OU2 Direct Push Field Investigation Summary

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1 Introduction

At the request of the U.S. Environmental Protection Agency (USEPA), CH2M HILL completed a focused direct push field investigation in Operable Unit 2 (OU2). The task order for this work was issued under the USEPA Architect and Engineering Services (AES) Contract No. 68-S7-04-01. The field investigation tasks described herein were completed in accordance with the USEPA-approved *Quality Assurance Project Plan, OU2/OU3 Direct Push Investigation, Shoshone County, Idaho* (QAPP; CH2M HILL, 2008a).

1.1 Purpose and Objectives

The purpose of the direct push field investigation was to collect additional data in select areas of OU2 identified in the *Source Areas of Concern Report, Bunker Hill Mining and Metallurgical Complex Superfund Site* (CH2M HILL, 2008b) and by the Bunker Hill Water Quality Assessment Team. The Bunker Hill Water Quality Assessment Team consists of representatives from the USEPA, the Idaho Department of Environmental Quality (IDEQ), and their contractor teams.

Key objectives of this investigation were to:

- Identify and document hydrogeologic characteristics
- Obtain metals concentrations in subsurface soil
- Install a series of temporary piezometers

Data obtained as part of this field investigation will be used to further expand the current understanding of the nature, character, and extent of the tailings-impacted valley alluvial deposits within OU2. Additionally, hydraulic data obtained from piezometers installed during this field effort will be used to support development of the numerical groundwater flow model within OU2 and the Upper Basin. The model will be used to support the development and evaluation of potential Phase II remedial actions.

This memorandum summarizes the direct push field investigation conducted in OU2 between June 17 and August 8, 2008. It presents information regarding project logistics;

drilling and sampling methods and procedures; decontamination; investigation-derived waste (IDW) management; piezometer development; and soil analytical data.

1.2 Background

The *Source Areas of Concern Report, Bunker Hill Mining and Metallurgical Complex Superfund Site* (CH2M HILL, 2008b) identified the need for further data collection at select areas in OU2 (Figure 1) based on the evaluation of Phase I remedial actions (CH2M HILL, 2007). The Bunker Hill Water Quality Assessment Team also identified the specific areas for further hydrogeologic and geochemical assessment. These areas included:

- Eastern City of Kellogg
- Bunker Creek
- Between Central Impoundment Area (CIA)/Slag Pile Area and Interstate 90 (I-90)
- Government Creek
- West of Page Wastewater Treatment Ponds
- West End Natural Infiltration (WENI) Area
- Smelterville Flats

The Bunker Hill Water Quality Assessment Team selected continuous core drilling using direct push, a comprehensive soil-sampling program, and temporary piezometer installation as the preferred data collection methods. The Bunker Hill Water Quality Assessment Team selected the number and locations for each of the soil borings and piezometer installations based on the specific data needs, the potential ease of obtaining access agreements, and the ease of drill rig access.

1.3 Document Organization

This memorandum contains the following sections:

- Section 1 – Introduction
- Section 2 – Field Investigation Overview
- Section 3 – Summary of Field Investigation Activities
- Section 4 – Geologic Characteristics
- Section 5 – Analytical Data Summary
- Section 6 – Summary
- Section 7 – References
- Section 8 – Acronyms
- Table
- Figures

The following attachments are also provided:

- Attachment A – Soil Boring Logs and Piezometer Completion Diagrams
- Attachment B – Piezometer Development Logs
- Attachment C – Analytical Results for Total Metals

2 Field Investigation Overview

This section summarizes the 2008 direct push field investigation activities conducted within OU2. Field investigation activities were conducted between June 17 and August 8, 2008. The following tasks are major elements of the direct push field investigation:

- Secured access agreements with property owners to drill, collect soil samples, install piezometers, and collect water quality samples from the temporary piezometers.
- Completed utility-locating and pre-drilling site-coordination activities.
- Drilled exploration boreholes at 38 locations in OU2 through unconsolidated fill and native alluvial materials. These included a subset of locations where borings were drilled to the confining unit to define the upper alluvium thickness and the vertical location of the top of the confining unit. Boreholes ranged in depth from 12 to 36 feet below ground surface (ft bgs).
- Collected continuous soil samples via direct push drilling methods for detailed stratigraphic logging and hydrogeologic characterization.
- Submitted 315 soil samples for the target analyte list (TAL) metals analysis.
- Installed 29 temporary piezometers in the eastern portion of OU2 and 7 temporary piezometers in the western portion of OU2 in the single unconfined and upper alluvial aquifers.
- Advanced borings for the Idaho National Laboratory (INL) near three existing piezometers for geochemistry analysis sequential extractions.
- Developed each new piezometer to remove residual formation fines from the filter pack and piezometer screen materials.

Section 3 presents a more detailed description of these field investigation activities. The tasks listed were completed in accordance with the USEPA-approved scope of work, the project-specific QAPP (CH2M HILL, 2008a), and the Health and Safety Plan (HSP; Appendix C of the QAPP, CH2M HILL, 2008a). Section 3.10 discusses minor deviations from the planned investigation activities.

3 Summary of Field Investigation Activities

This section summarizes the logistical issues and field investigation activities in support of the direct push field investigation.

3.1 Access Agreements

The drilling and piezometer installation work was performed on property owned by the USEPA, IDEQ, private industry, and various other local and state agencies. The USEPA secured access agreements to perform the drilling and piezometer installation work. Access agreements were received from all property owners in OU2 except for the City of Kellogg. The City of Kellogg denied the USEPA access to drill wells at the levee on the south side of the South Fork Coeur d'Alene River (SFCDR) near the Silver Mountain Resort.

The proposed drilling locations were staked prior to drilling to allow property owners to assess the proposed drilling locations and to provide a point of reference for utility locators.

3.2 Utility Locates

CH2M HILL staked and/or spray-painted all proposed drilling locations for utility locating and clearance. Shoshone-Benewah One-Call, which was notified of all proposed drilling locations, provided CH2M HILL with a ticket number for each of the drilling locations. All applicable utility locating entities responded within 48 hours of notification.

3.3 Health and Safety

The CH2M HILL Health and Safety Coordinator conducted a morning safety briefing daily during this field effort. Topics covered in the safety meetings included drilling and piezometer installation procedures, site access considerations, and general health and safety requirements outlined in the HSP (Appendix C of the QAPP, CH2M HILL, 2008a). The USEPA Environmental Services Assistance Team (ESAT) drilling contractor (TechLaw) operated under an ESAT-prepared HSP. Any health and safety concerns raised by the USEPA ESAT drilling crew were discussed at the time of the concern.

3.4 Drilling Overview, Equipment, and Methods

Drilling, soil sampling, and piezometer installation work were completed in OU2 between June 17 and August 5, 2008. TechLaw performed the drilling and piezometer installation work in accordance with the QAPP (CH2M HILL, 2008a). On June 16, 2008, TechLaw mobilized a Geoprobe Model 6000 direct push drill rig and support truck with decontamination trailer to Kellogg, Idaho. Drilling equipment and materials were temporarily stored at the United States Army Corps of Engineers yard located north of McKinley Avenue between Government Gulch and Bunker Creek.

Direct push drilling was used to advance borings and collect continuous soil samples at 38 locations in OU2. Twenty-nine of these borings were converted to piezometers in the eastern portion of OU2. Seven borings were converted to piezometers in the western portion of OU2. Soil borings advanced at two locations in the eastern portion of OU2 were abandoned after encountering refusal.

Boreholes were advanced using continuous core drilling methods (i.e., using 2-inch outer diameter [OD] Macro-Cores). The drilling advancement and soil core retrieval consisted of 4-foot (ft) runs. A 3-inch OD casing was advanced into the existing borehole location for installation of the piezometers.

Section 3.7 discusses piezometer construction and completion details such as screen length, casing diameter, and filter-pack material.

3.5 Lithologic Sampling and Hydrogeologic Characterization

Continuous samples were collected from each borehole to permit stratigraphic logging and hydrogeologic interpretation. Samples were collected using a 4-ft Macro-Core and acetate liner. The representative soil cores were retrieved continuously from the entire drilled interval of each boring. These samples were provided to the CH2M HILL field representative for geologic logging and photo-documentation.

Materials retrieved during Geoprobe drilling methods were logged according to the standard visual-manual procedure for logging of soils (American Society for Testing and Materials [ASTM] D 2488-0). Attachment A provides detailed soil boring logs and piezometer completion diagrams. Representative soil core photos with site-specific information (i.e., boring number and depth) were obtained to complement the visual-manual classifications and descriptions provided in this memorandum.

Borings were advanced using direct push drilling into the shallow unconfined aquifer. Hydrogeologic information from these borings was used to guide the installation depth and screened interval of each piezometer, as discussed subsequently.

Refusal was encountered at several locations throughout OU2. Typically, several attempts were made in the vicinity of the original drilling location until the targeted depth was achieved. If refusal was encountered after multiple attempts and the target depth could not be reached, the drilling location was abandoned. Two soil boring locations were abandoned in the eastern portion of OU2 (Figure 2).

Soil moisture characteristics, and the presence of saturated conditions, were noted in the boring logs. The zone of saturation observed at most boring locations typically ranged from 5 to 13 ft bgs. These borings are located in the eastern City of Kellogg, in the Bunker Creek corridor, and in the CIA, Slag Pile, and lower Government Creek areas. The zone of saturation for several borings located along the SFCDR in Kellogg, on McKinley Avenue, and west of the Page wastewater treatment ponds ranged from about 17 to 26 ft bgs. Additionally, the zone of saturation in soil borings located in Smelterville Flats and in the WENI area were generally less than 5 ft bgs.

The groundwater level observations noted during borehole advancement were generally consistent with the water levels observed in the piezometers following installation.

3.6 Soil Sampling for Analytical Testing

Immediately after lithological logging of each sample core, the CH2M HILL field representative collected composite soil samples for USEPA Superfund Contract Laboratory Program (CLP) TAL metals analysis. According to the QAPP (CH2M HILL, 2008a), soil samples submitted for laboratory analysis were to be collected in 2-ft increments from each 4-ft core equaling two samples per core. Actual sample recovery from most cores was less than 3 ft. In several cores, only one sample was submitted for laboratory analysis because of very limited recovery. Generally, soil cores with similar or homogenous soil types were split into equal lengths for composite sampling. Soil cores with stratigraphic layering or heterogeneous soil types were split for composite sampling at the interface of these different soil types.

Three-hundred-fifteen soil samples, including field quality-control (QC) samples, were submitted for laboratory analysis for CLP TAL metals. Samples were processed and tracked using Forms II Lite software and managed in accordance with USEPA protocols, as outlined in the QAPP (CH2M HILL, 2008a). For the duration of the field effort, soil samples were shipped to Liberty Analytical (located in Cary, North Carolina) or to Silver Valley Laboratories (located in Smelterville, Idaho).

On August 4, 2008, TechLaw advanced borings near three existing piezometer locations. The INL collected 13 one-ft (approximate length) soil cores from these borings for metals speciation testing. The soil boring locations and subsequent sample intervals included:

- BH-SF-E-PZ-12: 1.0–2.0, 3.0–4.0, 5.0–6.0, 7.0–8.0, and 8.0–9.0 ft bgs
- BH-SF-E-PZ-16: 1.0–2.0, 3.0–4.0, 5.0–6.0, and 7.0–8.0 ft bgs
- BH-SF-E-PZ-24: 1.0–2.0, 3.0–4.0, 5.0–6.0, and 7.0–8.0 ft bgs

The Bunker Hill Water Quality Assessment Team selected the drilling locations and sample depths based on analytical data for soils obtained from samples collected during coring/piezometer installation. INL performed work under a separate QAPP. CH2M HILL provided field oversight for the INL field-sampling activities.

3.7 Piezometer Installation Procedures and Materials

Piezometers were installed at 29 of the 31 drilling locations in the eastern portion of OU2 (Figure 2) where boreholes were advanced. (Boreholes at two of the locations were abandoned with bentonite slurry because of refusal and/or lack of groundwater.) Piezometers were installed at all seven drilling locations in the western portion of OU2 (Figure 3). Attachment A presents borehole logs and piezometer completion diagrams. Table 1 summarizes piezometer installation details.

All piezometers were constructed using flush-threaded, 1.5-inch-diameter, schedule 40 polyvinyl chloride (PVC) riser pipe and machined PVC 10-slot screen. The piezometers were pre-packed with No. 20 x 40 silica sand; the outside diameter of the pre-packed screened interval is 2.5-inches. The blank PVC riser pipe, slotted screen, and threaded sump/end cap assemblies were lowered into the temporarily cased borehole (3-inch) until they reached the target borehole completion depth. A 5-ft screen length was used for all piezometers. The CH2M HILL field representative determined screen placement intervals based on field observations and piezometer construction objectives.

Additional filter-pack material consisting of No. 20 x 40 silica sand was installed at least 2 ft above the pre-packed screened interval in each piezometer. Once the filter pack was installed, bentonite slurry was pressure grouted to form the annular seal from the top of the filter-pack material up to ground surface.

As each piezometer was being constructed and the piezometer construction materials (filter pack and bentonite slurry) were being placed down the annular space, the temporary steel casing was extracted to expose the native formation. Note that prior to constructing several piezometers where the confining unit was encountered, a lower bentonite seal of varying thicknesses was placed at the bottom of each borehole where the confining unit had been drilled into. This lower bentonite seal was installed on several shallow piezometers to prevent any potential direct hydraulic connection between the upper and lower aquifers.

Of the 29 piezometers installed in the eastern portion of OU2, 15 were constructed with above-ground-surface completions and 14 were constructed with flush-surface completions. All seven piezometers completed in the western portion of OU2 were constructed with above-ground-surface completions. Each above-ground-surface completion consisted of a 3-inch-diameter PVC pipe casing assembly with a PVC slip cap. Each flush-surface completion consisted of a 6-inch steel monument surrounded by a 1-ft concrete surface seal.

Flush-surface piezometer completions were placed in areas of known vehicular and/or pedestrian traffic or at the request of property owners. Above-ground-surface completions were constructed in areas where vehicular and/or pedestrian traffic are not expected to occur.

Soil borings at two drilling locations in the eastern portion of OU2 were abandoned after encountering refusal prior to the anticipated target drilling depth. Boring BH-SF-E-PZ-02 was located on the west side of the Idaho Housing Agency apartments and boring BH-SF-E-PZ-19 was located adjacent to and north of McKinley Avenue, northeast of the Smelter Closure Area (Figure 2). Both borings were abandoned with bentonite slurry placed from the bottom of the boring to ground surface.

Upon completion of the drilling and piezometer installation program, Terragraphics surveyed the top of piezometer casing elevations (on August 8, 2008). Table 1 presents the top-of-casing elevations for each piezometer.

3.8 Investigation Derived Waste Management

IDW generated during the field effort included drill cuttings (i.e., continuous sampled soil cores) and decontamination water. Drill cuttings produced during drilling operations were sequentially and temporarily contained in labeled 5-gallon buckets following lithologic logging and composite sampling. Laboratory analysis determined that the metals concentrations in all the buckets were below principal threat material (PTM) levels. Therefore, the CH2M HILL field team transported six 5-gallon buckets that consisted of moist soil cuttings to the USEPA-approved Page Ponds Repository for disposal.

Decontamination water was generated from steam-cleaning casings, samplers, and tools between drilling locations. The drill rig and all casings and tools were decontaminated prior to demobilization from the site. Decontamination water, estimated at approximately 200 gallons per day (about 3,500 gallons for the duration of the project), was temporarily contained in polyethylene tanks. Daily, the decontamination water was disposed at the decontamination station located on McKinley Avenue. The water at this station is routed directly to the Central Treatment Plant (CTP) in Kellogg, Idaho.

3.9 Piezometer Development

Following the drilling and piezometer installation phase of the field investigation work, Terragraphics developed all piezometers to remove residual/suspended soil in the piezometer bottom, filter pack, and screen zone for subsequent collection of representative groundwater levels and groundwater quality data. Development work was performed in accordance with procedures outlined in USEPA Standard Operation Procedure (SOP) 2044 (provided in the QAPP [CH2M HILL, 2008a]).

Piezometers were developed using a combination of surging, bailing, and/or pumping to remove formation fines. Pumping was performed with a peristaltic pump to remove residual formation fines following the initial surging. The volume of groundwater removed, groundwater level response, time of pumping, and field parameters were recorded on development logs. Field parameters were measured with an In-Situ Troll 9000 or a Hydrolab multi-parameter meter. A bailer was used only when necessary. Attachment B presents development logs.

Development water was contained in polyethylene tanks and discharged to the CTP's lined pond. Development was conducted until field parameters stabilized as specified in SOP 2044. Development time ranged from 1 to 6 hours per piezometer.

All development equipment was decontaminated prior to moving it between respective piezometer locations.

3.10 Scope-of-Work Deviations

Minor deviations from the planned scope of work occurred during the direct push field investigation. These deviations included:

- Piezometers were not installed at three locations in the eastern portion of OU2 (Figure 2). The City of Kellogg denied the USEPA access to install BH-SF-E-PZ-07. In addition, BH-SF-E-PZ-02 and BH-SF-E-PZ-19 were not installed because of refusal encountered during drilling.
- Based on the QAPP (CH2M HILL, 2008a), soil samples submitted for laboratory analysis were to be collected in 2-ft increments from each 4-ft core equaling two samples per core. Actual sample recovery from most cores was less than 3 ft. In several cores, only one sample was submitted for laboratory analysis because of very limited recovery. Generally, soil cores with similar or homogenous soil types were split into equal lengths. Soil cores with stratigraphic layering or heterogeneous soil types were split at the interface of these different soil types.
- Piezometer BH-SF-E-PZ-26A was installed 5 ft deeper than instructed because of a discrepancy between the 4-ft Macro-Core length and the 5-ft drill-casing length. This piezometer was replaced with piezometer BH-SF-E-PZ-26B, in which the screened interval was placed at the desired depth. Piezometer BH-SF-E-PZ-26A was not abandoned during the field effort (Figure 6). The "A" and "B" were added to the piezometer names to distinguish them from one another.

4 Geologic Characteristics

This section provides an overview of subsurface geologic and hydrologic conditions encountered during the 2008 direct push field investigation. The information and observations from this study help to refine the OU2 Conceptual Site Model (CSM) (CH2M HILL, 2006).

Subsurface characteristics of the shallow valley alluvium throughout OU2 were highly variable and consisted of gravel and sand layers with varying thicknesses. Silt and clay layers were also present at varying depths and thicknesses throughout OU2. This variability is likely caused by the extensive earthwork, grading, and mine-and-mill operation historically conducted in the area of Kellogg and the Bunker Hill Mine and Millsite. This variability decreased with depth along the Bunker Creek corridor and in the vicinity of the Slag Pile and Government Gulch. In this area, the native upper alluvial sand and gravel unit was generally encountered at about 12 ft bgs. This sand and gravel unit was also encountered in borings completed in Smelterville Flats and between the West Page Swamp

and I-90. The upper alluvial sand and gravel unit in the eastern portion of the City of Kellogg generally consists of higher sand content than observed in other areas of OU2.

The lacustrine confining unit was encountered in the western portion of the City of Kellogg at several boring locations. The confining unit depth ranged from 17 ft bgs (BH-SF-E-PZ-02) to 21 ft bgs (BH-SF-E-PZ-03). These depths are consistent with the lacustrine unit depths described in the OU2 CSM (CH2M HILL, 2006).The lacustrine unit was also encountered in BH-SF-E-PZ-21 and BH-SF-E-PZ-22 along Bunker Creek at a depth of 18 ft bgs. In general, the native upper alluvial sand and gravel units found in the eastern portion of OU2 were at deeper depths than those found in the western portion of OU2.

Evidence of mine wastes (i.e., slag, jig tailings, and flotation tailings) was apparent in numerous borings advanced along the Bunker Creek corridor and north of the Slag Pile area. Slag was primarily identified from borings in the lower Bunker Creek corridor/Slag Pile area at depths from about 1 to 5 ft bgs. Evidence of jig tailings was identified in several borings in the vicinity of the CTP, the lower Bunker Creek corridor/Slag Pile area, and the Silver Mountain Resort parking lot (BH-SF-E-PZ-10). Jig tailings were identified as heavily oxidized variations of sand and angular gravel fragments and were generally located from ground surface to about 10 ft bgs. Evidence of flotation tailings was identified in borings near the CTP and in the lower Bunker Creek corridor, and identified as layers of cohesive or elastic silts to fine sands, with a bluish-gray color.

5 Analytical Data Summary

Three-hundred-fifteen soil samples were submitted for laboratory analysis for CLP TAL metals. Continuous composite samples for laboratory analysis were collected from each boring that was converted to a temporary piezometer. Attachment C provides complete analytical summary tables. The data are organized and presented based on specific areas of OU2, including:

- Eastern City of Kellogg
- Bunker Creek
- Between CIA/Slag Pile area and I-90
- Government Creek
- West of Page Wastewater Treatment Ponds
- WENI Area
- Smelterville Flats

Figures 4 through 7 graphically depict cadmium, lead, and zinc concentration data for these areas, and the following subsections summarize these data.

5.1 Eastern City of Kellogg

5.1.1 Cadmium

Eight soil borings were advanced in the Eastern City of Kellogg (Figure 4). Cadmium concentrations in soil ranged from non-detect to 271 milligrams per kilogram (mg/kg). The highest cadmium concentrations were typically identified between ground surface and 10 ft bgs. The highest concentration (271 mg/kg) was from BH-SF-E-PZ-11, located southwest of

the Silver Mountain Resort parking lot near the Trail of the Coeur d'Alenes (Figure 4), at the depth interval of ground surface to 1.5 ft bgs. Cadmium concentrations of 131 mg/kg and 106 mg/kg were measured in soil from BH-SF-E-PZ-09 and BH-SF-E-PZ-10, respectively (Figure 4). Both of these piezometers were located in the Silver Mountain Resort parking lot.

Cadmium concentrations detected in samples from the four borings advanced along the SFCDR ranged from 10.1 mg/kg to 74.9 mg/kg; most ranged from about 10 mg/kg to 40 mg/kg. The highest concentration from this area (74.9 mg/kg) was from BH-SF-E-PZ-03 at 5.0 to 6.5 ft bgs.

Cadmium concentrations did not exceed the PTM threshold of 71,000 mg/kg in samples from these eight borings.

5.1.2 Lead

The highest lead concentration measured in soil from this area (67,800 mg/kg) was from BH-SF-E-PZ-03, located south of the SFCDR near existing monitoring well BH-SF-E-0104, at the depth interval of 8.0 to 9.0 ft bgs (Figure 4). Lead concentrations of 32,000 mg/kg and 26,700 mg/kg were also measured from BH-SF-E-PZ-10 (8.0 to 9.3 ft bgs) and BH-SF-E-PZ-09 (5.5 to 7.2 ft bgs), respectively (Figure 4).

The highest lead concentrations detected in the Eastern City of Kellogg were typically from ground surface to about 10 ft bgs. Lead was detected in samples from all eight borings in the eastern City of Kellogg at concentrations greater than 10,000 mg/kg.

Lead concentrations did not exceed the PTM threshold of 84,600 mg/kg in samples collected in the eastern portion of the City of Kellogg.

5.1.3 Zinc

The highest zinc concentrations were typically identified between ground surface and 10 ft bgs. The highest zinc concentration in the eastern portion of the City of Kellogg (23,000 mg/kg) was detected from BH-SF-E-PZ-10 at the depth interval of 4.0 to 5.9 ft bgs (Figure 4). Zinc concentrations of 12,200 mg/kg and 11,400 mg/kg were also measured from BH-SF-E-PZ-11 and BH-SF-E-PZ-03, at depth intervals of ground surface to 1.5 ft bgs and of 5.0 to 6.5 ft bgs, respectively (Figure 4). The highest zinc concentrations detected from all other soil borings ranged from about 4,000 mg/kg to 5,500 mg/kg. Because a PTM threshold for zinc was not established, it is not discussed in this memorandum.

5.2 Bunker Creek

5.2.1 Cadmium

Eleven drilling locations are present in the vicinity of the Bunker Creek corridor (Figures 5 and 6). Two of the 11 locations are adjacent to McKinley Avenue.

Cadmium concentrations in soil ranged from non-detect to 188 mg/kg. The highest cadmium concentrations were typically identified between ground surface and 10 ft bgs in borings located along Bunker Creek. The highest concentration (188 mg/kg) was from BH-SF-E-PZ-20 (Figure 6) between 8.0 and 1.5 ft bgs. This piezometer was located adjacent to the Trail of the Coeur d'Alenes and near Bunker Creek surface water monitoring station BH-BC-0006. Additionally, cadmium concentrations of 164 mg/kg and 155 mg/kg were

detected in BH-SF-E-PZ-16 and BH-SF-E-PZ-22, from 4.0 to 5.9 ft bgs and from 5.5 to 7.2 ft bgs, respectively (Figures 5 and 6).

Cadmium concentrations in samples collected from the two borings advanced adjacent to McKinley Avenue near Portal Gulch (BH-SF-E-PZ-13) and Railroad Gulch (BH-SF-E-PZ-15) (Figure 5) were lower than concentrations from all other OU2 soil borings.

Cadmium concentrations did not exceed the PTM threshold of 71,000 mg/kg in samples from this area.

5.2.2 Lead

Lead concentrations exceeded the PTM threshold of 84,600 mg/kg in two borings located adjacent to Bunker Creek. A lead concentration of 132,000 mg/kg was measured in soil from BH-SF-E-PZ-12 (Figure 5) between 8.0 and 9.0 ft bgs. A lead concentration of 88,000 mg/kg was detected in soil from BH-SF-E-PZ-22 (Figure 6) between 5.5 and 7.2 ft bgs. In addition, a lead concentration of 76,000 mg/kg was detected in soil from BH-SF-E-PZ-14 from 9.5 to 11.0 ft bgs. Lead concentrations from two soil samples taken from BH-SF-E-PZ-12 were measured at 61,800 mg/kg (9.0 to 10.6 ft bgs) and 60,900 mg/kg (12.0 to 14.5 ft bgs).

The highest lead concentrations in most soil borings were typically identified between ground surface and 10 ft bgs. However, elevated lead concentrations were observed to 15 ft bgs in the vicinity of the CTP.

5.2.3 Zinc

The highest zinc concentrations were collected from soil borings located near the lower portion of Bunker Creek (Figures 5 and 6). The highest zinc concentration in this area of OU2 was from BH-SF-E-PZ-26 at 45,200 mg/kg from 4.0 to 5.5 ft bgs. A zinc concentration of 37,900 mg/kg was measured from this same boring at the depth interval of 1.0 to 2.5 ft bgs. A zinc concentration of 41,000 mg/kg was measured from BH-SF-E-PZ-20 from the sample collected at the depth interval of ground surface to 1.5 ft bgs.

Zinc concentrations in three samples from BH-SF-E-PZ-22 ranged from 29,600 mg/kg to 37,700 mg/kg at the depth interval of ground surface to about 7 ft bgs. In addition, zinc concentrations of over 20,000 mg/kg were measured in two samples from BH-SF-E-PZ-16 and BH-SF-E-PZ-26 at the depth interval of ground surface to about 5 ft bgs.

Zinc concentrations ranging from 10,000 mg/kg to 20,000 mg/kg were measured from several samples along the Bunker Creek corridor. These samples collected in borings advanced in the upper portion of Bunker Creek near the CTP were primarily between 8.0 and 11.5 ft bgs. Zinc concentrations in this range were shallower in the lower portion of Bunker Creek and in the Slag Pile area; primarily from ground surface to 5 ft bgs.

5.3 Central Impoundment Area/Slag Pile Area

5.3.1 Cadmium

Three soil borings were advanced in the area between the CIA/Slag Pile area and I-90 (Figure 6).

Cadmium concentrations in soil ranged from 2.0 mg/kg to 34.9 mg/kg. The highest cadmium concentrations in two soil borings (BH-SF-E-PZ-24 and BH-SF-E-PZ-25) were from ground surface to about 10 ft bgs. The highest concentration observed from BH-SF-E-PZ-23 was up to the total depth of the boring at about 15 ft bgs. The highest concentration (34.9 mg/kg) was from BH-SF-E-PZ-25, located north of the Slag Pile area and south of I-90 (Figure 6), between 4.0 and 5.2 ft bgs.

Cadmium concentrations did not exceed the PTM threshold of 71,000 mg/kg in samples from this area.

5.3.2 Lead

The highest lead concentration measured in soil from this area (37,000 mg/kg) was from BH-SF-E-PZ-25, located north of the Slag Pile area and south of I-90, at the depth interval of 4.0 to 5.2 ft bgs (Figure 6). A lead concentration of 17,000 mg/kg was measured from this same boring at the depth interval of 2.2 to 3.3 ft bgs. Additionally, a lead concentration of 13,600 mg/kg was measured from BH-SF-E-PZ-24 at the depth interval of 4.0 to 5.5 ft bgs (Figure 6).

The highest lead concentrations detected in the City of Kellogg were typically from ground surface to about 7 ft bgs. Lead concentrations did not exceed the PTM threshold of 84,600 mg/kg in samples collected in this area.

5.3.3 Zinc

The highest zinc concentrations were typically identified between ground surface and 7 ft bgs. The highest zinc concentration (27,400 mg/kg) was detected from BH-SF-E-PZ-25 at the depth interval of 1.0 to 2.2 ft bgs (Figure 6). Zinc concentrations of 22,100 mg/kg and 13,400 mg/kg were measured from BH-SF-E-PZ-24, at depth intervals of 1.5 to 3.2 ft bgs and of ground surface to 1.5 ft bgs, respectively (Figure 6).

5.4 Government Creek

5.4.1 Cadmium

Six drilling locations are present along Government Creek between McKinley Avenue and I-90 (Figure 6).

Cadmium concentrations in soil ranged from less than 1.0 mg/kg to 73.6 mg/kg. The highest concentration (73.6 mg/kg) was from BH-SF-E-PZ-28, located west of Government Creek and North of McKinley Avenue (Figure 6), between 1.5 and 2.6 ft bgs. A cadmium concentration of 51.2 mg/kg was detected from this same boring at the depth interval of 4.0 to 5.0 ft bgs. Additionally, cadmium concentrations of 65.7 mg/kg and 50.3 mg/kg were measured from BH-SF-E-PZ-31 (9.0 to 10.0 ft bgs) and BH-SF-E-PZ-27 (0.5 to 2.0 ft bgs), respectively (Figure 6). The depth intervals of the elevated cadmium concentrations were variable in the six Government Creek borings and were identified up to the total depth of select borings (about 15 ft bgs).

Cadmium concentrations did not exceed the PTM threshold of 71,000 mg/kg in samples collected along the lower portion of Government Creek.

5.4.2 Lead

The highest lead concentration measured in soil from this area (33,300 mg/kg) was from BH-SF-E-PZ-31, located north of Government Creek near I-90, at the depth interval of 4.0 to 5.5 ft bgs (Figure 6). A lead concentration of 24,700 mg/kg was measured from BH-SF-E-PZ-28 (5.0 to 6.5 ft bgs) (Figure 6). Numerous lead concentrations were measured between 10,000 mg/kg and 20,000 mg/kg from five of the six borings. The depth interval for these elevated lead concentrations is less variable than the depth interval for the cadmium concentrations (from ground surface to about 10 ft bgs).

Lead concentrations did not exceed the PTM threshold of 84,600 mg/kg in borings located along Government Creek.

5.4.3 Zinc

The highest zinc concentration near Government Creek was 11,200 mg/kg, from BH-SF-E-PZ-28 at the depth interval of 1.5 to 2.6 ft bgs. A zinc concentration of 8,770 mg/kg was measured from this same boring at the depth interval of 4.0 to 5.0 ft bgs. A zinc concentration of 9,110 mg/kg was measured from the sample collected from 4.0 to 5.5 ft bgs at BH-SF-E-PZ-31.

The highest zinc concentrations observed in these borings were significantly less than zinc concentrations observed in nearby Bunker Creek borings. The depth interval for the elevated zinc concentrations along Government Creek is from ground surface to about 10 ft bgs (Figure 6).

5.5 West of Page Wastewater Treatment Ponds

5.5.1 Cadmium

Two borings were advanced west of the Page wastewater treatment ponds on top of the Page tailings pile (Figure 7). These borings were advanced to 5 ft below the first contact with groundwater. Review of boring logs at these locations does not reveal the location of the alluvium/tailings contact. Therefore, it is not known if the bottoms of the borings are located in native alluvium or in tailing materials.

Cadmium concentrations from samples collected in the two Page-ponds borings were variable throughout the depth of both borings. The highest cadmium concentrations measured were 33.3 mg/kg (BH-SF-W-PZ-01) and 36.1 mg/kg (BH-SF-W-PZ-02) at depths of about 17.5 ft bgs to 19.5 ft bgs. Numerous concentrations between 20 mg/kg and 30 mg/kg were measured from both borings at varying depths. Cadmium concentrations did not exceed the PTM threshold of 71,000 mg/kg in samples from these borings.

5.5.2 Lead

The highest lead concentrations from samples collected in the two Page-ponds borings were 10,200 mg/kg (BH-SF-W-PZ-01, 0.5 to 2.5 ft bgs) and 19,500 mg/kg (BH-SF-W-PZ-01, 8.0 to 8.7 ft bgs). Most lead concentrations in samples from these two borings ranged from about 2,000 mg/kg to 4,000 mg/kg. Lead concentrations did not exceed the PTM threshold of 84,600 mg/kg in samples collected in these borings.

5.5.3 Zinc

The highest zinc concentration in this area of OU2 was 32,700 mg/kg from BH-SF-W-PZ-01 at the depth interval of 15.0 to 16.0 ft bgs (Figure 7). In addition, a zinc concentration of 17,000 mg/kg was measured from BH-SF-W-PZ-02 at the depth interval of 16.0 to 17.5 ft bgs. Zinc concentrations measured from most samples collected in these two borings were less than 5,000 mg/kg.

5.6 West End Natural Infiltration Area

5.6.1 Cadmium

Elevated cadmium concentrations were identified from one of the three borings advanced in the WENI area (Figure 7). The two highest cadmium concentrations in this area were detected from BH-SF-W-PZ-07 at depth intervals of 4.0 to 5.5 ft bgs (57.7 mg/kg) and of 5.5 to 7.3 ft bgs (167 mg/kg). Cadmium concentrations from soil borings BH-SF-W-PZ-03 and BH-SF-W-PZ-06 were less than 4.0 mg/kg.

5.6.2 Lead

Elevated lead concentrations were identified from one of the three borings advanced in the WENI area. The highest lead concentration in this area was detected from BH-SF-W-PZ-07 at the depth interval of 5.5 to 7.3 ft bgs (59,000 mg/kg). Lead concentrations for samples collected from soil borings BH-SF-W-PZ-03 and BH-SF-W-PZ-06 were less than 90 mg/kg.

5.6.3 Zinc

Elevated zinc concentrations were measured only from BH-SF-W-PZ-07. Zinc concentrations of 28,500 mg/kg and 5,790 mg/kg were measured at depth intervals of 5.5 to 7.3 ft bgs and of 4.0 to 5.5 ft bgs, respectively. Zinc concentrations from BH-SF-W-PZ-03 and BH-SF-W-PZ-06 were less than 1,000 mg/kg.

5.7 Smelterville Flats

5.7.1 Cadmium

Two soil borings were advanced in the western portion of Smelterville Flats (Figure 7). The highest cadmium concentration (43.8 mg/kg) was measured from BH-SF-W-PZ-04 at the depth interval of 4.0 to 5.4 ft bgs. Two samples were submitted for laboratory analysis from BH-SF-W-PZ-05. The highest cadmium concentration measured at this site was 11.4 mg/kg at the depth interval of 4.0 to 5.8 ft bgs. Cadmium concentrations did not exceed the PTM threshold of 71,000 mg/kg in samples collected in Smelterville Flats.

5.7.2 Lead

The highest lead concentrations measured from each boring were 3,770 mg/kg (BH-SF-W-PZ-04) and 3,410 mg/kg (BH-SF-W-PZ-05) at depth intervals of 4.0 to 5.4 ft bgs and ground surface to 2.0 ft bgs, respectively (Figure 7). Please note that the site-specific removal excavation goal for Smelterville Flats was 3,000 mg/kg for lead.

5.7.3 Zinc

The highest zinc concentration (2,360 mg/kg) was measured from BH-SF-W-PZ-04 at the depth interval of 4.0 to 5.4 ft bgs. Zinc concentrations from all other samples were less than 2,000 mg/kg.

6 Summary

The following items summarize field activities and findings from the direct push field investigation:

- Thirty-eight soil borings were advanced into the upper alluvial sequence in OU2.
- Three-hundred-fifteen soil samples were collected from these borings and submitted for laboratory analysis.
- Thirty-six of the 38 borings were converted to temporary piezometers—29 in the eastern portion of OU2 and 7 in the western portion of OU2. Two soil borings were abandoned because of refusal and/or lack of groundwater.
- Lithologic logs of the soil borings show that, in general, the upper 12 ft of the soil column in the eastern portion of OU2 is highly disturbed and contains mixtures of native materials and mine and mill wastes. In the western portion of OU2, the disturbed thickness is less and likely results from the large number of remedial actions and of historic recovery of tailings in this area.
- The highest cadmium concentrations generally coincided with the tailings-impacted soils in the areas from the Silver Mountain Resort parking lot west through the Bunker Creek corridor. The vertical extent of elevated cadmium concentrations was also consistent with lithologic observations of disturbed soils as described previously. Elevated cadmium concentrations were observed in all areas investigated in OU2.
- Lead concentrations exceeded the PTM threshold of 84,600 mg/kg in two soil borings located near the CTP and along the lower portion of Bunker Creek. The highest lead concentrations present in subsurface soils coincided with the observed tailings-impacted soils, which are primarily located between the Silver Mountain Resort parking lot west through the Bunker Creek corridor. Elevated lead concentrations were observed in most areas investigated in OU2.
- Elevated zinc concentrations were observed in soil from most soil borings advanced in OU2. The highest zinc concentrations were observed in soil borings in the lower portion of Bunker Creek and in the Slag Pile area. These concentrations coincide with lithologic observations of tailings-impacted soils in this area. Other significant zinc concentrations were measured in the eastern portion of the City of Kellogg, the WENI area, and near the Page wastewater treatment ponds.

7 References

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CH2M HILL. 2008a. *Quality Assurance Project Plan, OU2/OU3 Direct Push Investigation, Shoshone County, Idaho*. Prepared for USEPA. June 2008.

CH2M HILL. 2008b. *Source Areas of Concern Report, Bunker Hill Mining and Metallurgical Complex Superfund Site*. Prepared for USEPA. March 2008.

8 Acronyms

AES	Architect and Engineering Services
ASTM	American Society for Testing and Materials
CIA	Central Impoundment Area
CLP	Contract Laboratory Program
CSM	*Current Status Conceptual Site Model, Operable Unit 2, Bunker Hill Mining and Metallurgical Complex Superfund Site* (CH2M HILL, 2006)
CTP	Central Treatment Plant
ESAT	Environmental Services Assistance Team
ft	foot (feet)
ft bgs	feet below ground surface
HSP	Health and Safety Plan
I-90	Interstate 90
IDEQ	Idaho Department of Environmental Quality
IDW	investigation-derived waste
INL	Idaho National Laboratory
mg/kg	milligrams per kilogram
OD	outer diameter
OU2	Operable Unit 2
PTM	principal threat material
PVC	polyvinyl chloride
QAPP	*Quality Assurance Project Plan, OU2/OU3 Direct Push Investigation, Shoshone County, Idaho* (CH2M HILL, 2008a)

QC	quality-control
SFCDR	South Fork Coeur d'Alene River
SOP	Standard Operation Procedure
TAL	target analyte list
USEPA	U.S. Environmental Protection Agency
WENI	West End Natural Infiltration

Table

TABLE 1
Summary of Piezometer Installation
OU2 Direct Push Field Investigation

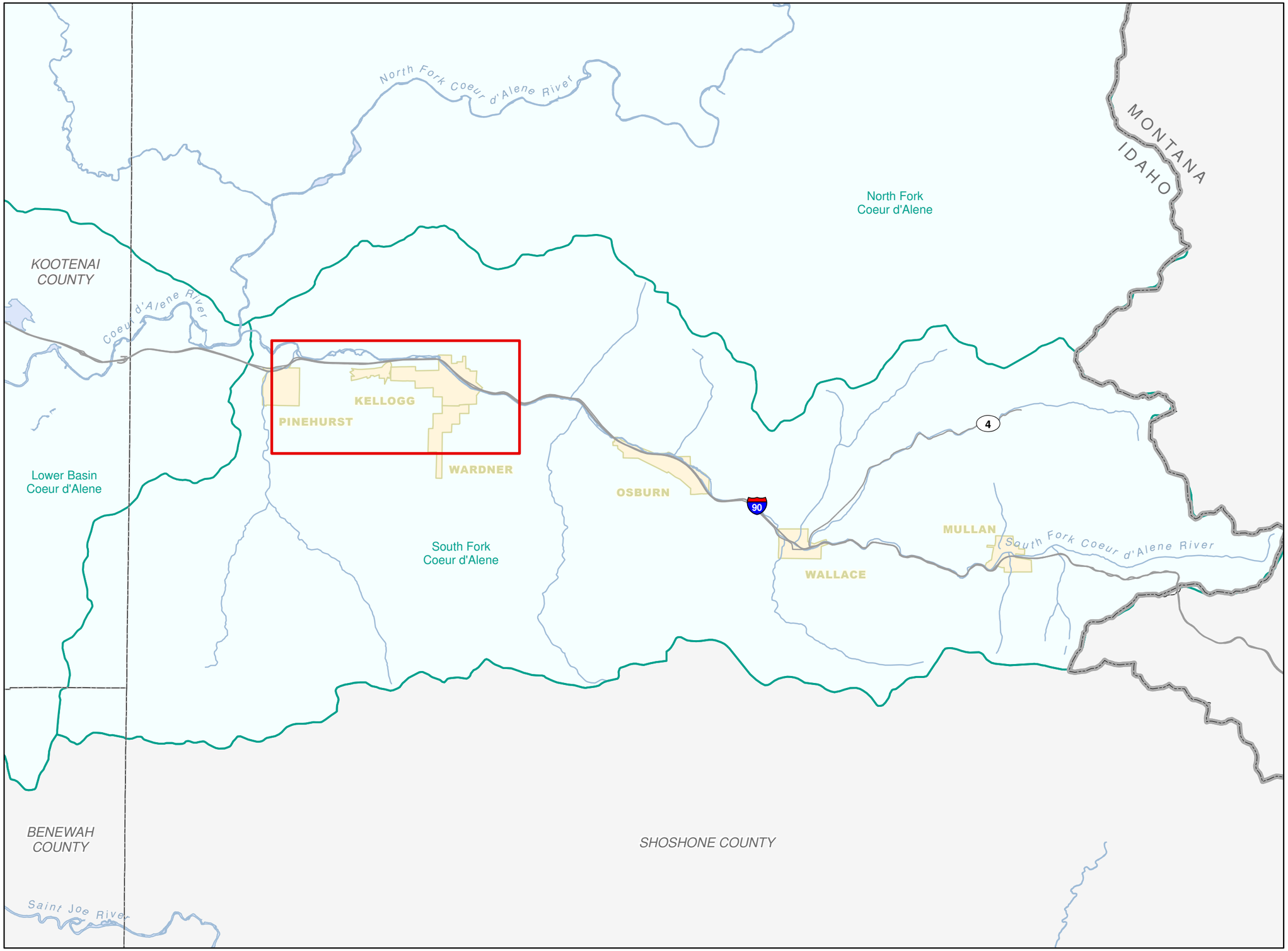
Piezometer ID	Date of Install	Northing	Easting	Elevation (ft amsl)	Total Depth of Boring (ft bgs)[2]	Casing Diameter (inches)	Screen Length (ft)	Screen Interval (ft bgs)	Screen Slot (inches)	Surface Completion
BH-SF-E-PZ-01	7/7/2008	2140648.061	2532260.888	2300.45	17.8	1.5	5	12.8-17.8	0.01	Flush 6-inch steel monument
BH-SF-E-PZ-03	7/10/2008	2141372.11	2531712.953	2300.63	21	1.5	5	16-21	0.01	Flush 6-inch steel monument
BH-SF-E-PZ-04	7/31/2008	2141489.696	2531783.057	2300.53	20.1	1.5	5	15.1-20.1	0.01	Flush 6-inch steel monument
BH-SF-E-PZ-05	7/10/2008	2142710.865	2531433.286	2291.36	18.4	1.5	5	13.4-18.4	0.01	Flush 6-inch steel monument
BH-SF-E-PZ-06	7/31/2008	2142030.14	2531211.262	2296.39	22.3	1.5	5	17.3-22.3	0.01	Flush 6-inch steel monument
BH-SF-E-PZ-08	8/5/2008	2142671.51	2530550.578	2294.18	24	1.5	5	19-24	0.01	Flush 6-inch steel monument
BH-SF-E-PZ-09	8/1/2008	2141623.829	2529768.862	2283.08	17.8	1.5	5	12.8-17.8	0.01	Flush 6-inch steel monument
BH-SF-E-PZ-10	7/2/2008	2141223.787	2530070.749	2288.15	20	1.5	5	15-20	0.01	Flush 6-inch steel monument
BH-SF-E-PZ-11	7/3/2008	2141055.405	2529343.889	2281.54	16	1.5	5	11-16	0.01	Flush 6-inch steel monument
BH-SF-E-PZ-12	7/3/2008	2141209.572	2528806.579	2279.81	16	1.5	5	11-16	0.01	Flush 6-inch steel monument
BH-SF-E-PZ-13	7/7/2008	2141002.129	2528580.617	2306.46	27.7	1.5	5	27.3-32.3	0.01	3-inch PVC stickup
BH-SF-E-PZ-14	6/20/2008	2141537.591	2527779.391	2278.20	18	1.5	5	13-18	0.01	3-inch PVC stickup
BH-SF-E-PZ-15	7/2/2008	2141343.112	2527551.302	2297.55	36	1.5	5	31-36	0.01	Flush 6-inch steel monument
BH-SF-E-PZ-16	6/20/2008	2141963.604	2527017.916	2271.69	16	1.5	5	11-16	0.01	3-inch PVC stickup
BH-SF-E-PZ-17	7/9/2008	2142452.733	2525685.091	2265.56	16.6	1.5	5	11.6-16.6	0.01	3-inch PVC stickup
BH-SF-E-PZ-18	6/20/2008	2142958.31	2524723.063	2260.92	16	1.5	5	11-16	0.01	3-inch PVC stickup
BH-SF-E-PZ-20	7/3/2008	2143163.903	2523881.586	2255.98	16	1.5	5	11-16	0.01	Flush 6-inch steel monument
BH-SF-E-PZ-21	6/18/2008	2143459.617	2522711.323	2252.61	20	1.5	5	15-20	0.01	3-inch PVC stickup
BH-SF-E-PZ-22	6/18/2008	2143536.048	2522727.982	2250.41	17.3	1.5	5	12.3-17.3	0.01	3-inch PVC stickup
BH-SF-E-PZ-23	6/19/2008	2144234.961	2524875.317	2260.50	17	1.5	5	12-17	0.01	3-inch PVC stickup

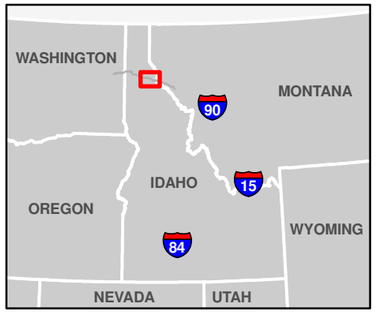
TABLE 1
Summary of Piezometer Installation
OU2 Direct Push Field Investigation

Piezometer ID	Date of Install	Northing	Easting	Elevation (ft amsl)	Total Depth of Boring (ft bgs)[2]	Casing Diameter (inches)	Screen Length (ft)	Screen Interval (ft bgs)	Screen Slot (inches)	Surface Completion
BH-SF-E-PZ-24	6/19/2008	2144219.884	2523855.251	2253.26	17	1.5	5	12-17	0.01	3-inch PVC stickup
BH-SF-E-PZ-25	6/18/2008	2144094.793	2522698.244	2250.81	17.8	1.5	5	12.8-17.8	0.01	3-inch PVC stickup
BH-SF-E-PZ-26A	6/17/2008	2143834.165	2522100.774	2248.55	21.5	1.5	5	16.5-21.5	0.01	3-inch PVC stickup
BH-SF-E-PZ-26B	7/21/2008	2143848.73	2522105.713	2249.73	16.2	1.5	5	11.2-16.2	0.01	3-inch PVC stickup
BH-SF-E-PZ-27	6/23/2008	2143490.58	2521735.209	2245.45	16	1.5	5	11-16	0.01	Flush 6-inch steel monument
BH-SF-E-PZ-28	6/23/2008	2143478.399	2521673.376	2247.46	16	1.5	5	11-16	0.01	3-inch PVC stickup
BH-SF-E-PZ-29	7/1/2008	2143854.121	2521515.993	2243.58	16	1.5	5	11-16	0.01	3-inch PVC stickup
BH-SF-E-PZ-30	7/1/2008	2143920.128	2521548.887	2245.06	16	1.5	5	11-16	0.01	3-inch PVC stickup
BH-SF-E-PZ-31	6/23/2008	2143826.35	2520748.132	2241.11	15.8	1.5	5	10.8-15.8	0.01	3-inch PVC stickup
BH-SF-E-PZ-32	6/19/2008	2143764.713	2520735.26	2241.20	16.2	1.5	5	11.2-16.2	0.01	3-inch PVC stickup
BH-SF-W-PZ-01	7/8/2008	2143048.246	2512251.574	2236.24	28.4	1.5	5	23.4-28.4	0.01	3-inch PVC stickup
BH-SF-W-PZ-02	7/8/2008	2142768.838	2512151.601	2236.24	28.4	1.5	5	23.4-28.4	0.01	3-inch PVC stickup
BH-SF-W-PZ-03	7/9/2008	2143666.125	2511379.409	2197.39	10.2	1.5	5	5.2-10.2	0.01	3-inch PVC stickup
BH-SF-W-PZ-04	7/21/2008	2144544.767	2511791.603	2198.91	10.8	1.5	5	5.8-10.8	0.01	3-inch PVC stickup
BH-SF-W-PZ-05	7/10/2008	2144102.174	2511038.306	2197.42	10	1.5	5	5-10	0.01	3-inch PVC stickup
BH-SF-W-PZ-06	7/9/2008	2143891.8	2509495.891	2196.23	17	1.5	5	12-17	0.01	3-inch PVC stickup
BH-SF-W-PZ-07	7/9/2008	2144131.131	2509059.554	2194.00	10	1.5	5	5-10	0.01	3-inch PVC stickup

Abbreviations:
amsl **=** Reference point measured in feet above mean sea level.
ft = Unit of length in feet.
bgs = Reference point measured in feet above/below ground surface at respective location.

Figures





OU2 Field Investigation Area
Coeur d'Alene Subbasin Boundary
City Limit

N 0 1 2 4 Miles

Source: IDWR (5th & 6th Level HUC); NHDPlus (Rivers, Waterbodies); ESRI base data (Interstates 2006, Major Highways 2008).

Figure 1.
OU2 Vicinity Map
OU2 Direct Push Field Investigation
BUNKER HILL SUPERFUND SITE OU2

CH2MHILL

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BH-SF-E-PZ-24
BH-SF-E-PZ-23
BH-SF-E-PZ-25
BH-SF-E-PZ-30
BH-SF-E-PZ-31
BH-SF-E-PZ-26B
SLAG PILE AREA
BH-SF-E-PZ-29
BH-SF-E-PZ-26A
BH-SF-E-PZ-32
BH-SF-E-PZ-22
CENTRAL IMPOUNDMENT AREA (CIA)
BH-SF-E-PZ-28
BH-SF-E-PZ-27
BH-SF-E-PZ-21
BH-SF-E-PZ-20
McKinley Ave
BH-SF-E-PZ-19
BH-SF-E-PZ-18
BH-SF-E-PZ-08
BH-SF-E-PZ-05
BH-SF-E-PZ-17
SMELTER CLOSURE AREA
BH-SF-E-PZ-06
BH-SF-E-PZ-16
Bunker Creek
BH-SF-E-PZ-09
BH-SF-E-PZ-14
McKinley Ave
BH-SF-E-PZ-04
BH-SF-E-PZ-15
BH-SF-E-PZ-12
BH-SF-E-PZ-10
BH-SF-E-PZ-03
BH-SF-E-PZ-02
BH-SF-E-PZ-11
BH-SF-E-PZ-13
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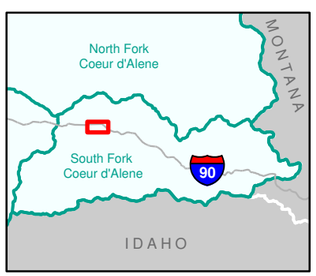
Magnet Gulch
Deadwood Gulch
Railroad Gulch
Portal Gulch
South Fork Coeur d'Alene River
Jackass Creek
90



Piezometer Location

Abandoned Bore Hole Location

Source: NHDPlus (Rivers, Waterbodies); Idaho Geospatial Data Clearinghouse (Roads 2008, City Limits 2003).

N 0 375 750 1,500 Feet

Figure 2. **Piezometers in Eastern OU2**
OU2 Direct Push Field Investigation
BUNKER HILL SUPERFUND SITE OU2

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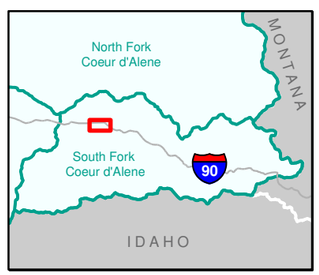
\\CASTAIC\PROJ\EPA\CDABASIN_382081\GIS\MAPFILES\OU2\FIG2_INSTALLEDPIEZOMEAST.MXD FIG2_INSTALLEDPIEZOMEAST.MXD RDEMARIS 2/20/2009 11:01:01

South Fork Coeur d'Alene River
BH-SF-W-PZ-04
SMELTERVILLE FLATS
BH-SF-W-PZ-07
BH-SF-W-PZ-05
BH-SF-W-PZ-06
BH-SF-W-PZ-03
90
West Page Swamp
Irrigation Ditch
BH-SF-W-PZ-01
BH-SF-W-PZ-02
PAGE WASTEWATER TREATMENT PONDS
East Page Swamp
Grouse Gulch
Humbolt Creek



Piezometer Location

West End Natural Infiltration Area

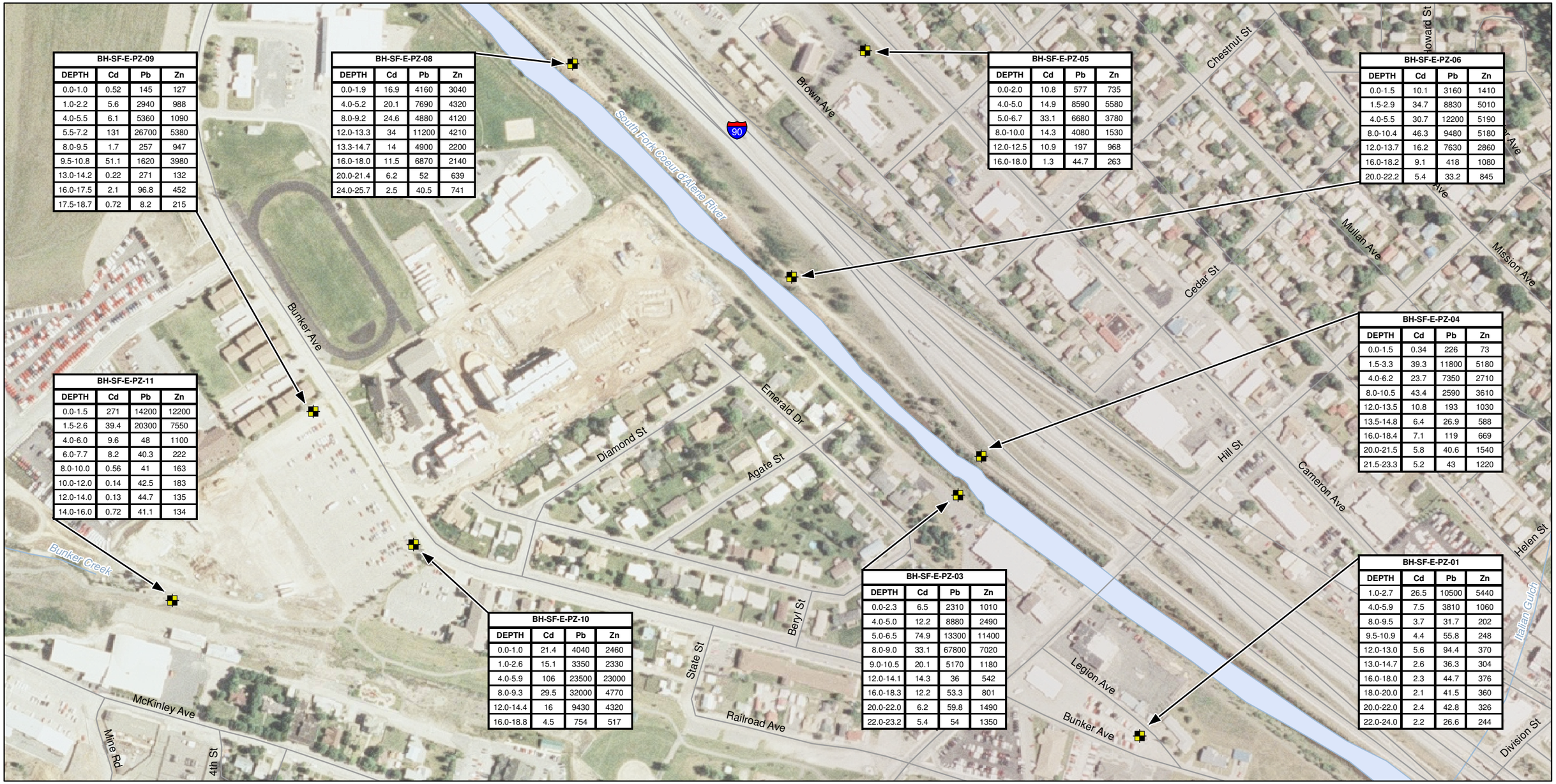
Source: NHDPlus (Rivers, Waterbodies); Idaho Geospatial Data Clearinghouse (Roads 2008, City Limits 2003).

N 0 375 750 1,500 Feet

Figure 3. **Installed Piezometers in Western OU2**
OU2 Direct Push Field Investigation
BUNKER HILL SUPERFUND SITE OU2

CH2MHILL

\\CASTAIC\PROJ\EPA\CDABASIN_382081\GIS\MAPFILES\OU2\FIG3_INSTALLEDPIEZOMWEST.MXD FIG3_INSTALLEDPIEZOMWEST.MXD RDEMARIS 2/20/2009 11:08:25



BH-SF-E-PZ-09			
DEPTH	Cd	Pb	Zn
0.0-1.0	0.52	145	127
1.0-2.2	5.6	2940	988
4.0-5.5	6.1	5360	1090
5.5-7.2	131	26700	5380
8.0-9.5	1.7	257	947
9.5-10.8	51.1	1620	3980
13.0-14.2	0.22	271	132
16.0-17.5	2.1	96.8	452
17.5-18.7	0.72	8.2	215

BH-SF-E-PZ-08			
DEPTH	Cd	Pb	Zn
0.0-1.9	16.9	4160	3040
4.0-5.2	20.1	7690	4320
8.0-9.2	24.6	4880	4120
12.0-13.3	34	11200	4210
13.3-14.7	14	4900	2200
16.0-18.0	11.5	6870	2140
20.0-21.4	6.2	52	639
24.0-25.7	2.5	40.5	741

BH-SF-E-PZ-05			
DEPTH	Cd	Pb	Zn
0.0-2.0	10.8	577	735
4.0-5.0	14.9	8590	5580
5.0-6.7	33.1	6680	3780
8.0-10.0	14.3	4080	1530
12.0-12.5	10.9	197	968
16.0-18.0	1.3	44.7	263

BH-SF-E-PZ-06			
DEPTH	Cd	Pb	Zn
0.0-1.5	10.1	3160	1410
1.5-2.9	34.7	8830	5010
4.0-5.5	30.7	12200	5190
8.0-10.4	46.3	9480	5180
12.0-13.7	16.2	7630	2860
16.0-18.2	9.1	418	1080
20.0-22.2	5.4	33.2	845

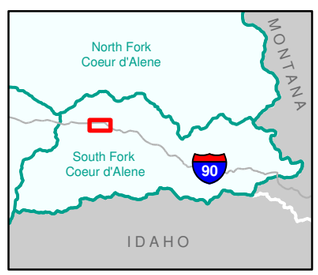
BH-SF-E-PZ-11			
DEPTH	Cd	Pb	Zn
0.0-1.5	271	14200	12200
1.5-2.6	39.4	20300	7550
4.0-6.0	9.6	48	1100
6.0-7.7	8.2	40.3	222
8.0-10.0	0.56	41	163
10.0-12.0	0.14	42.5	183
12.0-14.0	0.13	44.7	135
14.0-16.0	0.72	41.1	134

BH-SF-E-PZ-04			
DEPTH	Cd	Pb	Zn
0.0-1.5	0.34	226	73
1.5-3.3	39.3	11800	5180
4.0-6.2	23.7	7350	2710
8.0-10.5	43.4	2590	3610
12.0-13.5	10.8	193	1030
13.5-14.8	6.4	26.9	588
16.0-18.4	7.1	119	669
20.0-21.5	5.8	40.6	1540
21.5-23.3	5.2	43	1220

BH-SF-E-PZ-10			
DEPTH	Cd	Pb	Zn
0.0-1.0	21.4	4040	2460
1.0-2.6	15.1	3350	2330
4.0-5.9	106	23500	23000
8.0-9.3	29.5	32000	4770
12.0-14.4	16	9430	4320
16.0-18.8	4.5	754	517

BH-SF-E-PZ-03			
DEPTH	Cd	Pb	Zn
0.0-2.3	6.5	2310	1010
4.0-5.0	12.2	8880	2490
5.0-6.5	74.9	13300	11400
8.0-9.0	33.1	67800	7020
9.0-10.5	20.1	5170	1180
12.0-14.1	14.3	36	542
16.0-18.3	12.2	53.3	801
20.0-22.0	6.2	59.8	1490
22.0-23.2	5.4	54	1350

BH-SF-E-PZ-01			
DEPTH	Cd	Pb	Zn
1.0-2.7	26.5	10500	5440
4.0-5.9	7.5	3810	1060
8.0-9.5	3.7	31.7	202
9.5-10.9	4.4	55.8	248
12.0-13.0	5.6	94.4	370
13.0-14.7	2.6	36.3	304
16.0-18.0	2.3	44.7	376
18.0-20.0	2.1	41.5	360
20.0-22.0	2.4	42.8	326
22.0-24.0	2.2	26.6	244



Piezometer Location

Cd = cadmium
Pb = lead
Zn = zinc

Depth = Feet

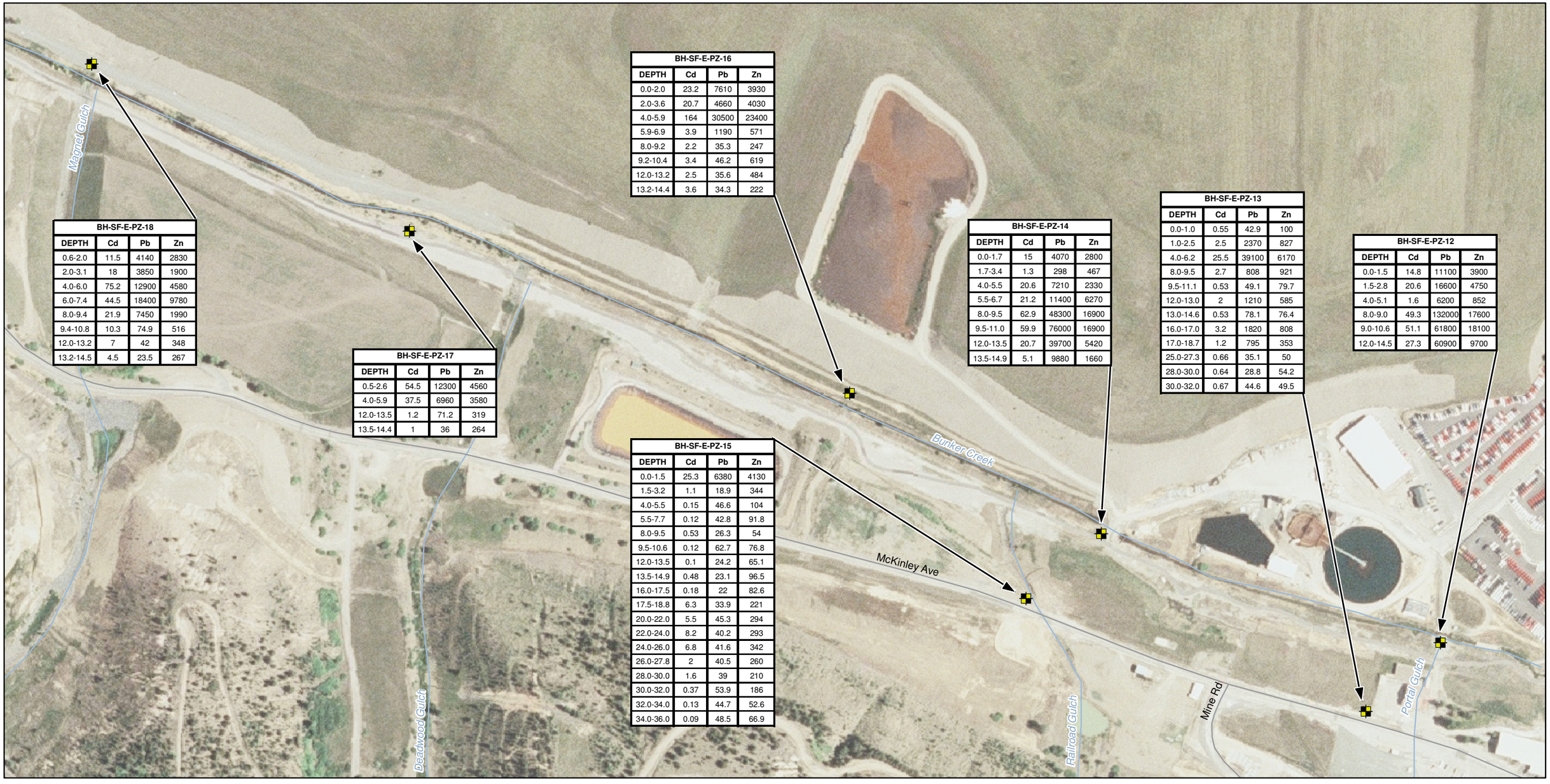
Metal concentrations = mg/Kg

N 0 125 250 500 Feet

Source: NHDPlus (Rivers, Waterbodies); Idaho Geospatial Data Clearinghouse (Roads 2008, City Limits 2003).

Figure 4. **Cadmium, Zinc, and Lead Concentrations in Soil**
City of Kellogg
OU2 Direct Push Field Investigation
BUNKER HILL SUPERFUND SITE OU2

CH2MHILL



BH-SF-E-PZ-18

DEPTH	Cd	Pb	Zn
0.6-2.0	11.5	4140	2830
2.0-3.1	18	3850	1900
4.0-6.0	75.2	12900	4580
6.0-7.4	44.5	18400	9780
8.0-9.4	21.9	7450	1990
9.4-10.8	10.3	74.9	516
12.0-13.2	7	42	348
13.2-14.5	4.5	23.5	267

BH-SF-E-PZ-17

DEPTH	Cd	Pb	Zn
0.5-2.6	54.5	12300	4560
4.0-5.9	37.5	6960	3580
12.0-13.5	1.2	71.2	319
13.5-14.4	1	36	264

BH-SF-E-PZ-16

DEPTH	Cd	Pb	Zn
0.0-2.0	23.2	7610	3930
2.0-3.6	20.7	4660	4030
4.0-5.9	164	30500	23400
5.9-6.9	3.9	1190	571
8.0-9.2	2.2	35.3	247
9.2-10.4	3.4	46.2	619
12.0-13.2	2.5	35.6	484
13.2-14.4	3.6	34.3	222

BH-SF-E-PZ-15

DEPTH	Cd	Pb	Zn
0.0-1.5	25.3	6380	4130
1.5-3.2	1.1	18.9	344
4.0-5.5	0.15	46.6	104
5.5-7.7	0.12	42.8	91.8
8.0-9.5	0.53	26.3	54
9.5-10.6	0.12	62.7	76.8
12.0-13.5	0.1	24.2	65.1
13.5-14.9	0.48	23.1	96.5
16.0-17.5	0.18	22	82.6
17.5-18.8	6.3	33.9	221
20.0-22.0	5.5	45.3	294
22.0-24.0	8.2	40.2	293
24.0-26.0	6.8	41.6	342
26.0-27.8	2	40.5	260
28.0-30.0	1.6	39	210
30.0-32.0	0.37	53.9	186
32.0-34.0	0.13	44.7	52.6
34.0-36.0	0.09	48.5	66.9

BH-SF-E-PZ-14

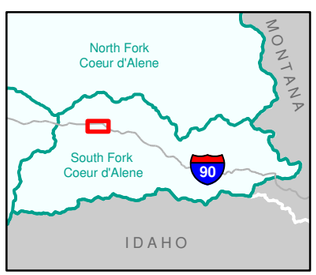
DEPTH	Cd	Pb	Zn
0.0-1.7	15	4070	2800
1.7-3.4	1.3	298	467
4.0-5.5	20.6	7210	2330
5.5-6.7	21.2	11400	6270
8.0-9.5	62.9	48300	16900
9.5-11.0	59.9	76000	16900
12.0-13.5	20.7	39700	5420
13.5-14.9	5.1	9880	1660

BH-SF-E-PZ-13

DEPTH	Cd	Pb	Zn
0.0-1.0	0.55	42.9	100
1.0-2.5	2.5	2370	827
4.0-6.2	25.5	39100	6170
8.0-9.5	2.7	808	921
9.5-11.1	0.53	49.1	79.7
12.0-13.0	2	1210	585
13.0-14.6	0.53	78.1	76.4
16.0-17.0	3.2	1820	808
17.0-18.7	1.2	795	353
25.0-27.3	0.66	35.1	50
28.0-30.0	0.64	28.8	54.2
30.0-32.0	0.67	44.6	49.5

BH-SF-E-PZ-12

DEPTH	Cd	Pb	Zn
0.0-1.5	14.8	11100	3900
1.5-2.8	20.6	16600	4750
4.0-5.1	1.6	6200	852
8.0-9.0	49.3	132000	17600
9.0-10.6	51.1	61800	18100
12.0-14.5	27.3	60900	9700



Piezometer Location

Cd = cadmium
Pb = lead
Zn = zinc

Depth = Feet

Metal concentrations = mg/Kg

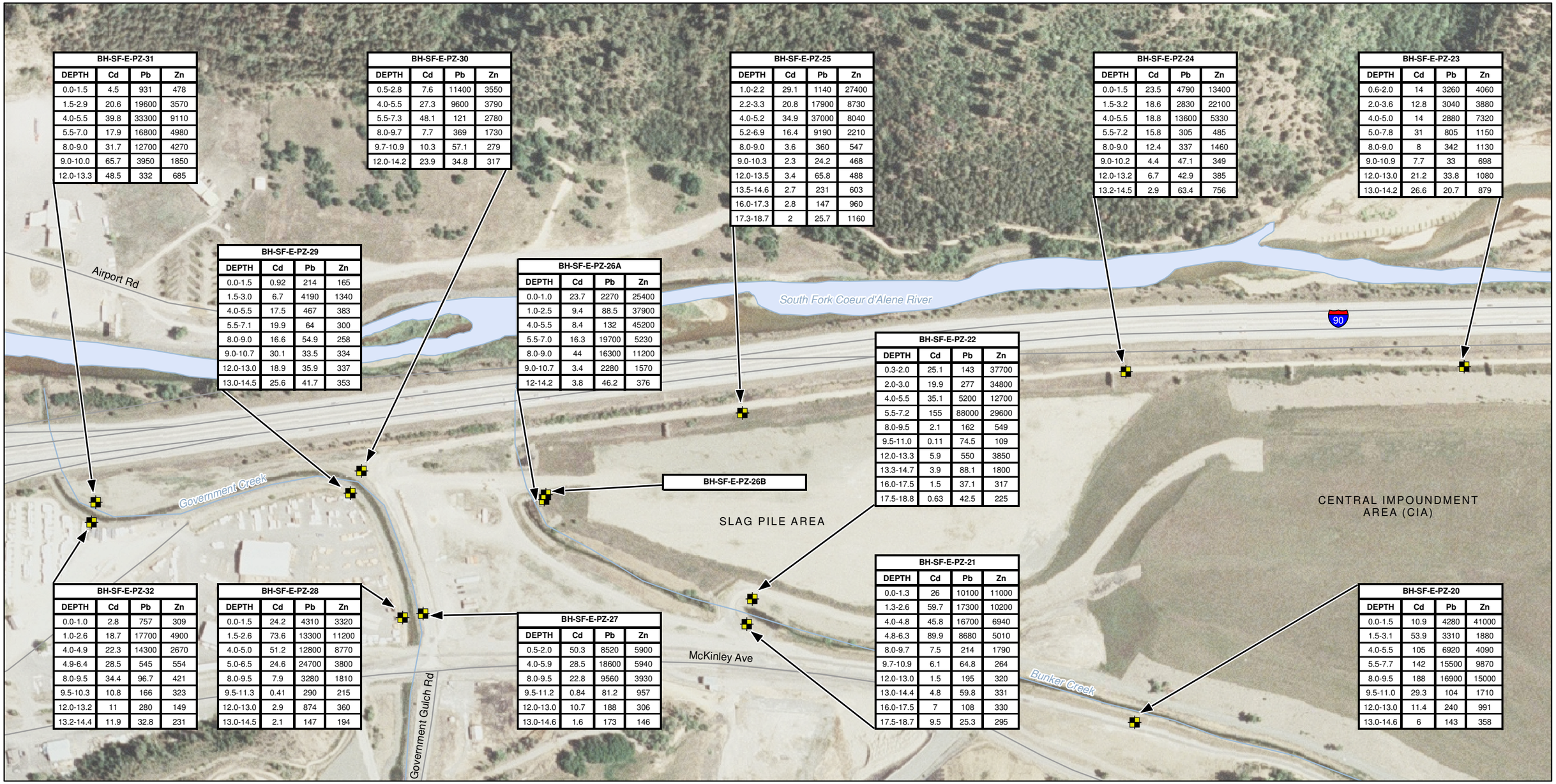
N 0 125 250 500 Feet

Source: NHDPlus (Rivers, Waterbodies); Idaho Geospatial Data Clearinghouse (Roads 2008, City Limits 2003).

Figure 5. **Cadmium, Zinc, and Lead Concentrations in Soil**
Bunker Creek Corridor
OU2 Direct Push Field Investigation
BUNKER HILL SUPERFUND SITE OU2

CH2MHILL

\\CASTAIC\PROJ\EPA\CDABASIN_382081\GIS\MAPFILES\OU2\FIG5_CDZNPB.MXD FIG5_CDZNPB.MXD RDEMARIS 2/20/2009 11:27:43



BH-SF-E-PZ-31			
DEPTH	Cd	Pb	Zn
0.0-1.5	4.5	931	478
1.5-2.9	20.6	19600	3570
4.0-5.5	39.8	33300	9110
5.5-7.0	17.9	16800	4980
8.0-9.0	31.7	12700	4270
9.0-10.0	65.7	3950	1850
12.0-13.3	48.5	332	685

BH-SF-E-PZ-30			
DEPTH	Cd	Pb	Zn
0.5-2.8	7.6	11400	3550
4.0-5.5	27.3	9600	3790
5.5-7.3	48.1	121	2780
8.0-9.7	7.7	369	1730
9.7-10.9	10.3	57.1	279
12.0-14.2	23.9	34.8	317

BH-SF-E-PZ-25			
DEPTH	Cd	Pb	Zn
1.0-2.2	29.1	1140	27400
2.2-3.3	20.8	17900	8730
4.0-5.2	34.9	37000	8040
5.2-6.9	16.4	9190	2210
8.0-9.0	3.6	360	547
9.0-10.3	2.3	24.2	468
12.0-13.5	3.4	65.8	488
13.5-14.6	2.7	231	603
16.0-17.3	2.8	147	960
17.3-18.7	2	25.7	1160

BH-SF-E-PZ-24			
DEPTH	Cd	Pb	Zn
0.0-1.5	23.5	4790	13400
1.5-3.2	18.6	2830	22100
4.0-5.5	18.8	13600	5330
5.5-7.2	15.8	305	485
8.0-9.0	12.4	337	1460
9.0-10.2	4.4	47.1	349
12.0-13.2	6.7	42.9	385
13.2-14.5	2.9	63.4	756

BH-SF-E-PZ-23			
DEPTH	Cd	Pb	Zn
0.6-2.0	14	3260	4060
2.0-3.6	12.8	3040	3880
4.0-5.0	14	2880	7320
5.0-7.8	31	805	1150
8.0-9.0	8	342	1130
9.0-10.9	7.7	33	698
12.0-13.0	21.2	33.8	1080
13.0-14.2	26.6	20.7	879

BH-SF-E-PZ-29			
DEPTH	Cd	Pb	Zn
0.0-1.5	0.92	214	165
1.5-3.0	6.7	4190	1340
4.0-5.5	17.5	467	383
5.5-7.1	19.9	64	300
8.0-9.0	16.6	54.9	258
9.0-10.7	30.1	33.5	334
12.0-13.0	18.9	35.9	337
13.0-14.5	25.6	41.7	353

BH-SF-E-PZ-26A			
DEPTH	Cd	Pb	Zn
0.0-1.0	23.7	2270	25400
1.0-2.5	9.4	88.5	37900
4.0-5.5	8.4	132	45200
5.5-7.0	16.3	19700	5230
8.0-9.0	44	16300	11200
9.0-10.7	3.4	2280	1570
12-14.2	3.8	46.2	376

BH-SF-E-PZ-22			
DEPTH	Cd	Pb	Zn
0.3-2.0	25.1	143	37700
2.0-3.0	19.9	277	34800
4.0-5.5	35.1	5200	12700
5.5-7.2	155	88000	29600
8.0-9.5	2.1	162	549
9.5-11.0	0.11	74.5	109
12.0-13.3	5.9	550	3850
13.3-14.7	3.9	88.1	1800
16.0-17.5	1.5	37.1	317
17.5-18.8	0.63	42.5	225

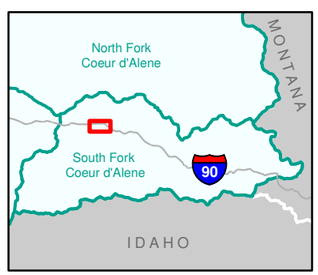
BH-SF-E-PZ-32			
DEPTH	Cd	Pb	Zn
0.0-1.0	2.8	757	309
1.0-2.6	18.7	17700	4900
4.0-4.9	22.3	14300	2670
4.9-6.4	28.5	545	554
8.0-9.5	34.4	96.7	421
9.5-10.3	10.8	166	323
12.0-13.2	11	280	149
13.2-14.4	11.9	32.8	231

BH-SF-E-PZ-28			
DEPTH	Cd	Pb	Zn
0.0-1.5	24.2	4310	3320
1.5-2.6	73.6	13300	11200
4.0-5.0	51.2	12800	8770
5.0-6.5	24.6	24700	3800
8.0-9.5	7.9	3280	1810
9.5-11.3	0.41	290	215
12.0-13.0	2.9	874	360
13.0-14.5	2.1	147	194

BH-SF-E-PZ-27			
DEPTH	Cd	Pb	Zn
0.5-2.0	50.3	8520	5900
4.0-5.9	28.5	18600	5940
8.0-9.5	22.8	9560	3930
9.5-11.2	0.84	81.2	957
12.0-13.0	10.7	188	306
13.0-14.6	1.6	173	146

BH-SF-E-PZ-21			
DEPTH	Cd	Pb	Zn
0.0-1.3	26	10100	11000
1.3-2.6	59.7	17300	10200
4.0-4.8	45.8	16700	6940
4.8-6.3	89.9	8680	5010
8.0-9.7	7.5	214	1790
9.7-10.9	6.1	64.8	264
12.0-13.0	1.5	195	320
13.0-14.4	4.8	59.8	331
16.0-17.5	7	108	330
17.5-18.7	9.5	25.3	295

BH-SF-E-PZ-20			
DEPTH	Cd	Pb	Zn
0.0-1.5	10.9	4280	41000
1.5-3.1	53.9	3310	1880
4.0-5.5	105	6920	4090
5.5-7.7	142	15500	9870
8.0-9.5	188	16900	15000
9.5-11.0	29.3	104	1710
12.0-13.0	11.4	240	991
13.0-14.6	6	143	358



Piezometer Location

Cd = cadmium
Pb = lead
Zn = zinc

Depth = Feet

Metal concentrations = mg/Kg

N 0 125 250 500 Feet

Source: NHDPlus (Rivers, Waterbodies); Idaho Geospatial Data Clearinghouse (Roads 2008, City Limits 2003).

Figure 6. **Cadmium, Zinc, and Lead Concentrations in Soil**
Bunker Creek Corridor, Slag Pile, CIA, and Government Creek Area
OU2 Direct Push Field Investigation
BUNKER HILL SUPERFUND SITE OU2

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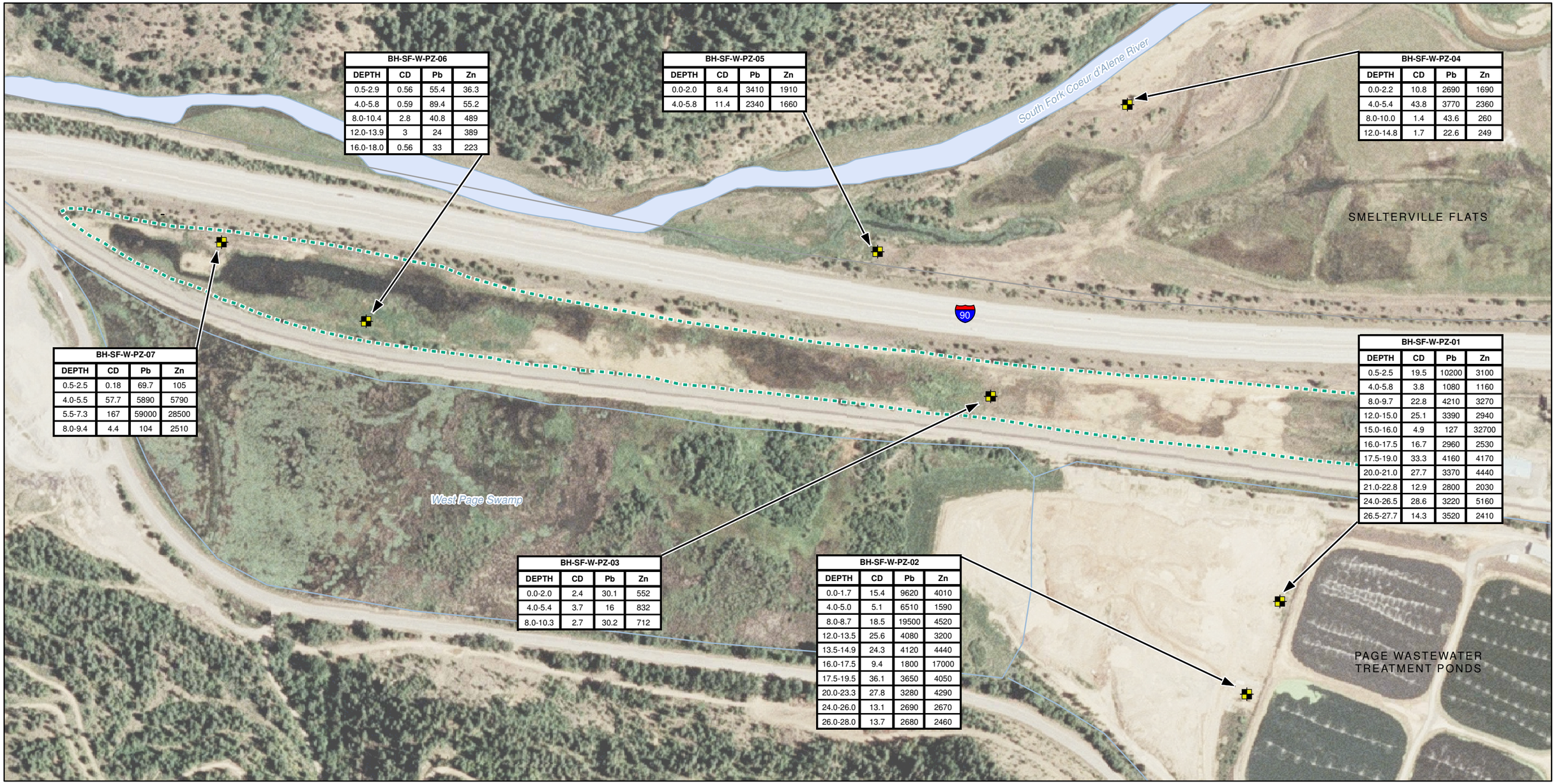
\\CASTAIC\PROJ\EPA\CDABASIN_382081\GIS\MAPFILES\OU2\FIG6_CDZNPB.MXD FIG6_CDZNPB.MXD RDEMARIS 2/20/2009 11:39:23



BH-SF-W-PZ-06			
DEPTH	CD	Pb	Zn
0.5-2.9	0.56	55.4	36.3
4.0-5.8	0.59	89.4	55.2
8.0-10.4	2.8	40.8	489
12.0-13.9	3	24	389
16.0-18.0	0.56	33	223

BH-SF-W-PZ-05			
DEPTH	CD	Pb	Zn
0.0-2.0	8.4	3410	1910
4.0-5.8	11.4	2340	1660

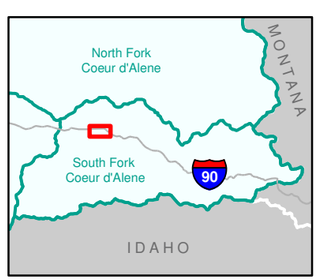
BH-SF-W-PZ-04			
DEPTH	CD	Pb	Zn
0.0-2.2	10.8	2690	1690
4.0-5.4	43.8	3770	2360
8.0-10.0	1.4	43.6	260
12.0-14.8	1.7	22.6	249

BH-SF-W-PZ-07			
DEPTH	CD	Pb	Zn
0.5-2.5	0.18	69.7	105
4.0-5.5	57.7	5890	5790
5.5-7.3	167	59000	28500
8.0-9.4	4.4	104	2510

BH-SF-W-PZ-01			
DEPTH	CD	Pb	Zn
0.5-2.5	19.5	10200	3100
4.0-5.8	3.8	1080	1160
8.0-9.7	22.8	4210	3270
12.0-15.0	25.1	3390	2940
15.0-16.0	4.9	127	32700
16.0-17.5	16.7	2960	2530
17.5-19.0	33.3	4160	4170
20.0-21.0	27.7	3370	4440
21.0-22.8	12.9	2800	2030
24.0-26.5	28.6	3220	5160
26.5-27.7	14.3	3520	2410

BH-SF-W-PZ-03			
DEPTH	CD	Pb	Zn
0.0-2.0	2.4	30.1	552
4.0-5.4	3.7	16	832
8.0-10.3	2.7	30.2	712

BH-SF-W-PZ-02			
DEPTH	CD	Pb	Zn
0.0-1.7	15.4	9620	4010
4.0-5.0	5.1	6510	1590
8.0-8.7	18.5	19500	4520
12.0-13.5	25.6	4080	3200
13.5-14.9	24.3	4120	4440
16.0-17.5	9.4	1800	17000
17.5-19.5	36.1	3650	4050
20.0-23.3	27.8	3280	4290
24.0-26.0	13.1	2690	2670
26.0-28.0	13.7	2680	2460



Piezometer Location

West End Natural Infiltration Area

Cd = cadmium
Pb = lead
Zn = zinc

Depth = Feet

Metal concentrations = mg/Kg

N 0 125 250 500 Feet

Source: NHDPlus (Rivers, Waterbodies); Idaho Geospatial Data Clearinghouse (Roads 2008, City Limits 2003).

Figure 7. **Cadmium, Zinc, and Lead Concentrations in Soil**
Page Ponds and Smelterville Flats Area
OU2 Direct Push Field Investigation
BUNKER HILL SUPERFUND SITE OU2

CH2MHILL

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