FINAL
REMEDIAL INVESTIGATION

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

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TITLE PAGE AND APPROVALS

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Plan Coverage:	This Remedial Investigation Report: 1) summarizes previous investigations and their results; 2) presents the results of the 2002 Investigation; 3) presents nature and extent of contamination; and 4) presents the results of the human health risk assessment and the ecological risk assessment.
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ACRONYMS AND ABBREVIATIONS

bgs	below ground surface
BLM	Bureau of Land Management
BLRA	Baseline Risk Assessment
BOR	Bureau of Reclamation
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CLP	Contract Laboratory Program
COC	Chemical of Concern
COPEC	Contaminants of Potential Ecological Concern
CSM	Conceptual Site Model
CSS	Contaminant Screening Study
DERR	Division of Environmental Response and Remediation
DQO	Data Quality Objective
EAPC	Ecological Areas of Potential Concern
EPA	United States Environmental Protection Agency
ERA	Ecological Risk Assessment
ETAG	Ecological Technical Advisory Group
FFS	Focused Feasibility Study
FS	Feasibility Study
FSP	Field Sampling Plan
GIS	Geographic Information System
GPS	Global Positioning System
GWQS	Ground Water Quality Standards
HHRA	Human Health Risk Assessment
HQ	Hazard Quotient
ICP	Inductively Coupled Plasma
IDW	Investigation Derived Waste
kg	kilogram
MCL	Maximum Contaminant Level
mg/kg	milligram per kilogram
mg/kg-day	milligram per kilogram-day
mg/L	milligrams per liter
MS/MSD	Matrix Spike/Matrix Spike Duplicate
OU	Operable Unit
PRE-RI	Pre-Remedial Investigaiton
ppm	parts per million
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RA	Remedial Action

ACRONYMS AND ABBREVIATIONS (continued)

RBC	Risk Based Concentration
RCRA	Resource Conservation Recovery Act
RD	Remedial Design
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RIWP	RI Work Plan
ROD	Record of Decision
RPD	Relative Percent Difference
RR	Rawhide Ranchette
SAP	Sampling and Analysis Plan
SERA	Screening Ecological Risk Assessment
Site	Jacobs Smelter Superfund Site
TAL	Target Analyte List
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TSOP	Technical Standard Operating Procedures
UDEQ	Utah Department of Environmental Quality
UDWR	Utah Department of Wildlife Resources
UNHP	UDWR Natural Heritage Program
UOS	URS Operating Services
µg/L	micrograms per liter
USDA	United States Department of Agriculture
XRF	X-ray Fluorescence Spectrophotometer

EXECUTIVE SUMMARY

The Utah Department of Environmental Quality (UDEQ), in cooperation with the U.S. Environmental Protection Agency (EPA), Region VIII, has completed a remedial investigation (RI) on the area known as the Jacobs Smelter Operable Unit 2 (OU2), near Stockton, Utah. The RI meets the following investigation objectives through several phases of data collection, evaluation, and risk assessment:

- The data needs identified through the data quality objectives (DQO) process, established for this project, have been met through completion of this RI and the human health risk, and ecological risk efforts.
- The areas of concern within OU2 are characterized for contaminant nature and extent. The field data collection ending in summer 2002 provided sufficient data for the completion of the ecological risk assessment (ERA) and the human health risk assessment (HHRA).
- A remediation effort at OU2 is warranted based on the results presented in this RI report. Key information regarding nature, extent, and risk in this RI will provide the basis for a feasibility study (FS) to determine remediation alternatives and costs, and remedial design (RD) to fully plan implementation of the preferred remedial technology.

Several phases of remedial investigation are documented in this RI report. Aspects of each data acquisition phase, including the Contaminant Screening Study (CSS), the Rawhide Ranchettes Investigation, and the Pre-RI are summarized in sections 1.0, 3.0, and 4.0. The individual reports are included by reference. The summer 2002 field data acquisition for the RI is presented in sections 3.5 and 4.5. Evaluation of all Jacobs OU2 data is submitted in section 5.0. Finally, the summaries of the ecological and human health risk assessments presented in sections 6.2 and 6.3, respectively, quantify the risk assessment elements the project risk managers will use to ensure protectiveness of human health and the environment at Jacobs OU2.

Nature and Extent

The following analytes were detected at least once at concentrations that exceeded Human Health Risk Assessment, Phase 2 screening levels for particular media:

- Soil & Sediment: antimony, arsenic, lead, manganese, and mercury
- Surface water: arsenic
- Groundwater: arsenic and lead (the screening levels exceeded here are the Region 3 Tap Water RBCs)

Concentrations of lead and arsenic above established action levels in soil are documented in several Jacobs OU2 areas. Elevated lead and arsenic soil concentrations are shown on report maps to occur primarily in the areas near the former Waterman, Carson-Buzzo, and Chicago smelters. Soil concentrations for lead and arsenic range as high as 47,000 ppm and 5,500 ppm, respectively. The elevated metals concentrations occur within the soil matrix at the surface, and in some areas down to at least 12 inches below ground surface (bgs). The areas of elevated metals at Jacobs OU2 are primarily west of the town of Stockton, however, laboratory and field XRF screening data identified elevated concentrations of lead and arsenic in soils associated with mine tailings and drainage areas in the hills east and northeast of Stockton.

Currently, there are no further groundwater investigations planned for Jacobs Smelter OU2. Available groundwater data, although limited in extent, show levels of arsenic and lead are below the current State of Utah groundwater criteria. These criteria are considered to be more applicable to the groundwater

present at OU2 than are the Region 3 Tap Water RBCs that were used as Phase 2 screening levels. Additionally, other factors that support no further groundwater investigation include great thickness of unsaturated zone beneath surface contamination (>100 feet), poor naturally-occurring groundwater quality, and lack of use for shallow groundwater by local residents.

The RI data coverage and quality provide a sound basis for risk management. Maps within the RI report show areas where lead and arsenic soil concentrations exceed human health-risk criteria. The ecological risk assessment and the human health risk assessment were performed to determine specific remedial goals relative to at-risk populations in the Jacobs OU2 area. The following conclusions are made regarding the nature of contamination as it relates to risk:

- A Conceptual Site Model (CSM) for residential exposure for OU2 (Figure 6-1) is similar to the Jacobs OU1 CSM. Residential children and adults are deemed at risk to lead and arsenic contaminants through oral ingestion of dust and soil from former smelter stack emissions or discrete waste piles. A CSM for non-residential exposure (Figure 6-2) shows that certain recreational activities in the Rush Lake area may pose a health risk due to lead and arsenic through oral ingestion or dermal contact with surface water or surface soil.
- Preliminary Remediation Goals (PRGs) were determined by Risk Managers based on the HHRA and are presented in the table below. Residential lead and arsenic action levels, determined for Jacobs Smelter OU1, will be applied at the residential properties within OU2 and are shown in the table below. Exposure areas were defined (by the UDEQ and EPA) for the recreational (three areas) and commercial/industrial (one area) properties within OU2, see Figure 6-3 for locations. A statistical evaluation was conducted in the SHHRA for these areas that determined only one exposure area, recreational exposure area 2 (the area around the former Waterman Smelter), has analytes that exceed human health risk screening levels at a cancer risk of 10^{-4}. The SHHRA further identified that removal of soils containing 10,000 ppm lead and above, would result in acceptable human health risk at a cancer risk of 10^{-4}. Areas that exceed the action levels shown in the table below should be addressed in the feasibility study to determine suitable remediation alternatives.
- The ERA (performed by an EPA contractor other than URS) is based on the assessment endpoints, the hazard quotients (HQs), and associated assumptions presented in the ERA (Lockheed Martin REAC, 2003). The ERA concluded that there is risk to biota at the site primarily from lead concentrations in surface soils. The EPA determined that ecological risk at the site would be represented by the Northern Flicker and from the ERA chose an ecological remediation goal of 1100 ppm soil lead (representing a HQ of 2). The EPA then conducted a moving window analysis on surface (0-2 inches) soil (EPA, 2003), which computed an average soil lead concentration in the circular, 55 hectare home range of the Northern Flicker across the site, to determine an action level that would meet the remediation goal. From this analysis it was determined that removing soil lead levels above 3000 ppm would meet the remediation goal.

Following are the preliminary remediation goals and action levels determined by the EPA and UDEQ for the Jacobs Smelter OU2 site:

Scenario	Preliminary Remediation Goals		Action Levels	
	Arsenic	Lead	Arsenic	Lead
Residential (Surface)	100	500	100	500
Residential (Subsurface)	100	800	100	800
Industrial/Commercial	NA	2200	NA	10,000
Recreational	NA	4200	NA	10,000
Ecological	NA	1100	NA	3,000

1.0 INTRODUCTION

URS Corporation (URS), formerly URS Greiner Woodward Clyde, has been tasked by the Utah Department of Environmental Quality (UDEQ), in cooperation with the U.S. Environmental Protection Agency (EPA), Region VIII, to perform a Remedial Investigation (RI) for Operable Unit (OU) 2 of the Jacobs Smelter Site (Site). RI activities are being performed under Contract No. 026324 for the UDEQ. This RI report provides analysis of field and laboratory data collected during the most recent 2002 field investigation, summarizes previous investigations, and presents a risk evaluation which includes a summary of the Ecological Risk Assessment (ERA) performed by the U.S. EPA. A Feasibility Study is also being prepared for this site and will be presented under separate cover.

The Jacobs Smelter Site was originally identified in 1997 and includes the northern part of Rush Valley in Tooele County, Utah (Figure 1-1). Contamination at the Site results from the operation of several historic smelters in the area. In 1998 the Site was divided into three operable units, OU1, OU2 and OU3. OU2 is that portion of the Jacobs Smelter Site outside the general town limits of Stockton and includes the Rush Lake area. OU1 generally includes the residential soils within the town limits of Stockton. OU3 includes only the soils within the Union Pacific railroad right-of-way. The boundary of the Jacobs Smelter Site is set by the boundary of OU2, which has been finalized with this RI. Within OU1, the EPA emergency removal action and the UDEQ remedial action (RA) for contaminated residential soils have been completed according to the requirements specified in EPA guidance and the OU1 Record of Decision (ROD). Contaminated soils in OU3 were remediated by Union Pacific in the summer/fall of 1999 and were located within the boundary of OU1 (AGI, 2000).

1.1 Previous Investigations

This section presents a summary of the investigations that have been conducted within the boundaries of OU2. Those investigations associated with OU1 which deal with OU2 are briefly discussed here, however, a more detailed summary can be found in the OU2 RI Work Plan as well as the OU1 RI/FS.

Work on an OU2 RI 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. During the CSS investigation, elevated levels of metals were found in the soils of the developing Rawhide Ranchettes (RR) Subdivision. This resulted in a focused investigation of this subdivision in May 2000. Review of the CSS and Rawhide Ranchettes data indicated several data gaps relative to the overall RI effort, so a Pre-RI Investigation was conducted in early 2001 to fill these specific data gaps and further focus the RI. Several other tasks were also conducted during this time period, as part of the DQO process, including preparation of the Human Health Risk Assessment (HHRA) Technical Memorandum, the Screening Ecological Risk Assessment (SERA) and the Reuse Assessment. These investigations and tasks form the basis of this RI and are summarized in this section.

1.1.1 OU1 Investigation

After the 1998 designation of OU1 and OU2 for the Jacobs Smelter Site, the EPA conducted sampling focused on the town of Stockton. This sampling was conducted in 1998 and was part of the EPA Emergency Removal Action investigation 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. Part of this effort included sampling on a large property that since became part of OU2. This property, Stockton West Subdivision (referred to as property J251 in OU1 documents), is located north of

the Rush Lake road and adjacent to the western boundary of OU3. This sampling in OU2 identified areas with elevated surface soil lead concentrations and the need for further investigation.

In February of 1999, as part of the OU1 Remedial Investigation/Focused Feasibility Study (RI/FFS), UDEQ contractor URS performed sampling of open ground along the eastern edge of the residential area of Stockton (see Figure 1-2 for sample locations). The results of this sampling were used to determine the eastern boundary between OU1 and OU2. The sampling locations are now contained in the part of OU2 east of Stockton. The action levels established based on the OU1 RI/FFS results are as follows: 500 ppm for surface soil (0 to 2 inches) and 800 ppm for subsurface soil (2 to 18 inches) lead concentrations (URSG 1999c). Subsequent to the OU1 RI/FFS a remedial design was prepared and remedial action completed for approximately 125 properties within the town of Stockton.

1.1.2 1999 OU2 Contaminant Screening Study (CSS)

In 1999, the contamination within OU2 from activities at the Jacobs, Chicago, Carson-Buzzo, Waterman, and other smelters located in Stockton and along the shore of Rush Lake, located to the west of town was investigated in the CSS by UDEQ contractor URS. The CSS was the first comprehensive investigation conducted to characterize the contamination present at OU2 and remains the most sample intensive. The objectives of the OU2 Contaminant Screening Study were to:

- Identify areas of soil, sediment, surface water, and groundwater contamination across OU2
- Use this information to establish the boundaries of OU2
- Provide limited initial data for screening-level ecological risk assessment
- Perform a preliminary ecological site characterization
- Provide information to support preparation of an RI work plan, if required

These objectives were limited in scope and recognized that additional data may be required for the development of an OU2 ecological risk assessment (ERA), a human health risk assessment (HHRA), or completion of an OU2 RI and that the future data needs and tasks to be performed for OU2 would be developed through the data quality objective (DQO) process.

Therefore, the CSS was only the first phase of OU2 delineation and characterization, although later phases of investigation have been based on the results of this phase of work. A Draft CSS Report was completed for use in the DQO process which directed further activity at the Site.

More than 1,500 samples were collected and analyzed during this investigation and the CSS report was completed in July 2000 (URS 2000a). Soil, sediment, and water sample results were entered into a Geographic Information System (GIS) database and incorporated into an aerial photography-based GIS map using existing aerial photographs. Analytical data was entered into a Microsoft Access™ database created for this project.

1.1.3 Rawhide Ranchette Investigation

The RR Subdivision is located west of the town of Stockton, just north of Silver Avenue. This area is currently being developed, and at the time of the sampling (May 2000) consisted largely of undisturbed land covered with sagebrush and grasses. A very limited number of soil samples were previously collected from the Subdivision area during the fall of 1999 as part of the CSS sampling program. The lead concentrations in some of these previously collected samples exceeded the OU1 action levels. Some areas of the Subdivision were determined during the fall 1999 CSS sampling to exceed OU2 screening

levels; therefore, the commencement of construction activities to develop the Subdivision prompted UDEQ to require further characterization and delineation of soils that may exceed OU2 screening levels.

Subsequently, URS collected surface and subsurface soil samples from 30 lots within the RR Subdivision, according to protocols established for OU1 residential properties in Stockton. A total of 180 composite soil samples were collected and submitted to the Bureau of Reclamation (BOR) for X-ray Fluorescence Spectrophotometer (XRF) analysis. Fixed-base laboratory analysis was also performed in order to confirm the XRF results.

Composite surface soil sample lead concentrations ranged from 151 to 12,100 ppm. The subsurface soil composite sample lead concentrations ranged from non-detect to 1,440 ppm lead. In most of the sample locations, the lead was reported at lower concentrations in the subsurface samples than in the surface samples. The overall average lead concentration for each depth interval consistently decreased with depth.

Analytical results of the soil samples indicated that only 5 of the 30 lots exceeded the OU2 screening level of 500 ppm lead for surface soil and 2 of those 5 lots exceeded the screening level of 800 ppm lead for subsurface soil. The contamination was generally highly localized and did not appear to be widespread in the RR Subdivision. There was a very large range in lead concentrations across the site. Generally, the southeast section of the Subdivision had higher levels than the rest of the site. This was possibly due to the proximity to the Waterman Smelter and windblown dust originating from the Waterman site, or due to an unidentified mining related source. Beyond the higher lead concentrations in the southeast, soil lead concentrations decreased to the north.

On December 27, 2000 the EPA signed an Action Memorandum for conducting a Time-Critical Removal Action at the Rawhide Ranchettes development located west of Stockton. EPA and Titan Development (Titan) signed an Administrative Order of Consent on July 2, 2001 that required Titan to remediate the five contaminated lots at Rawhide Ranchettes. Titan's contractor for all excavation, transportation, and disposal activities was Pacific West. UDEQ/DERR was responsible for overseeing removal activities. Construction began on August 15, 2001 and was completed August 31, 2001. The details of the work performed at Rawhide Ranchette Subdivision are described in the Rawhide Ranchette Investigation Report (URS, 2000b).

1.1.4 2001 OU2 Pre-Remedial Investigation

On completion of the CSS, data were evaluated as part of the DQO process, and a number of data gaps were identified, which if addressed immediately, would facilitate the scoping of the RI, and focus future investigation activities. The purpose of the Pre-RI was to acquire the additional data required to focus future Jacobs Smelter OU2 investigation efforts and better define the activities to be conducted as part of the RI. The Pre-RI was primarily conducted during the period March 27, 2001 through April 4, 2001.

Lake and surface (stream) water, sediment, groundwater, and soil data were acquired to address data gaps identified in the review of the CSS results and during preparation of the SERA. This data included:

- Data with lower detection limits to support an ecological risk assessment
- Additional potential background data
- Additional sediment data from Rush Lake shoreline to the high water mark
- Groundwater data
- Additional data to address the insufficient spatial distribution of fixed-based laboratory analytical data

A total of 101 samples were collected from 51 locations. Some limited information was also referenced from an initial sampling event in December/January.

The results of the Pre-RI indicated that investigation objectives had for the most part been achieved. Please refer to the OU2 Pre-Remedial Investigation Report (URS, 2001b) for further detail.

1.1.5 Human Health Risk Assessment Technical Memorandum Summary

An HHRA Technical Memorandum has been completed for Jacobs Smelter OU2 (URS, 2001c).

The HHRA approach for the Jacobs Smelter OU2 was developed as a phased approach to progressively focus both investigation and risk assessment efforts on analytes that could present a risk to human health under current or future land use scenarios. Three phases were identified. Phases 1 and 2 were completed in the HHRA, and Phase 3 is completed in this RI. Where possible, the HHRA approach for OU2 mirrors the approach used for Jacobs Smelter OU1, the adjacent residential area for which a BRA and ROD have been prepared and approved. However, the applicability of the OU1 BRA is limited because OU1 had only residential land use and considered only lead and arsenic, whereas OU2 encompasses both additional land uses and additional metals.

Phase 1 of the HHRA was a non-site-specific screen of maximum concentrations from existing data against generic and conservative risk-based levels (Phase 1 screening levels, which equate to EPA Region 3 risk based concentrations [RBCs]). This phase was used to (1) evaluate the adequacy of detection limits for existing data at OU2, and (2) identify COCs for each medium for Phase 2.

Phase 2 was a site-specific evaluation of exposure and toxicity, and included development of site-specific, risk-based screening levels (Phase 2 screening levels) for COCs in the various media. Specifically, screening levels were developed for residential exposure to soil, commercial/industrial exposure to soil, and recreational exposure to soil, sediment, and surface water. Risk-based screening levels were calculated for a hazard quotient (HQ) of 1 and cancer risks of 10^{-4}, 10^{-5}, and 10^{-6}. This was done to allow the risk manager to make informed choices about risks in specific exposure areas. To provide an initial sense of the COCs that have the potential to present a risk, the HHRA compared site-wide maxima, at a depth of 0-2 inches, to the Phase 2 screening levels at HQ of 1 plus cancer risk of 10^{-6}. Only analytes that have (1) at least one exceedance of a Phase 2 screening level or (2) inadequate detection limits need be analyzed during the RI. With the exception of arsenic in surface water and groundwater, detection limits for existing data meet site needs for assessing human health risk.

Phase 3 of the process for this site, referred to as the Second Human Health Risk Assessment (SHHRA) (URS, 2003) was not included in the HHRA Technical Memorandum, but rather was conducted as part of this RI and is summarized in Section 6.1 of this report.

1.1.6 Screening Ecological Risk Assessment (SERA) Summary

A Final SERA has been completed for Jacobs Smelter OU2 (URS, 2001a). The SERA was utilized during the DQO process to assist decision making and is the foundation for the Ecological Risk Assessment presented in Section 5.3 of this report. The ecological risk process for OU2 is following a tiered approach. Rush Lake and the surrounding shoreline are the principal focus of the ecological risk assessment, because Rush Lake is a key feeding stop for hundreds of migratory birds during years with adequate rainfall, as well as a known feeding area for bald eagles that winter in the Rush Lake Valley. Maintenance, and if necessary, remediation/restoration of aquatic, wetland, and terrestrial habitats to

support healthy, diverse, and self-sustaining populations of aquatic dependent avian and mammalian species is the principal resource management focus of the ecological risk investigation at Rush Lake.

Four primary ecological risk management goals were identified in the SERA:

1. Protection of threatened and endangered (T&E) species
2. Protection of migratory bird populations
3. Protection of wetlands and aquatic ecosystem
4. Protection of terrestrial wildlife populations

Based on these ecological risk management goals, one overall general assessment endpoint was identified:

- Protection of ecosystem integrity through maintenance of the ecosystem structural and functional components.

The SERA also identified Contaminants of Potential Ecological Concern (COPECs) and provided a list of recommended actions and data needs based on the risk analysis results and their interpretation in the screening characterization. Data needs for additional metals analyses with lower detection limits were fulfilled as part of the Pre-RI sampling program. A more detailed summary of the SERA can be found in the RI Work Plan (URS, 2001d).

1.1.7 Land Reuse Assessment

The EPA prepared a Land Reuse Assessment Report (EPA, 2001) in accordance with the "Land Use Directive" issued by the EPA's Office of Solid Waste and Emergency Response. This report directs EPA to consider land use when conducting investigations and assessing remedial alternatives on a Superfund site. To comply with the directive current land use and zoning within OU2 were evaluated based on information acquired from the Tooele County Assessor's Office maps and files, the Tooele County Engineering Department, Planning Division zoning maps, Tooele County and Stockton officials, landowners, and ecological maps. Figure 1-3 shows the map resulting from this activity.

The Reuse Assessment presents current land use that partly determines how future OU2 investigation and remediation activities are conducted. Land use has been incorporated into all facets of the RI, i.e., data acquisition, human health risk assessment, and ecological risk assessment, and will be a primary factor in the screening and evaluation of remedial alternatives in the FS, as well. OU2 land use categories include; single family residential, rural residential, agricultural, grazing, industrial / commercial, and open space / undeveloped / recreational.

1.2 Scope, Objectives, and Organization of the Remedial Investigation

The scope and objectives for the RI at OU2 are presented in the following sections, as well as a summary of the development of the data quality objectives for this site.

1.2.1 Scope of the RI

The scope of this RI is to determine the nature and extent of contamination at the Jacobs Smelter OU2 site resulting from mining activities in the area that may pose an unacceptable risk to human or ecological receptors. Figure 1-1 shows the area covered by this OU2 RI. OU1 (the town of Stockton) and OU3

(Union Pacific Railroad property) have been addressed elsewhere, OU1 in the RI for that site (URSG, 1999c) and OU3 privately by Union Pacific Railroad.

This effort allowed for finalization of the boundaries of OU2 and documentation of contaminant levels in soil, water (surface water and groundwater), and sediment. These contaminant data were then used, in conjunction with results from previous studies, to perform both a human health and ecological risk assessment. These assessments are included in this RI report to evaluate the impact of site contaminants of concern (COCs) on human and ecological receptors in the area. A Feasibility Study (to determine the most feasible remediation alternative) will be performed utilizing the results of this RI and will be presented under separate cover at a later date.

1.2.2 Development of Data Quality Objectives (DQO's)

The Data Quality Objectives (DQO) process provides a systematic method to evaluate project goals and objectives, data uses, and to determine data quality needs for sampling. The DQO process provides: 1) procedures for determining a quantifiable degree of certainty that can be used in making site-specific decisions and, 2) a formal approach to integrate overall program planning with sampling and analysis plan development. The goals of the DQO process are to improve the overall quality of sample data and to increase the cost effectiveness of further site investigations by focusing the data collection activities on only those contaminants, locations, media and end uses required for decision-making.

The DQO process for the development of project specific DQOs was initiated during the UDEQ/EPA review period for the Draft OU2 Contaminant Screening Study (CSS) Report. The recommendations formulated upon completion of the initial DQO meetings were discussed in the Final OU2 CSS Report (URS, 2000a) and are summarized below.

- Form an Ecological Technical Advisory Group (ETAG) to discuss ecological risk issues.
- Perform a Screening Ecological Risk Assessment (SERA) prior to ETAG meetings.
- Establish a human health approach, including a discussion of the basis for the screening levels for each medium and the need for extending the human health risk assessment (HHRA) used for OU1.
- Determine zoning, property ownership, and current and future development of the OU2 area prior to proceeding with additional work.
- Begin preparing an RI Work Plan.

A draft SERA was performed and was completed in 2001 (URS, 2001a). The DQO process was completed in conjunction with a series of ETAG meetings held between August 2000 and June 2001. The ETAG stakeholders discussed the analytical results of the investigations and the preliminary assessment of ecological risk presented in the SERA. The conclusions with respect to the purpose, objectives, and data insufficiencies in the areas of density, media, location, and detection limits are addressed in this RI.

In addition, HHRA activities were conducted concurrent with the ETAG activities. The OU1 Baseline Risk Assessment (BRA) served as the basis for evaluating the requirements for assessing human health risk at OU2. The inclusion of the additional metals other than lead and arsenic as potential contaminants of concern (COCs) and the multiple land uses within OU2 led the project team to conclude that preparation of a technical memorandum would be required to address these additional aspects of human health risk at OU2. The Final Human Health Risk Assessment Technical Memorandum (URS, 2001c) included input from UDEQ and EPA risk assessors. The HHRA conclusions have been incorporated into the purpose and data acquisition objectives developed for the RI.

Through the evaluation of the ecological information generated throughout the DQO and ETAG process, and presented in the SERA report, the need for development of OU2 Ecological Areas of Potential Concern (EAPCs) was recognized by the project team and stakeholders. The EAPCs, shown as polygons on Figure 2-1, focused ecological investigative activities during the RI on those areas believed to represent areas of greatest sensitivity and ecological value.

The Land Reuse Assessment Report (EPA, 2001), prepared by the EPA, presents the current land use that determines how future OU2 investigation and remediation activities are conducted. The multiple land uses identified were incorporated into investigation objectives and risk assessment determination.

The main output of the Jacobs Smelter DQO process has been a description of the contamination problem with its regulatory and programmatic decision context and the OU2 conceptual site models (CSMs). The OU2 Human Health CSMs are discussed in Section 6.1 of this report and presented in Figures 6-1 and 6-2. As part of the ongoing DQO process, the following Problem Statement, Principal RI Goals, and Key Decisions were identified.

Problem Statement. Several smelters historically operated in the vicinity of Rush Lake. Available data indicate that elevated concentrations of some metals attributed to these smelters and related facilities are present in soil, sediment, and water that may pose unacceptable risk to humans and to ecological resources (endpoints) in and around Rush Lake. The purpose of this RI is to acquire sufficient data to allow EPA and UDEQ to identify those areas and conditions that present unacceptable risk to humans or the site's ecological resources.

Principal Remedial Investigation Goals

- Define the general nature and extent of contamination that may pose unacceptable risk to humans or ecological receptors.
- Determine if remediation is necessary and provide information necessary to support this determination.

Key Decisions Resulting from the DQO Process and ETAG Meetings

- The smelter (and related smelter facility) source area boundaries have been identified and agreed upon.
- Existing data are adequate for delineating extent of contamination for the purposes of the RIWP. No additional sampling is needed to delineate lead concentrations down to the 100 ppm level away from these source areas. The only area where the 100 ppm lead contour may not have been completely delineated (closed) is in the northeast portion of the site. Elevation is an appropriate criterion for delineating the boundary of lead contamination in the canyon area in the northeast portion of the site.
- Lead contamination is the decision driver insofar as defining human health and ecological risk spatial boundaries for the RI and remedial decision purposes. This decision does not exclude the possibility that additional data needs, particularly with respect to remedial alternative evaluation and RD support, may be identified and addressed in some future RI phase of work.
- The Reuse Assessment Report provides the basis for categorizing the large recreational areas in terms of human use (e.g., limited accessibility) and potential exposure.

- Existing residential areas will be sampled in accordance with OU1 residential lot sampling procedures using the same sample density, including those lots that are among other densely sampled areas and have only been partially sampled.
- Adequate data will be acquired on completion of the RI sampling and analytical programs to evaluate human health and ecological risk, and a separate background study is not considered necessary.
- Decisions regarding data needs for the FS and RD will be made at a later date, as part of the FS and RD planning process, and not as part of this RI DQO process. Sampling to support FS and RD needs may be required.

The conclusions of the DQO process and ETAG meetings provide the basis of development of the RI.

1.2.3 Remedial Investigation Objectives

As stated above, the purpose of this RI is to acquire sufficient data to allow EPA and UDEQ to identify those areas and conditions that present unacceptable risk to humans or the site's ecological resources. The overall project objectives of the OU2 RI are to acquire sampling and analytical data to:

- Satisfy the additional data needs identified after completing review of the CSS, Rawhide Ranchettes Investigation and Pre-RI results, the ETAG process, and the DQO process.
- Adequately characterize the identified areas of concern within OU2, and to provide sufficient data for the completion of the ecological risk assessment (ERA) and the assessment of human health risk.
- Provide the information that will form the basis for the FS and RD processes.

To facilitate meeting these objectives, the RI has been divided into two separate efforts to address human health risk and ecological risk. To support these overall objectives, the following specific Human Health Risk objectives and Ecological Risk assessment endpoints are presented.

The human health sampling program has the following specific objectives:

- Accurately delineate the 500 ppm soil lead concentration contour near known contamination sources.
- Acquire sufficient data (combining existing data and new data) to determine distribution of metals concentrations, and specifically lead concentrations in the soils and sediments of OU2, based upon statistical evaluation.
- Acquire sufficient data (combining existing data and new data) to compare surface and near-surface soil concentrations at specific properties to site-specific human health contaminant screening levels established for various land uses.
- Determine if groundwater directly below, or immediately downgradient of, known smelter locations shows levels of site COCs that exceed screening levels.

The ecological sampling program is based on the following ecosystem-level assessment endpoints that were initially identified in the SERA.

- Protection of aquatic plant and animal communities (aquatic life).
- Protection of wetlands and plant and soil organism communities as a food base for wildlife.
- Protection of wildlife populations and their habitat.

1.2.4 Organization of the RI

The RI report has been organized into seven sections, as follows:

- Section 1 – Introduction - includes summary of previous investigations at the site as well as scope and objectives of the RI, BHHRA, and ERA.
- Section 2 – Site Characteristics - includes the location, history, climate, topography, geology, soils, hydrologic and hydrogeologic conditions, and threatened and endangered species.
- Section 3 – OU2 Field Investigations - details the procedures and practices used in the CSS, Pre-RI, and RI field investigations and laboratory analysis.
- Section 4 – Sampling Results - presents the results of all field and laboratory data collected within Jacobs Smelter OU2.
- Section 5 – Nature and Extent of Contamination - evaluates all field and laboratory data collected within Jacobs Smelter OU2 to define the nature and extent of contamination.
- Section 6 – Risk Evaluation – presents the conceptual site models for the HHRA and summarizes the results of the HHRA and the ERA.
- Section 7 – Conclusions and Recommendations.

1.3 Scope of the Baseline Human Health Risk Assessment

A Human Health Risk Assessment (HHRA) Technical Memorandum for the OU2 site has been completed (URS, 2001c). That document was the basis for the human health aspects of the RI data collection. The resultant data from this investigation, along with data from previous investigations, was used in conjunction with the Land Reuse Assessment (EPA, 2001), to complete a Second Human Health Risk Assessment (SHHRA) for the OU2 site (URS, 2003), which serves as the baseline human health risk assessment. The results of the SHHRA are summarized in Section 6 of this report.

1.4 Scope of the Ecological Risk Assessment

A Screening Ecological Risk Assessment (SERA) has been completed for Jacobs Smeleter OU2 (URS 2001a). A summary of the SERA can be found in the RI Work Plan. The final Ecological Risk Assessment (ERA) was prepared for EPA Region VIII by Lockheed Martin REAC (Lockheed Martin REAC, 2003). A summary of the ERA is presented in Section 6 of this report.

2.0 SITE CHARACTERISTICS

The following sections discuss the location, history, climate, topography, geology, soils, hydraulic and hydrogeologic conditions, ecological setting, and provide the background characteristics of Jacobs Smelter OU2.

2.1 Location

Jacobs Smelter OU2 is located within Rush Valley, Tooele County, Utah. 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 5 miles southwest of the city of Tooele, the county seat of Tooele County (Figure 1-1). According to 2000 census bureau information, the population of Tooele County was 40,735, and that of Stockton was 443.

OU2 encompasses but does not include OU1 (the town of Stockton) and OU3 (Union Pacific Railroad property). OU1 was addressed in the OU1 RI/FS (URSG, 1999c) and OU3 was addressed privately by Union Pacific Railroad. OU2 contains Rush Lake and is comprised mostly of valley floor, with it's eastern and a portion of it's western boundary extending onto the lower slopes of the surrounding mountains.

2.2 History

The Stockton area was the center of a silver- and base metal-mining, milling, and smelting district from the 1860s until 1970, but 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, the former train station and rail sidings have been removed. Land surrounding the town is used for agricultural and recreational purposes.

In April 1864, members of the 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). The district was located in the foothills of the Oquirrh Mountains in a block of land 1 to 2 miles due east of Stockton and running north for about 2 miles and south for another 2 miles. The first assays found $228 in silver per ton of ore, with the remainder nearly pure lead. The Stockton area immediately began to be used for smelting of gold, silver, and base metals after volunteer Lieutenant James Finnerty erected a small furnace. Larger furnaces were built by the Rush Valley Furnace & Smelting Company, the Monheim & Johnson Company, and J. W. Gibson by 1866. These smelters apparently operated only for a few years, then shut down. The exact locations are unknown, but several areas are suspected due to the presence of elevated concentrations of heavy metals detected in site soils collected during sampling.
In 1872, the Jacobs Smelter, owned by Lilly, Leisenring & Company of Philadelphia, went into operation within the town limits of Stockton (Guilluly 1932). This smelter processed ore from the Ophir Mining District, located 10 miles southeast of Stockton, in three vertical blast furnaces. By 1880, each of these furnaces could reduce 25 tons of ore per day and produce 5.5 tons of bullion, assaying 100 ounces of silver per ton. In other words, each furnace could produce 19.5 tons of smelter slag and flue dust per day. 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 a day. The Jacobs Smelter and Great Basin concentrator were both located within OU1 boundaries.

The Chicago Smelter opened on the eastern shore of Rush Lake at Slagtown, 2 miles south of Stockton, in August 1873 (Guilluly 1932). It was built by the Chicago Silver Mining Company, an English firm that also operated two mines in Dry Canyon. This smelter ran continuously until 1877, but was then shut

down for two years. In 1879, it was leased and operated for $1^1/_2$ additional years, but closed in 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. Both of these smelter locations are within OU2 boundaries.

The largest smelter in the Stockton area was the Waterman Smelting Works, which opened in 1871 on the site of Lieutenant Finnerly's small 1864 furnace (Guilluly 1932, p. 119). This smelter was owned by I.S. Waterman 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.

There was also mining activity to the east of Stockton in the foothills of the Oquirrh Mountians. The largest contributor to mining activities in this area was the Honerine Mine. Founded around 1900, the mine also had a stamp mill onsite 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 “ma and pa” smelters and stamp mills in the areas surrounding Stockton.

2.3 Climate and Topography

The climate of the Stockton area is subhumid, with warm, dry summers, cool winters, and wetter spring and fall periods (National Weather Service, 1999). The wettest periods of the year are March-April and October-November, with average annual precipitation of 18.5 inches at Tooele (from 1961 to 1990 data). Snow is possible between late September and early June, with a maximum reported snowfall of 2.5 feet in a 24 hour period.

Maximum daily temperatures at the Tooele airport (elevation 4950 ft above mean sea level, located 4 miles northeast of Stockton) average from 36.0 degrees Fahrenheit in December to 88.6 degrees in July. Minimum daily temperatures average from 18.6 degrees in December to 60.5 degrees in July. The frost-free season ranges from 100 to 120 days.

The topography of OU2 is dominated by the Rush Valley floor, which is generally smooth, at an elevation of approximately 5,000 feet. The eastern OU2 boundary rises approximately 300 to 400 feet into the lower slopes of the Oquirrh Mountains which continue to rise fairly steeply to elevations greater than 10,000 feet. The remaining OU2 boundaries lie on the valley floor with the exception of a small portion along the northwestern edge. Here elevations rise up to 100 feet where the boundary crosses the lower slope of South Mountain which continues to an elevation of approximately 6,600 feet.

2.4 Geology

The geology of the Stockton area is described in detail in U.S. Geological Survey Professional Paper 173 (Guilluly 1932); the summary presented in the following paragraphs has been excerpted from that report.

Rush Lake is a remnant of huge Pleistocene Lake Bonneville, which once covered most of northern Utah (Guilluly 1932). Rush Valley is separated from the Tooele Valley and Great Salt Lake by a transverse (east-west) drainage divide called South Mountain which is part of a geologic fold called the Ophir Anticline. Lake Bonneville left an age-dated series of shoreline bars and beaches. One remnant of the offshore Lake Bonneville bars and spits is located directly north of the Stockton town limit and has been named the "Stockton Bar" by geologists. The Lake Bonneville and Rush Lake lakebed deposits include well-bedded silt forming a veneer over older alluvial deposits. The smooth topography of the valley floor is due more to reworking of the older alluvium than to thick deposits of lakebed sediments because

nowhere is this veneer more than a few feet thick. Some evaporite deposits are present around the Lake Bonneville shoreline, but most of the cementing that occurs in lakebed deposits is due to the evaporation of shallow groundwater and the formation of secondary "caliche" (calcium carbonate) cement.

As is typical in the Basin and Range region of Utah and Nevada, the Oquirrh Range is surrounded by a coalescing series of alluvial fans (a bajada), which have steeply sloping apexes at the mouths of mountain canyons with flattening of the slopes as they approach the valley floor. The eastern half of OU2 sits on the lower edge of two of these steeply sloping fan deposits.

The fans/bajadas are comprised of coarsely stratified, poorly sorted, uncemented particles ranging from boulders at the mountain front to silt and sand at the lower edge. Because of the poor sorting and these grain-size variations, these fan deposits are called "fanglomerates" (from "alluvial fan" and "conglomerates"). These fanglomerates vary from hundreds of feet to 1,000 feet thick at the mountain front to a few feet thick approaching Rush Lake. Where groundwater is present at shallow depths, some caliche cementing may be found in these fanglomerates.

The fanglomerates of the Stockton area are derived from the limestone, quartzite, and shale of the bedrock of the Pennsylvanian-age Oquirrh Formation. These sedimentary rocks have been intruded, and slightly metamorphosed, by monzonite dikes and sills of mid-Tertiary (Eocene?) age. These intrusions also brought with them the hydrothermal fluids that deposited the gold, silver, lead, and zinc minerals contained in the veins that were mined for over half a century. The Stockton Mining District is located along the axis of the Ophir Anticline.

2.5 Soils

The soils of the Stockton area have been described in the United States Department of Agriculture's (USDA) Soil Survey of Tooele Area, Utah and Nevada, available on the Internet (USDA 1999). The primary soils underlying the Stockton area include the Abella gravelly loam, the Birdow sandy loam, and the Lakewin gravelly loam. These soils are described in detail in the OU1 RI Report and the CSS Report. The sampling conducted during the OU1 RI has verified these descriptions.

2.6 Hydrologic and Hydrogeologic Conditions

Rush Valley forms a closed drainage basin 36 miles long and a maximum of 18 miles wide. A transverse (east-west) drainage divide formed by South Mountain and by a Lake Bonneville-deposited sandbar named the "Stockton Bar" separates it from the Tooele Valley and Great Salt Lake. Nearly all surface drainage in the Rush Valley drainage basin is directed to Rush Lake, located at the northern extent of Rush Valley. Rush Lake receives its inflow from eight perennial streams originating in the Oquirrh Range to the east and the Stansbury Mountains to the west. These streams are: Clover, Soldier Ophir, Vernon, Bennion, Dutch, Harker, and Oak Brush Creeks. The major stream in OU2 is Soldier Creek, which heads in the Oquirrh Range approximately 8 miles east-southeast of Stockton. The valley floor of the drainage basin contains groundwater perched on bedrock at very shallow depths, causing it to be dominated by rushes and other hydrophytes at its lowest elevations.

The drainages in Rush Valley are generally short, high-gradient, ephemeral streams that carry runoff only during, and immediately after, precipitation events or during the relatively brief spring snowmelt period in the Oquirrh, Stansbury, and Onaqui mountains. The streams head in mountain gullies or canyons at gradients of 1,000 feet per mile or higher, drop to gradients of 100 to 120 feet per mile when they flow onto the alluvial fans ringing the valley floor (bajadas), and drop further, to a mere 10 feet per mile, in the playa area on the valley floor.

Because Rush Lake is located in a closed drainage basin, its level is completely dependent on the ratio of runoff to evaporation occurring each year in Rush Valley. The level and size of Rush Lake has dramatically fluctuated during the 150 years since the Lake was first documented in the historical record. During the mid-1800s, runoff increased and the Lake level peaked in 1877 (Gilbert 1890). After this period the lake evaporated to lower elevations. Lake- and stream-deposited sediments containing mine, mill, and smelter wastes may now be found throughout the floodplains, wetlands, and dry, valley-floor pastures surrounding Rush Lake, possibly including the new subdivision west of Stockton. By 1999, a new groundwater/runoff equilibrium and a wet year apparently contributed to an increase in the size of Rush Lake that approached its historic maximum. However, in the summer of 2002, after numerous drought seasons, the lake again receded, containing virtually no water. Based on historic fluctuations, the lake level may be expected to rise and drop in the future, intermittently exposing potentially contaminated Lake sediments to agricultural and recreational users.

Shallow groundwater in Rush Valley reaches Rush Lake by a combination of subsurface and spring flow. Most of the known smelter locations in Rush Valley are located adjacent to perennial springs. Only the Waterman Smelter is known to have excavated a canal to utilize the lake as a surface water supply (Tooele County DUP, 1961). In the Rush Lake playa, where groundwater is present at shallow depths, alkali deposits may be found in the surface soils. Some of these alkali deposits are caused by the seasonal evaporation of water from Rush Lake. However, some of these deposits are also created by the capillary rise and surface evaporation of the groundwater after it has redissolved sodium and calcium compounds from the older lacustrine evaporites.

Today the hydraulically connected subsurface flow (tributary groundwater) from Soldier Creek is used for sprinkler irrigation on hay fields on both sides of Utah Highway 36. Due to the limited supply of potable surface water in Rush Valley, residents outside the boundaries of the town of Stockton utilize tributary groundwater for drinking water and other domestic and livestock uses.

2.7 Ecological Setting

Terrestrial and riparian vegetation types at OU2 are characteristic of the Great Salt Lake, Great Basin vegetation types of Utah. The topography and corresponding calcareous, and moderate to strongly alkaline, soils at OU2 strongly influence the kinds and distribution of valley bottom vegetation types. An ecological characterization of the OU2 study area was presented in the CSS and SERA. The ecological characterization included an ecological inventory containing generalized yet comprehensive data on the site's flora, fauna, vegetation (habitat) types, and habitat condition.

Vegetation types at OU2 were classified into four main groups:

- Valley bottom habitats that occupy the valley floor, excluding Rush Lake. This vegetation type is dominated by shrubs and herbaceous plants that are adapted to saline and poorly drained, alkaline soils and shallow water tables. These areas occur mainly on flat terrain below the 5,000 foot elevation.
- Upland habitats within the study area include the valley slopes and lower foothills associated with the Oquirrh Mountains on the east, Stockton Bar to the north, and South Mountain on the northwest. These habitats include grassland, shrubland, and small areas of woodland at elevations ranging from about 5,000 to 5,500 feet, on gently to moderately sloping terrain.
- Riparian vegetation, which is associated with streams in upland areas and occurs only in a portion of the Soldier Creek drainage.

- Other cover types include habitats created by human activity and areas without vegetation, including open water.

Dominant cover types within each of these four groups and dominant plant species within each cover type were mapped and described in the CSS and the SERA. The vegetation cover types in OU2 are shown on Figure 2-1.

Four general wildlife habitats exist within the Rush Lake/Jacobs Smelter OU2 study area: (1) agricultural (hayfields, etc.); (2) upland (pinyon-juniper woodlands, sagebrush, upland riparian, etc.); (3) wetland/riparian (wet meadows, springs, etc. in valley bottom); and (4) open water.

The shallow water and rush-dominated wetlands and saltgrass-, glasswort-dominated salt flats surrounding Rush Lake provide critical duck molting areas and important feeding and resting areas for numerous species of migratory waterfowl and shorebirds. Both great-blue herons and double-crested cormorants have rookeries in the small groves of large dead cottonwoods at the springs on the eastern shoreline near the Chicago and Carson-Buzzo smelter locations. Bald eagles also use these groves for roosting, although they are not known to nest at Rush Lake.

Although there are no federal or state special status plant species in OU2, several state and federally protected wildlife species are known to occur or may potentially occur. The federally threatened bald eagle, the state endangered peregrine falcon, and the state threatened ferruginous hawk and yellow-billed cuckoo are potential visitors to Rush Lake. Fourteen other bird species potentially occurring at Rush Lake are state species of special concern. Seven small mammal species that potentially occur at Rush Lake are on the state's list of special concern species. Two state-sensitive amphibians could also occur within the study area. The Toquerville springsnail, a Utah Division of Wildlife Resources (UDWR) National Heritage Program (UNHP) species of concern, occurs in Section 2 (Township 5 South, Range 5 West) of the study area.

One state-sensitive fish species (least chub) could occur in Rush Lake. However, severe fluctuations in water level and salinity have probably caused the recent die-offs of carp as well as most game fish that were historically stocked in the lake. Bald eagles and other carrion-feeding wildlife are apt to be attracted to Rush Lake during these fish die-offs.

Site-wide species lists of terrestrial and aquatic fauna were developed for the range of wildlife resources potentially occurring within OU2 and were presented in the CSS and SERA. Sources for the information presented in these wildlife lists were regional books and reports obtained from UDWR and UNHP. These tables identify the vegetation/habitat types in which the wildlife is likely to occur, each wildlife species functional (feeding) group, and regulatory status. Avian species that have been observed at the site were identified based on data gathered during the Latilong Study (UDWR, 1983).

3.0 OPERABLE UNIT 2 FIELD INVESTIGATIONS

Three major field investigations have been conducted in 1999, 2001, and 2002 as part of the RI process to characterize potential contamination in OU2 of the Jacobs Smelter Site and to provide data to assess the human and ecological exposure risk. OU2 data was also generated in 1999 as part of the OU1 investigation.

3.1 Introduction

The following section discusses the field investigation activities conducted at the site in 1999, 2000, 2001, and 2002 by UOS and URS. These investigations represent a phased approach to completion of the RI at this site. The investigations performed in 1999, 2000 and 2001 will be briefly presented as they have a direct bearing on this RI, however, all have been presented in previous documents (listed in their respective subsections) and those documents provide further detail.

The field investigations and analytical programs were performed in accordance with the respective SAPs. Due to site conditions and preliminary results, some minor modifications were made during each of the investigations to some of the procedures described in the respective FSPs. Field quality control samples were collected at the frequency specified in the FSPs and QAPPs. Sampling equipment used, sample handling and management, documentation and recording, decontamination procedures, and investigation derived waste (IDW) management were performed in accordance with the procedures described in the FSPs. The investigations were performed in accordance with the Health and Safety Plans prepared for each investigation. A summary of all samples collected, by matrix, during each field investigation is presented in Table 3-1.

3.2 OU1 Investigation

In 1998 URS Operating Services (UOS) collected soil samples in OU2 along the western boundary of OU1 on property number J251, now known as Stockton West Subdivision (UOS, 1999). The property was divided into eight zones with a six point composite sample collected from each zone using a stainless steel scoop (see Figure 3-1a for sample locations). The samples were then analyzed for lead by XRF.

In 1999 URSGWC (now URS) collected soil samples in OU2 along the eastern boundary of OU1 as part of the OU1 RI (URSG, 1999c). Sampling took place on open ground and was intended to delineate the eastern boundary of OU1. The area was divided into 27 grids with a six point composite sample collected from depths of 0-2 inches, 2-12 inches, and 12-18 inches for a total of 81 samples (see Figure 3-1a for sample locations).

3.3 1999 Contaminant Screening Study

Soil, sediment, surface water, and spring/seep samples were collected within OU2 during the period from October through December 1999. During this investigation OU2 was divided into 11 different grids (see Figure 3-2 for grid locations, refer to the OU2 CSS Report, URS 2000 for further detail) and samples were collected from approximately 500 locations within these grids (see Figures 3-1a&b for sample locations). Sampling locations were referenced to the State Plane Grid using portable Global Positioning System (GPS) units.

The CSS phase of OU2 characterization included four sampling activities:

1. Collection of soil samples in the vicinity of former smelter operations and around the shores of Rush Lake for XRF metals (sulfur, chlorine, potassium, calcium, titanium, chromium, manganese, iron, cobalt, nickel, copper, zinc, mercury, arsenic, selenium, lead, rubidium, strontium, zirconium, molybdenum, cadmium, tin, antimony, barium, silver, uranium, and thorium); Superfund target analyte list (TAL) metals (aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, molybdenum, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc); grain size; pH; alkalinity; and total organic carbon (TOC) analyses.
2. Collection of sediment and surface water samples within Rush Lake, from the shoreline of Rush Lake, and from Soldier Creek for TAL metals, pH, and alkalinity. In addition, the surface water samples were analyzed for hardness and total dissolved solids (TDS), and the sediment samples were analyzed for TOC, grain size, and XRF metals.
3. Characterization of the ecological resources of the site to identify OU2 biota of concern.
4. Limited sampling from slopes and drainages above mine sites in the Oquirrh Mountains to obtain data that may be indicative of background concentrations.

The following sections summarize the soil, sediment, and water sampling activity during the OU2 Contaminant Screening Study (CSS). In accordance with the SAP (URSGWC 1999a), the sampling and analytical methodologies were based on the specific objectives of the project, which were limited to identifying contaminated areas, establishing the boundary of OU2, providing initial data for screening-level risk assessment, performing an ecological site characterization, and providing information for an RI work plan.

3.3.1 CSS Soil Sampling Activities

During the CSS 470 surface (0 to 2 inch) soil samples and 346 deep (2 to 12 inch) soil samples were collected (not including field or lab QA samples). Samples were collected using plastic spoons in a “five-spot” pattern at the corners and center of a one-meter square, and composited to create the sample for analysis. A portable XRF was set up at the project field office to analyze samples. Approximately 10 percent of the soil samples were submitted to DataChem Laboratories (DataChem) as confirmation samples and a good correlation was obtained. An XRF metals analysis was conducted on all surface samples. Deep soil samples within ecologically sensitive areas (e.g. Rush Lake) were analyzed by XRF where the corresponding surface sample concentrations exceeded 50 ppm lead. Deep soil samples in areas associated with potential human health concerns were analyzed by XRF where the corresponding surface sample concentration exceeded 500 ppm lead, the OU1 surface soil action level.

3.3.2 CSS Surface Water and Sediment Sampling Activities

Sediment samples were collected from 29 locations around Rush Lake. The sediment samples were collected as grab samples using a stainless steel mud auger.

Surface water samples were also collected from nine locations within Rush Lake. Surface water samples were collected as grab samples by immersing the sample container directly into the water. Samples submitted for analysis of Target Analyte List (TAL) metals were preserved with nitric acid. Field water quality measurements were also collected at 15 locations within Rush Lake. A Horiba U-10 water quality testing instrument was used to measure the following parameters: pH, specific conductivity, temperature, turbidity, dissolved oxygen, and salinity.

A total of seven sediment and four surface water samples were collected from Soldier Canyon, Ophir Canyon, and Settlement Canyon. These sample points were located in canyon drainages above the OU2 area, and were selected to provide data that may reflect the background chemical and physical characteristics for the Rush Valley area. The background sediment samples were collected as grab samples. The water samples were collected as grab samples by immersing the sample container directly into the water. Samples submitted for analysis of TAL metals were preserved with nitric acid. Field water quality measurements were also collected at each location as discussed above.

Spring and seep water samples were collected from locations around Rush Lake to provide information on the chemical and physical characteristics of the groundwater. Water samples from springs and seeps were collected as grab samples by immersing the sample container directly into the water. Samples submitted for analysis of TAL metals were preserved with nitric acid. Field water quality measurements were collected at eight locations as discussed above.

3.4 2001 Pre-Remedial Investigation

On completion of the CSS, data were evaluated as part of the DQO process and a number of data gaps were identified. The purpose of the Pre-RI was to acquire additional data that could be used to focus and better define the activities to be conducted as part of the RI. The sampling program was designed to address the identified data gaps summarized below.

- Data with lower detection limits to support an ecological risk assessment
- Additional potential background data
- Additional sediment data from Rush Lake shoreline to the high water mark
- Groundwater data
- Additional data to address the insufficient spatial distribution of fixed-based laboratory analytical data

A total of 101 lake and surface (stream) water, sediment, groundwater, and soil samples were collected from 51 locations within OU2 during the period of March 27, 2001 through April 4, 2001. See Figures 3-1a&b for sample locations. All samples were submitted to the fixed-base laboratory for the analytical program described in the QAPP. Sampling locations were referenced to the State Plane Grid using portable Global Positioning System (GPS) units. A previous sampling event was conducted during late December and early January of 2000-2001 but due to problems with the chemical analytical laboratory, it was decided that a re-sampling and analytical program was required. No chemical analytical data from the initial sampling was used in generation of the Pre-RI report.

The following sections summarize the sampling activity during the OU2 Pre-Remedial Investigation. Please refer to OU2 Pre-Remedial Investigation Report (URS, 2001b) for further detail.

3.4.1 Pre-RI Soil Sampling Activities

Twenty-one shallow (0 to 2 inch) and deep (2 to 12 inch) soil samples were collected in accordance with the procedures used during the CSS described in Section 3.3.1 above. XRF analysis was not utilized during this investigation.

3.4.2 Pre-RI Surface Water and Sediment Sampling Activities

In order to address the data gap of additional sediment data from Rush Lake shoreline to the high water mark, sediment was collected from areas not colocated with surface water. A shallow and a deep sediment sample were collected from 6 locations along the Rush Lake shoreline using the same method as described above for soil samples.

Colocated sediment and surface water samples were collected both from within Rush Lake and from drainages discharging into Rush Lake from the surrounding mountains. Field water quality parameters of temperature, pH, specific conductance, turbidity, dissolved oxygen, and salinity were measured for all surface water samples using a Horiba U-10 Water Quality Meter.

Nine Rush Lake colocated samples were collected. Surface water samples were collected as grab samples by immersing a stainless steel bowl in the open water, then pouring the samples into sample containers. Samples for dissolved metals analysis were filtered in the field. Sediment samples were also collected as a grab sample from a depth of 0-4 inches using a stainless steel mud auger. Sediment samples were homogenized using a stainless steel spoon and bowl prior to placement in the sample container. Four colocated sediment/surface water samples were collected from Ophir Canyon (two samples) and Soldier Canyon (two samples). Surface water samples were collected as grab samples by immersing the sample container directly in the water. Sediment samples were also collected as grab samples, using a stainless steel spoon, from points in the streambed in the vicinity of the surface water sample where enough sediment was present for sampling.

Four colocated springs/seeps samples were collected. However, no water was present at one of the sample locations along the southern end of the lake, therefore, a grab sediment sample was collected in an area that appeared to be previously covered by water. Surface water samples were collected as grab samples as described in the section above. Samples for dissolved metals analysis were filtered in the field. Sediment samples were also collected as grab samples from a depth of 0-2 inches as described above.

3.4.3 Pre-RI Groundwater Sampling Activities

The intention of the groundwater investigation was to collect subsurface soil and groundwater samples up and downgradient of the three smelter sites (Waterman, Chicago, and Carson Buzzo). However, refusal of the direct-push sampler before reaching the saturated zone precluded the collection of groundwater samples at all of the upgradient locations. Therefore, samples were only collected at the downgradient locations at each former smelter location (see Figure 3-3 for locations). Sampling was conducted using a hydraulic direct-push technology (DPT) rig in accordance with the SAP Addendum. A URS geologist was present during the sampling to record soil boring logs and to perform sampling. However, boring logs were only recorded for the December/January event as the March/April borings were directly adjacent and therefore in the same geologic media. The resultant boring logs were included in the Pre-RI report (URS, 2001b). All push-points were advanced until groundwater was encountered at a depth of 12 to 24 feet below ground surface.

<u>Subsurface Soil Sampling</u>

One subsurface soil sample was collected at each of the three former smelter sites (Waterman, Chicago, and Carson-Buzzo Smelters). The samples were collected from the bottom of each direct-push location at the top of the saturated zone. All samples were grab samples taken directly from the sample sleeve.

<u>Groundwater Sampling</u>

Each of the three boring locations was downgradient of the former smelter location. Three groundwater samples were collected using a peristaltic pump. Total and dissolved metals analysis was performed on each sample. Samples for dissolved metals analysis were filtered in the field. Water quality parameters, including temperature, pH, specific conductance, turbidity, dissolved oxygen, salinity, and Eh were recorded during purging. Purging continued until parameters had stabilized at which point the sample was collected.

3.5 2002 and 2003 Remedial Investigation

Remedial investigation (RI) sampling was conducted in two phases. The first phase took place in April and May of 2002, covered numerous areas (residential, recreational, etc.) within OU2, included soil and groundwater sampling, and constitutes the majority of the RI samples. Based on the results of this 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. The following sub-sections describe each sampling event.

3.5.1 2002 RI Sampling

The 2002 RI sampling included collection of both abiotic and biotic samples for chemical analyses to support the data needs identified through the DQO and ETAG processes for human health and ecological risk scenarios. Because of the difference in the type of data required to support the two risk scenarios, sampling was divided into two separate efforts, one to support the human health risk assessment and one to support the ecological risk assessment.

Abiotic samples were collected by URS (April 22 through May 7 of 2002) to support the human health risk analysis. This sampling was similar to previous sampling efforts in methodology and is summarized in the following sections. Biotic, and corresponding abiotic, samples were collected by Lockheed Martin REAC (May 2002) to support the ecological risk assessment. These sampling activities are described in detail in the RI Sampling and Analysis Plan Addendum (URS, 2001e) and in the Ecological Risk Assessment (Lockheed Martin REAC, 2003).

URS collected sediment, groundwater, and soil data to address two different data needs identified from the previous investigations, as well as the DQO and ETAG processes. The first data need was to delineate the 500 ppm surface soil lead contour within OU2. The second data need was to provide adequate data coverage to support the HHRA. Sampling locations were referenced to the State Plane Grid using portable Global Positioning System (GPS) units.

All samples were submitted to the CLP Program lab American Analytical & Technical Services, Inc. located in Broken Arrow, Oklahoma.

3.5.1.1 2002 RI Soil and Sediment Sampling Activities

From April 22 to May 1 of 2002, a total of 97 soil/sediment samples were collected (see Figures 3-1a&b for locations). All of the sediment samples included in this RI effort were located within the floodplain footprint of Rush Lake and not colocated with surface water. Therefore, they were all collected using soil-sampling techniques.

A portable XRF unit, provided by the UDEQ, was used during sampling to initially screen the sample locations identified in the RI work plan. The procedure used with the portable XRF unit differs from that used during the CSS. The portable XRF unit is simply placed on the ground and only analyzes the small area it is placed over. However, during the CSS, samples were first composited from a 1 meter square area (using the same techniques used for ICP analyzed samples) and then analyzed by XRF. In order to provide an initial independent verification of the portable XRF accuracy three soil samples were collected at XRF screened locations and were analyzed for lead at a local laboratory. The XRF and laboratory data sets showed a fair correlation.

For the samples collected to meet the 500 ppm contour delineation goal, if the XRF screening concentration was above the 500 ppm level, the sample location was moved in the near vicinity (generally

up-gradient) of the original point until a reading of 500 ppm or lower was obtained. At that point, a sample was collected for analysis at the fixed-based laboratory. For the samples collected to meet the greater data adequacy goal, the sample was analyzed by the fixed-based laboratory regardless of the XRF screening concentration.

Shallow (0 to 2 inches) and deep (2 to 12 inches) soil/sediment samples were collected using the same methodology described in Section 3.3.1 for the CSS. All samples were sent to a CLP laboratory and analyzed for TAL metals.

3.5.1.2 2002 RI Groundwater Sampling Activities

Groundwater samples were collected during the Pre-RI using direct-push technology (DPT) methods. It is suspected that this methodology resulted in groundwater sample contamination from surface soils. Therefore, as part of the RI sampling effort, in an attempt to more accurately characterize the groundwater at each of the former smelter sites, four permanent monitoring wells were installed as described below.

Monitoring Well Installation

Four monitoring wells were installed at the three historic OU2 smelter sites during the week of April 29, 2002. Monitoring well locations are shown in Figure 3-3. All monitoring wells were installed using a Morl M-10 auger rig with 4.25”Inner Diameter/8”Outer Diameter augers. Sampling was done continuously using a standard penetration test split spoon sampler in all wells except for monitoring well 061 (located at the former Waterman Smelter), which was installed to a total depth of 100 feet below ground surface (bgs). Sampling in monitoring well 061 was done continuously to a depth of 60 feet bgs and every five feet there after. All wells were installed using schedule 40 PVC casing, 0.010 slot screen 10/20 filter sand pack, bentonite chip seal, and bentonite grout. Filter sand pack was installed to approximately two feet above the top of the screened interval, approximately two feet of bentonite chips were place on top of the sand pack and hydrated. Bentonite grout was placed on top of the hydrated bentonite chip seal. The wells were completed at the surface with a flush mount manhole that was concreted in place. Complete well logs are included in Appendix B. A description of the well installation activity conducted at each historic smelter site is presented below.

Waterman Smelter

Two monitoring wells (MW-061 and MW-062) were installed at the Waterman Smelter location from April 29 to May 2, 2002. Monitoring well 061 was installed at the former smelter location and monitoring well 062 was installed to the south of the former smelter location.

Monitoring well 061 was installed to a depth of 100 feet bgs and is located on the Stockton Bar. The subsurface geology encountered at monitoring well 061 consisted of silt for the first two feet, then silty gravel from 2 to 18 feet bgs, silty sand from 18 to 22 feet bgs and silty gravel from 22 to 100 feet bgs. Groundwater was not encountered during the drilling of monitoring well 061. The monitoring well was screened from 60 to 100 feet bgs in an effort to capture possible perched aquifers.

Monitoring well 062 was installed to a depth of 42 feet bgs. The subsurface geology encountered at monitoring well 062 consisted of silty clay, clay, and sandy slit with some occasional gravel lenses to a depth 34 feet bgs. Silty gravel was encountered from 34 to 42 feet bgs. Approximately two feet of water was measured in the augers at 35 feet bgs. As a result the well depth was set at 42 feet bgs, however, an equilibrated groundwater level has not been documented in the installed well, which was screened from 27 to 42 feet bgs. This indicates that within the area of the Waterman Smelter, the shallow groundwater is only present in isolated, perched lenses.

Chicago Smelter

Monitoring well 085 was installed at the Chicago Smelter location on May 2, 2002. Monitoring well 085 was installed to a depth of 24 feet bgs. The subsurface geology encountered during the installation of monitoring well 085 consisted primarily of well graded gravel, however a zone of silty sand and silty clay was encountered at 23 to 25.5 feet bgs. Groundwater was encountered at approximately 15.5 feet bgs and the monitoring well was screened from 14 to 24 feet bgs.

Carson – Buzzo Smelter

Monitoring well 098 was installed at the Carson Buzzo Smelter location on May 3, 2002. The monitoring well was installed to a depth of 33 feet bgs. The subsurface geology encountered during the installation of monitoring well 098 consisted of interbedded silts, clays, silty sands and silty gravels. Groundwater was encountered at approximately 26 feet bgs and the monitoring well was screened from 23 to 33 feet bgs.

Sampling Activities

Soil

Three soil samples were collected at each monitoring well location. A shallow (0 to 2 inch) and a deep (2 to 12 inch) sample were collected prior to set-up of the drill rig. These samples were collected using the same methodology described in Section 3.3.1 for the CSS. Drilling was then initiated and a sample was collected immediately above the water table at the Chicago and Carson-Buzzo Smelters and at the bottom of the boring at the two Waterman Smelter locations (due to the lack of groundwater found at these locations). These samples were collected using a standard penetration test split-spoon sampler.

Groundwater

Two groundwater samples were collected during this investigation, one each at the Chicago and Carson-Buzzo Smelter locations. No permanent groundwater was found at either of the Waterman monitoring well locations, therefore, no samples were collected. The wells were purged according to TSOPs before sampling. A Horiba U-10 water quality testing meter was used to measure temperature, pH, specific conductance, turbidity, dissolved oxygen, salinity, and Eh at each location. Samples were collected using a Grundfos submersible sampling pump and were preserved with nitric acid. Samples for dissolved metals analysis were filtered in the field.

3.5.1.3 Deviations from RI Sampling Analysis Plan

During the investigation, some adjustments to the methods and procedures described in the SAP were necessary. However, the objectives described in the SAP were supported throughout the investigation. The principal modifications are summarized below:

- The proposed sample points located on Union Pacific Railroad property were relocated, as access was not allowed. These sample points were relocated to adjacent properties.
- While attempting to locate proposed points with the XRF for delineation of the 500 ppm lead contour in the northeastern corner of OU2, an area of orange stained soil was discovered. In this area, it was difficult to find locations to sample that were below 500 ppm lead. Therefore, on direction from UDEQ, an extensive XRF survey was conducted in the northeast corner of OU2 to delineate the stained soil and the areas of high lead concentration.

- The portable XRF was not originally proposed for use during the sampling that was conducted to meet the goal of data adequacy. However, during the field effort, UDEQ decided to be present with the XRF for all sample points.
- As described above in Section 3.4.2, although four groundwater samples were proposed, only two samples were collected due to the absence of groundwater.
- Initially only soil/sediment samples collected outside an EAPC (Ecological Area of Potential Concern) boundary were to be analyzed for the full suite of TAL metals. However, after finalization of the SAP, UDEQ decided to analyze all samples for the full suite of TAL metals.

3.5.2 February 2003 RI Residential Sampling

Based on the results of previous sampling, it was determined that additional soil data were required for the residential properties along the northern half of the B&B Subdivision (see Figure 1-2 for sample locations). This sampling was conducted February 11-12 of 2003 in accordance with protocol developed for residential sampling in OU1. The following four properties were sampled, J2-47, J2-48, J2-49, and J2-50. Each property was divided into zones based on use and size, with properties J2-47 and J2-50 having four zones and J2-48 and J2-49 having five zones (see Figure 4-5 for zone locations). A five point (one point approximately 50 feet in from each corner and one point in the center of the zone) 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 of 72 samples. See Appendix B for the associated soil sampling logs. Each sample was analyzed at a fixed-base laboratory for lead and arsenic.

3.5.3 RI Sample Identification

A total of five fields (areas within the sample identification) were used to represent the sample identification as described below, with the exception of the RI residential sampling, whose identification is described at the end of this section:

1. The first field is comprised of two characters “RI,” which designated the Remedial Investigation.
2. The second field is comprised of one character, which designates the depth of the sample or whether the sample is biological. The letters S, D, W, and G designate shallow, deep, surface water, and groundwater, respectively. The letter B designates the sample as biological.
3. The third field is comprised of three numerical digits, which designate the location number.
4. The fourth field is comprised of two characters, which designated the sample matrix. The letters SD, SO, SW, and GW designate sediment, soil, surface water, and groundwater, respectively.
5. The fifth field is comprised of one character, which designates the sample type. The letters Z, G, and Y designate composite soil sample, grab sample, and field duplicate sample, respectively.

An example would be the deep (2 to 12 inches) composite soil sample collected from location 017: RID017SOZ. The RI investigation has not been organized into grids for the sampling program, and therefore the “grid” field included in sample identification for previous OU2 investigations is not required.

The RI residential sample identification is also comprised of five fields, separated by hyphens, as described below:

1. The first field is comprised of two characters “RI,” which designated the Remedial Investigation.
2. The second field is comprised of five characters, which designate the property sampled.

3. The third field is comprised of one digit, which designates the zone within the property.

4. The fourth field is comprised of four digits, which designate the depth interval sampled, with 0002 representing the 0-2 inch interval, 0206 the 2-6 inch interval, 0612 the 6-12 inch interval, and 1218 the 12-18 inch interval.

5. The fifth field is comprised of one character, which designates the sample type. The letters Z and Y designate composite soil sample and field duplicate sample, respectively.

An example would be the 6 to 12 inch composite sample collected from zone 3 of property J2-49: RI-J2/49-3-0612-Z.

4.0 SAMPLING RESULTS

Jacobs OU2 has been under investigation since 1998 and has been subject to numerous sampling events. Therefore, to fully describe the sampling that has taken place in OU2 in a comprehensive manner, the results of previous sampling activities are summarized in Sections 4.2, 4.3, and 4.4. The results of the 2002 Remedial Investigation sampling activity are presented in Section 4.5. Table 3-1 presents a summary of total samples collected during each event.

4.1 Introduction

The results from each of the investigations are discussed separately. However, for purposes of evaluating the nature and extent of contamination, the resultant data have been integrated and are presented graphically as one comprehensive data set. It is this data integration that is the basis used in evaluating the site. The results of previous investigations are summarized here (these investigations are presented in their entirety under separate cover, please refer to the reports referenced in Section 3.0 for further details). Appendix A summarizes, in tabular format, all of the analytical results for investigations conducted in OU2. Full analytical data sets for previous investigations can be found in the corresponding reports referenced in the following sections. Appendix D of this document presents the complete set of RI analytical data, including the data validation performed by the EPA's Contractor.

4.2 OU1 Investigation

The OU1 investigation included two sample areas that, subsequent to OU1 boundary definition, became part of OU2. The first area, sampled in 1998 by UOS, is west of the OU1 boundary on property J251 (Stockton West Subdivision). Eight surface samples were collected and analyzed by XRF for lead and arsenic (UOS, 1999). The lead concentrations for these samples ranged in value from 410 ppm to 3,600 ppm. Arsenic was not detected in these samples using the XRF, likely due to the interference of high lead concentrations.

The second area, sampled in 1999 by URS, is along the eastern boundary of OU1. The area was divided into 27 sample parcels and composite samples were collected from three depths (0-2 inches, 2-12 inches, & 12-18 inches) in each parcel. The samples were analyzed at a fixed-base laboratory for total arsenic and lead (URSG, 1999c). Lead was reported as detected in all of the samples, ranging from 25 ppm to a maximum of 2,200 ppm. However, the dominant trend was for the highest concentrations of lead to be present in the 0-2 inch depth range and for lead concentrations to decrease with depth. Twelve of the 27 0-2 inch composites reported lead concentrations above 500 ppm. Five of the 2-12 inch composites reported lead concentrations above 500 ppm and none of the 12-18 inch composites exceeded lead concentrations of 500 ppm. These sample results formed the basis for establishing the eastern OU1 boundary.

Table 4-1 summarizes the samples within OU2, that were sampled during the OU1 investigation, which exceed residential action levels for lead and arsenic. See Table A.1 in Appendix A for a summary of the complete analytical results for the OU2 portion of the above investigations. Figures 4-1a, 4-2a, 4-3a, and 4-4a present surface and subsurface lead and arsenic concentration contours in both areas based on the above results.

4.3 2000 Contaminant Screening Study (CSS)

The CSS was the first phase of characterization of the entire OU2 area. It involved a large number of samples collected systematically to locate source areas, delineate contamination, and create a conceptual

site model. To accomplish this, OU2 was broken into eleven grid areas (see Figure 3-2 for grid locations). This section provides a qualitative summary of the affected grids and discusses if the surrounding soil, sediments, and waters are considered to be affected by former smelting activities, as evidenced by elevated levels of metal contamination. The soils are considered affected (for the purpose of the CSS) if the concentrations are greater than three times background levels in areas that are ecologically sensitive, or greater than 500 ppm lead in residential/future residential areas. The results are presented graphically (along with results from all other investigations) in Figures 4-1a through 4-4b using shaded contour intervals which represent lead and arsenic concentration ranges. Complete analytical results are tabulated in Appendix A. For further information, refer to the OU2 Contaminant Screening Study Report (URS, 2000a).

4.3.1 CSS Soil Sampling Results

Analytical results of the soil samples indicate that there are elevated levels (at least three times the background level) of some heavy metals in most of the grids. A total of 816 (470 surface and 346 deep) soil samples (not including field or lab QA samples) were analyzed by XRF. Ten percent of these samples were analyzed at a fixed-base laboratory by ICP. A good correlation was obtained between the XRF and ICP analyses.

There is a very large range of metals concentrations across the site. Of the 470 surface soil samples that were collected, approximately 175, or 37%, of the samples exceeded the OU1 residential cleanup goal of 500 ppm for lead, which is one evaluation criterion used for this OU2 study. The highest metal concentrations were located in the former smelter areas. The areas of elevated lead concentrations are generally highly localized in the immediate area around the smelters. Generally, lower lead concentrations were reported for the deep samples in comparison to the associated surface sample.

Table 4-2 presents, graphically and in tabular format, the number of surface soil & sub-surface samples collected from each grid along with the minimum, maximum and average lead concentration reported. For a complete summary of the data collected during this investigation see Appendix A, Tables A.1a, A.1b, & A.2. It should be noted that in grid 05, 60 discrete soil samples, previously archived from the OU1 Boundary investigation, were analyzed by XRF and included as part of the OU2 CSS data set to provide additional metals data along the eastern edge of that grid.

A brief summary including a qualitative evaluation of contaminant levels and the approximate extent of the contamination is provided below. The reader is directed to Section 3 of the CSS Report (URS, 2000a) for a more detailed discussion including concentrations and soil sample locations.

- Grid 01 (Waterman Smelter) has elevated metals concentrations. The highest measured XRF lead values in OU2 were reported from Grid 01, with several samples having lead concentration in the percent range. The contamination around the smelter site generally has an elliptical shape centered on the former smelter location.
- Grid 02 (West of Stockton) has elevated metals concentrations. The grid did not contain any known source of contamination and was most likely impacted by the Waterman Smelter to the west and the Jacobs Smelter and Great basin Concentrator, which were located to the east and upgradient in the town of Stockton. The contamination in this area appears to be due to direct deposit of materials from the former smelter activities (stockpiling) as well as runoff from the east. The higher contamination areas appear to be confined to a relatively long, narrow area that is probably attributable to material being carried along the ravine crossing the area or transported along haul roads.

- Grid 03 (Chicago Smelter) has elevated metals concentrations, although the maximum lead concentration in Grid 03 is significantly lower than concentrations reported from the Waterman Smelter area. The area of elevated metals in the soils generally has an elliptical shape, centered on the former smelter location. A moderate amount of slag remains in the area in the vicinity of the spring that was used as a source of water for the smelting process.
- Grid 04 (Carson Buzzo Smelter) has moderately elevated metals concentrations. The extent of the area of elevated metals in the soils is limited and the exact location of the smelter has not been identified through this sampling effort. The elevated metals concentrations lie on either side of SR 36 which suggests that the smelter formerly was located near the present alignment of SR 36.
- Grid 05 (East and South of Stockton) has relatively low elevated metal concentrations with no obvious source near this area. This grid was intended to delineate the extent of contamination in OU1 that extended south and east of town of Stockton. It is considered that the extent of elevated metals to the south of the town was identified; however, the elevated metals concentrations extend eastward into the Oquirrh Mountains where mining activity has historically taken place. Sampling was discontinued in this direction as the area was outside of the proposed OU2 sampling effort.
- Grid 06 (Mouth of Soldier Canyon) has relatively low metals concentrations that are near background levels considered typical for this region. This site was suspected to contain the former town of Martinsville but the sampling suggests that there is no obvious source in this area.
- Grid 07 (North of Stockton) has moderately elevated metals concentrations in the soils near the emergency removal action stockpile and higher metals concentrations east of SR 36. These percent level concentrations east of SR 36 are likely due to mining activities in the Oquirrh Mountains to the east, and may not be due to smelting activities. The elevated metal concentrations are relatively uniform west of SR 36. East of SR 36 the concentrations increase nearer the Oquirrh Mountains.
- Grid 08 (Rush Lake Shoreline) generally has metal concentrations near background levels with a few individual locations that have slightly elevated concentrations. It should be noted that the shoreline and Rush Lake (Grid 09) are the more ecologically important grids in OU2 because of the wetlands that are present. Highly localized areas of significant soil metals concentrations occur to the east, around the former smelters, notably the Chicago and Carson Buzzo smelters. The Waterman Smelter is located further away from the lake and appears to have impacted the current shoreline to a lesser extent. Additionally, calcium and strontium, are present at significantly elevated levels along the southern portion of the lake. However, this does not appear to be related to activities at the former smelter sites. These levels may reflect a natural enrichment from repeated evaporation and growth lake cycles or a source outside and to the south of OU2.
- Grid 09 (Rush Lake) sampling included sediment and surface water samples only (covered below).
- Grid 10 (Discretionary Samples) has a wide range of metals concentrations, as would be expected due to the large and varied area that was sampled. Most of the samples had low metals concentrations near background levels, with the exception of a few samples collected west of the railroad and north of Silver Avenue.
- Grid 11 (Background) soil and sediment samples are in the range of typical regional background concentrations.

Although it is possible that isolated pockets of contamination within the OU2 boundary have been missed, it is felt that the significant sources of contamination and substantial areas of contamination have been identified.

4.3.2 CSS Sediment Sampling Results

During the CSS, the definition of sediment referred to only those samples colocated with surface water (i.e. lake or stream sediments). It is those samples that are addressed here. Subsequent investigations additionally define sediment as any sample collected within the former footprint of Rush Lake (from the historical high water mark to the current shoreline). A total of 35 sediment samples were collected in Grids 09 (Rush Lake) and 11 (Background) and were analyzed by XRF. Nine of these samples were also analyzed at a fixed base laboratory by ICP. A good correlation was obtained between the XRF and ICP analyses.

Analytical results for the sediment samples indicate that there are slightly elevated metals concentrations at some locations in Grids 09 (Rush Lake) and 11 (Background). The highest metals concentrations found in Rush Lake were near the Chicago Smelter. This contamination is highly localized in the immediate area of the smelter. There are two exceptions, calcium and strontium, which are present in significantly elevated levels and appear to be widespread. A brief summary of the results is provided below. The reader is directed to Section 3 of the CSS Report (URS, 2000a) for a more detailed discussion including concentrations and soil sample locations.

- Grid 09 (Rush Lake) sediment metals concentrations were reported close to regional soil concentrations, with a few individual locations that had slightly higher concentrations near the Chicago Smelter. Elevated metals soil concentrations are highly localized around the area of the former smelters, notably the Chicago and Carson Buzzo smelters. The Waterman Smelter is located further away from the lake and appears to have impacted the lake to a lesser extent. The two exceptions, calcium and strontium, as mentioned above, are present at significantly elevated levels and appear to be widespread across the southern portion of the lake. Their presence does not appear to be related to activities at the former smelter sites and may reflect a natural enrichment from repeated evaporation and growth lake cycles, or a source outside and to the south of OU2.
- Grid 11 (Background) sediment samples were collected from streams located in the Oquirrh Mountains and are considered to provide metals concentration data that may represent background levels for sediments unaffected by mining activities.

Table 4-2 presents, graphically and in tabular format, the number of sediment samples collected from both grids along with the minimum, maximum and average lead concentration reported. For a complete summary of the data collected during this investigation see Appendix A.

4.3.3 CSS Surface, Spring, and Seep Water Sampling Results

Nine surface water samples were collected from Rush Lake. These samples were analyzed at a fixed base laboratory for TAL metals, hardness, pH, TDS and alkalinity. Based on limited data, the water quality of Rush Lake can be classified as poor, as shown by average TDS of 12,000 milligrams per liter (mg/L) and average hardness and alkalinity ($CaCo_3$) of 4,800 and 275 mg/L respectively. Most metals concentrations were reported as either non-detect or at concentrations close to the reporting limits.

Seven surface water samples were collected from springs and seeps located close to the Rush Lake shoreline. These samples were analyzed at a fixed-base laboratory for TAL metals, hardness, pH, TDS and alkalinity. Based on the data acquired, the water quality of the seven springs and seeps sampled around Rush Lake is considered to be of fair quality. Water sample results reported ranges of hardness, alkalinity, and TDS of 260 to 1,100 mg/L; 130 to 410 mg/L; and 350 to 2,300 mg/L, respectively. These waters are alkaline and may be classified as very hard. Most metals concentrations were either reported as non-detect or at concentrations close to the reporting limit.

4.4 2001 Pre-Remedial Investigation Results

URS conducted the Pre-RI sampling during the period March 27, 2001 through April 4, 2001 in OU2. A total of 101 samples were collected from 51 locations. A Pre-RI sampling event was conducted during December 2000/January 2001 but due to problems with the chemical analytical laboratory tasked with conducting the analytical program, it was decided that a re-sampling and re-analysis program was required. The decision to re-sample was a collaborative decision between EPA, UDEQ, and URS. Certain attributes from the initial sampling program were used to support the March/April re-sampling event, for example, re-visiting sample locations wherever possible, use of water quality measurements, and design of groundwater program based on knowledge gained during the initial sampling. No chemical analytical data from the initial sampling was used in generation of the report.

The data acquired during the Pre-RI investigation supplements data collected during the CSS conducted in November and December 1999 and the Rawhide Ranchette data acquired in May 2000. As discussed in Section 3.4 of this report, the Pre-RI investigation was intended to fill the following data gaps identified during the DQO process:

- Data with lower detection limits to support an ecological risk assessment
- Additional potential background data
- Additional sediment data from Rush Lake shoreline to the high water mark
- Groundwater data
- Additional data to fill spatial gaps in fixed-based laboratory analytical data

The following sections summarize the results on a data gap basis. For further detail the reader is directed to the OU2 Pre-Remedial Investigation Report (URS, 2001b).

The chemical analytical results are summarized (along with results from other studies) in Tables A.1a, A.1b, & A.2 in Appendix A. A graphical representation of the results (including results from all other studies) can be found in Figures 4-1a through 4-6.

4.4.1 Lower Detection Limits to Support Ecological Risk Assessment – Pre-RI

During the evaluation of the data for ecological risk assessment purposes, it was established that metal detection limits in the CSS, even for the fixed-based laboratory analyses, were significantly higher than ecological risk levels of concern for a number of metals. In addition, metals analytical data for water were reported on a total basis only; no dissolved metals analyses were performed.

To address these data gaps, surface water and sediment samples from selected springs and seeps and drainages discharging into Rush Lake, were re-sampled to acquire metals analytical data with the lower detection limits and the specified water quality chemical and field measurement data. These samples were primarily collected within the CSS Grids 08 and 09.

Based on the reported detected results at the lower reporting limits, the initial review of all the Pre-RI data indicated that the following metals were reported as detected above the ecological risk-based screening levels:

- Lead, selenium, and thallium in surface water
- Beryllium, cadmium, molybdenum, nickel, selenium, silver, thallium, and vanadium in sediments
- Manganese in deep soils

4.4.2 Background Sampling – Pre-RI

The background data collected during the CSS was limited and, therefore, does not provide a statistical representation of the background concentrations in the OU2 area. As part of the Pre-RI, an effort was made to collect additional samples, and further, to acquire total and dissolved data for the surface water samples and improved detection limits for reporting of the chemical analytical data. However, the ground conditions present during the Pre-RI (March/April) did not allow for collection of samples in Settlement Canyon. The sample locations in Soldier and Ophir Canyon were similar to those visited during the CSS (December). Sediment and surface water samples were collected from a total of four stream locations in Soldier and Ophir Canyon. Two soil sample locations were sampled adjacent to the west side of Rush Lake.

The chemical analytical results demonstrate that metal concentrations in the surface waters, with the exception of the water quality metals (calcium, magnesium, and sodium) were mostly reported as non-detect or at values close to the detection limit. Therefore, the water chemistry characteristics as shown by the total and dissolved metals results were similar. Metals concentrations were all reported within typical ranges in the associated metals results. Similarly, there were apparently no anomalously high soil metal concentrations for the locations to the west of Rush Lake.

4.4.3 Sediment Data from Rush Lake Shoreline to the High Water Mark – Pre-RI

During the CSS, permission to sample along the western and south-western shore of Rush Lake was not obtained and, as a result, there were no CSS samples collected along this stretch of the shoreline. Prior to the Pre-RI sampling, permission was obtained from the Bureau of Land Management to collect samples from their land, enabling the sampling crew to collect four of the scheduled samples along the western shoreline. Therefore, with the acquisition of these four locations along the western shoreline, chemical analytical data is available for sediments from almost the entire perimeter of Rush Lake.

4.4.4 Groundwater Program – Pre-RI

Groundwater was only encountered in the borings located downgradient of each smelter site. Groundwater was not encountered in the upgradient borings, therefore, no upgradient samples were collected for analysis. Soil samples were collected immediately above the water table in the downgradient borings. The associated groundwater sample was collected using the techniques described in Section 2.0.

Data with respect to the groundwater depths encountered and termination depths are shown below:

Smelter	Downgradient Borings			Upgradient Borings	
	Location	Groundwater Encountered (below ground surface)		Location	Termination Depths (groundwater not encountered)
		Dec/Jan	March/April		
Waterman Smelter	0102	20 feet	24 feet	0103	20 feet
Chicago Smelter	0305	13 feet	12 feet	0304	14 feet
Carson-Buzzo Smelter	0406	16.5 feet	14 feet	0403	18 – 19 feet

Almost all of the analyzed metals were reported as detected in the soil samples, with the exception of mercury and silver (at all three of the smelter sites) and molybdenum and selenium (from samples at Waterman and Carson-Buzzo). However, the results may be considered to be within a reasonable range, considered representative of regional soils, for these metals.

Groundwater samples were submitted for both total and dissolved analyses. The dissolved (filtered) analytical results were evaluated against the State of Utah Ground Water Quality Standards (GWQS). All dissolved metals groundwater results for the Waterman, Chicago, and Carson-Buzzo smelter locations were reported below the GWQS. However, there was significant variation in the results between total and dissolved metals (see Table 4-3 for groundwater metals exceedances and the associated dissolved results). For example, the reported lead result from Waterman was 8,360 μg/L, which is significantly greater by comparison to the associated dissolved result of 9.5 μg/L. Associated groundwater information acquired from the Chicago smelter site and the springs and seeps during the CSS and Pre-RI did not detect elevated levels of lead or other associated metals. The surface soils in the vicinity of the Waterman and Carson-Buzzo borings contain elevated concentrations of metals. This, coupled with the direct-push method used to collect groundwater samples, suggest that sampling contamination contributed to the elevated total lead, arsenic and other reported metals results for the Waterman and Carson-Buzzo Smelter sites.

4.4.5 Spatial Gap in Fixed-Base Laboratory Data – Pre-RI

These data were collected to provide additional fixed-base laboratory chemical analytical data. In addition to providing an improved spatial distribution of fixed-base laboratory data, the analytical results were reported at detection limits that better support evaluation of the data for risk assessment purposes. Surface (0-2 inches) and deep (2-12 inches) soil samples were collected. Most metals were reported as detected, including metals that were reported as not detected (below the XRF detection limits) from the XRF analyses performed during the CSS. The concentrations of metals reported by the XRF analyses were compatible with the fixed-base laboratory results from these Pre-RI chemical analyses. For example, the high lead concentrations identified during the CSS in Grids 01, 03, 04, and 07, were reported correspondingly high for the Pre-RI data.

4.4.6 Summary of Status of OU2 Investigation Through the Pre-RI

The status of the decisions and issues identified on completion of the Pre-RI are summarized as follows:

1. The wetland/shoreline habitats typified by elevated soil lead levels in the vicinity of the Waterman, Chicago, and Carson-Buzzo smelters are the primary areas of ecological risk concern due to waterbird exposure.
2. Elevated levels of metals occur in or near the current residential areas and areas that are currently platted for future residential development. These areas primarily extend to the west and northwest of Stockton (extending to the Waterman Smelter Site) and to the north and northeast of Stockton. Areas identified for potential future residential land use are described in the Draft Reuse Assessment Report (EPA, 2001).
3. Principal large smelter locations in the OU2 area have been identified on the basis of elevated metals concentrations in soils.
4. Results presented in the CSS show that some areas, such as Grids 06, 08, and most of Zone 10, have no indication of contamination from mining and smelting activities.
5. Background data are adequate for screening COCs and preparing the RIWP.
6. Additional groundwater data may be required to establish that no concerns exist regarding contamination of a potential drinking water aquifer, although dissolved metals results for groundwater samples provide a preliminary indication that groundwater meets GWQS criteria.
7. Elevated soil lead concentrations (greater than 5,000 mg/kg) were identified on BLM property to the northeast of Stockton.
8. The OU2 boundary has been reasonably determined for most of the perimeter (See Figure 1-1).

4.5 2002 Remedial Investigation Results

URS conducted the majority of the RI sampling during the period April 22 through May 7 of 2002 in OU2. A total of 194 soil/sediment samples (surface plus subsurface) were collected from 97 locations. Four monitoring wells were installed and three soil samples were collected, one from each downgradient boring location. Two groundwater samples were collected, one from each of the two monitoring wells where groundwater was encountered. Two wells installed to depths of 42 and 100 feet at the Waterman Smelter Site did not encounter sufficient groundwater for sampling purposes. See Figure 3-3 for sample locations.

The samples were analyzed by an EPA CLP Laboratory. Validated laboratory data was received from the EPA and is included in Appendix D. Validation reports were completed for approximately 20% of the analyzed data and are included in Appendix D.

4.5.1 RI Soil and Sediment Sampling Results

All of the sediment samples collected during this RI Investigation were located between the Rush Lake shoreline and the historic high water mark. They were not colocated with water and were collected in the same manner as soil samples. Surface (0-2 inches) and subsurface (2-12 inches) samples were collected at 97 locations within OU2. Tables A.1a and A.1b in Appendix A summarize the analytical results for these RI samples (as well as samples from previous events).

The analytical results were combined with the previous data set to create isoconcentration maps for analytes of concern identified in the SHHRA (URS, 2003). These maps are shown on Figures 4-1a through 4-4b. The 500 ppm surface lead contour was delineated and is shown on Figures 4-1a&b. The results of the RI sampling were included in the project database and used to complete the SHHRA (URS, 2003).

4.5.2 RI Groundwater Sample Results

Groundwater monitoring wells were installed at each of the historical smelter locations (Waterman, Chicago, and Carson Buzzo) with two wells being installed at the Waterman Smelter. Data with respect to the groundwater depths encountered and termination depths are shown in the table below:

	Downgradient Borings		Upgradient Borings	
Smelter	**Location**	**Groundwater Encountered (below ground surface)**	**Location**	**Termination Depth / No Groundwater (below ground surface)**
		April/May		**April/May**
Waterman Smelter	062	No Groundwater Found Terminated at 42 feet	061	100 feet
Chicago Smelter	085	15.5 feet	-	-
Carson-Buzzo Smelter	098	26 feet	-	-

Three down-hole soil samples were collected (one at each downgradient monitoring well). All of the soil lead results were low (below 11 ppm). Only two groundwater samples were collected, as no groundwater was encountered at the Waterman Smelter well locations. Table 4-3 presents groundwater samples (both RI and Pre-RI) that exceed the USEPA Region 3 RBCs for tap water. The associated results from measurement of physical water quality parameters are presented in the table below. With the exception of

arsenic and thallium (which has two non-detect results where the detection limit is above the RBC), the RI groundwater metals results are all below the Region 3 Tap Water RBC's. Table A.2 in Appendix A contains a complete summary of the RI groundwater analytical results (as well as samples from previous events).

Monitoring Well	pH	Conductivity (ms)	Temperature (°C)
085 (Chicago Smelter)	7.86	0.478	11.9
098 (Carson-Buzzo Smelter)	7.66	0.601	13.0

4.5.3 RI XRF Survey Results

Several areas of high lead concentration were identified during the portable XRF survey associated with locating some of the sample points for the 500 ppm isoconcentration data need. URS and the UDEQ pursued these areas with the portable XRF and found that several drainages in the foothills to the east of Stockton have lead concentrations exceeding 2000 ppm, up to a maximum concentration of 42,400 ppm. These drainages are downgradient from historic mining operations, with the highest concentrations found downgradient from the Honerine Mine. Figure 4-7 shows the XRF locations and provides a table with the associated results.

To determine if the results of the portable XRF survey were of sufficient quality to include for surface lead contouring purposes, a regression analysis was conducted. For 77 of the 97 surface soil RI samples that were sent to a fixed-base laboratory for ICP analysis there was also a portable XRF result at the same location. The regression analysis performed on this data set (shown in Table 4-4) shows an overall R Square of 0.5 (where R Square is a measure of the strength of the linear association between the XRF result and the ICP result; a direct linear association would have an R Square of 1.0) which indicates that the XRF data generally do not provide a good representation of what the ICP result would be. The XRF results tended to be lower than the ICP results. Therefore, the XRF results were considered to be of screening quality and not included in the data set used to produce the surface lead isoconcentration map. However, the results of the XRF survey are of substantial value in assessing areas of undelineated contamination and indicating data gaps to be addressed in future phases of the Jacobs OU2 work.

4.6 February 2003 RI Residential Sampling Results

Sampling on four residential properties (J2-47, 48, 49 and 50), along the north of the B&B Subdivision in OU2, was conducted February 11 through 13 of 2003. A total of 72 five-point composite soil samples were collected from these properties at 4 depths (0-2 inches, 2-6 inches, 6-12 inches and 12-18 inches) on a total of 18 zones, as described in Section 3.5.2. The samples were analyzed at a fixed-base laboratory for lead and arsenic. A summary of the analytical results can be found in Appendix A and a complete set of the analytical results can be found in Appendix D.

Of the 18 zones sampled on the four properties, only two properties (J2-49 and 50), and only one zone within each property, had composite soil results that exceeded residential action levels for lead (500 ppm for surface soil and 800 ppm for subsurface soil). No properties exceeded the residential action level for arsenic (100 ppm for surface and subsurface). Table 4-5 summarizes the properties, zones, and depths with residential lead composite soil sample exceedances. Figures 4-5 and 4-6 show where those exceedances are located in the surface and subsurface respectively.

5.0 NATURE AND EXTENT OF CONTAMINATION

The nature and extent of contamination was determined from review of all of the OU2 data and is presented below. Figures 4-1a through Figure 4-4b present the lead and arsenic isoconcentrations for surface (0-2 inches) and subsurface (2-12 inches) depth intervals.

5.1 Nature of Contamination

The nature of the contamination at the Jacobs Smelter OU2 site consists mainly of lead and arsenic in site soils (with a small amount of manganese and antimony) and arsenic in the surface water. Lead and arsenic are naturally occurring elements that are present in the sulfide ores that were processed at the smelters (Waterman, Chicago, and Carson-Buzzo). The ore was extracted from the numerous mines above the Rush Valley. The smelting process involved the crushing and melting of sulfide ore in order to concentrate the desired metals. This crushing process likely released arsenic, lead, and other metals from the rock matrix in the form of dust. In addition, flue ash from the smelting process likely contained concentrated levels of these metals and this would have settled across the Smelter sites and vicinity.

Chemical speciation analysis was performed for the residential soils found in OU1 of the Jacobs Smelter site (ISSI, 1999). Although the contamination in OU2 was generated by different smelters, it originated from the same mine ore as the contamination found in OU1. Therefore, it is considered to be of similar chemical composition. The OU1 lead and arsenic speciation results indicated that the majority of the lead mass in soils was in the form of lead carbonate (cerrusite) and the majority of the arsenic mass was in the lead arsenic oxide particles. The majority of both the lead and arsenic-bearing particles occurred in the fine fraction of the soil. Lead carbonate is a highly soluble species of lead and is therefore highly bioavailable to both humans and animals. Determining the relative bioavailability (RBA) of arsenic in site soils would require testing of animals from the site for this purpose, which was not done. Comments on the RBA of arsenic present in the OU1 site soils are based on similar soils at the Murray Smelter site, where animal testing was conducted. The Murray Smelter sample was found to have an RBA of 0.63 for arsenic, which is slightly lower than the EPA Region 8 default value of 0.80, which suggests that the arsenic present is relatively less bioavailable.

5.2 Extent of Soil and Sediment Contamination

Areal Extent of Contamination

The known extent of soil and sediment contaminated by lead and arsenic is depicted in Figures 4-1a through Figure 4-2b for lead and Figures 4-3a through Figure 4-4b for arsenic. The isoconcentration contour values selected for presentation were derived in conjunction with the UDEQ and EPA and are based on the following. The low values (500 ppm and 800 ppm for surface and subsurface lead, respectively, and 100 ppm for surface and subsurface arsenic) are the OU1 residential clean-up action levels. The intermediate value for lead (3000 ppm) was chosen based on results of the ecological risk analysis (Lockheed Martin REAC, 2003) and subsequent analysis conducted by the EPA (EPA 2003). The high value for lead (10,000 ppm) and the intermediate value for arsenic were chosen based on risk-derived numbers determined in the HHRA. The high value for arsenic (500 ppm) was chosen to show a more descriptive concentration range.

Tables 5-1 and 5-2 present the surface soil and sediment samples that exceed the HHRA Phase 2 screening levels for contaminants of concern (COC) at the Site. Comparisons to both the more (cancer risk = 10^{-6}) and less (cancer risk = 10^{-4}) conservative sets of numbers are presented. Arsenic and lead are the only COCs with differing values between the two sets of numbers.

As discussed in Section 4.6, lead is the only COC with residential soil exceedances. There are only two residential properties in OU2 with soil lead concentrations exceeding residential action levels, J2-49 and J2-50. These properties are located in the B&B Subdivision and are shown on Figures 4-5 and 4-6.

Table 5-2 shows that there are five COCs with Phase 2 recreational surface soil/sediment exceedances: antimony, arsenic, lead, manganese, and mercury. With the exception of arsenic, all non-residential locations with COC exceedances are associated with a lead exceedance. As described in detail in Section 6, soil lead concentrations of greater than 10,000 ppm are considered to be human health 'hot spots' and their removal results in OU2 having an acceptable 10^{-4} human health cancer risk level for all metals. The total area (surface plus subsurface) within OU2 with soil lead concentrations greater than 10,000 ppm is equal to 25.65 acres. Similarily, the ecological 'hot spots' are those areas with soil lead concentrations greater than 3,000 ppm and their removal results in OU2 having an acceptable ecological risk level (EPA, 2003). The total area (surface plus subsurface) within OU2 with soil lead concentrations between 3,000 and 10,000 ppm is equal to 58.27 acres.

The only sediment exceedances of Phase 2 screening values are by sediment associated with surface water at the two seeps found downgradient of the Chicago and Carson-Buzzo Smelters. Only one sample was collected at each seep. Both seep samples have sediment lead concentrations above 4000 ppm. However, only the seep associated with the Carson-Buzzo Smelter has an arsenic exceedance.

Vertical Extent of Contamination

Subsurface sampling within OU2 was conducted to a depth of 12 inches. There are no Human Health Risk Phase 2 screening numbers for subsurface (2 to 12 inches) contamination, as it was determined to only evaluate surface (0 to 2 inches) contamination in Phase 2 of the Human Health Risk Assessment. However, Figures 4-2a&b and 4-4a&b show the known extent of subsurface lead and arsenic contamination.

As shown on Figure 5-1a&b and 5-2a&b, there is not a strong correlation between the extent of surface and subsurface lead contamination above 10,000 ppm or above 3000 ppm in the northern or southern portions of OU2. In other words, there are areas of surface contamination without subsurface contamination and areas of subsurface contamination without associated surface contamination.

5.2 Extent of Surface Water Contamination

Throughout the summer and fall of 2002, Rush Lake has been dry. However, during all of the sampling events water was present in the lake and samples were collected. Stream and seep samples were also collected. Table 5-3 shows the lake and stream exceedances of the HHRA Phase 2 recreational screening numbers at a cancer risk of 10^{-6}. Arsenic is the only COC that has surface water exceedances, with over half of the exceedances being by samples from the CSS that had detection limits higher than screening numbers. Samples collected during subsequent sampling events with lower detection limits did not exceed the screening numbers.

As noted on Table 5-3, there are no surface water exceedances of the HHRA Phase 2 screening levels at a cancer risk of 10^{-4}. It should be noted that the arsenic HHRA Phase 2 screening number for a cancer risk of 10^{-6} (11.2 μg/l) is approximately 5 times lower than the current primary drinking water standard for arsenic (50 μg/l), although this number is proposed to decrease to 10 μg/l in January of 2006.

5.4 Extent of Groundwater Contamination

Conclusions regarding groundwater quality are based on several phases of investigation at OU2. Groundwater sampling was conducted during the pre-RI in March 2001 and during the RI in May 2002 in the vicinity of the Waterman, Chicago, and Carson/Buzzo Smelters. Grab groundwater samples were collected by direct-push technology during the pre-RI. One sample was collected from each of the smelter locations and analyzed for inorganic parameters. The laboratory data from this investigation was inconclusive since the temporary well installed in the vicinity of the Waterman Smelter contained an elevated arsenic concentration at 46 μg/L. This information drove the decision to install permanent monitoring wells to provide more reliable groundwater data during the RI.

The RI planned for installation of four permanent monitoring wells during the field effort. Two wells were installed at the former Waterman Smelter, one well was installed at the former Chicago Smelter, and one well was installed at the former Carson/Buzzo Smelter. Both wells at the Waterman site were dry. Several thin perched saturated zones were observed during drilling at these locations, however, none of these zones yielded enough water to fill the casing and establish a water level in the well. Drilling at the second Waterman well was discontinued at a depth of 100 feet because saturated conditions had also not been encountered.

Groundwater was encountered approximately 20 feet bgs at both the Chicago and Carson/Buzzo Smelter locations. Filtered and unfiltered groundwater samples were collected from both wells and were analyzed for inorganic parameters. The concentrations of dissolved arsenic and lead from these wells were below the current State of Utah groundwater criteria and the future MCL for arsenic (10 μg/L).

Although the current data are limited, there is no evidence to suggest that the smelter activities have impacted the OU2 groundwater. Samples at the Chicago and Carson/Buzzo smelter sites showed concentrations of lead and arsenic below State of Utah groundwater criteria. Because of the low contaminant concentrations detected in groundwater found only 20 feet below smelter locations having surface soil with elevated contaminant concentrations, it is very unlikely that usable groundwater deeper than 100 feet bgs at the Waterman Smelter site would be impacted at levels that pose a risk concern.

6.0 RISK EVALUATION

A Human Health Risk Assessment (URS, 2003) and an Ecological Risk Assessment (Lockheed Martin REAC, 2003) were performed to determine the human health and ecological risks associated with contamination at the Site. The following subsections summarize each Assessment's findings.

6.1 Summary of Human Health Risk Assessment

The HHRA is an evaluation of the potential adverse effects on human health that could result from the presence or release of hazardous substances. Following is a summary of the human health risk analysis.

6.1.1 Introduction

The human health risk assessment for this project was performed in two stages. The first stage produced the "The Human Health Risk Assessment Technical Memorandum" (URS, 2001c) also referred to as the Original Human Health Risk Assessment (OHHRA) and was completed before the final RI sampling was conducted, based on data gathered up to that point. The second stage produced the "Second Human Health Risk Assessment" (SHHRA) (URS, 2003) which was based on the OHHRA and performed after RI sampling was completed in summer 2002 including those results. Neither risk assessment evaluated risks from subsurface (below 2 inches) solid media. The following discussion summarizes both assessments.

6.1.2 Conceptual Site Models

A Conceptual Site Model (CSM) is a schematic representation of the chemical source areas, chemical release mechanisms, environmental transport media, potential exposure routes, and potential receptors. The purpose of the CSM is to represent chemical sources and exposure pathways that may result in human health risks, to aid in developing a sampling plan that provides for the acquisition of data which adequately characterizes significant chemical release and migration pathways, and to aid in identifying effective remediation alternatives, if necessary, that are targeted at significant contaminant sources and exposure pathways.

Only complete exposure pathways are evaluated in risk assessment. A complete exposure pathway includes all of the following elements:

- A source and mechanism of contaminant release
- A transport or contact medium (e.g., air or soil)
- An exposure point where humans can contact the contaminated medium
- An exposure (intake) route (such as ingestion or inhalation)

The absence of any one of these elements results in an incomplete exposure pathway. Where there is no potential human exposure, there is no potential human health risk.

A CSM for residential exposure was developed by ISSI for the Jacobs Smelter OU1 site (ISSI, 1999). As residential exposure will be the same for OU2 as it was for OU1, this same residential CSM was used and is shown in Figure 6-1. It should be noted that the inhalation pathway was considered to be a minor source of exposure, and therefore, was not quantitatively evaluated in the BLRA (ISSI, 1999) conducted for OU1. A CSM for non-residential soil receptors at the Jacobs Smelter OU2 was developed as part of the OU2 HHRA and is provided in Figure 6-2.

6.1.3 Contaminants of Concern

The process of determining which analytes will become contaminants of concern (COCs) was conducted in three phases. The first phase compared all of the analytical results to the Phase 1 screening levels (Region 3 residential RBCs for solid media and Region 3 tap water RBCs for surface and groundwater). Any analyte that had (1) at least one detected result above the Phase 1 screening level or (2) at least one detection limit for a non-detect result above the Phase 1 screening level became a Phase 1 COC. The list of Phase 1 COCs was: aluminum, antimony, arsenic, cadmium, chromium VI, copper, lead, manganese, mercury, silver, thallium, uranium, and vanadium.

The analytical results for the Phase 1 COCs were then compared to Phase 2 (site-specific) screening levels which were developed in the OHHRA. These screening levels were developed for the different land uses (residential, commercial/industrial, and recreational, agricultural and grazing were considered to be recreational) and media types (soil, sediment, and surface water) present in OU2. No Phase 2 screening levels were developed specific to groundwater as potential exposure to groundwater is considered to be via surface water (where groundwater discharges to the surface) or as drinking water (assuming that it is suitable for such purpose). Therefore, groundwater results in Phase 2 were compared to both the Phase 2 surface water screening values and the Region 3 tap water RBC's. The following analytes had one or more detection limit for non-detect data that exceed Phase 2 screening levels:

- Soil: Thallium (Detection limits in older data exceed the Phase 2 residential screening level, but 1/2 detection limits do not.)
- Surface water: Arsenic (Detection limits in the older dataset exceed Phase 2 screening levels.)
- Groundwater: Arsenic (Arsenic detection limits in the older dataset exceed Phase 2 screening levels. When comparison is made to the EPA Region 3 RBCs for Tap Water, antimony and thallium are added to this list.)

The following analytes had at least one detected result that exceeded Phase 2 screening levels:

- Soil & Sediment: antimony, arsenic, lead, manganese, and mercury
- Surface water: arsenic
- Groundwater: arsenic and lead (if comparison is made to the EPA Region 3 RBCs for Tap Water, aluminum, antimony, cadmuim, manganese, thallium, and vanadium are added)

It should be noted that when the less conservative, cancer risk of 1E-4, Phase 2 screening level is used, arsenic is no longer a contaminant of concern for surface water. Therefore, at a cancer risk level of 1E-4, surface water does not pose a threat to human health.

Phase 3 of the SHHRA further evaluated exceedances in soil by utilizing EPA's 2002 draft guidance, "Guidance on Surface Soil Cleanup at Superfund Sites Applying Cleanup Levels". This phase included development of exposure point concentrations (EPCs), through statistical analysis of existing data, for three recreational exposure areas and one commercial/industrial exposure area (developed by the UDEQ and EPA and shown in Figure 6-3). The exposure areas are: recreational - northeast of Stockton, west of Stockton, and Rush Lake vicinity; and commercial/industrial – J2-3. The EPC is a statistical representation of the analyte concentration that a person may be expected be exposed to within a pre-determined area. It is based on the idea that a person is not in the same exact location for the duration of their stay in an area, but instead would be exposed to many locations within the area.

EPCs were developed within each exposure area for those analytes identified in Phase 2. The resulting EPCs were then compared to Phase 2 screening levels (at both the 1E-6 and 1E-4 cancer risk levels). Those analytes with an EPC that exceeded the Phase 2 screening levels were considered contaminants of

concern. Arsenic, lead and mercury all had an EPC within one or all of the exposure areas that exceeded the Phase 2 screening level at both a cancer risk level of 1E-6 and 1E-4. Table 6-2 summarizes the results of the Phase 3, EPC analysis.

However, further analysis was also conducted to determine if removal of areas with high analyte concentrations would result in EPCs that did not pose a risk to human health. Therefore, if the EPC exceeded the Phase 2 screening level then all data associated with lead "hot spots" were removed from the data set. Lead "hot spots" are those areas where lead concentrations exceed 10,000 ppm (i.e., mg/kg). This lead concentration value was provided by the agencies – the presumption is that these areas will be remediated. A revised EPC (REPC) was then statistically calculated for those analytes in exceedance and compared to the Phase 2 screening level. If the REPC exceeded the Phase 2 screening level then all analyte-specific "hot spots" (areas exceeding 3 times the Phase 2 screening level) were removed from the data set and statistical analysis was repeated for the analytes in exceedance, resulting in a second REPC (SREPC). The SREPC was then compared to the Phase 2 screening level. No further statistical analysis was conducted past the SREPC.

6.1.5 Human Health Risk Assessment Conclusions

There are areas within Jacobs Smelter OU2 that may pose a risk to human health from surface soil or water metals concentrations based on comparison to the Phase 2 Screening Levels developed for the different land uses within OU2. Figures 6-4a and 6-4b show the sample locations that exceed the Phase 2 Screening levels for each COC and sample matrix. Table 6-1 summarizes the Phase 2 Screening Levels for each contaminant of concern that had a sample result which exceeded the associated number in the respective land use category. Table 6-2 summarizes the results of the Phase 3, EPC analysis.

When an EPC analysis is done (described above and in further detail in the SHHRA), the following conclusions are made.

- When Phase 2 screening levels are based on a cancer risk of 10^{-6} and soils with greater than 10,000 ppm lead and greater than 3 times the arsenic screening levels for soil and sediment are removed, arsenic still has EPCs exceeding risk based screening levels in all but one exposure area (area 2) and lead still exceeds risk based screening levels in the commercial/industrial exposure area.
- When Phase 2 screening levels are based on a cancer risk of 10^{-4} and EPCs are calculated for the different exposure areas, the only area with analytes that exceed the Phase 2 screening levels is area 2 (the former Waterman Smelter area) shown on Figure 6-3. Removal of soils with greater than 10,000 ppm lead results in no areas with analytes having EPCs that exceed the risk based screening levels.

6.2 Summary of Ecological Risk Assessment

Following is a summary of the *Final Report Ecological Risk Assessment Jacobs Smelter Site, Stockton, Utah* (Lockheed Martin REAC, 2003) performed by Lockheed Martin REAC for the U.S. EPA Environmental Response Team Center (ERTC). This ecological risk assessment (ERA) generated site-specific ecological and contaminant data for the Jacobs Smelter OU2 site. It was designed to evaluate potential threats to ecological receptors in the terrestrial and aquatic systems (Rush Lake and the surrounding terrestrial area) from exposure to site contaminants by looking for ranges of toxic effects. Sampling took place during May of 2002 and consisted of soil, sediment, water, plants, invertebrates and small mammals. Contaminant concentrations were compared to benchmark values to determine whether they posed a direct risk to biota. Analytical data generated from these samples were also used in food chain exposure models to determine whether they posed a risk to higher trophic level organisms.

The ERA concluded that both aquatic and terrestrial biota are at risk from the contaminants associated with the Jacobs Smelter OU2 site. However, risk at the site appears to be driven by lead concentrations in soil. The area in the immediate vicinity of the historical location of the Chicago Smelter and the area to the northeast of the town of Stockton exhibit the highest model calculated risk.

Based on the results of the ERA, the EPA determined that lead data derived for the Northern Flicker would be representative of the ecological risk at the site. The following table, provided by EPA in a memorandum dated May 16, 2003, presents the range and selected value of lead concentrations chosen as ecologically protective for the Jacobs Smelter OU2 site.

Ecological Cleanup Levels for Soil at the Jacobs Smelter OU2 Site		
Lead (ppm)		
Low	High	Selected
574	1,148	1,100

The range provided represents a hazard quotient (HQ) of 1 for low and 2 for high. The cleanup level of 1,100 ppm (closest to a HQ of 2) was chosen because the low value (HQ = 1) was determined from literature and based on a form of lead that is typically twice as bioavailable relative to forms of lead found in site soils. Similar to what was done for the HHRA, the EPA then conducted a "Moving Window Analysis" for surface (0-2 inches) soil (USEPA, 2003). This analysis is based on the premise that species do not occupy single points through time, but rather forage across a home-range. The home-range used for the Northern Flicker, and deemed representative of other species, was a circular area of 55 hectares. Therefore, for this analysis, a circle (or window) of 55 hectares was created and moved across the site in 100 foot increments both laterally and longitudinally and the average concentration within the moving circle was determined. All areas where the circle average exceeded the ecological cleanup goal of 1100 ppm were highlighted. Then, cleanup in those areas was simulated at three different levels (1000, 3000, and 5000 ppm) by removing the data points above these levels and replacing them with 200 ppm lead and the analysis was run again. Through this method, it was determined that cleaning up all areas above 3000 ppm would satisfy the ecological cleanup goal of an average lead exposure of less than 1100 ppm in all 55 hectare 'home-range' areas.

7.0 CONCLUSIONS

This Remedial Investigation report contains adequate information for Risk Managers to confidently determine preliminary clean-up goals and action levels for the Jacobs Smelter OU2 site. As described in Section 4.5.3, specific data gaps exist (e.g. northeast of the Town of Stockton), however, they will not affect the -30%/+50% error associated with feasibility study cost estimates. Therefore, these data gaps can be most effectively addressed during remedial design.

Maps within the RI report show areas where lead and arsenic soil concentrations exceed human health-risk criteria. The ecological risk assessment and the human health risk assessment were performed to aid in determining specific action levels relative to at-risk populations in the Jacobs OU2 area. The following conclusions are made regarding the nature of contamination as it relates to risk:

- The Conceptual Site Model (CSM) for residential exposure within OU2 (Figure 6-1) is the same as the Jacobs OU1 CSM. Residential children and adults are deemed at risk to lead and arsenic contaminants through oral ingestion of dust and soil from former smelter stack emissions or discrete waste piles.
- HHRA residential scenarios exist that constitute unacceptable risk to the public. These are areas where soil lead concentrations exceed 500 ppm and 800 ppm, for surface (0-2 inches) and subsurface (2-18 inches) respectively. These areas should be addressed in the feasibility study to determine suitable remediation alternatives.
- A CSM for non-residential exposure (Figure 6-2) shows that certain recreational activities in the Rush Lake area may pose health risk through oral ingestion or dermal contact with surface water or surface soil. There are areas within the Jacobs OU2 site where metals concentrations in soil exceed the HHRA Phase 2 Screening values for non-residential use. These areas are generally centered around the former smelter locations (Waterman, Chicago, and Carson-Buzzo), and to the northeast of the Town of Stockton. However, OU2 was also divided into exposure areas by the EPA and UDEQ (three recreational and one commercial/industrial) and a statistical, human health risk analysis was conducted on the data within these areas. The analysis concluded that the only area that exceeded human health screening values was recreational area 2 (the area around the former Waterman Smelter). It was further concluded that removal of soil within recreational area 2, where lead concentrations exceed 10,000 ppm, would result in exposure point concentrations for all metals that are below the Phase 2 Screening values for a cancer risk of 10E-4.
- Surface water within OU2 is primarily composed of intermittent Rush Lake waters. Throughout the summer and fall of 2002, Rush Lake has been dry. However, water existed in Rush Lake in the past (and more specifically during the RI sampling events). Arsenic is the only contaminant of concern exceeding HHRA recreational screening levels in surface water and only at a cancer risk equal to 10^{-6}. There are no surface water exceedances for a recreational cancer risk of 10^{-4}.
- The ERA (performed by an EPA contractor other than URS) is based on the assessment endpoints, the hazard quotients (HQs), and associated assumptions presented in the ERA. The HQs provided for each analyte represent the ratio of the exposure doses divided by lowest-observed-adverse-effect-level-based (LOAEL-based) benchmark doses. If the calculated HQ for an analyte, location, and representative species (i.e., receptor) is greater than 1.0, there is the potential to produce an adverse effect on survival, growth, or reproduction of the receptor (Lockheed Martin REAC, 2002). The ERA determined that lead concentrations in soil pose the primary ecological risk at the site. From the ERA, the EPA chose the Northern Flicker to be the representative species for the site and from the high and low soil lead values (representing HQs of 1 and 2 respectively), selected 1100 ppm as the ecological cleanup goal.

The values selected by the EPA as preliminary remediation goals and action levels are as follows:

Scenario	Preliminary Remediation Goals		Action Levels	
	Arsenic	Lead	Arsenic	Lead
Residential (Surface)	100	500	100	500
Residential (Subsurface)	100	800	100	800
Industrial/Commercial	NA	2200	NA	10,000
Recreational	NA	4200	NA	10,000
Ecological	NA	1100	NA	3,000

The selected iso-concentration contour values used for presentation purposes in the RI for lead and arsenic are presented below. The lead concentrations are based on the preliminary action levels determined necessary to meet risk goals for both human health and ecological receptors with the low value representing a residential scenario, the middle value representing an ecological scenario, and the high value representing a recreational scenario. The arsenic concentrations are based primarily on risk to human health with the low value representing a residential scenario, the middle value representing a recreational scenario and the high value providing a more descriptive range.

Selected Iso-Concentration Contour Values			
Analyte	Low Value (ppm)	Middle Value (ppm)	High Value (ppm)
Surface Lead	500	3000	10,000
Subsurface Lead	800	3000	10,000
Arsenic	100	145	500

The above residential values are the same as those used in Jacobs Smelter OU1. The above recreational values are based on the SHHRA and EPA analysis and were defined with concurrence from the UDEQ and EPA.

Currently, there are no further groundwater investigations planned for Jacobs Smelter OU 2. The following reasons support no further groundwater investigation:

- Groundwater Quality in the Vicinity of the Waterman Smelter: Only one groundwater sample was collected in this area (via direct-push drilling during the pre-RI). The concentrations of dissolved metals from this sample were below the State of Utah groundwater criteria except for arsenic. The concentration of dissolved arsenic in this sample was 45.9 μg/L, which is below the current State of Utah groundwater criteria (50 μg/L), but exceeds the future federal MCL (10 μg/L). It should be noted that this sample was collected from a perched groundwater aquifer. Because these zones of perched groundwater contain very little water (which could easily be dewatered), it is unlikely that this water would be extracted and used as an irrigation, stockwater, or drinking water source. Additionally, the total dissolved solids (TDS) reading for this sample was 5,050 mg/L, which would classify the aquifer as a "limited use, Class III, aquifer" under the State of Utah groundwater classification. Saturated conditions in the Waterman Smelter vicinity are greater than 100 feet bgs, therefore it is unlikely that leaching of surficial soil contamination could impact any usable deeper aquifers in the area.

- Groundwater Quality in the Vicinity of the Chicago Smelter: A permanent monitoring well was installed and sampled at this location during the RI. The concentrations of total and dissolved metals from this sample were below the State of Utah groundwater criteria and the future federal arsenic MCL. The TDS reading (based on sampling data from the Pre-RI) in this area is approximately 300 mg/L, which would classify the aquifer as a "pristine, Class I, aquifer" under the State of Utah groundwater classification.

- Groundwater Quality in the Vicinity of the Carson/Buzzo Smelter: A permanent monitoring well was also installed and sampled at this location during the RI. The concentrations of total and dissolved metals from this sample were below the State of Utah groundwater criteria and the future federal arsenic MCL. The TDS reading (based on sampling data from the Pre-RI) in this area is approximately 850 mg/L, which would classify the aquifer as a "drinking water quality, Class II, aquifer" under the State of Utah groundwater classification.

- Drinking Water Wells and Groundwater Quality in Rush Valley: The shallow aquifer in Rush Valley is not currently used as a drinking water source. The Town of Stockton uses surface water from Soldier Creek for their municipal drinking water source. Tooele County Health Department indicated that drinking water wells in Rush Valley must be drilled to a depth of at least 200 feet bgs to obtain high quality water since the shallow aquifer(s) contain naturally-elevated levels of TDS, chloride, and sodium. As an example, high quality water is documented from two drinking water wells several miles from the OU2 site, but at depths from 660 feet to 900 feet bgs. Water that requires treatment is produced from one drinking water well on the west shore of Rush Lake at a depth of 410 feet bgs.

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URS. 2003. Final Second Human Health Risk Assessment, Jacobs Smelter OU2. July 2003.

TABLES

Table 3-1
Summary of Samples Collected Within Jacobs Smelter OU2

Sampling Event	Soil/Sediment	Surface Water	Groundwater
UOS (1999)	8	-	-
OU1 (1999)	179	-	-
RR (2000)	181	-	-
CSS (2000)	855	20	-
PRE-RI (2001)	82	16	3
RI (2002)	204	-	2
RI (2003)	72	-	-
Total	1581	36	5

Notes:
-Numbers do not include samples collected for quality control/quality assurance purposes
-Surface and subsurface samples counted individually

Table 4-1
Summary of OU1 Delineation of Eastern Boundary and Property J251 Samples
with Lead and Arsenic Results Above Residential Action Levels

		Lead (ppm)	Arsenic (ppm)
Action Level (ppm)		500	100
Field ID	Map ID		
JBI-01Z-0002-299	670	**570J**	36
JBI-01Z-0212-299	670	**600J**	34
JBI-02Z-0002-299	673	**770J**	38
JBI-03Z-0002-299	678	**510J**	34
JBI-03Z-0212-299	678	**550J**	55
JBI-04Z-0002-299	683	**740J**	38
JBI-05Z-0002-299	687	**810J**	<8.6
JBI-05Z-0212-299	687	**630J**	41
JBI-08Z-0002-299	696	**600J**	<8.6
JBI-09Z-0002-299	698	**790J**	<8.6
JBI-10Z-0002-299	701	**790J**	<8.6
JBI-12Z-0002-299	709	**1600J**	<8.6
JBI-19Z-0002-299	732	**1800J**	**120**
JBI-19Z-0212-299	732	**770J**	56
JBI-20Z-0002-299	735	**2200J**	**150**
JBI-20Z-0212-299	735	**920J**	**100**
JBI-21Z-0002-299	738	**790J**	37J
OU1J251-01	759	**540**	nd
OU1J251-02	760	**2800**	nd
OU1J251-03	761	**790**	nd
OU1J251-04	762	**1300**	nd
OU1J251-05	763	**910**	nd
OU1J251-06	764	**3600**	nd
OU1J251-08	766	**890**	nd

Notes:

Bold: Value equal to or greater than the action level

<: Sample value less than the reporting limit

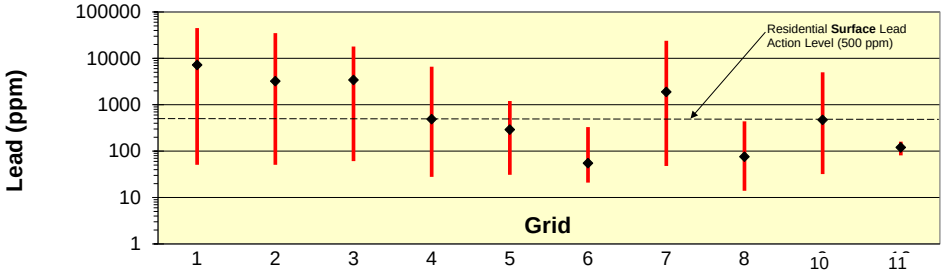
ppm: parts per million (equivalent to milligrams per kilogram [mg/kg] for soils)

J: Estimated value (see discussion of data quality in Section 4.3.2.1 in OU1 RI Report)

nd: Not Detected, likely due to lead interference

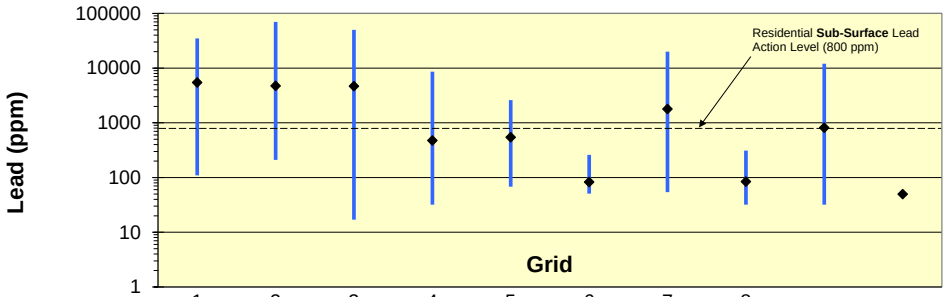
Table 4-2
Summary of CSS Lead Results (XRF and Laboratory) by Grid*
Jacobs Smelter OU2

CSS Surface Soil Lead Concentration Range and Mean



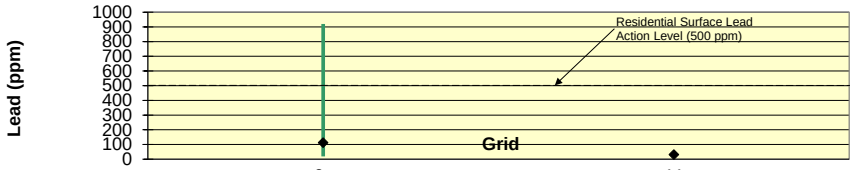
Grid	1	2	3	4	5	6	7	8	10	11
Maximum	45000	35000	18000	6600	1200	330	24000	440	5000	160
Minimum	51	51	61	28	31	21	48	14	32	81
◆ Mean	7218.02	3219.76	3417.23	489.692	292.207	55.0667	1898.92	76.2326	471.133	120.5
# Results	50	96	61	65	58	60	65	43	30	2

CSS Sub-Surface Soil Lead Conc. Range and Mean



Grid	1	2	3	4	5	6	7	8	10	11
Maximum	35000	70000	50000	8600	2600	260	20000	310	12000	50
Minimum	110	210	17	32	68	51	54	32	32	50
◆ Mean	5488.2	4755.41	4700.53	476.133	545.667	83.0769	1795.89	84.4	818	50
# Results	50	61	59	60	9	3	65	20	19	1

CSS Sediment Lead Concentration Range and Mean



Grid	9	11
Maximum	920	31
Minimum	19	31
◆ Mean	112.6	31
# Results	39	5

*Grid Descriptions:
1 (Waterman Smelter)
2 (West of Stockton)
3 (Chicago Smelter)
4 (Carson Buzzo Smelter)
5 (South and East of Stockton)
6 (Mouth of Soldier Canyon)
7 (North of Stockton)
8 (Rush Lake Shoreline)
9 (Rush Lake)
10 (Discretionary Samples)
11 (Background Samples)

See Figure 3-2 for Grid Locations

Table 4-3
Groundwater Exceedances of USEPA Region 3 RBCs for Tap Water

FieldID	Map ID	Smelter	Analytical Method	Analyte Result (UG/L)							
				Aluminum	*Antimony*	*Arsenic*	*Cadmium*	*Lead*	*Manganese*	*Thalluim*	*Vanadium*
SHHRA Screening Level (Region 3 Tap Water RBC)				*37000*	*15*	*0.045*	*18*	*15*	*730*	*2.6*	*260*
State of Utah Groundwater Quality Standards				*-*	*-*	*50*	*5*	*15*	*-*	*-*	*-*
Future Arsenic Standard				*-*	*-*	*10*	*-*	*-*	*-*	*-*	*-*
PRI01G02GWG	31	*Waterman*	Dissolved Metals	20 U	6 U	**45.9**	2 U	9.5	2 U	1 U	13.9
PRI01G02GWG	31	*Waterman*	Total Metals	**168000 J**	**26.1 J**	**902**	**56.6**	**8360**	**3960**	1.4 J	**410**
PRI03G05GWG	232	*Chicago*	Dissolved Metals	20 U	6 U	**16.6**	2 U	5 U	2 U	1 U	5 U
PRI03G05GWG	232	*Chicago*	Total Metals	111J	6 U	**10 U**	2 U	5 U	3.4	1 U	5 U
PRI04G06GWG	309	*Carson-Buzzo*	Dissolved Metals	533	6 U	**16.9**	2 U	5 U	59.8	1 U	5 U
PRI04G06GWG	309	*Carson-Buzzo*	Total Metals	**196000 J**	14.6 J	**43.8**	7.5	**167**	**6180**	1 UJ	**344**
RIG085GWG	569	*Chigaco*	Dissolved Metals	55.3 UJ	2 U	**2.2**	1 U	1 U	27.6	**5.5 U**	1.2
RIG085GWG	569	*Chigaco*	Total Metals	210 UJ	2 U	**2.9**	1 U	1 U	32.6	2 U	1.7
RIG098GWG	620	*Carson-Buzzo*	Dissolved Metals	71.6 UJ	2.1	**3.3**	1 U	1 U	27.3	2 U	1.4
RIG098GWG	620	*Carson-Buzzo*	Total Metals	1370 J	2 U	**2.4**	1 U	1 U	57.2	2 U	3.3

Note:

SHHRA - Second Human Health Risk Assessment

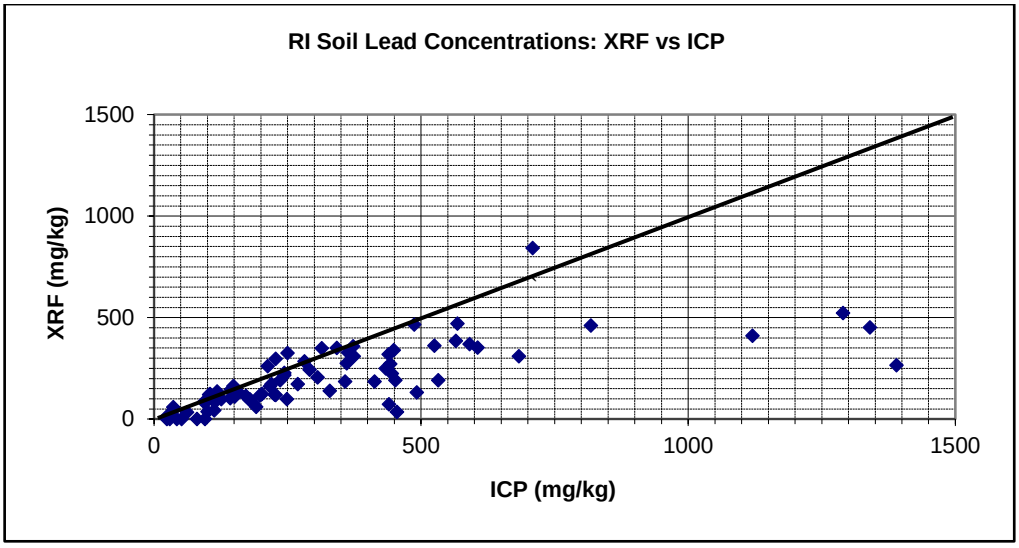
Bold - indicates result is above the Region 3 Tap Water RBC

J - indicates the associated value is estimated

U - indicates the analyte was not detected above the associated value

UJ - indicates the analyte was not detected above the associated value and the value is an estimate

Table 4-4
Comparison of Portable XRF Results to Fixed-Base Laboratory Results for Jacobs OU2 Remedial Investigation



Regression Statistics			
Multiple R	0.706693819	Standard Error	108.8055763
R Square	0.499416154	Observations	77
Adjusted R Square	0.492741703		

Data

FieldID	ICP Result	XRF Result	FieldID	ICP Result	XRF Result
RIS001S0Z	172	114	RIS041S0Z	149	163
RIS002S0Z	36	58.4	RIS042S0Z	157	134
RIS003S0Z	61.8	34.4	RIS043S0Z	434	250
RIS004S0Z	445	225	RIS044S0Z	606	352
RIS005S0Z	126	98.2	RIS045S0Z	329	139
RIS006S0Z	143	103	RIS046S0Z	709	842
RIS007S0Z	492	131	RIS047S0Z	1290	522
RIS008S0Z	282	284	RIS048S0Z	818	461
RIS009S0Z	314	349	RIS050S0Z	442	272
RIS010S0Z	249	98.2	RIS052S0Z	291	244
RIS011S0Z	525	362	RIS053S0Z	452	192
RIS012S0Z	220	172	RIS054S0Z	374	310
RIS013S0Z	532	191	RIS055S0Z	93.7	84.6
RIS014S0Z	1120	411	RIS056S0Z	440	72.8
RIS015S0Z	226	121	RIS057S0Z	413	185
RIS016S0Z	99.3	88.9	RIS058S0Z	244	227
RIS017S0Z	683	309	RIS059S0Z	202	123
RIS018S0Z	118	136	RIS060S0Z	373	358
RIS019S0Z	1340	452	RIS063S0Z	358	185
RIS020S0Z	100	36.8	RIS064S0Z	269	173
RIS021S0Z	198	115	RIS065S0Z	191	61.1
RIS022S0Z	151	111	RIS066S0Z	228	119
RIS023S0Z	342	350	RIS067S0Z	306	205
RIS025S0Z	103	120	RIS068S0Z	591	370
RIS026S0Z	250	326	RIS069S0Z	178	97
RIS027S0Z	228	297	RIS070S0Z	439	319
RIS028S0Z	217	161	RIS071S0Z	455	35.9
RIS029S0Z	213	261	RIS072S0Z	26.4	19.7
RIS030S0Z	105	123	RIS075S0Z	51.7	ND
RIS031S0Z	180	96.9	RIS076S0Z	36.3	43.4
RIS032S0Z	236	191	RIS077S0Z	24.2	ND
RIS033S0Z	449	340	RIS078S0Z	29.6	ND
RIS034S0Z	568	470	RIS079S0Z	114	84
RIS035S0Z	565	385	RIS080S0Z	95.2	ND
RIS036S0Z	487	466	RIS081S0Z	113	43.9
RIS037S0Z	1390	266	RIS082S0Z	80.4	ND
RIS038S0Z	361	275	RIS083S0Z	43	ND
RIS039S0Z	363	328	RIS084S0Z	244	217
RIS040S0Z	144	145			

Table 4-5
B and B Subdivision Residential Composite Soil Sample Lead Exceedances

Property / Zone	Property Owner	Lead Composite Result Exceedances at Depths		
		0-2 inches	2-6 inches	6-12 inches
J2-49 / Zone 2	Jill T. and David Rapp	666 ppm	1050 ppm	-
J2-50 / Zone 1	Jesper and Jenny Rasmussen	1030 ppm	-	994 ppm

Table 5-1
Non-Residential Surface Soil and Sediment Exceedances of the HHRA Phase 2 Screening Levels

FieldID	Map ID	Matrix	Land Use Code	HQ=1 & CR=10^{-6} Analyte (ppm)					HQ=1 & CR=10^{-4} Analyte (ppm)				
				Antimony	Arsenic	Lead	Manganese	Mercury	Antimony	Arsenic	Lead	Manganese	Mercury
Recreational Phase 2 Screening Level				*196*	*2.66 (SO) 19 (SDW)*	*3268 (SO & SDW)*	*9590*	*147*	*196*	*147 (SO) 1880 (SDW)*	*5146 (SO & SDW)*	*9590*	*147*
4500XRF	668	SO	REC	-	-	6800	-	-	-	-	6800	-	-
JBI-19Z-0002-299	732	SO	REC	-	120	-	-	-	-	-	-	-	-
JBI-20C-0002-299	734	SO	REC	-	-	4000	-	-	-	-	-	-	-
PRI01S01SOZ	20	SO	REC	-	344	29600	-	-	-	344	29600	-	-
PRI02S04SOZ	111	SO	REC	-	141	-	-	-	-	-	-	-	-
PRI03S02SOZ	200	SO	GZ	-	442	14300	-	-	-	442	14300	-	-
PRI03S06SDG	237	SDW	GZ	-	-	4310	-	-	-	-	-	-	-
PRI04S07SDG	310	SDW	GZ	-	458	6900	-	-	-	458	6900	-	-
PRI07S01SOZ	456	SO	REC	-	4130	14100	13000 J		-	4130	14100	13000 J	
PRI07S02SOZ	467	SO	REC	-	107	-	-	-	-	-	-	-	-
RIS019S0Z	67	SO	REC	-	202	-	-	-	-	202	-	-	-
RIS047S0Z	317	SO	REC	-	134	-	-	-	-	-	-	-	-
RIS049S0Z	319	SO	REC	-	1640	20400	-	-	-	1640	20400	-	-
RIS061S0Z	11	SO	REC	-	1160	47000	-	-	-	1160	47000	-	-
RIS085S0Z	569	SO	GZ	-	818	22000	-	-	-	818	22000	-	-
RIS091S0Z	613	SO	REC	-	136	-	-	-	-	-	-	-	-
RIS097S0Z	619	SO	REC	-	1100	42400	-	-	-	1100	42400	-	-
RIS098S0Z	620	SO	GZ	-	151	-	-	-	-	151	-	-	-
S01S001SOZ	11	SO	REC	-	1000 J	45000 J	-	-	-	1000 J	45000 J	-	-
S01S002SOZ	12	SO	REC	-	-	3900	-	-	-	-	-	-	-
S01S003SOZ	13	SO	REC	-	-	19000	-	-	-	-	19000	-	-
S01S004SOZ	14	SO	REC	-	-	14000	-	-	-	-	14000	-	-
S01S005SOZ	15	SO	REC	-	-	4200	-	-	-	-	-	-	-
S01S006SOZ	16	SO	REC	-	-	15000	-	-	-	-	15000	-	-
S01S007SOZ	17	SO	REC	-	-	8000	-	-	-	-	8000	-	-
S01S009SOZ	19	SO	REC	-	-	11000	-	-	-	-	11000	-	-
S01S011SOZ	22	SO	REC	-	-	17000	-	-	-	-	17000	-	-
S01S012SOZ	23	SO	REC	-	-	7600	-	-	-	-	7600	-	-
S01S013SOZ	24	SO	REC	-	-	8000	-	-	-	-	8000	-	-
S01S015SOZ	26	SO	REC	-	-	22000	-	200	-	-	22000	-	200
S01S017SOZ	28	SO	REC	-	-	19000	-	-	-	-	19000	-	-
S01S019SOZ	30	SO	REC	-	-	13000	-	-	-	-	13000	-	-
S01S020SOZ	32	SO	REC	-	-	7300	-	-	-	-	7300	-	-
S01S021SOZ	33	SO	REC	-	-	4300	-	-	-	-	-	-	-
S01S030SOZ	43	SO	REC	-	-	3300	-	-	-	-	-	-	-

Table 5-1
Non-Residential Surface Soil and Sediment Exceedances of the HHRA Phase 2 Screening Levels

FieldID	Map ID	Matrix	Land Use Code	HQ=1 & CR=10^{-6} Analyte (ppm)					HQ=1 & CR=10^{-4} Analyte (ppm)				
				Antimony	Arsenic	Lead	Manganese	Mercury	Antimony	Arsenic	Lead	Manganese	Mercury
Recreational Phase 2 Screening Level				*196*	*2.66 (SO) 19 (SDW)*	*3268 (SO & SDW)*	*9590*	*147*	*196*	*147 (SO) 1880 (SDW)*	*5146 (SO & SDW)*	*9590*	*147*
S01S031SOZ	44	SO	REC	-	150 J		-	-	-	150 J	-	-	-
S01S033SOZ	46	SO	REC	-	-	4100	-	-	-	-	-	-	-
S01S034SOZ	47	SO	REC	-	-	7800	-	-	-	-	7800	-	-
S01S035SOZ	48	SO	REC	-	-	7400	-	-	-	-	7400	-	-
S01S036SOZ	49	SO	REC	-	-	6200	-	-	-	-	6200	-	-
S02S013SOZ	82	SO	REC	-	-	4100	-	-	-	-	-	-	-
S02S022SOZ	92	SO	REC	-	-	7600	-	-	-	-	7600	-	-
S02S024SOZ	94	SO	REC	-	160	-	-	-	-	160	-	-	-
S02S026SOZ	96	SO	REC	-	-	15000	-	-	-	-	15000	-	-
S02S031SOZ	102	SO	REC	-	-	12000	-	-	-	-	12000	-	-
S02S032SOZ	103	SO	REC	-	-	6100	-	-	-	-	6100	-	-
S02S036SOZ	107	SO	REC	-	-	22000	-	-	-	-	22000	-	-
S02S037SOZ	108	SO	REC	230	-	16000	-	-	230	-	16000	-	-
S02S040SOZ	112	SO	REC	-	4300 J	35000	-	-	-	4300 J	35000	-	-
S02S041SOZ	113	SO	REC	-	-	10000	-	-	-	-	10000	-	-
S02S044SOZ	116	SO	REC	-	3800	21000	-	-	-	3800	21000	-	-
S02S045SOZ	117	SO	REC	-	-	3600	-	-	-	-	-	-	-
S02S046SOZ	118	SO	REC	-	-	3400	-	-	-	-	-	-	-
S02S050SOZ	123	SO	REC	-	-	11000	-	-	-	-	11000	-	-
S02S053SOZ	126	SO	REC	-	1200 J	13000	-	-	-	1200 J	13000	-	-
S02S063SOZ	137	SO	REC	-	-	9900	-	-	-	-	9900	-	-
S03S001SOZ	180	SO	GZ	-	-	8000	-	-	-	-	8000	-	-
S03S004SOZ	183	SO	GZ	-	-	12000	-	-	-	-	12000	-	-
S03S005SOZ	184	SO	GZ	-	-	7900	-	-	-	-	7900	-	-
S03S007SOZ	186	SO	GZ	-	-	8000	-	-	-	-	8000	-	-
S03S012SOZ	192	SO	GZ	-	-	3600	-	-	-	-	-	-	-
S03S014SOZ	194	SO	GZ	-	-	3500	-	-	-	-	-	-	-
S03S017SOZ	197	SO	GZ	-	-	14000	-	-	-	-	14000	-	-
S03S018SOZ	198	SO	GZ	-	-	4000	-	-	-	-	-	-	-
S03S022SOZ	202	SO	GZ	-	-	8100	-	-	-	-	8100	-	-
S03S023SOZ	203	SO	GZ	-	-	10000	-	-	-	-	10000	-	-
S03S027SOZ	207	SO	GZ	-	-	9400	-	-	-	-	9400	-	-
S03S036SOZ	217	SO	GZ	-	-	7400	-	-	-	-	7400	-	-
S03S037SOZ	218	SO	GZ	-	-	11000	-	-	-	-	11000	-	-
S03S038SOZ	219	SO	GZ	-	330 J	7700 J	-	-	-	330 J	7700 J	-	-

Table 5-1
Non-Residential Surface Soil and Sediment Exceedances of the HHRA Phase 2 Screening Levels

FieldID	Map ID	Matrix	Land Use Code	HQ=1 & CR=10^{-6}					HQ=1 & CR=10^{-4}				
				Analyte (ppm)					Analyte (ppm)				
				Antimony	Arsenic	Lead	Manganese	Mercury	Antimony	Arsenic	Lead	Manganese	Mercury
Recreational Phase 2 Screening Level				*196*	*2.66 (SO) 19 (SDW)*	*3268 (SO & SDW)*	*9590*	*147*	*196*	*147 (SO) 1880 (SDW)*	*5146 (SO & SDW)*	*9590*	*147*
S03S050SOZ	233	SO	GZ	-	120	3300	-	-	-	-	-	-	-
S04S037SOZ	287	SO	GZ	-	-	4500	-	-	-	-	-	-	-
S04S042SOZ	293	SO	GZ	-	-	6600	-	-	-	-	6600	-	-
S07S004SOZ	450	SO	REC	-	400	-	-	-	-	400	-	-	-
S07S009SOZ	455	SO	REC	-	160	-	-	-	-	160	-	-	-
S07S011SOZ	458	SO	REC	-	190 J	-	-	-	-	190 J	-	-	-
S07S041SOZ	489	SO	REC	-	5500	24000 J	15000	-	-	5500	24000 J	15000	-
S07S042SOZ	490	SO	REC	-	-	4400	-	-	-	-	-	-	-
S07S043SOZ	491	SO	REC	-	2600	11000	-	-	-	2600	11000	-	-
S07S047SOZ	495	SO	REC	-	1100	6300	-	-	-	1100	6300	-	-
S07S048SOZ	496	SO	IND[a]	-	-	1900	-	-	-	-	-	-	-
S07S049SOZ	497	SO	REC	-	340	-	-	-	-	340	-	-	-
S07S052SOZ	500	SO	REC	-	150	-	-	-	-	150	-	-	-
S07S055SOZ	503	SO	REC	-	2100	6900	14000	-	-	2100	6900	14000	-
S07S057SOZ	505	SO	REC	-	6900	15000	45000	-	-	6900	15000	45000	-
S08S008SOZ	523	SO	GZ	-	120	-	-	-	-	-	-	-	-

Notes:

Indicates a location where there was an arsenic exceedance without a lead exceedance

[a] The following Industrial Phase 2 Screening Levels were used for comparison at this location: CR=10^{-6} = 1671 ppm & CR=10^{-4} = 2632 ppm

J indicates associated value is estimated, see applicable data validation report for specific reason

GZ = Grazing
IND = Industrial
REC = Recreational
RRES = Rural Residential
SFRES = Single Family Residential
SO = Soil
SDW = Sediment associated with water
ppm = parts per million
HQ = Hazard Quotient
CR = Cancer Risk

Table 5-2
Surface Water Exceedances of the HHRA Phase 2 Screening Levels
Hazard Quotient = 1 and Cancer Risk = 10^{-6}

FieldID	Map ID	Sample Type	Land Use Code	Analyte (ug/l)
				Arsenic
Recreational Phase 2, CR=10^{-6}, Screening Level				11.2
PRI09W01SWG	584	L	REC	106
PRI09W01SWG	584	L	REC	113
PRI09W02SWG	595	L	REC	106
PRI09W02SWG	595	L	REC	112
PRI09W03SWG	606	L	REC	110
PRI09W03SWG	606	L	REC	113
PRI09W04SWG	607	L	GZ	99.8
PRI09W04SWG	607	L	GZ	100
PRI09W05SWG	608	L	GZ	119
PRI09W06SWG	608	L	REC	110
PRI09W07SWG	609	L	REC	83.2
PRI09W07SWG	610	L	REC	97.8
PRI09W08SWG	610	L	REC	111
PRI09W08SWG	611	L	REC	114
PRI09W09SWG	611	L	REC	88.5
PRI09W09SWG	612	L	REC	97.3
PRI09W05SWG	612	L	GZ	300 U
S09W002SWG	576	L	REC	300 U
S09W004SWG	578	L	REC	300 U
S09W006SWG	580	L	REC	300 U
S09W007SWG	581	L	REC	300 U
S09W010SWG	585	L	REC	300 U
S09W013SWG	588	L	REC	300 U
S09W016SWG	591	L	GZ	300 U
S09W018SWG	593	L	GZ	300 U
S09W029SWG	605	L	REC	300 U
S10W012SWG	630	S	GZ	300 U
S10W014SWG	631	S	GZ	300 U
S10W016SWG	632	S	GZ	300 U
S10W017SWG	633	S	GZ	300 U
S10W018SWG	634	S	GZ	300 U
S10W019SWG	635	S	REC	300 U
S11W001SWG	655	S	REC	300 U
S11W002SWG	656	S	REC	300 U
S11W003SWG	657	S	REC	300 U
S11W004SWG	658	S	REC	300 U

Notes:

There are no surface water exceedances for a CR=10^{-4}

L = Lake

S = Stream

U - Indicates the analyte was not detected above the associated value and the associated value is the detection limit

GZ = Grazing

REC = Recreational

CR = Cancer Risk

Table 6-1
Summary of Human Health Risk Phase 2 Screening Levels
for Contaminants of Concern with OU2 Surface Sample Result Exceedances

Contaminant of Concern (COC)	Residential Soil (mg/kg)	Industrial Soil (mg/kg)	Recreational Soil (mg/kg)		Recreational Sediment (mg/kg)		Recreational Surface Water (mg/L)	
			HQ = 1 & CR = 10^{-4}	HQ = 1 & CR = 10^{-6}	HQ = 1 & CR = 10^{-4}	HQ = 1 & CR = 10^{-6}	HQ = 1 & CR = 10^{-4}	HQ = 1 & CR = 10^{-6}
Antimony	110	-	196	196	-	-	-	-
Arsenic	100	-	147	2.66	1,880	19	1.12	0.0112
Lead	500	1,671 to 2,632	3,268 - 5,146	3,268 - 5,146	3,268 - 5,146	3,268 - 5,146	-	-
Manganese	-	-	9,590	9,590	-	-	-	-
Mercury	-	-	147	147	-	-	-	-

Notes:
HQ = Hazard Quotient
CR = Cancer Risk

Table 6-2 – Phase 3 Comparison of Maximum Concentrations, EPCs, REPCs, & SREPCs to Phase 2 Screening Levels (More Conservative and Less Conservative)

Exposure Area/Analyte[a]	More Conservative Comparison (HQ=1, CR=1E-6)				Less Conservative Comparison (HQ=1, CR=1E-4)			
	Step 1[b] Maximum Concentration Exceeds Phase 2 screening level?[c]	Step 2[d] EPC Exceeds Phase 2 screening level?[c]	Step 3[e] REPC Exceeds Phase 2 screening level?[c] (lead "hotspots" removed)	Step 4[f] SREPC Exceeds Phase 2 screening level?[c] (lead and arsenic "hot spots" removed)	Step 1[b] Maximum Concentration Exceeds Phase 2 screening level?[c]	Step 2[d] EPC Exceeds Phase 2 screening level?[c]	Step 3[e] REPC Exceeds Phase 2 screening level?[c] (lead "hotspots" removed)	Step 4[f] SREPC Exceeds Phase 2 screening level?[c] (lead and arsenic "hot spots" removed)
Recreational Exposure Area 1								
Antimony	No	--	--	--	No	--	--	--
Arsenic	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	--	--
Lead[h]	**Yes**	No	--	--	**Yes**	No	--	--
Manganese	**Yes**	No	--	--	**Yes**	No	--	--
Mercury	No	--	--	--	No	--	--	--
Recreational Exposure Area 2 – Soil and Sediment								
Antimony	**Yes**	No	--	--	**Yes**	No	--	--
Arsenic	**Yes**	**Yes**	**Yes**	NC	**Yes**	**Yes**	No	--
Lead[h]	**Yes**	**Yes**	No	--	**Yes**	**Yes**	No	--
Manganese	No	--	--	--	No	--	--	--
Mercury	**Yes**	**Yes**	No	--	**Yes**	**Yes**	No	--
Recreational Exposure Area 2 – Soil Only								
Antimony	**Yes**	No	--	--	**Yes**	No	--	--
Arsenic	**Yes**	**Yes**	**Yes**	NC	**Yes**	**Yes**	No	--
Lead[h]	**Yes**	**Yes**	No	--	**Yes**	**Yes**	No	--
Manganese	No	--	--	--	No	--	--	--
Mercury	**Yes**	**Yes**	No	--	**Yes**	**Yes**	No	--
Recreational Exposure Area 2 – Sediment Only[g]								
Arsenic	**Yes**	**Yes**	**Yes**	**Yes**	No	--	--	--
Lead[h]	No	--	--	--	No	--	--	--
Recreational Exposure Area 3 – Soil and Sediment								
Antimony	No	--	--	--	No	--	--	--
Arsenic	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	--	--
Lead[h]	**Yes**	No	--	--	**Yes**	No	--	--
Manganese	No	--	--	--	No	--	--	--
Mercury	No	--	--	--	No	--	--	--
Recreational Exposure Area 3 – Soil Only								
Antimony	No	--	--	--	No	--	--	--
Arsenic	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	--	--
Lead[h]	**Yes**	No	--	--	**Yes**	No	--	--
Manganese	No	--	--	--	No	--	--	--
Mercury	No	--	--	--	No	--	--	--
Recreational Exposure Area 3 – Sediment Only								
Arsenic	**Yes**	**Yes**	**Yes**	No	No	--	--	--
Lead[h]	**Yes**	No	--	--	**Yes**	No	--	--
Commercial/Industrial Area J2-3 Soil								
Lead[i]	**Yes**	**Yes**	**Yes**	**Yes**	**No**	--	--	--

Notes:

a - Analytes shown are those that exceeded Phase 2 screening levels on a site wide basis.

b - For all sample locations in each exposure area, maximum concentrations were compared to Phase 2 screening levels. Analytes with maximum concentrations that did not exceed Phase 2 screening levels were eliminated from further consideration because they do not pose an unacceptable threat to human health.

c - Phase 2 screening levels used in the comparisons are based on the acceptable cancer risk level shown in the heading and an acceptable hazard quotient for non-cancer effects of 1.

d - For all sample locations in each exposure area, the exposure point concentrations (EPCs - the smaller of the 95% UCL and the maximum detected concentration) were compared to Phase 2 screening levels. Analytes with EPCs that did not exceed Phase 2 screening levels were eliminated from further consideration in that exposure area because they do not pose an unacceptable threat to human health.

e - Lead "hot spots" (concentrations of 10,000 ppm or higher) were removed from the database in each exposure area. For the remaining sampling locations in each exposure area, revised EPCs (REPCs) were compared to Phase 2 screening levels. Analytes with REPCs that did not exceed Phase 2 screening levels were removed from further consideration in that exposure area because they do not pose an unacceptable threat to human health if lead "hot spots" were remediated.

f - Lead "hot spots" (concentrations of 10,000 ppm and higher) and arsenic "hot spots" (concentrations exceed the screening level by 3-times or more) were both removed from the databases for each exposure area. In general, most arsenic values in each exposure area exceeded three times the screening level. For the remaining samples in each exposure area, second REPCs (SREPCs) were compared to Phase 2 screening levels. Because there was an insufficient number of samples in the remaining data to run statistics, all SREPCs were maximum concentrations of the remaining data.

g - Area 2 had only 5 sediment samples. Therefore, the maximum concentration was used as the EPC, REPC, and SREPC.

h - Screening levels for lead were developed in the OHHRA, and include a range of acceptable levels for the recreational receptor. The low range lead value was used in the 1E-6 cancer risk comparison and the high range value was used in the 1E-4 cancer risk comparison.

i - There is no Region 3 Industrial soil RBC available for lead. Therefore EPA's Adult Lead Exposure Model was used to calculate Phase 2 soil screening levels for lead, which ranged from 1671 to 2632 mg/kg. The low end of the range was used as the screening level in Phase 2 and in the Phase 3, 1E-6 cancer risk comparison. The high end of the range was used for the Phase 3, 1E-4 cancer risk comparison. For the EPC, REPC, and SREPC in J2-3, the maximum detected concentration was used because it was less than the 95% UCL.

NC - No comparison was possible, because all samples that remained after removing lead "hot spots" had arsenic concentrations that exceeded 3 times the screening level. Therefore, removing all of the analyte-specific hot spots (areas exceeding 3 times the Phase 2 screening level) would require eliminating all the data points.

CR - Cancer Risk.

HQ - Hazard Quotient. Non-cancer risk value.