide Ranchettes subdivision where sample results exceeded a residential soil lead-screening level (surface sample exceedance, subsurface sample exceedance, or both). As shown in Figure 5-2, the 11 samples that exceeded a soil residential lead-screening level occurred in ten different decision units in five different lots. Figure 5-2 also shows that the highest lead concentration reported for the Rawhide Ranchettes subdivision was 1367 +/- 21 ppm, which was reported for the sample JOU2-RR-LOT3-DU5-SURF (the surface sample collected from Lot 3, Decision Unit 5).

5.2 B&B Subdivision

A histogram for lead results for 832 samples collected at the B&B subdivision is presented in Figure 5-3. Like the histogram shown in Figure 5-1, the sample results consist of both surface soil and subsurface soil samples. Figure 5-3 shows that the majority of the samples (n = 507) fell within the range of 1 ppm to 100 ppm, and that 247 samples fell within the 101 ppm to 500 ppm range. The remaining 78 sample results were greater than 500 ppm, with 25 of these samples having a lead concentration greater than 1,701 ppm.

Of the 832 sample results shown in Figure 5-3, 15 surface soil samples and 39 subsurface soil samples exceeded their respective soil residential lead-screening levels (500 ppm and 800 ppm, respectively), for a total of 54 samples that exceeded a screening level. Figure 5-4 shows the lots at B&B subdivision where sample results exceeded a residential soil lead-screening level (surface sample exceedance, subsurface sample exceedance, or both). As shown in Figure 5-4, the 54 samples that exceeded a soil residential lead-screening level occurred in 22 different decision units in four different lots. All of these samples were collected in the northernmost lots of the B&B subdivision, from decision units in the northern portion of each lot. Figure 5-4 also shows that the highest lead concentration reported for the B&B subdivision was 8,198 +/- 83 ppm, which was reported for the sample JOU2-BB-LOT1-DU3-0006 (the subsurface sample collected from Lot 1, Decision Unit 3, from 0 to 6 inches below the surface).

5.3 Waterman Smelter

Figure 5-5 shows both field-based XRF and laboratory-based XRF lead results for samples collected at the Waterman Smelter area. The field-based XRF lead results shown in Figure 5-5 were also contoured to show the estimated distribution of lead concentrations in the soil at the Waterman Smelter area. These lead contours show that the highest concentrations of field-based XRF lead results occurred generally in the center of the sample area, where the two east-west transects met with the westernmost north-south transect. The highest field-based XRF lead value reported for the Waterman Smelter area was 133,879 ± 4,555 ppm.

As discussed in Section 2.2.2, ten grab samples were collected at the Waterman Smelter area and analyzed by ECCS using laboratory-based XRF. The laboratory-based XRF lead results for the 10 grab samples are shown in Figure 5-5 and the concentrations range from 3,786 ppm to 154,887 ppm. The highest laboratory-based XRF concentration reported (154,887 ppm) was for sample JOU2-Smelter-1 that was collected at the assumed location of the former Waterman Smelter.

5.4 Winegar Property

Figure 5-6 shows field-based XRF and laboratory-based XRF lead results for samples collected at the Winegar Property. The field-based XRF data were contoured in Figure 5-6 to show the estimated distribution of lead concentrations in soil in this area. The lead contours show that the highest concentrations of lead in the soil generally occur along the ATV track that is approximately in the center of the sample area and that is visible beneath the contours in Figure 5-6. The highest field-based XRF lead value reported for the Winegar Property was 51,319 ± 1,485 ppm.

Eleven grab samples were collected at the Winegar Property and analyzed by ECCS using laboratory-base XRF. The laboratory-based XRF lead results for the 11 grab samples are shown in Figure 5-6 and the concentrations range from 198 ppm to 44,130 ppm. The highest laboratory-based XRF concentration reported (44,130 ppm) was for sample JOU2-WINEGER-6-SURF that was collected near the center of the east-west transect that generally follows the ATV track.

5.5 XRF vs. ICP Data Correlations

As stated in Section 4.3, five percent of the primary samples that were sent to ECCS laboratory for fixed-base XRF analysis were also sent to AWAL for analysis of lead and arsenic by ICP instrumentation. Linear regressions of the XRF vs. ICP data were then created to evaluate how closely the laboratory XRF and ICP data compare. Figure 5-7 shows the linear regressions for both lead and arsenic data for laboratory XRF vs. ICP data plots. Linear regressions for field-based XRF vs. laboratory-based XRF results are not discussed in the body of this report, but are presented in Appendix H.

Figure 5-7 shows that laboratory XRF and ICP analysis results are similar for the samples analyzed, particularly when comparing lead datasets. The linear regression for lead data shows that the lead concentrations for most of the samples are nearly identical between the laboratory XRF and ICP datasets, especially for samples where the concentrations are less than approximately 1,000 ppm. In addition, the R^2 value of 0.9875 for the lead data suggests a strong correlation, and near perfect agreement between the two data sets. The linear regression for the arsenic data also shows good agreement between the laboratory XRF and ICP datasets, but the results are more scattered (and therefore less similar) than with the lead datasets, even at the lower concentrations (e.g., less than 100 ppm). The R^2 value of 0.6705 for the arsenic data suggests a reasonable correlation between the two datasets, yet not as robust as the correlation seen with the lead datasets.

6.0 DATA VALIDATION SUMMARY

The following section summarizes results of the data review conducted on the analytical data analyzed for lead and arsenic by fixed-base XRF, as well as the data reported in laboratory analytical data packages received by AWAL for the Jacobs Smelter superfund Site. The full data validation report is included in Appendix D of this report. Field results for 1,751 sites were reported in 12 batches and laboratory analytical results for 81 equipment rinsate samples and 88 comparison samples were reported by AWAL in eight analytical data packages. The data review was conducted in accordance with the QAPP for this project (URS, 2009). A data review was conducted on the results that included but was not limited to the following:

- Sample Receipt and Condition
- Hold Time and Sample Preservation and Containers
- Method Blanks
- Matrix Spikes (MS) and Matrix Spike Duplicates (MSD)
- Field Duplicate (FD) Comparison
- Equipment Rinsate Blanks (RB)
- Laboratory Control Spikes (LCS)
- ECCS Quality Control Samples
- Confirmation Results Comparison
- Data Package Completeness
- Overall Assessment of the Data

Several minor data quality issues were identified during the data validation process; however, qualification was not required and/or considered necessary. These minor issues are summarized below.

1. Several samples were received by AWAL outside the required temperature criteria of ≤ 6°C. Based on the stability of the parameters, the analysis for metals on the associated samples were unlikely affected and qualification was not considered necessary.
2. Three samples (JOU2-RR-LOT3-DU4-0006, JOU2-RR-LOT3-DU5-SURF, JOU2-RR-LOT3-DU7-1218) were received by AWAL outside the 180 day method required holding time. Due to the stability of arsenic and lead in soils, results were unlikely affected and data qualification was not considered necessary.
3. As no criteria was specified in the QAPP for comparison of confirmation samples analyzed by AWAL to the original samples analyzed by XRF, the criterion specified for field duplicate precision (RPD ≤ 50%) was used. The lead results between 1 of 88 (1.1%) confirmation samples and the arsenic results for 10 of 88 (11.4%) confirmation samples did not meet this criterion. Data qualifiers were not issued for confirmation sample comparison outliers.

Data qualification that was required for some of the analytical results was based on MS, MSD, and FD results not satisfying the applicable evaluation criterion as summarized below.

1. The arsenic results for one of the 87 FD pairs (JOU2-RR-LOT11-DU3-0006-Y) and the lead results for two of the 87 FD pairs (JOU2-BB-LOT4-DU20-0006-Y and JOU2-RR-LOT29-DU5-0006-Y) did not meet the criteria specified in the QAPP. As 1.1% of the arsenic results and 2.3% of the lead results did not meet the applicable evaluation criterion, qualification based on FD was limited to the FD pair results.
2. The MS recovery for arsenic for AWAL confirmation sample JOU2-RR-LOT3-DU4-0006 was above the control limits. Since the MSD recovery and RPD between the MS and MSD for this sample as well as the MS/MSD recoveries and RPDs for the other samples were within control limits, qualification was limited to the parent sample.

Based on the data review as well as data precisions, accuracy, representativeness, completeness, comparability, and sensitively, all data was determined to be usable as qualified.

7.0 CONCLUSIONS

Field-based XRF, laboratory XRF, and laboratory ICP data from the additional sampling effort at the Jacobs OU2 Site yielded the following conclusions:

1. At the Rawhide Ranchettes subdivision, nine surface soil samples and two subsurface soil samples exceeded their respective soil residential lead-screening levels (500 ppm and 800 ppm, respectively), for a total of 11 samples that exceeded a screening level.
2. The 11 samples that exceeded a soil residential lead-screening level at the Rawhide Ranchettes subdivision occurred in ten different decision units in five different lots, with the highest laboratory-based XRF lead concentration being 1,367 +/- 21 ppm, which was reported for the sample JOU2-RR-LOT3-DU5-SURF (the surface sampled collected from Lot 3, Decision Unit 5).
3. At the B&B subdivision, 15 surface soil samples and 39 subsurface soil samples exceeded their respective soil residential lead-screening levels (500 ppm and 800 ppm, respectively), for a total of 54 samples that exceeded a screening level.
4. The 54 samples that exceeded a soil residential lead-screening level at the B&B subdivision occurred in 22 different decision units in four different lots.
5. All of the samples that exceeded a soil residential lead-screening level at the B&B subdivision were collected in the northernmost lots of the B&B subdivision, with the highest laboratory-based XRF lead concentration being 8,198 +/- 83 ppm, which was reported for the sample JOU2-BB-LOT1-DU3-0006 (the subsurface sample collected from Lot 1, Decision Unit 3, from 0 to 6 inches below the surface).
6. At the Waterman Smelter and Winegar Property areas, the laboratory-based XRF lead concentrations were significantly higher than the laboratory based XRF concentrations reported for the Rawhide Ranchettes and B&B subdivisions. The maximum lead concentration reported for the Waterman Smelter area was 154,887 ppm, while the maximum lead concentration reported for the Winegar Property area was 44,130 ppm.
7. Arsenic and lead linear regressions of laboratory XRF vs. ICP data created for this report show that the lead correlation for XRF and ICP is very strong, with an R^2 value of 0.9875, and that the arsenic correlation is not as strong, but is reasonable, with an R^2 value of 0.6705.

8.0 REFERENCES

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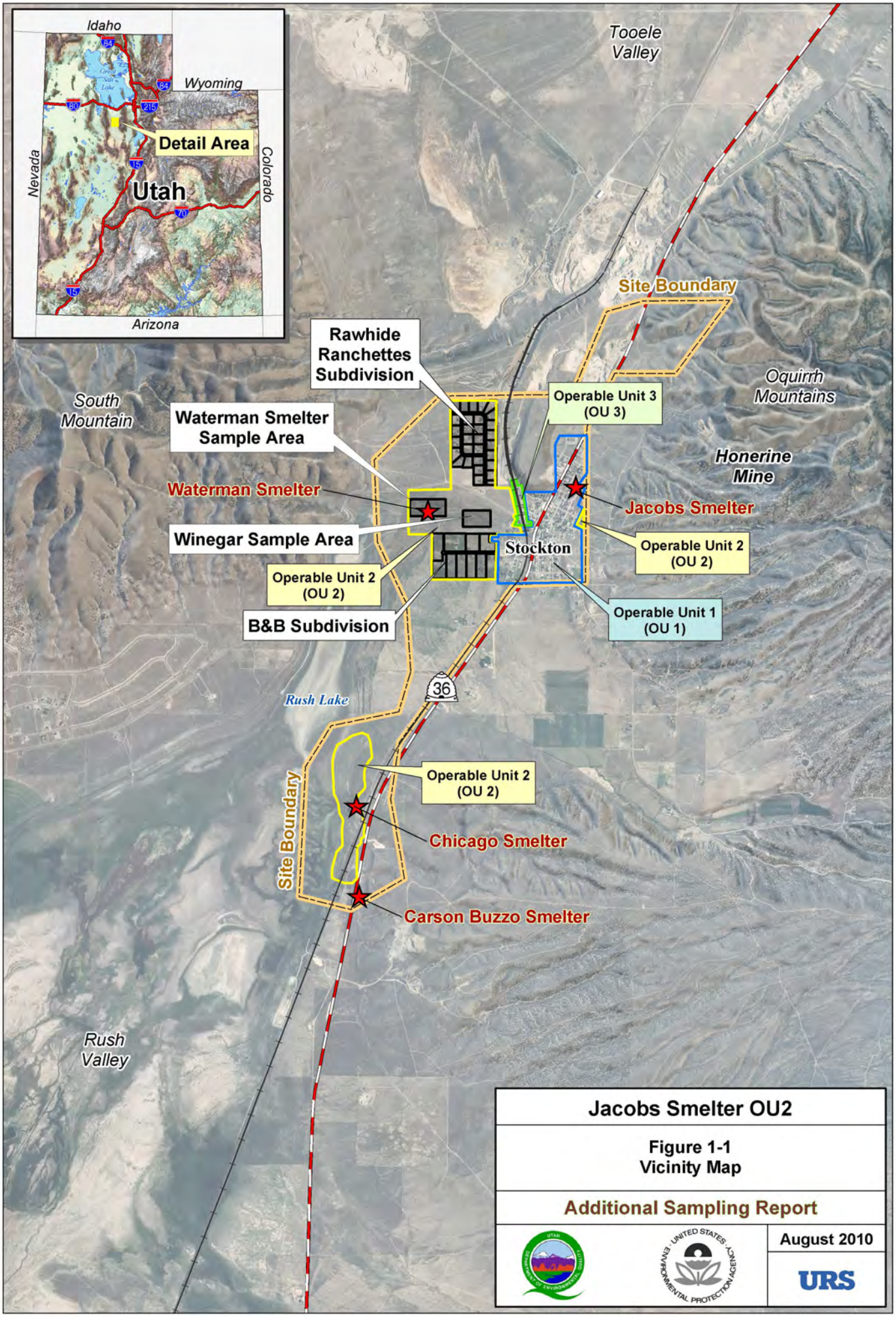
TABLES

Table 2-1. Vario-Plot Summary Table

Property	Number of Aliqouts
Rawhide Ranchettes	
RR Lot 1	6
RR Lot 2	5
RR Lot 3	8
RR Lot 4	5
RR Lot 5	5
RR Lot 6	5
RR Lot 7	7
RR Lot 8	5
RR Lot 9	5
RR Lot 10	5
RR Lot 11	8
RR Lot 12	10
RR Lot 13	6
RR Lot 14	5
RR Lot 15	5
RR Lot 16	13
RR Lot 17	5
RR Lot 18	13
RR Lot 19	5
RR Lot 20	7
RR Lot 21	5
RR Lot 22	6
RR Lot 23	5
RR Lot 24	9
RR Lot 25	6
RR Lot 26	6
RR Lot 27	13
RR Lot 28	5
RR Lot 29	5
RR Lot 30	5
B&B Subdivision	
B&B Lot 1	5
B&B Lot 2 Unsampled	8
B&B Lot 2 Sampled	5
B&B Lot 3	5
B&B Lot 4	5
B&B Lot 5	5
B&B Lot 6	5
B&B Lot 7	5
B&B Lot 8	5
B&B Lot 9	5
B&B Lot 10	5

FIGURES



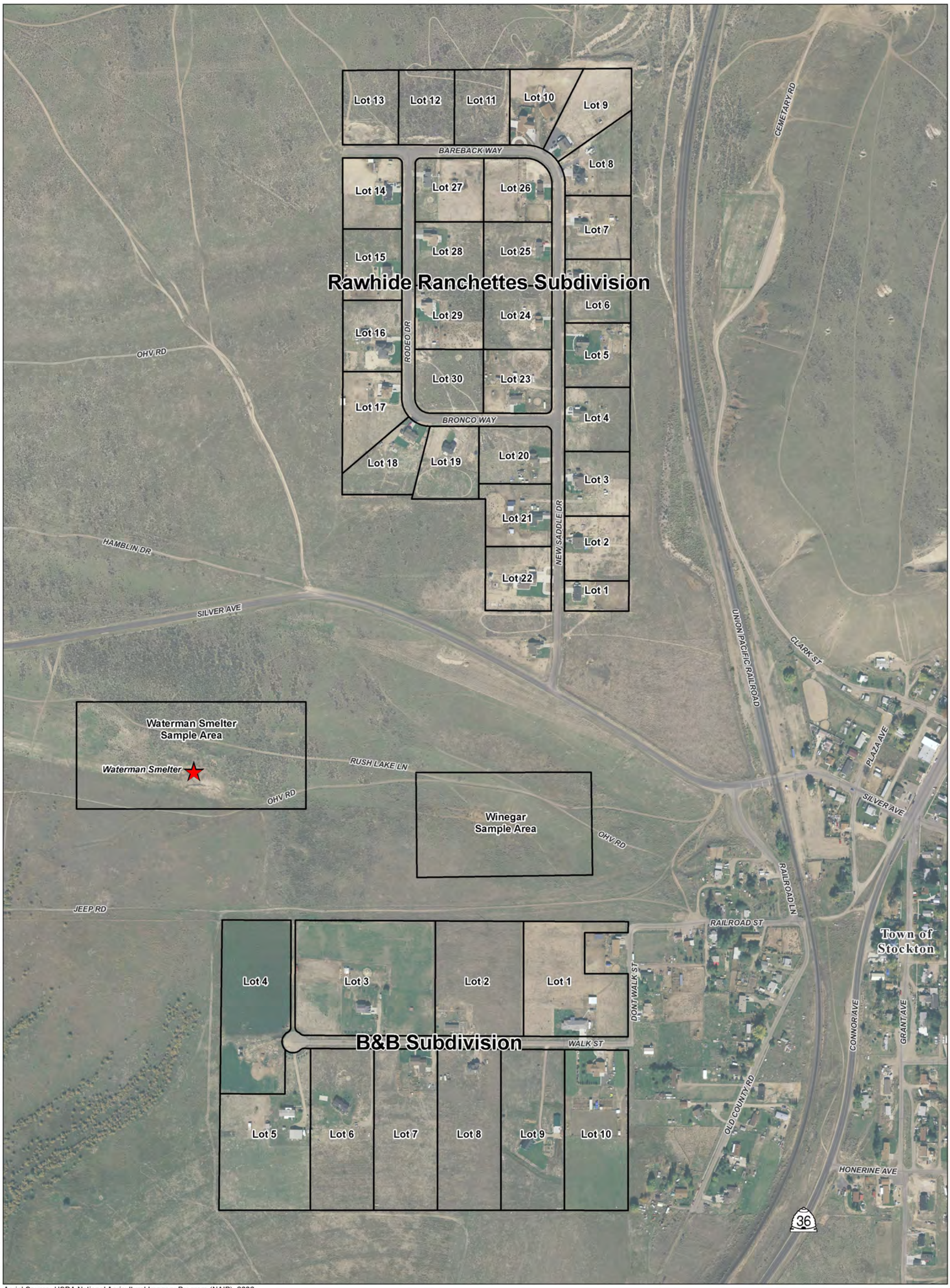
Jacobs Smelter OU2

Figure 1-1
Vicinity Map

Additional Sampling Report

August 2010

URS



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Aerial Source: USDA National Agricultural Imagery Program (NAIP), 2006

Sampled Boundary Area

N
W E
S

0 200 400 600
Feet

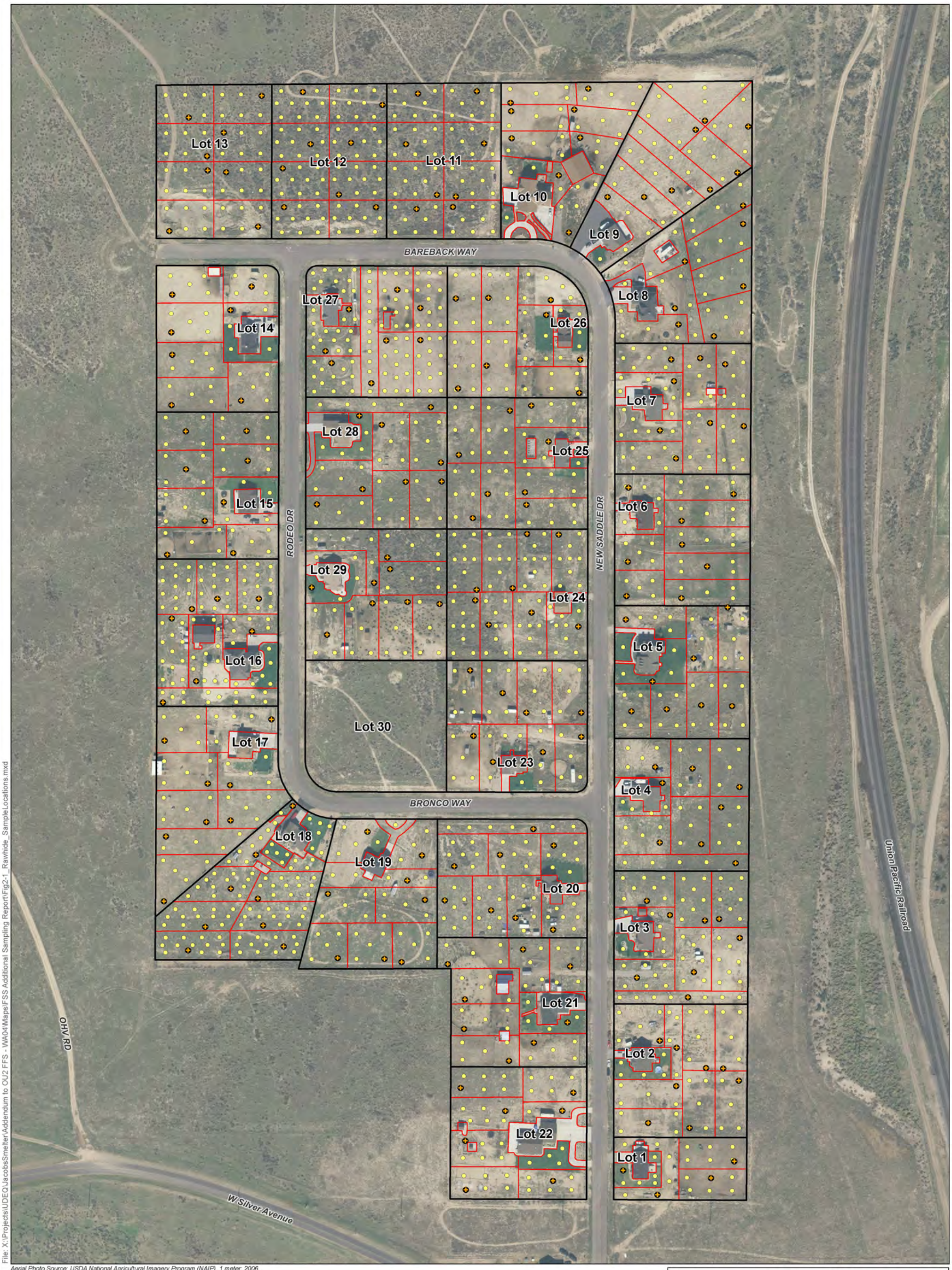
Jacobs Smelter OU2

Figure 1-2
Site Map

Additional Sampling Report

August 2010

URS



Aerial Photo Source: USDA National Agricultural Imagery Program (NAIP), 1 meter; 2006

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Surface Composite Aliquot Location (Number determined by varioplot)

Depth Profile

Decision Unit

Lot Boundary

N W E S

0 100 200 300 Feet

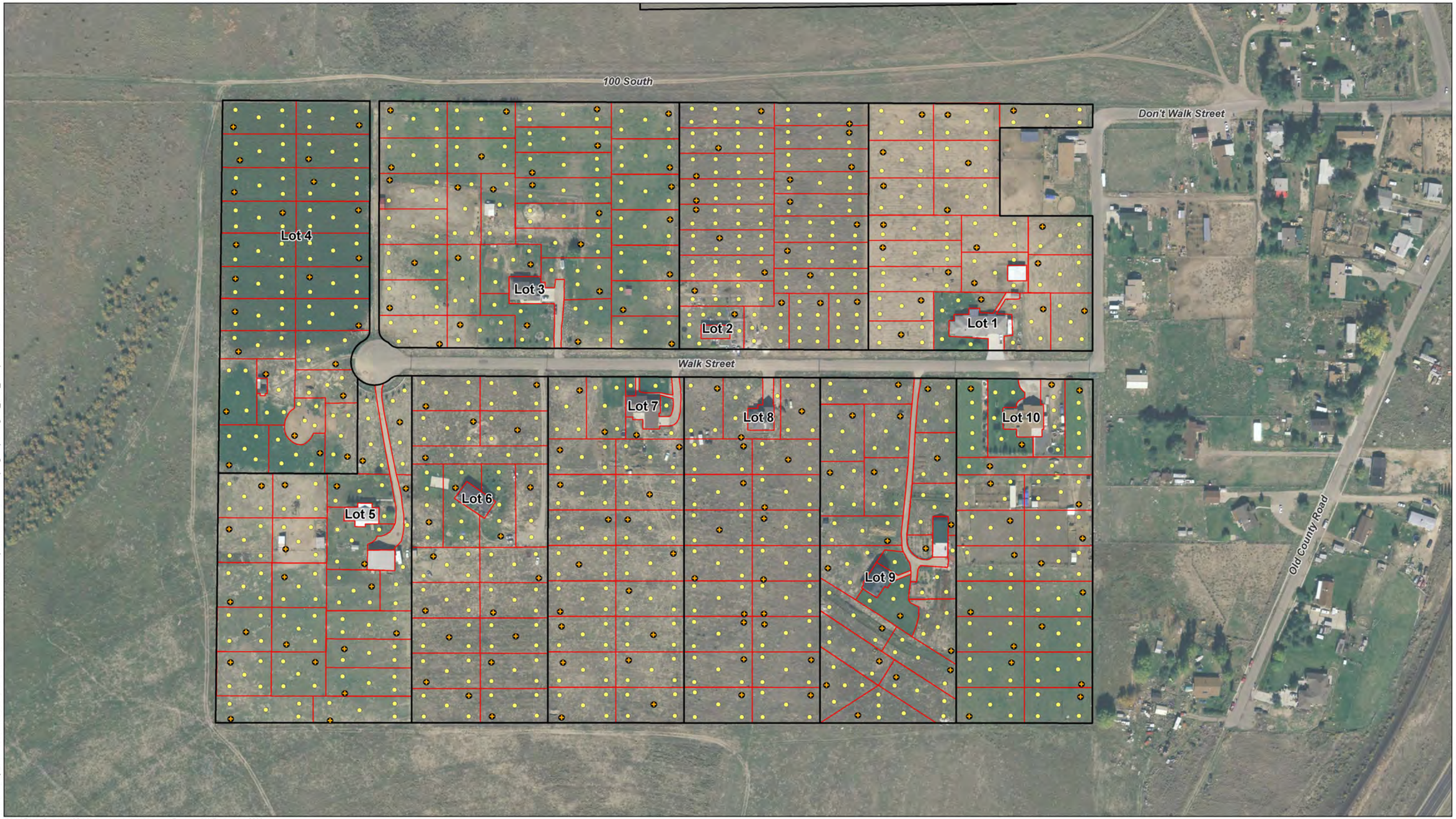
Jacobs Smelter OU2

Figure 2-1
Rawhide Ranchettes
Sample Locations

Additional Sampling Report

August 2010

URS



Aerial Photo Source: USDA National Agricultural Imagery Program (NAIP), 1 meter; 2006

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Surface Composite Aliquot Location (Number determined by varioplot)

Depth Profile

Decision Unit

Parcel Boundary

N
W E
S

0 100 200 300 Feet

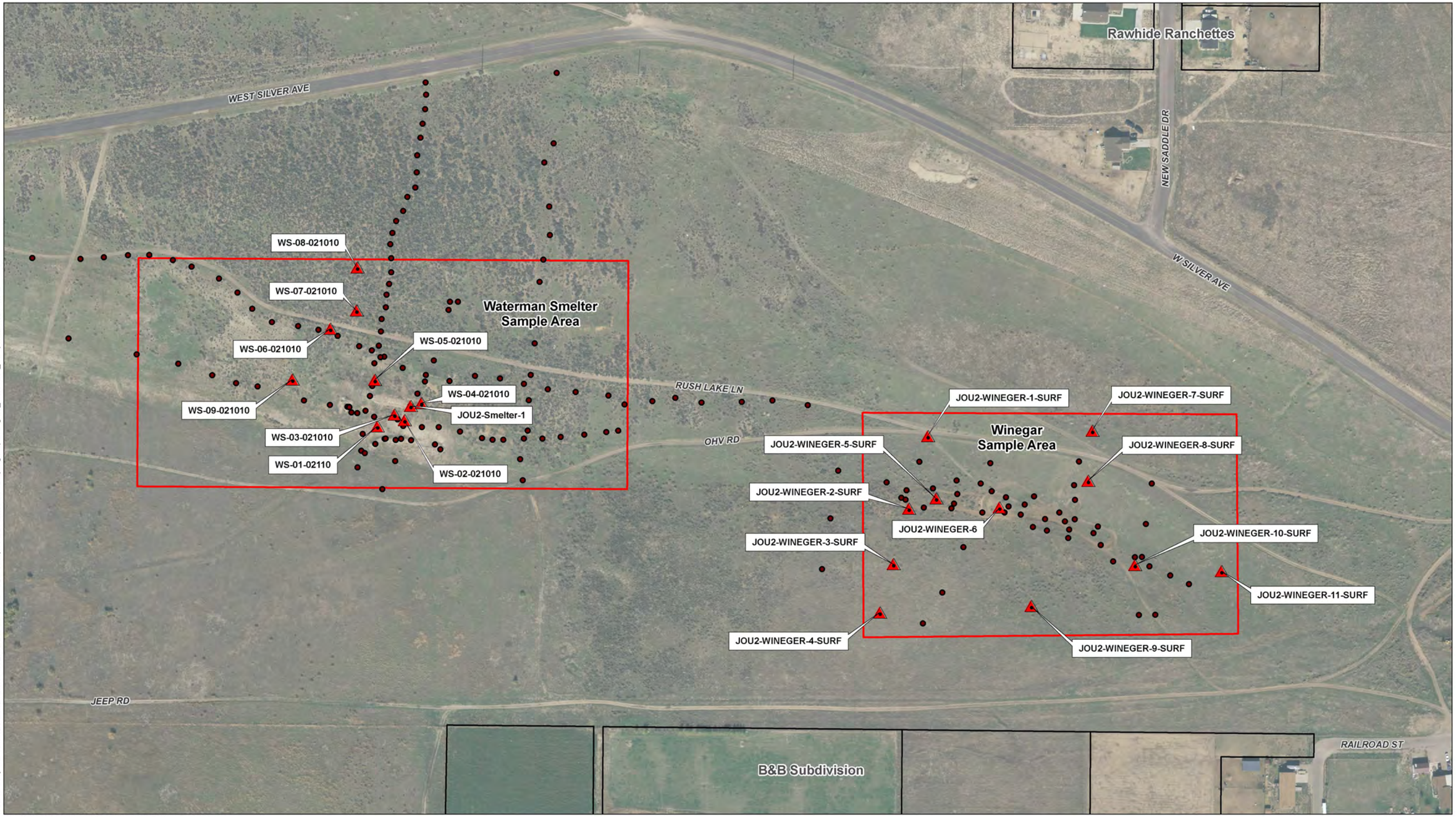
Jacobs Smelter OU2

Figure 2-2
B&B Subdivision
Sample Locations

Additional Sampling Report

August 2010

URS



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Aerial Source: AGRC, 2006 High Resolution Ortho-Imagery 1 Foot Color

- Field XRF Sample Location
- Laboratory XRF Sample Location
- Waterman Smelter and Winegar Laboratory XRF Sample Area Boundary
- Lot Boundary

N W E S

0 100 200 300 Feet

Jacobs Smelter OU2

Figure 2-3
Recreational Areas
Sample Locations

Additional Sampling Report

August 2010

URS

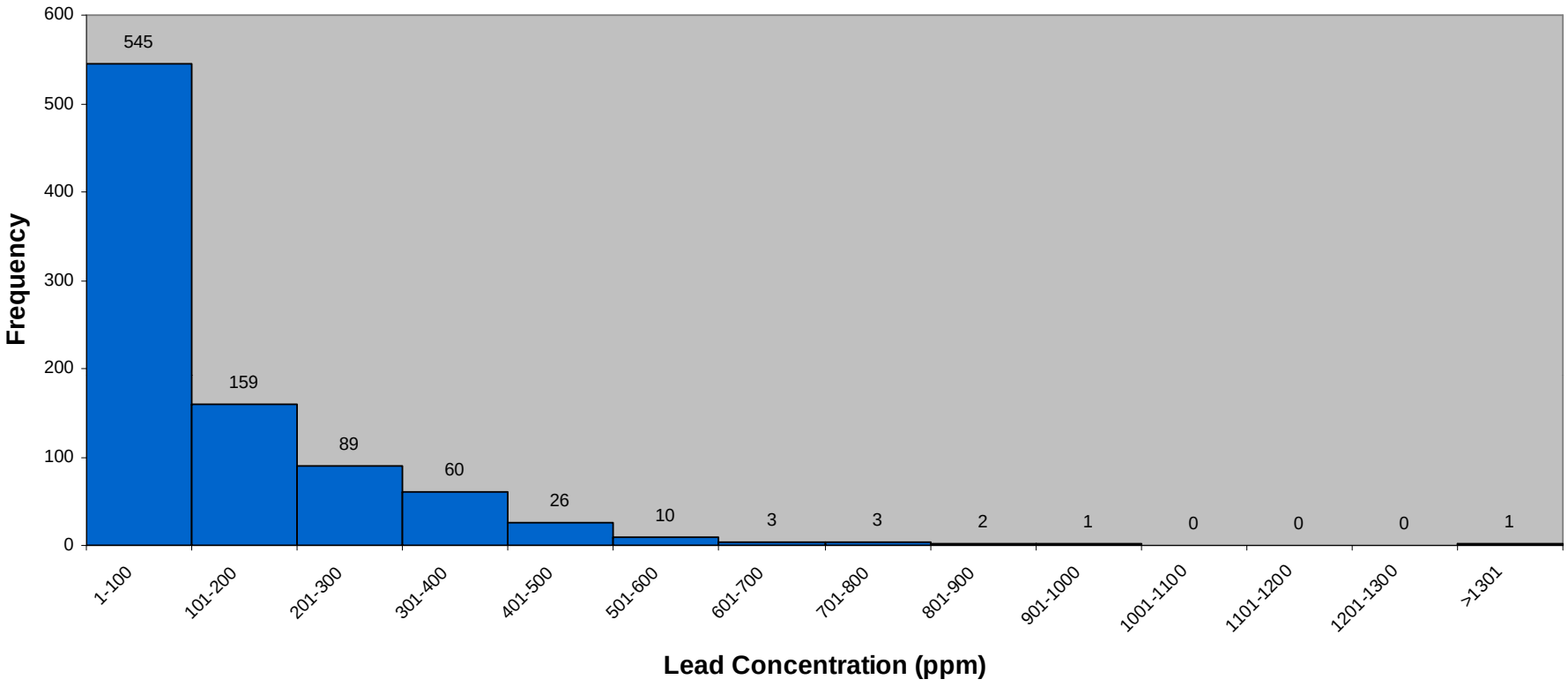


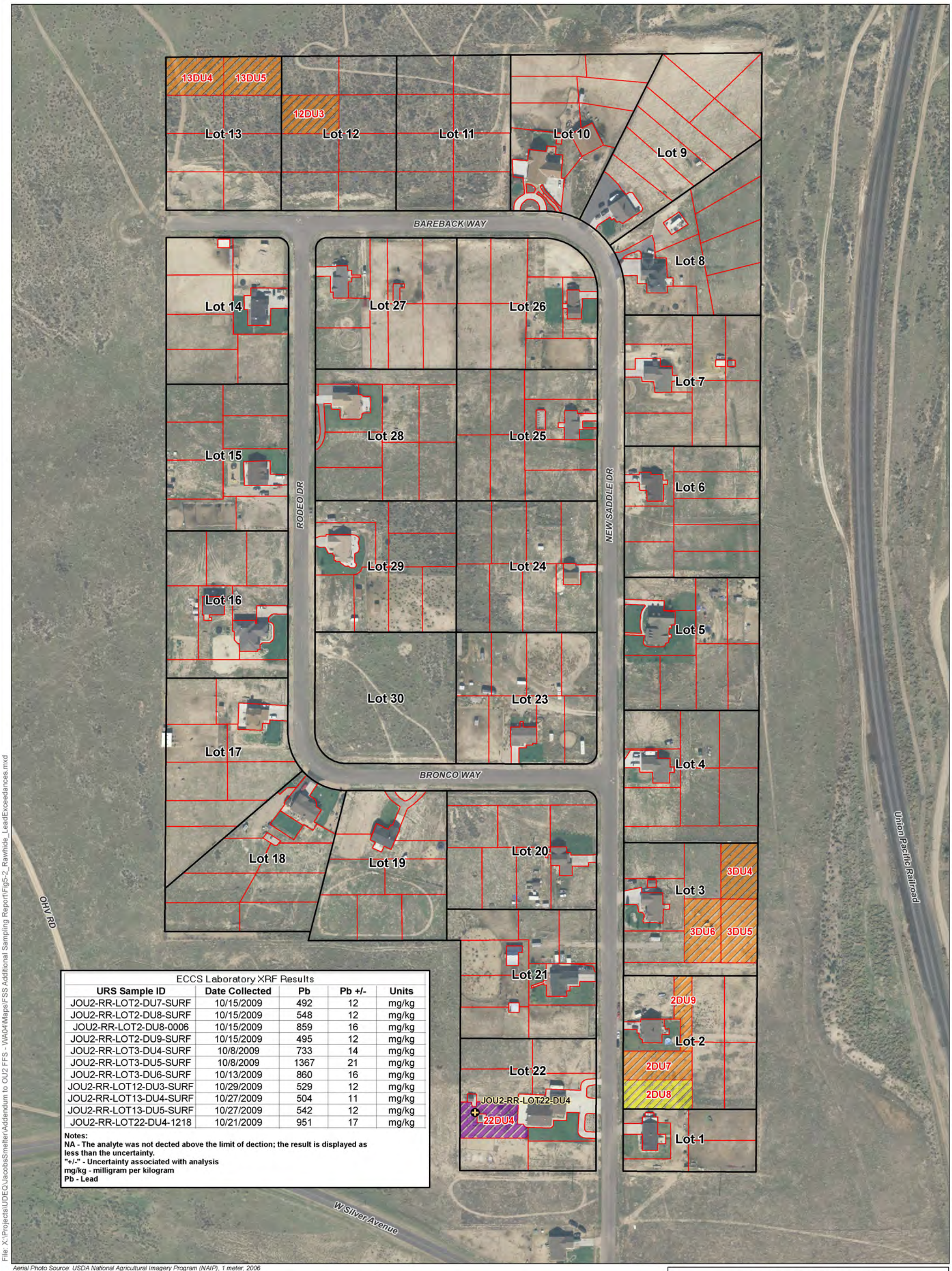
Figure 5-1. Histogram of Laboratory (ECCS) Lead Results at Rawhide Ranchettes Subdivision

ECCS - Environmental Chemistry Consulting Services, Madison Wisconsin
mg/kg - milligrams per kilogram
Note - Complete laboratory data packages can be found in Appendix F of this report.

Jacobs Smelter OU2
Additional Sampling Report

2010

URS



ECCS Laboratory XRF Results				
URS Sample ID	Date Collected	Pb	Pb +/-	Units
JOU2-RR-LOT2-DU7-SURF	10/15/2009	492	12	mg/kg
JOU2-RR-LOT2-DU8-SURF	10/15/2009	548	12	mg/kg
JOU2-RR-LOT2-DU8-0006	10/15/2009	859	16	mg/kg
JOU2-RR-LOT2-DU9-SURF	10/15/2009	495	12	mg/kg
JOU2-RR-LOT3-DU4-SURF	10/8/2009	733	14	mg/kg
JOU2-RR-LOT3-DU5-SURF	10/8/2009	1367	21	mg/kg
JOU2-RR-LOT3-DU6-SURF	10/13/2009	860	16	mg/kg
JOU2-RR-LOT12-DU3-SURF	10/29/2009	529	12	mg/kg
JOU2-RR-LOT13-DU4-SURF	10/27/2009	504	11	mg/kg
JOU2-RR-LOT13-DU5-SURF	10/27/2009	542	12	mg/kg
JOU2-RR-LOT22-DU4-1218	10/21/2009	951	17	mg/kg

Notes:
NA - The analyte was not dected above the limit of dection; the result is displayed as less than the uncertainty.
"+/-" - Uncertainty associated with analysis
mg/kg - milligram per kilogram
Pb - Lead

File: X:\Projects\UDEQ\JacobsSmelter\Addendum to OU2 FFS - WA04\Maps\FSS Additional Sampling Report\Fig5-2_Rawhide_LeadExceedances.mxd

Aerial Photo Source: USDA National Agricultural Imagery Program (NAIP), 1 meter, 2006

Surface Composite Sample Has Lead Concentration That Exceeds Site Criteria of 500 mg/kg

At Least One Subsurface Sample Has Lead Concentration That Exceeds Site Criteria of 800 mg/kg

Surface Composite Sample and at Least One Subsurface Sample Have Lead Concentration that Exceed Site Criteria of:
Surface = 500 mg/kg and Subsurface = 800 mg/kg

Depth Profile

Decision Unit

Lot Boundary

Notes:
Exceedances calculated by adding lead concentration and uncertainty

N W E S

0 100 200 300 Feet

Jacobs Smelter OU2

Figure 5-2
Rawhide Ranchettes
Lead Exceedances

Additional Sampling Report

August 2010

URS

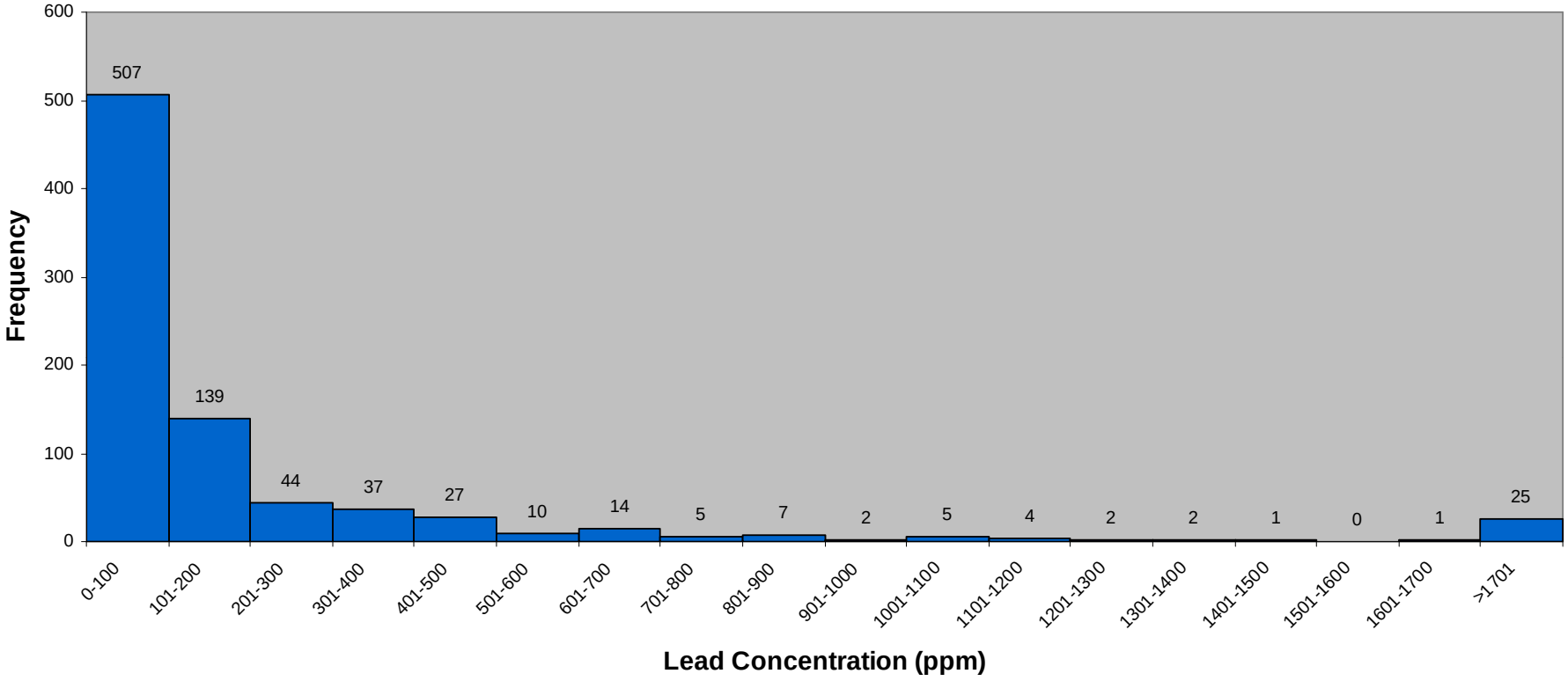


Figure 5-3. Histogram of Laboratory (ECCS) Lead Results at B&B Subdivision

ECCS - Environmental Chemistry Consulting Services, Madison Wisconsin
mg/kg - milligrams per kilogram
Note - Complete laboratory data packages can be found in Appendix F of this report.

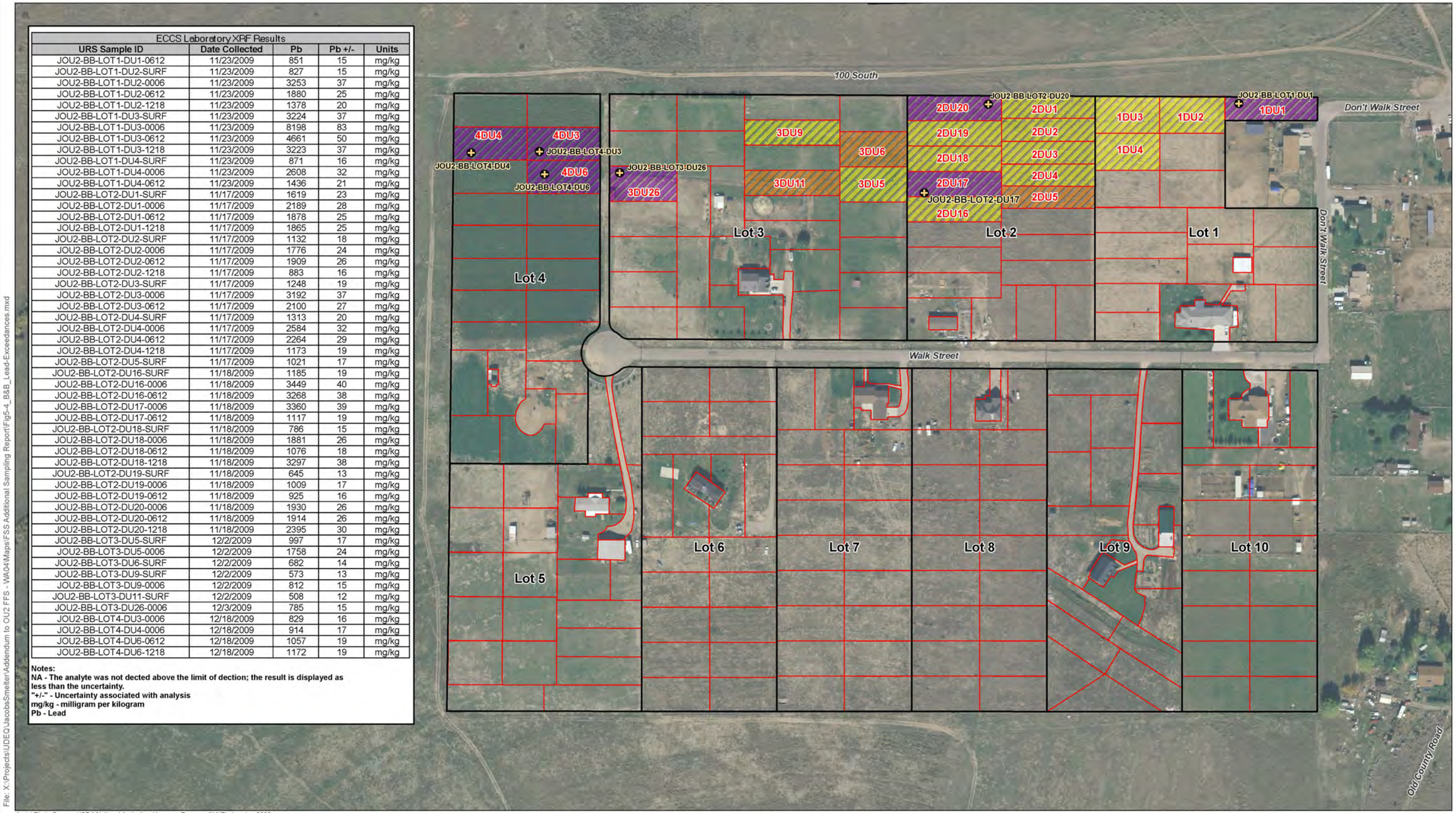
Jacobs Smelter OU2
Additional Sampling Report

2010

URS

ECCS Laboratory XRF Results				
URS Sample ID	Date Collected	Pb	Pb +/-	Units
JOU2-BB-LOT1-DU1-0612	11/23/2009	851	15	mg/kg
JOU2-BB-LOT1-DU2-SURF	11/23/2009	827	15	mg/kg
JOU2-BB-LOT1-DU2-0006	11/23/2009	3253	37	mg/kg
JOU2-BB-LOT1-DU2-0612	11/23/2009	1880	25	mg/kg
JOU2-BB-LOT1-DU2-1218	11/23/2009	1378	20	mg/kg
JOU2-BB-LOT1-DU3-SURF	11/23/2009	3224	37	mg/kg
JOU2-BB-LOT1-DU3-0006	11/23/2009	8198	83	mg/kg
JOU2-BB-LOT1-DU3-0612	11/23/2009	4661	50	mg/kg
JOU2-BB-LOT1-DU3-1218	11/23/2009	3223	37	mg/kg
JOU2-BB-LOT1-DU4-SURF	11/23/2009	871	16	mg/kg
JOU2-BB-LOT1-DU4-0006	11/23/2009	2608	32	mg/kg
JOU2-BB-LOT1-DU4-0612	11/23/2009	1436	21	mg/kg
JOU2-BB-LOT2-DU1-SURF	11/17/2009	1619	23	mg/kg
JOU2-BB-LOT2-DU1-0006	11/17/2009	2189	28	mg/kg
JOU2-BB-LOT2-DU1-0612	11/17/2009	1878	25	mg/kg
JOU2-BB-LOT2-DU1-1218	11/17/2009	1865	25	mg/kg
JOU2-BB-LOT2-DU2-SURF	11/17/2009	1132	18	mg/kg
JOU2-BB-LOT2-DU2-0006	11/17/2009	1776	24	mg/kg
JOU2-BB-LOT2-DU2-0612	11/17/2009	1909	26	mg/kg
JOU2-BB-LOT2-DU2-1218	11/17/2009	883	16	mg/kg
JOU2-BB-LOT2-DU3-SURF	11/17/2009	1248	19	mg/kg
JOU2-BB-LOT2-DU3-0006	11/17/2009	3192	37	mg/kg
JOU2-BB-LOT2-DU3-0612	11/17/2009	2100	27	mg/kg
JOU2-BB-LOT2-DU4-SURF	11/17/2009	1313	20	mg/kg
JOU2-BB-LOT2-DU4-0006	11/17/2009	2584	32	mg/kg
JOU2-BB-LOT2-DU4-0612	11/17/2009	2264	29	mg/kg
JOU2-BB-LOT2-DU4-1218	11/17/2009	1173	19	mg/kg
JOU2-BB-LOT2-DU5-SURF	11/17/2009	1021	17	mg/kg
JOU2-BB-LOT2-DU16-SURF	11/18/2009	1185	19	mg/kg
JOU2-BB-LOT2-DU16-0006	11/18/2009	3449	40	mg/kg
JOU2-BB-LOT2-DU16-0612	11/18/2009	3268	38	mg/kg
JOU2-BB-LOT2-DU17-0006	11/18/2009	3360	39	mg/kg
JOU2-BB-LOT2-DU17-0612	11/18/2009	1117	19	mg/kg
JOU2-BB-LOT2-DU18-SURF	11/18/2009	786	15	mg/kg
JOU2-BB-LOT2-DU18-0006	11/18/2009	1881	26	mg/kg
JOU2-BB-LOT2-DU18-0612	11/18/2009	1076	18	mg/kg
JOU2-BB-LOT2-DU18-1218	11/18/2009	3297	38	mg/kg
JOU2-BB-LOT2-DU19-SURF	11/18/2009	645	13	mg/kg
JOU2-BB-LOT2-DU19-0006	11/18/2009	1009	17	mg/kg
JOU2-BB-LOT2-DU19-0612	11/18/2009	925	16	mg/kg
JOU2-BB-LOT2-DU20-0006	11/18/2009	1930	26	mg/kg
JOU2-BB-LOT2-DU20-0612	11/18/2009	1914	26	mg/kg
JOU2-BB-LOT2-DU20-1218	11/18/2009	2395	30	mg/kg
JOU2-BB-LOT3-DU5-SURF	12/2/2009	997	17	mg/kg
JOU2-BB-LOT3-DU5-0006	12/2/2009	1758	24	mg/kg
JOU2-BB-LOT3-DU6-SURF	12/2/2009	682	14	mg/kg
JOU2-BB-LOT3-DU9-SURF	12/2/2009	573	13	mg/kg
JOU2-BB-LOT3-DU9-0006	12/2/2009	812	15	mg/kg
JOU2-BB-LOT3-DU11-SURF	12/2/2009	508	12	mg/kg
JOU2-BB-LOT3-DU26-0006	12/3/2009	785	15	mg/kg
JOU2-BB-LOT4-DU3-0006	12/18/2009	829	16	mg/kg
JOU2-BB-LOT4-DU4-0006	12/18/2009	914	17	mg/kg
JOU2-BB-LOT4-DU6-0612	12/18/2009	1057	19	mg/kg
JOU2-BB-LOT4-DU6-1218	12/18/2009	1172	19	mg/kg

Notes:
NA - The analyte was not dected above the limit of dection; the result is displayed as less than the uncertainty.
"+/-" - Uncertainty associated with analysis
mg/kg - milligram per kilogram
Pb - Lead



File: X:\Projects\UDEQ\JacobsSmelter\Addendum to OU2 FFS - WA04\Maps\FSS Additional Sampling Report\Fig5-4_B&B_Lead-Exceedances.mxd

Aerial Photo Source: USDA National Agricultural Imagery Program (NAIP), 1 meter, 2006

Surface Composite Sample Has Lead Concentration That Exceeds Site Criteria of 500 mg/kg

At Least One Subsurface Sample Has Lead Concentration That Exceeds Site Criteria of 800 mg/kg

Surface Composite Sample and at Least One Subsurface Sample Have Lead Concentration that Exceed Site Criteria of: Surface = 500 mg/kg and Subsurface = 800 mg/kg

Depth Profile

Decision Unit

Lot Boundary

Notes:
Exceedances calculated by adding lead concentration and uncertainty

N W E S

0 100 200 300 Feet

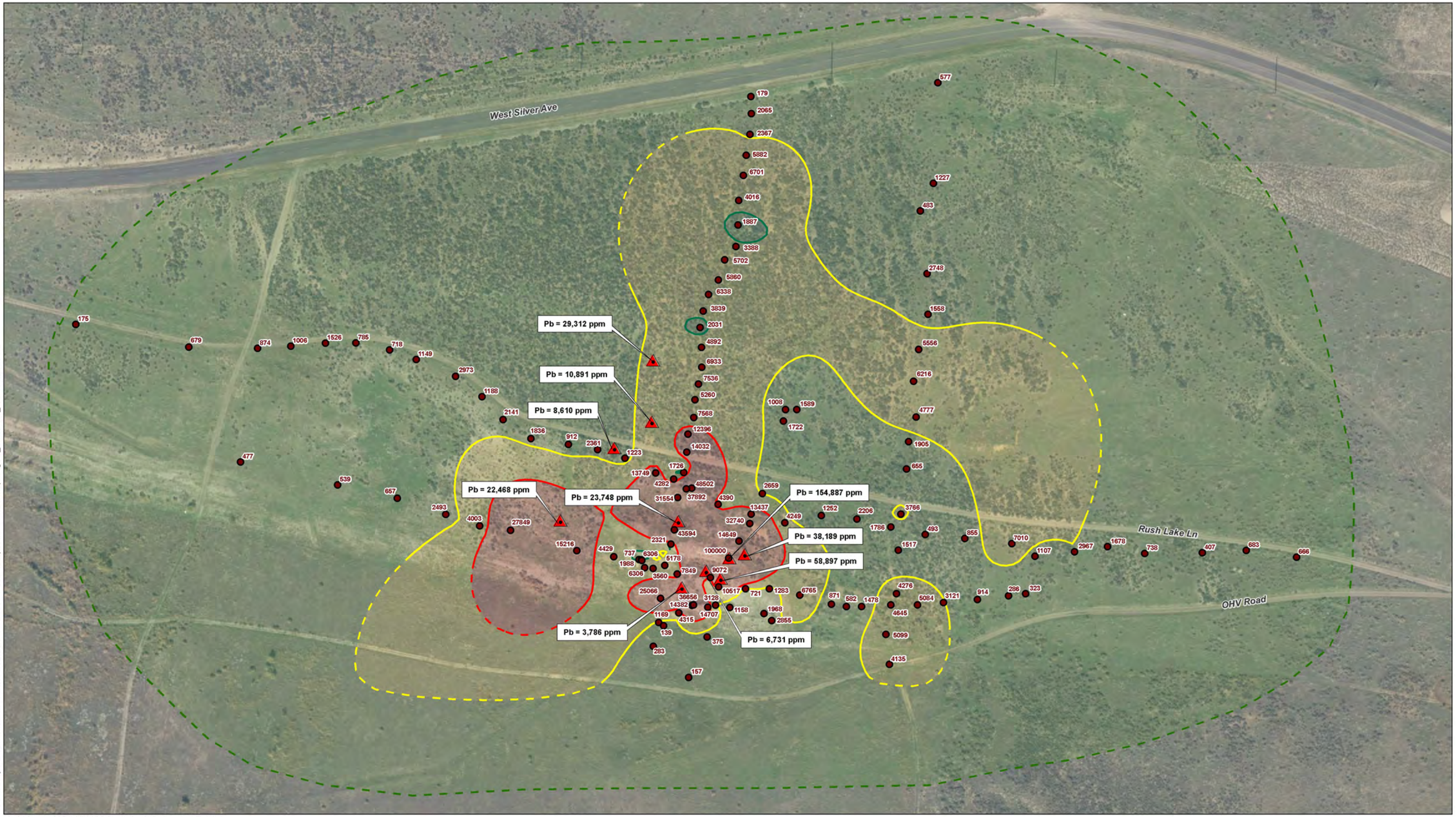
Jacobs Smelter OU2

Figure 5-4
B&B Subdivision
Lead Exceedances

Additional Sampling Report

August 2010

URS



File: X:\Projects\UDEQ\JacobsSmelter\Addendum to OU2 FFS - WA04\Maps\XRF Contour Maps\Fig5-3_Waterman_XRFcontours.mxd

Aerial Source: AGRC, 2006 High Resolution Ortho-Imagery 1 Foot Color

483 **Field XRF Sample Location and Lead Result**

Laboratory XRF Sample Location and Lead Result

Field XRF Lead Contours (PPM)

- **< 3,000**
- **3,000 - 10,000**
- **> 10,000**

Notes:
- Field XRF data used to generate contours
- Contours dashed where inferred
- PPM = Parts per million

N W E S

0 70 140 210 Feet

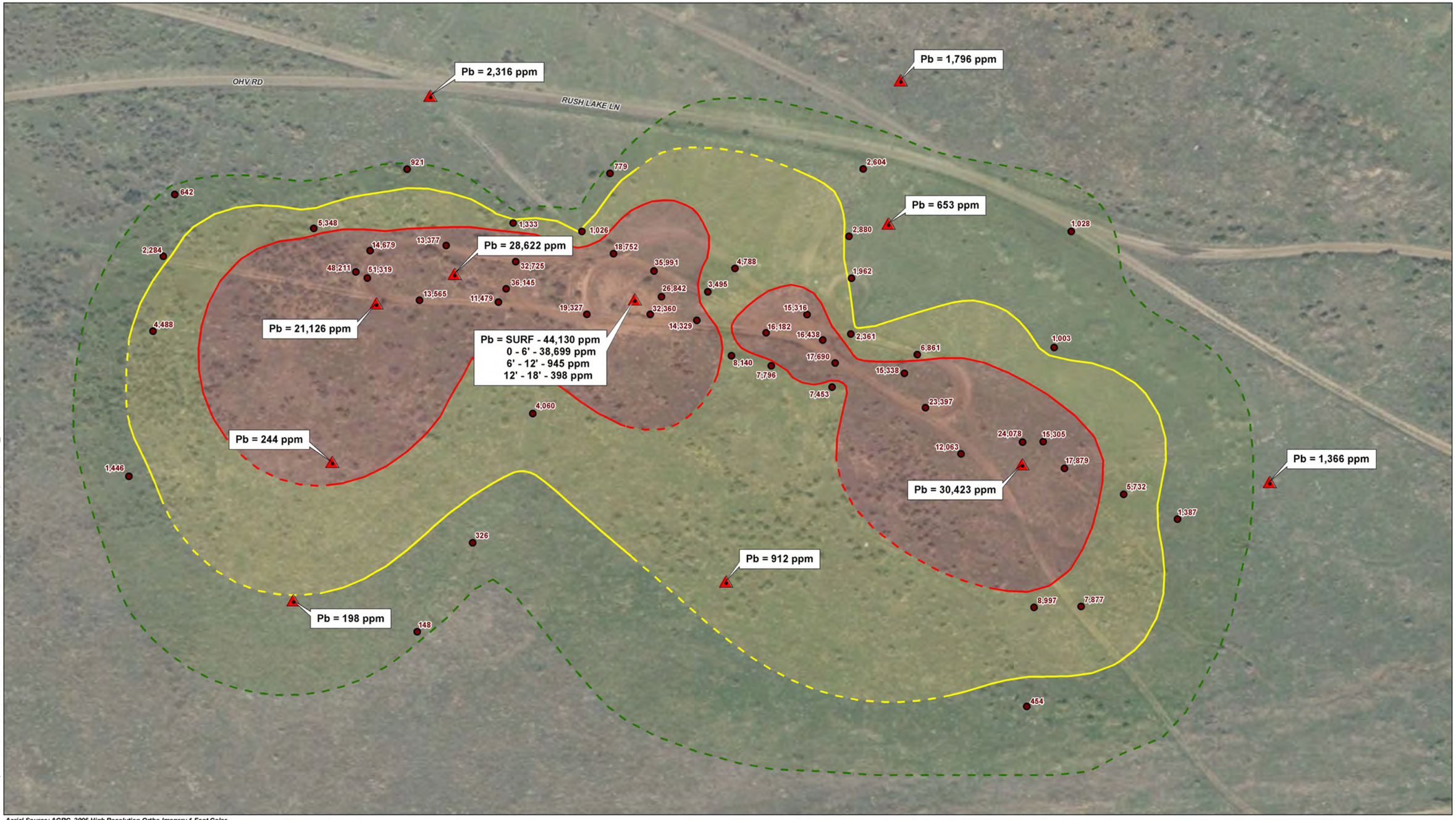
Jacobs Smelter OU2

Figure 5-5
Waterman Smelter
Lead Results

Additional Sampling Report

August 2010

URS



File: X:\Projects\UDEQ\JacobsSmelter\Addendum to OU2 FFS - WA04\Maps\XRF Contour Maps\ATV-Track_XRFcontours.mxd

Aerial Source: AGRC, 2006 High Resolution Ortho-Imagery 1 Foot Color

326 **Field XRF Sample Location and Lead Result**

Laboratory XRF Sample Location and Lead Result

Field XRF Lead Contours (PPM)

- **< 3,000**
- **3,000 - 10,000**
- **> 10,000**

Notes:
- Field XRF data used to generate contours
- Contours dashed where inferred
- PPM = Parts per million

N W E S

0 35 70 105 Feet

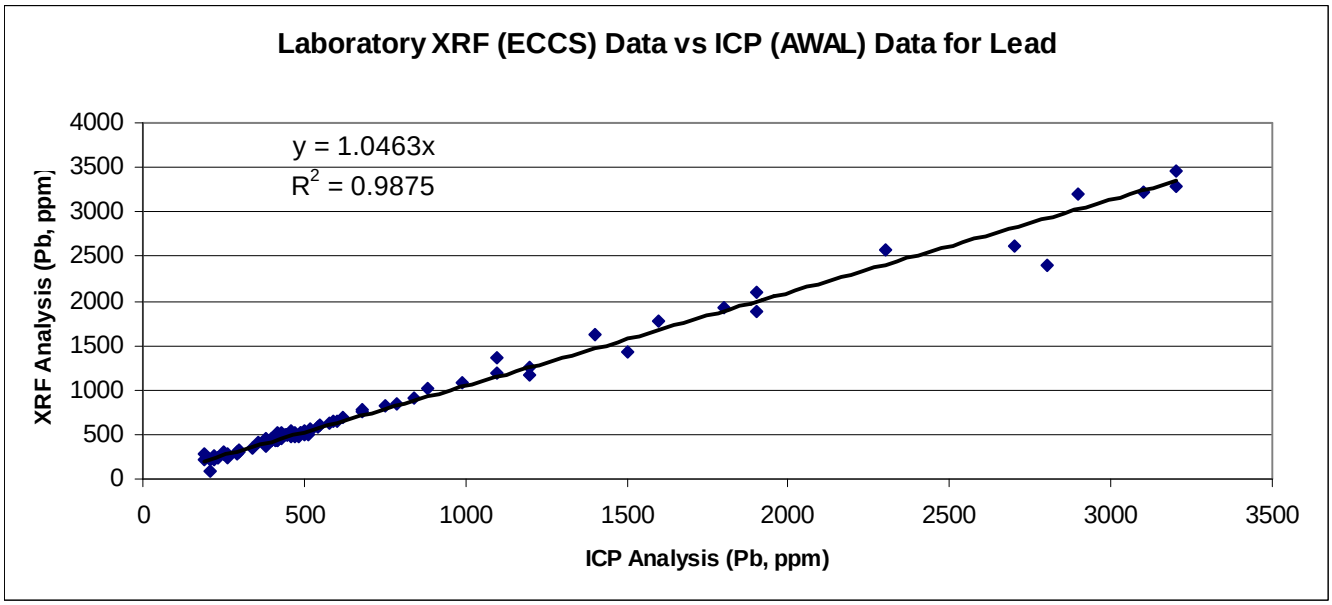
Jacobs Smelter OU2

Figure 5-6
Winegar Area
Lead Results

Additional Sampling Report

August 2010

URS



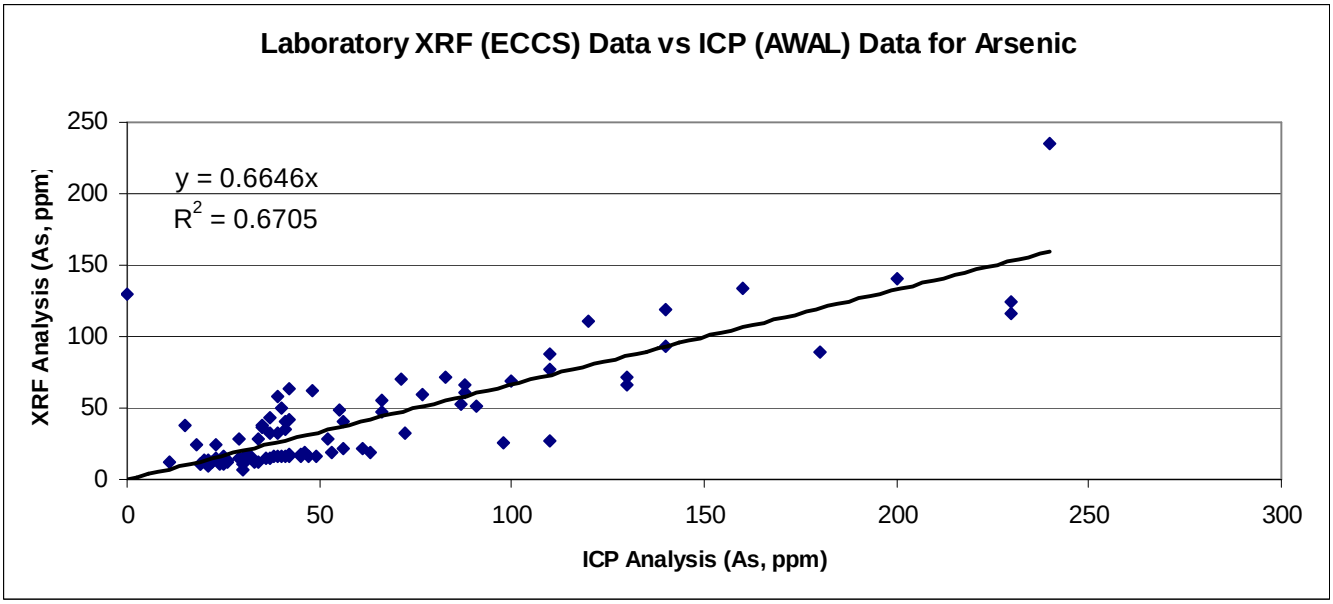


Figure 5-7. Laboratory XRF vs. Laboratory ICP Linear Regressions

XRF - X-Ray fluorescence
ECCS - Environmental Chemistry Consulting Services, Madison Wisconsin
ICP - Inductively coupled plasma
AWAL - American West Analytical Laboratories, Salt Lake City UT
ppm - part per million
Pb - lead; As - arsenic
Note - Complete laboratory data packages are in Appendices F and I of this report.

Jacobs Smelter OU2
Additional Sampling Report

2010

URS

APPENDICES

APPENDIX A - Vario-plotting

APPENDIX B - Field Forms

APPENDIX C - Control Charts

APPENDIX D - Data Validation Report

APPENDIX E - Field XRF Data

APPENDIX F - ECCS Lab Data XRF

APPENDIX G - Residential Lot Figures & XRF Data

APPENDIX H - Field XRF Correlations

APPENDIX I - AWAL Lab Data ICP

(Appendices submitted separately in folder on this CD)

APPENDIX D

2011 EPA Sampling Report

SAMPLING ACTIVITIES REPORT
August 2011 Sampling Event
Draft, Revision A

Jacob Smelter Operable Unit 2 Superfund Site
Stockton, Utah

Prepared for:

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Ecosystem Protection and Remediation – Program Support
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December 2011

Contract No. EP-W-06-033

DCN: EP8-6-6573

Distribution List

Sampling Activities Report – Jacob Smelter – Stockton, Utah

The following is a distribution list of personnel who will receive an electronic copy of the Sampling Activities Report for the sampling event conducted in August of 2011 at the Jacobs Smelter Operable Unit (OU) 2 Superfund Site. Agency and/or contractor affiliations are also listed for each individual.

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Acronym List

AOC	Administrative Order on Consent
CLP	Contract Laboratory Program
CSS	Contaminant Screening Study
EPA	United States Environmental Protection Agency
ESAT	Environmental Services Assistance Team
HHRA	Human Health Risk Assessment
KUC	Kennecott Utah Copper
Mg/kg	Milligram per kilogram
NPL	National Priorities List
OU	Operable Unit
ppm	Parts Per Million
QC	Quality Control
RI	Remedial Investigation
RFS	Revised Feasibility Study
RPD	Relative Percent Difference
SAP	Sampling and Analysis Plan
SAR	Sampling Activities Report
SOP	Standard Operating Procedure
WS	Waterman Smelter (sample prefix)

1.0 INTRODUCTION

This document is the Sampling Activities Report (SAR) for the Jacob Smelter Superfund Site located in Stockton, Utah. This document summarizes field activities for the soil sampling event conducted in August of 2011. The sampling event conducted in 2011 was conducted in order to refine the estimates of spatial and horizontal contamination at Waterman Smelter (WS) OU2. Soil samples were collected from 97 sample locations at three depth intervals (0-6", 6-12", and 12-18"). Samples were sent to a Contract Laboratory Program (CLP) laboratory for analysis.

This SAR also includes the following sections: Sampling Activities and Procedures (Section 2.0), Sample Quality Control (Section 3.0), Field Changes and/or Corrective Actions (Section 4.0), Analytical Results (Section 5.0), References (Section 6.0), scanned field notebook pages (Appendix A), and site photos (Appendix B).

1.1 Site Background and Description

The Jacobs Smelter Site is located in and around the Town of Stockton, Utah, approximately 25 miles southwest of Salt Lake City, Utah and five miles south of Tooele, Utah. The entire Site is referred to as "Jacobs Smelter," after the name of a large smelting operation that was located within the Town of Stockton, Utah. Reports of up to nine former smelters with milling operations within the Site boundaries have been documented. The Jacobs Smelter was one of these historic smelters. The entire Superfund Site was named Jacobs Smelter as a matter of convenience.
The risks posed by the Site derive from smelting and mining activity, which occurred primarily in the 1860's and 1870's. Wastes in the form of heavy metal contaminated soil, mill tailings, and smelter wastes exist at several locations within the Site boundaries. The primary contaminants are lead and arsenic. Little visible evidence exists of the former smelting operations.

In April 1864, volunteer soldiers discovered silver ore east of Stockton and organized the first mining district in the area. The area around the military reservation became the base for small-scale milling and smelting activities. The Town of Stockton was established in 1864. By 1866, the town contained over 400 inhabitants. Several smelting furnaces were built in the area, operated for a short time with marginal results, and then were shut down. The exact locations of most of these smelters remain unknown.

By 1870, mining in the area had expanded and smelting technology had improved to the point that metals extraction was profitable. The largest smelter in the Stockton area was the Waterman Smelting Works, which opened in 1871 on the northern shore of Rush Lake, about 1/2 mile west of Stockton. The Smelter operated through 1886 and produced approximately 3,300 tons of flue dust and nearly 15,000 tons of smelter slag.

In 1872, the Jacobs Smelter, owned by Lilly, Liesenring & Company, began operation within the town limits of Stockton. The smelter processed ore from the Ophir Mining District, located 10 miles south of Stockton in three vertical blast furnaces. By 1880, each of these furnaces could reduce 25 tons of ore per day. In 1879, the great Basin concentrator was constructed adjacent to the Jacobs Smelter and by 1880 was milling 100 tons of ore per day with approximately 80 tons of mill tailings produced as waste.

The Chicago Smelter opened in 1873 on the eastern shore of Rush Lake two miles south of Stockton, within the boundary of the former military camp. It was owned and operated by the Chicago Silver Mining Company, a British firm that also operated two nearby mines. The smelter operated sporadically through 1880. The Carson & Buzzo Smelter was located about 1/2 mile

south of the Chicago Smelter, also on the eastern shore of Rush Lake. The production rate of these smelters is unknown.

A total of at least nine smelting/milling operations are reported to have been in operation in the Stockton area, including the four mentioned here. Nearly all traces of these smelting operations have vanished. Buried timbers, stained soils, and some foundations are virtually all of the physical evidence that remain. Homes were built upon a portion of the former Jacobs Smelter location. Much of the slag produced was likely reprocessed at other smelters located in Tooele Valley or the Salt Lake Valley.

In 1995, the Site was added to the Comprehensive Environmental Response Compensation and Liability Information System under the name Stockton Smelters. A Preliminary Assessment and Site Investigation (PA/SI) detected lead and arsenic in Site soils in December 1998, and the name of the entire Site was changed to Jacobs Smelter. Based upon a removal assessment conducted in late 1998 that discovered lead and arsenic at concentrations that represented a significant risk to human health and the environment, a Time Critical Removal Action was initiated in March 1999 that cleaned up 29 of the most contaminated residential properties in Stockton. A Record of Decision for OU1 was signed on July 29, 1999. The Jacobs Smelter Superfund Site was listed on the National Priorities List on February 4, 2000. In 2000, an additional 126 residential properties were cleaned up as a Remedial Action. The residential properties cleaned up during the Removal Action and the Remedial Actions for OU1 were partially deleted from the National Priorities List (NPL) in 2001.

In 1999, the Union Pacific Railroad, under agreement with Environmental Protection Agency (EPA), addressed the contamination on OU3 by placing a 16-inch soil cover over the contaminated soils in the railroad right-of-way through Stockton. OU3 was partially deleted from the NPL on November 29, 2005.

Remedial Investigations for OU2 began in 1999. Due to the large geographic extent of OU2 and the relatively small amount of data available, a Contaminant Screening Study (CSS) was conducted to identify the general areas of contamination in OU2 and to establish a geographic boundary for future study. During the CSS, elevated concentrations of heavy metals were found in the soils of a proposed subdivision within OU2, known as the Rawhide Ranchettes Subdivision.

A focused investigation of the Rawhide Ranchettes Subdivision in May 2000 indicated that five of the 30 lots within the subdivision exceeded residential lead-screening levels. A Non-Time-Critical Removal Action for the five contaminated lots was completed by the developer in 2001. The Removal Action consisted of excavating 6 to 18 inches of contaminated soil from the identified lots and placing the contaminated soil within the roadbed and in a covered "repository" located within the subdivision that remains deeded to the subdivision's developer.

In order to address data gaps identified by the CSS and the Rawhide Ranchettes subdivision investigation and to focus Remedial Investigation activities for OU2, a Pre- Remedial Investigation study was conducted in early 2001.

In 2001, a Human Health Risk Assessment (HHRA) along with ecological clean up goals were developed for OU2.

A land reuse assessment was finalized in 2001. The land reuse assessment looked at current land use and habitat types as well as reasonably anticipated future land use for the area encompassed by OU2.

A Remedial Investigation (RI) that characterized lead and arsenic contaminated soil was performed for OU2 in 2002. Based on the data collected during the RI and the results of the HHRA The ecological risk assessment performed in 2003, clean up levels were established for OU2.

A Feasibility Study was prepared in December 2003. A Revised Feasibility Study (RFS) was developed in 2004. The RFS identified and evaluated several different alternatives for cleaning up contaminated soil.

In July 2004, Kennecott Utah Copper LLC (KUC) conducted a soil characterization investigation of a Parcel within OU2, owned by KUC subsidiary OM Enterprises located to the immediate northeast of the Town of Stockton. The purpose of the investigation was to better define the nature and extent of lead and arsenic contamination on the parcel. The results of KUC's investigation suggested that the lead and arsenic contamination came from up-gradient waste rock piles that are actively eroding and depositing waste rock on the Kennecott Stockton Northeast Parcel. In December 2007, EPA Region 8 requested that KUC collect additional soil samples from the parcel to further characterize the parcel and more definitively assess the source of the contamination. Based on the results of these two sampling events, EPA Region 8 along with the Utah Division of Environmental Response and Remediation concurred that the elevated concentrations of lead and arsenic were from up-gradient mining waste rock piles and were not associated with smelter wastes from the Jacobs Smelter Superfund Site. Thus, in 2009 an Administrative Order on Consent was signed that requires KUC to address the Kennecott Northeast Parcel through a removal action as a non-NPL site. The Order documents that this parcel is not longer part of the Jacobs Smelter NPL site.

In July 2008, EPA issued an Administrative Order on Consent (AOC) and Action Memorandum to KUC that required KUC to clean up a parcel located near the Stockton rail-yard. The parcel was designated as OU4. The documents specified a cleanup level of 500 milligrams per kilogram (mg/kg) lead in residential areas and also required covering soil contaminated with lead at concentrations between 3,000 mg/kg and 10,000 mg/kg lead for non- residential areas, and removal of all soil containing more than 10,000 mg/kg lead.

KUC conducted a Removal Action consistent with the terms of the AOC and Action Memorandum between mid-September and mid-November, 2008. Soil with lead concentrations greater than 500 mg/kg was removed from OU4 except for where contaminated soil was located underneath a large gravel hill. An Environmental Covenant was put in place for the contamination located underneath the large gravel hill.

In 2009 additional soil sampling, performed by Utah Department of Environmental Quality, at the request of residents in the Rawhide Ranchettes subdivision, showed contamination levels in excess of cleanup standards established for the Removal Action conducted in 2001. In order to address community concerns regarding lead and arsenic contaminated soil within the Rawhide Ranchettes and B&B Subdivisions, now both within the Town of Stockton boundaries; and to revisit the remedial alternatives and associated cost estimates in the RFS for OU2, an addendum to the RFS was commissioned. The addendum focused on collecting and analyzing soil samples from within the two subdivisions and around the location of the Waterman Smelter. Data utilized

in the RI and the RFS was also re-evaluated and compared to the data generated for the addendum.

In 2010, a time-critical removal action was initiated at four residential lots in the Rawhide Ranchettes subdivision that had surface lead levels exceeding the residential cleanup level. Two of the lots were part of the 2001 removal. Surface soils exceeding the residential cleanup levels of 500 parts per million (ppm) lead at the surface and subsurface soil up to 12" with lead levels at exceeding 800 ppm were removed. The excavated areas of two currently developed residential lots were replaced with clean fill and top soil with a maximum level of 200 ppm lead. The other two residential lots are un-developed and no additional fill was brought in after removal. Reseeding of the lots was completed in the spring of 2011.

1.2 Objective

One sampling event was conducted in 2011 in order to evaluate the current spatial distribution of metals contamination (both vertically and horizontally) within Waterman Smelter OU2. The following data was collected during these events:

- Soil samples at three depths: 0-6 inches, 6-12 inches, and 12-18 inches
- Confirmatory Global Position System data
- Photo documentation

2.0 SAMPLING ACTIVITIES AND PROCEDURES

Field activities at the Jacob Smelter site took place during the week of August 15th 2011. The following sections describe how samples were collected, handled, and documented.

2.1 Sample Handling and Identification

Samples were collected, placed in containers, labeled, processed, and preserved in accordance with EPA Region 8 Standard Operating Procedure (SOP) #2012 “Soil Sampling” (EPA 1994) and as outlined in the Final Sampling and Analysis Plan (SAP) for the Jacob Smelter site (Environmental Services Assistance Team [ESAT], 2011). Sample tags, labels, and chain of custody records were completed in accordance with provisions outlined in the SAP.

2.2 Soil Sampling

Soil samples collected during these events were identified by a pre-determined alpha-numeric grid (Figure 2.2-1) followed by depth interval. The prefix for each location was WS (Waterman Smelter) followed by a pre-determined number between 1 and 122, followed by the depth interval (0-6”). An example of the sample identifier showing site name, location ID, and depth interval followed this naming scheme: WS-001 0-6. Duplicate samples were indicated with a lower case “d” immediately following the sampling location identification number, and were collected at a frequency of one per twenty samples collected. Sampling locations are shown in Figure 2.2-1.

Soil samples were collected with either a hand auger or gas powered drill auger/teflon scoop depending on soil conditions. Hand augured samples were collected by drilling the auger to the desired depth and retrieving the sample from the core of the auger orifice. Gas powered auger samples were collected at locations where coarse gravel did not allow use of a hand auger.

Samples were then collected by scraping the sides of the wall of the hole at each depth until enough soil was collected.

2.3 Sample Documentation

During sampling activities, logbooks were maintained by individuals in the field. While sampling at each sampling location, the logbook was filled out with the following information: sampling date, time, location, photograph ID's, and equipment used. Chain of Custody information was filled out at the end of each sampling day. Soil samples were sent to CLP for Total Recoverable Metals analysis.

3.0 SAMPLE QUALITY CONTROL

This section details the quality control (QC) methods used in the field for activities performed during the sampling effort. These include sample equipment decontamination and duplicate sample collection.

3.1 Decontamination Methods

Decontamination procedures were performed in accordance with EPA Region 8 SOP# 2006 "Sampling Equipment Decontamination" (EPA, 1994). All non-disposable equipment involved in field sampling activities required decontamination. Hand augers, a power auger, and Teflon scoops were the exclusive methods for collecting samples. At locations where a hand auger was used, equipment was decontaminated after collection from each of the sampling locations and each depth interval. All non-disposable sampling equipment (hand augers, teflon scoops) were first rinsed with de-ionized water, then 10% nitric acid solution, then rinsed a third time with de-ionized water. The equipment was then wiped dry with a paper towel to keep the soil from sticking. At locations where a power drill auger was used, Teflon scoops were decontaminated after sampling at each location and each depth interval. Teflon scoops that were rendered unusable or could not be decontaminated were discarded as investigative derived waste.

3.2 Duplicate Sample Collection

Duplicate samples were collected at a rate of 1per 20 during the event in order to determine sampling precision and correlation between samples. According to the EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (2004), a control limit of 35% for the Relative Percent Difference (RPD) shall be used for original and duplicate soil sample values that are ≥ 5 times the Contract Required Quantitation Limit. These are laboratory guidelines which may not apply to all field situations. RPD was evaluated for total metals (contaminants of concern only) for soil samples collected in August. Results of the RPD evaluation are included in Table 3.2-1. RPD values were calculated using the following equation:

$$RPD = [ABS\ (Sample\ Result - Duplicate\ Result)] / [(0.5 * (Sample\ Result + Duplicate\ Result)]$$

RPD values for total metals analysis were generally under 35% for many analytes, with some exceptions. See Table 3.2-1 for results.

4.0 FIELD CHANGES AND/OR CORRECTIVE ACTIONS

There were several sampling locations at the Jacob Smelter site that were very difficult to sample at the 6-12" and 12-18" depths with a hand auger. For these sites, a gas powered drill auger was rented and holes were drilled to the proper depth. Samples were then collected by scraping the sides of the hole at each depth and collecting the fine loose fill. Before collection, the first couple of inches of the sides were scraped off in order to avoid cross contamination issues with the auger.

In addition to this corrective action, there were several sites that were not collected during this event due to accessibility. Access was not granted in a timely manner for several of the sites on the Northeast corner of the grid including sites WS-052, WS-068, WS-069, WS-070, WS-084 WS-085, WS-086, WS-087, WS-088, WS-099, WS-100, WS-101, WS-102, WS-103, WS-104, WS-105, WS-106, and sites WS-116 through WS-122 (Figure 2.2-1).

5.0 ANALYTICAL RESULTS

Analytical results for soil collection are presented in Table 5.0-1 through Table 5.0-3. All results are published in Scribe including analytical data from CLP.

6.0 REFERENCES

Environmental Services Assistance Team. 2011. Final Sampling Analysis Plan/Quality Assurance Project Plan – 2011 Sampling Events. Jacob Smelter Site, Tooele County, Utah

United States Environmental Protection Agency Environmental Response Team (1994) SOP #2006 –" Sampling Equipment Decontamination"

United States Environmental Protection Agency Region 8. 1994. SOP# 2012 "Soil Sampling."

United States Environmental Protection Agency. October 2004. EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review.

Tables

Table 3.2-1 Relative Percent Difference Analysis for Duplicate Soil Samples

Jacob Smelter 2011 Collection

Relative Percent Difference Calculations for Duplicate Samples : 0-6 inch depth

Location	Depth	Analysis	Result_Units	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
WS-018	0-6 inches	Total Metals	mg/kg	16900	6R	45.8	97J-	0.74J-	5	49500	24.8J-	5.7J-	38.4	17200J-	385	9380	164J-	18.7	6500J-	3.5U	0.74	500U	3.1J-	26.6J-	192
WS-018 Dup	0-6 inches	Total Metals	mg/kg	19200	4.4UJ	39.4	103J-	0.93J-	5.7	53300	28.0J-	6.1J-	44.4	17700J-	396	9790	153J-	20.2	6990J-	2.6R	0.94	365U	3.3J-	30.3J-	195
		% RPD	%	12.74%	N/A	15.02%	N/A	N/A	13.08%	7.39%	N/A	N/A	14.49%	N/A	2.82%	4.28%	N/A	7.71%	N/A	N/A	23.81%	N/A	N/A	N/A	1.55%
Location	Depth	Analysis	Result_Units	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
WS-035	0-6 inches	Total Metals	mg/kg	17900	6.6R	37.3	113J-	0.79J-	9.7	54000	26.1J-	5.7J-	73.3	18200J-	795	10500	220J-	18.7	6480J-	3.9U	1.2	251J-	3.3J-	27.7J-	244
WS-035 Dup	0-6 inches	Total Metals	mg/kg	19700	5.0UJ	32.2	122J-	0.92J-	10.3	54600	28.6J-	6.1J-	81.2	18200J-	674	11300	224J-	20	7230J-	2.9R	1.4	415U	3.1J-	29.7J-	229
		% RPD	%	9.57%	N/A	14.68%	N/A	N/A	6.00%	1.10%	N/A	N/A	10.23%	N/A	16.47%	7.34%	N/A	6.72%	N/A	N/A	15.38%	N/A	N/A	N/A	6.34%
Location	Depth	Analysis	Result_Units	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
WS-039	0-6 inches	Total Metals	mg/kg	13000	23J-	749	155J-	0.55J-	105	23700	20.3J-	6.4J-	2110	31000J-	18100	5590	1160J-	25	3740J-	12.8J-	32.1	249J-	2.7J-	25.1J-	11000
WS-039 Dup	0-6 inches	Total Metals	mg/kg	17300	12.6J-	448	174J-	0.85J-	87.2	40500	25.4J-	5.5J-	1890	30200J-	14300	7630	632J-	25	5340J-	10.0J-	29	511U	3.9J-	32.9J-	5820
		% RPD	%	28.38%	N/A	50.29%	N/A	N/A	18.52%	52.34%	N/A	N/A	11.00%	N/A	23.46%	30.86%	N/A	0.00%	N/A	N/A	10.15%	N/A	N/A	N/A	61.59%
Location	Depth	Analysis	Result_Units	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
WS-056	0-6 inches	Total Metals	mg/kg	12200	306J-	1130	113J-	0.73J-	345	19800	22.9J-	7.9J-	5100	79300J-	103000	5910	1570J-	54.1	4850J-	50.7J-	212	432J-	6.0J-	46.5J-	14200
WS-056 Dup	0-6 inches	Total Metals	mg/kg	10900	210J-	1020	131J-	0.74J-	380	22400	21.6J-	9.4J-	4570	85200J-	114000	4360	1570J-	47.4	3760J-	39.3J-	182	451J-	7.3J-	50.3J-	13400
		% RPD	%	11.26%	N/A	10.23%	N/A	N/A	9.66%	12.32%	N/A	N/A	10.96%	N/A	10.14%	30.19%	N/A	13.20%	N/A	N/A	15.23%	N/A	N/A	N/A	5.80%
Location	Depth	Analysis	Result_Units	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
WS-097	0-6 inches	Total Metals	mg/kg	17900	5.7R	36.7	202J-	0.86J-	7	7060	20.6J-	5.7J-	52.7	17700J-	580	7570	640J-	14.4	5440J-	1.4J-	0.89	471U	4.6J-	27.2J-	196
WS-097 Dup	0-6 inches	Total Metals	mg/kg	20300	5.5U	20.9	219J-	1.1J-	2.9	7840	21.5J-	6.7J-	36.5	19900J-	195	8720	652J-	15.9	6170J-	0.82J-	0.92	268J-	3.8J-	27.5J-	141
		% RPD	%	12.57%	N/A	54.86%	N/A	N/A	82.83%	10.47%	N/A	N/A	36.32%	N/A	99.35%	14.12%	N/A	9.90%	N/A	N/A	3.31%	N/A	N/A	N/A	32.64%

Relative Percent Difference Calculations for Duplicate Samples : 6-12 inch depth

Location	Depth	Analysis	Result_Units	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
WS-018	6-12 inches	Total Metals	mg/kg	18400	5.4R	22.9	112J-	0.81J-	2.9	53100	26.5J-	5.7J-	28.9	17900J-	210	10100	164J-	19.4	7060J-	3.2R	0.48	452U	3.3J-	27.5J-	171
WS-018 Dup	6-12 inches	Total Metals	mg/kg	20500	4.9UJ	14.9	113J-	0.98J-	1.8	54800	30.3J-	6.3J-	25.8	18200J-	144	10800	162J-	21.1	7570J-	2.8R	0.81	406U	3.5J-	31.4J-	161
		%RPD	%	10.80%	N/A	42.33%	N/A	N/A	46.81%	3.15%	N/A	N/A	11.33%	N/A	37.29%	6.70%	N/A	8.40%	N/A	N/A	51.16%	N/A	N/A	N/A	6.02%
Location	Depth	Analysis	Result_Units	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
WS-035	6-12 inches	Total Metals	mg/kg	20200	5.9R	10.3	111J-	0.84J-	1.4	38700	27.5J-	5.5J-	23.2	18600J-	142	11000	177J-	17.6	6990J-	3.4U	0.2	237J-	3.8J-	29.1J-	163
WS-035 Dup	6-12 inches	Total Metals	mg/kg	21100	5.9UJ	12.2	125J-	0.98J-	2.3	42900	29.7J-	6.3J-	31.2	19100J-	203	11500	202J-	19.3	7450J-	3.5R	0.99	495U	3.6J-	31.1J-	171
		%RPD	%	4.36%	N/A	16.89%	N/A	N/A	48.65%	10.29%	N/A	N/A	29.41%	N/A	35.36%	4.44%	N/A	9.21%	N/A	N/A	132.77%	N/A	N/A	N/A	4.79%
Location	Depth	Analysis	Result_Units	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
WS-039	6-12 inches	Total Metals	mg/kg	20700	5R	60.2	155J-	0.89J-	9.5	11700	26.1J-	6.8J-	85.1	19700J-	711	10600	307J-	19	6420J-	2.9U	1.5	248J-	3.6J-	27.8J-	284
WS-039 Dup	6-12 inches	Total Metals	mg/kg	19900	5.5UJ	55.3	147J-	0.94J-	35.5	13000	25.6J-	6.8J-	169	22300J-	1330	9570	224J-	19.9	6290J-	1.6J-	2.6	460U	3.1J-	28.0J-	683
		%RPD	%	3.94%	N/A	8.48%	N/A	N/A	115.56%	10.53%	N/A	N/A	66.04%	N/A	60.66%	10.21%	N/A	4.63%	N/A	N/A	53.66%	N/A	N/A	N/A	82.52%
Location	Depth	Analysis	Result_Units	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
WS-056	6-12 inches	Total Metals	mg/kg	12100	58.1J-	742	109J-	0.59J-	461	36200	19.9J-	5.4J-	2540	37700J-	85400	4480	654J-	33.8	3380J-	19.1J-	105	449U	6.4J-	38.5J-	7720
WS-056 Dup	6-12 inches	Total Metals	mg/kg	17500	53.1J-	711	158J-	0.93J-	851	45100	26.0J-	7.6J-	2650	43400J-	58500	6850	883J-	40.5	4900J-	19.0J-	101	310J-	8.8J-	46.7J-	11100
		%RPD	%	36.49%	N/A	4.27%	N/A	N/A	59.45%	21.89%	N/A	N/A	4.24%	N/A	37.39%	41.84%	N/A	18.03%	N/A	N/A	3.88%	N/A	N/A	N/A	35.92%
Location	Depth	Analysis	Result_Units	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
WS-097	6-12 inches	Total Metals	mg/kg	22300	4.9R	13.1	224J-	1.1J-	0.78	7570	23.2J-	6.3J-	22.3	20300J-	43.2	9140	616J-	16.7	6720J-	2.8R	0.11	406U	4.8J-	30.2J-	104
WS-097 Dup	6-12 inches	Total Metals	mg/kg	18200	6.1U	10.9	192J-	0.94J-	0.31	6630	19.4J-	5.9J-	20.1	17100J-	37.6	7890	518J-	14.5	5500J-	3.5R	1	235J-	3.7J-	25.2J-	91.4
		%RPD	%	20.25%	N/A	18.33%	N/A	N/A	86.24%	13.24%	N/A	N/A	10.38%	N/A	13.86%	14.68%	N/A	14.10%	N/A	N/A	160.36%	N/A	N/A	N/A	12.90%

Relative Percent Difference Calculations for Duplicate Samples : 12-18 inch depth

Location	Depth	Analysis	Result_Units	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
WS-018	12-18 inches	Total Metals	mg/kg	17900	5.8R	10.8	110J-	0.76J-	1.5	51600	25.5J-	5.2J-	20.6	17400J-	114	9980	149J-	18.3	6550J-	3.4R	0.3	487U	3.3J-	27.5J-	141
WS-018 Dup	12-18 inches	Total Metals	mg/kg	20100	5.1UJ	10.9	117J-	0.95J-	0.9	53300	29.3J-	6.4J-	21	18400J-	111	10600	162J-	20.7	6990J-	3.0R	0.85	426U	3.4J-	32.6J-	152
		%RPD	%	11.58%	N/A	0.92%	N/A	N/A	50.00%	3.24%	N/A	N/A	1.92%	N/A	2.67%	6.03%	N/A	12.31%	N/A	N/A	95.65%	N/A	N/A	N/A	7.51%
Location	Depth	Analysis	Result_Units	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
WS-035	12-18 inches	Total Metals	mg/kg	18400	5R	9.8	91.7J-	0.78J-	1.2	58500	25.7J-	5.3J-	19.6	18800J-	95.4	9790	195J-	17.8	6090J-	2.9U	0.065	242J-	3.3J-	28.6J-	130
WS-035 Dup	12-18 inches	Total Metals	mg/kg	20000	5.1UJ	11.3	103J-	0.94J-	1.6	58700	28.5J-	6.1J-	25.3	19100J-	146	10300	208J-	19.7	6600J-	3.0R	0.85	425U	3.9J-	31.7J-	147
		%RPD	%	8.33%	N/A	14.22%	N/A	N/A	28.57%	0.34%	N/A	N/A	25.39%	N/A	41.92%	5.08%	N/A	10.13%	N/A	N/A	171.58%	N/A	N/A	N/A	12.27%
Location	Depth	Analysis	Result_Units	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
WS-039	12-18 inches	Total Metals	mg/kg	20400	5.9UJ	166	148J-	0.86J-	23.5	17400	25.6J-	6.4J-	388	21800J-	3490	10200	338J-	20.1	6080J-	3.4U	6.8	299J-	4.4J-	28.5J-	909
WS-039 Dup	12-18 inches	Total Metals	mg/kg	19500	5.4UJ	146	207J-	0.95J-	40.5	20400	26.5J-	6.4J-	754	20300J-	5500	9020	537J-	22.1	5930J-	3.9J-	10.4	450U	3.3J-	31.6J-	3160
		%RPD	%	4.51%	N/A	12.82%	N/A	N/A	53.13%	15.87%	N/A	N/A	64.10%	N/A	44.72%	12.28%	N/A	9.48%	N/A	N/A	41.86%	N/A	N/A	N/A	110.64%
Location	Depth	Analysis	Result_Units	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
WS-056	12-18 inches	Total Metals	mg/kg	15100	32.4J-	914	140J-	0.71J-	392	34900	20.4J-	5.4J-	1420	26900J-	37800	6400	653J-	26.6	4070J-	10.8J-	59.7	530U	12.7J-	31.8J-	5370
WS-056 Dup	12-18 inches	Total Metals	mg/kg	13400	40.8J-	750	131J-	0.70J-	392	56700	20.8J-	5.8J-	1780	28500J-	38600	6190	762J-	28.5	3800J-	12.2J-	59.9	255J-	10.2J-	33.6J-	6570
		%RPD	%	11.93%	N/A	19.71%	N/A	N/A	0.00%	47.60%	N/A	N/A	22.50%	N/A	2.09%	3.34%	N/A	6.90%	N/A	N/A	0.33%	N/A	N/A	N/A	20.10%
Location	Depth	Analysis	Result_Units	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
WS-097	12-18 inches	Total Metals	mg/kg	21400	5.1R	12.8	223J-	1J-	1	10300	22.3J-	6.3J-	23.2	19900J-	62.4	9320	600J-	16.5	6200J-	0.79J-	0.15	424U	5J-	29.7J-	107
WS-097 Dup	12-18 inches	Total Metals	mg/kg	18700	5.4R	9.7	191J-	0.95J-	0.24	12600	23.1J-	5.7J-	19.8	17100J-	35.9	9120	486J-	15	5600J-	3.1R	0.9	234J-	3.0J-	27.2J-	95.2
		%RPD	%	13.47%	N/A	27.56%	N/A	N/A	122.58%	20.09%	N/A	N/A	15.81%	N/A	53.92%	2.17%	N/A	9.52%	N/A	N/A	142.86%	N/A	N/A	N/A	11.67%

Note: Flags removed from all data for RPD calculations

Table 5.0-1 August Soil Analytical Results: 0-6 Inch Depth

Location	Depth	Analysis	Result_Units	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
WS-001	0-6 inches	Total Metals	mg/kg	13800J-	4.5R	20.3J-	78.5J-	0.83J-	1.4J-	93900J-	30.7J-	5.7J-	15.8J-	16700J-	38.6J-	7870J-	256J-	27.6J-	4140J-	2.6R	0.21J-	373U	1.3J-	27.3J-	100J-
WS-002	0-6 inches	Total Metals	mg/kg	10300J-	5.2R	16.7J-	69.8J-	0.62J-	1.3J-	94300J-	21.4J-	4.6J-	13.5J-	13000J-	51.4J-	6860J-	201J-	20J-	3210J-	3R	0.14J-	430U	2J-	20.4J-	82.5J-
WS-003	0-6 inches	Total Metals	mg/kg	6370J-	5.4R	12.8J-	45.1J-	0.42J-	0.94J-	102000J-	16.1J-	3.2J-	8.7J-	9860J-	32.4J-	4720J-	135J-	15.3J-	1860J-	3.1R	0.043J-	448U	1.3J-	14.4J-	61.1J-
WS-004	0-6 inches	Total Metals	mg/kg	11800J-	5.2R	86.3J-	99J-	0.63J-	47.2J-	82600J-	20.7J-	4.4J-	143J-	13900J-	3310J-	8250J-	179J-	18.3J-	4430J-	3R	3.8J-	431U	2.5J-	22.8J-	500J-
WS-005	0-6 inches	Total Metals	mg/kg	16000J-	4.6R	55.7J-	107J-	0.82J-	37.9J-	53700J-	24.1J-	5.7J-	105J-	18300J-	1990J-	8960J-	185J-	21.3J-	5620J-	2.7R	2.4J-	385U	2.2J-	25.7J-	371J-
WS-006	0-6 inches	Total Metals	mg/kg	17800J-	5.5UJ	30.2J-	146J-	0.87J-	12.8J-	21100J-	24J-	5.8J-	59.6J-	19800J-	972J-	9550J-	239J-	18.5J-	6300J-	3.2U	1.4J-	457U	2.7J-	26.5J-	261J-
WS-007	0-6 inches	Total Metals	mg/kg	17800J-	4.4UJ	33.2J-	164J-	0.87J-	4.6J-	15500J-	22.8J-	6.1J-	39.6J-	19000J-	428J-	8590J-	650J-	17.8J-	6090J-	2.5U	0.85J-	363U	2.1J-	25.9J-	220J-
WS-008	0-6 inches	Total Metals	mg/kg	16800J-	6.0UJ	20.5J-	156J-	0.73J-	2.4J-	23500J-	22.6J-	6.2J-	26.9J-	17000J-	202J-	8240J-	585J-	17.5J-	5260J-	3.5U	0.39J-	215J-	2.7J-	26.7J-	158J-
WS-009	0-6 inches	Total Metals	mg/kg	17500J-	4.5UJ	37.1J-	162J-	0.75J-	2.2J-	8810J-	22.5J-	6.3J-	28.6J-	17300J-	307J-	8270J-	662J-	17.0J-	5850J-	2.6U	0.72J-	199J-	2.8J-	26.4J-	210J-
WS-010	0-6 inches	Total Metals	mg/kg	17100J-	4.9UJ	27.3J-	165J-	0.71J-	1.7J-	12400J-	22.4J-	6.3J-	26.3J-	17500J-	221J-	7960J-	640J-	16.3J-	5580J-	2.9U	0.55J-	196J-	3.1J-	28.0J-	185J-
WS-011	0-6 inches	Total Metals	mg/kg	16700J-	5.7UJ	26.4J-	160J-	0.65J-	1.6J-	14100J-	22.4J-	6.1J-	25.5J-	16900J-	188J-	7580J-	607J-	15.7J-	5510J-	3.3U	0.42J-	200J-	3.2J-	28.8J-	176J-
WS-012	0-6 inches	Total Metals	mg/kg	14000J-	4.8UJ	23.2J-	141J-	0.59J-	1.4J-	10300J-	18.7J-	5.4J-	22.3J-	14400J-	178J-	6800J-	569J-	13.9J-	4730J-	2.8U	0.42J-	166J-	2.0J-	22.7J-	153J-
WS-013	0-6 inches	Total Metals	mg/kg	11900J-	4.7R	37.2J-	148J-	0.49J-	1.7J-	29800J-	20.0J-	5.0J-	26.3J-	13500J-	246J-	6230J-	766J-	16.9J-	3900J-	2.8R	0.48J-	168J-	1.7J-	22.8J-	170J-
WS-014	0-6 inches	Total Metals	mg/kg	13800J-	16.6J-	1040J-	151J-	0.56J-	12.3J-	11100J-	19.3J-	5.0J-	200J-	27200J-	9240J-	6300J-	834J-	13.9J-	4350J-	5.6J-	14.5J-	175J-	4.1J-	25.0J-	1910J-
WS-015	0-6 inches	Total Metals	mg/kg	13400J-	5.9UJ	53.6J-	134J-	0.55J-	1.7J-	9950J-	18J-	5J-	29.7J-	14400J-	512J-	6360J-	527J-	13.2J-	4160J-	3.5U	0.97J-	494U	1.7J-	22J-	214J-
WS-016	0-6 inches	Total Metals	mg/kg	14700J-	67.4J-	2200J-	183J-	0.63J-	39.1J-	23300J-	23.2J-	5.3J-	637J-	46000J-	23900J-	6390J-	1800J-	16.5J-	4200J-	9.6J-	39.2J-	474U	11.4J-	29.2J-	5040J-
WS-017	0-6 inches	Total Metals	mg/kg	12400J-	16.4J-	676J-	133J-	0.53J-	8.8J-	15200J-	18.8J-	4.7J-	203J-	22200J-	6330J-	5680J-	871J-	12.5J-	4590J-	4.1J-	10.1J-	400U	3.6J-	22.6J-	1510J-
WS-018	0-6 inches	Total Metals	mg/kg	16900J-	6R	45.8J-	97J-	0.74J-	5J-	49500J-	24.8J-	5.7J-	38.4J-	17200J-	385J-	9380J-	164J-	18.7J-	6500J-	3.5U	0.74J-	500U	3.1J-	26.6J-	192J-
WS-018 Dup	0-6 inches	Total Metals	mg/kg	19200J-	4.4UJ	39.4J-	103J-	0.93J-	5.7J-	53300J-	28.0J-	6.1J-	44.4J-	17700J-	396J-	9790J-	153J-	20.2J-	6990J-	2.6R	0.94J-	365U	3.3J-	30.3J-	195J-
WS-019	0-6 inches	Total Metals	mg/kg	9650J-	6R	41.6J-	70.9J-	0.53J-	3J-	97600J-	21.4J-	4.2J-	23.2J-	12700J-	260J-	6720J-	183J-	18.7J-	2990J-	3.5R	0.52J-	497U	2.5U	20.5J-	114J-
WS-020	0-6 inches	Total Metals	mg/kg	15200J-	16.4J-	1170J-	142J-	0.7J-	90.9J-	70600J-	25.9J-	4.8J-	569J-	31500J-	15300J-	8990J-	236J-	21.6J-	5480J-	10.4J-	24.5J-	497U	4.4J-	28.7J-	2160J-
WS-021	0-6 inches	Total Metals	mg/kg	11800J-	71.6J-	8260J-	181J-	0.52J-	71.9J-	20200J-	26.6J-	1.9J-	1180J-	105000J-	54500J-	6040J-	199J-	14.6J-	4890J-	31.4J-	81.9J-	511J-	4.2J-	27.1J-	8920J-
WS-022	0-6 inches	Total Metals	mg/kg	19600J-	6.1UJ	48.9J-	192J-	0.81J-	33.0J-	22800J-	25.6J-	5.6J-	464J-	20000J-	2680J-	11700J-	176J-	19.2J-	6770J-	3.6UJ	4.6J-	509U	3.8J-	27.7J-	495J-
WS-023	0-6 inches	Total Metals	mg/kg	17600J-	5.2UJ	33.3J-	147J-	0.78J-	5.0J-	20200J-	23.5J-	6.2J-	41.3J-	18100J-	478J-	9070J-	243J-	18.4J-	5780J-	3.0UJ	0.91J-	432U	3.0J-	26.9J-	219J-
WS-024	0-6 inches	Total Metals	mg/kg	17000J-	4.3UJ	89.2J-	153J-	0.73J-	4.9J-	16500J-	22.3J-	6.0J-	48.4J-	18500J-	875J-	7900J-	644J-	17.1J-	5530J-	2.5UJ	1.8J-	360U	2.1J-	26.1J-	325J-
WS-025	0-6 inches	Total Metals	mg/kg	17000J-	5.4UJ	38.4J-	162J-	0.70J-	2.7J-	11000J-	22.1J-	5.9J-	31.7J-	17600J-	339J-	7840J-	642J-	16.0J-	5480J-	3.2UJ	0.76J-	454U	2.5J-	27.3J-	207J-
WS-026	0-6 inches	Total Metals	mg/kg	14600J-	4.3UJ	39.0J-	144J-	0.61J-	2.1J-	13100J-	19.6J-	5.4J-	26.7J-	15400J-	353J-	6780J-	566J-	14.6J-	4630J-	2.5UJ	0.72J-	356U	1.8J-	23.5J-	177J-
WS-027	0-6 inches	Total Metals	mg/kg	16400J-	4.6UJ	51.6J-	162J-	0.71J-	2.1J-	11100J-	22.0J-	5.9J-	30.6J-	17500J-	450J-	7680J-	651J-	15.8J-	5310J-	2.7UJ	0.89J-	386U	2.1J-	25.6J-	220J-
WS-028	0-6 inches	Total Metals	mg/kg	15300J-	17.1J-	785J-	154J-	0.68J-	12.3J-	14900J-	22.4J-	5.4J-	247J-	31600J-	9010J-	6990J-	830J-	15.3J-	4880J-	5.4J-	12.0J-	449U	5.4J-	27.2J-	1740J-
WS-029	0-6 inches	Total Metals	mg/kg	13800J-	25.3J-	891J-	167J-	0.58J-	15.5J-	14100J-	20.4J-	5.0J-	244J-	30800J-	10700J-	6370J-	924J-	13.8J-	4490J-	6.0J-	16.0J-	421U	4.4J-	26.4J-	2350J-
WS-030	0-6 inches	Total Metals	mg/kg	12100J-	35.2J-	3310J-	148J-	0.51J-	50.0J-	14600J-	19.7J-	4.1J-	393J-	52400J-	26100J-	5630J-	1170J-	13.2J-	4060J-	10.4J-	31.5J-	446U	9.7J-	26.6J-	6260J-
WS-031	0-6 inches	Total Metals	mg/kg	21600J-	5.7UJ	102J-	208J-	0.85J-	2.8J-	7160J-	23.7J-	6.6J-	50.5J-	22500J-	967J-	9010J-	707J-	18.4J-	6590J-	3.3U	1.9J-	475U	3.0J-	29.8J-	343J-
WS-032	0-6 inches	Total Metals	mg/kg	17200J-	4.3UJ	83.7J-	163J-	0.72J-	2.2J-	5640J-	20.4J-	6.3J-	40.5J-	18500J-	796J-	6930J-	628J-	15.9J-	5580J-	2.5U	1.4J-	357U	2.0J-	25.9J-	306J-
WS-033	0-6 inches	Total Metals	mg/kg	17600J-	4.9UJ	231J-	160J-	0.70J-	3.5J-	7930J-	21.7J-	6.0J-	68.5J-	20800J-	2090J-	7330J-	673J-	15.3J-	5440J-	2.9U	3.3J-	412U	3.2J-	28.3J-	501J-
WS-034	0-6 inches	Total Metals	mg/kg	11700J-	58.6J-	3560J-	143J-	0.49J-	26.2J-	21200J-	22.5J-	3.5J-	733J-	61500J-	34800J-	5260J-	1100J-	12.0J-	3810J-	18.3J-	51.7J-	372U	12.6J-	40.8J-	5430J-
WS-035	0-6 inches	Total Metals	mg/kg	17900J-	6.6R	37.3J-	113J-	0.79J-	9.7J-	54000J-	26.1J-	5.7J-	73.3J-	18200J-	795J-	10500J-	220J-	18.7J-	6480J-	3.9U	1.2J-	251J-	3.3J-	27.7J-	244J-
WS-035 Dup	0-6 inches	Total Metals	mg/kg	19700J-	5.0UJ	32.2J-	122J-	0.92J-	10.3J-	54600J-	28.6J-	6.1J-	81.2J-	18200J-	674J-	11300J-	224J-	20.0J-	7230J-	2.9R	1.4J-	415U	3.1J-	29.7J-	229J-
WS-036	0-6 inches	Total Metals	mg/kg	15800J-	5R	64.1J-	107J-	0.74J-	34.3J-	72600J-	24.2J-	4.9J-	130J-	16700J-	1830J-	10000J-	218J-	19.8J-	5600J-	2.9U	2.5J-	244J-	2.6J-	27.3J-	412J-
WS-037	0-6 inches	Total Metals	mg/kg	14200J-	5.1J-	195J-	115J-	0.9J-	40.2J-	57500J-	26.2J-	4.6J-	4490J-	66400J-	16200J-	7050J-	795J-	24.9J-	4630J-	26.9J-	36.9J-	431J-	1.4J-	32.1J-	16100J-
WS-038	0-6 inches	Total Metals	mg/kg	11900J-	5.3R	39J-	101J-	0.58J-	12.1J-	82400J-	21.3J-	4.5J-	67.1J-	13800J-	516J-	7690J-	224J-	18.6J-	4150J-	3.1R	0.92J-	229J-	1.5J-	22.5J-	247J-
WS-039	0-6 inches	Total Metals	mg/kg	13000J-	23J-	749J-	155J-	0.55J-	105J-	23700J-	20.3J-	6.4J-	2110J-	31000J-	18100J-	5590J-	1160J-	25J-	3740J-	12.8J-	32.1J-	249J-	2.7J-	25.1J-	11000J-
WS-039 Dup	0-6 inches	Total Metals	mg/kg	17300J-	12.6J-	448J-	174J-	0.85J-	87.2J-	40500J-	25.4J-	5.5J-	1890J-	30200J-	14300J-	7630J-	632J-	25.0J-	5340J-	10.0J-	29.0J-	511U	3.9J-	32.9J-	5820J-
WS-040	0-6 inches	Total Metals	mg/kg	11700J-	103J-	1240J-	120J-	0.56J-	91.6J-	27400J-	18.1J-	4.1J-	4080J-	74200J-	24700J-	4840J-	858J-	26J-	3460J-	20.4J-	49.3J-	310J-	1J-	22.7J-	12800J-
WS-041	0-6 inches	Total Metals	mg/kg	13800J-	9.1J-	338J-	145J-	0.65J-	32.3J-	8920J-	17.1J-	5.2J-	387J-	20400J-	7360J-	6450J-	817J-	13.9J-	4550J-	3.9J-	12.1J-	501U	2.2J-	22.4J-	1360J-
WS-042	0-6 inches	Total Metals	mg/kg	13900J-	8.4J-	767J-	154J-	0.65J-	11.7J-	6550J-	18.2J-	4.7J-	162J-	22800J-	5620J-	6010J-	552J-	12.8J-	4200J-	4J-	7.7J-	506U	2.7J-	23.5J-	802J-
WS-043	0-6 inches	Total Metals	mg/kg	16700J-	5.6UJ	73.9J-	184J-	0.79J-	7.3J-	7530J-	19.8J-	5.5J-	130J-	18000J-	1290J-	7460J-	611J-	14.7J-	5190J-	3.3U	2.3J-	467U	2.5J-	25.3J-	348J-
WS-044	0-6 inches	Total Metals	mg/kg	17600J-	5.8UJ	69.4J-	185J-	0.81J-	4.1J-	13800J-	20.9J-	5.8J-	106J-	18400J-	1770J-	8750J-	604J-	15.6J-	5490J-	3.4U	2.5J-	482U	2.8J-	27.3J-	321J-
WS-045	0-6 inches	Total Metals	mg/kg	12200J-	4.6UJ	39.4J-	119J-	0.57J-	2J-	49600J-	16.9J-	4.5J-	33.1J-	13100J-	413J-	7330J-	383J-	12.7J-	4060J-	2.7U	0.77U	383U	2.1J-	19.8J-	155J-
WS-046	0-6 inches	Total Metals	mg/kg	18500J-	4.4R	35.9J-	195J-	0.81J-	1.2J-	8280J-	20.6J-	5.6J-	33.6J-	18600J-	325J-	8830J-	569J-	14.7J-	5670J-	2.6U	0.74U	368U	3.3J-	27.7J-	155J-
WS-047	0-6 inches	Total Metals	mg/kg	15400J-	4.8UJ	66.6J-	162J-	0.72J-	3.7J-	18700J-	19.5J-	5.2J-	76.6J-	18000J-	1100J-	7480J-	550J-	15J-	4720J-	2.8U	1.5J-	400U	2.1J-	25.1J-	243J-

Table 5.0-1 Continued

Location	Depth	Analysis	Result_Units	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
WS-048	0-6 inches	Total Metals	mg/kg	16900J-	5.6J-	199J-	176J-	0.77J-	7.2J-	16900J-	33J-	11.8J-	327J-	93600J-	2830J-	7740J-	880J-	53.2J-	5010J-	6J-	5.7J-	384U	0.77J-	27.8J-	760J-
WS-049	0-6 inches	Total Metals	mg/kg	16700J-	5.2J-	266J-	179J-	0.78J-	4.8J-	12400J-	23.1J-	5.9J-	89.8J-	21500J-	2930J-	7040J-	716J-	15.6J-	5490J-	3U	4.6J-	422U	3.2J-	27.4J-	741J-
WS-050	0-6 inches	Total Metals	mg/kg	12500J-	12.8J-	1070J-	136J-	0.58J-	7.1J-	18100J-	18.3J-	4.4J-	152J-	26600J-	8720J-	5380J-	571J-	12.6J-	3710J-	4.7J-	11.7J-	418U	3.6J-	24.9J-	1240J-
WS-051	0-6 inches	Total Metals	mg/kg	15300J-	4.2UJ	85.8J-	179J-	0.68J-	3J-	7480J-	18.1J-	5.1J-	60.3J-	17000J-	1000J-	6310J-	610J-	12.6J-	4630J-	2.5U	1.7J-	353U	2.6J-	24.6J-	289J-
WS-053	0-6 inches	Total Metals	mg/kg	7420J-	5.7UJ	20.5J-	89.5J-	0.47U	10J-	64400J-	12.7J-	3.1J-	214J-	8730J-	915J-	5410J-	272J-	10.3J-	2310J-	3.3U	2J-	473U	1J-	15.8J-	422J-
WS-054	0-6 inches	Total Metals	mg/kg	13200J-	21.3J-	488J-	123J-	0.71J-	307J-	21900J-	21.1J-	4.1J-	3320J-	43800J-	57800J-	5390J-	1010J-	25.3J-	4110J-	25.6J-	66.7J-	445U	3.8J-	31.5J-	11900J-
WS-055	0-6 inches	Total Metals	mg/kg	20800J-	5.9UJ	90.2J-	202J-	0.94J-	35.8J-	25400J-	23.7J-	6.4J-	541J-	22900J-	4600J-	10500J-	610J-	19.4J-	6610J-	4.6J-	8.2J-	494U	3.4J-	30J-	687J-
WS-056	0-6 inches	Total Metals	mg/kg	12200J-	306J-	1130J-	113J-	0.73J-	345J-	19800J-	22.9J-	7.9J-	5100J-	79300J-	103000J-	5910J-	1570J-	54.1J-	4850J-	50.7J-	212J-	432J-	6.0J-	46.5J-	14200J-
WS-056 Dup	0-6 inches	Total Metals	mg/kg	10900J-	210J-	1020J-	131J-	0.74J-	380J-	22400J-	21.6J-	9.4J-	4570J-	85200J-	114000J-	4360J-	1570J-	47.4J-	3760J-	39.3J-	182J-	451J-	7.3J-	50.3J-	13400J-
WS-057	0-6 inches	Total Metals	mg/kg	20500J-	5.7UJ	97.3J-	190J-	0.91J-	26.2J-	11800J-	22.5J-	6.3J-	249J-	21300J-	3250J-	9150J-	586J-	17.8J-	5940J-	3.3U	4.9J-	472U	3.0J-	29.2J-	544J-
WS-058	0-6 inches	Total Metals	mg/kg	20800J-	6.0R	13.8J-	213J-	0.89J-	1.8J-	16000J-	21.9J-	5.8J-	35.9J-	18400J-	184J-	10500J-	509J-	15.7J-	6100J-	3.5U	0.42J-	502U	3.1J-	29.0J-	112J-
WS-059	0-6 inches	Total Metals	mg/kg	20500J-	4.9R	87.7J-	210J-	0.88J-	2.2J-	9540J-	21.9J-	6.0J-	39.9J-	19100J-	628J-	9950J-	558J-	15.6J-	6330J-	2.9U	1.0J-	412U	2.7J-	28.4J-	168J-
WS-060	0-6 inches	Total Metals	mg/kg	16600J-	5.2UJ	57.5J-	282J-	0.76J-	4.9J-	24800J-	19.8J-	4.9J-	69.1J-	23200J-	912J-	9110J-	495J-	14.0J-	4700J-	3.1U	1.6J-	468J-	3.0J-	26.2J-	271J-
WS-061	0-6 inches	Total Metals	mg/kg	20400J-	5.4R	21.1J-	193J-	0.87J-	2.1J-	12200J-	21.4J-	6.0J-	39.3J-	19700J-	261J-	9550J-	533J-	15.9J-	6310J-	3.2U	0.46J-	451U	3.1J-	27.7J-	145J-
WS-062	0-6 inches	Total Metals	mg/kg	16400J-	5.6UJ	22.3J-	178J-	0.61J-	2.5J-	6670J-	18.0J-	5.2J-	38.7J-	16100J-	261J-	7510J-	527J-	13.2J-	5150J-	3.3U	0.60J-	465U	3.0J-	23.9J-	142J-
WS-063	0-6 inches	Total Metals	mg/kg	19500J-	6.1UJ	21.0J-	191J-	0.68J-	1.8J-	8030J-	21.0J-	6.2J-	31.9J-	18700J-	177J-	9910J-	554J-	15.8J-	6230J-	3.6U	0.50J-	509U	3.6J-	28.9J-	131J-
WS-064	0-6 inches	Total Metals	mg/kg	22500J-	5.6UJ	29.8J-	198J-	0.83J-	1.9J-	10300J-	26.0J-	7.1J-	35.6J-	22500J-	237J-	9350J-	682J-	18.8J-	6990J-	3.3U	0.76J-	470U	4.7J-	32.4J-	233J-
WS-065	0-6 inches	Total Metals	mg/kg	16100J-	4.7J-	286J-	126J-	0.69J-	3.7J-	60300J-	24.3J-	6.1J-	72.8J-	21500J-	2170J-	7870J-	499J-	21.8J-	5270J-	2.8J-	3.9J-	374U	3.0J-	27.6J-	408J-
WS-066	0-6 inches	Total Metals	mg/kg	14700J-	5.9UJ	190J-	163J-	0.49J-	3.0J-	5760J-	17.9J-	5.3J-	60.1J-	17900J-	1810J-	6060J-	534J-	12.7J-	4650J-	3.4U	3.1J-	489U	3.2J-	25.1J-	396J-
WS-071	0-6 inches	Total Metals	mg/kg	16600J-	4.7UJ	9.6J-	101J-	0.74J-	1.1J-	92200J-	18.5J-	5.6J-	31.4J-	18900J-	106J-	8940J-	176J-	15.7J-	4800J-	2.7U	0.34J-	393U	2.0J-	24.2J-	72.5J-
WS-072	0-6 inches	Total Metals	mg/kg	16100J-	5.5UJ	15.9J-	112J-	0.65J-	6.6J-	65900J-	19.5J-	5.4J-	84.7J-	16100J-	586J-	8610J-	241J-	16.1J-	5210J-	3.2U	1.3J-	460U	2.5J-	25.9J-	146J-
WS-073	0-6 inches	Total Metals	mg/kg	18400J-	4.8UJ	24.7J-	184J-	0.66J-	14.7J-	8400J-	19.8J-	5.6J-	88.6J-	19800J-	1190J-	9200J-	511J-	15.1J-	5750J-	2.8U	2.4J-	397U	2.9J-	24.7J-	232J-
WS-074	0-6 inches	Total Metals	mg/kg	16800J-	4.3UJ	118J-	179J-	0.56J-	73.6J-	7950J-	18.4J-	5.3J-	326J-	21300J-	6030J-	7930J-	573J-	14.7J-	5750J-	3.5J-	12.9J-	357U	3.4J-	24.8J-	626J-
WS-075	0-6 inches	Total Metals	mg/kg	16700J-	4.3UJ	90.3J-	173J-	0.55J-	78.6J-	7670J-	18.8J-	5.2J-	317J-	20000J-	7070J-	7300J-	573J-	15.4J-	5000J-	4.4J-	8.8J-	355U	3.5J-	25.4J-	871J-
WS-076	0-6 inches	Total Metals	mg/kg	16900J-	4.9UJ	97.9J-	171J-	0.58J-	53.7J-	10000J-	19.9J-	5.5J-	214J-	19500J-	4070J-	7310J-	597J-	16.0J-	5190J-	4.0J-	5.9J-	406U	3.7J-	26.2J-	584J-
WS-077	0-6 inches	Total Metals	mg/kg	14300J-	17.0J-	617J-	179J-	0.54J-	10.2J-	19200J-	21.4J-	5.4J-	301J-	38300J-	13200J-	5790J-	790J-	13.3J-	4350J-	6.8J-	12.5J-	576J-	7.9J-	28.4J-	1740J-
WS-078	0-6 inches	Total Metals	mg/kg	11000J-	5.1J-	175J-	122J-	0.41J-	6.8J-	44700J-	14.7J-	3.5J-	70.7J-	14100J-	2060J-	6040J-	446J-	10.8J-	3570J-	2.7U	3.3J-	392U	2.5J-	19.1J-	453J-
WS-079	0-6 inches	Total Metals	mg/kg	18500J-	5.5R	12.3J-	181J-	0.69J-	0.49J-	5760J-	20.2J-	5.8J-	23.5J-	17500J-	83.9J-	7580J-	510J-	15.2J-	5560J-	3.2U	0.91U	455U	3.0J-	24.8J-	110J-
WS-080	0-6 inches	Total Metals	mg/kg	14400J-	4.6UJ	120J-	178J-	0.76J-	4.6J-	6340J-	17.3J-	5.1J-	63.7J-	20600J-	1330J-	6200J-	631J-	12.7J-	4290J-	1.8J-	2.1J-	385U	3.8J-	23.5J-	334J-
WS-081	0-6 inches	Total Metals	mg/kg	16400J-	5.3UJ	20.5J-	172J-	0.83J-	1.5J-	6570J-	18.3J-	5.1J-	28.9J-	15600J-	204J-	7040J-	511J-	13.0J-	5200J-	1.3J-	0.51J-	443U	3.3J-	24.1J-	137J-
WS-082	0-6 inches	Total Metals	mg/kg	10700J-	4.9R	18.8J-	115J-	0.54J-	0.94J-	8690J-	14.4J-	3.9J-	18.7J-	10900J-	149J-	4740J-	364J-	10.3J-	3470J-	1.0J-	0.39J-	407U	2.3J-	18.6J-	92.0J-
WS-083	0-6 inches	Total Metals	mg/kg	14300J-	9.2J-	271J-	158J-	0.68J-	4.7J-	6040J-	18.2J-	5.2J-	97.3J-	18500J-	3240J-	6020J-	581J-	12.6J-	4310J-	3.0J-	5.6J-	369U	4.1J-	24.7J-	679J-
WS-089	0-6 inches	Total Metals	mg/kg	17800J-	4.8UJ	32.9J-	189J-	0.84J-	21.4J-	7890J-	20.9J-	5.9J-	167J-	17900J-	2130J-	7670J-	641J-	16.0J-	5240J-	2.1J-	3.0J-	398U	4.1J-	27.2J-	372J-
WS-090	0-6 inches	Total Metals	mg/kg	18400J-	4.9UJ	99.6J-	182J-	0.86J-	102J-	8200J-	21.9J-	6.8J-	336J-	20800J-	9160J-	7190J-	716J-	19.3J-	6020J-	3.9J-	9.1J-	409U	4.1J-	29.3J-	1040J-
WS-091	0-6 inches	Total Metals	mg/kg	18500J-	4.6UJ	96.3J-	174J-	0.93J-	106J-	6810J-	20J-	5.7J-	288J-	20300J-	6440J-	7770J-	589J-	16.8J-	5610J-	2.8J-	8.5J-	380U	4J-	26.2J-	813J-
WS-092	0-6 inches	Total Metals	mg/kg	19600J-	4.3UJ	31.2J-	209J-	0.98J-	43.2J-	6990J-	21.6J-	5.9J-	138J-	18300J-	2220J-	7990J-	630J-	16.3J-	5910J-	0.93J-	3.5J-	358U	4.3J-	27.4J-	372J-
WS-093	0-6 inches	Total Metals	mg/kg	17000J-	6.1UJ	54.6J-	171J-	0.87J-	59.8J-	6030J-	19.4J-	5.3J-	239J-	17500J-	3900J-	6830J-	544J-	14.8J-	5290J-	3.4J-	5.2J-	506U	4.4J-	24.9J-	498J-
WS-094	0-6 inches	Total Metals	mg/kg	21400J-	4.8UJ	68.4J-	212J-	1.1J-	58.2J-	7560J-	22.9J-	6.3J-	238J-	21900J-	4500J-	8910J-	724J-	17.7J-	6360J-	2.9J-	5.2J-	402U	4.6J-	29.9J-	603J-
WS-095	0-6 inches	Total Metals	mg/kg	17700J-	4.4UJ	81.3J-	184J-	0.88J-	37.1J-	14000J-	20.1J-	5.4J-	137J-	19100J-	2980J-	8550J-	662J-	15.4J-	5370J-	2J-	4J-	369U	4J-	27.1J-	500J-
WS-096	0-6 inches	Total Metals	mg/kg	18000J-	4.8R	20.7J-	203J-	0.88J-	7J-	6920J-	20.3J-	5.4J-	47.5J-	17900J-	426J-	8530J-	613J-	14.4J-	5590J-	1.5J-	0.69J-	399U	4.8J-	27.6J-	148J-
WS-097	0-6 inches	Total Metals	mg/kg	17900J-	5.7R	36.7J-	202J-	0.86J-	7J-	7060J-	20.6J-	5.7J-	52.7J-	17700J-	580J-	7570J-	640J-	14.4J-	5440J-	1.4J-	0.89J-	471U	4.6J-	27.2J-	196J-
WS-097 Dup	0-6 inches	Total Metals	mg/kg	20300J-	5.5U	20.9J-	219J-	1.1J-	2.9J-	7840J-	21.5J-	6.7J-	36.5J-	19900J-	195J-	8720J-	652J-	15.9J-	6170J-	0.82J-	0.92U	268J-	3.8J-	27.5J-	141J-
WS-098	0-6 inches	Total Metals	mg/kg	18800J-	6.1UJ	29.6J-	200J-	0.91J-	2.4J-	7620J-	20.9J-	5.7J-	35.1J-	18100J-	278J-	8050J-	587J-	14.7J-	5810J-	1.4J-	0.53J-	507U	4.5J-	27.6J-	149J-
WS-107	0-6 inches	Total Metals	mg/kg	22600J-	6.3UJ	21J-	235J-	1.1J-	9.4J-	8480J-	24.8J-	6.9J-	71.1J-	21400J-	671J-	9830J-	747J-	18.8J-	6930J-	0.83J-	0.98J-	525U	5.1J-	32.1J-	201J-
WS-108	0-6 inches	Total Metals	mg/kg	19600J-	6.2UJ	30.5J-	234J-	0.94J-	25.7J-	7630J-	22.2J-	6.5J-	105J-	19100J-	1510J-	8590J-	737J-	17.7J-	5980J-	1.2J-	2.3J-	516U	4.6J-	29.1J-	284J-
WS-109	0-6 inches	Total Metals	mg/kg	20500J-	4.2UJ	45.1J-	228J-	0.96J-	38.7J-	7370J-	22.7J-	6.2J-	127J-	19800J-	2320J-	7970J-	765J-	17.7J-	5920J-	0.95J-	3J-	348U	4.4J-	30.3J-	402J-
WS-110	0-6 inches	Total Metals	mg/kg	21700J-	5.5UJ	20.2J-	215J-	1.1J-	26.6J-	7110J-	22.6J-	6.4J-	72.3J-	19900J-	1090J-	8620J-	676J-	17.9J-	6590J-	1.9J-	1.7J-	455U	4.4J-	28.6J-	227J-
WS-111	0-6 inches	Total Metals	mg/kg	17400J-	4.9UJ	114J-	203J-	0.84J-	81.6J-	7540J-	19.8J-	5.5J-	347J-	18800J-	7280J-	6790J-	736J-	16J-	5100J-	3.4J-	8J-	407U	4.6J-	27.6J-	897J-
WS-112	0-6 inches	Total Metals	mg/kg	19300J-	5UJ	69.2J-	198J-	0.93J-	53.4J-	7420J-	20.6J-	5.8J-	201J-	26300J-	4150J-	7690J-	696J-	15.8J-	6000J-	3J-	4.5J-	417U	4.8J-	27.9J-	567J-
WS-113	0-6 inches	Total Metals	mg/kg	18700J-	4.9UJ	29.2J-	206J-	0.87J-	26.5J-	6120J-	20.8J-	6.5J-	98.4J-	18800J-	1490J-	7640J-	662J-	16.5J-	5790J-	1.7J-	2.1J-	407U	3.1J-	27.3J-	282J-
WS-114	0-6 inches	Total Metals	mg/kg	15600J-	5.9UJ	20.3J-	176J-	0.72J-	7.6J-	5820J-	18.3J-	5.5J-	43.0J-	18000J-	536J-	6490J-	556J-	14.8J-	4690J-	1.0J-	0.98U	491U	2.0J-	24.3J-	157J-
WS-115	0-6 inches	Total Metals	mg/kg	19500J-	4.7UJ	17.3J-	220J-	0.90J-	5.7J-	7360J-	21.4J-	6.3J-	42.2J-	18600J-	343J-	8760J-	711J-	17.5J-	5830J-	1.9J-	0.82J-	390U	3.8J-	27.5J-	145J-

Table 5.0-2 August Soil Analytical Results: 6-12 Inch Depth

Location	Depth	Analysis	Result_Units	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
WS-001	6-12 inches	Total Metals	mg/kg	14700J-	5.9R	52.9J-	95.4J-	0.8J-	2.4J-	70500J-	25.9J-	4.9J-	27.6J-	17200J-	334J-	8790J-	228J-	21.3J-	5060J-	3.4R	0.75J-	491U	2J-	24.3J-	167J-
WS-002	6-12 inches	Total Metals	mg/kg	12600J-	5.5R	16.1J-	74.8J-	0.78J-	1.4J-	99000J-	28.2J-	5.5J-	14.2J-	15500J-	39.7J-	7350J-	260J-	27.1J-	3420J-	3.2R	0.19J-	461U	1.5J-	24.8J-	97J-
WS-003	6-12 inches	Total Metals	mg/kg	9220J-	6.3R	11.4J-	62.8J-	0.61J-	1J-	103000J-	22.6J-	4.8J-	10.7J-	13100J-	20.6J-	6240J-	228J-	22.6J-	2520J-	3.6R	0.058J-	521U	1.7J-	20.1J-	76.8J-
WS-004	6-12 inches	Total Metals	mg/kg	15600J-	6.1R	12.8J-	106J-	0.78J-	6.5J-	58700J-	22.9J-	4.7J-	28J-	15300J-	192J-	9600J-	178J-	18.5J-	5800J-	3.6R	0.4J-	512U	2.4J-	25.1J-	118J-
WS-005	6-12 inches	Total Metals	mg/kg	16400J-	6.2UJ	23.5J-	109J-	0.85J-	23.7J-	59200J-	25.3J-	6J-	44.9J-	17400J-	466J-	9290J-	195J-	22.1J-	5730J-	3.6R	0.65J-	521U	2J-	26.4J-	197J-
WS-006	6-12 inches	Total Metals	mg/kg	17000J-	5R	17.9J-	156J-	0.83J-	1.8J-	37000J-	23J-	6.1J-	20.2J-	17800J-	120J-	9140J-	600J-	19.5J-	5780J-	2.9U	0.24J-	416U	2.4J-	26.5J-	129J-
WS-007	6-12 inches	Total Metals	mg/kg	16600J-	6.3R	15.5J-	150J-	0.8J-	1J-	33700J-	22.8J-	6J-	17.9J-	17000J-	84.8J-	8190J-	518J-	18.5J-	5490J-	3.7U	0.25J-	525U	2.5J-	26.5J-	122J-
WS-008	6-12 inches	Total Metals	mg/kg	15800J-	4.5R	18.7J-	139J-	0.70J-	1.0J-	33900J-	21.3J-	6.0J-	17.5J-	16100J-	91.4J-	7650J-	490J-	17.7J-	5040J-	2.6U	0.23J-	193J-	2.5J-	25.8J-	121J-
WS-009	6-12 inches	Total Metals	mg/kg	17400J-	6.2R	21.6J-	163J-	0.70J-	0.99J-	15400J-	22.9J-	6.4J-	19.4J-	17200J-	141J-	8230J-	602J-	16.9J-	5720J-	3.6U	0.32J-	209J-	2.9J-	27.9J-	163J-
WS-010	6-12 inches	Total Metals	mg/kg	17900J-	6.2UJ	25.2J-	169J-	0.72J-	1.3J-	18200J-	23.1J-	6.3J-	23.5J-	17600J-	190J-	8270J-	625J-	16.7J-	6040J-	3.6R	0.45J-	226J-	2.7J-	29.3J-	175J-
WS-011	6-12 inches	Total Metals	mg/kg	16300J-	4.9R	20.9J-	153J-	0.65J-	1.0J-	15900J-	21.7J-	5.9J-	19.4J-	16700J-	134J-	7730J-	567J-	15.7J-	5530J-	2.9U	0.36J-	191J-	2.8J-	27.3J-	152J-
WS-012	6-12 inches	Total Metals	mg/kg	15000J-	4.7R	20.3J-	152J-	0.61J-	0.95J-	15600J-	19.8J-	5.9J-	18.0J-	15200J-	133J-	7120J-	568J-	14.9J-	5070J-	2.7U	0.29J-	182J-	2.5J-	25.5J-	139J-
WS-013	6-12 inches	Total Metals	mg/kg	12300J-	5.4UJ	29.4J-	127J-	0.47J-	1.3J-	17000J-	19.1J-	5.4J-	21.8J-	13500J-	204J-	5840J-	544J-	13.7J-	3990J-	3.1U	0.42J-	167J-	2.6J-	23.3J-	143J-
WS-014	6-12 inches	Total Metals	mg/kg	12300J-	7.2J-	376J-	130J-	0.53J-	5.8J-	11600J-	17.4J-	4.8J-	98.6J-	18500J-	3910J-	5800J-	608J-	13.8J-	3830J-	3.2J-	6.3J-	380U	2.1J-	22J-	857J-
WS-015	6-12 inches	Total Metals	mg/kg	13800J-	6UJ	50.7J-	138J-	0.57J-	1.5J-	18300J-	18.9J-	5.2J-	27.1J-	14700J-	408J-	6610J-	522J-	14.2J-	4460J-	3.5U	0.83J-	499U	2.5J-	23.2J-	187J-
WS-016	6-12 inches	Total Metals	mg/kg	11100J-	83.5J-	2930J-	186J-	0.5J-	44.8J-	18500J-	23.3J-	4.6J-	696J-	57200J-	34000J-	5010J-	1540J-	13.8J-	3420J-	14.4J-	63.5J-	490U	8.6J-	28.3J-	7070J-
WS-017	6-12 inches	Total Metals	mg/kg	13700J-	18.7J-	887J-	157J-	0.55J-	16.7J-	16000J-	19.9J-	5J-	367J-	27200J-	10700J-	6080J-	1700J-	13.3J-	4610J-	4.7J-	15.3J-	397U	5.6J-	24.9J-	2940J-
WS-018	6-12 inches	Total Metals	mg/kg	18400J-	5.4R	22.9J-	112J-	0.81J-	2.9J-	53100J-	26.5J-	5.7J-	28.9J-	17900J-	210J-	10100J-	164J-	19.4J-	7060J-	3.2R	0.48J-	452U	3.3J-	27.5J-	171J-
WS-018 Dup	6-12 inches	Total Metals	mg/kg	20500J-	4.9UJ	14.9J-	113J-	0.98J-	1.8J-	54800J-	30.3J-	6.3J-	25.8J-	18200J-	144J-	10800J-	162J-	21.1J-	7570J-	2.8R	0.81U	406U	3.5J-	31.4J-	161J-
WS-019	6-12 inches	Total Metals	mg/kg	16900J-	8.5J-	751J-	113J-	0.73J-	52.4J-	39300J-	26.2J-	5.4J-	437J-	27000J-	7970J-	8770J-	206J-	20.8J-	6220J-	6.3J-	13.9J-	546U	4.5J-	28.2J-	1580J-
WS-020	6-12 inches	Total Metals	mg/kg	17000J-	5.6UJ	139J-	104J-	0.75J-	12J-	41600J-	24.2J-	5J-	74.3J-	18700J-	1280J-	9780J-	180J-	18.6J-	6040J-	3.3U	2.6J-	469U	3.2J-	26.2J-	316J-
WS-021	6-12 inches	Total Metals	mg/kg	16500J-	13.0J-	1180J-	131J-	0.71J-	62.7J-	44200J-	24.7J-	5.6J-	275J-	29100J-	10100J-	9130J-	189J-	19.1J-	5830J-	6.6J-	12.8J-	512U	4.3J-	27.5J-	1450J-
WS-022	6-12 inches	Total Metals	mg/kg	18300J-	5.9UJ	38.4J-	135J-	0.77J-	8.2J-	34900J-	24.7J-	6.3J-	738J-	18900J-	1150J-	10300J-	169J-	20.8J-	6250J-	3.4UJ	3.5J-	488U	3.0J-	27.9J-	401J-
WS-023	6-12 inches	Total Metals	mg/kg	18300J-	6.2UJ	22.9J-	164J-	0.73J-	1.7J-	25800J-	24.6J-	6.4J-	22.7J-	18100J-	167J-	9380J-	599J-	18.3J-	5580J-	3.6UJ	0.39J-	520U	2.7J-	29.6J-	162J-
WS-024	6-12 inches	Total Metals	mg/kg	21300J-	5.3UJ	22.2J-	193J-	0.88J-	1.4J-	16200J-	26.8J-	7.0J-	22.9J-	20700J-	132J-	9380J-	699J-	20.0J-	6810J-	3.1UJ	0.41J-	438U	2.9J-	31.3J-	175J-
WS-025	6-12 inches	Total Metals	mg/kg	16800J-	4.8UJ	23.3J-	164J-	0.69J-	1.4J-	18700J-	21.6J-	6.0J-	20.7J-	17400J-	156J-	7930J-	588J-	16.2J-	5400J-	2.8UJ	0.36J-	400U	2.7J-	27.0J-	166J-
WS-026	6-12 inches	Total Metals	mg/kg	16900J-	5.9UJ	23.0J-	162J-	0.67J-	1.3J-	14200J-	22.5J-	5.9J-	20.0J-	16600J-	164J-	7580J-	598J-	15.9J-	5220J-	3.5UJ	0.36J-	494U	2.9J-	27.4J-	159J-
WS-027	6-12 inches	Total Metals	mg/kg	17100J-	5.8UJ	34.3J-	167J-	0.66J-	1.4J-	13500J-	23.1J-	6.0J-	24.0J-	17000J-	237J-	7830J-	614J-	16.3J-	5560J-	3.4UJ	0.58J-	483U	2.6J-	28.5J-	206J-
WS-028	6-12 inches	Total Metals	mg/kg	17000J-	5.2UJ	81.2J-	162J-	0.70J-	2.1J-	15700J-	22.3J-	5.9J-	39.2J-	18900J-	857J-	7740J-	618J-	15.9J-	5420J-	3.0U	1.3J-	432U	3.0J-	27.8J-	279J-
WS-029	6-12 inches	Total Metals	mg/kg	15400J-	4.3UJ	84.4J-	154J-	0.63J-	2.0J-	13600J-	21.0J-	5.6J-	34.1J-	16600J-	859J-	6910J-	587J-	15.1J-	5010J-	2.5U	1.4J-	358U	2.3J-	25.8J-	286J-
WS-030	6-12 inches	Total Metals	mg/kg	11400J-	4.4UJ	379J-	119J-	0.49J-	3.3J-	21400J-	16.5J-	4.3J-	57.9J-	16900J-	2880J-	5270J-	511J-	12.1J-	3470J-	2.6U	3.6J-	366U	2.5J-	20.7J-	475J-
WS-031	6-12 inches	Total Metals	mg/kg	22900J-	6.0UJ	32.9J-	209J-	0.90J-	1.2J-	7080J-	24.8J-	6.9J-	26.2J-	22200J-	229J-	9500J-	645J-	18.3J-	6690J-	3.5U	0.59J-	504U	2.8J-	30.7J-	175J-
WS-032	6-12 inches	Total Metals	mg/kg	18600J-	5.7UJ	30.8J-	165J-	0.72J-	1.1J-	30400J-	22.7J-	6.4J-	21.6J-	17400J-	174J-	7770J-	534J-	16.5J-	5840J-	3.3R	0.39J-	473U	3.6J-	30.6J-	156J-
WS-033	6-12 inches	Total Metals	mg/kg	16500J-	4.5UJ	89.8J-	154J-	0.65J-	1.7J-	14400J-	19.8J-	5.8J-	31.0J-	17100J-	665J-	6910J-	537J-	14.9J-	5050J-	2.6U	1.2J-	374U	2.7J-	26.4J-	231J-
WS-034	6-12 inches	Total Metals	mg/kg	9170J-	139J-	5700J-	158J-	0.42J-	45.6J-	15300J-	23.2J-	2.2J-	1060J-	96300J-	56200J-	4320J-	2650J-	10.6J-	3270J-	27.1J-	90.4J-	257J-	18.6J-	42.9J-	8970J-
WS-035	6-12 inches	Total Metals	mg/kg	20200J-	5.9R	10.3J-	111J-	0.84J-	1.4J-	38700J-	27.5J-	5.5J-	23.2J-	18600J-	142J-	11000J-	177J-	17.6J-	6990J-	3.4U	0.2J-	237J-	3.8J-	29.1J-	163J-
WS-035 Dup	6-12 inches	Total Metals	mg/kg	21100J-	5.9UJ	12.2J-	125J-	0.98J-	2.3J-	42900J-	29.7J-	6.3J-	31.2J-	19100J-	203J-	11500J-	202J-	19.3J-	7450J-	3.5R	0.99U	495U	3.6J-	31.1J-	171J-
WS-036	6-12 inches	Total Metals	mg/kg	19300J-	5.1R	18.1J-	105J-	0.84J-	11J-	33000J-	26J-	5.4J-	41.2J-	18700J-	378J-	10600J-	169J-	18.1J-	7270J-	3U	0.5J-	207J-	3.4J-	26.1J-	230J-
WS-037	6-12 inches	Total Metals	mg/kg	19300J-	4.5R	29.8J-	102J-	0.84J-	26.4J-	40000J-	26.5J-	5.8J-	452J-	19400J-	1220J-	10500J-	202J-	21J-	6990J-	2.8J-	2.6J-	237J-	3.6J-	27.8J-	608J-
WS-038	6-12 inches	Total Metals	mg/kg	14100J-	4.9R	40.7J-	116J-	0.72J-	7.4J-	88000J-	25.7J-	5.1J-	60.8J-	15700J-	448J-	8760J-	287J-	22J-	4630J-	2.8U	0.87J-	238J-	1.8J-	26.1J-	197J-
WS-039	6-12 inches	Total Metals	mg/kg	20700J-	5R	60.2J-	155J-	0.89J-	9.5J-	11700J-	26.1J-	6.8J-	85.1J-	19700J-	711J-	10600J-	307J-	19J-	6420J-	2.9U	1.5J-	248J-	3.6J-	27.8J-	284J-
WS-039 Dup	6-12 inches	Total Metals	mg/kg	19900J-	5.5UJ	55.3J-	147J-	0.94J-	35.5J-	13000J-	25.6J-	6.8J-	169J-	22300J-	1330J-	9570J-	224J-	19.9J-	6290J-	1.6J-	2.6J-	460U	3.1J-	28.0J-	683J-
WS-040	6-12 inches	Total Metals	mg/kg	15200J-	6.4J-	228J-	203J-	0.61J-	105J-	30700J-	19.9J-	4.1J-	1860J-	23000J-	14800J-	7010J-	631J-	26.5J-	4660J-	8.3J-	23.5J-	297J-	2.9J-	24.2J-	4180J-
WS-041	6-12 inches	Total Metals	mg/kg	13700J-	5.4UJ	84J-	144J-	0.65J-	16.1J-	9290J-	16.3J-	4.5J-	319J-	15300J-	3740J-	6290J-	475J-	14.3J-	4460J-	3.2U	4.6J-	452U	2.2J-	20.7J-	540J-
WS-042	6-12 inches	Total Metals	mg/kg	14800J-	5.1R	40.9J-	157J-	0.68J-	0.62J-	5910J-	17.6J-	5.1J-	21.5J-	15000J-	211J-	5980J-	436J-	14.5J-	4230J-	3U	0.86U	429U	2.2J-	21.1J-	116J-
WS-043	6-12 inches	Total Metals	mg/kg	15600J-	5.5R	17.8J-	161J-	0.71J-	0.79J-	8960J-	17.1J-	5.1J-	27.7J-	15200J-	136J-	6910J-	457J-	13.9J-	4560J-	3.2U	0.91U	457U	2.4J-	22.7J-	108J-
WS-044	6-12 inches	Total Metals	mg/kg	17600J-	5.3R	13.7J-	185J-	0.78J-	0.52J-	23100J-	19.9J-	5.6J-	24.6J-	16600J-	112J-	9240J-	489J-	15J-	5440J-	3.1U	0.88U	442U	3.1J-	26.8J-	111J-
WS-045	6-12 inches	Total Metals	mg/kg	9710J-	4.7R	8.5J-	102J-	0.45J-	0.3J-	50900J-	14.1J-	3.7J-	11.3J-	10100J-	19.3J-	6120J-	269J-	10.5J-	3240J-	2.8R	0.79R	394U	1.5J-	16.5J-	58J-
WS-046	6-12 inches	Total Metals	mg/kg	18400J-	5.3R	15.1J-	193J-	0.81J-	0.34J-	29200J-	18.8J-	5.5J-	20.6J-	16600J-	60.5J-	9360J-	445J-	14.5J-	5440J-	3.1R	0.89U	444U	3.2J-	27J-	90.1J-
WS-047	6-12 inches	Total Metals	mg/kg	19700J-	5.4R	17.7J-	216J-	0.9J-	0.75J-	9790J-	21.3J-	6.3J-	25J-	19700J-	137J-	8450J-	648J-	16.7J-	5720J-	3.2U	0.91U	454U	2.7J-	28.3J-	112J-

Table 5.0-2 Continued

Location	Depth	Analysis	Result_Units	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
WS-048	6-12 inches	Total Metals	mg/kg	20900J-	6R	35.2J-	219J-	0.89J-	0.93J-	54400J-	20.8J-	6.1J-	39.8J-	18700J-	282J-	10400J-	473J-	18.2J-	5620J-	3.5R	0.53J-	497U	3.9J-	31.9J-	141J-
WS-049	6-12 inches	Total Metals	mg/kg	21700J-	6.2R	53.2J-	186J-	0.99J-	1.2J-	7490J-	26.5J-	7.5J-	33.3J-	22600J-	504J-	8890J-	712J-	19.7J-	7230J-	3.6U	0.86J-	520U	3.6J-	33.6J-	266J-
WS-050	6-12 inches	Total Metals	mg/kg	13000J-	5.7UJ	351J-	130J-	0.59J-	2.2J-	18500J-	17.5J-	4.6J-	53.5J-	17000J-	2610J-	5450J-	440J-	12.9J-	3890J-	3.3U	3.6J-	473U	2.2J-	22.6J-	402J-
WS-051	6-12 inches	Total Metals	mg/kg	18200J-	5.7R	22.6J-	195J-	0.79J-	0.83J-	7330J-	20.6J-	6J-	27.2J-	17800J-	174J-	7270J-	567J-	19.8J-	5310J-	3.3U	0.31J-	472U	3.1J-	27.8J-	126J-
WS-053	6-12 inches	Total Metals	mg/kg	4870J-	5.9R	26.4J-	101J-	0.49U	6.7J-	118000J-	10.6J-	2.6J-	126J-	6630J-	612J-	4810J-	175J-	9.2J-	1600J-	3.5R	0.9J-	494U	1.6J-	12.7J-	313J-
WS-054	6-12 inches	Total Metals	mg/kg	19200J-	6.1UJ	335J-	173J-	0.82J-	201J-	12400J-	23.4J-	5.8J-	1320J-	26400J-	18300J-	8180J-	649J-	24.3J-	5660J-	9.3J-	22.9J-	505U	4.1J-	30.9J-	2290J-
WS-055	6-12 inches	Total Metals	mg/kg	20800J-	6.4R	13.4J-	226J-	0.98J-	1.4J-	25000J-	22.5J-	6.3J-	35.6J-	19200J-	165J-	10400J-	545J-	17.3J-	6550J-	3.7U	0.40J-	533U	3.3J-	29.0J-	109J-
WS-056	6-12 inches	Total Metals	mg/kg	12100J-	58.1J-	742J-	109J-	0.59J-	461J-	36200J-	19.9J-	5.4J-	2540J-	37700J-	85400J-	4480J-	654J-	33.8J-	3380J-	19.1J-	105J-	449U	6.4J-	38.5J-	7720J-
WS-056 Dup	6-12 inches	Total Metals	mg/kg	17500J-	53.1J-	711J-	158J-	0.93J-	851J-	45100J-	26.0J-	7.6J-	2650J-	43400J-	58500J-	6850J-	883J-	40.5J-	4900J-	19.0J-	101J-	310J-	8.8J-	46.7J-	11100J-
WS-057	6-12 inches	Total Metals	mg/kg	18500J-	4.6R	18.4J-	179J-	0.80J-	3.1J-	42300J-	19.5J-	5.6J-	48.8J-	18100J-	310J-	8730J-	371J-	15.5J-	5200J-	2.7U	0.62J-	384U	3.6J-	24.7J-	108J-
WS-058	6-12 inches	Total Metals	mg/kg	19400J-	4.4R	12.4J-	198J-	0.84J-	0.25J-	27100J-	19.5J-	5.5J-	18.3J-	17500J-	34.8J-	9830J-	449J-	14.5J-	5610J-	2.6U	0.059J-	370U	3.0J-	27.4J-	77.2J-
WS-059	6-12 inches	Total Metals	mg/kg	17700J-	6.2R	14.2J-	184J-	0.76J-	0.24J-	15600J-	19.2J-	5.2J-	17.5J-	16100J-	41.9J-	8860J-	436J-	13.6J-	5160J-	3.6U	0.076J-	519U	2.7J-	25.2J-	77.1J-
WS-060	6-12 inches	Total Metals	mg/kg	22100J-	5.3R	22.7J-	227J-	0.92J-	1.5J-	10800J-	22.8J-	6.2J-	33.1J-	20800J-	251J-	10500J-	561J-	16.2J-	6530J-	3.1U	0.41J-	440U	3.9J-	30.6J-	132J-
WS-061	6-12 inches	Total Metals	mg/kg	21200J-	5.4R	12.0J-	204J-	0.90J-	0.59J-	27300J-	21.8J-	6.1J-	27.1J-	19200J-	64.8J-	10500J-	463J-	16.6J-	6380J-	3.2U	0.10J-	451U	3.3J-	28.8J-	101J-
WS-062	6-12 inches	Total Metals	mg/kg	18400J-	4.8UJ	14.7J-	190J-	0.68J-	1.1J-	8610J-	19.1J-	5.8J-	24.1J-	18600J-	77.9J-	8440J-	488J-	14.7J-	5380J-	2.9J-	0.31J-	397U	3.0J-	25.6J-	98.8J-
WS-063	6-12 inches	Total Metals	mg/kg	17900J-	4.9R	16.2J-	175J-	0.62J-	1.2J-	21500J-	19.8J-	5.6J-	24.8J-	18200J-	110J-	9020J-	480J-	14.8J-	5480J-	2.9U	0.34J-	412U	3.5J-	26.8J-	101J-
WS-064	6-12 inches	Total Metals	mg/kg	24000J-	6.1UJ	23.0J-	207J-	0.91J-	1.4J-	8160J-	27.4J-	7.8J-	27.2J-	23400J-	132J-	9960J-	733J-	20.3J-	7540J-	3.6U	0.55J-	507U	4.5J-	33.6J-	196J-
WS-065	6-12 inches	Total Metals	mg/kg	19300J-	4.6UJ	103J-	160J-	0.73J-	2.1J-	34600J-	25.4J-	6.9J-	40.1J-	21100J-	769J-	8600J-	609J-	21.0J-	6630J-	2.7U	1.6J-	381U	3.7J-	30.7J-	245J-
WS-066	6-12 inches	Total Metals	mg/kg	12800J-	4.5UJ	34.1J-	127J-	0.44J-	0.74J-	4410J-	14.7J-	4.5J-	18.0J-	12800J-	252J-	5160J-	353J-	10.7J-	3620J-	2.6U	0.57J-	372U	2.4J-	20.0J-	110J-
WS-071	6-12 inches	Total Metals	mg/kg	21800J-	5.3UJ	8.0J-	113J-	0.93J-	0.68J-	108000J-	23.7J-	6.6J-	10.6J-	22900J-	23.3J-	11300J-	177J-	19.3J-	6050J-	3.1U	0.17J-	439U	2.4J-	32.0J-	56.0J-
WS-072	6-12 inches	Total Metals	mg/kg	16500J-	6.2UJ	14.3J-	119J-	0.65J-	5.6J-	57300J-	19.0J-	5.2J-	73.0J-	15900J-	536J-	8720J-	233J-	15.0J-	4890J-	3.6R	1.1J-	519U	2.0J-	26.2J-	124J-
WS-073	6-12 inches	Total Metals	mg/kg	19900J-	5.6R	12.3J-	202J-	0.64J-	2.6J-	29400J-	21.5J-	5.8J-	37.3J-	17800J-	209J-	12600J-	460J-	15.2J-	5700J-	3.3U	0.94U	470U	3.9J-	28.3J-	102J-
WS-074	6-12 inches	Total Metals	mg/kg	19300J-	4.8UJ	62.0J-	212J-	0.64J-	9.9J-	9190J-	20.4J-	5.8J-	125J-	21200J-	1500J-	9660J-	561J-	15.3J-	5970J-	3.3J-	4.8J-	400U	3.0J-	27.1J-	237J-
WS-075	6-12 inches	Total Metals	mg/kg	17700J-	4.4UJ	16.8J-	197J-	0.60J-	5.4J-	6950J-	19.5J-	5.6J-	42.9J-	19000J-	585J-	8020J-	560J-	14.6J-	5090J-	2.6U	1.0J-	370U	3.3J-	25.7J-	146J-
WS-076	6-12 inches	Total Metals	mg/kg	18400J-	4.8R	13.0J-	200J-	0.67J-	1.0J-	8540J-	20.2J-	5.8J-	22.3J-	18800J-	74.8J-	7690J-	585J-	15.4J-	5570J-	2.8U	0.80U	399U	3.3J-	25.7J-	94.1J-
WS-077	6-12 inches	Total Metals	mg/kg	10800J-	33.2J-	1220J-	146J-	0.44J-	10.8J-	19300J-	20.0J-	4.3J-	704J-	55600J-	16600J-	4830J-	1540J-	11.2J-	3270J-	9.0J-	18.6J-	400U	4.9J-	26.8J-	3170J-
WS-078	6-12 inches	Total Metals	mg/kg	12700J-	6.3UJ	59.5J-	135J-	0.53U	2.2J-	8050J-	16.0J-	4.1J-	34.1J-	13100J-	596J-	6270J-	441J-	12.1J-	3770J-	3.7U	1.3J-	528U	2.4J-	19.7J-	171J-
WS-079	6-12 inches	Total Metals	mg/kg	15900J-	5.9UJ	10.1J-	125J-	0.86J-	0.49R	7570J-	19.3J-	5.2J-	18.4J-	15600J-	27.5J-	6570J-	342J-	15.7J-	4450J-	3.4U	0.10J-	491U	2.4J-	23.5J-	81.3J-
WS-080	6-12 inches	Total Metals	mg/kg	15500J-	4.4R	33.8J-	173J-	0.80J-	1.3J-	6470J-	17.5J-	4.7J-	24.1J-	16000J-	285J-	6490J-	492J-	12.1J-	4690J-	1.4J-	0.51J-	368U	3.2J-	22.8J-	129J-
WS-081	6-12 inches	Total Metals	mg/kg	21100J-	5.5R	13.8J-	224J-	1.1J-	0.36J-	8370J-	22.7J-	6.4J-	21.4J-	19100J-	71.9J-	9230J-	605J-	16.4J-	6410J-	2.2J-	0.28J-	458U	3.9J-	29.8J-	129J-
WS-082	6-12 inches	Total Metals	mg/kg	11400J-	4.5R	9.5J-	116J-	0.57J-	0.22J-	9300J-	15.2J-	4.0J-	12.3J-	11100J-	48.0J-	5020J-	335J-	10.7J-	3600J-	1.1J-	0.18J-	377U	2.2J-	19.3J-	72.3J-
WS-083	6-12 inches	Total Metals	mg/kg	11000J-	5.1R	12.7J-	103J-	0.55J-	0.012J-	4630J-	13.2J-	4.0J-	11.1J-	10800J-	39.3J-	4460J-	264J-	10.0J-	3220J-	0.69J-	0.23J-	428U	2.2J-	17.5J-	63.0J-
WS-089	6-12 inches	Total Metals	mg/kg	17000J-	6.1R	8.3J-	188J-	0.81J-	0.56J-	8040J-	19.1J-	6.0J-	20.1J-	16100J-	62.3J-	8370J-	544J-	15.5J-	4890J-	1.1J-	0.33J-	506U	3.1J-	25.1J-	81.7J-
WS-090	6-12 inches	Total Metals	mg/kg	22700J-	5.1UJ	10.7J-	232J-	1.1J-	3.6J-	7610J-	24.7J-	7.6J-	35.6J-	20800J-	226J-	9040J-	661J-	20.8J-	6970J-	1.6J-	0.83J-	426U	3.4J-	30.6J-	127J-
WS-091	6-12 inches	Total Metals	mg/kg	16300J-	6.1UJ	14.2J-	155J-	0.82J-	10.7J-	9790J-	17.9J-	5.1J-	43.4J-	15400J-	556J-	6990J-	417J-	15J-	4630J-	3.6R	1J-	508U	3.7J-	22.7J-	141J-
WS-092	6-12 inches	Total Metals	mg/kg	20000J-	4.5R	11.6J-	206J-	0.99J-	2.7J-	6990J-	21.5J-	5.8J-	26.9J-	18300J-	149J-	8370J-	546J-	16J-	5980J-	2.6R	0.33J-	375U	4.5J-	28J-	116J-
WS-093	6-12 inches	Total Metals	mg/kg	18700J-	6.1R	13.3J-	194J-	0.94J-	3.1J-	9350J-	20.6J-	5.6J-	28.5J-	17700J-	207J-	7820J-	509J-	15.5J-	5350J-	0.89J-	0.42J-	505U	4J-	27.8J-	105J-
WS-094	6-12 inches	Total Metals	mg/kg	20700J-	4.7R	11.6J-	200J-	1J-	3.1J-	7060J-	21.9J-	5.9J-	28.6J-	20000J-	167J-	8770J-	545J-	16.4J-	6140J-	0.56J-	0.33J-	395U	4.3J-	28.3J-	103J-
WS-095	6-12 inches	Total Metals	mg/kg	17500J-	5.7UJ	46.4J-	178J-	0.87J-	41.9J-	9380J-	20.8J-	5.3J-	139J-	17500J-	2990J-	8270J-	592J-	16.2J-	5190J-	1.6J-	3.4J-	474U	3.8J-	25.6J-	436J-
WS-096	6-12 inches	Total Metals	mg/kg	18400J-	6.1R	11.7J-	182J-	0.88J-	0.49J-	6860J-	20J-	5.4J-	17.4J-	16700J-	23.2J-	8310J-	461J-	14.7J-	5440J-	3.6R	0.066J-	509U	4.4J-	26.8J-	74.8J-
WS-097	6-12 inches	Total Metals	mg/kg	22300J-	4.9R	13.1J-	224J-	1.1J-	0.78J-	7570J-	23.2J-	6.3J-	22.3J-	20300J-	43.2J-	9140J-	616J-	16.7J-	6720J-	2.8R	0.11J-	406U	4.8J-	30.2J-	104J-
WS-097 Dup	6-12 inches	Total Metals	mg/kg	18200J-	6.1U	10.9J-	192J-	0.94J-	0.31J-	6630J-	19.4J-	5.9J-	20.1J-	17100J-	37.6J-	7890J-	518J-	14.5J-	5500J-	3.5R	1.0U	235J-	3.7J-	25.2J-	91.4J-
WS-098	6-12 inches	Total Metals	mg/kg	16800J-	6R	12J-	173J-	0.82J-	0.67J-	10300J-	19.1J-	5.1J-	18.5J-	15800J-	55.4J-	7450J-	426J-	13.6J-	4870J-	3.5R	0.078J-	497U	3.9J-	25.4J-	87.6J-
WS-107	6-12 inches	Total Metals	mg/kg	23300J-	6.3R	11.3J-	239J-	1.1J-	0.45J-	8100J-	24.5J-	6.9J-	20.8J-	21200J-	19.4J-	10200J-	689J-	19J-	6700J-	3.6R	0.091J-	521U	5.3J-	32.2J-	98.6J-
WS-108	6-12 inches	Total Metals	mg/kg	22500J-	5R	10.7J-	220J-	1.1J-	0.88J-	7290J-	23.8J-	6.5J-	22.1J-	21300J-	47.7J-	9420J-	619J-	18.5J-	6490J-	1.1J-	0.18J-	418U	4.5J-	30.9J-	95.3J-
WS-109	6-12 inches	Total Metals	mg/kg	22600J-	6R	9.2J-	232J-	1.1J-	0.67J-	6830J-	24.2J-	6.6J-	20.6J-	21100J-	33.2J-	9110J-	675J-	18.6J-	6280J-	3.5R	0.14J-	497U	5.5J-	32.5J-	93.1J-
WS-110	6-12 inches	Total Metals	mg/kg	21300J-	4.7R	9.1J-	216J-	1J-	1.3J-	6880J-	22.5J-	6.2J-	21J-	19800J-	65.2J-	8480J-	634J-	17.4J-	6330J-	0.82J-	0.18J-	392U	4.5J-	29.3J-	94.8J-
WS-111	6-12 inches	Total Metals	mg/kg	23000J-	5.3UJ	28J-	219J-	1.1J-	20.9J-	9520J-	24.4J-	6.8J-	95.3J-	21700J-	1360J-	9150J-	683J-	20.7J-	6490J-	1.1J-	1.8J-	441U	5J-	32.8J-	249J-
WS-112	6-12 inches	Total Metals	mg/kg	21400J-	4.4UJ	11.0J-	228J-	1.0J-	1.5J-	7250J-	22.6J-	7.0J-	24.2J-	20800J-	113J-	8820J-	649J-	18.6J-	6390J-	1.4J-	0.73U	367U	2.8J-	28.9J-	102J-
WS-113	6-12 inches	Total Metals	mg/kg	23200J-	4.4UJ	12.4J-	237J-	1.1J-	0.85J-	7070J-	24.8J-	7.5J-	24.1J-	21000J-	69.8J-	9430J-	646J-	19.4J-	6970J-	1.4J-	0.73U	366U	3.9J-	33.1J-	103J-
WS-114	6-12 inches	Total Metals	mg/kg	20400J-	5.2UJ	11.9J-	209J-	0.96J-	1.6J-	6640J-	22.8J-	6.8J-	25.0J-	16700J-	132J-	8650J-	620J-	18.7J-	5770J-	0.82J-	0.86U	432U	2.8J-	29.0J-	108J-
WS-115	6-12 inches	Total Metals	mg/kg	19900J-	4.6UJ	11.1J-	226J-	0.91J-	1.3J-	9390J-	21.1J-	6.3J-	23.0J-	20600J-	77.4J-	8930J-	665J-	17.8J-	5830J-	0.96J-	0.77U	384U	3.3J-	28.0J-	95.1J-

Table 5.0-3 August Soil Analytical Results: 12-18 Inch Depth

Location	Depth	Analysis	Result_Units	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
WS-001	12-18 inches	Total Metals	mg/kg	14100J-	5R	14.8J-	82.7J-	0.7J-	0.88J-	60500J-	21.2J-	4.4J-	16.2J-	15100J-	96.6J-	8480J-	188J-	16.9J-	5110J-	2.9R	0.21J-	416U	2.6J-	22.6J-	112J-
WS-002	12-18 inches	Total Metals	mg/kg	18000J-	5.2R	25.9J-	110J-	0.93J-	4.8J-	56200J-	27.7J-	5.9J-	31.3J-	19200J-	264J-	10600J-	212J-	22.8J-	6740J-	3.1R	0.55J-	436U	2J-	27.6J-	170J-
WS-003	12-18 inches	Total Metals	mg/kg	12200J-	5.1R	56.2J-	98.5J-	0.7J-	13.4J-	79200J-	22.6J-	4.9J-	60.9J-	15200J-	1070J-	8100J-	274J-	20.5J-	4200J-	3R	1.9J-	427U	2.1J-	22.8J-	266J-
WS-004	12-18 inches	Total Metals	mg/kg	21300J-	4.9R	17.3J-	133J-	1.1J-	3.4J-	31800J-	28.5J-	5.8J-	29.9J-	22100J-	217J-	11200J-	188J-	22.4J-	8000J-	2.9U	0.45J-	410U	3.3J-	30.7J-	175J-
WS-005	12-18 inches	Total Metals	mg/kg	13200J-	5.1R	14.5J-	106J-	0.71J-	2.5J-	86900J-	22.9J-	5.8J-	16.7J-	14700J-	97.1J-	7630J-	266J-	21.7J-	3980J-	3R	0.17J-	428U	2.3J-	26.4J-	90.3J-
WS-006	12-18 inches	Total Metals	mg/kg	16200J-	4.5R	16J-	135J-	0.87J-	1.7J-	73100J-	24.7J-	6.4J-	19J-	18400J-	103J-	8950J-	450J-	23.2J-	5110J-	2.6R	0.26J-	378U	1.9J-	27.6J-	124J-
WS-007	12-18 inches	Total Metals	mg/kg	13900J-	6.1R	13.6J-	118J-	0.68J-	0.95J-	59800J-	21.6J-	5.8J-	15.3J-	16100J-	62.7J-	7390J-	411J-	19.5J-	4270J-	3.5R	0.16J-	195J-	2.5U	25.1J-	95.6J-
WS-008	12-18 inches	Total Metals	mg/kg	16400J-	5.4R	16.2J-	146J-	0.73J-	1.1J-	42300J-	23.2J-	6.1J-	18.8J-	16700J-	95.0J-	7890J-	494J-	18.8J-	5240J-	3.1R	0.20J-	211J-	3.1J-	27.7J-	123J-
WS-009	12-18 inches	Total Metals	mg/kg	17700J-	5.3R	18.5J-	170J-	0.72J-	0.90J-	19000J-	23.5J-	6.2J-	19.2J-	17500J-	127J-	8300J-	586J-	16.9J-	5390J-	3.1U	0.31J-	198J-	3.2J-	29.2J-	159J-
WS-010	12-18 inches	Total Metals	mg/kg	17100J-	5.0R	20.0J-	162J-	0.67J-	0.96J-	22600J-	21.8J-	6.0J-	19.7J-	16400J-	142J-	7850J-	549J-	15.9J-	5900J-	2.9U	0.33J-	208J-	3.1J-	28.2J-	148J-
WS-011	12-18 inches	Total Metals	mg/kg	16000J-	6.3R	19.2J-	156J-	0.64J-	0.91J-	20600J-	21.7J-	5.9J-	18.4J-	16200J-	131J-	7790J-	549J-	15.9J-	5380J-	3.6U	0.34J-	204J-	2.8J-	27.0J-	145J-
WS-012	12-18 inches	Total Metals	mg/kg	15700J-	4.9R	22.8J-	152J-	0.61J-	0.95J-	18800J-	21.1J-	5.8J-	19.0J-	15600J-	139J-	7210J-	545J-	15.0J-	5160J-	2.8U	0.33J-	196J-	2.5J-	26.9J-	144J-
WS-013	12-18 inches	Total Metals	mg/kg	11100J-	6.0R	27.6J-	119J-	0.43J-	1.0J-	17500J-	18.9J-	4.8J-	18.9J-	12500J-	173J-	5380J-	477J-	13.1J-	3600J-	3.5U	0.34J-	159J-	2.7J-	22.3J-	132J-
WS-014	12-18 inches	Total Metals	mg/kg	14000J-	6.1UJ	47.1J-	142J-	0.59J-	1.2J-	37000J-	18J-	5.4J-	22.1J-	14600J-	327J-	6940J-	494J-	14.1J-	4550J-	3.6R	0.59J-	511U	2.6J-	24J-	161J-
WS-015	12-18 inches	Total Metals	mg/kg	12500J-	4.9UJ	23J-	120J-	0.51J-	0.9J-	26800J-	17.1J-	4.9J-	17.6J-	13300J-	150J-	6130J-	420J-	13.4J-	3800J-	2.9U	0.31J-	411U	2.2J-	22.8J-	121J-
WS-016	12-18 inches	Total Metals	mg/kg	7220J-	101J-	3410J-	128J-	0.48U	48.8J-	12800J-	17.7J-	4.2J-	799J-	71000J-	37300J-	3450J-	1910J-	9.6J-	2300J-	28.5J-	69J-	482U	8.9J-	22.6J-	10100J-
WS-017	12-18 inches	Total Metals	mg/kg	8290J-	108J-	3850J-	147J-	0.41U	47.6J-	14200J-	15.9J-	2.7J-	913J-	57300J-	35900J-	4550J-	4280J-	11.1J-	2840J-	13.1J-	72.9J-	406U	13.6J-	21.3J-	6660J-
WS-018	12-18 inches	Total Metals	mg/kg	17900J-	5.8R	10.8J-	110J-	0.76J-	1.5J-	51600J-	25.5J-	5.2J-	20.6J-	17400J-	114J-	9980J-	149J-	18.3J-	6550J-	3.4R	0.3J-	487U	3.3J-	27.5J-	141J-
WS-018 Dup	12-18 inches	Total Metals	mg/kg	20100J-	5.1UJ	10.9J-	117J-	0.95J-	0.90J-	53300J-	29.3J-	6.4J-	21.0J-	18400J-	111J-	10600J-	162J-	20.7J-	6990J-	3.0R	0.85U	426U	3.4J-	32.6J-	152J-
WS-019	12-18 inches	Total Metals	mg/kg	18700J-	4.9UJ	193J-	100J-	0.78J-	13.3J-	36600J-	26.8J-	5.7J-	105J-	20600J-	1560J-	9620J-	161J-	19.4J-	6780J-	2.9U	3.5J-	408U	3.4J-	28.5J-	443J-
WS-020	12-18 inches	Total Metals	mg/kg	20800J-	6.1UJ	94.9J-	123J-	0.89J-	4.8J-	21200J-	28.5J-	6.4J-	46.4J-	22200J-	742J-	10800J-	180J-	20.2J-	7280J-	3.6U	1.6J-	511U	3.7J-	29.4J-	276J-
WS-021	12-18 inches	Total Metals	mg/kg	17000J-	5.1UJ	282J-	123J-	0.76J-	19.0J-	50500J-	24.6J-	5.6J-	64.2J-	22000J-	1620J-	9140J-	244J-	20.1J-	5730J-	3.0UJ	2.7J-	422U	2.6J-	26.2J-	386J-
WS-022	12-18 inches	Total Metals	mg/kg	17500J-	4.5R	28.8J-	139J-	0.76J-	6.1J-	46300J-	24.2J-	6.2J-	90.9J-	18400J-	572J-	9820J-	209J-	19.4J-	5920J-	2.6UJ	1.1J-	371U	3.4J-	28.2J-	203J-
WS-023	12-18 inches	Total Metals	mg/kg	18200J-	4.5R	21.0J-	170J-	0.78J-	1.4J-	27600J-	23.6J-	6.6J-	20.2J-	18300J-	126J-	9420J-	654J-	18.5J-	5560J-	2.6UJ	0.31J-	373U	2.4J-	28.3J-	153J-
WS-024	12-18 inches	Total Metals	mg/kg	23000J-	5.5UJ	17.7J-	187J-	0.92J-	1.3J-	23000J-	28.2J-	7.3J-	23.5J-	22400J-	132J-	9870J-	647J-	21.3J-	7220J-	3.2UJ	0.37J-	459U	3.2J-	33.5J-	180J-
WS-025	12-18 inches	Total Metals	mg/kg	17800J-	6.5UJ	18.5J-	171J-	0.71J-	1.1J-	21400J-	22.9J-	6.1J-	19.1J-	17200J-	127J-	8230J-	584J-	16.4J-	5640J-	3.8UJ	0.29J-	542U	3.0J-	28.9J-	156J-
WS-026	12-18 inches	Total Metals	mg/kg	16500J-	6.5UJ	23.1J-	166J-	0.66J-	1.2J-	20600J-	22.6J-	6.0J-	19.5J-	16300J-	162J-	7610J-	580J-	15.8J-	5110J-	3.8UJ	0.37J-	539U	3.6J-	27.8J-	161J-
WS-027	12-18 inches	Total Metals	mg/kg	17000J-	6.5UJ	23.2J-	168J-	0.70J-	1.1J-	21100J-	22.4J-	6.1J-	19.4J-	16700J-	159J-	7980J-	602J-	16.3J-	5420J-	3.8U	0.36J-	538U	2.7J-	27.4J-	173J-
WS-028	12-18 inches	Total Metals	mg/kg	14500J-	5.4UJ	48.3J-	146J-	0.58J-	1.4J-	15600J-	20.0J-	5.2J-	26.2J-	15300J-	500J-	6780J-	534J-	13.8J-	4590J-	3.1U	0.82J-	446U	3.0J-	25.2J-	215J-
WS-029	12-18 inches	Total Metals	mg/kg	15800J-	5.7UJ	40.9J-	160J-	0.65J-	1.2J-	17600J-	21.7J-	5.8J-	22.0J-	16200J-	352J-	7080J-	580J-	15.4J-	4980J-	3.3U	0.66J-	474U	3.2J-	27.0J-	182J-
WS-030	12-18 inches	Total Metals	mg/kg	11100J-	30.6J-	1540J-	137J-	0.48J-	13.6J-	30500J-	18.2J-	4.2J-	250J-	30900J-	13700J-	5180J-	935J-	13.6J-	3250J-	5.3J-	19.4J-	368U	5.2J-	24.1J-	2190J-
WS-031	12-18 inches	Total Metals	mg/kg	22700J-	4.7UJ	21.7J-	208J-	0.91J-	0.97J-	9350J-	23.9J-	6.8J-	22.8J-	21700J-	135J-	9490J-	602J-	18.2J-	6510J-	2.8U	0.37J-	393U	2.6J-	30.5J-	149J-
WS-032	12-18 inches	Total Metals	mg/kg	17900J-	6.1R	27.6J-	155J-	0.68J-	1.0J-	39900J-	22.3J-	6.3J-	19.4J-	16900J-	134J-	7760J-	511J-	16.6J-	5350J-	3.6R	0.30J-	509U	3.6J-	32.0J-	141J-
WS-033	12-18 inches	Total Metals	mg/kg	16500J-	4.7UJ	85.5J-	149J-	0.64J-	1.6J-	20800J-	20.2J-	5.8J-	31.1J-	17700J-	615J-	6960J-	515J-	14.9J-	4920J-	2.7U	1.1J-	392U	2.9J-	28.0J-	227J-
WS-034	12-18 inches	Total Metals	mg/kg	16500J-	13.9J-	662J-	167J-	0.82J-	4.2J-	9250J-	21.1J-	5.3J-	133J-	23800J-	5630J-	8710J-	698J-	14.9J-	4780J-	5.7J-	7.6J-	231J-	3.9J-	25.5J-	844J-
WS-035	12-18 inches	Total Metals	mg/kg	18400J-	5R	9.8J-	91.7J-	0.78J-	1.2J-	58500J-	25.7J-	5.3J-	19.6J-	18800J-	95.4J-	9790J-	195J-	17.8J-	6090J-	2.9U	0.065J-	242J-	3.3J-	28.6J-	130J-
WS-035 Dup	12-18 inches	Total Metals	mg/kg	20000J-	5.1UJ	11.3J-	103J-	0.94J-	1.6J-	58700J-	28.5J-	6.1J-	25.3J-	19100J-	146J-	10300J-	208J-	19.7J-	6600J-	3.0R	0.85U	425U	3.9J-	31.7J-	147J-
WS-036	12-18 inches	Total Metals	mg/kg	20400J-	5.3R	18.3J-	115J-	0.88J-	11.9J-	40300J-	27.1J-	5.3J-	33.8J-	19700J-	303J-	11000J-	194J-	19.1J-	7170J-	3.1U	0.38J-	223J-	3.3J-	29.3J-	227J-
WS-037	12-18 inches	Total Metals	mg/kg	20600J-	5.7R	15.1J-	112J-	0.88J-	2.7J-	22400J-	27.2J-	6.4J-	56.9J-	19600J-	232J-	10600J-	202J-	19J-	7070J-	3.3U	0.48J-	216J-	4.1J-	28.1J-	212J-
WS-038	12-18 inches	Total Metals	mg/kg	15000J-	6.7UJ	260J-	128J-	0.73J-	145J-	69100J-	26.8J-	4.5J-	3260J-	30100J-	9720J-	8680J-	357J-	32J-	4890J-	11.8J-	28.8J-	303J-	3.4J-	30.3J-	4340J-
WS-039	12-18 inches	Total Metals	mg/kg	20400J-	5.9UJ	166J-	148J-	0.86J-	23.5J-	17400J-	25.6J-	6.4J-	388J-	21800J-	3490J-	10200J-	338J-	20.1J-	6080J-	3.4U	6.8J-	299J-	4.4J-	28.5J-	909J-
WS-039 Dup	12-18 inches	Total Metals	mg/kg	19500J-	5.4UJ	146J-	207J-	0.95J-	40.5J-	20400J-	26.5J-	6.4J-	754J-	20300J-	5500J-	9020J-	537J-	22.1J-	5930J-	3.9J-	10.4J-	450U	3.3J-	31.6J-	3160J-
WS-040	12-18 inches	Total Metals	mg/kg	15100J-	6.3UJ	94.1J-	130J-	0.62J-	32J-	10400J-	18.4J-	4.6J-	527J-	16800J-	3610J-	7060J-	517J-	15.9J-	4570J-	3.7U	6.1J-	212J-	2.2J-	20.4J-	1470J-
WS-041	12-18 inches	Total Metals	mg/kg	16900J-	4.4UJ	79.8J-	178J-	0.78J-	7.5J-	8460J-	19.5J-	5.4J-	133J-	18600J-	1670J-	7500J-	543J-	15.3J-	5440J-	2.6U	2.6J-	366U	2.5J-	24.1J-	378J-
WS-042	12-18 inches	Total Metals	mg/kg	15800J-	6UJ	212J-	156J-	0.71J-	3.2J-	6570J-	21.4J-	5.1J-	57.1J-	17700J-	1420J-	6390J-	464J-	14.3J-	4590J-	3.5U	2.1J-	498U	2.7J-	23.2J-	284J-
WS-043	12-18 inches	Total Metals	mg/kg	17200J-	4.7UJ	29.6J-	184J-	0.77J-	1.8J-	11200J-	19.2J-	5.6J-	45.7J-	17400J-	581J-	7700J-	496J-	14.9J-	5160J-	2.7R	0.79U	393U	2.7J-	25.3J-	159J-
WS-044	12-18 inches	Total Metals	mg/kg	16000J-	4.6R	21.7J-	169J-	0.72J-	1.1J-	26600J-	18.1J-	5.4J-	44.5J-	16100J-	511J-	8110J-	455J-	13.8J-	5150J-	2.7R	0.76U	381U	2.6J-	24.3J-	134J-
WS-045	12-18 inches	Total Metals	mg/kg	8150J-	4.5R	8.2J-	99.4J-	0.37U	0.35J-	53100J-	13.3J-	3.3J-	9.9J-	8600J-	43.2J-	5680J-	217J-	9.5J-	2680J-	2.6R	0.74R	372U	1.6J-	15.6J-	51.7J-
WS-046	12-18 inches	Total Metals	mg/kg	18700J-	4.7R	19.6J-	203J-	0.82J-	0.57J-	36500J-	19.2J-	5.7J-	24.4J-	17400J-	110J-	9290J-	442J-	14.9J-	5490J-	2.7U	0.78U	391U	3.6J-	28.4J-	103J-
WS-047	12-18 inches	Total Metals	mg/kg	19400J-	4.8R	16.5J-	210J-	0.92J-	0.56J-	11000J-	21.8J-	6.4J-	23.5J-	17800J-	118J-	8270J-	586J-	16.8J-	5330J-	2.8U	0.16J-	403U	2.4J-	28.3J-	103J-

Table 5.0-3 Continued

Location	Depth	Analysis	Result_Units	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
WS-048	12-18 inches	Total Metals	mg/kg	19200J-	5.3R	31J-	202J-	0.81J-	0.71J-	61300J-	19.2J-	5.4J-	31.4J-	16700J-	219J-	9260J-	391J-	14.1J-	4960J-	3.1R	0.33J-	443U	4.3J-	31.4J-	117J-
WS-049	12-18 inches	Total Metals	mg/kg	19400J-	5.9R	35.3J-	151J-	0.88J-	1.2J-	19900J-	24.2J-	6.9J-	24.9J-	24300J-	299J-	8370J-	575J-	18.1J-	6170J-	3.4U	0.56J-	492U	3.3J-	31.9J-	210J-
WS-050	12-18 inches	Total Metals	mg/kg	11900J-	4.8UJ	153J-	111J-	0.56J-	1.2J-	11600J-	17.3J-	4.5J-	31.3J-	14200J-	1110J-	5130J-	336J-	12.9J-	3410J-	2.8U	1.6J-	398U	2J-	21.9J-	223J-
WS-051	12-18 inches	Total Metals	mg/kg	16200J-	5.2R	15.4J-	169J-	0.75J-	0.38J-	6300J-	18J-	5.4J-	18.7J-	16000J-	60.5J-	6580J-	479J-	13.7J-	4500J-	3.1U	0.11J-	437U	2.4J-	24.8J-	89.7J-
WS-053	12-18 inches	Total Metals	mg/kg	9070J-	4.8R	19.3J-	85.3J-	0.42J-	5.6J-	75700J-	12.9J-	3.1J-	163J-	9450J-	483J-	6860J-	189J-	10J-	2660J-	2.8R	1.3J-	402U	1.6J-	16.1J-	243J-
WS-054	12-18 inches	Total Metals	mg/kg	17300J-	4.3UJ	107J-	161J-	0.74J-	49.2J-	23400J-	20.1J-	4.8J-	545J-	19200J-	9840J-	7670J-	485J-	16.4J-	4820J-	5.2J-	12.7J-	354U	3.1J-	26J-	981J-
WS-055	12-18 inches	Total Metals	mg/kg	21900J-	4.8R	10.7J-	229J-	0.96J-	1.5J-	33600J-	22.9J-	6.4J-	35.5J-	20000J-	143J-	10600J-	537J-	17.6J-	6900J-	2.8U	0.46J-	399U	3.9J-	31.0J-	106J-
WS-056	12-18 inches	Total Metals	mg/kg	15100J-	32.4J-	914J-	140J-	0.71J-	392J-	34900J-	20.4J-	5.4J-	1420J-	26900J-	37800J-	6400J-	653J-	26.6J-	4070J-	10.8J-	59.7J-	530U	12.7J-	31.8J-	5370J-
WS-056 Dup	12-18 inches	Total Metals	mg/kg	13400J-	40.8J-	750J-	131J-	0.70J-	392J-	56700J-	20.8J-	5.8J-	1780J-	28500J-	38600J-	6190J-	762J-	28.5J-	3800J-	12.2J-	59.9J-	255J-	10.2J-	33.6J-	6570J-
WS-057	12-18 inches	Total Metals	mg/kg	19600J-	5.9R	36.9J-	162J-	0.89J-	5.9J-	66000J-	22.3J-	6.1J-	70.1J-	18300J-	782J-	8850J-	323J-	17.9J-	5200J-	3.5R	1.1J-	494U	2.5J-	30.0J-	181J-
WS-058	12-18 inches	Total Metals	mg/kg	18500J-	5.3R	14.2J-	182J-	0.79J-	1.4J-	37500J-	19.9J-	5.4J-	28.8J-	16300J-	144J-	9050J-	392J-	14.5J-	5350J-	3.1R	0.22J-	444U	2.9J-	26.9J-	94.4J-
WS-059	12-18 inches	Total Metals	mg/kg	18100J-	5.5R	44.6J-	192J-	0.76J-	1.0J-	33400J-	19.5J-	5.2J-	26.0J-	16200J-	269J-	9980J-	399J-	13.7J-	5130J-	3.2R	0.36J-	462U	3.7J-	26.9J-	108J-
WS-060	12-18 inches	Total Metals	mg/kg	22400J-	6.2UJ	44.2J-	237J-	0.96J-	1.5J-	17100J-	23.0J-	6.2J-	41.5J-	22300J-	4910J-	10900J-	640J-	16.3J-	6450J-	3.6U	1.6J-	519U	4.5J-	31.7J-	164J-
WS-061	12-18 inches	Total Metals	mg/kg	18400J-	4.5R	13.2J-	178J-	0.79J-	0.64J-	28600J-	18.9J-	5.3J-	26.0J-	16100J-	70.9J-	9200J-	356J-	14.4J-	5270J-	2.7R	0.093J-	379U	3.6J-	25.5J-	90.5J-
WS-062	12-18 inches	Total Metals	mg/kg	17100J-	4.9R	14.1J-	173J-	0.61J-	1.2J-	11900J-	18.1J-	5.3J-	24.5J-	16000J-	93.0J-	7670J-	429J-	13.4J-	4750J-	2.8U	0.34J-	405U	3.4J-	24.4J-	95.7J-
WS-063	12-18 inches	Total Metals	mg/kg	18600J-	5.0R	15.3J-	185J-	0.66J-	1.1J-	19900J-	20.1J-	5.8J-	25.8J-	18200J-	107J-	9040J-	474J-	15.1J-	5600J-	2.9U	0.33J-	420U	3.9J-	27.6J-	108J-
WS-064	12-18 inches	Total Metals	mg/kg	23400J-	5.1R	19.1J-	185J-	0.90J-	1.2J-	8900J-	26.8J-	7.6J-	23.0J-	23000J-	105J-	9730J-	629J-	20.5J-	7150J-	3.0U	0.48J-	427U	3.6J-	32.6J-	179J-
WS-065	12-18 inches	Total Metals	mg/kg	26300J-	5.0R	33.7J-	175J-	0.94J-	1.5J-	9310J-	29.3J-	8.0J-	28.8J-	24300J-	237J-	10200J-	673J-	22.4J-	8420J-	2.9U	0.82J-	418U	4.7J-	34.9J-	212J-
WS-066	12-18 inches	Total Metals	mg/kg	13500J-	5.8UJ	41.5J-	134J-	0.46J-	0.91J-	5010J-	15.7J-	4.9J-	21.3J-	13900J-	341J-	5460J-	371J-	11.7J-	3790J-	3.4U	0.73J-	484U	2.9J-	21.2J-	134J-
WS-071	12-18 inches	Total Metals	mg/kg	16800J-	5.4UJ	7.9J-	145J-	0.73J-	0.61J-	146000J-	19.4J-	5.3J-	10.4J-	15700J-	26.2J-	12800J-	141J-	16.2J-	4980J-	3.1R	0.12J-	447U	2.4J-	25.5J-	46.3J-
WS-072	12-18 inches	Total Metals	mg/kg	14600J-	4.5UJ	13.4J-	118J-	0.60J-	6.3J-	80800J-	17.3J-	4.8J-	72.9J-	14200J-	558J-	9480J-	204J-	14.6J-	4450J-	2.6R	1.1J-	378U	2.2J-	23.8J-	117J-
WS-073	12-18 inches	Total Metals	mg/kg	13400J-	5.4R	10.1J-	132J-	0.45U	3.0J-	65200J-	18.5J-	4.0J-	24.8J-	12000J-	237J-	6880J-	288J-	11.2J-	3930J-	3.1R	0.90U	449U	2.8J-	21.0J-	83.3J-
WS-074	12-18 inches	Total Metals	mg/kg	18700J-	5.4R	13.6J-	211J-	0.57J-	1.9J-	19100J-	19.5J-	5.5J-	31.6J-	17000J-	274J-	10100J-	473J-	14.4J-	5370J-	3.1U	0.90U	449U	3.7J-	26.9J-	97.7J-
WS-075	12-18 inches	Total Metals	mg/kg	15800J-	4.2UJ	22.7J-	167J-	0.52J-	14.0J-	8200J-	17.1J-	4.7J-	66.3J-	16300J-	1200J-	7130J-	459J-	12.5J-	4340J-	2.6J-	1.9J-	353U	3.0J-	23.0J-	198J-
WS-076	12-18 inches	Total Metals	mg/kg	19000J-	5.6R	8.2J-	209J-	0.70J-	0.46UJ	7920J-	20.5J-	6.0J-	20.0J-	18000J-	33.7J-	8150J-	598J-	15.8J-	5610J-	3.2U	0.93U	464U	3.5J-	26.9J-	94.6J-
WS-077	12-18 inches	Total Metals	mg/kg	12200J-	56.8J-	1570J-	164J-	0.48J-	15.1J-	20100J-	21.8J-	4.6J-	595J-	55200J-	20600J-	5270J-	1270J-	12.5J-	3800J-	10.9J-	28.6J-	428U	10.7J-	28.4J-	3620J-
WS-078	12-18 inches	Total Metals	mg/kg	16400J-	5.1UJ	41.4J-	178J-	0.61J-	1.3J-	11000J-	19.0J-	5.3J-	27.3J-	16000J-	360J-	7420J-	560J-	15.0J-	4980J-	2.9U	0.84U	421U	3.1J-	24.2J-	153J-
WS-079	12-18 inches	Total Metals	mg/kg	13100J-	6.0UJ	8.8J-	103J-	0.70J-	0.033J-	24100J-	16.3J-	4.7J-	15.0J-	13600J-	40.0J-	6760J-	270J-	13.7J-	3720J-	3.5R	0.16J-	503U	2.1J-	21.1J-	61.3J-
WS-080	12-18 inches	Total Metals	mg/kg	19300J-	4.6R	31.4J-	201J-	0.99J-	1.0J-	7350J-	20.8J-	5.8J-	27.6J-	18300J-	271J-	8000J-	544J-	14.8J-	5660J-	1.5J-	0.53J-	384U	3.9J-	27.5J-	146J-
WS-081	12-18 inches	Total Metals	mg/kg	18700J-	5.8R	9.6J-	197J-	0.93J-	0.10J-	9010J-	20.9J-	5.8J-	17.1J-	17000J-	30.3J-	8370J-	498J-	15.1J-	5540J-	1.4J-	0.18J-	481U	3.5J-	27.2J-	110J-
WS-082	12-18 inches	Total Metals	mg/kg	10700J-	4.9UJ	8.8J-	111J-	0.52J-	0.20J-	8400J-	14.5J-	4.0J-	11.4J-	10600J-	47.3J-	4780J-	325J-	10.3J-	3350J-	2.8R	0.19J-	407U	2.4J-	18.7J-	68.4J-
WS-083	12-18 inches	Total Metals	mg/kg	12900J-	4.6UJ	27.0J-	129J-	0.62J-	0.33J-	7960J-	15.8J-	4.9J-	18.2J-	12600J-	217J-	5470J-	311J-	11.9J-	3670J-	0.94J-	0.58J-	386U	2.5J-	20.4J-	111J-
WS-089	12-18 inches	Total Metals	mg/kg	20900J-	4.9R	8.1J-	217J-	0.97J-	0.57J-	11600J-	22.1J-	6.6J-	21.7J-	18900J-	67.9J-	9000J-	605J-	17.1J-	5930J-	1.4J-	0.32J-	412U	3.7J-	29.4J-	93.3J-
WS-090	12-18 inches	Total Metals	mg/kg	22200J-	5.4R	13.7J-	219J-	1.1J-	10.7J-	8040J-	24.1J-	7.5J-	50.8J-	20700J-	730J-	8920J-	655J-	20.3J-	6110J-	2.6J-	1.2J-	453U	3.6J-	30.2J-	184J-
WS-091	12-18 inches	Total Metals	mg/kg	13400J-	4.4UJ	11.5J-	131J-	0.68J-	2.5J-	64100J-	15.2J-	4.3J-	21.8J-	12500J-	144J-	6150J-	314J-	13.9J-	3490J-	2.5R	0.19J-	364U	2.8J-	21.2J-	76.2J-
WS-092	12-18 inches	Total Metals	mg/kg	13700J-	5R	9.8J-	141J-	0.68J-	3.2J-	20900J-	16.4J-	4.5J-	26J-	13000J-	182J-	6050J-	347J-	12.7J-	4020J-	2.9R	0.32J-	413U	3.5J-	21.5J-	97J-
WS-093	12-18 inches	Total Metals	mg/kg	16600J-	4.6UJ	35.5J-	164J-	0.81J-	29.1J-	12500J-	18.3J-	4.8J-	149J-	16000J-	2340J-	6640J-	458J-	13.6J-	4850J-	2.1J-	3.1J-	384U	3.8J-	24.8J-	324J-
WS-094	12-18 inches	Total Metals	mg/kg	21100J-	6.4R	13.6J-	199J-	1J-	3.5J-	14100J-	23.4J-	6.3J-	31.1J-	19600J-	213J-	9060J-	537J-	17.6J-	5960J-	1.1J-	0.27J-	534U	4.5J-	30.5J-	114J-
WS-095	12-18 inches	Total Metals	mg/kg	20500J-	4.8R	25.1J-	200J-	1J-	8J-	15100J-	22.2J-	6J-	45J-	19000J-	589J-	9330J-	613J-	17.5J-	6000J-	0.7J-	0.81J-	396U	4.4J-	29.2J-	173J-
WS-096	12-18 inches	Total Metals	mg/kg	16600J-	4.8R	14.2J-	172J-	0.78J-	1.8J-	33300J-	18.7J-	4.9J-	24.4J-	15100J-	116J-	7610J-	403J-	13.7J-	4800J-	2.8R	0.18J-	396U	3.8J-	26.3J-	88.8J-
WS-097	12-18 inches	Total Metals	mg/kg	21400J-	5.1R	12.8J-	223J-	1J-	1J-	10300J-	22.3J-	6.3J-	23.2J-	19900J-	62.4J-	9320J-	600J-	16.5J-	6200J-	0.79J-	0.15J-	424U	5J-	29.7J-	107J-
WS-097 Dup	12-18 inches	Total Metals	mg/kg	18700J-	5.4R	9.7J-	191J-	0.95J-	0.24J-	12600J-	23.1J-	5.7J-	19.8J-	17100J-	35.9J-	9120J-	486J-	15.0J-	5600J-	3.1R	0.90U	234J-	3.0J-	27.2J-	95.2J-
WS-098	12-18 inches	Total Metals	mg/kg	19000J-	6.5R	11.1J-	191J-	0.9J-	0.52J-	6530J-	21J-	5.7J-	17.7J-	17500J-	24J-	8110J-	502J-	14.9J-	5680J-	3.8R	0.087J-	538U	4.2J-	27.9J-	89.6J-
WS-107	12-18 inches	Total Metals	mg/kg	19100J-	6.4R	10.4J-	194J-	0.92J-	1.9J-	9690J-	20.2J-	5.8J-	26.9J-	17500J-	118J-	8690J-	565J-	16J-	5550J-	3.8R	0.22J-	537U	3.6J-	26.7J-	98.9J-
WS-108	12-18 inches	Total Metals	mg/kg	24800J-	6.3R	8.8J-	242J-	1.2J-	0.57J-	9630J-	25.9J-	7J-	22J-	21500J-	28.3J-	10300J-	663J-	20J-	6620J-	1.3J-	0.11J-	528U	5.5J-	34.1J-	98.9J-
WS-109	12-18 inches	Total Metals	mg/kg	20000J-	4.9UJ	23.6J-	206J-	0.96J-	16.7J-	7540J-	21.4J-	6J-	66.6J-	18800J-	1060J-	7930J-	646J-	17.1J-	5490J-	0.89J-	1.4J-	409U	4.3J-	28.6J-	222J-
WS-110	12-18 inches	Total Metals	mg/kg	19200J-	5R	11.6J-	196J-	0.93J-	3J-	6990J-	22.2J-	6J-	26.7J-	18300J-	184J-	7910J-	529J-	17.7J-	5280J-	0.6J-	0.34J-	418U	4.2J-	28.5J-	102J-
WS-111	12-18 inches	Total Metals	mg/kg	18400J-	4.8UJ	29.9J-	200J-	0.9J-	8.9J-	28900J-	20.9J-	6.2J-	57.1J-	18300J-	772J-	6890J-	659J-	20.3J-	4850J-	1.1J-	0.94J-	398U	5.6J-	30.8J-	170J-
WS-112	12-18 inches	Total Metals	mg/kg	20400J-	5.9UJ	15.5J-	205J-	0.96J-	7.2J-	6900J-	22.1J-	6.8J-	41.9J-	22000J-	492J-	8380J-	582J-	18.3J-	5740J-	2.2J-	0.99U	494U	2.9J-	29.8J-	148J-
WS-113	12-18 inches	Total Metals	mg/kg	19200J-	4.9UJ	11.7J-	186J-	0.88J-	2.5J-	13500J-	21.8J-	6.4J-	26.4J-	19400J-	154J-	7770J-	498J-	17.3J-	5300J-	2.9R	0.82U	412U	3.3J-	29.1J-	105J-
WS-114	12-18 inches	Total Metals	mg/kg	15100J-	6.4UJ	10.1J-	152J-	0.71J-	1.5J-	16300J-	16.9J-	5.1J-	19.1J-	18800J-	122J-	6480J-	436J-	14.9J-	4280J-	0.76J-	1.1U	530U	2.5J-	22.9J-	84.7J-
WS-115	12-18 inches	Total Metals	mg/kg	20600J-	4.6UJ	9.3J-	226J-	0.92J-	0.50J-	28100J-	22.0J-	6.3J-	20.6J-	18300J-	41.2J-	9460J-	654J-	19.6J-	5590J-	2.7R	0.76U	381U	3.5J-	30.5J-	88.5J-

Figures

Jacob Smelter
Figure 2.2 - 1
2011 Sampling Event
TechLaw
Sample Location
Date: June 28, 2011
Map Projection: UTM, Meters, Zone 12, NAD83
Data Sources:
Sample Locations - U.S. EPA Region 8 (2011)
Aerial - NAIP (2009)
0
250
500 Feet
N
Utah
Area of Interest
W Silver Ave
W Clark St
Railroad Ln
Plaza
Railroad St
Dont Walk St
36
WS-107 WS-108 WS-109 WS-110 WS-111 WS-112 WS-113 WS-114 WS-115 WS-116 WS-117 WS-118 WS-119 WS-120 WS-121 WS-122
WS-089 WS-090 WS-091 WS-092 WS-093 WS-094 WS-095 WS-096 WS-097 WS-098 WS-099 WS-100 WS-101 WS-102 WS-103 WS-104 WS-105 WS-106
WS-071 WS-072 WS-073 WS-074 WS-075 WS-076 WS-077 WS-078 WS-079 WS-080 WS-081 WS-082 WS-083 WS-084 WS-085 WS-086 WS-087 WS-088
WS-053 WS-054 WS-055 WS-056 WS-057 WS-058 WS-059 WS-060 WS-061 WS-062 WS-063 WS-064 WS-065 WS-066 WS-067 WS-068 WS-069 WS-070
WS-035 WS-036 WS-037 WS-038 WS-039 WS-040 WS-041 WS-042 WS-043 WS-044 WS-045 WS-046 WS-047 WS-048 WS-049 WS-050 WS-051 WS-052
WS-018 WS-019 WS-020 WS-021 WS-022 WS-023 WS-024 WS-025 WS-026 WS-027 WS-028 WS-029 WS-030 WS-031 WS-032 WS-033 WS-034
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Appendices

CONTENTS

PAGE	REFERENCE	DATE

Location: Date:

Project/Client:

08/16/11 Sunny, light breeze 90's
WS-001 9:40, SS, CL
0-6; 6-12; 12-18 samples taken
photo taken

08/16/11
WS-002 1005 SS CL
0-6; 6-12; 12-18 samples tak
photo taken

08/16/11
WS-003 1022 SS, CL
0-6; 6-12; 12-18 samples taken
photo taken

08/16/11
WS-~~003~~ 004 1045 SS, CL
0-6; 6-12 12-18 samples taken
photo take

08/16/11
WS-005 1125 SS, CL
0-6, 6-12 12-18 samples taken
photo take

Location Date

Project / Client

WS006

08/16/11 0-6; 6-12; 12-18
11:45 SS, CL taken
photos taken

08/16/11 0-6; 6-12; 12-18
WS-007 taken 1205
CL, SS photos taken

08/16/11 WS-008 1220
0-6; 6-12, 12-18
CL, SS photos taken

08/16/11 WS-009 1235
0-6, 6-12; 12-18
CL, SS photos take

08/16/11 WS-010 1255
0-6; 6-12, 12-18
CL, SS photos take

08/16/11 WS-011 1310
0-6, 6-12, 12-18
CL, SS photos take

08/16/11 WS-012 1410
0-6; 6-12; 12-18, taken
photo taken

08/16/11 WS-013 1430
0-6, 6-12, 12-18;
area very ~~rock~~ rocky; resampled
4 feet north of GPS'ed point
Photo taken

8/16/11 WS-014 1500
0-6, 6-12, 12-18,
area very rocky, 0-6, 12-18
taken c̄ auger 6-12 taken with
hand trowel photo taken

08/16/11 WS-015 1520
0-6, 6-12, 12-18 SS, CL
area very rocky, 0-6, 12-18
taken c̄ auger, 6-12 taken c̄
hand trowel, photo taken

08/16/11
WS-016 1535
0-6, 6-12, 12-18 SS CL
photo taken

2-2

Location Date

Project Client

08/16/11 1600 WS-017
0-6", 6-12", 12-18" ~~ES~~ SS, CL
photos taken

08/16/11 1705 WS-035
DUPLICATE (DUP 2)
0-6" 6-12" 12-18 taken
photo taken SS, CL

08/16/11 1740 WS-038
0-6", 6-12", 12-18" taken
photo taken SS, CL

08/17/11 12:55 WS-~~045~~ 034~~8~~
12-18" taken ; photo taken
SS, JW
power auger for this sample
depth only

08/17/11 1305 WS-033 SS/JW
12-18" taken - power auger
photo taken

Location Date

Project Client

8/17/11 WS-048
power auger 1137
0-6; 6-12, 12-18

08/17/11 WS-066 JW/SS
power auger 13:25
0-6 6-12 - 12-18
photo taken

08/17/11 WS-065 JW/SS
hand auger 1340
0-6 6-12 ; 12-18
photo taken

08/17/11 WS-063
power auger 1405
0-6; 6-12, 12-18
photo taken

8/17/11 WS-062
power auger 1420
0-6; 6-12; 12-18
photo taken

WS-060 SP

08/17/11 1135 Power Auger
0-6, 6-12, 12-18
Freakin' hot! JW/SS
Picture taken

CSR

08/17/11 1400 Power Auger
WS-~~060~~ 059 14:50
0-6, 6-12, 12-18
photo taken

08/17/11 WS-058 1515
power auger 0-6, 6-12, 12-18
Photo taken SS/JW
12-18 - ants (few present

08/17/11 WS-057 1525
power auger 0-6, 6-12, 12-18
photo taken JW/SS

WS71 8/17/11 1620 Power Auger
0-6", 6-12", 12-18" RB

Cobbly subsurface up to 8" in size. Scraped side for sample. Picture taken here. Sample → DW
Hot & Dry!

WS72 8/17/11 1645
0-6" 6-12" 12-18"

Cobbly substrate. Picture taken. Power Auger.

WS73 8/17/11 1700
0-6" 6-12" 12-18"

Power Auger. Fine silt w/ 2" rock. Next to road. Hot & Dry. No shade

Location _____ Date _____

Project / Client _____

WS-74 1720 8/17/11

Cobbly hard "soil"
Power auger
RB Sampler

WS-76 1735 8/17/11

Cobbly hard "soil"
Power Auger
RB sampler

WS-79 1750 8/17/11

Cobbly hard "soil"
Power Auger
RB Sampler

Location _____ Date _____

Project / Client _____

WS-081 1800 8/17/11

RB sampler
Power Auger
Cobbly Hard Soil

WS-083 1800 8/17/11

RB Sampler
Power Auger
Cobbly hard soil

WS-45 RB Sampler

Power Auger 1125
Loamy soil

WS-30 1135

Shovel RB Sampler
Loamy

WS-65 8/18/11
1145
RB sampler
Loam and cobble

WS-107 1205 8/18/11
RB sampler
Loamy

WS-108 1215 8/18/11
RB-Sampler
Cobble loam

Location Jacobs Smelter Date 8/16/11

Project / Client

John Weber, Dan Wall

WS-18

0-6	0940
6-12	0943
12-18	0947

WS-18 dup → Dup 01

0-6	0955
6-12	1000
12-18	1005

Very fine soil

WS-19

0-6	1025
6-12	1033
12-18	1036

WS-20

0-6	1048
6-12	1055
12-18	1100

Jacobs 8/16/11

WS-21
0-6 1115
6-12 1120
12-18 1125

WS-022
0-6 1140
6-12 1142
12-18 1146

WS-023
0-6 1200
6-12 1203
12-18 1206

WS-024
0-6 1215
6-12 1221
12-18 1226

WS-025
0-6 1235
6-12 1240
12-18 1245

WS-026
0-6 1250
6-12 1255
12-18 1300

WS-027
0-6 1305
6-12 1310
12-18 1315

WS-028
0-6 1318
6-12 1322
12-18 1326

WS-029
0-6 1410
6-12 1413
12-18 1417

Location: Date:

Project / Client:

8/10/11

WS-030

0-6 1425
6-12 1428
12-18 ~~1431~~ → Refusal - new hole

WS-31

0-6 ~~1425~~ DW ~~1500~~ 1500
6-12 ~~1428~~ 1506
12-18 ~~1431~~ 1523

WS-32 ~~1535~~ LPL

0-6 1535
6-12 1540
12-18 1543

WS-033

0-6 1400
6-12 1404
12-18 ~~1410~~ DW Rocks refusal

Location: Date:

Project / Client:

WS-034

0-6 1618
6-12 1622
refusal 12-18 ~~1626~~ rock

WS-036

0-6 1700
6-12 1705
12-18 1710

WS-037

0-6 1725
6-12
12-18

Jacobs 8/17/11

WS-039 - Power Auger

0-6 8:18 JW/SS
6-12 8:18
12-18 8:18

WS-039 (Dup-03) - Power Auger

0-6 8:45 JW/SS
6-12 8:45
12-18 8:45

WS-040 - Power Auger JW/SS
0905, 0-6; 6-12; 12-18;
photo taken

WS-041 - Power Auger JW/SS
0925 0-6; 6-12; 12-18;
photo taken

WS-042 - Power Auger JW/SS
0950 - 0-6; 6-12; 12-18
photo taken

WS-043 Power Auger
JW/SS
10:10 0-6; 6-12; 12-18"
photos taken

WS-044 Power Auger
10:30 0-6; 6-12; 12-18"
photos taken

WS-046 Power Auger
11:05 0-6; 6-12; 12-18
Photo taken

WS-047 1100
0-6; 6-12; 12-18
power auger
photo taken

WS-49
0-6 1141
6-12 1145
12-18 1150
hand auger

Location _____ Date _____

Project / Client _____

8/17/11 WS-056 1600
0-6; 6-12; 12-18
panel gauger

8/17/11 WS-056 Dup4
0-6; 6-12; 12-18
power auger 1600

dup from opposite side of hole
photo (one) taken

08/17/11 WS-055 JW/SS
power auger
0-6; 6-12; 12-18
photo taken

08/17/11 WS-054 JW/SS
power auger
0-6; 6-12; 12-18
photo taken

Location _____ Date _____

Project / Client _____

08/17/11 WS-053
JW/SS power auger
0-6; 6-12; 12-18
photo taken
0-6 - 99% gravel; recovered as much soil as possible

08/17/11 WS-075
17:20 SS/JW Power auger
0-6, 6-12, 12-18
photo taken

08/17/11 WS 077
1735 SS/JW Power auger
0-6; 6-12; 12-18
photo taken

08/17/11 WS-078 SS/JW
17:40 0-6; 6-12; 12-18
power auger; photo take

08/17/11 WS-080 SS/JW
1750 0-6; 6-12; 12-18
power auger, photo take

08/17/11 WS-082 SS/JW
1805 0-6; 6-12; 12-18
power auger photo take

slight breeze, clear, high cloud 70's

08/18/11 WS-089 SS/JW
0815 0-6; 6-12; 12-18
power auger photo take

08/18/11 WS-090 SS/JW
0830 0-6 6-12 12-18
power auger; photo take

08/18/11 WS-091 power auger
0845 0-6, 6-12, 12-18 take
photo take, JW/SS

08/18/11 WS-092 power auger
0855 0-6; 6-12; 12-18 take
photo take, JW/SS

08/18/11 WS-093 power auger
0910 0-6; 6-12; 12-18 taken
photo taken JW/SS

08/18/11 WS-094 power auger
0920 0-6; 6-12; 12-18 take
photo take JW/SS

08/18/11 WS-095 power auger
0935 0-6 6-12 12-18 take
photo take JW/SS

08/18/11 WS-096 power auger
0955 0-6; 6-12; 12-18
photo taken JW/S

08/18/11 WS-097 10:55 JW/SS
0-6, 6-12, 12-18 take power auger
photo taken (one c dup)

08/18/11 WS-DUP5 1055 JW/SS
0-6, 6-12, 12-18 take power auger
photo taken c WS-097

08/18/11 WS-098 1025 JW/SS
0-6, 6-12, 12-18 take power auger
photo taken

08/18/11 WS-1115 1040
JW/SS power auger
0-6, 6-12, 12-18 take
power auger JW/SS
photo take

08/18/11 WS-114 1050
JW/SS power auger
0-6, 6-12, 12-18 take
photo take

08/18/11. WS-113 11:10
JW/SS power auger
0-6, 6-12, 12-18 take
photo take

08/18/11 WS-112 11:25
JW/SS power auger
0-6, 6-12, 12-18 take
photo take

08/18/11. WS-111 11:45
JW/SS power auger
0-6, 6-12, 12-18 take
photo take

08/18/11 WS-110 1155
JW/SS power auger
0-6, 6-12, 12-18 take
photo take

08/18/11 1210 WS-109
JW/SS 0-6, 6-12, 12-18
photo taken power aux

Appendix B
Jacob Smelter Site Photos
August, 2011

Appendix B
Jacob Smelter Site Photos
August, 2011

Appendix B
Jacob Smelter Site Photos
August, 2011

APPENDIX E

UDEQ/EPA Site Related Memorandums

to AR 12113106

KL Bradford

Katherine Bradford
03/23/2004 08:17 AM

To: Joshua Knight/EPR/R8/USEPA/US@EPA
cc:
Subject: Jacob's Smelter and Bevill issues

Per our discussions with the State of Utah and their request for an EPA Bevill determination, please be advised that I consider this site to be Bevill exempt as to the heavy metal wastes/hazardous substances.

The great majority of the waste from these smelters is from primary lead smelting. For the twenty year period from 1870 to 1890 alone, 378 million pounds of lead were produced in this Jacob's Smelter area. This far exceeded any other metal produced.

The lead wastes involved at the Site were created during a process of beneficiation and smelting of the metal ores extracted in and around the Site. The lead ores in their natural form were intermingled with silver, gold, copper and zinc. The smelting (production) of lead at this Site far exceeded production of any other metal for the entire production life of the Site. The beneficiation and smelting processes which created these ores was a simultaneous process for all of the metals, each metal was not created separately. Thus the silver, gold, copper and zinc wastes, both slag from processing and tailings from beneficiation were incidental wastes created during the process/beneficiation of the lead ores.

"Primary lead processing" wastes appear on the Bevill exempt list. These lead smelter wastes are all considered to be Bevill exempt since the primary process of lead smelting generated the slag wastes and the beneficiation of the ore created the tailings. Pursuant to the regulations the resulting slag and tailings wastes are exempt. (See 40 CFR 261.4 (b)(7)(ii)(B)) and 40 CFR 261(b)(7)(i)).

Since these wastes are Bevill exempt, they are by definition not hazardous wastes and legally you may proceed to the extent permitted by the regulations without RCRA Subtitle C compliance in the remediation of this smelting site. However, some of the wastes at the site fail TCLP(Toxic Characteristic Leachate Procedure). Thus, many of the RCRA Subtitle C requirements are relevant and appropriate standards for the Site response action.

Katherine Letson Bradford
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Legal Enforcement Program
U.S. EPA, Region VIII
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State of Utah

GARY R. HERBERT
Governor

GREG BELL
Lieutenant Governor

Department of
Environmental Quality

Amanda Smith
Executive Director

DIVISION OF ENVIRONMENTAL
RESPONSE AND REMEDIATION

Brent H. Everett
Director

ERRC-125-10

MEMORANDUM

TO: Lisa Lloyd, Project Manager
U.S. EPA Region 8

Administrative Record File for
Jacobs Smelter Superfund Site Operable Unit Two

FROM: Thomas D. Daniels, Project Manager
Utah Department of Environmental Quality TDD

DATE: June 17, 2010

SUBJECT: Risk management proposal regarding clean up levels based on human health risk for Operable Unit Two of the Jacobs Smelter Superfund Site.

The Jacobs Smelter Site is located in and around the Town of Stockton, Utah. Approximately 25 miles southwest of Salt Lake City, Utah and five miles south of Tooele, Utah. Lead and arsenic contamination from historic smelter operations has been identified in site soils. Operable Unit Two (OU2) includes underdeveloped and undeveloped land outside of the general town limits, the Rawhide Ranchettes and B&B Subdivisions, the area between the two subdivisions that contains elevated lead and arsenic concentrations related to the Waterman Smelter and a small area east of the Town of Stockton, as well as the areas surrounding the Chicago and Carson/Buzzo smelters south of Stockton.

The Preliminary Remediation Goals (PRGs) that were developed in 2001 evaluated risks associated with occasional recreational All Terrain Vehicle (ATV) use of the area around Stockton. Recently Project Managers noticed physical evidence that there had been an increase in ATV use near the Waterman Smelter area. On April 8, 2010, representatives of the Environmental Protection Agency (EPA) and the Utah Department of Environmental Quality (UDEQ) asked residents of the Rawhide Ranchettes and B&B Subdivisions about recreational ATV use by town residents throughout the year.

Based on the observed increased ATV use of the Waterman Smelter area as well as the information regarding frequency and duration of use from residents, it is clear that the exposure frequency parameters utilized in the calculation of the 2001 PRGs required adjustment to appropriately reflect observed use patterns and frequencies.

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The Utah Department of Environmental Quality, Division of Environmental Response and Remediation (DERR) recalculated the exposure parameters and documented the results in a May 26, 2010 memorandum (attached). The "safe" range calculated using these adjustments is 2,408 mg/kg – 3,792 mg/kg lead in surface soils.

The clean up level proposed for recreational use at OU2 of the Jacobs Smelter Superfund Site is 3,000 mg/kg lead.

This clean up level is within the range specified in the May 26, 2010 memorandum and is protective of human health.

The 3,000 mg/kg clean up level would be applied to the area located between the Rawhide Ranchettes and B&B Subdivisions.

The lead clean up levels for residential properties utilized in OU1 (500 mg/kg in surface soils and 800 mg/kg subsurface soils) proposed in the 2004 Proposed Plan have not been changed and are still protective of human health. The residential clean up level would be applied to the lots within the Rawhide Ranchettes and B&B Subdivisions.

Both the recreational and residential use clean up levels will be proposed to the public in a revised Proposed Plan.

Since arsenic contamination is co-located with the lead contamination and will be addressed by clean up of the lead contaminated soils, an arsenic clean up level is not necessary and is not being proposed.

State of Utah
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Department of
Environmental Quality

Amanda Smith
Executive Director

DIVISION OF ENVIRONMENTAL
RESPONSE AND REMEDIATION

Brent H. Everett
Director

ERRA-32-10

MEMORANDUM

TO: Thomas Daniels, Project Manager
Utah Department of Environmental Quality

Lisa Lloyd, Project Manager
U.S. Environmental Protection Agency, Region VIII

THROUGH: Susan Griffin, Regional Toxicologist
U.S. Environmental Protection Agency, Region VIII

FROM: Scott Everett, Toxicologist
Utah Department of Environmental Quality SDE

DATE: May 26, 2010

SUBJECT: Revised Preliminary Remediation Goals for Recreation Use in Waterman Smelter Area

On April 8, 2010, representatives of the Environmental Protection Agency (EPA) and the Utah Department of Environmental Quality (UDEQ) held a meeting at the Stockton Town Council meeting room in the township of Stockton, Utah. At this meeting, the EPA and the UDEQ Project Managers presented residents with results from a recent sampling effort. Representatives from the UDEQ and the EPA questioned those in attendance about recreational All Terrain Vehicle (ATV) use during the year. Most responded that there was ATV use by residents throughout the year, even during the colder, wetter months. Residents indicated that they enjoyed the times riding through the area when there was standing water and mud.

The recreational Preliminary Remediation Goals (PRGs) that were developed in 2001, ["Preliminary Remediation Goals for Recreational Land Use at Jacobs Smelter Site (OU2), 22 May 2001] was with an estimate of ". . . teens ride approximately 3 days a week in June, July, and August, and approximately 1 day per week in April, May, September, and October for a total of 56 days a year." This estimate of an exposure frequency was acceptable at the time.

Recently, Project Managers noticed physical evidence that there had been an increase of ATV use at the site, due to formation of an off-road figure 8 track. With this evidence and the anecdotal information from the residents, it is clear the exposure frequency parameter of the lead risk model should be adjusted. This adjustment includes the assumption that residents spend an additional 1 day a week in the months of January, February, March, November, and December, which equals a total of 76 days a year. Using the same methodology as found in the 2001 memorandum, the range of PRGs for recreational exposure to lead in the soil are 3,792 - 2,408 mg/kg.

Table 1: Summary of Parameter Values

Parameter	Value	Comment
Goal for the 95th percentile blood lead concentration in fetuses – $PbB_{fetal,\ 0.95\ goal}$	10 ug/dl	Default assumption
Geometric standard Deviation – $GSD_{i,\ audit}$	1.53 1.69	Site-specific GSD_i derived from the Bingham Creek and Sandy City, Utah blood lead studies (U.S. EPA, 1996c)
Ratio of fetal to maternal blood lead levels – $R_{fetal/maternal}$	0.9	Default assumption
Baseline Blood Lead Concentration – $PbB_{adult,\ 0}$	1.3 2.28	Site-specific geometric mean blood lead levels from the Bingham Creek and Sandy City, Utah blood lead studies
Biokinetic Slope Factor – BKSF	0.4 ug/dl per ug/day	Default assumption
Soil Ingestion rate – IR_s	0.1 grams/day	Recreational dirt bike scenario – Anaconda, MT risk assessment (U.S. EPA, 1996b)
Exposure Frequency – EF	76 days/year	Site-specific observation (2010)
Absorption Fraction – AF	0.12	Default assumption

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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May 14, 2013

MEMORANDUM

SUBJECT: Reevaluation of Exposure Estimates and Clean-up Goals for Waterman Smelter Soils at the Jacobs Smelter Site.

FROM: Dan Wall
Toxicologist
USEPA Region 8

TO: Lisa, Lloyd
Remedial Project Manager
USEPA Region 8

This memo describes the technical approach used to estimate exposures and illustrate remediation scenarios for the Waterman Smelter area of the Jacobs Smelter Superfund Site in Stockton, Utah. It was determined that because of new data and the more limited exposure area that the exposure estimates needed to be refined. Additionally, it was determined that the refined exposure model would be useful for evaluating potential remediation scenarios.

Background

In 2003, EPA completed an ecological risk assessment (Lockheed Martin, REAC, 2003) which encompassed the east and northeast portion of Rush Lake to the southwest edge of the town of Stockton. This included the Chicago, Carson-Buzzo and Waterman smelters and potentially contaminated areas between the smelters.

Clean-up goals were derived for sediments and soils from data collected for the ecological risk assessment but for the purposes of this memo, the re-assessment of exposures will focus solely on Waterman Smelter soils (Hoff, 2003). Risks were primarily driven by lead concentrations in soil and food items although, other metals were co-located with the lead. Concentrations of lead in ants collected from the Jacobs Smelter NPL site ranged from 2.1-143.5 ppm with an average bioaccumulation factor (BAF) of 0.055 and an upper 95th percentile of 0.122.

Using the 95th percentile BAF for lead, clean-up goals for terrestrial wildlife receptors were developed. Predicted risks were greatest to insectivorous birds (represented by the Northern Flicker) and therefore, protection of this species will protect all other species. The resulting conservative and representative clean up goals equated to 574 and 1148 ppm average concentration of lead over the home range of the Northern Flicker, respectively.

Estimating exposures for the Northern Flicker was detailed in the 2003 Dale Hoff memo and is excerpted below.

All species do not occupy single points through time, but rather forage across the site within a home-range. A moving window analysis (ArcGIS Desktop Help, Calculating Neighborhood Statistics, ESRI, 2002), utilizing ARC-View software, was employed to identify any potential areas across the site which had an average lead soil concentration above the lead clean-up goal. These concentrations were rounded down to 500 and 1000 ppm dw for ease in interpretation and model calculation. Prior to actually running the moving window model, extrapolation of point data was completed using ordinary kriging. Briefly, the moving window model then systematically moves a 55 hectare circle (home range size of the flicker) in 100 foot increments both laterally and longitudinally across the entire site. Every potential 55 hectare circle that had average soil concentrations ranging from 500 ppm to 1000 ppm (HQ = 1) were identified in Figure 4 as a pink color; while those areas with average concentrations greater than 1000 (HQ = 2) were identified in red.

Reevaluation of Exposure at Waterman Smelter

In an effort to refine soil concentrations in the vicinity of Waterman Smelter, the state of Utah has collected additional surficial soil data and EPA collected additional soil data in 2011. In light of the additional data and the smaller exposure unit, EPA was uncertain if the existing exposure estimate was still valid. To address this uncertainty and to establish a tool for evaluation of remediation scenarios, EPA reconstructed the exposure model in 2012.

In 2012 a moving window analysis was again employed using ArcGIS 10.0 software to identify any potential areas across the Waterman Smelter portion of the site which had an average lead soil concentration above the lead clean-up goal. The same general approach that was used in 2003 was used in 2012 with the following exceptions:

1) The analysis was conducted using data within the area of interest from different sampling events and soil horizons (horizon 1 = 0”, 0”-2”, 0”-6”, 2”-6”; horizon 2 = 2”-12’, 6”-12”; and horizon 3 = 12”-18”). Point data are presented in Figures 1-3.
2) Prior to running the moving window analysis extrapolation of point data was completed for each soil horizon group using the natural neighbor interpolation method instead of the kriging method. An output grid cell size of 50 feet was chosen instead of 100 feet. The resulting lead concentration surfaces and approximate volumes are presented in Figures 4-6.
3) A moving window analysis using neighborhood statistics was conducted for each soil horizon by moving a 55 hectare circle (home range size of the flicker) in 50 foot increments both laterally and longitudinally across the entire site. The results were categorized to illustrate areas where average concentrations of lead exceed 1148 ppm over the 55 hectare home range. Figures 7-9 illustrate theses results for each soil horizon.
4) Three remediation scenarios were run for each soil horizon. The scenarios assumed that all soils with concentrations of lead above 3,000, 5,000 and 10,000 ppm were removed and replaced with soils containing 3,000 ppm lead. This should result in a total of 9 maps of potential residual risk however only the 0-6 inch soil horizon under the 3,000, 5,000 and

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10,000 ppm lead removal scenarios resulted in residual risk. Those results are presented in Figures 10-12.

Results

Risks to avian insectivores as represented by the Northern Flicker are currently at unacceptable levels in the Waterman Smelter area at all sample depths. Evaluation of Figures 10-12 indicates that remediation of soils greater than 5000 ppm is sufficient to reduce risks to avian insectivores to acceptable levels in the 0-6 inch soil horizon. Because significant exposure can potentially occur via ingestion of soil invertebrates (ants), concentrations of lead at depths of at least 18 inches are of concern. However, the reassessment of exposures indicate that remediation of subsurface soils (6-18 inches below ground surface) to 5,000 ppm is overly conservative and remediation of soils to 10,000 ppm will be protective by reducing the average exposures to below the 1,148 ppm "representative" effect level. The 6-12" remediation scenario (10,000 ppm) is presented in Figure 13. The 12-18" remediation scenario had no residual risk and does not have an accompanying figure.

Uncertainty

Much effort was made to reduce uncertainties of this analysis however uncertainties do exist.

- Ant colonies may burrow significantly deeper than 18 inches however data were only available for the first 18 inches. There is a potential that this data gap may lead to an underestimation of risks.
- The original ecological risk assessment was conducted for the entire Jacobs Smelter NPL site which encompasses many habitats not seen in the Waterman Smelter area. The Northern Flicker was used to represent the avian insectivore feeding guild and was applied to Waterman Smelter. The habitat of the Waterman Smelter area is however, not ideal for a Northern Flicker. It is uncertain how much the risk estimates would be altered if a bird species more suited to the Waterman Smelter habitat were used to represent the avian insectivore feeding guild.
- The estimate of the geographic extent of clean-up relied on creating a surface from point data by extrapolating concentrations between points. Interpolation methods are more reliable where there are higher densities of equally spaced data. Areas or soil horizons that do not have high densities of data are more likely to have interpolation errors. This is most likely to be seen in the subsurface data sets.

Hoff, Dale. "Development of Ecological Clean-up Goals for the Jacobs Smelter Site in Stockton UT". USEPA, Region 8. April 25, 2003.

Lockheed Martin REAC. 2003. Ecological Risk Assessment: Jacobs Smelter Site Stockton, Utah. Prepared for USEPA.

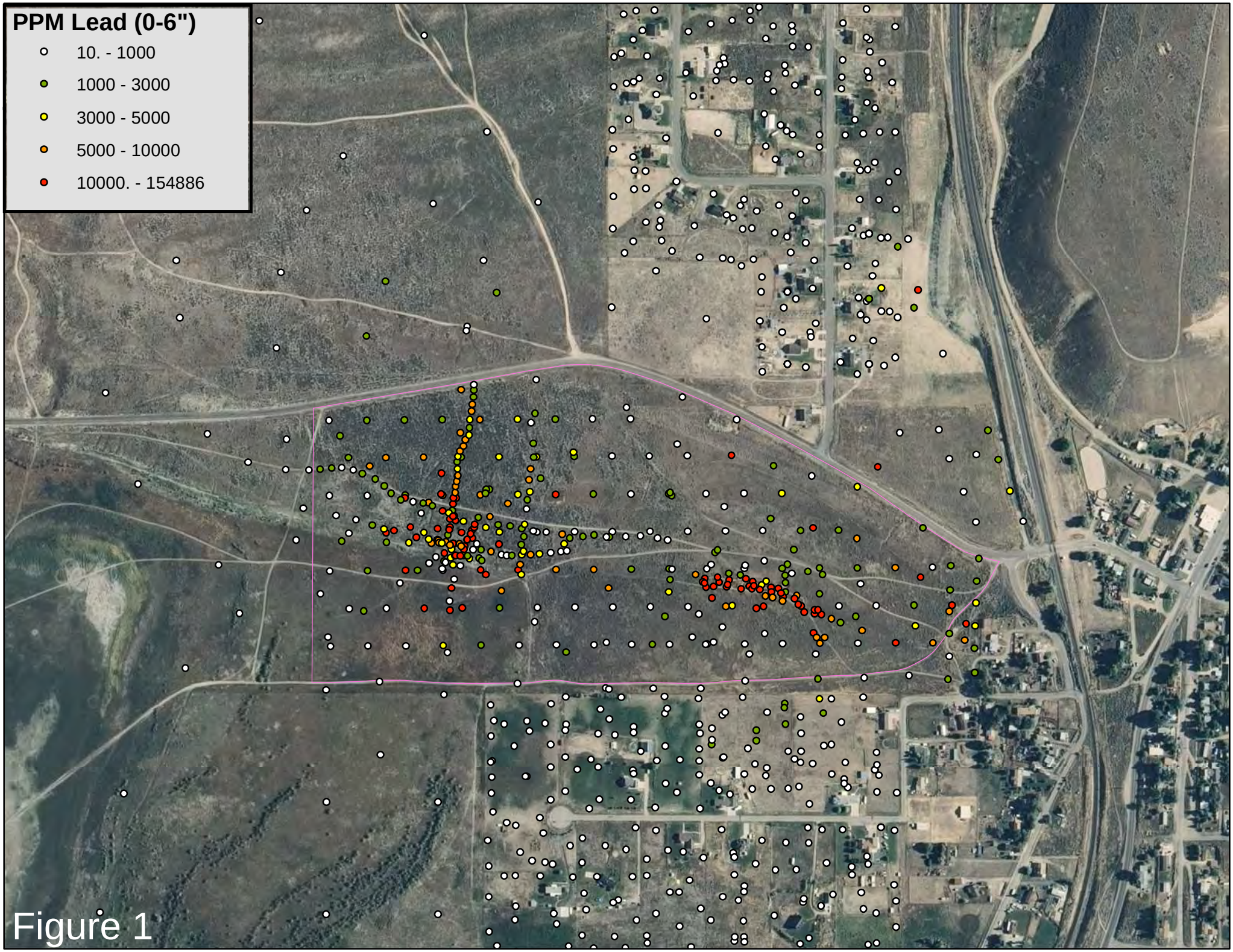

PPM Lead (0-6")
10. - 1000
1000 - 3000
3000 - 5000
5000 - 10000
10000. - 154886

Figure 1

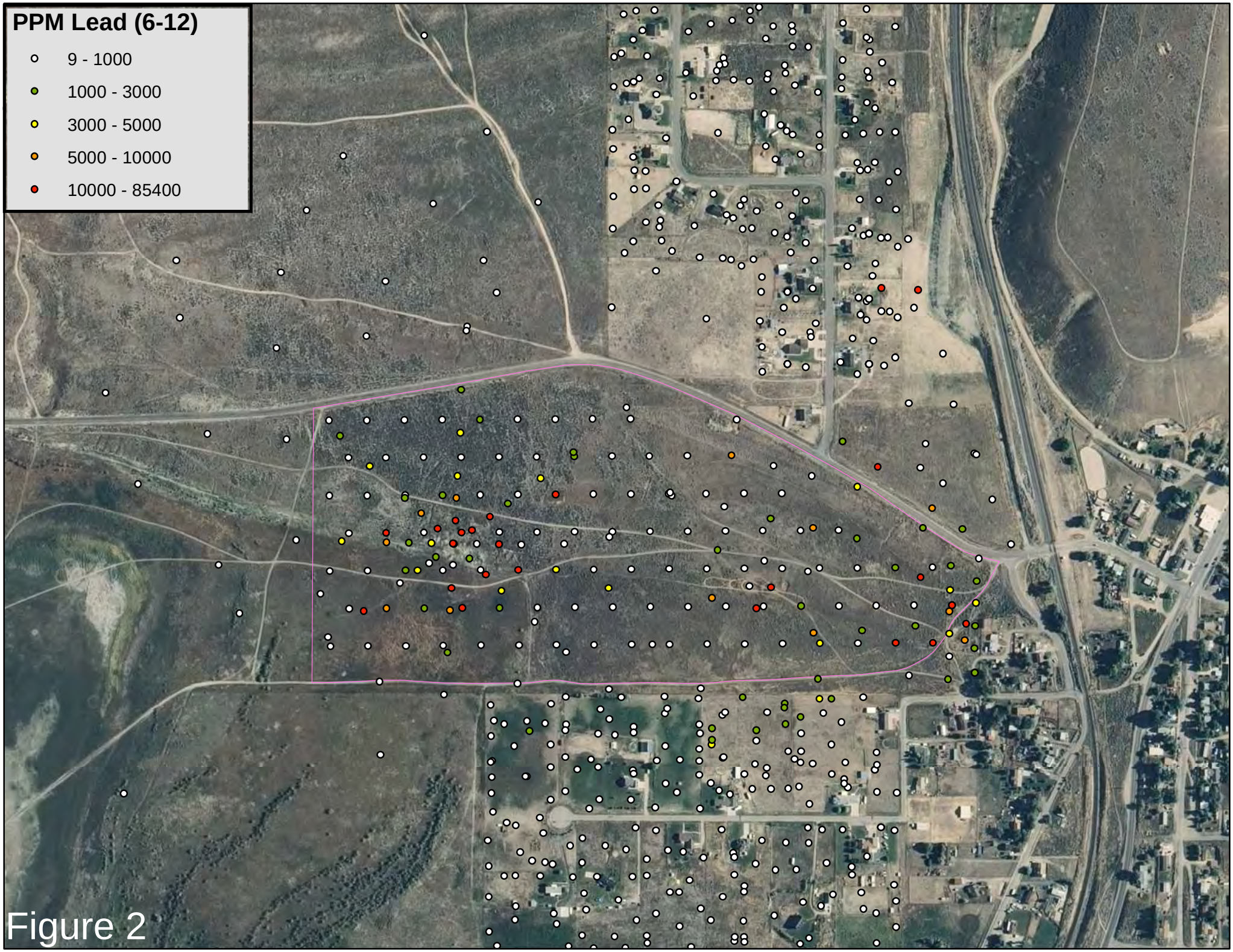

PPM Lead (6-12)
9 - 1000
1000 - 3000
3000 - 5000
5000 - 10000
10000 - 85400

Figure 2

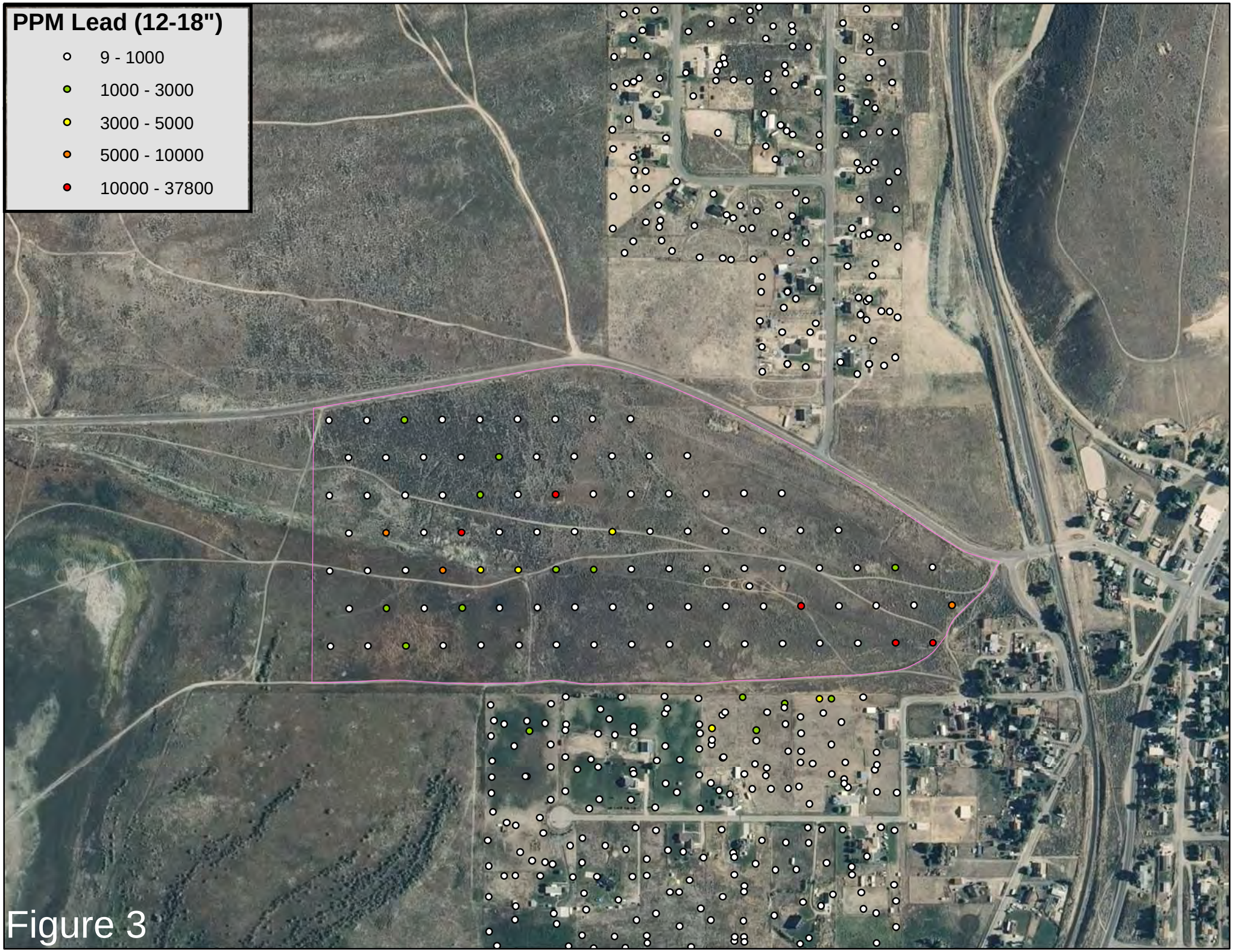
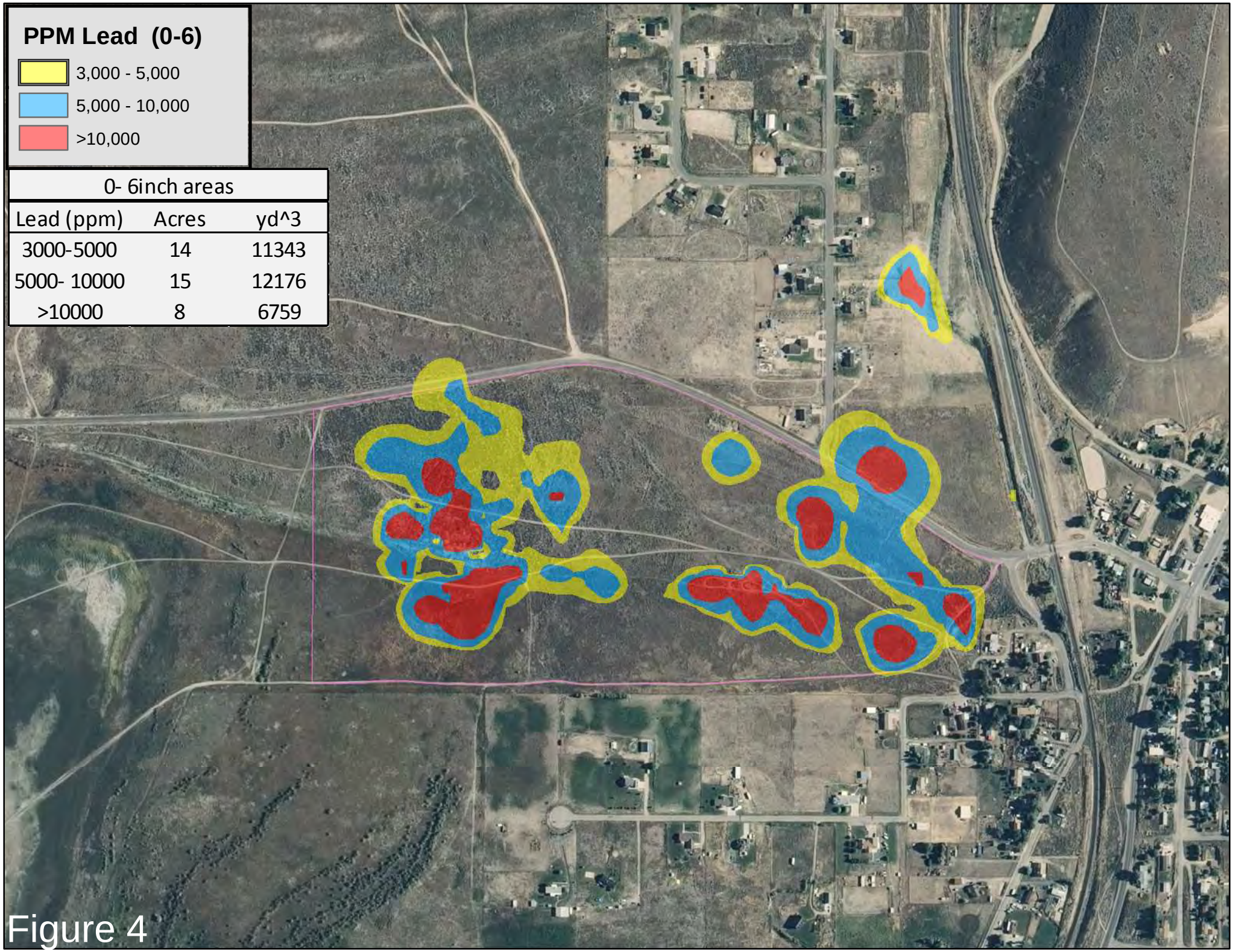
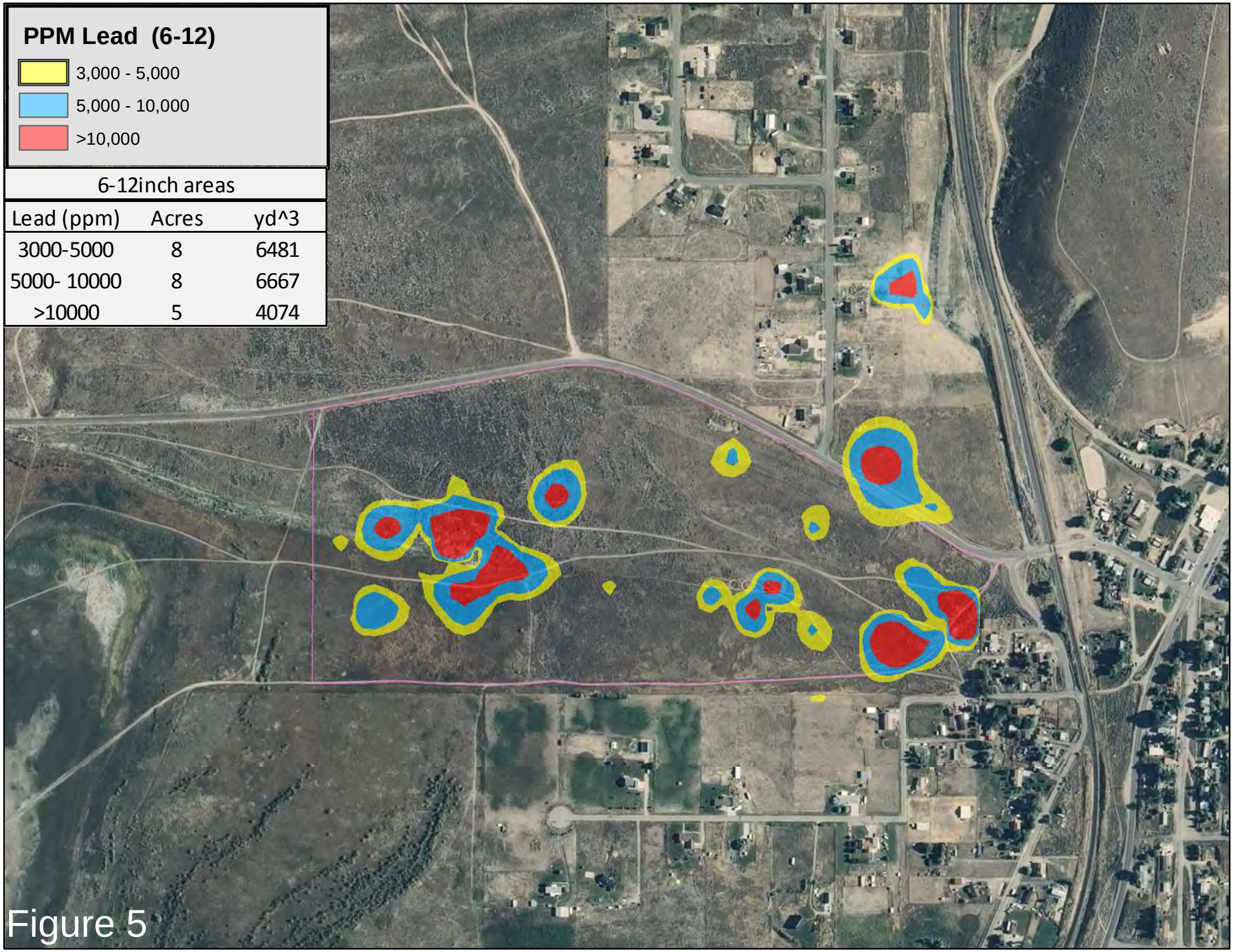

PPM Lead (12-18")
9 - 1000
1000 - 3000
3000 - 5000
5000 - 10000
10000 - 37800

Figure 3



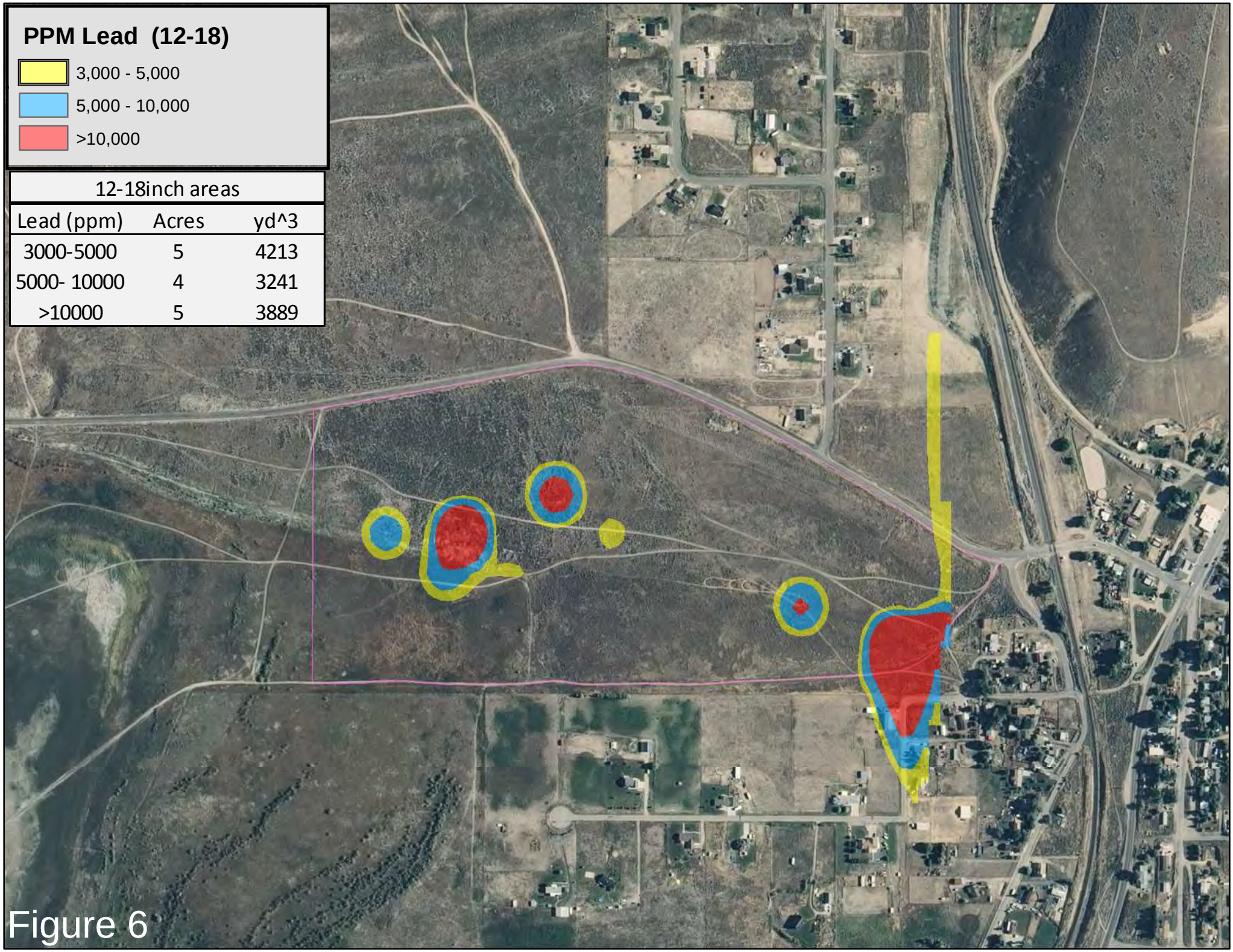
0- 6inch areas		
Lead (ppm)	Acres	yd^3
3000-5000	14	11343
5000- 10000	15	12176
>10000	8	6759

Figure 4



6-12inch areas		
Lead (ppm)	Acres	yd^3
3000-5000	8	6481
5000- 10000	8	6667
>10000	5	4074

Figure 5



12-18inch areas		
Lead (ppm)	Acres	yd^3
3000-5000	5	4213
5000- 10000	4	3241
>10000	5	3889

Figure 6

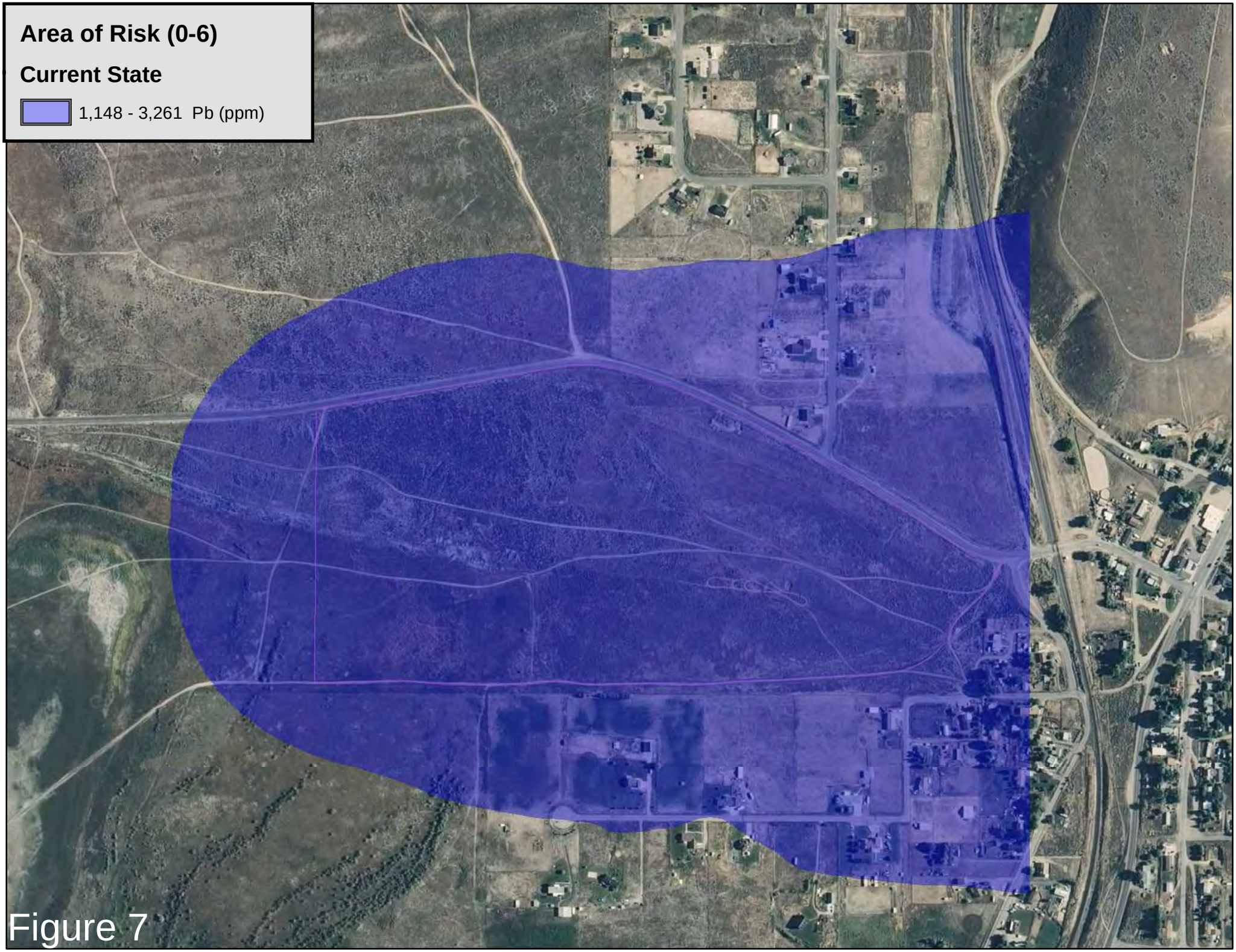


Figure 7

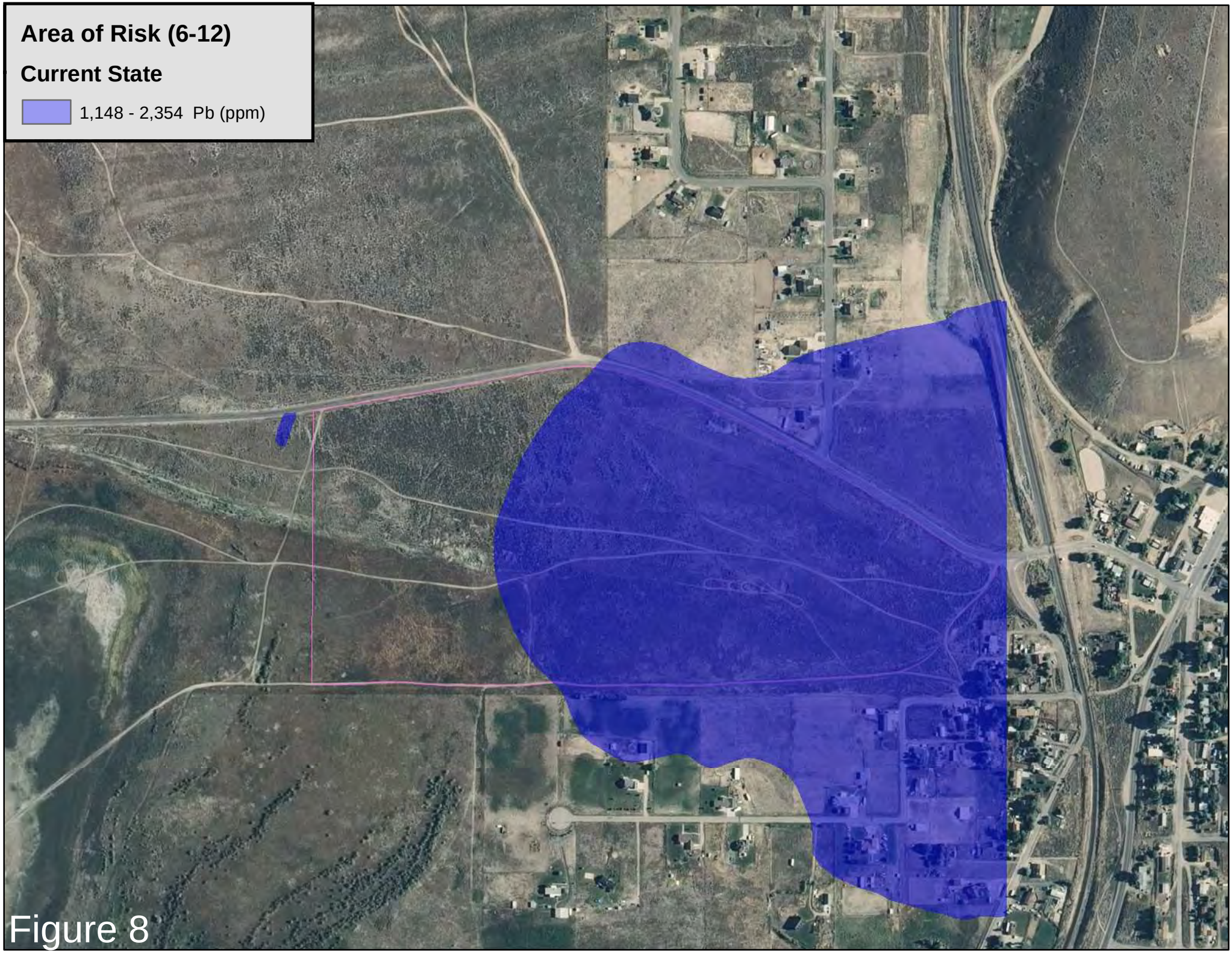


Figure 8

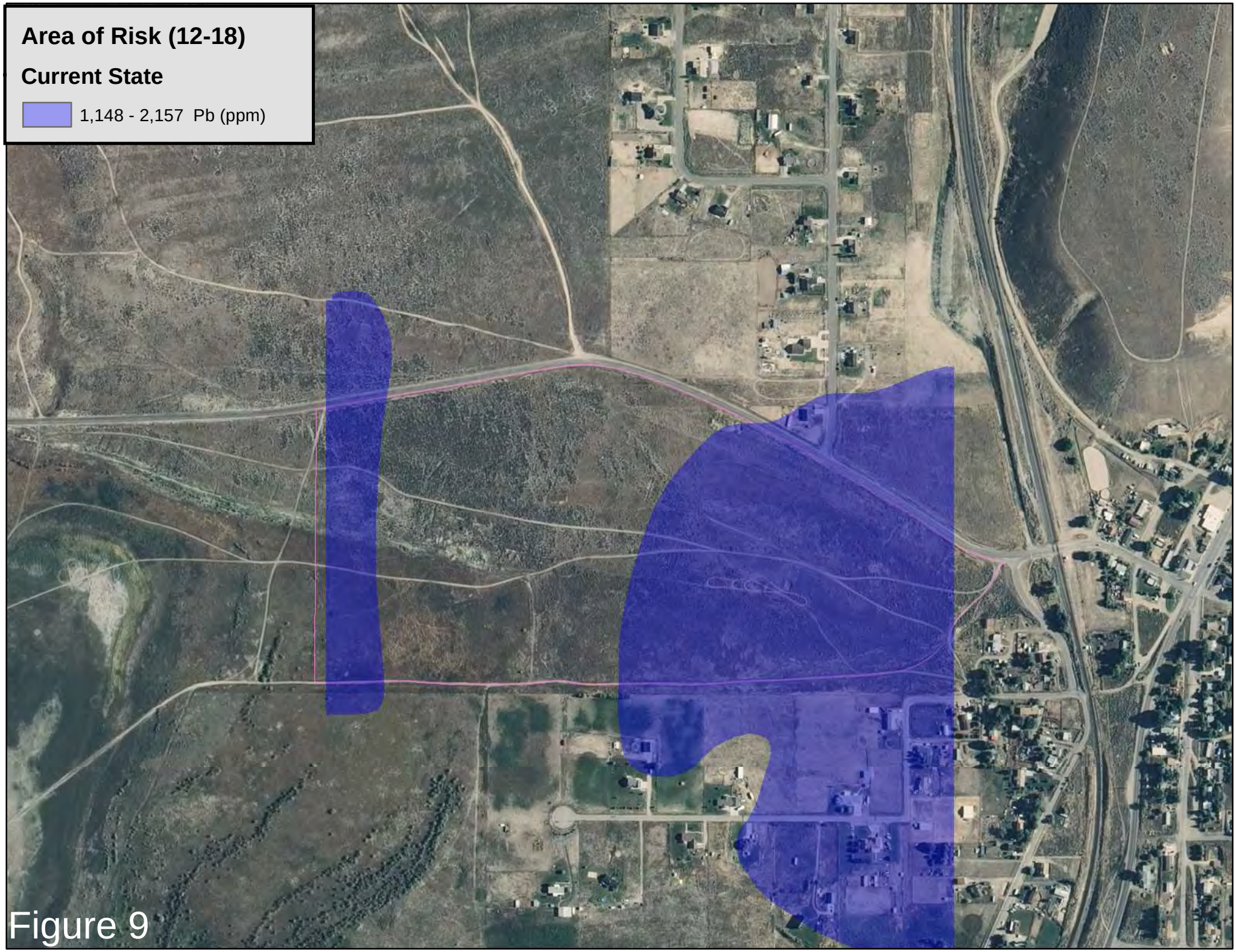


Figure 9

Figure 10

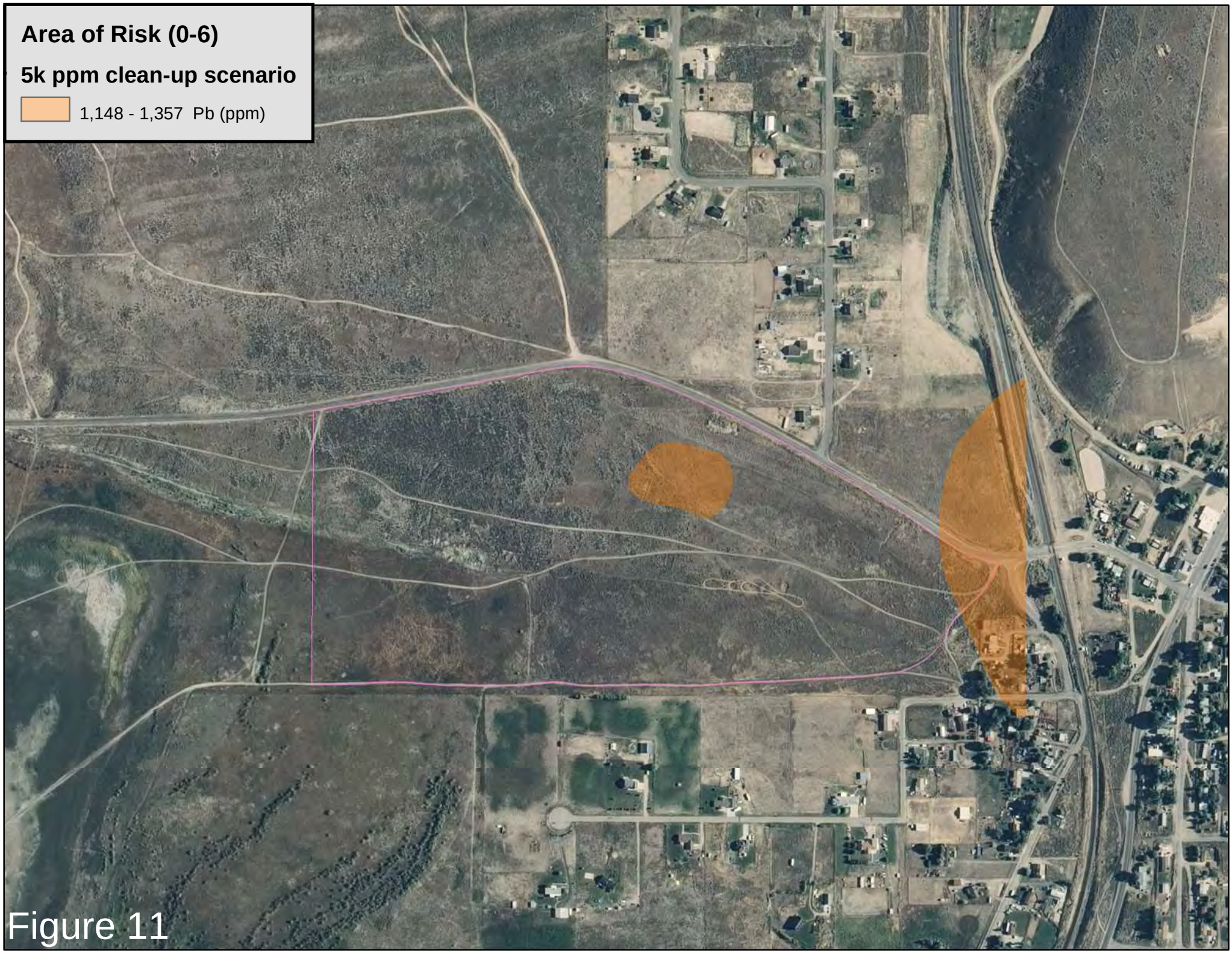


Figure 11

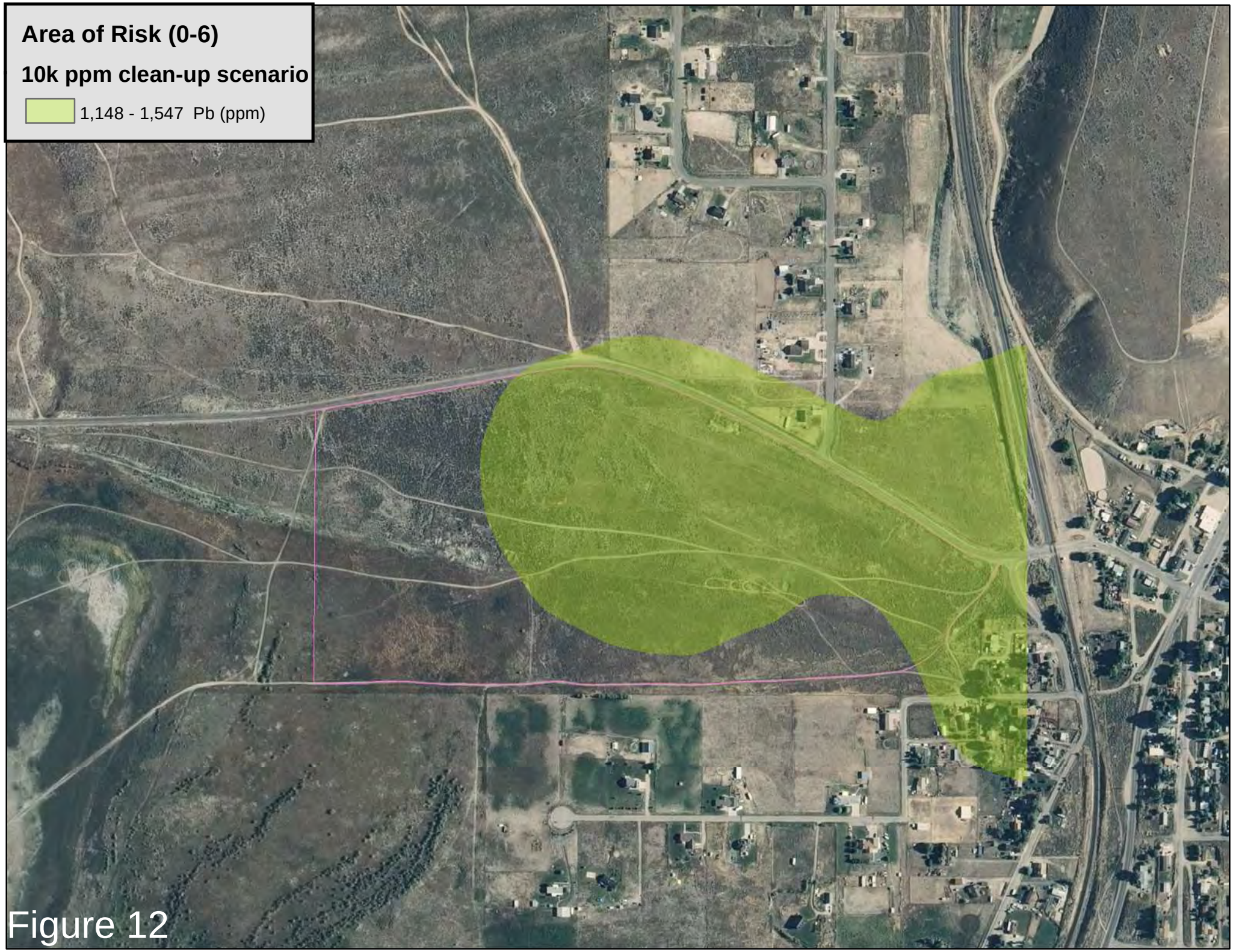


Figure 12

Figure 13

State of Utah

GARY R. HERBERT
Governor

SPENCER J. COX
Lieutenant Governor

Department of
Environmental Quality

Amanda Smith
Executive Director

DIVISION OF ENVIRONMENTAL
RESPONSE AND REMEDIATION

Brent H. Everett
Director

ERRC-004-14

MEMORANDUM

TO: Jacobs Smelter Site File

THROUGH: Lisa Lloyd, Remedial Project Manager, Region 8, U.S. EPA

FROM: TDD Thomas D. Daniels, Environmental Engineer, Division of Environmental Response and Remediation, Utah Department of Environmental Quality

DATE: January 14, 2014

REGARDING: Site Summary and Creation of Operable Unit 6 for Jacobs Smelter Superfund Site

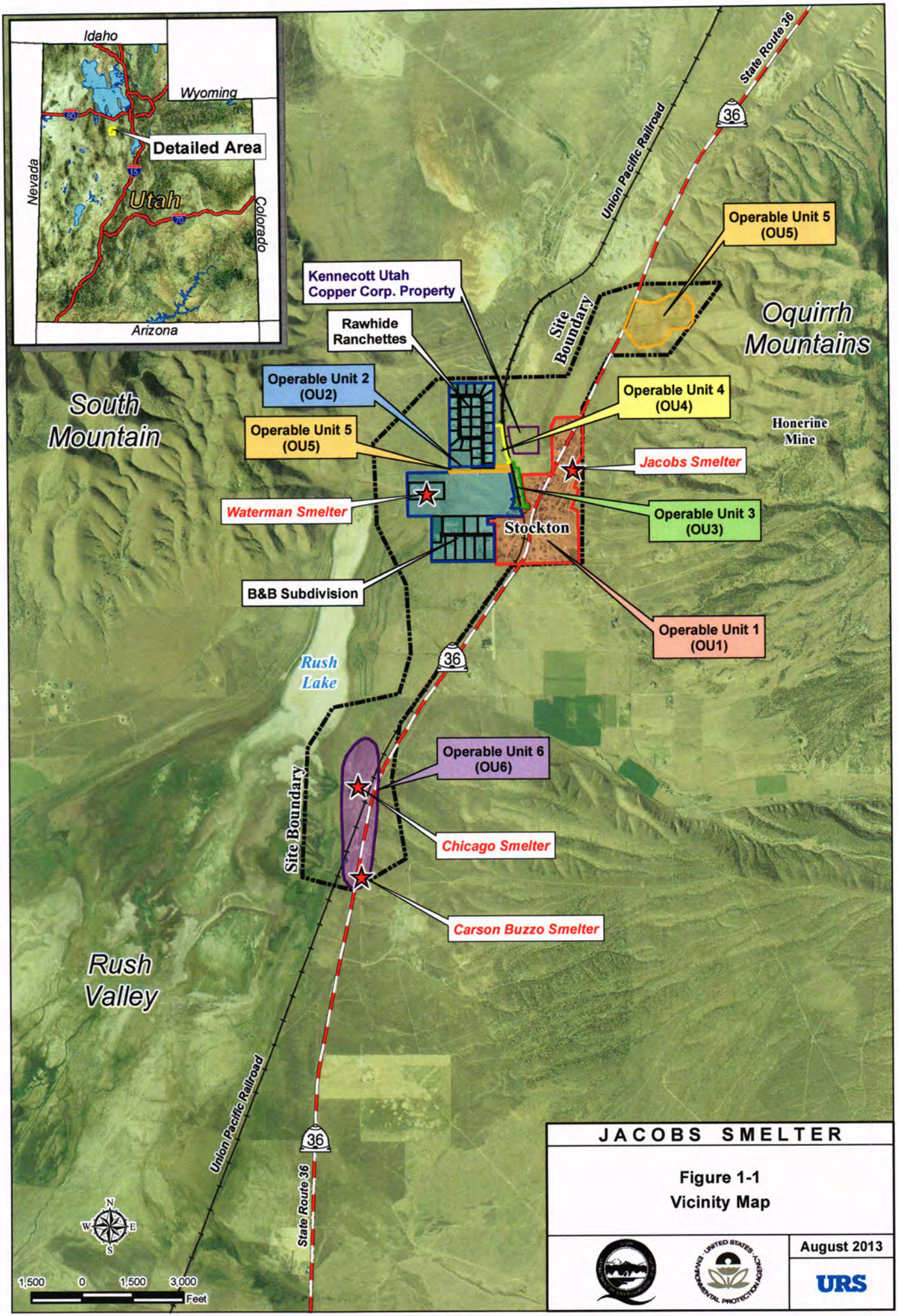
The Jacobs Smelter Superfund Site was discovered in 1996. In 1998, the Site was divided into three Operable Units, OU1, OU2 and OU3. OU1 consisted of residential properties within the town limits of Stockton, Utah, which were cleaned up in 1999. At that time, OU2 included underdeveloped and undeveloped land associated with the Waterman Smelter, west of Stockton, and the Chicago and Carson Buzzo Smelters south of Stockton. OU3 included contaminated soil within the Union Pacific railroad right of way, which was cleaned up by Union Pacific in 1999. This memo documents the decision to modify OU2 to address the contamination associated solely with the Waterman Smelter, including the Rawhide Ranchettes and B&B Subdivision. It also creates an additional Operable Unit, OU6, which will address the area around the Chicago and Carson Buzzo Smelters.

During 2010, a memo to the file was issued by the Utah Department of Environmental Quality in conjunction with Region 8 of the Environmental Protection Agency that documented modifications to the boundaries of the Site. Areas, shown through sampling efforts, to not be impacted by smelter –related contamination were no longer part of the Site and the boundaries were changed to reflect that. The 2010 memo documented the creation of two additional Operable Units, OU 4, which consisted of land east of the Rawhide Ranchettes and OU 5, land owned by the Bureau of Land Management. The memo also modified the boundary of OU2 to include the Waterman Smelter, Rawhide Ranchettes, B&B subdivisions, as well as the area surrounding the Chicago and Carson Buzzo Smelters, located south of Stockton (Site Boundary and designation of additional Operable Units for Jacobs Smelter Superfund Site, May 17, 2010).

In order to address concerns regarding lead and arsenic contaminated soil associated with the Waterman Smelter and to revisit the remedial alternatives and associated cost estimates in the Revised Feasibility Study (RFS) soil samples were collected and analyzed during 2009 and 2010 from within the Waterman Smelter and two subdivisions (Rawhide Ranchettes and B&B Subdivision). The results of this sampling endeavor resulted in a non-time critical removal of contaminated soil from residences within the Rawhide Ranchettes Subdivision (performed in 2010 and 2011). Smelter related contamination that remains within the vicinity of the Waterman Smelter and at residential properties within the B&B Subdivision, will be addressed in future remedial actions.

The Chicago and Carson Buzzo Smelters are located approximately two miles south of the Town of Stockton and are much more remote than the Waterman Smelter. The area is mainly used for agricultural purposes and represents a different exposure scenario than the Waterman Smelter. The risk associated with contamination related to the Waterman Smelter was calculated using residential and recreational use exposure scenarios. Based on the difference in uses, differences in exposure scenarios, and the remote location of the Chicago and Carson Buzzo Smelters in relation to the town of Stockton, the risk and exposure assumptions used for the Waterman Smelter are not applicable to the Chicago and Carson Buzzo Smelters.

This memorandum modifies OU2 to address contamination associated solely with the Waterman Smelter including the Rawhide Ranchettes and B&B Subdivisions. In addition, the area surrounding the Chicago and Carson Buzzo Smelters is now designated as OU 6. The new boundaries for OUs 2 and 6 are depicted in the attached Figure. Additional investigations, including risk assessments will be performed for OU 6. OUs 1, 3, 4, and 5 remain unchanged.



JACOBS SMELTER

Figure 1-1
Vicinity Map

August 2013

URS