OU2 2008 Groundwater/Surface Water Interaction Monitoring Data Summary

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1.0 Introduction

This technical memorandum presents a summary of methods and results from the September 2008 groundwater/surface water interaction monitoring conducted in Operable Unit 2 (OU2) of the Bunker Hill Mining and Metallurgical Complex Superfund Site located in Shoshone County, Idaho (Figure 1). The study was conducted by CH2M HILL during September 2008 as part of the OU2 Environmental Monitoring Plan (EMP) (CH2M HILL, 2006). The initial groundwater/surface water interaction study was conducted in 1999 by G.J. Barton of the U.S. Geological Survey (USGS) (Barton, 2002). The study, referred to in this technical memorandum as "the 1999 study," was titled, *Dissolved Cadmium, Zinc, and Lead Loads from Groundwater Seepage into the South Fork Coeur d'Alene River System, Northern Idaho.* The primary objectives of the 1999 study were to define and conduct a low-flow groundwater seepage study that could be repeated during and after implementation of remedial actions to quantify metals loading to surface water from groundwater and to assess the effectiveness of the remedial actions in reducing contaminant metal loading to surface water. Subsequent groundwater/surface water interactions studies have been performed in OU2 in 2003, 2006, and 2007. In 2007, the study was cancelled after the first day of monitoring because of a large precipitation event that resulted in a significant increase in discharge in the South Fork Coeur d'Alene River (SFCDR).

1.1 Purpose and Objectives

As part of the current OU2 EMP, CH2M HILL replicated that portion of the 1999 study that was conducted within OU2. The purpose of the 2008 study was to assess contaminant metal loading from groundwater to the SFCDR under low-flow conditions and compare the data to previous studies. Key objectives of this 2008 study were to:

- Assess the nature and extent of contaminant metal inputs from OU2 groundwater to the SFCDR.
- Evaluate surface water quality with respect to ambient water quality criteria (AWQC).
- Identify or confirm significant source areas of groundwater contaminant metal loading along selected reaches of the SFCDR within OU2.

- Collect information to help assess the effectiveness of OU2 Phase I remedial actions and evaluate potential Phase II remedial alternatives.
- Identify site conditions or methodology issues that may affect the validity and representativeness of the 2008 study and previous study results and may require modification of future studies.

The focus of this technical memorandum is on dissolved metal (cadmium, lead, and zinc) conditions in the SFCDR resulting from the interaction of groundwater and surface water within OU2. In addition to dissolved metal data, additional parameters were collected during the 2008 study and select parameters are presented in this memorandum. While additional data collected during the 2008 study and data from the OU2 EMP semi-annual monitoring event conducted in September and October 2008 are presented and discussed in this memorandum, this memorandum is not intended to act as a full evaluation of geochemical and contaminant conditions within the greater OU2 site.

The OU2 EMP semi-annual monitoring data presented in this memorandum was collected over a month-long period (September 22 to October 20, 2008). Despite this extended period of time, the data are believed to be representative of surface water and groundwater conditions with OU2 during low-flow conditions and valid for the analysis in this memorandum.

1.2 Background

The environmental system within OU2 and the larger Coeur d'Alene Basin (OU3) has been impacted by mining and mineral processing activities since the late 1800s. The impacts include a degradation of water quality caused by the leaching of contaminant metals (primarily cadmium, lead, and zinc) from tailings and other mine wastes and byproducts to surface water and groundwater within OU2. Contaminant metals are transported from water quality-impacted surface water and groundwater to the SFCDR as it passes through OU2. The initial 1999 study (Barton, 2002) focused on three separate areas within the SFCDR drainage: Woodland Park in the Canyon Creek drainage, the Osburn area, and OU2. The goals of the 1999 study were to identify gaining and losing reaches of the SFCDR within valley fill/floodplain aquifers at the three areas, define the distribution of groundwater seepage to the SFCDR, and quantify metal loading in gaining reaches over a range of stream stage and water table conditions. The overall objective of the 1999 study was to define and conduct a low-flow groundwater seepage study that could be repeated during and after implementation of remedial actions to measure the effectiveness of these actions at reducing metal loading to the SFCDR.

The 1999 study reported significant gains in contaminant metal load from groundwater to the SFCDR within OU2. The net gain of dissolved zinc load from groundwater to the SFCDR through OU2 was estimated at 732 pounds per day (lb/day) under low-flow conditions. This estimate far overshadowed dissolved zinc load estimates at the two other 1999 study areas (Canyon Creek at Woodland Park at 164 lb/day, and SFCDR near Osburn at 168 lb/day).

The 1999 study was conducted during a period when large-scale Phase I remedial actions were being conducted within OU2. During subsequent studies (2003, 2006, 2007, and 2008), Phase I remedial actions within OU2 were completed.

1.3 Document Organization

This document is organized into seven sections and two attachments:

Section 1, Introduction. This section includes the purpose and objectives, background discussion, and document organization.

Section 2, Methodology. This section includes discussion of the field methodology, data collection requirements, quality assurance procedures, the method used for dissolved contaminant metals load estimation, and uncertainty and variability associated with the study methods used in support of this study.

Section 3, Hydrologic Conditions. This section discusses hydrologic conditions within OU2 during the 2008 study.

Section 4, Water Quality. This section summarizes surface water and groundwater field parameters, water quality results, loading, and ambient water quality criteria ratios for dissolved cadmium, dissolved lead, and dissolved zinc from the 2008 study.

Section 5, Comparison of 2008 Results to Previous Studies. This section compares the results from the 2008 with previous low-flow seepage studies.

Section 5, Summary of Key Findings. This section provides a summary of key findings from the 2008 study and comparison with previous studies.

Section 6, Recommendations. This section presents recommendations for future monitoring of groundwater/surface water interaction within OU2.

Section 7, References.

Attachment A, **Field Parameter Summary Tables**

Attachment B, Water Quality Summary Tables

2.0 Methodology

This section describes the methods employed during the 2008 OU2 groundwater/surface water interaction monitoring (2008 study).

2.1 Study Approach and Field Setup

The 2008 study was conducted on September 23, 24, and 25, 2008, in OU2. Monitoring locations are shown in Figure 2. The 2008 study was timed to obtain discharge and water quality data during the anticipated period of low and stable discharge (base flow) in the SFCDR that typically occurs from July through October. The historic average SFCDR discharge for September 23 through 25, as measured at the USGS Gaging Station 12413210 located at Elizabeth Park (SF-268), is approximately 75 cubic feet per second (cfs). The historic average SFCDR discharge for this same period, as measured at the USGS Gaging Station 12413470 located at Pinehurst (SF-271), is approximately 110 cfs.

Groundwater/surface water monitoring locations are presented in Figure 2. Because the 2008 study was conducted to replicate previous studies, efforts were taken to maintain monitoring locations consistent with previous studies. However, the stream morphology of the SFCDR changed significantly as a result of the May 2008 high-flow event at a number of locations. New locations were chosen in the immediate vicinity of the original locations that would facilitate the most accurate discharge measurements and provide representative water quality samples. The GPS coordinates for the 2008 monitoring locations are presented in Table 1 along with the coordinates for the original 1999 study stations.

For groundwater/surface water interaction monitoring, a monitoring location consists of a selected location on the SFCDR (or at the mouth of a SFCDR tributary) where a transect is established for the purpose of collecting discharge measurements, field parameter measurements, and water quality samples. Each transect includes temporary placement of a fiberglass measuring tape stretched tautly between steel T-posts installed on each side of the stream bank perpendicular to flow. Information recorded at each transect includes the width of stream flow, flow depth, and flow velocity. At each location, discrete intervals along each transect were established for the collection of field parameter measurements and water quality samples in accordance with the cross-sectional, depth-integrated water quality sampling techniques discussed in Edwards and Glysson (1988).

The 1999 study explains how the gaining and losing subreaches were originally selected. Reassessment of gaining and losing subreaches was not part of the scope of the 2008 or previous studies. The approximate gaining and losing reaches established in the 1999 study were used for the 2008 study. A reach is a portion of the SFCDR between two sampling stations that subdivides the river into segments to allow for evaluation of groundwater seepage, head relationships, and discharge as the river flows down-valley (east to west) through OU2.

Eleven SFCDR stations and four SFCDR tributary stations were included in the 2008 study (Figure 2). The main-stem SFCDR monitoring stations are identified along the SFCDR from upstream to downstream (east to west) as BH-SF-LF-0001 through BH-SF-LF-0011 (formerly known as C1 through C11 in the 1999 study). The four SFCDR tributary stations are Milo, Bunker, Government, and Pine creeks. The sampling stations for the 2008 study are approximately the same as the previous studies conducted by CH2M HILL. Deviations from the 1999 study are as follows:

- Station BH-SF-LF-0011 (C11 in the 1999 study) was moved downstream approximately 2,000 feet for the post-1999 studies to coincide with the western OU2 boundary and USGS Gaging Station 12413470 (SF-271). BH-SF-LF-0011 is approximately 250 feet downstream of SF-271.

- A sampling station was established at the mouth of Pine Creek near its confluence with the SFCDR. Pine Creek is the largest tributary to the SFCDR within OU2 and was not sampled during the 1999 study.

At the main-stem SFCDR stations, stainless steel minipiezometers were driven into the river bed at the approximate center of the low-flow river channel to depths ranging from approximately 2.0 to 3.5 feet below the river bottom. The minipiezometers act as sampling points for groundwater quality, specific conductance, and groundwater head immediately below the river bed. Minipiezometers were not installed at the mouths of SFCDR tributaries because of the presence of physical barriers (for example, boulders, concrete, or riprap) and because minipiezometers previously installed at tributary mouth locations during previous studies had not provided valuable information.

Minipiezometers consist of 1-inch-diameter blank stainless steel casing with a 6-inch-long well point, perforated with 1/2-inch-diameter holes and stainless steel mesh backing. Prior to installation, the stainless steel minipiezometers were cleaned by rinsing the casing interior and exterior, screen assembly, and well point using a dilute solution of ultra-pure nitric acid (HNO_3) followed by rinsing with deionized water. Prior to installation, the minipiezometers were thoroughly rinsed in the SFCDR.

The head difference between surface water stage and groundwater immediately below the river bed was measured using a hydraulic potentiomanometer. A schematic of the hydraulic potentiomanometer is presented in the 1999 study report, and a detailed description of the uses and theory of hydraulic potentiomanometers can be found in Winter et al. (1983).

Following minipiezometer installation, a portable peristaltic pump was used to inject and withdraw water to develop each minipiezometer and establish a good hydraulic connection with the groundwater immediately below the river bed. The groundwater intake tube was installed in the lower portion of the minipiezometer screen. The surface water intake tube was installed within an 8-inch-diameter clay pot placed on the river bottom at the base of the minipiezometer to minimize the effects of turbulence and flow on surface water stage measurements. Both the groundwater and surface water tubes were attached to the potentiomanometer board. The accuracy for measuring the head difference between the river stage and groundwater is estimated to be approximately 1 millimeter. The potentiomanometer boards/posts, minipiezometers, and transect posts were removed at the conclusion of the field study.

2.2 Field Measurements and Water Quality Sampling

The same protocols for collecting field measurements and water quality samples during previous studies were employed during the 2008 study. During collection of all surface and groundwater quality samples the temperature, pH, and specific conductance were measured in accordance with the QAPP, except where noted below. Meters and probes used for field measurements were calibrated at the beginning of each day and operated according to manufacturers' specifications. Terragraphics, the State of Idaho contractor, performed sample management activities for the 2008 study. Surface water samples were submitted for laboratory analysis of total and dissolved metals, alkalinity, anions, total and dissolved phosphorous, nitrate plus nitrite, dissolved ammonia, and total Kjeldhal nitrogen (TKN). Groundwater samples were submitted for laboratory analysis of dissolved metals, anions, alkalinity, nitrate plus nitrite, and total phosphorous.

The 2008 study consisted of three sets of discharge and water quality measurements collected over three consecutive days on September 23, 24, and 25. One set of groundwater quality samples was collected from in-stream stainless steel minipiezometers on the third day of the study (September 25). Each day, discharge measurements and surface water quality samples were collected at each station. Sampling began at the most downstream station (BH-SF-LF-0011) and progressed upstream to station BH-SF-LF-0001. At each of the fifteen stations, discharge, groundwater and surface water specific conductance, and surface water quality samples were collected. At the eleven SFCDR stations, groundwater quality samples were collected on the third day.

Surface water samples were collected using cross-sectional, depth-integrated sampling techniques (Edwards and Glysson, 1988). At each sample location, depth-integrated water samples were collected from ten equal-width segments across the river. The ten equal-width samples were collected beginning at the west bank and moving to the east bank. The samples were composited in a churn sample splitter and the sample withdrawn for laboratory analysis. During withdrawal, samples for analysis of dissolved constituents were filtered through a 0.45-micron capsule filter using a peristaltic pump into pre-preserved polyethylene bottles. Surface water specific conductance and pH was measured at each of the ten equal-width segments used for water quality sampling moving from the west bank to the east bank.

On the third day, groundwater quality samples were collected from the minipiezometers. Groundwater was purged using a peristaltic pump and temperature, pH, and specific conductance were measured until stabilized criteria was achieved (as defined in the QAPP) prior to collection of the sample. The samples were filtered through a 0.45-micron filter and placed in pre-preserved polyethylene bottles.

3.0 Hydrologic Conditions

This section summarizes the hydrologic conditions of the SFCDR and its tributaries (Milo, Bunker, Government, and Pine Creeks) during the 3-day study period.

3.1 2008 Study SFCDR Discharge Conditions

The 2008 OU2 groundwater/surface water interaction monitoring event was conducted on September 23, 24, and 25, 2008, at the locations shown in Figure 2. Stream discharge measurements were collected each day from the 11 stations along the SFCDR and the 4 major tributaries to the SFCDR within OU2 (Milo, Bunker, Government, and Pine creeks). Daily discharge measurements collected at each of the 15 stations during the study are presented in Table 2.

The 2008 study was timed to obtain discharge and water quality data during the anticipated period of low and stable discharge (base flow) in the SFCDR that typically occurs from July through October. The historic average SFCDR discharge for September 23 through 25, as measured at the USGS Gaging Station 12413210 located at Elizabeth Park (SF-268), is about 75 cfs. The historic average SFCDR discharge for this same period, as measured at the USGS Gaging Station 12413470 located at Pinehurst (SF-271), is about 110 cfs. Figure 3 presents a hydrograph of the SFCDR at Pinehurst (USGS Gaging Station 12413470) during the 2008 study, and the mean historic SFCDR flow at this station.

Provisional discharge measurements from two USGS gaging stations at Elizabeth Park (SFCDR at the eastern OU2 boundary [SF-268]) and near Pinehurst (SFCDR at the western OU2 boundary [SF-271]) were used to compare with field discharge measurements collected during the study and assess overall comparability.

The 2008 study was conducted during the historical seasonal low discharge period for the SFCDR (Figure 3). Local precipitation data from the Kellogg meteorological station were obtained to evaluate transient discharge conditions within the SFCDR during the 3-day study. The study area received approximately 1.3 inches of precipitation between September 21, 2008, and September 23, 2008, prior to the 2008 study conducted between September 23, 2008 and September 25, 2008 (National Weather Service, National Oceanic and Atmospheric Administration [NOAA Fisheries] database for Kellogg, Idaho).

As shown in Figure 3, discharge in the SFCDR at SF-271 increased from about 120 cfs to 180 cfs in response to the precipitation event. The 2008 study was conducted on the falling limb of the response to the precipitation event, with SFCDR discharge at SF-271 declining from approximately 160 cfs at the beginning of the study to approximately 130 cfs at the end of the study. Discharge measurements at BH-SF-LF-0011 located downstream of SF-271 ranged from 177 cfs at the beginning of the study to 133 cfs at the end of the study.

In previous evaluations of groundwater/surface water interaction monitoring, data collected over the 3-day study period were averaged. Because of the large variation among the 3 days of the 2008 study, the discharge data are not considered to be comparable. Because data collected on the last day of the study are more closely aligned with historic base flow conditions and with conditions prior to the precipitation event, the third day of the study is the primary focus of this technical memorandum.

3.2 2008 Study Tributary Discharge Conditions

As part of the 2008 study, discharge measurements (Table 2) were collected from the major tributaries to the SFCDR within OU2 at the locations shown in Figure 2.

Milo Creek discharges to the SFCDR between SFCDR monitoring locations BH-SF-LF-0001 and BH-SF-LF-0002. During the 3-day study, discharge in Milo Creek was relatively consistent and ranged from 3.3 cfs to 3.8 cfs.

Bunker Creek discharges to the SFCDR between SFCDR monitoring locations BH-SF-LF-0005 and BH-SF-LF-0006. Under base flow conditions, the majority of the Bunker Creek flow is comprised of treated effluent from the Central Treatment Plant (CTP). Discharge measurements collected from Bunker Creek were compared with discharge monitoring reports generated by the CTP. During the first and last days of the study, discharge measured at the mouth of Bunker Creek was approximately 3.5 cfs. On the second day of the study, a discharge of 1 cfs was recorded at the mouth of Bunker Creek. During this time, the CTP operator was adjusting discharge and testing piping systems in order to prepare for the Bunker Creek Pilot Study (CH2M HILL, 2009). CTP discharge is estimated using the total volume of water discharged during a 24-hour period. Temporary adjustments are not noted in the operator’s daily log; however, nearly 0.5 million gallons less water was discharged on the second day of the study.

Government Creek discharges to the SFCDR between SFCDR monitoring locations BH-SF-LF-0006 and BH-SF-LF-0007. During the 3-day study, discharge in Government Creek ranged from 1.1 to 1.2 cfs.

Pine Creek discharges to the SFCDR between SFCDR monitoring locations BH-SF-LF-0010 and BH-SF-LF-0011. During the 3-day study, discharge in Pine Creek ranged from 9.6 to 9.9 cfs.

3.3 Head Differences Between Surface Water Stage and Groundwater Levels

In-stream potentiomanometers were installed at ten main stem SFCDR stations (excluding BH-SF-LF-0002) to measure the head difference between groundwater immediately below the river bed and surface water stage at each station. A potentiomanometer board was not installed at BH-SF-LF-0002 because the downward gradient between surface water and groundwater exceeded the capabilities of the potentiomanometer board scale.

In addition to the uncertainty with measuring hydraulic head differences using the potentiomanometer board as described by Rosenbery and LaBaugh (2008), the higher discharge observed during the early portion of the 2008 study likely resulted in a shift in the flow gradients in the hyporheic zone affecting potentiomanometer head differences. A high degree of variability was observed among head differences measured during studies performed in 2003, 2006, 2007, and 2008. The measured head difference during the study may not represent actual hydraulic head differences between surface water and groundwater and may mislead interpretation of gaining and losing reaches. However, other data obtained from the study (such as gains/losses in discharge and groundwater elevations in nearby monitoring wells) are used to corroborate these reaches. This is of particular importance when reviewing and interpreting potentiomanometer data collected from the SFCDR within OU2. The bed of the SFCDR within OU2 is comprised of a significant amount of coarse-grained material (such as gravel, cobbles, and larger grain sizes). This often precludes the ability to install piezometers to sufficient depths to reduce the impact of hyporheic effects (Rosenbery and LaBaugh, 2008). Table 3 presents head differences collected at SFCDR monitoring locates during each day of the 2008 study.

3.4 2008 Study Surface Water Flow Balance

During the 1999 study, readings from potentiomanometers were used to define gaining and losing reaches of the SFCDR within OU2. In the 1999 study, it was determined that there were generally two losing and two gaining reaches of the SFCDR within OU2. The losing reaches occurred between BH-SF-LF-0001 and BH-SF-LF-0003 in the eastern portion of OU2 and between BH-SF-LF-0006 and BH-SF-LF-0007 in the western portion of OU2. Gaining reaches were identified between BH-SF-LF-0003 and BH-SF-LF-0006 in the eastern portion of OU2 and BH-SF-LF-0007 and BH-SF-LF-0011 in the western portion of OU2.

Review of discharge data from the 2008 study indicates that changes to the locations of gaining and losing reaches appear to have occurred. The changes in the gaining and losing reaches may be indicative of changes to the system since the 1999 study or may be representative of the system reacting to the precipitation event discussed in previous text. Revised gaining and losing reaches representative of the third day of the 2008 study have been developed for this technical memorandum and are identified in Figure 4.

In the eastern portion of OU2, the losing and gaining reaches are the same as those identified during the 1999 study (that is, losing from BH-SF-LF-0001 to BH-SF-LF-0003 and gaining from BH-SF-LF-0003 to BH-SF-LF-0006). In the western portion of OU2, the losing reach has been revised to include that portion of the SFCDR from BH-SF-LF-0006 to BH-SF-LF-0008. In 1999, the losing reach was identified as that portion of the SFCDR between BH-SF-LF-0006 and BH-SF-LF-0007. The remainder of the SFCDR within OU2 has been identified as a gaining reach. For the purposes of this technical memorandum, the gaining reach in the western portion of OU2 is subdivided to the reaches between BH-SF-LF-0008 and BH-SF-LF-0010 and between BH-SF-LF-0010 and BH-SF-LF-0011. This subdivision was made so that the impact of the relatively large groundwater and surface water system associated with the Pine Creek drainage could be evaluated separately. A gain/loss summary using the 1999 study and 2008 study gaining and losing reaches is presented in Table 4.

Discharge data collected on the third day of the 2008 study (Table 4) provide an estimate of the degree to which OU2 groundwater and surface water interact under base flow conditions. Exchanges between surface water and groundwater in the western portion of OU2 (BH-SF-LF-0006 downstream to BH-SF-LF-0011) appear to be much greater than those observed in the eastern portion of OU2 (BH-SF-LF-0001 downstream to BH-SF-LF-0006).

In the eastern portion of OU2, an estimated 7 cfs of discharge was lost from the SFCDR between BH-SF-LF-0001 and BH-SF-LF-0003 and approximately 6 cfs was discharged from groundwater to the SFCDR between BH-SF-LF-0003 and BH-SF-LF-0006.

In the western portion of OU2, approximately 11 cfs was lost from the SFCDR between BH-SF-LF-0006 and BH-SF-LF-0008 and approximately 43 cfs was discharged from groundwater to the SFCDR between BH-SF-LF-0008 and BH-SF-LF-0011. When the gains measured in the portion of the SFCDR between BH-SF-LF-0010 and BH-SF-LF-0011 (where the Pine Creek drainage joins the SFCDR drainage are removed), the gain in the western portion of OU2 between BH-SF-LF-0008 and BH-SF-LF-0010 is approximately 15 cfs.

As shown in Table 2, a loss of discharge was observed between monitoring stations BH-SF-LF-0009 and BH-SF-LF-0010. This loss of discharge is likely due to discharge measurement error rather than actual conditions. During the 2008 flood event, the channel morphology at station BH-SF-LF-0010 was altered significantly. During previous monitoring events, the SFCDR channel in this area was relatively flat bottomed. During the 2008 peak runoff event, the channel was scoured out resulting in a deeper U-shaped channel. The increased depth of the channel may have resulted in additional potential error associated with discharge measurements at this location. Therefore, estimates of discharge gained in the SFCDR reach between stations BH-SF-LF-0010 and BH-SF-LF-0011 are likely overestimated and gains between stations BH-SF-LF-0008 and BH-SF-LF-0010 are likely underestimated.

Overall, when the SFCDR reach that includes inputs from the Pine Creek drainage are removed from the flow balance for OU2, roughly the same amount of discharge is lost from the SFCDR to groundwater (approximately 18 cfs) as is discharged from groundwater to the SFCDR (approximately 21 cfs) between BH-SF-LF-0001 and BH-SF-LF-0010.

4.0 Water Quality

This section summarizes surface water and groundwater field parameters and water quality results from the 2008 study. As noted earlier, because of elevated discharge resulting from a precipitation event prior to the 2008 study, the discussion in this memorandum is focused on data collected during the final day of the 3-day 2008 study. During the third day of the study, discharge conditions were most closely aligned with base flow conditions in the SFCDR. All data for the 3-day study are presented in tables and attachments at the end of this memorandum. Field parameter summary tables are presented in Attachment A. Analytical summary tables are provided in Attachment B.

4.1 Field Parameters

This section presents and summarizes field-measured parameter data collected during the 2008 study. For surface water only specific conductance, pH, and temperature measurements were collected. Measurements of specific conductance, pH, temperature, and dissolved oxygen were collected for groundwater collected from in-stream minipiezometers. Field parameter summary tables for the 2008 study are included in Attachment A.

4.1.1 Specific Conductance/Conductivity

Specific conductance measurements were collected at all surface water stations during each day of the study. Surface water specific conductance measurements were collected at the same increments across each stream transect used for collection of depth-integrated, flow-weighted water quality samples. Groundwater conductivity measurements were collected on the third day of the study during the collection of groundwater quality samples at the in-stream minipiezometers.

In this section, specific conductance and conductivity are compared to assess relative relationships. Specific conductance measurements for surface water and conductivity measurements for groundwater are a result of the different field measurement devices employed during surface water and groundwater sampling. It is important to understand that conductivity is an indicator of the relative abundance of ions in solution at a given temperature. Specific conductance is equal to the conductivity adjusted to an ambient temperature of 25ºC. Typically, specific conductance measurements are lower than conductivity measurements. For this report, conductivity values were not adjusted to specific conductance values because comparison is performed on a relative basis.

Specific conductance indicates the relative abundance of ions in solution (Hem, 1985). Lateral stratification of specific conductance across the width of the SFCDR channel at each monitoring transect can be an indicator of either the presence groundwater with elevated dissolved metal concentrations discharging to surface water, or partial mixing of tributary discharges with relatively high specific conductance with the receiving stream. Specific conductance profiles for each station, plotted as the distance from the left edge (south bank) of the river (in feet) versus specific conductance, are presented in Figure 5. Specific conductance profiles were generated at each station and used to evaluate locations of groundwater discharge and tributary input to the SFCDR.

Specific conductance profiles at monitoring locations within losing reaches of the SFCDR (BH-SF-LF-0001, BH-SF-LF-0002, BH-SF-LF-0003, BH-SF-LF-0007, and BH-SF-LF-0008) showed very little difference across the profile of the SFCDR.

The specific conductance profiles for monitoring locations in the gaining reach of the SFCDR in the eastern portion of OU2 (BH-SF-LF-0004, BH-SF-LF-0005, and BH-SF-LF-0006) show lateral stratification across the stream profile. The specific conductance profiles for all of these locations show elevated specific conductance along the southern bank of the SFCDR. The lateral stratification of specific conductance at BH-SF-LF-0004 and BH-SF-LF-0005 most likely results from the groundwater containing elevated dissolved metals and other constituents discharging to the SFCDR (including the area of visible discrete groundwater seepage located immediately upstream of station BH-SF-LF-0004). Prior to BH-SF-LF-0006, Bunker Creek discharges to the SFCDR. Specific conductance measurements in Bunker Creek were greater than 2,000 microsiemens per centimeter (µS/cm). Under base flow conditions, the majority of discharge in Bunker Creek consists of effluent from the CTP. At the CTP, acid mine drainage (AMD) from the Bunker Hill Mine is treated using a lime precipitation process. Effluent from the CTP has a high specific conductance resulting from this process. The lateral stratification of the specific conductance profile observed along the south bank of the BH-SF-LF-0006 is most likely a result of groundwater discharge, seep water discharge, and the introduction of the high specific conductance discharge from Bunker Creek.

Specific conductance measured at SFCDR monitoring locations in the western portion of OU2 exhibited minimal variability across the stream profile in both losing and gaining reaches. The lack of stratification at locations in the gaining reach in the western portion of OU2 suggests that groundwater discharging to the SFCDR in this area does not have particularly high concentrations of dissolved metals or other constituents when compared to locations in the gaining reach in the eastern portion of OU2.

In general, the conductivity of groundwater measured from SFCDR in-stream minipiezometers was equal to or slightly lower than the specific conductance measured in surface water with the exception of BH-SF-LF-0006 and BH-SF-LF-0008. At BH-SF-LF-0006, groundwater conductivity was 612 uS/cm, similar to surface water specific conductance measured along the southern bank of the SFCDR but much higher than specific conductance throughout the remainder of the stream profile. At BH-SF-LF-0008, groundwater conductivity was 652 uS/cm versus the approximately 290 uS/cm specific conductance measured in the SFCDR measured at this location.

Figures 6a and 6b show specific conductance and conductivity measured during the 2008 study as well as conductivity measured in groundwater within OU2 during the OU2 EMP semi-annual monitoring event. The specific conductance values shown for the 2008 study surface water monitoring locations represent the average specific conductance measured across the monitoring transect and the specific conductance value measured in groundwater from the in-stream minipiezometers.

In the eastern portion of OU2, conductivity values are elevated in groundwater in the Bunker Creek corridor, along Government Creek, and near the northwestern edge of the CIA.

In the western portion of OU2, conductivity in groundwater was typically lower than that observed in the eastern portion of OU2.

4.1.2 pH

Field measurements of pH were collected at each surface water station using the ten equal-width stream segments where water quality samples were collected and from groundwater during water quality sample collection on the third day of the study. Figures 7a and 7b show pH values measured during the 2008 study as well as pH measured in groundwater within OU2 during the OU2 EMP semi-annual monitoring event. The pH values shown for the 2008 study surface water monitoring locations represent the average pH measured across the monitoring transect and the pH value measured in groundwater from the in-stream minipiezometers. The pH values measured at each sampling increment for the 2008 monitoring locations are presented by location and day in Attachment A. The focus of the discussion below is on pH values collected during the third day of the 2008 study.

At monitoring locations BH-SF-LF-0001, BH-SF-LF-0002, and BH-SF-LF-0003, pH values were relatively consistent between stations and across the stream transect. pH values at these locations ranged from 7.67 to 7.87. All three of these monitoring locations are within the losing reach of the SFCDR in the eastern portion of OU2. The pH of groundwater collected from minipiezometers at these locations ranged from 7.45 to 7.57.

At monitoring locations BH-SF-LF-0004, BH-SF-LF-0005, and BH-SF-LF-0006, pH values began to decrease with distance downstream. pH at these locations ranged from 7.12 (lowest value at BH-SF-LF-0006) to 7.51 (highest value at BH-SF-LF-0004). In addition to a decrease in pH with distance downstream, pH at all locations increased from the south bank to the north bank of the SFCDR (lowest pH values along the southern bank). All three locations are within the gaining reach of the SFCDR in the eastern portion of OU2. Groundwater pH at these locations ranged from 6.29 (BH-SF-LF-0006) to 6.87 (BH-SF-LF-0004). The lower pH values along the southern bank of the SFCDR observed in surface water at these locations is similar to elevated specific conductance values in these locations and may be indicative of groundwater discharging to the SFCDR along the southern bank in these areas.

At SFCDR monitoring locations BH-SF-LF-0007 and BH-SF-LF-0008 in the losing reach of the SFCDR in the western portion of OU2, pH values increased slightly in comparison to upstream pH values. pH at these locations ranged from 7.26 to 7.37. No significant changes in pH values across the stream transect were observed. Groundwater pH values at BH-SF-LF-0007 and BH-SF-LF-0008 were 6.82 and 6.17, respectively.

pH values at monitoring locations BH-SF-LF-0009, BH-SF-LF-0010, and BH-SF-LF-0011 in the gaining reach of the SFCDR in the western portion of OU2 were lower than upstream values and ranged from 6.76 to 7.10. At BH-SF-LF-0009, pH values increased from the southern bank to the northern bank. The pH of groundwater at BH-SF-LF-0009 was 5.80. The lower pH conditions observed along the southern bank of the SFCDR at BH-SF-LF-0009 may be indicative of groundwater discharging to the SFCDR in this area. At BH-SF-LF-0010, no significant changes in pH values across the stream transect were noted. Groundwater pH at BH-SF-LF-0010 was measured at 5.76. At BH-SF-LF-0011, pH values increased from the northern bank to the southern bank. Groundwater pH at BH-SF-LF-0011 was 6.11. The lower pH values observed along the northern bank of the SFCDR at BH-SF-LF-0011 suggests that groundwater may be discharging to the SFCDR in this area. Groundwater from the Pine Creek drainage is relatively cleaner (lower metals concentrations) than groundwater from the OU2 area. It is likely that groundwater from the relatively large Pine Creek drainage dominates groundwater along the southern margin of the valley in this area and forces groundwater from upgradient in OU2 towards the northern portion of the valley.

Comparison of 2008 study pH values with OU2 groundwater pH values (Figures 7a and 7b) shows that groundwater in the majority of OU2 is more acidic than surface water, with typical pH values ranging from less than 5 to 6. It appears that surface water lost to groundwater in losing reaches becomes more acidic as distance from the SFCDR increases. Below neutral groundwater conditions persist throughout most of the OU2 site. pH values do increase to near neutral conditions in the Page Ponds area and in the far western portion of OU2.

4.1.3 Temperature

The temperature of surface water was measured daily at all monitoring stations. The temperature of groundwater from the minipiezometers was measured on the third day of the study (September 25) during water quality sample collection. Surface water temperature was recorded at each of the ten equal-width stream segments used for the collection of depth-integrated, flow-weighted water quality samples. Groundwater temperature was measured during purging and sampling of piezometers. Groundwater temperature ranged from 9.1 to 12.8 °C while surface water temperature ranged from 9.4 to 17.4 °C. Temperature data for each location during the 2008 study are presented in Attachment A.

4.1.4 Dissolved Oxygen

In the OU2 EMP QAPP, measurements of dissolved oxygen in surface water during groundwater/surface water interaction monitoring were not identified; therefore, no dissolved oxygen measurements were collected at SFCDR and SFCDR tributary surface water monitoring locations during the 2008 study. This section also presents a summary of dissolved oxygen measurements for groundwater collected from in-stream minipiezometers as part of the 2008 study and monitoring wells and piezometers within OU2 as part of the OU2 EMP semi-annual monitoring event, which was conducted between September 22 and October 20, 2008, Dissolved oxygen was measured at SFCDR tributary monitoring locations only during the semi-annual monitoring event. Dissolved oxygen measurements from these monitoring events are also presented in Figures 8a and 8b.

Dissolved oxygen values in groundwater measured in SFCDR in-stream minipiezometers during the third day of the 2008 study decreased from 13.29 milligrams per liter (mg/L) to 13.00 mg/L in the losing reach of the SFCDR between locations BH-SF-LF-0001 and BH-SF-LF-0003. In the gaining reach between BH-SF-LF-0003 and BH-SF-LF-0006, dissolved oxygen concentrations decreased from 13.00 mg/L to 8.76 mg/L. In the losing reach of the SFCDR in the western portion of OU2, dissolved oxygen concentrations increased between BH-SF-LF-0006 (8.76 mg/L) and BH-SF-LF-0007 (8.82 mg/L) and then decreased to the lowest measured concentration at BH-SF-LF-0008 (4.47 mg/L). In the gaining reach of the SFCDR dissolved oxygen concentrations increased from their low at BH-SF-LF-0008 to 7.84 mg/L at BH-SF-LF-0009. Concentrations then decreased to 6.43 mg/L at BH-SF-LF-0010 before increasing to 6.77 mg/L at BH-SF-LF-0011.

Dissolved oxygen measurement collected from groundwater at 2008 study in-stream minipiezometers and at monitoring wells, piezometers, and SFCDR tributary monitoring locations within OU2 during the OU2 EMP semi-annual monitoring event are shown in Figures 8a and 8b. Review of dissolved oxygen data spatially shows that dissolved oxygen concentrations in groundwater in the eastern portion of OU2 are greatest at those locations that are closest to the losing reaches of the SFCDR. Dissolved oxygen concentrations in groundwater decrease with distance downgradient from the losing reach. Lower dissolved oxygen concentrations persist throughout the groundwater system in the eastern portion of OU2 even in areas where recharge of oxygenated groundwater is known to occur. In the Bunker Creek dissolved oxygen concentrations range from 8 to 9 mg/L. Dissolved oxygen concentrations in groundwater immediately adjacent to Bunker Creek are consistently less than 1 mg/L.

In the western portion of OU2, dissolved oxygen concentrations in groundwater follow a similar pattern to those in the eastern half of OU2. However, dissolved oxygen concentrations are typically higher than those observed in the eastern half of OU2 with the exception of low dissolved oxygen concentrations in the Page Ponds area.

4.2 Dissolved Metal Concentrations

This section presents dissolved cadmium, dissolved lead, and dissolved zinc concentrations observed in surface water and groundwater samples collected during on the third day of the 2008 study (September 25, 2008) and from applicable monitoring wells and piezometers completed in the single unconfined and upper aquifers within OU2 that were sampled during the OU2 EMP semi-annual monitoring event. Other select metals and constituents sampled for during the 2008 study are discussed in Section 4.3. Table 5 presents dissolved cadmium, dissolved lead, and dissolved zinc concentrations measured in surface water at SFCDR and SFCDR tributary monitoring locations during the 2008 study as well as concentrations in groundwater collected from SFCDR in-stream minipiezometers on the third day of the 2008 study. Table 5 only includes dissolved cadmium, dissolved lead, and dissolved zinc concentrations. Summary tables detailing all dissolved metal concentrations measured during the 2008 study are included in Attachment B.

In this section, the discussion of 2008 study data is limited to data collected during the third day of the study. Data from the OU2 EMP semi-annual monitoring event are also included in this discussion where applicable to groundwater/surface water interaction. The inclusion of OU2 EMP semi-annual monitoring data is not intended to be a full treatment or discussion of contaminant metal concentrations in OU2 groundwater. While the 2008 study data discussed in this section were collected on the same day, the OU2 EMP semi-annual monitoring data were collected over a longer period of time (September 22 to October 20, 2008). However, only one sample was collected from each of these locations during the sampling event.

Dissolved metal concentrations measured in the SFCDR are used to evaluate spatial trends in SFCDR water quality as it passes through OU2. Supporting data from tributaries and groundwater are used to further evaluate these trends and define areas where the SFCDR is gaining water with relatively high dissolved metal concentrations from groundwater and/or tributaries within OU2. In addition to aiding in the evaluation of spatial trends and potential dissolved metal source areas, groundwater and surface water concentration data at the same location can be used to further evaluate gaining and losing reaches of the SFCDR. Groundwater quality immediately below a losing portion of the SFCDR is expected to be similar in composition to SFCDR surface water. Conversely, in a gaining reach, the groundwater quality may be notably different from the quality of SFCDR surface water. In particular, where dissolved metals are being contributed to the SFCDR from groundwater, their concentrations are expected to be higher than those observed in the SFCDR.

4.2.1 Dissolved Cadmium

Dissolved cadmium concentrations from the 2008 study are presented in Table 5. Figures 9a and 9b show dissolved cadmium concentrations measured at 2008 study monitoring locations during the third day of the study (September 25, 2008) as well as dissolved cadmium concentrations measured in groundwater during the OU2 EMP semi-annual monitoring event.

The dissolved cadmium concentration in the SFCDR at BH-SF-LF-0001 was 0.0052 mg/L. The concentration remained relatively constant through the losing reach of the SFCDR and then increased to 0.0073 mg/L at BH-SF-LF-0004. Dissolved cadmium concentrations in the SFCDR increased through the gaining reach at BH-SF-LF-0005 (0.0081 mg/L) and BH-SF-LF-0006 (0.0102 mg/L).

Dissolved cadmium concentrations in groundwater measured at in-stream minipiezometers in the losing reach in the eastern portion of OU2 were comparable to SFCDR surface water concentrations and ranged from 0.0046 mg/L to 0.0055 mg/L at BH-SF-LF-0001, BH-SF-LF-0002, and BH-SF-LF-0003. Dissolved cadmium concentrations in groundwater at minipiezometers from stations in the gaining reach of the SFCDR in the eastern portion of OU2 at BH-SF-LF-0004 and BH-SF-LF-0005 were 0.006 mg/L and 0.0043 mg/L, respectively, and are similar to the dissolved cadmium concentrations measured in surface water at these stations. The highest dissolved cadmium concentration detected in groundwater from the in-stream minipiezometers was detected at BH-SF-LF-0006 (0.208 mg/L).

The easternmost portion of OU2 is comprised of a single unconfined aquifer from the eastern OU2 boundary to about the Milo Creek area, which is the approximate eastern extent of the confining unit. The confining unit extends westward to the western OU2 boundary resulting in an upper unconfined aquifer and a lower confined aquifer. In the eastern portion of OU2 (Figure 9a), dissolved cadmium concentrations measured in groundwater in the single unconfined and upper unconfined aquifers during the OU2 EMP semi-annual monitoring event generally increased with distance from the SFCDR in the losing reach. In the gaining reach of the SFCDR, dissolved cadmium concentrations were variable. However, the greatest dissolved cadmium concentrations detected in groundwater in this area typically occurred near the SFCDR, Bunker Creek, and Government Creek.

Upon entering the losing reach in the western portion of OU2, dissolved cadmium concentrations in the SFCDR decreased from 0.0102 mg/L at BH-SF-LF-0006 to 0.0098 mg/L at BH-SF-LF-0007 and 0.0096 mg/L at BH-SF-LF-0008. In the gaining reach in the western portion of OU2, dissolved cadmium concentrations increased to 0.0101 mg/L at BH-SF-LF-0009 and then decreased to 0.0097 mg/L at BH-SF-LF-0010. Dissolved cadmium concentrations further decreased to 0.0082 mg/L at BH-SF-LF-0011 at the western boundary of OU2.

Dissolved cadmium concentrations in groundwater measured at in-stream minipiezometers in the losing reach in the western portion of OU2 were lower than surface water at BH-SF-LF-0007 and greater than surface water at BH-SF-LF-0008. In the gaining reach of the SFCDR in the western portion of OU2, dissolved cadmium concentrations in groundwater measured at in-stream minipiezometers were significantly lower than those measured in surface water.

Dissolved cadmium concentrations in groundwater in the upper aquifer in the western portion of OU2 measured during the OU2 EMP semi-annual monitoring event are shown in Figure 9b. In general, dissolved cadmium was not detected or detected at relatively low concentrations in the southern half of the western portion of OU2 and near the western boundary of OU2. Near the SFCDR, dissolved cadmium concentrations are lower near the losing reach of the SFCDR and greater in the gaining reach of the SFCDR.

4.2.2 Dissolved Lead

Dissolved lead concentrations from 2008 study monitoring locations are presented in Table 5. Dissolved lead concentrations at 2008 study monitoring locations on the third day of the study and at groundwater monitoring wells and piezometers collected during the OU2 EMP semi-annual monitoring event are shown in Figure 10a and 10b.

Dissolved lead concentrations measured in surface water during the 2008 study were relatively consistent at each of the eleven SFCDR monitoring stations ranging from 0.0033 to 0.0061 mg/L. Dissolved lead was not detected at tributary monitoring locations with the exception of Milo Creek where dissolved lead was detected at a concentration of 0.149 mg/L. The elevated dissolved lead concentration at this location is likely a result of AMD discharge from the Reed/Russel adits upstream in Milo Gulch.

Dissolved lead concentrations measured in groundwater from in-stream minipiezometers were typically less than SFCDR surface water concentrations with the exception of elevated dissolved lead concentrations at BH-SF-LF-0004 (0.0101 mg/L), BH-SF-LF-0006 (0.034 mg/L), and BH-SF-LF-0009 (0.048 mg/L). All three locations are within gaining reaches of the SFCDR.

Dissolved lead concentrations in groundwater in the single unconfined and upper unconfined aquifers collected during the OU2 EMP semi-annual monitoring event are shown in Figures 10a and 10b. Throughout OU2, dissolved lead was not detected or detected at relatively low concentrations. However, elevated lead concentrations were detected in some areas within OU2, particularly in the vicinity of Bunker Creek, Government Creek, and the far western portion of OU2 near Pinehurst Narrows.

4.2.3 Dissolved Zinc

Dissolved zinc concentrations from the 2008 study are summarized in Table 5. Dissolved zinc concentrations at 2008 study monitoring locations on the third day of the study and at groundwater monitoring wells and piezometers collected during the OU2 EMP semi-annual monitoring event are shown in Figure 11a and 11b.

Dissolved zinc concentrations at BH-SF-LF-0001 (0.66 mg/L), BH-SF-LF-0002 (0.66 mg/L), and BH-SF-LF-0003 (0.70 mg/L) in the losing reach of the SFCDR in the eastern portion of OU2 were relatively constant. The dissolved zinc concentration in the SFCDR entering OU2 at station BH-SF-LF-0001 was 0.656 mg/L, which remained relatively constant through the losing reach to BH-SF-LF-0003 (0.70 mg/L). The dissolved zinc concentration increased to 1.09 at BH-SF-LF-0004 through the gaining reach to 1.30 mg/L at BH-SF-LF-0006.

Dissolved zinc concentrations in groundwater measured at in-stream piezometers in the SFCDR in the losing reach in the eastern portion of OU2 were comparable to concentrations measured in surface water. In the gaining reach, dissolved zinc concentrations were typically greater than surface water concentrations.

In OU2 groundwater in the eastern portion of OU2, dissolved zinc concentrations behaved similarly to dissolved cadmium concentrations as discussed above. Similar to dissolved cadmium concentrations the greatest dissolved zinc concentrations were present near the gaining reach of the SFCDR, in the Bunker Creek corridor, and in the Government Creek corridor. Dissolved zinc concentrations in groundwater in the vicinity of this gaining reach and in the CIA seeps are among the highest measured across the OU2 site.

In the western portion of OU2, dissolved zinc concentrations decreased slightly from BH-SF-LF-0006 (1.30 mg/L) through the losing reach to BH-SF-LF-0008 (1.27 mg/L). In the gaining reach, dissolved zinc concentrations increased slightly between BH-SF-LF-0008 and BH-SF-LF-0010 (1.36 mg/L) before decreasing at BH-SF-LF-0011 (1.19 mg/L) at the western boundary of OU2.

Dissolved zinc concentrations in groundwater measured at in-stream piezometers were similar surface water concentrations in the losing reaches and greater than surface water concentrations in the gaining reaches with the exception of BH-SF-LF-0011 where the groundwater concentration was 0.278 mg/L and the surface water concentration was 1.19 mg/L. The lower groundwater concentration at this location likely reflects the relatively clean groundwater input from the Pine Creek drainage.

In the western portion of OU2, dissolved zinc concentrations were their greatest near the gaining reach of the SFCDR and at isolated locations near the Page Swamp area.

4.3 Other Constituents Sampled During the 2008 Study

This section presents a brief overview of phosphorous, sulfate, iron, manganese, and fluoride data collected during the 2008 groundwater/surface water interaction monitoring event. Table 6 presents the concentrations of these constituents measured during the study. These five constituents are added to the discussion to collaborate with the metal influx distribution found throughout OU2. The abundant nature of these five constituents is known throughout this terrain because of the aspects related to mining and/or processing which will be described briefly in each section. A number of other constituents were sampled during the 2008 study that are not discussed in this section. Analytical data for all constituents sampled during the 2008 study are provided in Attachment B.

4.3.1 Phosphorous

Nutrient enrichment of Coeur d’Alene Lake is of concern because nutrient loading may result in a change of the trophic status of the lake. OU2 is a source for phosphorous loading to the SFCDR, and is sourced primarily from treated wastewater effluent and wastewater leakage from the Page and Smelterville wastewater treatment ponds, and also as a byproduct from phosphoric acid/fertilizer plant process materials located in the A-4 Gypsum Pond and the CIA. The majority of materials within the CIA are believed to be located above the original ground surface and the top of the CIA is capped. Material initially placed in the CIA area may have been placed in depression in the valley floor and may be periodically contact groundwater.

Total phosphorous was measured at all monitoring locations sampled during the 2008 study and, and the data are summarized in Table 6. Figures 12a and 12b display available phosphorous monitoring data collected on the third day of the 2008 study and during the OU2 EMP semi-annual monitoring event. During the OU2 EMP semi-annual monitoring event only a certain number of monitoring locations were targeted for total phosphorous analysis. These locations were identified by the Water Quality Assessment Team as potential areas where phosphorous may be present within OU2. Dissolved phosphorous data are also available for some monitoring wells sampled during the semi-annual monitoring event. Monitoring results presented in Figures 12a and 12b are annotated to differentiate total versus dissolved phosphorous concentrations. In Figures 12a and 12b, monitoring locations are identified based on whether the results presented are for total or dissolved phosphorous.

Total phosphorous concentrations at BH-SF-LF-0001 (7.8 micrograms per liter [µg/L]), BH-SF-LF-0002 (9.7 µg/L), and BH-SF-LF-0003 (9.2 µg/L) were relatively constant in the losing reach of the SFCDR in the eastern portion of OU2. Total phosphorous concentrations in groundwater from minipiezometers at these locations ranged from 4.6 to 4.7 µg/L.

In the gaining reach of the SFCDR in the eastern portion of OU2, total phosphorous concentrations increased notably at BH-SF-LF-0004 (35 µg/L), BH-SF-LF-0005 (37 µg/L), and BH-SF-LF-0006 (56 µg/L). Total phosphorous concentrations measured in groundwater at these locations were somewhat lower and ranged from 8.3 to 14 µg/L. Dissolved phosphorous concentrations in groundwater measured in monitoring wells in the vicinity of the gaining reach of the SFCDR at BH-SF-E-0317-U (113 µg/L) and BH-SF-E-0321-U (373 µg/L) were significantly higher than concentrations measured in groundwater at SFCDR locations. The increase in total phosphorous concentrations in the gaining reach of the SFCDR is likely attributable to the discharge of high phosphorous concentration groundwater to the SFCDR. In addition to the discharge of groundwater, the increase in total phosphorous concentrations in the SFCDR between BH-SF-LF-0005 and BH-SF-LF-0006 is likely the result of high total phosphorous concentration surface water from Bunker Creek (152 µg/L at BH-BC-0001).

As shown in Figure 12a, phosphorous concentrations in the upstream portions of Bunker Creek are relatively low and then increase from 5.9 µg/L at BH-BC-0005 to 162 µg/L at BH-BC-0006. In this segment of Bunker Creek, Bunker Creek passes by the A-4 Gypsum Pond and receives discharge from Magnet Creek. The total phosphorous concentration in Magnet Creek measured at BH-MG-0001 measured upstream of the A-4 Gypsum Pond was 39.5 µg/L. This concentration would not be expected to result in the large concentration increase seen in Bunker Creek. The A-4 Gypsum Pond French drain discharges to Magnet Creek near its confluence with Bunker Creek. It is likely that total phosphorous in this discharge is resulting in the increase in concentrations observed in Bunker Creek between BH-BC-0005 and BH-BC-0006.

In the losing reach of the SFCDR in the western portion of OU2, total phosphorous concentrations decrease at BH-SF-LF-0007 (36 µg/L) and BH-SF-LF-0008 (34 µg/L).

Total phosphorous concentrations continue to decrease in the gaining reach of the SFCDR in the western portion of OU2 at BH-SF-LF-0009 (32µg/L) before increasing to 76 µg/L at BH-SF-LF-0010. As shown in Figure 12b, phosphorous concentrations in groundwater in this area are elevated, particularly at BH-SF-W-0111-U (211 μg/L) and BH-SF-W-0118-U (154 μg/L) located near the Page and Smelterville wastewater treatment plants. It is likely that groundwater with elevated phosphorous concentrations from this portion of Smelterville Flats discharges to the SFCDR and results in the increase in concentration observed between BH-SF-LF-0009 and BH-SF-LF-0010.

Between BH-SF-LF-0010 and BH-SF-LF-0011, total phosphorous concentrations in the SFCDR decreased from 76 μg/L to 59 μg/L.

4.3.2 Sulfate

Sulfate in groundwater and surface water in OU2 is believed to be associated with three primary sources: the oxidation of sulfide minerals, treatment of AMD at the CTP using a lime precipitation process, and the dissolution of gypsum materials (a byproduct of the phosphoric acid/fertilizer production process).

Sulfate was measured at all monitoring locations sampled during the 2008 study and the results are summarized in Table 6. Figures 13a and 13b display sulfate data from the third day of the 2008 study and the OU2 EMP semi-annual monitoring event.

Sulfate concentrations in the losing reach of the SFCDR in the eastern portion of OU2 at BH-SF-LF-0001, BH-SF-LF-0002, and BH-SF-LF-0003 ranged from 44.6 to 45.3 mg/L. Sulfate concentrations measured in groundwater from in-stream minipiezometers at these locations were similar to surface water concentrations and ranged from 44.3 to 46.6 mg/L.

In the gaining reach of the SFCDR in the eastern portion of OU2, sulfate concentrations increased to 54.1 mg/L at BH-SF-LF-0004 and 55.3 mg/L at BH-SF-LF-0005. Sulfate concentrations in groundwater measured at in-stream minipiezometers were 60.3 mg/L at BH-SF-LF-0004 and 60.9 mg/L at BH-SF-LF-0005. A substantial increase in sulfate concentrations occurred at BH-SF-LF-0006 in both surface water (119 mg/L) and groundwater (302 mg/L). The increase in sulfate concentrations at this location is likely due to the input of discharge from Bunker Creek (sulfate concentration of 1,530 mg/L) and groundwater.

Sulfate concentrations decreased in the losing reach of the SFCDR in western OU2 to concentrations of 94.5 and 93.6 mg/L at BH-SF-LF-0007 and BH-SF-LF-0008, respectively. Sulfate concentrations in groundwater measured at these locations were 84.3 and 80.4 mg/L, respectively.

In the gaining reach of the SFCDR in western OU2, sulfate concentrations increased slightly at BH-SF-LF-0009 (98.3 mg/L) and BH-SF-LF-0010 (104 mg/L) before decreasing at BH-SF-LF-0011 (90.9 mg/L).

As shown in Figure 13a, in the eastern portion of OU2, sulfate concentrations in groundwater are relatively low in locations near the losing reach of the SFCDR and begin to increase rapidly downgradient. The highest concentrations of sulfate were detected in the vicinity of the A-4 Gypsum Pond, along the Bunker Creek Corridor, and on the northern edge of the CIA between the CIA and the SFCDR. In the western portion of OU2 (Figure 13b), sulfate concentrations in groundwater were considerably less than those observed in groundwater in the eastern portion of the site.

4.3.3 Iron

Dissolved iron concentrations were measured at all monitoring locations sampled during the 2008 study and the results are summarized in Table 6. Figures 14a and 14b display dissolved iron data from the third day of the 2008 study and the OU2 EMP semi-annual monitoring event.

In the losing reach of the SFCDR in the eastern portion of OU2, dissolved iron concentrations ranged from 0.0087 to 0.015 mg/L and increased from BH-SF-LF-0001 to and BH-SF-LF-0003. Dissolved iron concentrations measured from in-stream piezometers at these locations were variable and ranged from 0.0025 to 0.1 mg/L with the greatest concentrations occurring at BH-SF-LF-0003.

In the gaining reach of the SFCDR in the eastern portion of OU2, dissolved iron concentrations were greater than in the losing reach and ranged from 0.161 to 0.199 mg/L. Dissolved iron concentrations in this reach decreased from upstream monitoring location BH-SF-LF-0004 to BH-SF-LF-0006. Dissolved iron in groundwater measured from in-stream minipiezometers was detected at a concentration of 0.163 mg/L at BH-SF-LF-0004 and was not detected at BH-SF-LF-0005 and BH-SF-LF-0006.

In the losing reach of the SFCDR in the western portion of OU2, dissolved iron was detected at a concentration of 0.088 mg/L at BH-SF-LF-0007 and was not detected at BH-SF-LF-0008. The dissolved iron concentration in groundwater at BH-SF-LF-0007 was 0.0271 mg/L, and dissolved iron not detected at BH-SF-LF-0008.

In the gaining reach of the SFCDR in the western portion of OU2, dissolved iron was not detected at BH-SF-LF-0009 and BH-SF-LF-0011. Dissolved iron was detected at a concentration of 0.172 mg/L at BH-SF-LF-0010. Dissolved iron was detected at a relatively high concentration at BH-SF-LF-0009 (0.411 mg/L) in the groundwater. Dissolved iron was not detected in groundwater at BH-SF-LF-0010 and BH-SF-LF-0011.

Within OU2 groundwater, dissolved iron was not detected at the majority of monitoring locations. However, in the eastern portion of OU2, elevated dissolved iron concentrations were detected in monitoring wells in the vicinity of Bunker Creek, the A-4 Gypsum Pond, and the CIA area. In the western portion of OU2, dissolved iron concentrations in groundwater were elevated in the vicinity of the Page Ponds area.

4.3.4 Manganese

Dissolved manganese was measured at all monitoring locations sampled during the 2008 study and the results are summarized in Table 6. Figures 15a and 15b display dissolved manganese data from the third day of the 2008 study and the OU2 EMP semi-annual monitoring event.

In the losing reach of the SFCDR in the eastern portion of OU2, dissolved manganese concentrations in surface water ranged from 0.0394 to 0.0465 mg/L at BH-SF-LF-0001, BH-SF-LF-0002, and BH-SF-LF-0003. Dissolved manganese in groundwater measured at these locations ranged from 0.002 to 0.0438 mg/L.

In the gaining reach of the SFCDR in the eastern portion of OU2, dissolved manganese concentrations were approximately an order of magnitude greater than in the losing reach and increased downstream between BH-SF-LF-0004 (0.216 mg/L), BH-SF-LF-0005 (0.254 mg/L), and BH-SF-LF-0006 (0.652 mg/L). Dissolved manganese concentrations measured at these locations were also elevated and were greater than concentrations observed in surface water with the exception of BH-SF-LF-0005 (0.0115 mg/L). The increase in dissolved manganese in the SFCDR in this reach is likely due to the discharge of groundwater with elevated dissolved manganese concentrations to the SFCDR. However, the marked increase in dissolved manganese observed between BH-SF-LF-0005 (0.254 mg/L) and BH-SF-LF-0006 (0.652 mg/L) can also be attributed to the input of discharge from Bunker Creek (8.61 mg/L).

In the losing reach of the SFCDR in the western portion of OU2, dissolved manganese concentrations began to decrease slightly to 0.469 mg/L at BH-SF-LF-0007 and 0.443 mg/L at BH-SF-LF-0008. The dissolved manganese concentration in groundwater at BH-SF-LF-0007 (0.0093 mg/L) was significantly lower than the surface water concentration. At BH-SF-LF-0008, the dissolved manganese concentration in groundwater (0.619 mg/L) was greater than the surface water concentration.

In the gaining reach of the SFCDR in the western portion of OU2, dissolved manganese concentrations increased at BH-SF-LF-0009 (0.494 mg/L) and BH-SF-LF-0010 (0.529 mg/L) before decreasing at BH-SF-LF-0011 (0.456 mg/L). Dissolved manganese concentrations in groundwater at these locations were significantly lower than those measured in surface water and ranged from 0.0037 to 0.0527 mg/L.

Similar to dissolved iron, dissolved manganese concentrations in groundwater within OU2 were greatest in the vicinity of Bunker Creek, the A-4 Gypsum Pond, and the CIA area. In the western portion of OU2, dissolved iron concentrations were elevated in the vicinity of the Page Ponds area.

4.3.5 Fluoride

The presence of fluoride in groundwater may be a result of the dissolution of gypsum materials that are present in the A-4 Gypsum Pond and the western portion of the CIA, and the presence of fluoride in wastes from smelting practices in direct contact with groundwater. Gypsum was placed in the CIA beneath the cap, but may periodically be in direct contact with groundwater. The sides of the CIA are not capped, and runoff may infiltrate through these waste materials.

Fluoride was measured at all monitoring locations sampled during the 2008 study and the results are summarized in Table 6. Figures 16a and 16b display dissolved fluoride data from the third day of the 2008 study and the OU2 EMP semi-annual monitoring event.

Fluoride was not detected at any stream locations monitored during the 2008 study with the exception of groundwater at BH-SF-LF-0006. At BH-SF-LF-0006, fluoride was detected at a concentration of 0.13 mg/L.

As shown in Figures 16a and 16b, fluoride was not detected in the majority of groundwater sampled within OU2. Areas where fluoride was detected are in the Bunker Creek and Government Creek corridors, and near the A-4 Gypsum Pond and CIA. The A-4 Gypsum Pond French drain discharges in Magnet Creek near the confluence with the Bunker Creek.

4.4 Loading to the SFCDR from OU2 Groundwater

This section presents and discusses the estimated dissolved cadmium, dissolved lead, dissolved zinc, and total phosphorous loads from groundwater to the SFCDR within OU2 based on the results of the third day of the 2008 monitoring event. Dissolved cadmium, dissolved lead, dissolved zinc, and total phosphorous loads for each day of the 2008 monitoring event are presented in Table 7. Similar to discharge and concentration data, the focus of discussion presented in this section is on the third day of the 2008 study. Load balances are presented in Table 8 based on the revised 2008 study reaches. Load balances presented in Table 8 are for gains and losses observed in the SFCDR that can be attributed to groundwater. Measured tributary load inputs have been subtracted from the load balances.

4.4.1 Dissolved Cadmium

During the third day of the 2008 study, the SFCDR gained approximately 2.9 lb/day of dissolved cadmium from groundwater and approximately 0.7 lb/day from tributaries within OU2.

The dissolved cadmium load entering the study area at BH-SF-LF-0001 was 2.3 lb/day on the third day of the study. As noted earlier, between BH-SF-LF-0001 and BH-SF-LF-0003, the SFCDR is considered to be a losing reach. In this losing reach of the SFCDR, approximately 0.1 lb/day of dissolved cadmium was lost from the SFCDR to underlying groundwater.

In the gaining reach of the SFCDR in the eastern portion of OU2 (BH-SF-LF-0003 to BH-SF-LF-0006), the SFCDR gained approximately 2.4 lb/day of dissolved cadmium from groundwater. This gaining reach represents the area within OU2 where the greatest contribution of dissolved cadmium loading from groundwater to the SFCDR is occurring. Approximately 6 cfs of groundwater is contributed to the SFCDR in this reach. The resultant dissolved cadmium concentration to result in 2.4 lb/day of load at 6 cfs is approximately 0.075 mg/L. This is comparable to dissolved cadmium concentrations measured in monitoring wells in this vicinity.

In the losing reach of the SFCDR in the western portion of OU2 (BH-SF-LF-0006 to BH-SF-LF-0008), the SFCDR lost approximately 1.2 lb/day to underlying groundwater.

In the gaining reach of the SFCDR in the western portion of OU2 between BH-SF-LF-0008 and BH-SF-LF-0010, the SFCDR gained approximately 0.9 lb/day of dissolved cadmium from groundwater. Approximately 15 cfs of groundwater is contributed to the SFCDR in this reach. The resultant dissolved cadmium concentration to result in 0.9 lb/day of load at 15 cfs is approximately 0.011 mg/L. This concentration is slightly lower than dissolved cadmium concentrations measured in monitoring wells in the western portion of Smelterville Flats.

In the gaining reach of the SFCDR between Pinehurst Narrows (BH-SF-LF-0010) and the western boundary of OU2, the SFCDR gained approximately 0.9 lb/day of dissolved cadmium from groundwater. Approximately 28 cfs of groundwater is contributed to the SFCDR in this reach. The resultant dissolved cadmium concentration to result in 0.9 lb/day of load at 28 cfs is approximately 0.006 mg/L. This concentration is close to the dissolved cadmium concentration measured in the upper aquifer along the north bank of the SFCDR at BH-SF-W-0206-U.

4.4.2 Dissolved Lead

During the third day of the 2008 study, the dissolved lead load between BH-SF-LF-0001 and BH-SF-LF-0011 increased approximately 0.8 lb/day. However, dissolved load input from Milo Creek equaled 3.1 lb/day. This results in a negative net dissolved lead load balance and indicates that dissolved lead is being lost from the SFCDR to groundwater at a greater rate than dissolved lead is being released from groundwater to the SFCDR.

The geochemical behavior of dissolved lead is notably different than that of dissolved cadmium and zinc. Lead is known to show a greater tendency to form insoluble precipitates and/or adsorb to organic and inorganic particulates. These characteristics result in dissolved lead behaving in a less conservative manner than dissolved cadmium and zinc in surface water within OU2. Because of these factors, dissolved lead loading data is of limited use when evaluating loading trends from groundwater to the SFCDR within the OU2. Consequently, lead is of concern for higher flows when sediment transportation and deposition processes are occurring.

4.4.3 Dissolved Zinc

During the third day of the 2008 study, the SFCDR gained approximately 513 lb/day of dissolved zinc from groundwater and approximately 52 lb/day from tributaries within OU2.

The dissolved zinc load entering the study area at BH-SF-LF-0001 was 295 lb/day on the third day of the 2008 study. As noted earlier, between BH-SF-LF-0001 and BH-SF-LF-0003, the SFCDR is considered to be a losing reach. In this losing reach of the SFCDR, approximately 17 lb/day of dissolved zinc was lost from the SFCDR to underlying groundwater.

In the gaining reach of the SFCDR in the eastern portion of OU2 (BH-SF-LF-0003 to BH-SF-LF-0006), the SFCDR gained approximately 317 lb/day of dissolved zinc from groundwater. Similar to dissolved cadmium, this reach of the SFCDR is where the greatest loading of dissolved zinc to the SFCDR occurs. Approximately 6 cfs of groundwater is discharged to the SFCDR in this reach. The resultant dissolved zinc concentration to achieve a gain of 317 lb/day at 6 cfs is approximately 9.8 mg/L. Dissolved zinc concentrations in monitoring wells located near the beginning and end of the gaining reach are generally less than 8 mg/L while concentrations in the middle portion of the reach are consistently greater than 20 mg/L.

In the losing reach of the SFCDR in the western portion of OU2 (BH-SF-LF-0006 to BH-SF-LF-0008), the SFCDR lost approximately 96 lb/day of dissolved zinc to underlying groundwater.

In the gaining reach of the SFCDR in the western portion of OU2 between BH-SF-LF-0008 and BH-SF-LF-0010, the SFCDR gained approximately 95 lb/day of dissolved zinc from groundwater. Approximately 15 cfs of groundwater is discharged to the SFCDR in this reach. The resultant dissolved zinc concentration to achieve a gain of 95 lb/day at 15 cfs is approximately 1.18 mg/L. This is somewhat lower than dissolved zinc concentrations observed in groundwater monitoring wells in the western portion of Smelterville Flats.

In the gaining reach of the SFCDR between Pinehurst Narrows (BH-SF-LF-0010) and the western boundary of OU2, the SFCDR gained approximately 214 lb/day of dissolved zinc from groundwater. Approximately 28 cfs of groundwater is discharged to the SFCDR in this reach. The resultant dissolved zinc concentration to achieve a gain of 214 lb/day at 28 cfs is approximately 1.42 mg/L. This is comparable to the dissolved zinc concentration measured in groundwater monitoring well BH-SF-W-0206-U located on the north bank of the SFCDR at the western boundary of OU2. The large load gain in this reach of the SFCDR is not likely the result of source area contaminant inputs to the SFCDR because the dissolved zinc concentration decreases between station BH-SF-LF-0010 (1.36 mg/L) and BH-SF-LF-0011 (1.19 mg/L). Rather, it is likely the result of the large discharge input of relatively clean water from Pine Creek and groundwater from the Pine Creek drainage.

4.4.4 Total Phosphorous

During the third day of the 2008 study, the SFCDR gained approximately 35 lb/day of total phosphorous from groundwater and approximately 4 lb/day from tributaries within OU2. For tributaries, approximately 2.9 lb/day of total phosphorous were measured at Bunker Creek. Much of this 2.9 lb/day likely originates from the A-4 Gypsum Pond French drain which intercepts a portion of the groundwater beneath the A-4 Gypsum Pond. Pine Creek, Government Creek, and Milo Creek contributed 0.57 lb/day, 0.28 lb/day, and 0.16 lb/day, respectively.

The total phosphorous load entering the study area at BH-SF-LF-0001 was 3.5 lb/day on the third day of the 2008 study. As noted earlier, between BH-SF-LF-0001 and BH-SF-LF-0003, the SFCDR is considered to be a losing reach. However, a gain in total phosphorous load of approximately 0.3 lb/day was calculated in this reach. The cause of this gain in phosphorous is not known.

In the gaining reach of the SFCDR in the eastern portion of OU2 (BH-SF-LF-0003 to BH-SF-LF-0006), the SFCDR gained approximately 20.4 lb/day of total phosphorous from groundwater.

In the losing reach of the SFCDR in the western portion of OU2 (BH-SF-LF-0006 to BH-SF-LF-0008), the SFCDR lost approximately 12.9 lb/day of total phosphorous to underlying groundwater.

In the gaining reach of the SFCDR in the western portion of OU2 between BH-SF-LF-0008 and BH-SF-LF-0010, the SFCDR gained approximately 24.4 lb/day of total phosphorous from groundwater. It is important to note that the outfalls of both the Page and Smelterville wastewater treatment plants discharge to the SFCDR in this area. Total phosphorous loading data from these discharges was not available for evaluation during the preparation of this memorandum.

In the gaining reach of the SFCDR between Pinehurst Narrows (BH-SF-LF-0010) and the western boundary of OU2, the SFCDR gained approximately 2.8 lb/day of total phosphorous from groundwater.

4.5 Ambient Water Quality Criteria

Table 9 presents AWQC ratios for dissolved cadmium, dissolved lead, and dissolved zinc at each 2008 low-flow study monitoring stations. AWQC for dissolved cadmium, dissolved lead, and dissolved zinc are hardness dependant. The AWQC ratio a represents the degree to which the concentration of a select parameter exceeds the AWQC. For example, an AWQC ratio of 1 indicates that the concentration is equal to the AWQC while an AWQC of 10 indicates that the concentration is 10 times the AWQC. Similar to other discussion in this document, the discussion of AWQC ratios presented in this section focus on the third day of the 2008 study.

4.5.1 Dissolved Cadmium

During the third day of the 2008 study, the dissolved cadmium AWQC ratio in the SFCDR increased from 5.5 at BH-SF-LF-0001 to 7.3 at BH-SF-LF-0011.

In the losing reach of the SFCDR in the eastern portion of OU2, the dissolved cadmium AWQC ratio was relatively constant between BH-SF-LF-0001 and BH-SF-LF-0003. In this reach, discharge from Milo Creek entered the SFCDR with a dissolved cadmium AWQC ratio of 10.

In the gaining reach of the SFCDR in the eastern portion of OU2, the dissolved cadmium AWQC ratio increased between BH-SF-LF-0003 (5.4) and BH-SF-LF-0004 (7.3). The dissolved cadmium AWQC continued to increase to 7.8 at BH-SF-LF-0005 before dropping to 6.9 at BH-SF-LF-0006. As noted earlier, the dissolved cadmium concentration increased between BH-SF-LF-0005 and BH-SF-LF-0006. However, because the dissolved cadmium AWQC is hardness dependant, the introduction of high hardness water from Bunker Creek between these two locations resulted in a higher AWQC and, therefore, a lower AWQC ratio despite the concentration increase.

In the losing reach of the SFCDR in the western portion of OU2, the dissolved cadmium AWQC ratio increased to 7.6 at both BH-SF-LF-0007 and BH-SF-LF-0008. In the reach between BH-SF-LF-0006 and BH-SF-LF-0007, discharge from Government Creek with a dissolved cadmium AWQC ratio of 138 entered the SFCDR.

In the gaining reach of the SFCDR, the dissolved cadmium AWQC ratio increased to 7.8 at BH-SF-LF-0009 before decreasing to 7.4 at BH-SF-LF-0010 and 7.3 at BH-SF-LF-0011.

4.5.2 Dissolved Lead

Dissolved lead AWQC ratios were consistently below 1 and ranged from 0.1 to 0.2 in the SFCDR on the third day of the 2008 study. Dissolved lead was not detected at tributary locations with the exception of Milo Creek where the dissolved lead AWQC ratio was 15. The elevated dissolved lead concentrations observed in Milo Creek are attributable to discharge of AMD from the Reed and Russell adits to Milo Creek.

4.5.3 Dissolved Zinc

During the third day of the 2008 study, the dissolved zinc AWQC ratio increased from 3.6 at BH-SF-LF-0001 to 5.6 at BH-SF-LF-0011.

In the losing reach of the SFCDR in eastern OU2, the dissolved zinc AWQC ratio was relatively constant between BH-SF-LF-0001 (3.6) and BH-SF-LF-0003 (3.8).

Similar to the dissolved cadmium AWQC ratio, the dissolved zinc AWQC ratio increased to 5.8 at BH-SF-LF-0004 and 6.5 at BH-SF-LF-0005 before decreasing to 4.8 at BH-SF-LF-0006 after the introduction of Bunker Creek discharge to the SFCDR.

In the losing reach of the SFCDR in the western portion of OU2, the dissolved zinc ratio increased to 5.4 at BH-SF-LF-0007 and BH-SF-LF-0008. Between BH-SF-LF-0006 and BH-SF-LF-0007, Government Creek discharged water to the SFCDR with an dissolved zinc AWQC ratio of 22.

In the gaining reach of the SFCDR in the western portion of OU2, the dissolved zinc AWQC ratio increased to 5.6 between BH-SF-LF-0008 and BH-SF-LF-0009. The dissolved zinc AWQC ratio remained at 5.6 until the western boundary of OU2 at BH-SF-LF-0011.

5.0 Comparison of 2008 Results to Previous Studies

This section provides a general comparison of the 2008 study findings to those of previous findings (1999, 2003, 2006, and 2007).

5.1 SFCDR Discharge

Table 10 presents the daily discharge measurements for the 2008 study per site, along with the average discharge from previous years per site. Measured discharge during the 1999, 2003, and 2006 studies is consistent with the average historic discharge presented in Figure 3. The 2007 and 2008 studies were performed during precipitation events and the resulting discharge measurements are higher than the historic average. Measured discharge during the 2007 and 2008 studies is more variable and not comparable to previous studies because of the fluctuating hydrologic conditions. Variability of discharge measurements likely occurs as detailed in Section 2.5.1 and, in many instances, the rate of exchange between surface water and groundwater varies over time scales of hours, days, or months (Rosenberry and LaBaugh, 2008). Therefore, only trends will be discussed.

Measured discharge from stations BH-SF-LF-0001 to BH-SF-LF-0003 shows no change to a slight decline for all years measured. Measured discharge between stations BH-SF-LF-0004 and BH-SF-LF-0006 shows slight variability that cannot be fully explained, but may be a combination of factors described above.

Discharge increases during each of the studies in Smelterville Flats between station BH-SF-LF-0007 and BH-SF-LF-0010. A large increase during all years of the studies was measured between stations BH-SF-LF-0010 and BH-SF-LF-0011, except for the 1999 study. However, the discharge measurement at this station was collected further upstream and 10 days after (October 25, 1999) the actual 1999 study (October 15 to 17, 1999).

5.2 Dissolved Metal Concentrations

The average contaminant metal concentrations for surface water and groundwater for the 1999, 2003, 2006, along with individual days for the 2008 study are presented in Table 11. As shown in the table, not all stations were sampled during the 1999 study, and few groundwater stations were established.

Dissolved cadmium concentrations measured in surface water are generally similar at the SFCDR monitoring stations between 1999 and 2008. Dissolved lead concentrations are slightly variable from 1999 to 2006, and increased in 2008. Milo Creek shows the highest dissolved lead concentration difference, ranging from 0.07 mg/L (1999) to 0.37 mg/L (2003). Dissolved zinc concentrations were higher in 1999 than in subsequent years. Dissolved zinc concentrations are relatively similar from 2003 to 2008.

5.3 Contaminant Metal Loads

Table 12 provides a comparison of the average net gain of dissolved cadmium, lead, and zinc loads from groundwater during 2008 and previous studies. The net dissolved cadmium load gain in the SFCDR as it passes through OU2 ranges from 1.2 lb/day (2006) to 2.9 lb/day (2008). The majority of these load gains occurred between monitoring stations BH-SF-LF-0004 and BH-SF-LF-0006, and between stations BH-SF-LF-0008 and BH-SF-LF-0011.

As discussed in Section 4.4.2, dissolved lead does not behave in a conservative manner in site surface water and, therefore, dissolved lead loading information is limited use for interpretation.

The net dissolved zinc load gain the SFCDR as it passes through OU2 ranges from 273 lb/day (2006) to 732 lb/day (1999). The largest gains generally occur between monitoring stations BH-SF-LF-0003 and BH-SF-LF-0006, located in the stretch of SFCDR directly north and northwest of the CIA. In 1999, a significant amount of dissolved zinc loading to the SFCDR occurred between monitoring stations BH-SF-LF-0004 and BH-SF-LF-0006 and is attributed to in-stream excavation of tailings. These large load gains are not observed in subsequent years and are likely the result of the Phase I remedial actions performed for the CIA. Additional load gains in Smelterville Flats and in the Pinehurst narrows also occur during each study year and are expected because of groundwater and Pine Creek discharge to the SFCDR in this area.

5.4 Ambient Water Quality Criteria

Table 13 presents the dissolved cadmium, lead, and zinc AWQC ratios for all OU2 low-flow studies. Dissolved cadmium AWQC ratios were higher in 1999 than in any subsequent year. From 2003 to 2008, the dissolved cadmium AWQC ratios ranged from 6.0 to 8.0 at SFCDR monitoring stations. AWQC ratios from the SFCDR tributaries Milo Creek, Bunker Creek, and Government Creek show variability among the study years.

Dissolved lead AWQC ratios were less than 1.0 for all SFCDR stations during all years the study was performed.

Dissolved zinc AWQC ratios were similar to dissolved cadmium. Dissolved zinc AWQC ratios were higher in 1999 than in subsequent years. The dissolved zinc AWQC from 2003 to 2008 ranged from 4.5 to 7.0. AWQC ratios from the SFCDR tributaries Milo Creek, Bunker Creek, and Government Creek were variable among the study years.

6.0 Summary of Key Findings

This section presents a summary of the key findings from the OU2 Groundwater/Surface Water Interaction Monitoring event. The key finding below are based mostly on data collected during the third day of the 2008 study.

6.1 Hydrologic Conditions

- The three-day study was conducted during a hydrologic period where the SFCDR discharge was not stable over the 3-day study period because of a precipitation event prior to the study. The historic average discharge at the USGS gaging station located at Pinehurst for this same period is 110 cfs. During the 3-day study, discharge at this station decline from about 160 cfs to 130 cfs. Data obtained during the 3-day study was not averaged because of these non-steady state hydrologic conditions. Data evaluation and interpretation was performed using only data from the third day of the study. Even though this study was not performed under optimal hydrologic conditions, and each day was not comparative with another, the data obtained from this monitoring were obtained under low-flow conditions providing additional hydrologic characteristics for these varying flow conditions.
- Evaluation of discharge data collected during the 2008 study indicated that the location of the transition between gaining and losing reaches in the western portion of OU2 has changed. This may be the result of error associated with discharge measurements, a shifting transition because of the higher measured discharge than in previous studies, or changes to the SFCDR channel during the May 2008 high water event.

6.2 Field Parameters

- Specific conductance profiles collected at SFCDR monitoring locations show lateral variations in specific conductance across the stream profile at stations BH-SF-LF-0004, BH-SF-LF-0005, and BH-SF-LF-0006. All other stations show little or no change in specific conductance across the channel profile. This lateral stratification of specific conductance at these locations is likely the result of contaminated groundwater discharging the SFCDR along the southern bank in this gaining reach of the SFCDR. At BH-SF-LF-0006, a portion of the stratification of the lateral profile is likely associated with the introduction of water with high specific conductance from Bunker Creek.
- pH measured at SFCDR monitoring locations was generally lower in gaining reaches and higher in losing reaches.

6.3 Concentration

- Dissolved cadmium and dissolved zinc concentrations in the SFCDR consistently increased in gaining reaches and decreased in losing reaches. This is consistent with the discharged of groundwater with elevated concentrations to the SFCDR.
- Dissolved lead concentrations in the SFCDR were relatively consistent within OU2. The greatest dissolved lead concentration measured during the 2008 study occurred at Milo Creek (0.149 mg/L). These elevated concentrations are believed to be associated with the discharge of AMD from the Reed and Russell adits to Milo Creek. No other tributaries

exhibited dissolved lead concentrations above the detection limit. Note that lead typically occurs in particulate form and is detected at higher concentrations during periods of runoff and higher stream flows when sediment transport and deposition processes are occurring.

- Total phosphorous concentrations in the SFCDR increase substantially in the gaining reaches of the SFCDR. In the eastern portion of OU2, the gains in phosphorous appear to be the result of high concentration groundwater discharging to the SFCDR and also from Bunker Creek. The high concentrations measured in Bunker Creek are likely the result of discharge from the A-4 Gypsum Pond. In the western portion of OU2, increases in phosphorous appear to be associated with the discharge of high concentration groundwater to the SFCDR between BH-SF-LF-0009 and BH-SF-LF-0010. The source of phosphorous in this groundwater appears to be from the Page and Smelterville wastewater treatment plants.
- Similar to phosphorous, sulfate concentrations in the SFCDR increased in the gaining reaches of the SFCDR. However, the greatest increases were observed in the eastern portion of OU2. The increases in sulfate concentrations in the SFCDR are related to discharge of high sulfate concentration groundwater and discharge from Bunker Creek. The sources of sulfate within OU2 are associated with the oxidation of sulfide minerals, dissolution of gypsum, and effluent from the lime-precipitation treatment process employed to treat AMD at the CTP.
- Dissolved iron and dissolved manganese concentrations in the SFCDR within OU2 increased in the gaining reaches of the SFCDR. In OU2 groundwater, dissolved iron and dissolved manganese were primarily detected in areas located upgradient and within the gaining reaches of the SFCDR.
- Fluoride was not detected at concentrations above the detection limit in the SFCDR within OU2. Fluoride was only detected in groundwater in the vicinity of the A-4 Gypsum Pond, the northwest corner of the CIA near the SFCDR, and at one location near the former phosphoric acid/fertilizer plant in Government Gulch.

6.4 Load

- The dissolved cadmium load added to the SFCDR from groundwater sources within OU2 was approximately 2.9 lb/day on the third day of the 2008 study.
- The dissolved zinc load added to the SFCDR from groundwater sources within OU2 was approximately 513 lb/day on the third day of the 2008 study.
- The greatest loads of dissolved cadmium and dissolved zinc to the SFCDR from groundwater occurred in the gaining reach of the SFCDR in the eastern portion of OU2 between monitoring locations BH-SF-LF-0003 and BH-SF-LF-0006.
- Dissolved lead loads were highly variable and resulted in an overall negative load balance. This is a result of the geochemistry of lead in OU2 surface water and groundwater. The highest load of dissolved lead was from Milo Creek.
- Total phosphorous loading to the SFCDR within OU2 from groundwater during the third day of the study was approximately 35 lb/day.

6.5 AWQC

- AWQC ratios for dissolved lead in the SFCDR and measured tributaries were consistently below 1 with the exception of Milo Creek (AWQC ratio = 15).
- AWQC ratios for dissolved cadmium and dissolved zinc exhibited their greatest increase in the gaining reach of the SFCDR in eastern OU2. The introduction of high hardness discharge from Bunker Creek actually resulted in a reduction of the AWQC ratios for dissolved cadmium and dissolved zinc. The AWQC remained relatively constant in the SFCDR in the western portion of OU2. AWQC ratios for dissolved cadmium and dissolved zinc in Government Creek were 138 and 22, respectively. The AWQC ratios for both metals exhibited increases in the SFCDR after the confluence of Government Creek.

7.0 Recommendations

The following recommendations have been developed following the evaluation of 2008 OU2 Groundwater/Surface Water Interaction Monitoring data:

1. The need to continue using in-stream minipiezometers and potentiomanometers should be reviewed prior to future monitoring efforts. The presence of coarse-grained materials in the SFCDR channel make installation of the minipiezometers difficult and also does not allow for a satisfactory seal between the piezometer and surrounding sediments. Water quality samples collected from these locations were highly variable and were often not representative of expected conditions. In addition, variability of the hydraulic gradient measured on potentiomanometers can occur because of the heterogeneity of river sediments in the SFCDR. This variability can affect the magnitude and direction of the hydraulic gradient shown on potentiomanometers.
2. The potential impacts of Diel effects (Nimick, 2003) should be evaluated. Diel effects result in significant changes in dissolved metal concentrations in streams and rivers over the course of a day in response to biological activity. The impacts of the Diel signal on water quality samples is being evaluated in upcoming documents for OU3 studies and monitoring and pending the results may warrant further investigation within OU2.
3. The need to conduct dedicated groundwater/surface water interaction monitoring events on an annual basis should be reevaluated. The focus of these monitoring events is on an evaluation of dissolved metal loading from groundwater to surface water. While loading is an important indicator, the real parameter of interest in evaluating the ability of the SFCDR to support a native fishery is the AWQC ratio. The presence of several USGS/BEMP surface water monitoring stations at strategic locations within OU2 (near gaining and losing reach transition zones) may allow for AWQC ratio evaluations to be conducted using BEMP data.
4. A data gap associated with this study is the lack of data obtained between monitoring stations BH-SF-LF-0003 and BH-SF-LF-0004. This reach of the SFCDR is characterized with a transition from a losing to a gaining reach with a large contaminated groundwater input to the SFCDR. A groundwater/surface water interaction study should be performed in this localized area of OU2, between BH-SF-LF-0003 and BH-LF-

LF-0006 with additional SFCDR monitoring locations incorporated between BH-SF-LF-0003 and BH-SF-LF-0004. Data obtained from this type of study will further refine the site conceptual model and provide data to guide the development and design of potential Phase II remedial actions.

8.0 References

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Tables

TABLE 1

Station Coordinates for the 1999 and 2008 Studies

OU2 Groundwater/Surface Water Interaction Monitoring

Bunker Hill Superfund Site OU2

Station	Type	1999 Coordinates[5]		2008 Coordinates[5]	
		Easting	Northing	Easting	Northing
BH-SF-LF0001[1]	SFCDR	2535126.94	2139742.10	2535177.61	2139620.26
BH-SF-LF0002	SFCDR	2531704.16	2141379.34	2531871.22	2141334.69
BH-SF-LF0003	SFCDR	2529998.49	2143312.76	2529919.53	2143186.88
BH-SF-LF0004	SFCDR	2523967.54	2144458.00	2523980.27	2144495.66
BH-SF-LF0005	SFCDR	2523143.85	2144361.02	2522801.60	2144365.55
BH-SF-LF0006	SFCDR	2521016.82	2144271.08	2521194.33	2144204.82
BH-SF-LF0007	SFCDR	2515331.95	2145822.46	2515484.68	2146141.20
BH-SF-LF0008	SFCDR	2513614.24	2145325.73	2513770.25	2145406.45
BH-SF-LF0009	SFCDR	2511966.21	2145031.38	2512086.44	2144908.96
BH-SF-LF0010	SFCDR	2508807.21	2144442.28	2508458.59	2144587.51
BH-SF-LF0011 [2,3]	SFCDR	2508198.46	2145864.47	2504509.29	2145482.99
Milo Creek	Tributary	2533687.04	2139951.35	2533340.73	2140110.10
Bunker Creek	Tributary	2522251.56	2144264.44	2522043.89	2144235.44
Government Creek	Tributary	2520604.69	2144171.99	2520620.30	2144090.02
Pine Creek[4]	Tributary	--	--	2507892.22	2146087.63

Notes:

[1] BH-SF-LF001 is located approximately 5,000 feet downstream of SF-268.

[2] Station BH-SF-LF-0011 for 2008 was moved approximately 2000 feet downstream of the original 1999 location.

[3] BH-SF-LF-011 is located approximately 250 feet downstream of SF-271

[4] Pine Creek was not included in the 1999 study.

[5] Coordinates shown in State Plane, NAD83 (feet), Idaho West.

-- = Data Not Available

TABLE 2
2008 Discharge Measurements
OU2 Groundwater/Surface Water Interaction Monitoring
Bunker Hill Superfund Site OU2

Station	2008 Discharge (cfs)		
	09/23/08	09/24/08	09/25/08
BH-SF-LF0001	111	104	83
BH-SF-LF0002	118	98	90
BH-SF-LF0003	108	98	80
BH-SF-LF0004	114	105	90
BH-SF-LF0005	113	102	83
BH-SF-LF0006	116	98	90
BH-SF-LF0007	121	113	99
BH-SF-LF0008	112	102	80
BH-SF-LF0009	131	115	100
BH-SF-LF0010	135	111	95
BH-SF-LF0011	177	162	133
Milo Creek	3.3	3.7	3.8
Bunker Creek	3.5	1.0	3.5
Government Creek	1.2	1.2	1.1
Pine Creek	9.7	9.9	9.6

TABLE 3

Groundwater Head/Surface Water Stage Differences for the 2008 Study

OU2 Groundwater/Surface Water Interaction Monitoring

Bunker Hill Superfund Site OU2

Station	Head Difference[1] (cm)		
	09/23/08	09/24/08	09/25/08
BH-SF-LF0001	-0.9	-0.7	-0.7
BH-SF-LF0002	--	--	--
BH-SF-LF0003	-0.6	-0.7	-0.7
BH-SF-LF0004	0.2	0.5	0.6
BH-SF-LF0005	0.0	0.0	-0.4
BH-SF-LF0006	-0.2	-0.2	-0.2
BH-SF-LF0007	-0.6	-0.6	-0.5
BH-SF-LF0008	-0.2	-0.3	0.0
BH-SF-LF0009	1.0	1.1	1.2
BH-SF-LF0010	-0.9	-0.8	-0.3
BH-SF-LF0011	3	2.9	2.7
Milo Creek	--	--	--
Bunker Creek	--	--	--
Government Creek	--	--	--
Pine Creek	--	--	--

Notes:

[1] Head difference calculated as surface water potentiomanometer measurement minus groundwater potentiomanometer measurement. Positive head indicates surface water gaining discharge from groundwater, negative head indicates surface water losing discharge to groundwater.

--- = Not Measured

Table 4
Gaining and Losing Reaches
OU2 Groundwater/Surface Water Interaction Monitoring
Bunker Hill Superfund Site OU2

1999 Reaches	Gain/Loss Condition	SFCDR Discharge Gain/Loss (cfs)		
		9/23/2008	9/24/2008	9/25/2008
BH-SF-LF-0001 to BH-SF-LF-0003	Losing	-6	-10	-7
BH-SF-LF-0003 to BH-SF-LF-0006	Gaining	+5	-1	+6
BH-SF-LF-0006 to BH-SF-LF-0007	Losing	+4	+14	+8
BH-SF-LF-0007 to BH-SF-LF-0010	Gaining	+14	-1	-4[1]
BH-SF-LF-0010 to BH-SF-LF-0011	Gaining	+32	+41	+28[1]

2008 Revised Reaches	Gain/Loss Condition	SFCDR Discharge Gain/Loss (cfs)		
		9/23/2008	9/24/2008	9/25/2008
BH-SF-LF-0001 to BH-SF-LF-0003	Losing	-6	-10	-7
BH-SF-LF-0003 to BH-SF-LF-0006	Gaining	+5	-1	+6
BH-SF-LF-0006 to BH-SF-LF-0008	Losing	-5	+3	-11
BH-SF-LF-0008 to BH-SF-LF-0010	Gaining	+23	+9	+15[1]
BH-SF-LF-0010 to BH-SF-LF-0011	Gaining	+32	+41	+28[1]

Notes:

Tributary contributions to discharge subtracted from gain/loss for segment

"+" indicates a gain in SFCDR discharge from groundwater

"-" indicates a loss in SFCDR discharge to groundwater

[1] Changes to SFCDR channel morphology at station BH-SF-LF-0010 may have resulted in increased error in discharge measurements. Therefore, gains in discharge between BH-SF-LF-0010 and BH-SF-LF-0011 may be overestimated and gains and losses between BH-SF-LF-0007/BH-SF-LF-0008 and BH-SF-LF-0010 may be underestimated.

TABLE 5

Dissolved Metal Concentrations Under Base Flow Conditions - South Fork Coeur d'Alene River

OU2 Groundwater/Surface Water Interaction Study

Bunker Hill Site OU2

	Dissolved Cadmium (mg/L)				Dissolved Lead (mg/L)				Dissolved Zinc (mg/L)			
Station	**09/23/08**	**09/24/08**	**09/25/08**	**09/25/08 Groundwater**	**09/23/08**	**09/24/08**	**09/25/08**	**09/25/08 Groundwater**	**09/23/08**	**09/24/08**	**09/25/08**	**09/25/08 Groundwater**
BH-SF-LF0001	0.0048	0.0048	0.0052	0.0054	0.0042	0.0081	0.0052	0.0036	0.610	0.623	0.656	0.704
BH-SF-LF0002	0.0048	0.0049	0.0050	0.0055	0.0062	0.0059	0.0060	0.0041	0.609	0.648	0.657	0.716
BH-SF-LF0003	0.0047	0.0050	0.0052	0.0046	0.0056	0.0057	0.0056	0.0023	0.616	0.658	0.695	1.616
BH-SF-LF0004	0.0067	0.0074	0.0073	0.0060	0.0037	0.0057	0.0059	0.0101	0.982	1.090	1.090	1.290
BH-SF-LF0005	0.0070	0.0077	0.0081	0.0043	0.0053	0.0059	0.0061	<0.001	1.060	1.200	1.270	0.946
BH-SF-LF0006	0.0088	0.0096	0.0102	0.2080	0.0047	0.0057	0.0046	0.0340	1.110	1.240	1.300	6.590
BH-SF-LF0007	0.0085	0.0093	0.0098	0.0037	<0.001	0.0039	0.0045	<0.001	1.100	1.230	1.280	0.388
BH-SF-LF0008	0.0081	0.0096	0.0096	0.0117	0.0022	<0.001	0.0033	0.0027	1.100	1.280	1.270	3.610
BH-SF-LF0009	0.0085	0.0096	0.0101	<0.001	0.0024	0.0038	0.0034	0.0480	1.140	1.270	1.320	1.510
BH-SF-LF0010	0.0089	0.0093	0.0097	0.0048	0.0040	0.0046	0.0052	0.0022	1.250	1.330	1.360	1.190
BH-SF-LF0011	0.0075	0.0081	0.0082	<0.001	0.0030	0.0040	0.0043	<0.001	1.090	1.180	1.190	0.278
Milo Creek	0.0039	0.0046	0.0045	--	0.1180	0.0947	0.1490	--	0.959	1.110	1.100	--
Bunker Creek	0.0147	0.0191	0.0149	--	<0.001	<0.001	<0.001	--	0.749	1.360	0.846	--
Government Gulch	0.0486	0.0505	0.0516	--	<0.001	<0.001	<0.001	--	1.640	1.710	1.760	--
Pine Creek	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	--	0.0572	0.0598	0.0655	--

Notes:

-- = Not Sampled.

TABLE 6

Phosphorous, Sulfate, Iron, Manganese, and Fluoride Concentrations

OU2 Groundwater/Surface Water Interaction Monitoring

Bunker Hill Superfund Site OU2

	Total Phosphorous (µg/L)				Sulfate (mg/L)				Dissolved Iron (mg/L)				Dissolved Manganese (mg/L)				Fluoride (mg/L)			
Station	**9/23/08**	**9/24/08**	**9/25/08**	**Groundwater 9/25/08**	**9/23/08**	**9/24/08**	**9/25/08**	**Groundwater 9/25/08**	**9/23/08**	**9/24/08**	**9/25/08**	**Groundwater 9/25/08**	**9/23/08**	**9/24/08**	**9/25/08**	**Groundwater 9/25/08**	**9/23/08**	**9/24/08**	**9/25/08**	**Groundwater 9/25/08**
BH-SF-LF0001	8.5	15	7.8	4.6	56.8	49.4	45.3	44.3	0.0038	0.0093	0.0175	0.0087	0.0402	0.0401	0.0394	0.01	<0.04	<0.1	<0.04	<0.04
BH-SF-LF0002	8.7	16	9.7	4.6	54.4	49.7	44.6	45.5	0.0112	0.0103	0.0025	0.0101	0.0452	0.0456	0.0465	0.002	<0.04	<0.1	<0.04	<0.04
BH-SF-LF0003	7.8	17	9.2	4.7	51.4	49.3	46.2	46.6	0.0058	0.0057	0.1	0.015	0.0467	0.0485	0.0438	0.0031	<0.04	<0.1	<0.04	<0.04
BH-SF-LF0004	31	31	35	14	121	59.3	54.1	60.3	0.117	0.166	0.163	0.199	0.188	0.207	0.216	0.640	<0.04	<0.1	<0.04	<0.04
BH-SF-LF0005	33	42	37	13	68.9	22.8	55.3	60.9	0.169	0.205	0.18	<0.1	0.229	0.254	0.254	0.0115	<0.04	<0.1	<0.04	<0.04
BH-SF-LF0006	37	42	56	8.3	2040	84.4	119	302	0.145	0.162	0.161	<0.011	0.537	0.405	0.652	1.0	<0.04	<0.1	<0.04	0.13
BH-SF-LF0007	34	33	36	18	87.3	107	94.5	84.3	0.042	0.108	0.088	0.0271	0.389	0.554	0.469	0.0093	<0.04	<0.1	<0.04	<0.04
BH-SF-LF0008	30	31	34	<10	82.5	86.8	93.6	80.4	0.0605	0.0651	<0.0827	<0.011	0.377	0.398	0.443	0.619	<0.04	<0.1	<0.04	<0.04
BH-SF-LF0009	34	35	32	34	87.1	82.2	98.3	55.5	0.061	0.092	<0.0808	0.411	0.383	0.366	0.494	0.0527	<0.04	<0.1	<0.04	<0.04
BH-SF-LF0010	<1	70	76	6.3	101	83.2	104	98.2	0.132	0.160	0.172	<0.01	0.452	0.412	0.529	0.0037	<0.04	<0.1	<0.04	<0.04
BH-SF-LF0011	<1	58	59	4.9	89.0	73.8	90.9	15.0	0.0888	0.108	<0.1	<0.003	0.384	0.350	0.456	0.0083	<0.04	<0.1	<0.04	<0.04
Milo Creek	7.1	6.2	8.0	--	22.6	24.3	22.1	--	<0.1	<0.1	<0.1	--	0.296	0.337	0.329	--	<0.04	<0.1	<0.1	--
Bunker Creek	--[1]	270	152	--	71	1190	1530	--	<0.1	<0.1	<0.1	--	8.98	6.72	8.61	--	<0.04	<0.1	<0.04	--
Government Gulch	48	50	48	--	22.4	60.1	22.1	--	<0.1	<0.1	<0.1	--	0.056	0.053	0.051	--	<0.04	<0.1	<0.04	--
Pine Creek	<1	11	11	--	5.12	5.12	4.94	--	<0.0128	0.0081	<0.0071	--	0.0043	0.0048	0.0032	--	<0.04	<0.1	<0.04	--

Notes:

-- = Groundwater samples not collected from tributary monitoring stations.

[1] = The Bunker Creek total phosphorous analytical result was not received in the laboratory data package for September 23, 2008.

Table 7
Measured Loading for the 2008 Study
OU2 Groundwater/Surface Water Interaction Monitoirng
Bunker Hill Superfund Site OU2

Station	Dissolved Cadmium Load (lb/day)		
	9/23/2008	9/24/2008	9/25/2008
BH-SF-LF-0001	2.9	2.7	2.3
BH-SF-LF-0002	3.1	2.6	2.4
BH-SF-LF-0003	2.7	2.6	2.3
BH-SF-LF-0004	4.1	4.2	3.5
BH-SF-LF-0005	4.3	4.2	3.6
BH-SF-LF-0006	5.5	5.1	5.0
BH-SF-LF-0007	5.5	5.7	5.2
BH-SF-LF-0008	4.9	5.5	4.1
BH-SF-LF-0009	6.0	6.0	5.5
BH-SF-LF-0010	6.5	5.6	5.0
BH-SF-LF-0011	7.2	7.1	5.9
Milo Creek	0.1	0.1	0.1
Bunker Creek	0.3	0.1	0.3
Government Creek	0.3	0.3	0.3
Pine Creek	--	--	--

Station	Dissolved Lead Load (lb/day)		
	9/23/2008	9/24/2008	9/25/2008
BH-SF-LF-0001	2.5	4.5	2.3
BH-SF-LF-0002	3.9	3.1	2.9
BH-SF-LF-0003	3.3	3.0	2.4
BH-SF-LF-0004	2.3	3.2	2.9
BH-SF-LF-0005	3.2	3.2	2.7
BH-SF-LF-0006	2.9	3.0	2.2
BH-SF-LF-0007	0.6	2.4	2.4
BH-SF-LF-0008	1.3	0.4	1.4
BH-SF-LF-0009	1.7	2.4	1.9
BH-SF-LF-0010	2.9	2.8	2.1
BH-SF-LF-0011	2.9	3.5	3.1
Milo Creek	2.1	1.9	3.1
Bunker Creek	--	--	--
Government Creek	--	--	--
Pine Creek	--	--	--

Table 7 (cont)
Measured Loading for the 2008 Study
OU2 Groundwater/Surface Water Interaction Monitoirng
Bunker Hill Superfund Site OU2

Station	Dissolved Zinc Load (lbs/day)		
	9/23/2008	9/24/2008	9/25/2008
BH-SF-LF-0001	365	349	295
BH-SF-LF-0002	388	342	320
BH-SF-LF-0003	358	347	301
BH-SF-LF-0004	606	618	628
BH-SF-LF-0005	644	658	567
BH-SF-LF-0006	696	658	634
BH-SF-LF-0007	716	753	682
BH-SF-LF-0008	662	701	548
BH-SF-LF-0009	806	790	725
BH-SF-LF-0010	913	796	643
BH-SF-LF-0011	1040	1031	857
Milo Creek	17	22	23
Bunker Creek	14	8	16
Government Creek	11	11	10
Pine Creek	3	3	3

Station	Total Phosphorous Load (lbs/day)		
	9/23/2008	9/24/2008	9/25/2008
BH-SF-LF-0001	5.1	8.4	3.5
BH-SF-LF-0002	5.5	8.4	4.7
BH-SF-LF-0003	4.5	9.0	4.0
BH-SF-LF-0004	19.1	17.6	17.0
BH-SF-LF-0005	20.0	23.0	16.5
BH-SF-LF-0006	23.2	22.3	27.3
BH-SF-LF-0007	22.1	20.2	19.2
BH-SF-LF-0008	18.0	17.0	14.7
BH-SF-LF-0009	24.0	21.8	17.2
BH-SF-LF-0010	--	41.9	39.1
BH-SF-LF-0011	--	50.6	42.5
Milo Creek	0.1	0.1	0.2
Bunker Creek	--	1.5	2.9
Government Creek	0.3	0.3	0.3
Pine Creek	--	0.6	0.6

Note:
-- = Not sampled, not analyzed, or concentration not detected.

Table 8
Loads from Groundwater for SFCDR Reaches
OU2 Groundwater/Surface Water Interaction Monitoring
Bunker Hill Superfund Site OU2

SFCDR Reach	Gain/Loss Condition	Dissolved Cadmium Gain/Loss (lb/day)		
		9/23/2008	9/24/2008	9/25/2008
BH-SF-LF-0001 to BH-SF-LF-0003	Losing	-0.3	-0.2	-0.1
BH-SF-LF-0003 to BH-SF-LF-0006	Gaining	+2.5	+2.4	+2.4
BH-SF-LF-0006 to BH-SF-LF-0008	Losing	-0.9	+0.1	-1.2
BH-SF-LF-0008 to BH-SF-LF-0010	Gaining	+1.6	+0.1	+0.9
BH-SF-LF-0010 to BH-SF-LF-0011	Gaining	+0.7	+1.5	+0.9
Net Gain in Dissolved Cadmium Load		**3.6**	**3.9**	**2.9**

SFCDR Reach	Gain/Loss Condition	Dissolved Lead Gain/Loss (lb/day)		
		9/23/2008	9/24/2008	9/25/2008
BH-SF-LF-0001 to BH-SF-LF-0003	Losing	-1.3	-3.4	-3
BH-SF-LF-0003 to BH-SF-LF-0006	Gaining	-0.4	0	-0.2
BH-SF-LF-0006 to BH-SF-LF-0008	Losing	-1.6	-2.6	-0.8
BH-SF-LF-0008 to BH-SF-LF-0010	Gaining	+1.6	+2.4	+0.7
BH-SF-LF-0010 to BH-SF-LF-0011	Gaining	0	+0.7	+1
Net Gain in Dissolved Lead Load		**-1.7**	**-2.9**	**-2.3**

SFCDR Reach	Gain/Loss Condition	Dissolved Zinc Gain/Loss (lb/day)		
		9/23/2008	9/24/2008	9/25/2008
BH-SF-LF-0001 to BH-SF-LF-0003	Losing	-24	-24	-17
BH-SF-LF-0003 to BH-SF-LF-0006	Gaining	+324	+303	+317
BH-SF-LF-0006 to BH-SF-LF-0008	Losing	-45	-32	-96
BH-SF-LF-0008 to BH-SF-LF-0010	Gaining	+251	+95	+95
BH-SF-LF-0010 to BH-SF-LF-0011	Gaining	+127	+235	+214
Net Gain in Dissolved Zinc Load		**633**	**577**	**513**

SFCDR Reach	Gain/Loss Condition	Total Phosphorous Gain/Loss (lb/day)		
		9/23/2008	9/24/2008	9/25/2008
BH-SF-LF-0001 to BH-SF-LF-0003	Losing	-0.7	+0.5	+0.3
BH-SF-LF-0003 to BH-SF-LF-0006	Gaining	+18.7	+11.8	+20.4
BH-SF-LF-0006 to BH-SF-LF-0008	Losing	-5.5	-5.6	-12.9
BH-SF-LF-0008 to BH-SF-LF-0010	Gaining	--	+24.9	+24.4
BH-SF-LF-0010 to BH-SF-LF-0011	Gaining	--	+8.1	+2.8
Net Gain in Total Phosphorous Load		**--**	**39.7**	**35**

Notes:
Tributary contributions of load subtracted from gain/loss for segment
"+" indicates a gain in load from groundwater
"-" indicates a loss in load in reach
Net gain in load equals net gain in load from groundwater between BH-SF-LF-0001 and BH-SF-LF-0011
-- = load difference could not be calculated

TABLE 9

Dissolved Metal AWQC Ratios for the 2008 Study

OU2 Groundwater/Surface Water Interaction Study

Bunker Hill Site OU2

Location	Dissolved Cadmium AWQC			Dissolved Lead AWQC Ratio			Dissolved Zinc AWQC Ratio		
	9/23/08	9/24/08	9/25/08	9/23/08	9/24/08	9/25/08	9/23/08	9/24/08	9/25/08
BH-SF-LF001	4.6	4.9	5.5	0.1	0.3	0.2	3.1	3.4	3.6
BH-SF-LF002	4.7	5.1	5.2	0.2	0.2	0.2	3.2	3.5	3.6
BH-SF-LF003	4.7	5.2	5.4	0.2	0.2	0.2	3.3	3.6	3.8
BH-SF-LF004	6.4	7.3	7.3	0.1	0.2	0.2	4.9	5.7	5.7
BH-SF-LF005	6.6	7.4	7.8	0.2	0.2	0.2	5.3	6.1	6.5
BH-SF-LF006	6.3	8.2	6.9	0.1	0.2	0.1	4.3	5.7	4.8
BH-SF-LF007	6.7	6.9	7.6	0.0	0.1	0.1	4.7	4.9	5.4
BH-SF-LF008	6.8	8.2	7.6	0.1	0.0	0.1	5.0	5.7	5.4
BH-SF-LF009	6.8	8.1	7.8	0.1	0.1	0.1	4.9	5.7	5.6
BH-SF-LF010	7.1	7.9	7.4	0.1	0.1	0.1	5.4	6.0	5.6
BH-SF-LF011	6.4	7.5	7.3	0.1	0.1	0.1	5.0	5.8	5.6
Milo Creek	9.1	10	10	13	9.7	15	11	12	12
Bunker Creek	2	3	2.0	--	--	--	0.6	1.4	0.7
Government Creek	130	133	138	--	--	--	21	21	22
Pine Creek	0.4	0.5	0.5	--	--	--	1.1	1.1	1.2

Notes:

-- = Not applicable, dissolved lead concentrations at these locations were below detection limits.

TABLE 10

Discharge Measurements for the 2008 and Previous Studies

OU2 Groundwater/Surface Water Interaction Study

Bunker Hill Site OU2

Station	1999 (cfs)	2003 (cfs)	2006 (cfs)	2007 (cfs)	9/23/08 (cfs)	9/24/08 (cfs)	9/25/08 (cfs)
BH-SF-LF0001	79	74	74	104	111	104	83
BH-SF-LF0002	79	74	81	105	118	98	90
BH-SF-LF0003	75	74	76	95	108	98	80
BH-SF-LF0004	77	78	--	97	114	105	90
BH-SF-LF0005	79	74	68	92	113	102	83
BH-SF-LF0006	88	78	76	82	116	98	90
BH-SF-LF0007	76	73	68	78	121	113	99
BH-SF-LF0008	78	68	68	90	112	102	80
BH-SF-LF0009	86	79	76	86	131	115	100
BH-SF-LF0010	91	81	79	62	135	111	95
BH-SF-LF0011[1]	85	113	99	145	177	162	133
Milo Creek	1.2	2.3	3.0	4.3	3.3	3.7	3.8
Bunker Creek[2]	5.3	1.3	3.2	2.9	3.5	1.0	3.5
Government Creek	1.4	0.7	0.72	0.84	1.2	1.2	1.1
Pine Creek	--	3.0	7.5	4.7	9.7	9.9	9.6

Notes:

[1] One discharge measurement collected on 10/25/99.

[2] Bunker Creek discharge was measured on 10/25/99 and 11/03/99; value presented represents average of these two days.

-- = Not Available

TABLE 11

Average Dissolved Contaminant Metal Concentrations for the 2008 and Previous Studies

OU2 Groundwater/Surface Water Interaction Study

Bunker Hill Site OU2

	1999 - Average Concentration (mg/L)						2003 - Average Concentration (mg/L)						2006 - Average Concentration (mg/L)						2007[1] (mg/L)			2008[2] (mg/L)					
	Cadmium		Lead		Zinc		Cadmium		Lead		Zinc		Cadmium		Lead		Zinc		Cadmium	Lead	Zinc	Cadmium		Lead		Zinc	
Station	SW	GW	SW	GW	SW	GW	SW	GW	SW	GW	SW	GW	SW	GW	SW	GW	SW	GW	SW	SW	SW	SW	GW	SW	GW	SW	GW
BH-SF-LF0001	0.007	--	0.005	--	0.93	--	0.006	0.006	0.003	<0.01	0.77	0.70	0.006	0.001	0.003	0.003	0.75	0.73	0.006	0.002	0.80	0.0052	0.0054	0.0052	0.0036	0.66	0.70
BH-SF-LF0002	--	--	--	--	--	--	0.006	0.006	0.008	0.010	0.77	0.78	0.006	0.006	0.006	0.007	0.78	0.71	0.006	0.003	0.85	0.0050	0.0055	0.0060	0.0041	0.66	0.72
BH-SF-LF0003	0.007	--	0.007	--	0.96	--	0.006	0.005	0.008	<0.01	0.76	0.68	0.006	0.005	0.006	0.008	0.76	0.59	0.006	0.004	0.90	0.0052	0.0046	0.0056	0.0023	0.70	0.62
BH-SF-LF0004	0.008	0.005	0.008	0.002	1.64	31.1	0.006	0.016	0.005	0.011	0.95	5.56	--	--	--	--	--	--	0.006	0.004	1.20	0.0060	0.0060	0.0101	0.0101	1.10	1.29
BH-SF-LF0005	0.008	--	0.005	--	1.72	--	0.006	0.003	0.005	0.003	0.98	0.84	0.006	0.005	0.006	0.004	1.04	0.91	0.007	0.007	1.35	0.0081	0.0043	0.0061	<0.001	1.27	0.95
BH-SF-LF006	0.010	--	0.004	--	1.99	--	0.009	0.914	0.003	0.531	1.12	13.3	0.009	0.758	0.005	0.588	1.12	8.52	0.009	0.005	1.38	0.0102	0.2080	0.0046	0.0034	1.30	6.59
BH-SF-LF0007	0.010	--	0.003	--	1.93	--	0.010	0.007	0.003	0.001J	1.18	0.87	0.008	0.007	0.004	<0.001	1.03	0.86	0.008	0.004	1.33	0.0098	0.0037	0.0045	<0.001	1.28	0.39
BH-SF-LF0008	0.011	--	0.003	--	2.05	--	0.010	0.014	0.003	0.011	1.18	3.67	0.008	0.017	0.003	0.008	1.12	2.20	0.009	0.003	1.39	0.0096	0.0117	0.0033	0.0027	1.27	3.61
BH-SF-LF0009	--	--	--	--	--	--	0.010	0.001	0.002	0.038	1.26	1.70	0.009	<0.001	0.003	0.001	1.23	1.39	0.009	0.003	1.48	0.0102	0.0010	0.0034	0.0480	1.32	1.51
BH-SF-LF0010	0.013	0.005	0.01	0.07	2.41	3.3	0.010	0.004	0.004	<0.01	1.38	1.19	0.009	0.003	0.003	0.019	1.33	1.76	0.009	0.003	1.54	0.0097	0.0048	0.0052	0.0022	1.36	1.19
BH-SF-LF0011	--	--	--	--	--	--	0.009	0.002	0.01	0.005	1.26	0.36	0.007	<0.001	0.003	0.014	1.14	0.17	0.008	0.003	1.45	0.0082	0.0007	0.0043	<0.001	1.19	0.28
Milo Creek	0.005	--	0.07	--	1.22	--	0.005	--	0.37	--	1.05	--	0.005	--	0.000	--	0.30	--	0.01	0.05	4.80	0.0045	--	0.1490	--	1.10	--
Bunker Creek	0.002	--	<0.001	--	0.12	--	0.014	--	0.001	--	0.72	--	0.057	--	0.001	--	1.75	--	0.004	<0.01	0.38	0.0149	--	<0.001	--	0.85	--
Government Creek	0.136	--	0.002	--	4.62	--	0.083	0.09	0.002	0.005	2.78	3.1	0.005	--	0.063	--	1.27	--	0.07	0.002	2.50	0.0516	--	<0.001	--	1.76	--
Pine Creek	--	--	--	--	--	--	<0.001	0.003	<0.001	0.023	0.10	0.42	0.0001	0.003	0.001	0.022	0.07	0.45	0.0002	<0.01	0.12	<0.001	--	<0.001	--	0.07	--

Notes:

[1] 2007 study conducted over one day.

[2] 2008 data presented is for day three of the three day study.

-- = Not Available

TABLE 12

Average Dissolved Metal Loads from the 2008 and Previous Studies

OU2 Groundwater/Surface Water Interaction Study

Bunker Hill Site OU2

	1999		2003		2006		2007		9/23/2008		9/24/2008		9/25/2008	
	Average Load	Average Load Minus Tributary Inflow	Average Load	Average Load Minus Tributary Inflow	Average Load	Average Load Minus Tributary Inflow	Average Load	Average Load Minus Tributary Inflow	Load	Load Minus Tributary Inflow	Load	Load Minus Tributary Inflow	Load	Load Minus Tributary Inflow
Station	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**
BH-SF-LF0001	3.1	3.1	2.4	2.4	2.4	2.4	3.1	3.1	2.9	2.9	2.7	2.7	2.3	2.3
BH-SF-LF0002	NA	--	2.3	2.2	2.5	2.5	3.2	3.1	3.1	3.0	2.6	2.5	2.4	2.3
BH-SF-LF0003	3.0	3.0	2.4	2.3	2.4	2.3	2.9	2.9	2.7	2.7	2.6	2.5	2.3	2.2
BH-SF-LF0004	3.2	3.2	2.4	2.1	--	--	3.3	3.2	4.1	4.1	4.2	4.1	2.9	2.8
BH-SF-LF0005	3.3	3.3	2.3	2.2	2.2	2.1	3.3	3.2	4.3	4.2	4.2	4.1	3.6	3.5
BH-SF-LF0006	4.5	4.4	3.8	3.7	3.5	3.2	4.0	3.7	5.5	5.2	5.1	4.9	5.0	4.6
BH-SF-LF0007	4.3	3.2	3.8	3.4	3.1	3.1	3.4	2.8	5.5	4.9	5.7	5.5	5.2	4.9
BH-SF-LF0008	4.7	3.6	3.6	3.1	3.0	2.6	4.2	3.5	4.9	4.2	5.5	5.0	4.1	3.5
BH-SF-LF0009	NA	--	4.3	3.8	3.6	3.2	4.3	3.6	6.0	5.3	6.0	5.5	5.5	4.8
BH-SF-LF0010	6.3	5.2	4.4	4.0	3.7	3.3	3.0	2.3	6.5	5.8	5.6	5.0	5.0	4.3
BH-SF-LF0011	NA	--	5.4	4.9	4.0	3.6	6.3	5.6	7.2	6.5	7.1	6.5	5.9	5.2
Milo Creek	0.03	--	0.06	--	0.1	--	0.1	--	0.07	--	0.1	--	0.09	--
Bunker Creek	0.07	--	0.10	--	0.2	--	0.3	--	0.28	--	0.1	--	0.28	--
Government Creek	1.0	--	0.30	--	0.1	--	0.3	--	0.32	--	0.3	--	0.31	--
Pine Creek	NA		0.04	--	0.005	--	0.006	--	--	--	0.006	--	0.01	--
Net Dissolved Cadmium Load from Groundwater[1]:		**2.1**		**2.5**		**1.2**		**2.5**		**3.6**		**3.9**		**2.9**

Average Dissolved Lead Loads

	1999		2003		2006		2007		9/23/2008		9/24/2008		9/25/2008	
	Average Load	Average Load Minus Tributary Inflow	Average Load	Average Load Minus Tributary Inflow	Average Load	Average Load Minus Tributary Inflow	Average Load	Average Load Minus Tributary Inflow	Average Load	Load Minus Tributary Inflow	Average Load	Load Minus Tributary Inflow	Average Load	Load Minus Tributary Inflow
Station	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**
BH-SF-LF0001	2.4	2.4	1.3	1.3	1.1	1.1	1.2	1.2	2.5	2.5	4.5	4.5	2.3	2.3
BH-SF-LF0002	--	--	3.2	-1.3	2.5	2.4	1.6	0.5	3.9	1.8	3.1	1.2	2.9	-0.2
BH-SF-LF0003	2.6	2.1	3.3	-1.2	2.3	2.3	2.2	1.1	3.3	1.1	3.0	1.1	2.4	-0.7
BH-SF-LF0004	3.4	2.9	2.1	-2.4	--	--	2.3	1.2	2.3	0.2	3.2	1.3	4.9	1.8
BH-SF-LF0005	2.2	1.7	2.1	-2.4	2.1	2.1	3.3	2.2	3.2	1.1	3.2	1.4	2.7	-0.4
BH-SF-LF0006	1.7	1.2	1.3	-3.2	2.2	2.1	2.4	1.3	2.9	0.8	3.0	1.2	2.2	-0.9
BH-SF-LF0007	1.2	0.7	1.1	-3.4	1.5	0.5	1.5	0.4	0.6	-1.6	2.4	0.5	2.4	-0.7
BH-SF-LF0008	1.3	0.8	1.0	-3.5	1.1	0.1	1.5	0.4	1.3	-0.8	0.4	-1.4	1.4	-1.7
BH-SF-LF0009	--	--	0.9	-3.6	1.1	0.1	1.4	0.3	1.7	-0.4	2.4	0.5	1.9	-1.2
BH-SF-LF0010	2.5	2.0	1.5	-3.0	1.3	0.3	1.1	0.0	2.9	0.8	2.8	0.9	2.1	-1.0
BH-SF-LF0011	--	--	3.4	-1.1	1.4	0.3	2.3	1.2	2.9	0.7	3.5	1.6	3.1	0.00
Milo Creek	0.47	--	4.5	--	0.01	--	1.1	--	2.1	--	1.9	--	3.1	--
Bunker Creek	0.03	--	0.01	--	0.004	--	--	--	--	--	--	--	--	--
Government Creek	0.02	--	0.009	--	1.0	--	0.01	--	--	--	--	--	--	--
Pine Creek	--	--	0.002	--	0.02	--	--	--	--	--	--	--	--	--
Net Dissolved Lead Load from Groundwater[1]:		**-0.4**		**-2.4**		**-0.7**		**0.1**		**-1.8**		**-2.9**		**-2.3**

TABLE 12 (cont.)

Average Dissolved Metal Loads from the 2008 and Previous Studies

OU2 Groundwater/Surface Water Interaction Study

Bunker Hill Site OU2

Average Dissolved Zinc Loads

	1999		2003		2006		2007		9/23/2008		9/24/2008		9/25/2008	
	Average Load	Average Load Minus Tributary Inflow	Average Load	Average Load Minus Tributary Inflow	Average Load	Average Load Minus Tributary Inflow	Average Load	Average Load Minus Tributary Inflow	Average Load	Load Minus Tributary Inflow	Average Load	Load Minus Tributary Inflow	Average Load	Load Minus Tributary Inflow
Station	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**	**lb/day**
BH-SF-LF0001	398	398	304	304	299	299	448	448	365	365	349	349	295	295
BH-SF-LF0002	--	--	303	290	343	338	482	372	388	370	342	320	320	298
BH-SF-LF0003	390	382	304	291	311	306	464	354	358	341	347	325	301	278
BH-SF-LF0004	683	675	397	384	--	--	631	521	606	589	618	596	628	605
BH-SF-LF0005	736	728	392	379	378	372	669	559	644	626	658	636	567	545
BH-SF-LF0006	943	930	466	448	458	446	612	496	696	665	658	629	634	595
BH-SF-LF0007	791	745	461	431	378	346	557	430	716	674	753	724	682	644
BH-SF-LF0008	860	814	435	405	412	380	671	544	662	620	701	660	548	499
BH-SF-LF0009	NA	--	534	504	503	470	685	557	806	764	790	749	725	676
BH-SF-LF0010	1180	1130	602	572	570	538	517	390	913	868	796	755	643	594
BH-SF-LF0011	--	--	772	742	607	572	1135	1005	1040	--	1031	987	857	804
Milo Creek	7.9	--	4.5	--	5.2	--	110	--	17	--	22	--	23	--
Bunker Creek	3.5	--	0.01	--	6.8	--	6	--	14	--	7.5	--	16	--
Government Creek	35	--	0.009	--	20	--	11	--	11	--	11	--	10	--
Pine Creek	--	--	0.002	--	2.7	--	3	--	3	--	3.2	--	3.4	--
Net Dissolved Lead Load from Groundwater[1]:		**732**		**438**		**273**		**557**		**503**		**638**		**509**

[1] The net gain in load for the 1999 study is from BH-SF-LF-0001 to BH-SF-LF-0010.

-- = Data Not Available

TABLE 13

Dissolved Metal AWQC Ratios from 2008 and Previous Studies

OU2 Groundwater/Surface Water Interaction Study

Bunker Hill Site OU2

Location	Dissolved Cadmium AWQC Ratio					Dissolved Lead AWQC Ratio					Dissolved Zinc AWQC Ratio				
	1999	2003[2]	2006	2007[8]	2008[8]	1999	2003[1]	2006	2007[2]	2008[2]	1999	2003[1]	2006	2007[2]	2008[2]
BH-SF-LF001	9.2	7.5	7.5	7.1	5.5	0.3	0.2	0.1	0.1	0.2	6.1	5.0	4.8	5.2	3.6
BH-SF-LF002	--	7.5	7.4	7.3	5.2	--	0.4	0.3	0.1	0.2	--	5.0	5.1	5.7	3.6
BH-SF-LF003	3.7	7.6	7.5	7.3	5.4	0.1	0.4	0.3	0.2	0.2	2.7	5.0	5.0	5.9	3.8
BH-SF-LF004	--	--	--	7.5	7.3	--	--	--	0.2	0.2	--	--	--	7.5	5.7
BH-SF-LF005	8.8	6.7	7.2	7.6	7.8	0.2	0.2	0.3	0.3	0.2	10.2	6.0	6.3	8.1	6.5
BH-SF-LF006	8.0	6.7	6.4	6.1	6.9	0.1	0.1	0.1	0.1	0.1	8.9	4.5	4.5	5.1	4.8
BH-SF-LF007	--	5.4	6.7	7.3	7.6	--	0.1	0.1	0.1	0.1	--	5.1	4.5	6.3	5.4
BH-SF-LF008	7.0	7.7	6.4	7.3	7.6	0.1	0.1	0.1	0.1	0.1	7.0	5.1	4.8	6.3	5.4
BH-SF-LF009	--	7.9	6.9	7.6	7.8	--	0.1	0.1	0.1	0.1	--	5.4	5.2	6.6	5.6
BH-SF-LF010	10.7	8.0	6.8	7.5	7.4	0.1	0.1	0.1	0.1	0.1	--	5.8	5.6	7.0	5.6
BH-SF-LF011	--	7.7	6.6	7.0	7.3	--	0.2	0.1	0.1	0.1	--	5.9	5.3	6.8	5.6
Milo Creek	3.7	8.4	14	22	10	2.0	29	5.0	3.8	15	5.2	9.5	12	43	12
Bunker Creek	0.8	4.8	1.7	0.6	1.9	0.2	0.01	0.003	--	--	0.2	1.5	0.6	0.4	0.7
Government Creek	342	256	170	172	138	0.2	0.4	0.1	0.2	--	55	39	24	30	22
Pine Creek	--	--	0.5	0.8	0.5	--	0.3	0.1	--	--	--	1.7	1.2	2.1	1.2

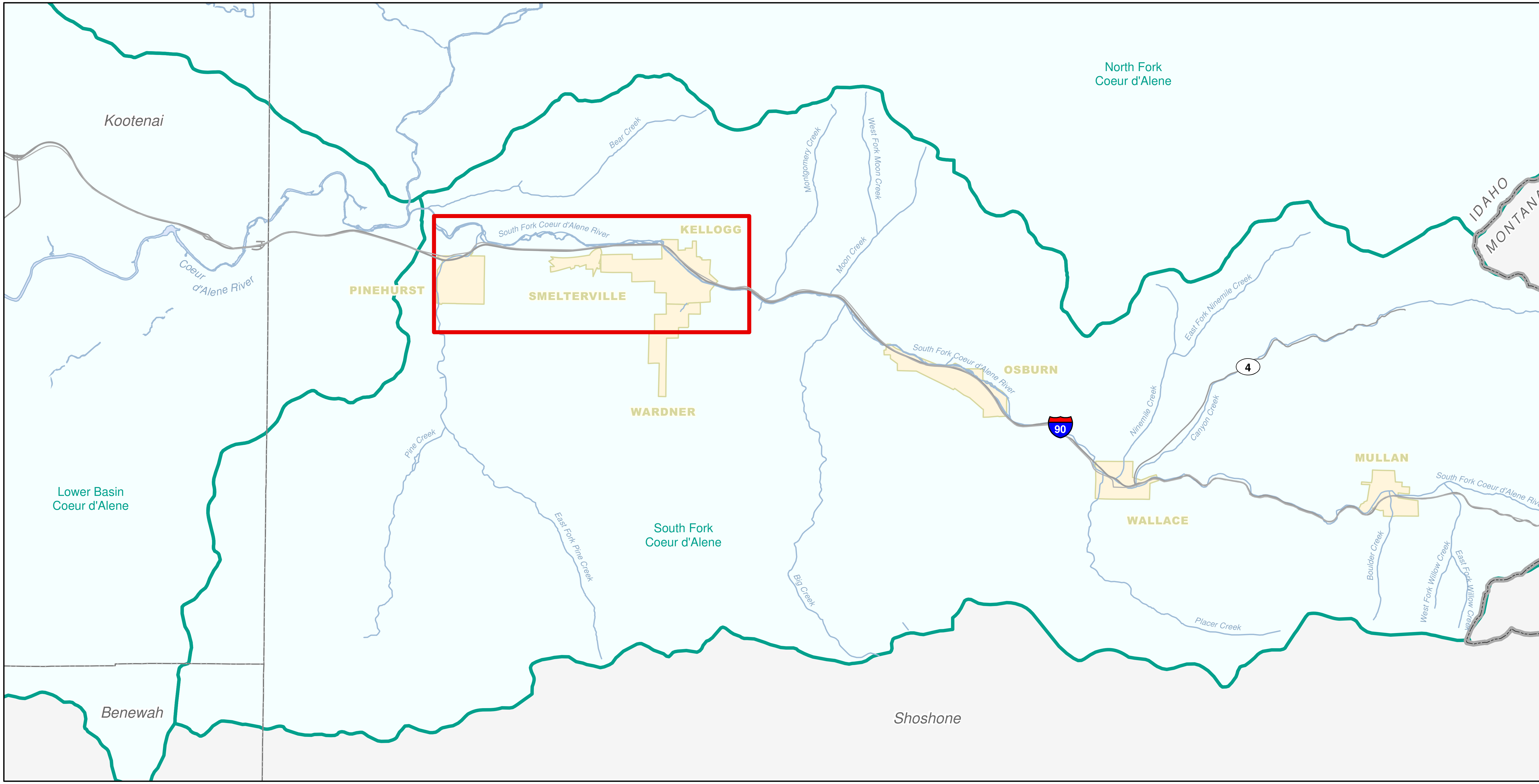
Notes:

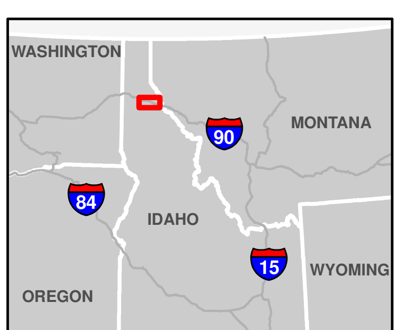
[1] The 2003 AWQC ratios were calculated using the 2006 hardness values.

[2] The AWQC ratios for the 2007 and 2008 studies were calculated from data obtained during one day of monitoring.

-- = Data Not Available

Figures





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

Source: NHDPlus (Rivers, Waterbodies); ESRI base data (Interstates 2006, Major Highways 2008).

N 0 2 4 8 Miles

Figure 1
OU2 Vicinity Map
2008 OU2 Groundwater/Surface Water Interaction Monitoring
BUNKER HILL SUPERFUND SITE OU2

CH2MHILL

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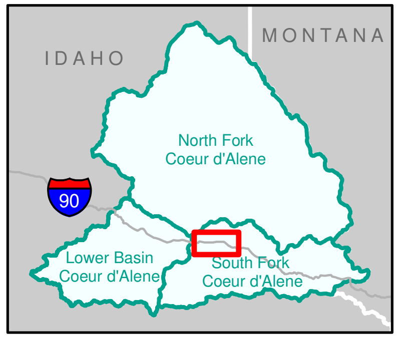


- Tributary Surface Water Monitoring Station
- SFCDR Surface Water Monitoring Station
- USGS/BEMP Monitoring Location

N 0 1,000 2,000 4,000 Feet

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

Figure 2
OU2 Groundwater/Surface Water Interaction Monitoring Locations
2008 OU2 Groundwater/Surface Water Interaction Monitoring
BUNKER HILL SUPERFUND SITE OU2

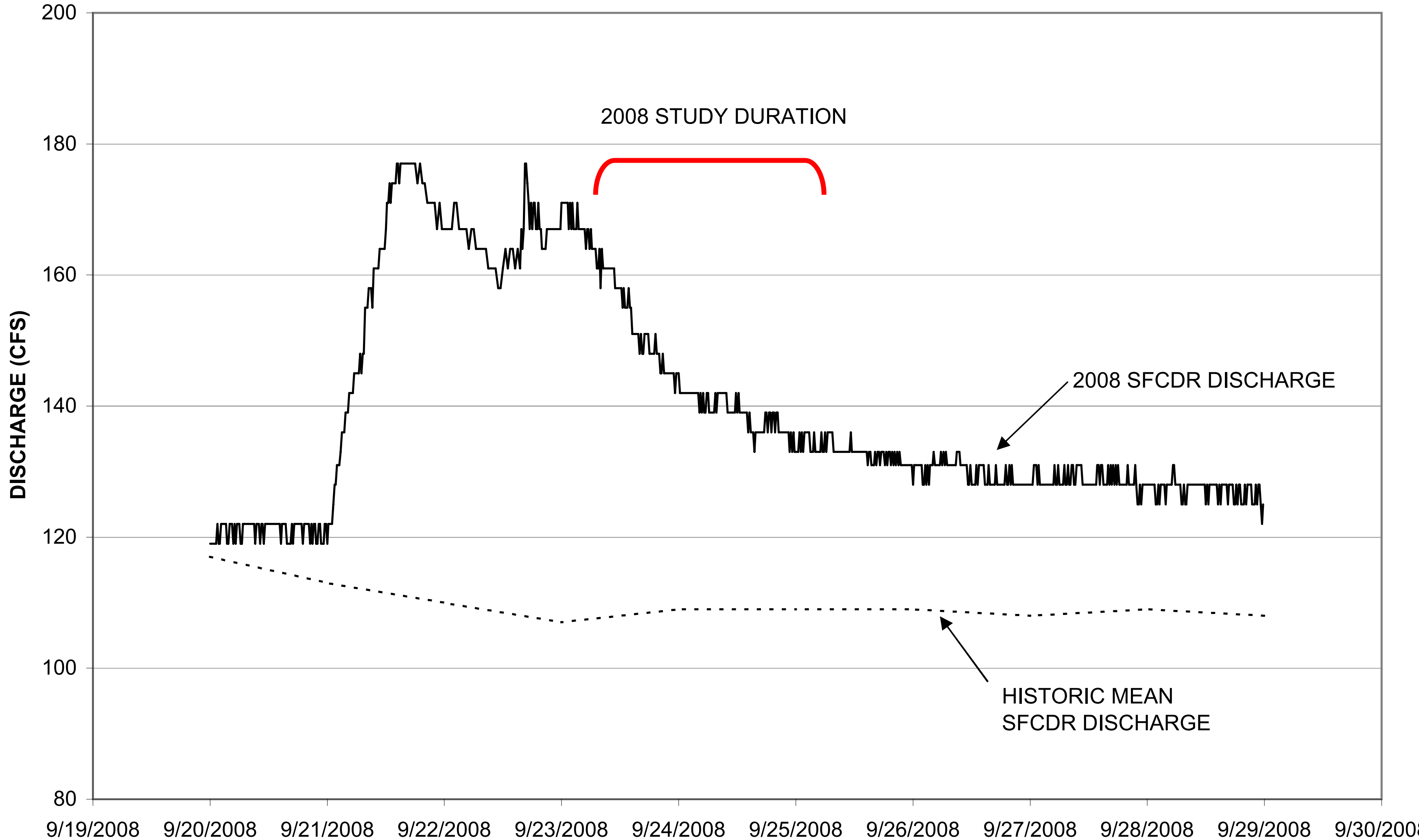
\\WOODY\PROJ\EPA\CDABASIN_382081\GIS\MAPFILES\OU2\GWSW\GWSW_FIG02_GWSWMONLOCS_20090325.MXD RDEMARIS 3/25/2009 14:18:40

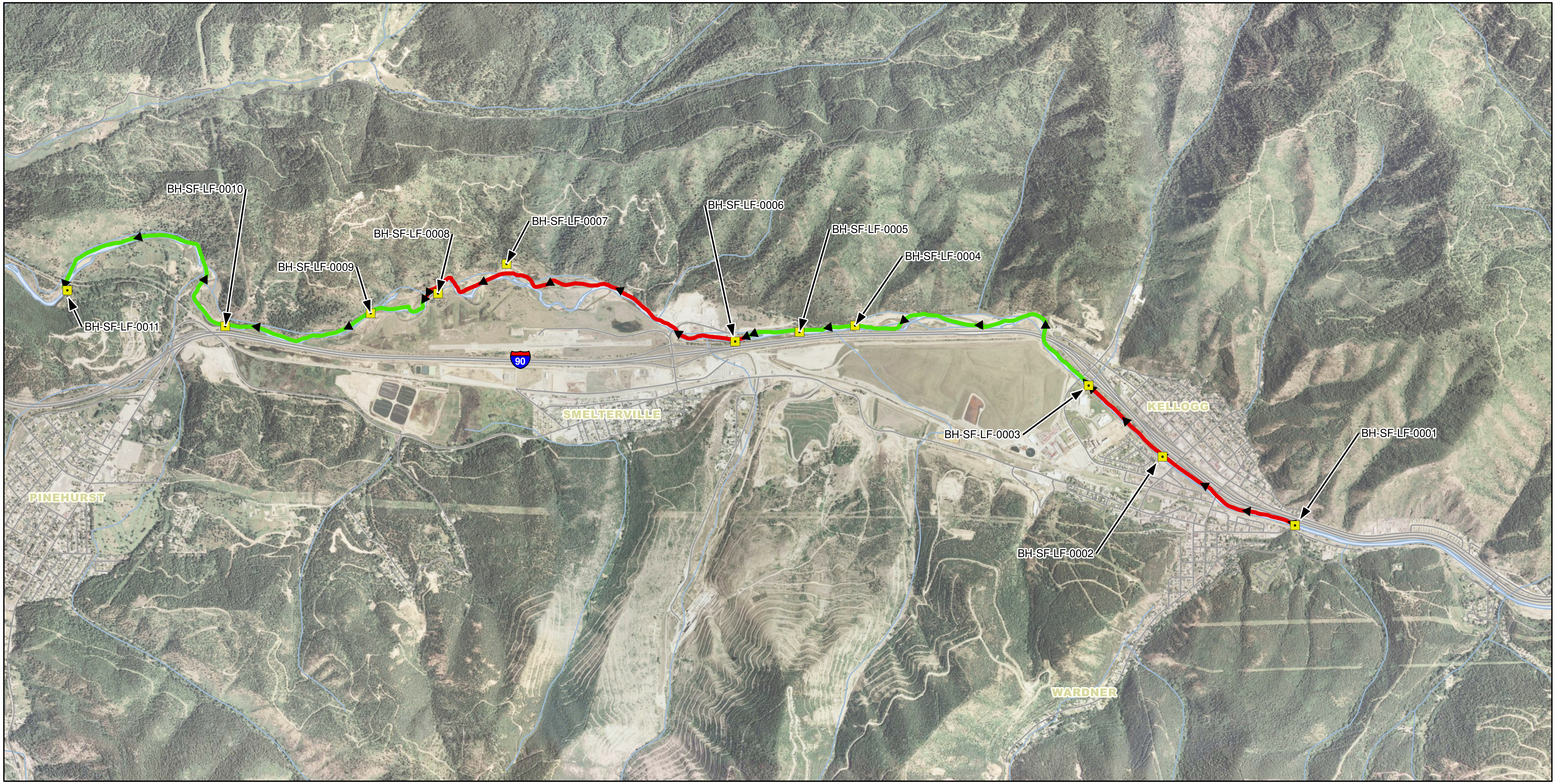
CH2MHILL

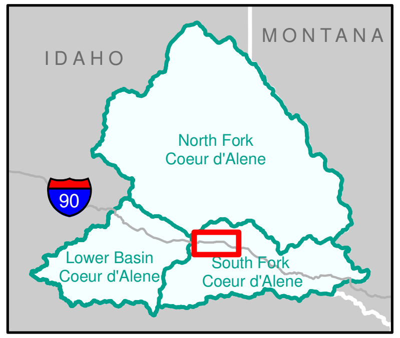
Figure 3: SFCDR DISCHARGE AT PINEHURST (SF-271)

OU2 Groundwater/Surface Water Interaction Study

Bunker Hill Site OU2







2008 Study Station Identifier

Measured Data

Gaining Stream Reach

Losing Stream Reach

N 0 1,000 2,000 4,000 Feet

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

Figure 4
Gaining and Losing Reaches of the South Fork Coeur d'Alene River
2008 OU2 Groundwater/Surface Water Interaction Monitoring
BUNKER HILL SUPERFUND SITE OU2

CH2MHILL

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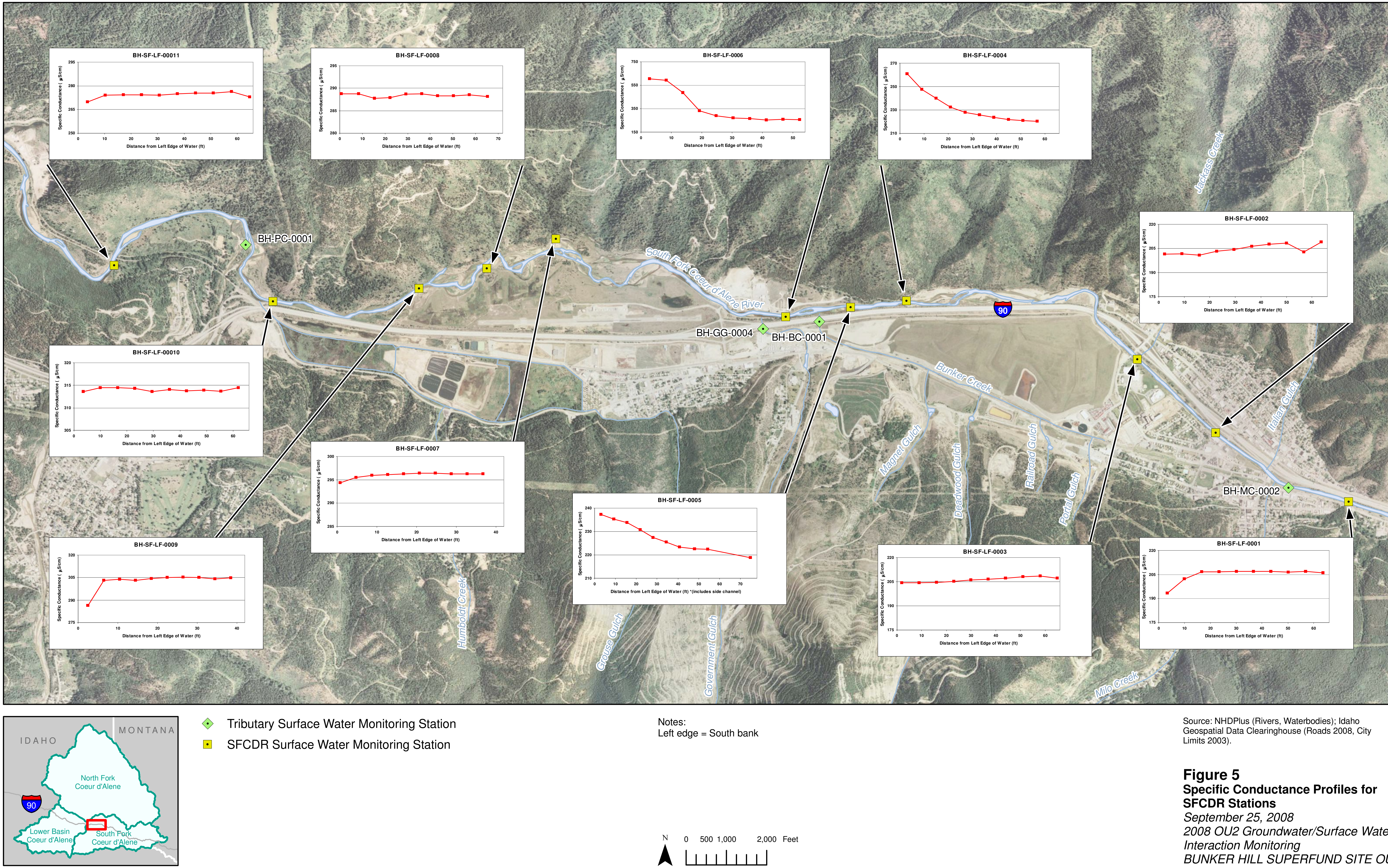

Figure 5
Specific Conductance Profiles for SFCDR Stations
September 25, 2008
2008 OU2 Groundwater/Surface Water Interaction Monitoring
BUNKER HILL SUPERFUND SITE OU2

CH2MHILL

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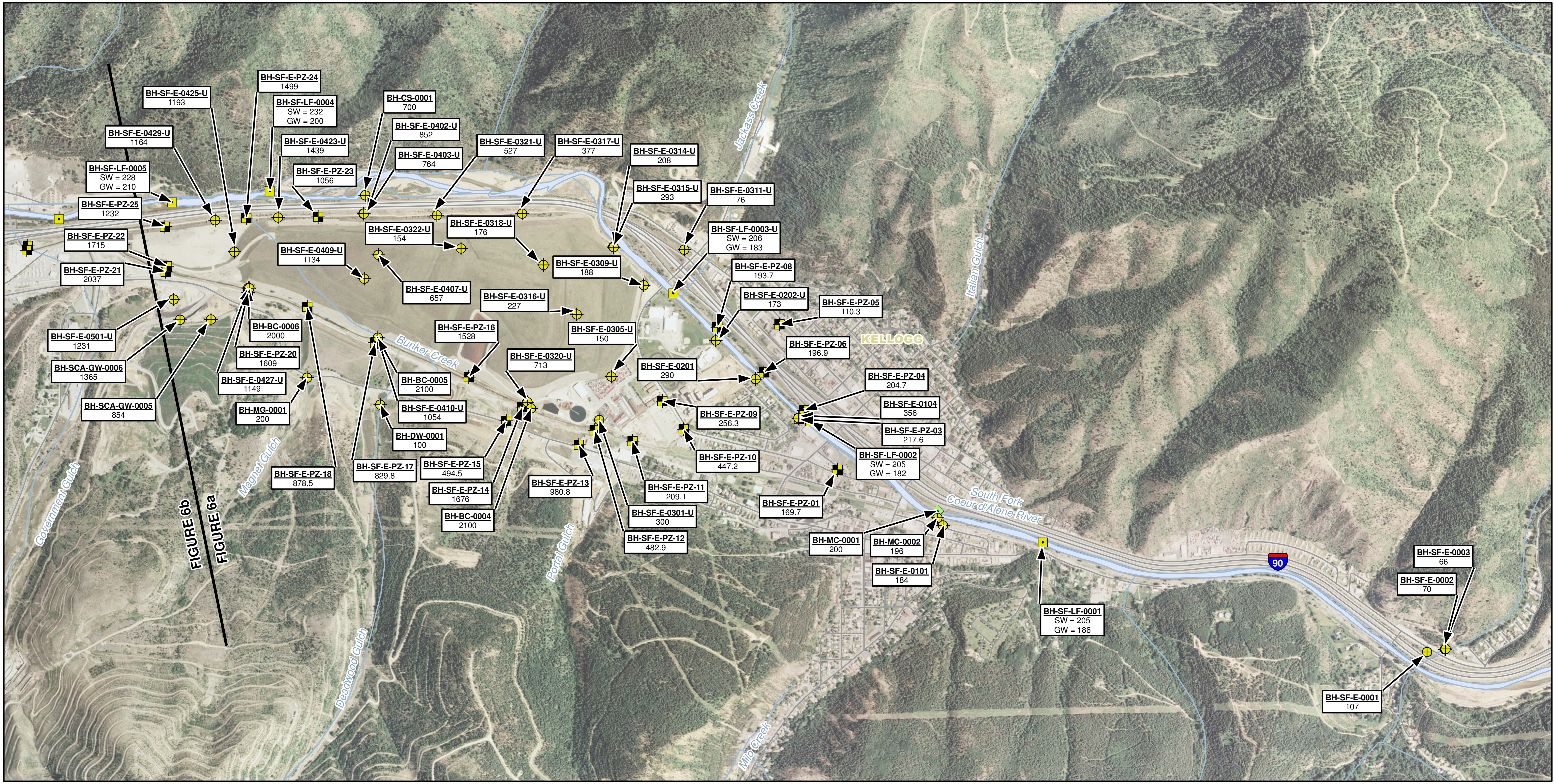

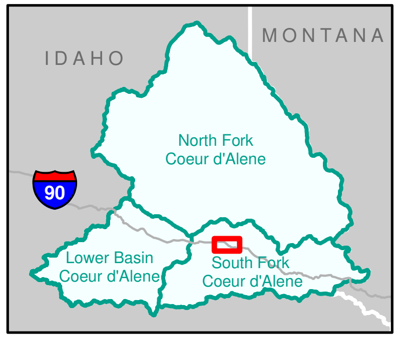

Groundwater Monitoring Location

Tributary Surface Water Monitoring Location

SFCDR Surface Water Monitoring Location

Piezometer

Notes:
Concentrations shown in microSiemens per centimeter (uS/cm).
GW = Groundwater Concentration (Conductivity)
SW = Surface Water Concentration (Specific Conductance)

N 0 500 1,000 2,000 Feet

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

Figure 6a
Specific Conductance / Conductivity Summary
September 25, 2008
2008 OU2 Groundwater/Surface Water Interaction Monitoring
BUNKER HILL SUPERFUND SITE OU2

CH2MHILL

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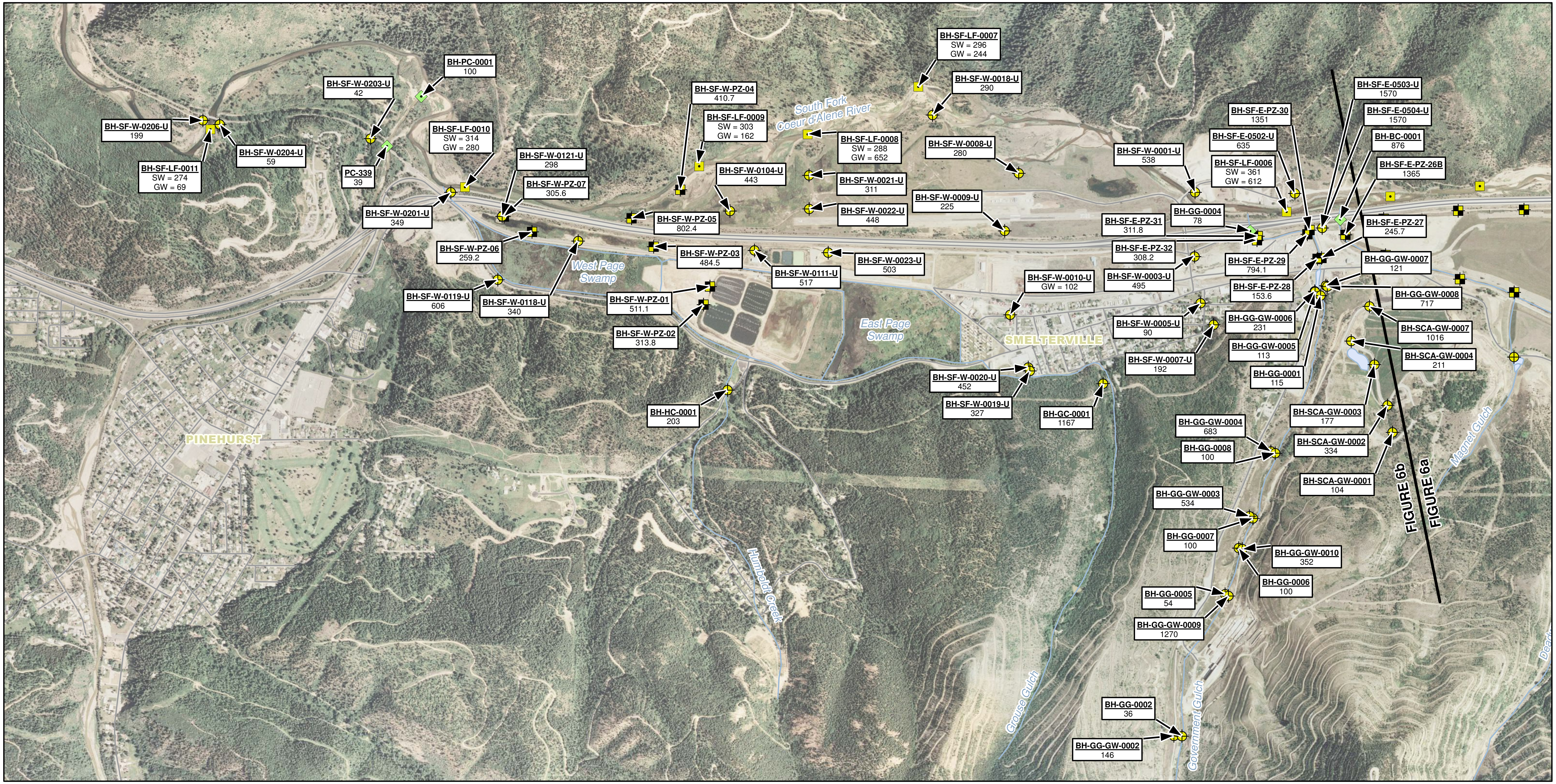

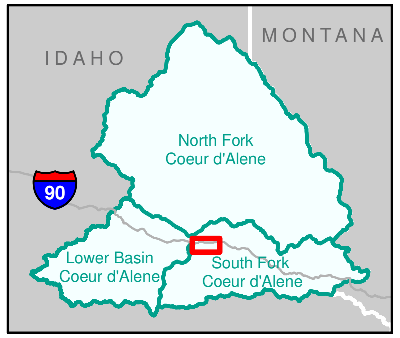

Groundwater Monitoring Location
Tributary Surface Water Monitoring Location
SFCDR Surface Water Monitoring Location
Piezometer

Notes:
Concentrations shown in microSiemens per centimeter (uS/cm).
GW = Groundwater Concentration (Conductivity)
SW = Surface Water Concentration (Specific Conductance)

N 0 500 1,000 2,000 Feet

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

Figure 6b
Specific Conductance / Conductivity Summary
September 25, 2008
2008 OU2 Groundwater/Surface Water Interaction Monitoring
BUNKER HILL SUPERFUND SITE OU2

CH2MHILL

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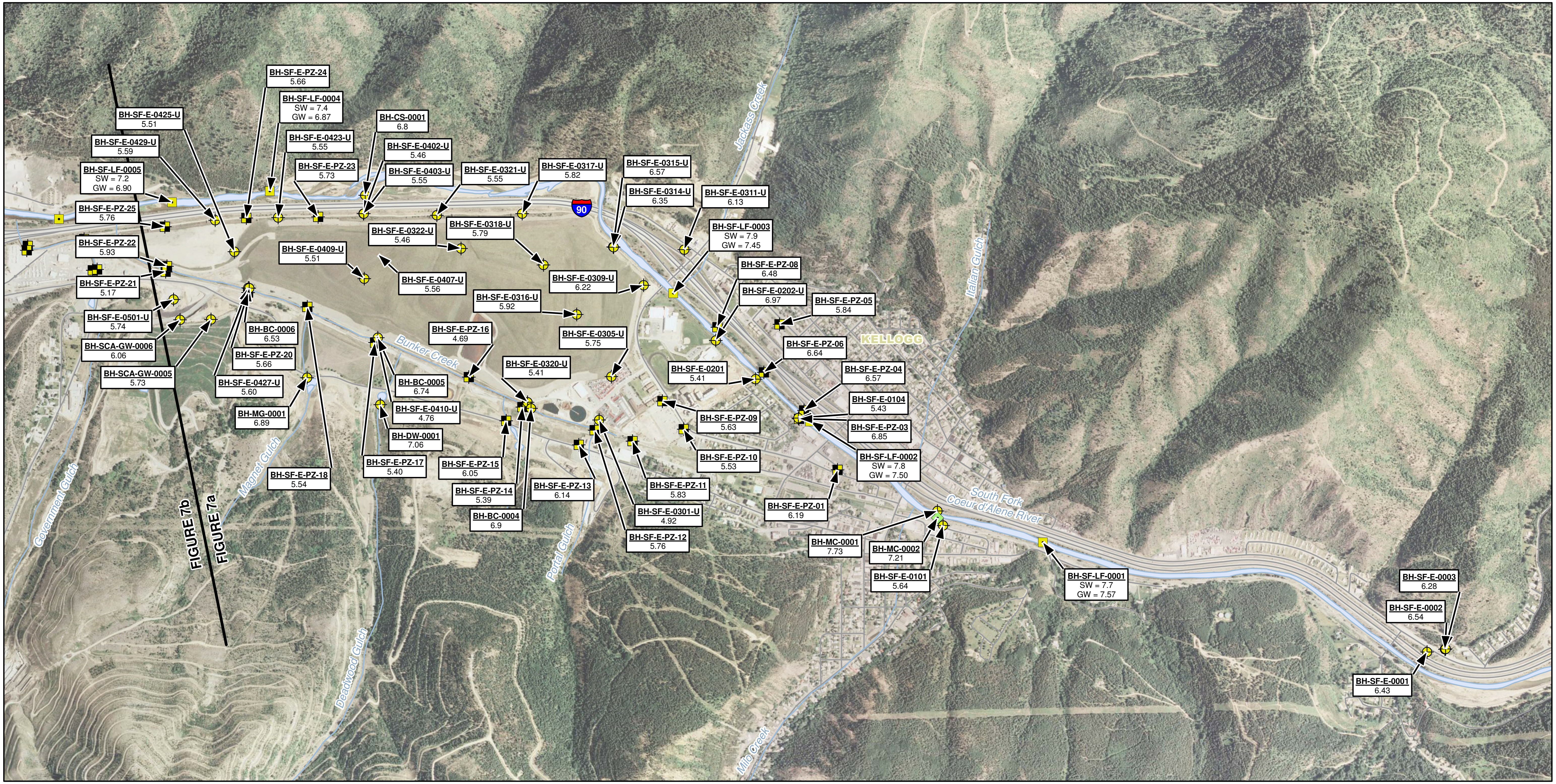

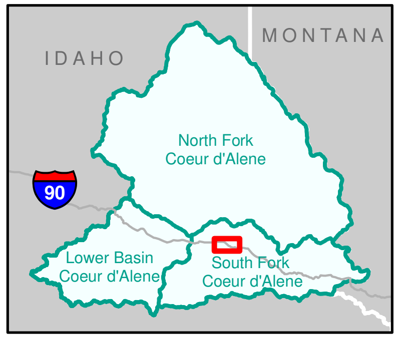

Groundwater Monitoring Location
Tributary Surface Water Monitoring Location
SFCDR Surface Water Monitoring Location
Piezometer

Notes:
GW = Groundwater
SW = Surface Water

N 0 500 1,000 2,000 Feet

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

Figure 7a
pH Summary
September 25, 2008
2008 OU2 Groundwater/Surface Water Interaction Monitoring
BUNKER HILL SUPERFUND SITE OU2

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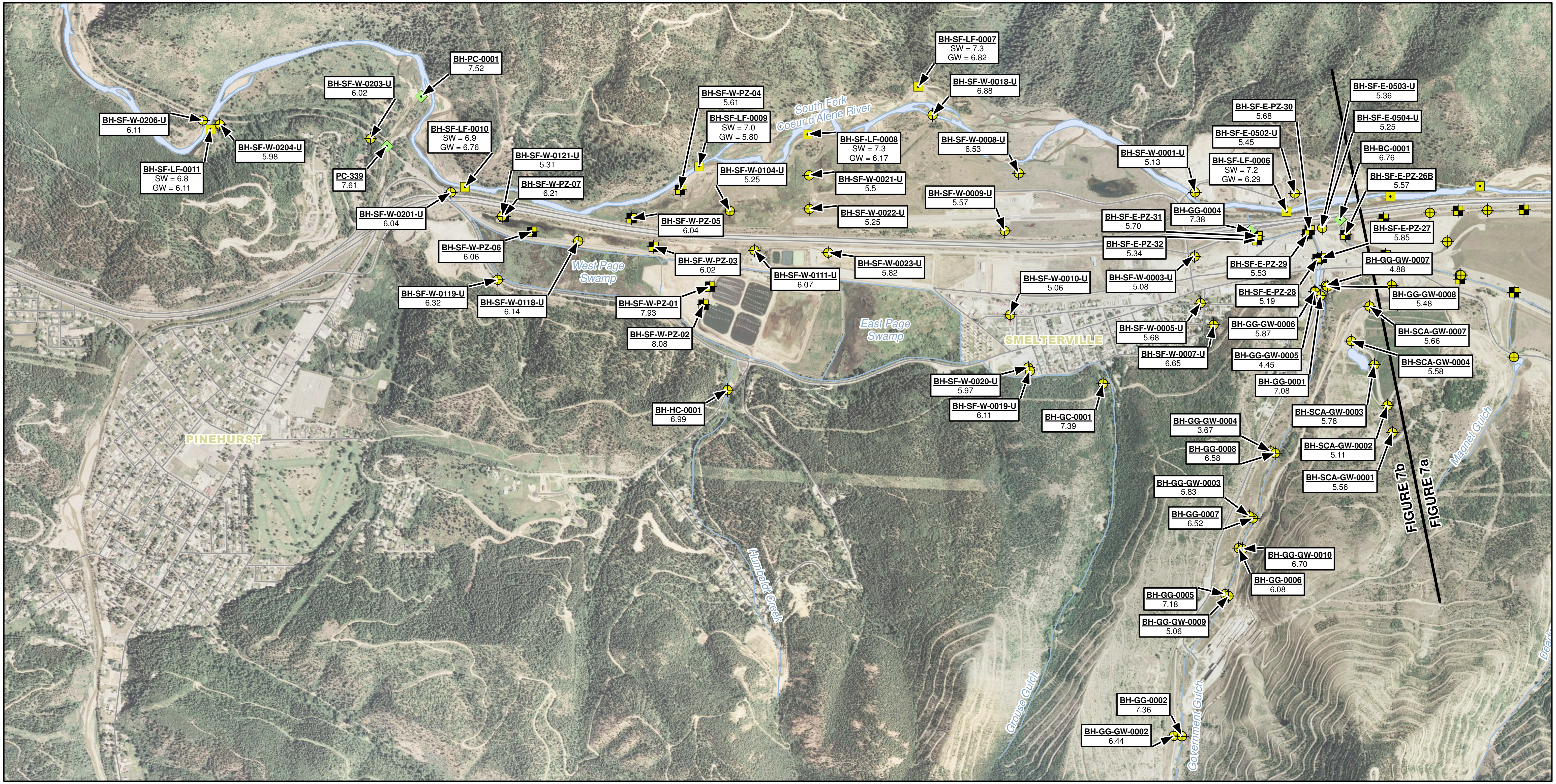
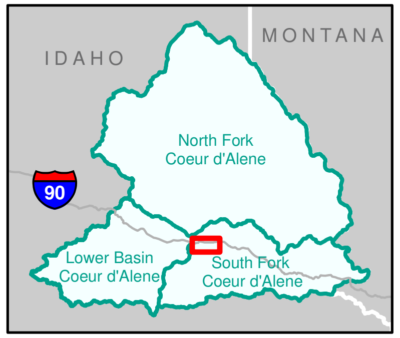
CH2MHILL





- Groundwater Monitoring Location
- Tributary Surface Water Monitoring Location
- SFCDR Surface Water Monitoring Location
- Piezometer

Notes:
GW = Groundwater
SW = Surface Water

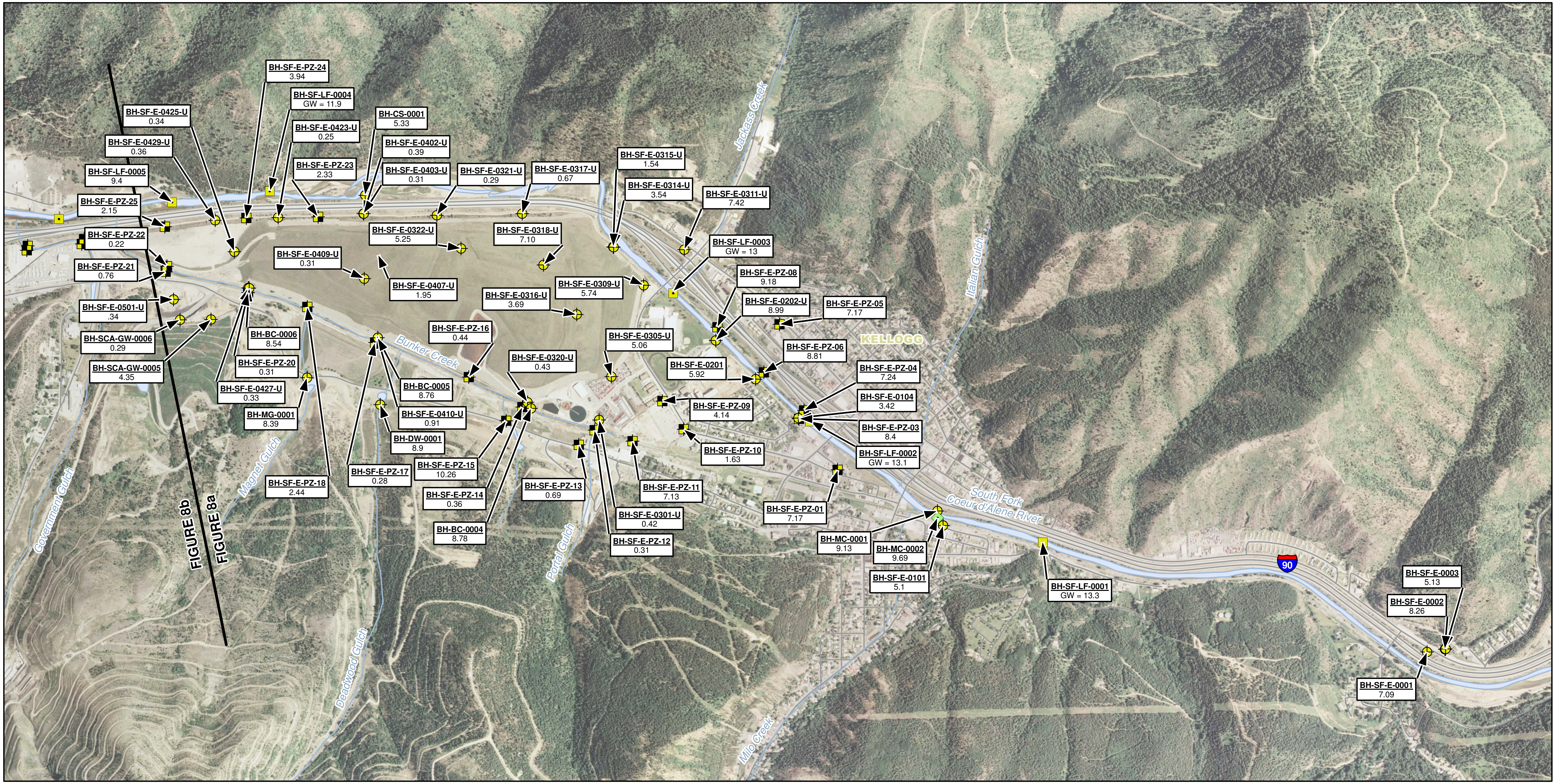
N 0 500 1,000 2,000 Feet

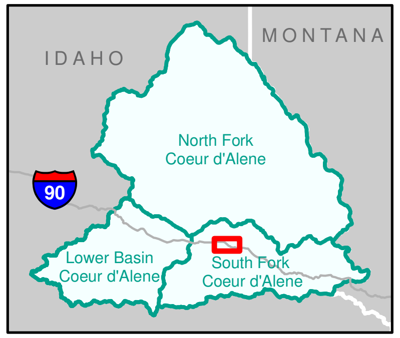
Source: NHDPlus (Rivers, Waterbodies); Idaho Geospatial Data Clearinghouse (Roads 2008).

Figure 7b
pH Summary
September 25, 2008
2008 OU2 Groundwater/Surface Water Interaction Monitoring
BUNKER HILL SUPERFUND SITE OU2

CH2MHILL

\\WOODY\PROJ\EPA\CDABASIN_382081\GIS\MAPFILES\OU2\GWSW\GWSW_PH_BH-W.MXD RDEMARIS 3/25/2009 18:09:13





Groundwater Monitoring Location
Tributary Surface Water Monitoring Location
SFCDR Surface Water Monitoring Location
Piezometer

Notes:
Concentrations shown in milligrams per liter (mg/L).
GW = Groundwater Concentration

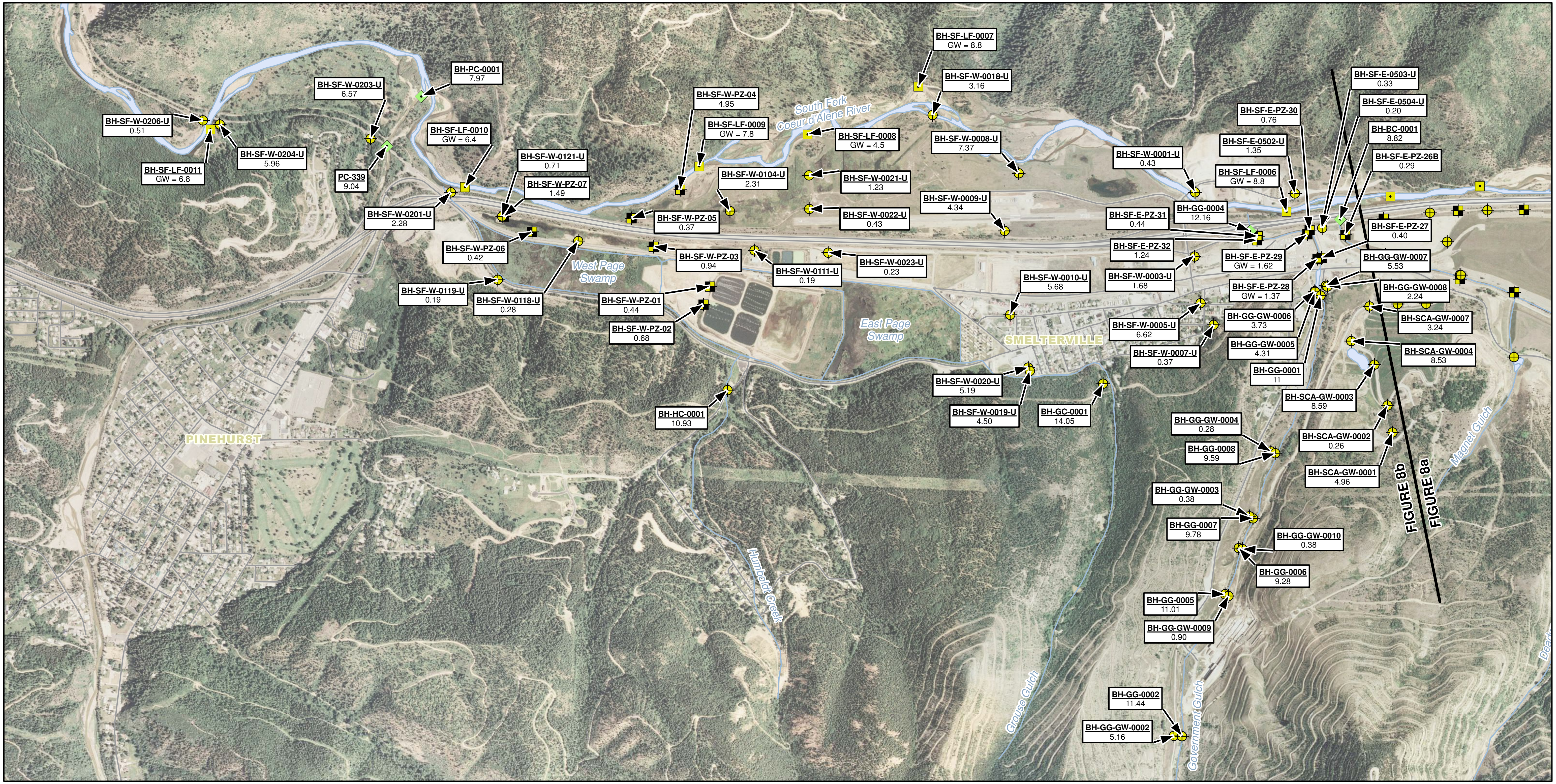
N
0 500 1,000 2,000 Feet

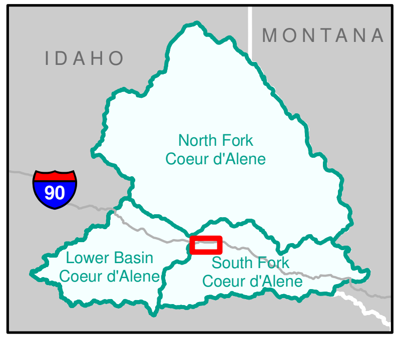
Source: NHDPlus (Rivers, Waterbodies); Idaho Geospatial Data Clearinghouse (Roads 2008).

Figure 8a
Dissolved Oxygen Summary
September 25, 2008
2008 OU2 Groundwater/Surface Water Interaction Monitoring
BUNKER HILL SUPERFUND SITE OU2

CH2MHILL

\\WOODY\PROJ\EPA\CDABASIN_382081\GIS\MAPFILES\OU2\GWSW\GWSW_DISSOXY_E.MXD RDEMARIS 3/26/2009 12:18:40





Groundwater Monitoring Location
Tributary Surface Water Monitoring Location
SFCDR Surface Water Monitoring Location
Piezometer

Notes:
Concentrations shown in milligrams per liter (mg/L).
GW = Groundwater Concentration

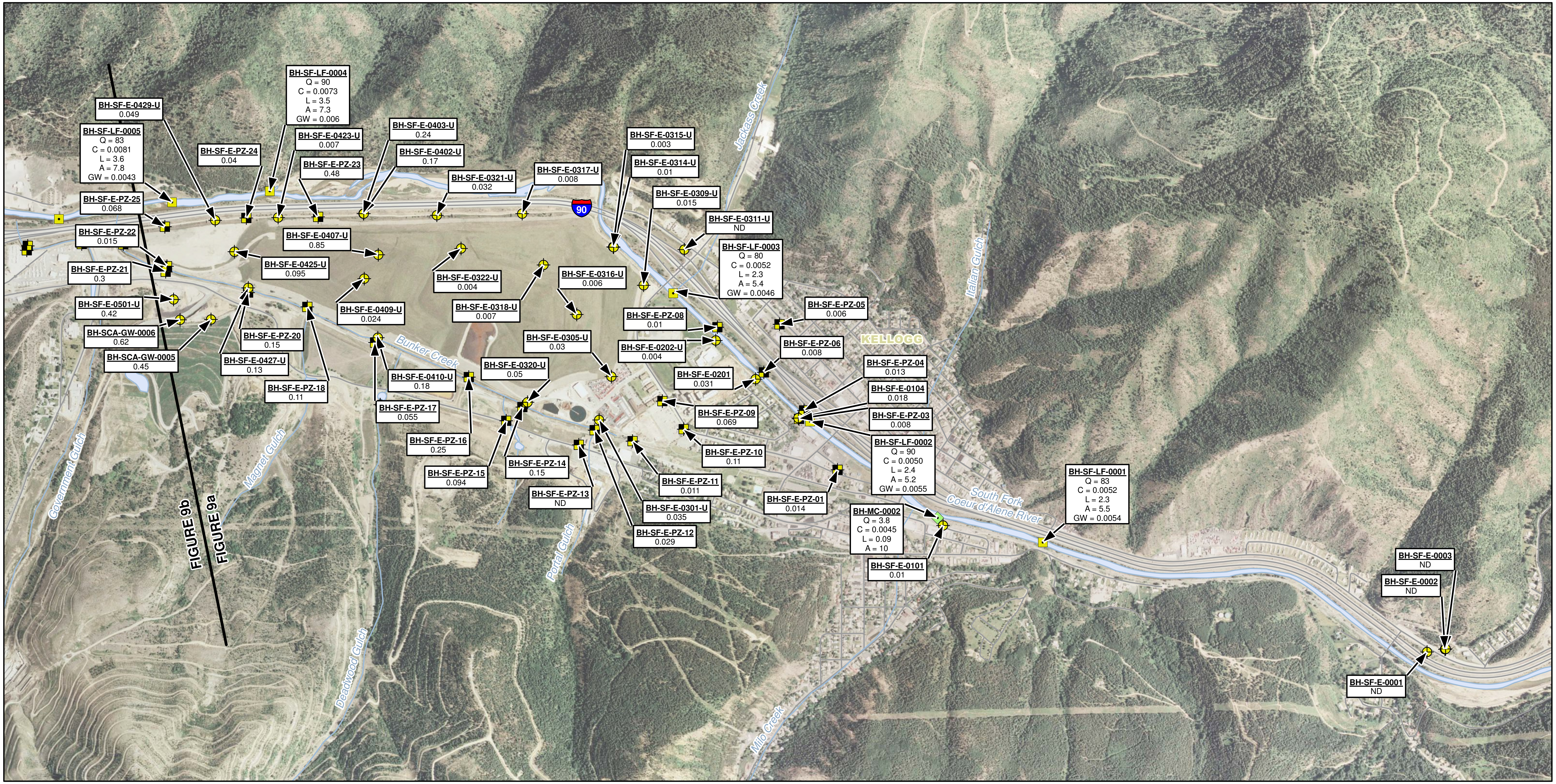
N 0 500 1,000 2,000 Feet

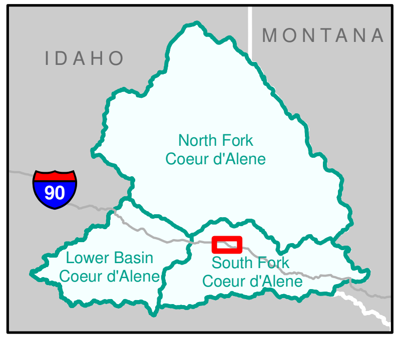
Source: NHDPlus (Rivers, Waterbodies); Idaho Geospatial Data Clearinghouse (Roads 2008).

Figure 8b
Dissolved Oxygen Summary
September 25, 2008
2008 OU2 Groundwater/Surface Water Interaction Monitoring
BUNKER HILL SUPERFUND SITE OU2

CH2MHILL

\\WOODY\PROJ\EPA\CDABASIN_382081\GIS\MAPFILES\OU2\GWSW\GWSW_DISSOXY_W.MXD RDEMARIS 3/26/2009 12:58:21





Groundwater Monitoring Well
SFCDR Surface Water Monitoring Location
Tributary Surface Water Monitoring Location
Piezometer

Notes:
Concentrations shown in milligrams per liter (mg/L).
ND = Not Detected Above the Method Detection Limit
-- = Not Measured or Quantified
Q = Discharge (cfs)
C = Concentration (mg/L)
L = Load (lbs/day)
A = AWQC Ratio
GW = Groundwater Concentration (mg/L)

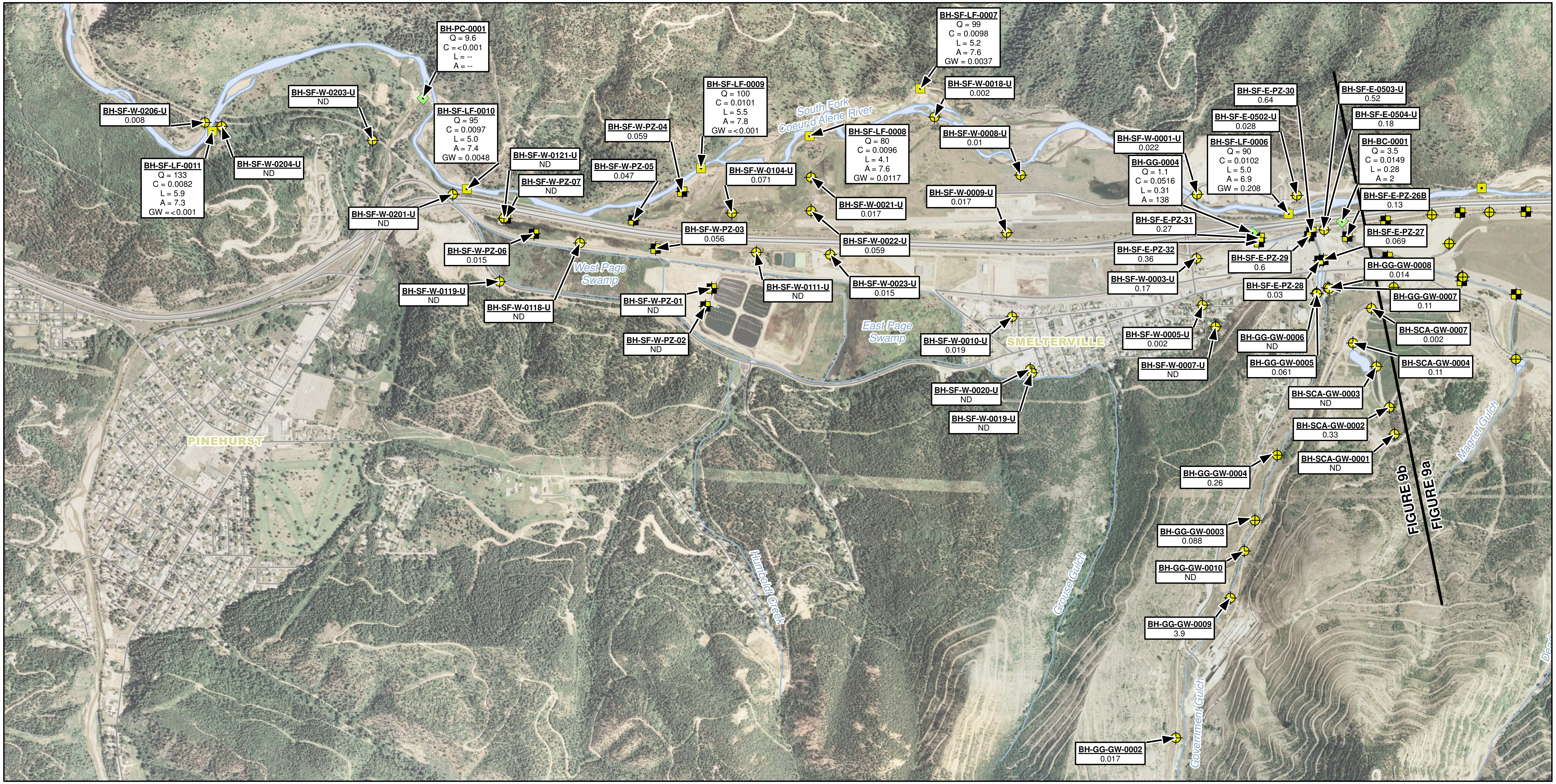
N
0 500 1,000 2,000 Feet

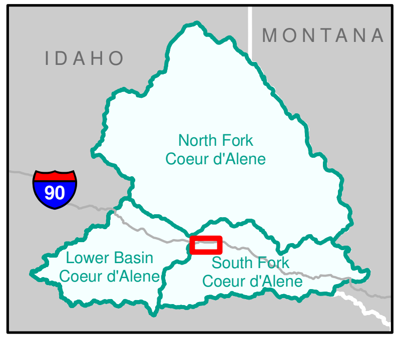
Source: NHDPlus (Rivers, Waterbodies); Idaho Geospatial Data Clearinghouse (Roads 2008).

Figure 9a
Dissolved Cadmium Summary
September 25, 2008
2008 OU2 Groundwater/Surface Water Interaction Monitoring
BUNKER HILL SUPERFUND SITE OU2

CH2MHILL

\\WOODY\PROJ\EPA\CDABASIN_382081\GIS\MAPFILES\OU2\GWSW\GWSW_DISSCD_E.MXD RDEMARIS 3/26/2009 13:36:12





- Groundwater Monitoring Well
- SFCDR Surface Water Monitoring Location
- Tributary Surface Water Monitoring Location
- Piezometer

Notes:
Concentrations shown in milligrams per liter (mg/L).
ND = Not Detected Above the Method Detection Limit
-- = Not Measured or Quantified
Q = Discharge (cfs)
C = Concentration (mg/L)
L = Load (lbs/day)
A = AWQC Ratio
GW = Groundwater Concentration (mg/L)

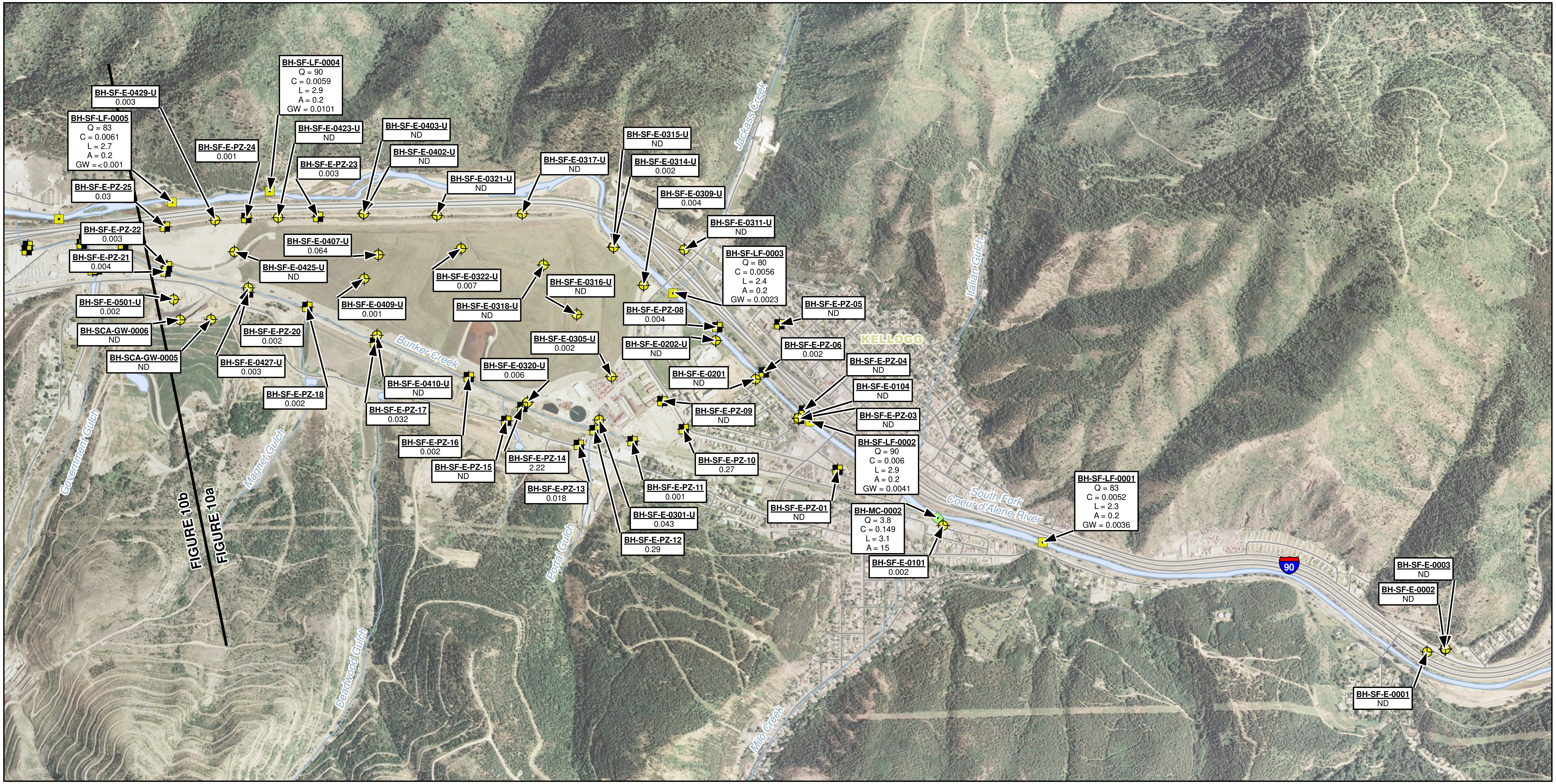
N 0 500 1,000 2,000 Feet

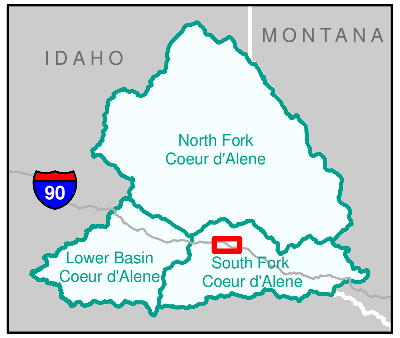
Source: NHDPlus (Rivers, Waterbodies); Idaho Geospatial Data Clearinghouse (Roads 2008).

Figure 9b
Dissolved Cadmium Summary
September 25, 2008
2008 OU2 Groundwater/Surface Water Interaction Monitoring
BUNKER HILL SUPERFUND SITE OU2

CH2MHILL

\\WOODY\PROJ\EPA\CDABASIN_382081\GIS\MAPFILES\OU2\GWSW\GWSW_DISSCD_W.MXD RDEMARIS 3/26/2009 13:57:12





Groundwater Monitoring Well
SFCDR Surface Water Monitoring Location
Tributary Surface Water Monitoring Location
Piezometer

Notes:
Concentrations shown in milligrams per liter (mg/L).
ND = Not Detected Above the Method Detection Limit
-- = Not Measured or Quantified
Q = Discharge (cfs)
C = Concentration (mg/L)
L = Load (lbs/day)
A = AWQC Ratio
GW = Groundwater Concentration (mg/L)

N

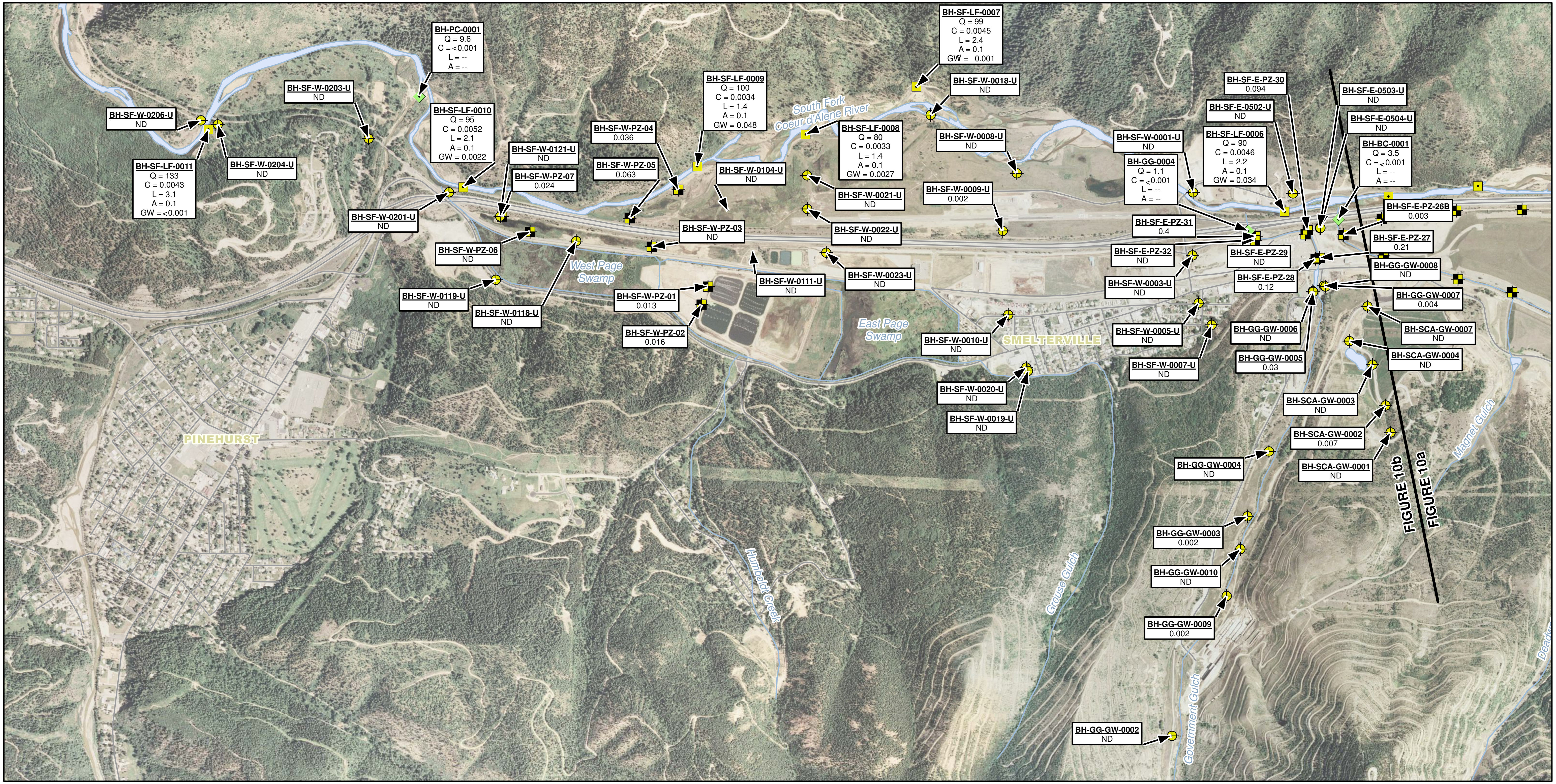
0 500 1,000 2,000 Feet

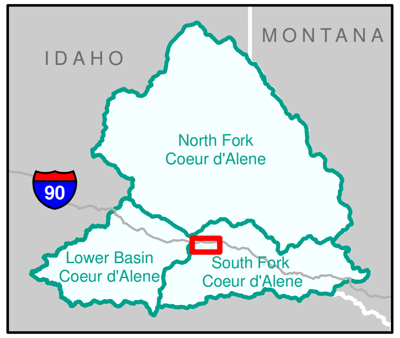
Source: NHDPlus (Rivers, Waterbodies); Idaho Geospatial Data Clearinghouse (Roads 2008).

Figure 10a
Dissolved Lead Summary
September 25, 2008
2008 OU2 Groundwater/Surface Water Interaction Monitoring
BUNKER HILL SUPERFUND SITE OU2

\\WOODY\PROJ\EPA\CDABASIN_382081\GIS\MAPFILES\OU2\GWSW\GWSW_DISSPB_E.MXD RDEMARIS 3/26/2009 14:17:55

CH2MHILL





- Groundwater Monitoring Well
- SFCDR Surface Water Monitoring Location
- Tributary Surface Water Monitoring Location
- Piezometer

Notes:
Concentrations shown in milligrams per liter (mg/L).
ND = Not Detected Above the Method Detection Limit
-- = Not Measured or Quantified
Q = Discharge (cfs)
C = Concentration (mg/L)
L = Load (lbs/day)
A = AWQC Ratio
GW = Groundwater Concentration (mg/L)

N 0 500 1,000 2,000 Feet

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

Figure 10b
Dissolved Lead Summary
September 25, 2008
2008 OU2 Groundwater/Surface Water Interaction Monitoring
BUNKER HILL SUPERFUND SITE OU2

CH2MHILL

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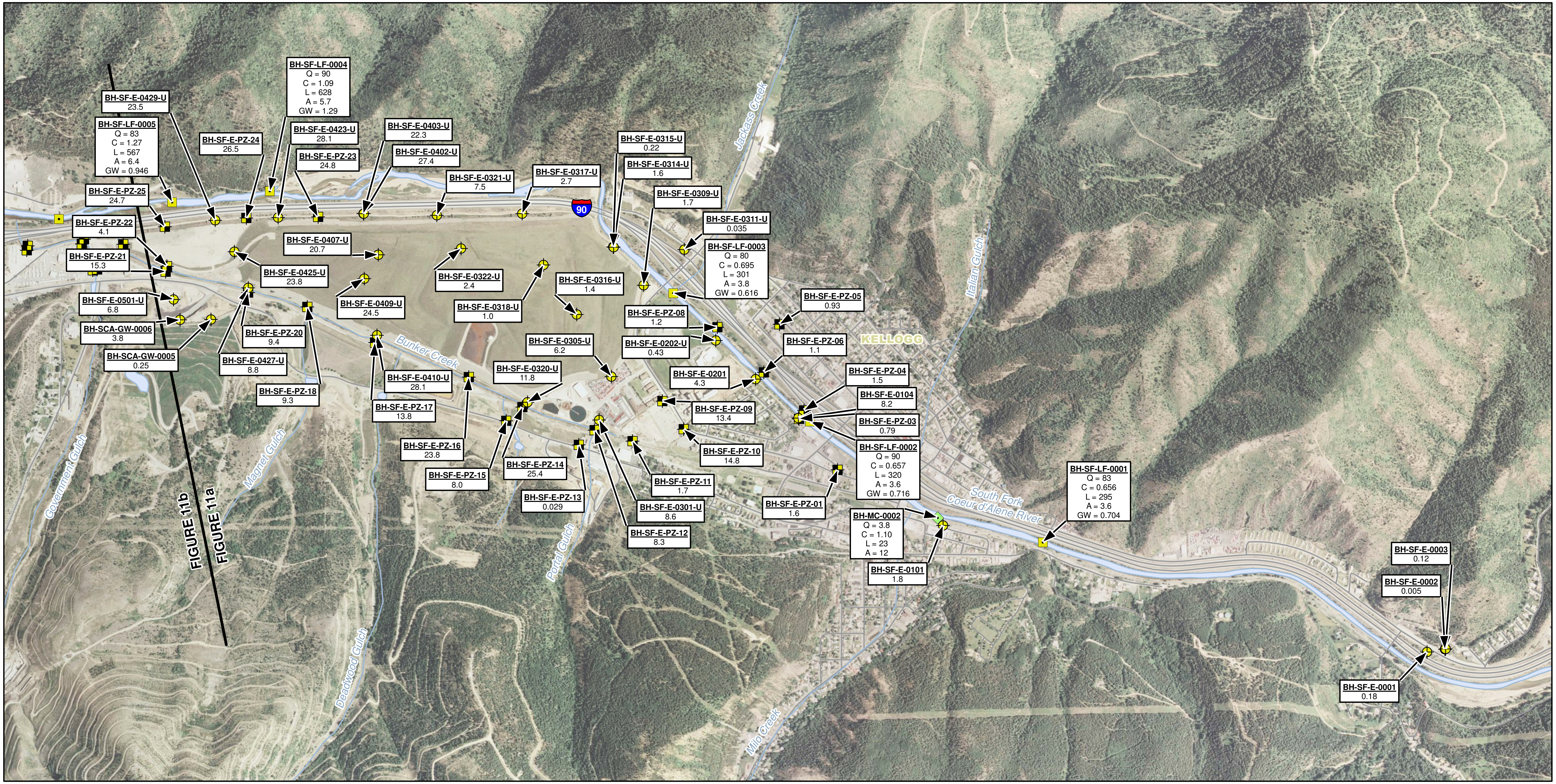

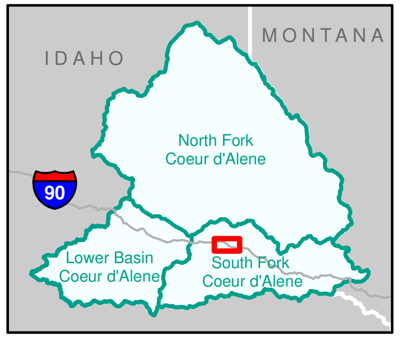

- Groundwater Monitoring Well
- SFCDR Surface Water Monitoring Location
- Tributary Surface Water Monitoring Location
- Piezometer

Notes:
Concentrations shown in milligrams per liter (mg/L).
ND = Not Detected Above the Method Detection Limit
-- = Not Measured or Quantified
Q = Discharge (cfs)
C = Concentration (mg/L)
L = Load (lbs/day)
A = AWQC Ratio
GW = Groundwater Concentration (mg/L)

N 0 500 1,000 2,000 Feet

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

Figure 11a
Dissolved Zinc Summary
September 25, 2008
2008 OU2 Groundwater/Surface Water Interaction Monitoring
BUNKER HILL SUPERFUND SITE OU2

CH2MHILL

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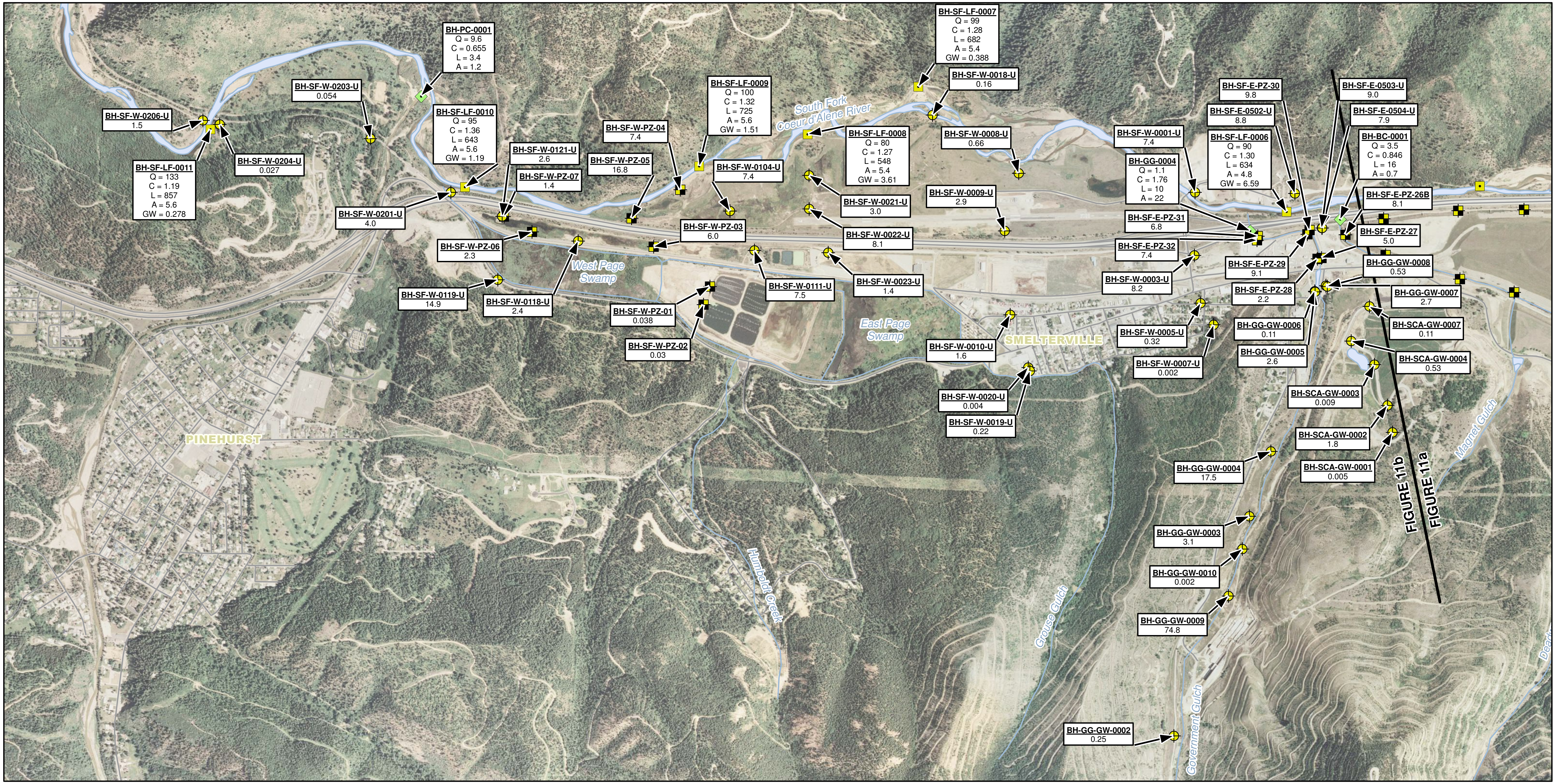
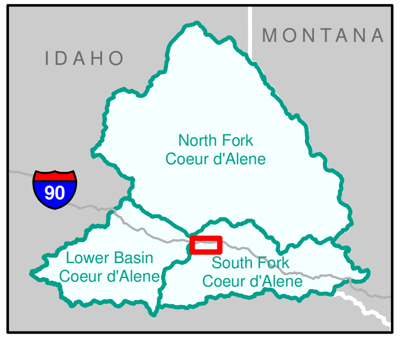




- Groundwater Monitoring Well
- SFCDR Surface Water Monitoring Location
- Tributary Surface Water Monitoring Location
- Piezometer

Notes:
Concentrations shown in milligrams per liter (mg/L).
ND = Not Detected Above the Method Detection Limit
-- = Not Measured or Quantified
Q = Discharge (cfs)
C = Concentration (mg/L)
L = Load (lbs/day)
A = AWQC Ratio
GW = Groundwater Concentration (mg/L)

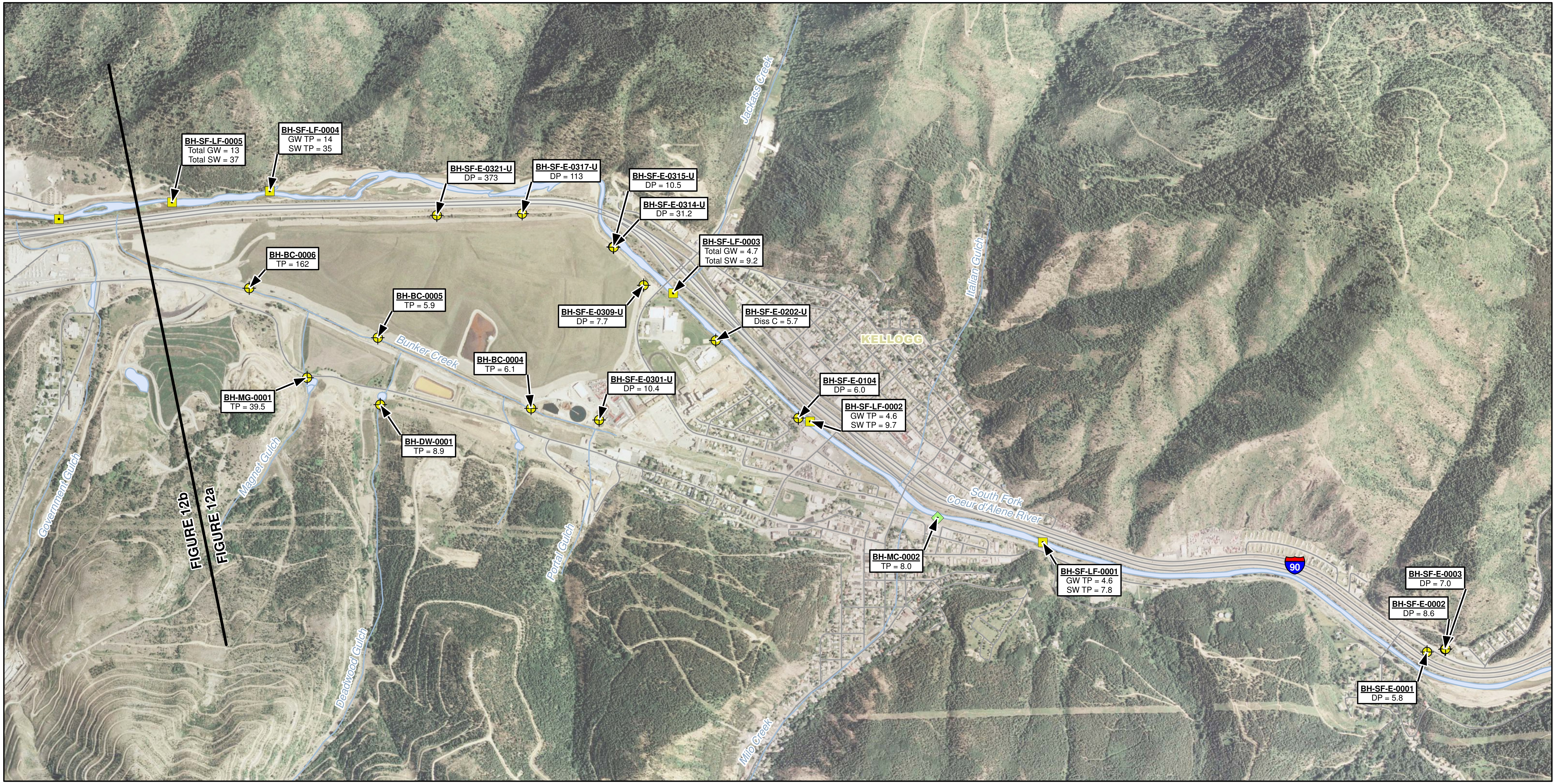
N 0 500 1,000 2,000 Feet

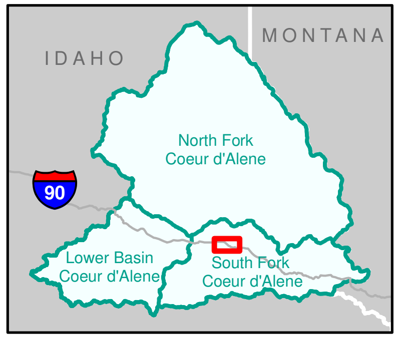
Source: NHDPlus (Rivers, Waterbodies); Idaho Geospatial Data Clearinghouse (Roads 2008).

Figure 11b
Dissolved Zinc Summary
September 25, 2008
2008 OU2 Groundwater/Surface Water Interaction Monitoring
BUNKER HILL SUPERFUND SITE OU2

CH2MHILL

\\WOODY\PROJ\EPA\CDABASIN_382081\GIS\MAPFILES\OU2\GWSW\GWSW_FIG10B_DISSZN_BH-W.MXD RDEMARIS 3/26/2009 14:41:40





- Groundwater Monitoring Location
- Tributary Surface Water Monitoring Location
- SFCDR Surface Water Monitoring Location

Notes:
Concentrations shown in micrograms per liter (ug/L).
Total and Dissolved Concentrations noted in label.
ND = Not Detected Above the Method Detection Limit
GW = Groundwater
SW = Surface Water
TP = Total Phosphorous
DP = Dissolved Phosphorous

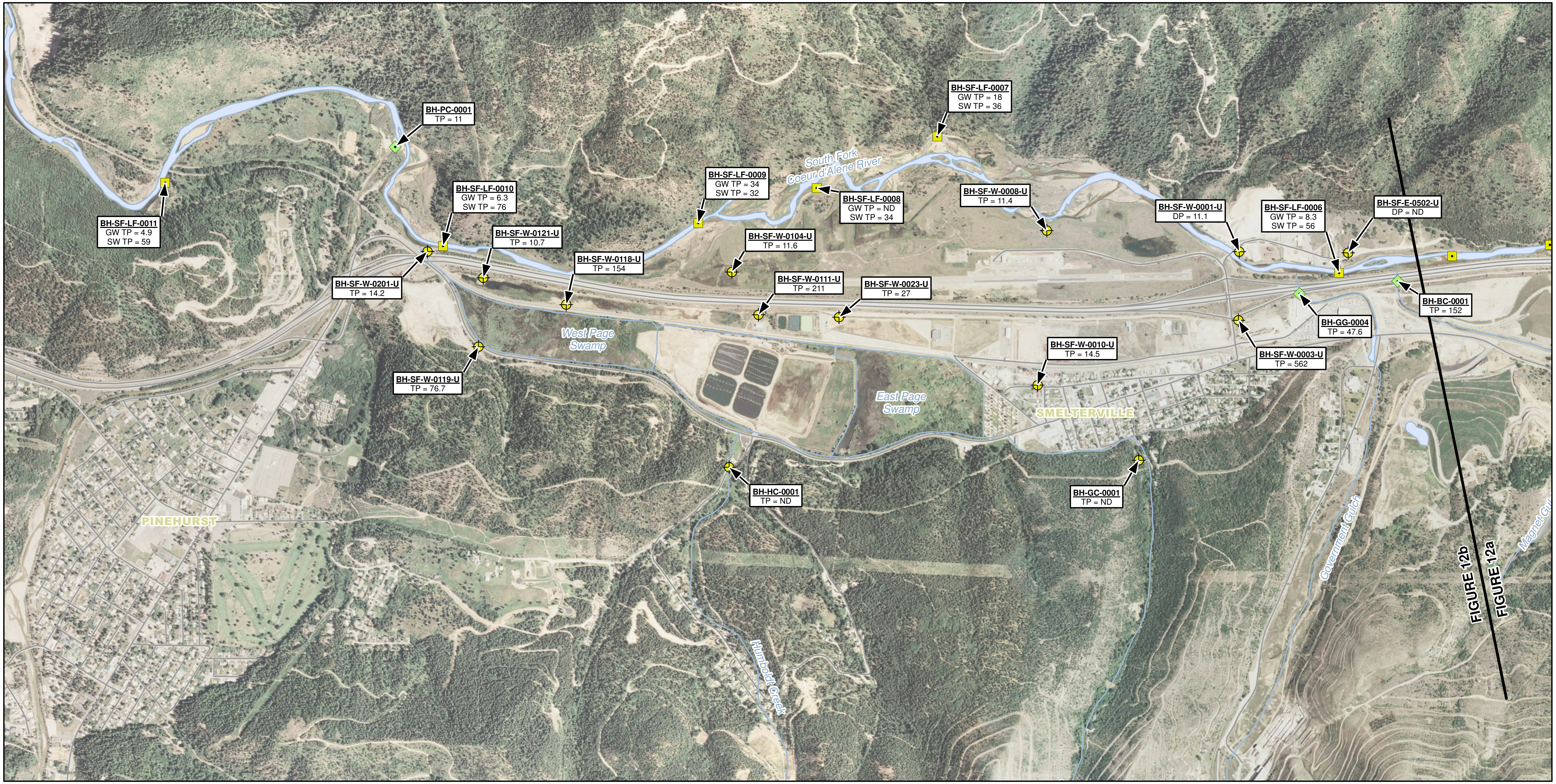
N 0 500 1,000 2,000 Feet

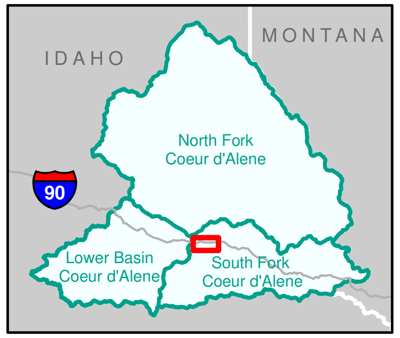
Source: NHDPlus (Rivers, Waterbodies); Idaho Geospatial Data Clearinghouse (Roads 2008).

Figure 12a
Phosphorous Summary
September 25, 2008
2008 OU2 Groundwater/Surface Water Interaction Monitoring
BUNKER HILL SUPERFUND SITE OU2

CH2MHILL

\\WOODY\PROJ\EPA\CDABASIN_382081\GIS\MAPFILES\OU2\GWSW\GWSW_DISSPHS_E.MXD RDEMARIS 3/26/2009 15:43:56





Groundwater Monitoring Location

Tributary Surface Water Monitoring Location

SFCDR Surface Water Monitoring Location

Notes:
Concentrations shown in micrograms per liter (ug/L).
Total and Dissolved Concentrations noted in label.
ND = Not Detected Above the Method Detection Limit
GW = Groundwater
SW = Surface Water
TP = Total Phosphorous
DP = Dissolved Phosphorous

N

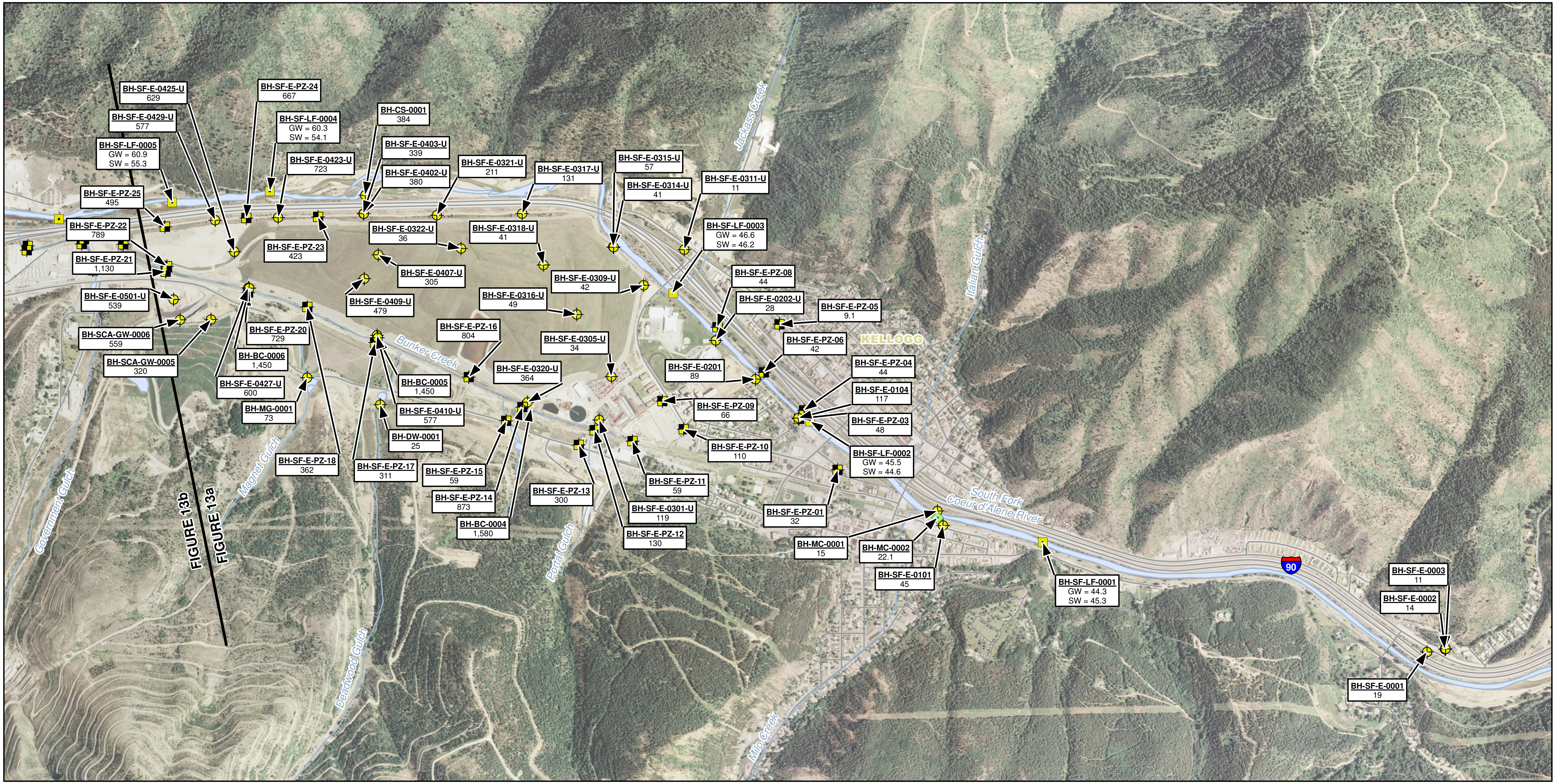
0 500 1,000 2,000 Feet

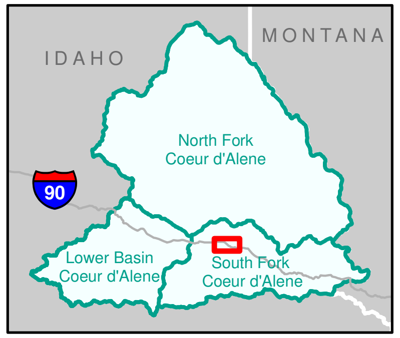
Source: NHDPlus (Rivers, Waterbodies); Idaho Geospatial Data Clearinghouse (Roads 2008).

Figure 12b
Phosphorous Summary
September 25, 2008
2008 OU2 Groundwater/Surface Water Interaction Monitoring
BUNKER HILL SUPERFUND SITE OU2

CH2MHILL

\\WOODY\PROJ\EPA\CDABASIN_382081\GIS\MAPFILES\OU2\GWSW\GWSW_DISSPHS_W.MXD RDEMARIS 3/26/2009 16:06:51





Groundwater Monitoring Location
Tributary Surface Water Monitoring Location
SFCDR Surface Water Monitoring Location
Piezometer

Notes:
Concentrations shown in milligrams per liter (mg/L).
GW = Groundwater
SW = Surface Water

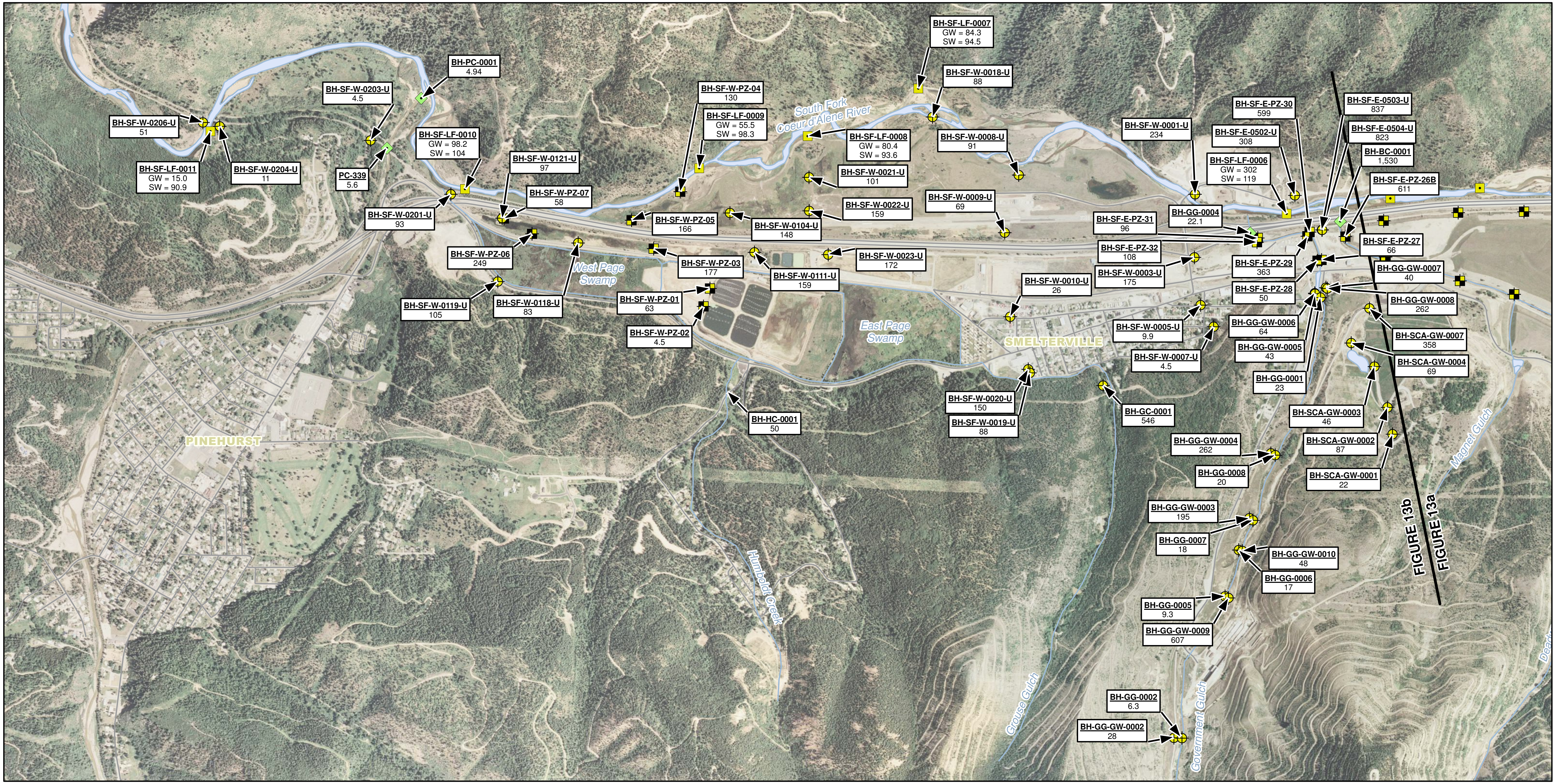
N
0 500 1,000 2,000 Feet

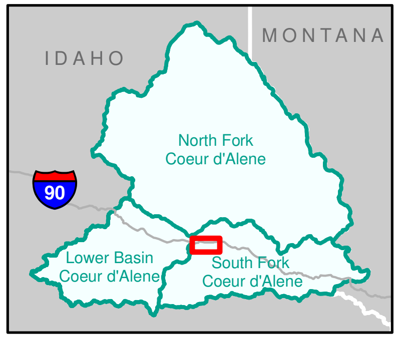
Source: NHDPlus (Rivers, Waterbodies); Idaho Geospatial Data Clearinghouse (Roads 2008).

Figure 13a
Sulfate Summary
September 25, 2008
2008 OU2 Groundwater/Surface Water Interaction Monitoring
BUNKER HILL SUPERFUND SITE OU2

CH2MHILL

\\WOODY\PROJ\EPA\CDABASIN_382081\GIS\MAPFILES\OU2\GWSW\GWSW_SU_E.MXD RDEMARIS 3/26/2009 16:30:03





- Groundwater Monitoring Location
- Tributary Surface Water Monitoring Location
- SFCDR Surface Water Monitoring Location
- Piezometer

Notes:
Concentrations shown in milligrams per liter (mg/L).
GW = Groundwater
SW = Surface Water

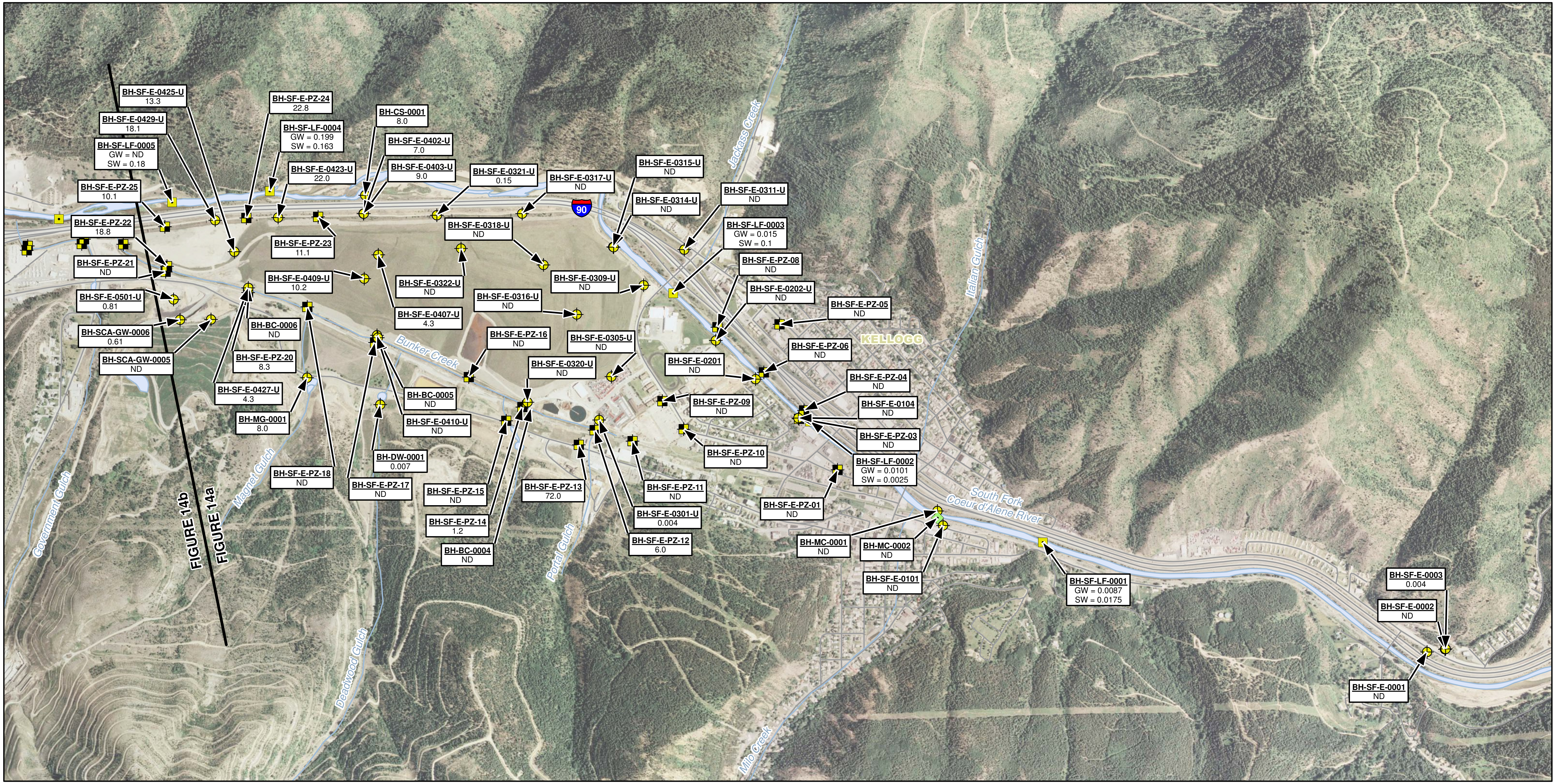
N 0 500 1,000 2,000 Feet

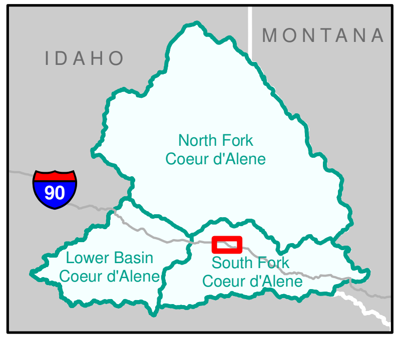
Source: NHDPlus (Rivers, Waterbodies); Idaho Geospatial Data Clearinghouse (Roads 2008).

Figure 13b
Sulfate Summary
September 25, 2008
2008 OU2 Groundwater/Surface Water Interaction Monitoring
BUNKER HILL SUPERFUND SITE OU2

CH2MHILL

\\WOODY\PROJ\EPA\CDABASIN_382081\GIS\MAPFILES\OU2\GWSW\GWSW_SU_W.MXD RDEMARIS 3/26/2009 16:48:16





Groundwater Monitoring Location
Tributary Surface Water Monitoring Location
SFCDR Surface Water Monitoring Location
Piezometer

Notes:
Concentrations shown in milligrams per liter (mg/L).
ND = Not Detected Above the Method Detection Limit
GW = Groundwater Concentration
SW = Surface Water Concentration

N 0 500 1,000 2,000 Feet

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

Figure 14a
Dissolved Iron Summary
September 25, 2008
2008 OU2 Groundwater/Surface Water Interaction Monitoring
BUNKER HILL SUPERFUND SITE OU2

CH2MHILL

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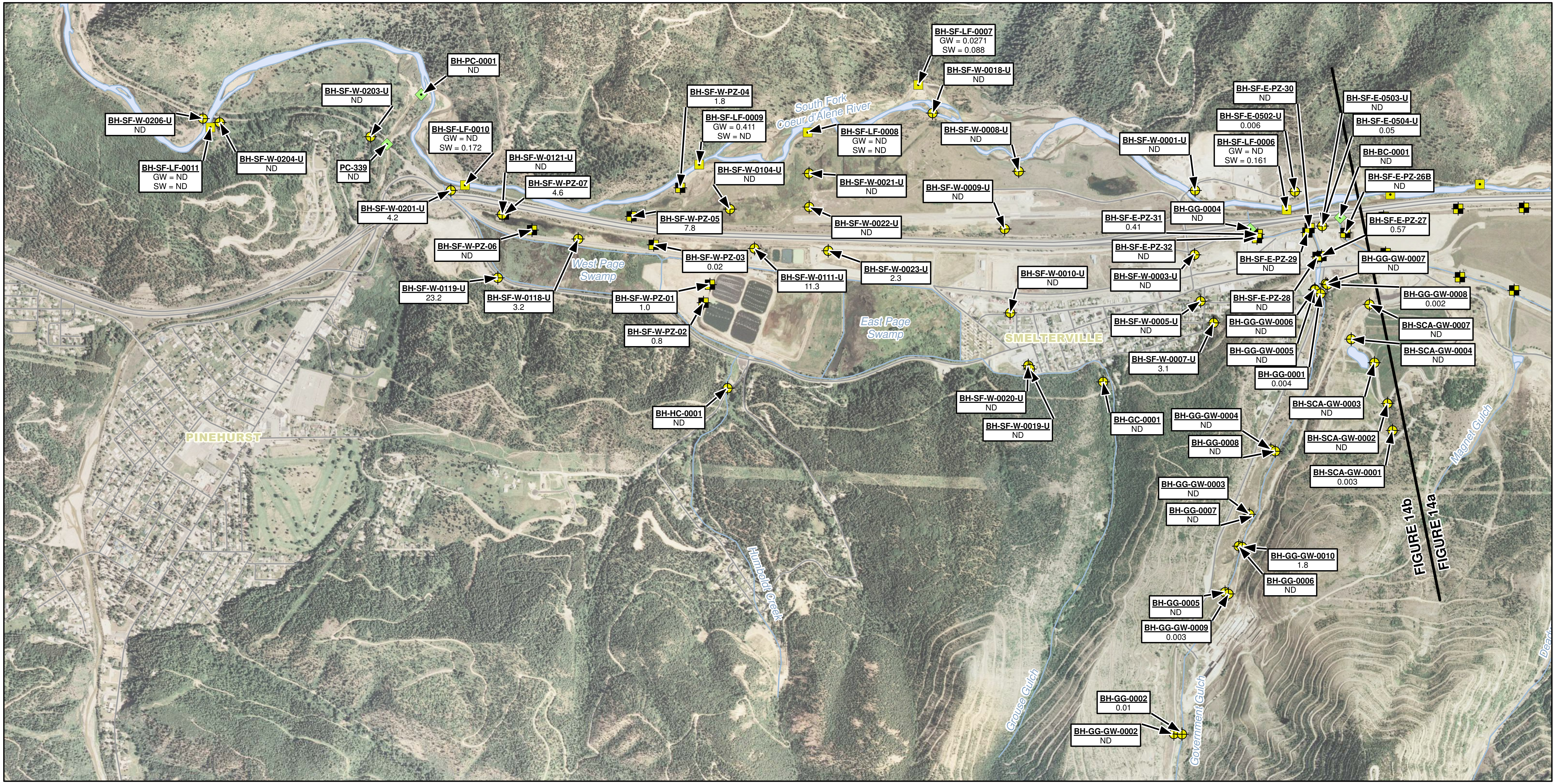
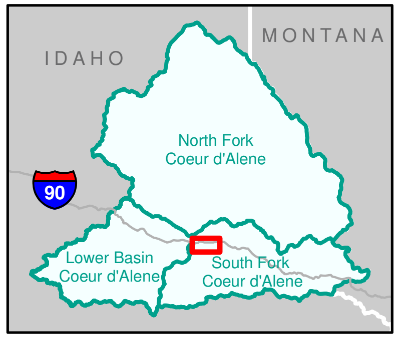




- Groundwater Monitoring Location
- Tributary Surface Water Monitoring Location
- SFCDR Surface Water Monitoring Location
- Piezometer

Notes:
Concentrations shown in milligrams per liter (mg/L).
ND = Not Detected Above the Method Detection Limit
GW = Groundwater Concentration
SW = Surface Water Concentration

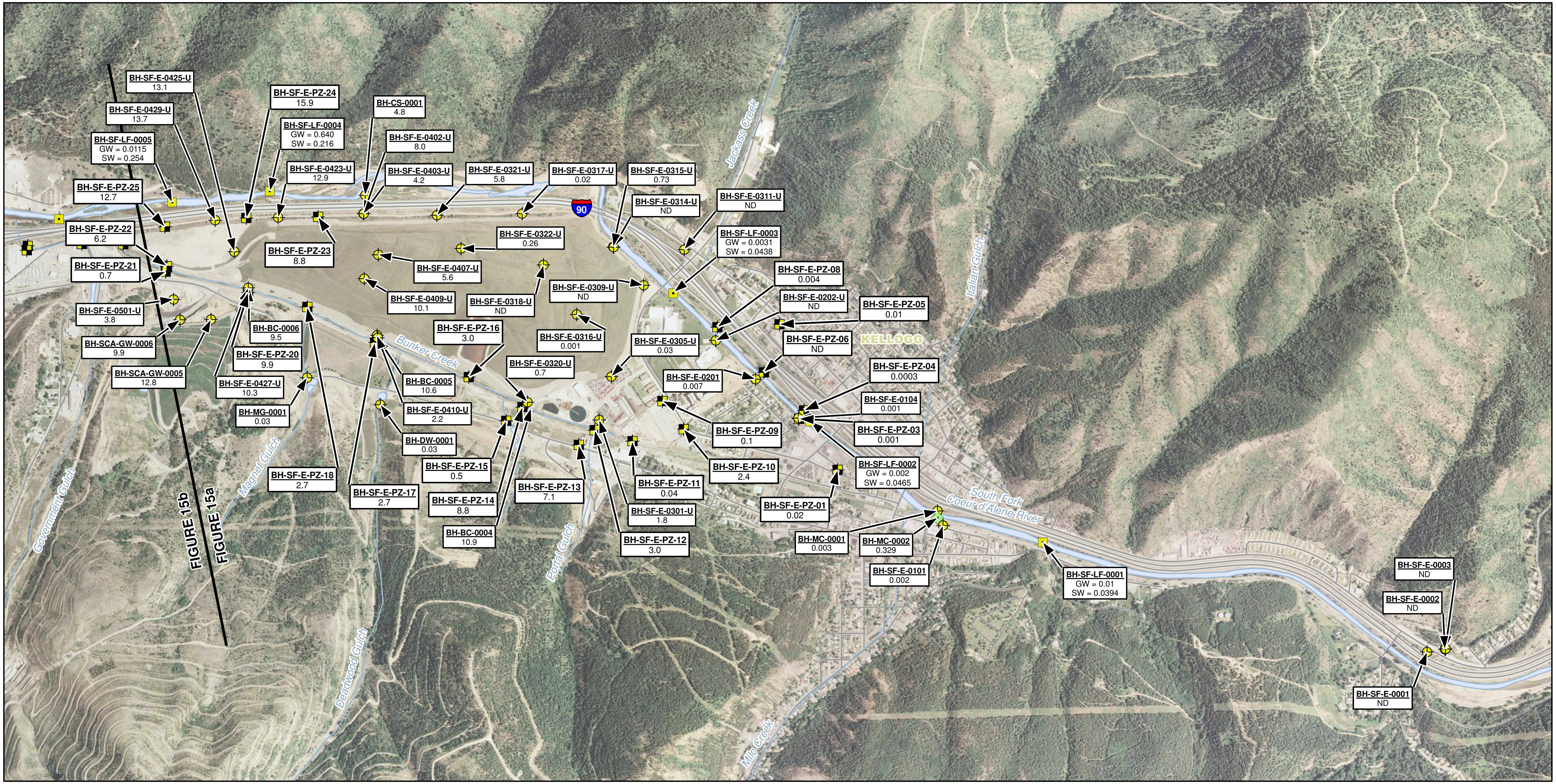
N
0 500 1,000 2,000 Feet

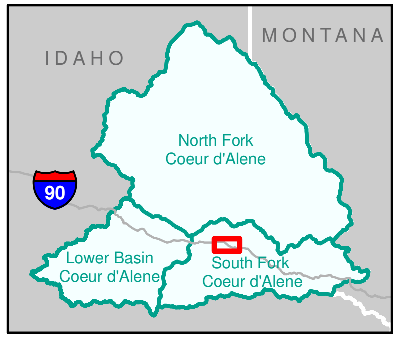
Source: NHDPlus (Rivers, Waterbodies); Idaho Geospatial Data Clearinghouse (Roads 2008).

Figure 14b
Dissolved Iron Summary
September 25, 2008
2008 OU2 Groundwater/Surface Water Interaction Monitoring
BUNKER HILL SUPERFUND SITE OU2

CH2MHILL

\\WOODY\PROJ\EPA\CDABASIN_382081\GIS\MAPFILES\OU2\GWSW\GWSW_DISSFE_W.MXD RDEMARIS 3/26/2009 17:21:35





- Groundwater Monitoring Location
- Tributary Surface Water Monitoring Location
- SFCDR Surface Water Monitoring Location
- Piezometer

Notes:
Concentrations shown in milligrams per liter (mg/L).
ND = Not Detected Above the Method Detection Limit
GW = Groundwater Concentration
SW = Surface Water Concentration

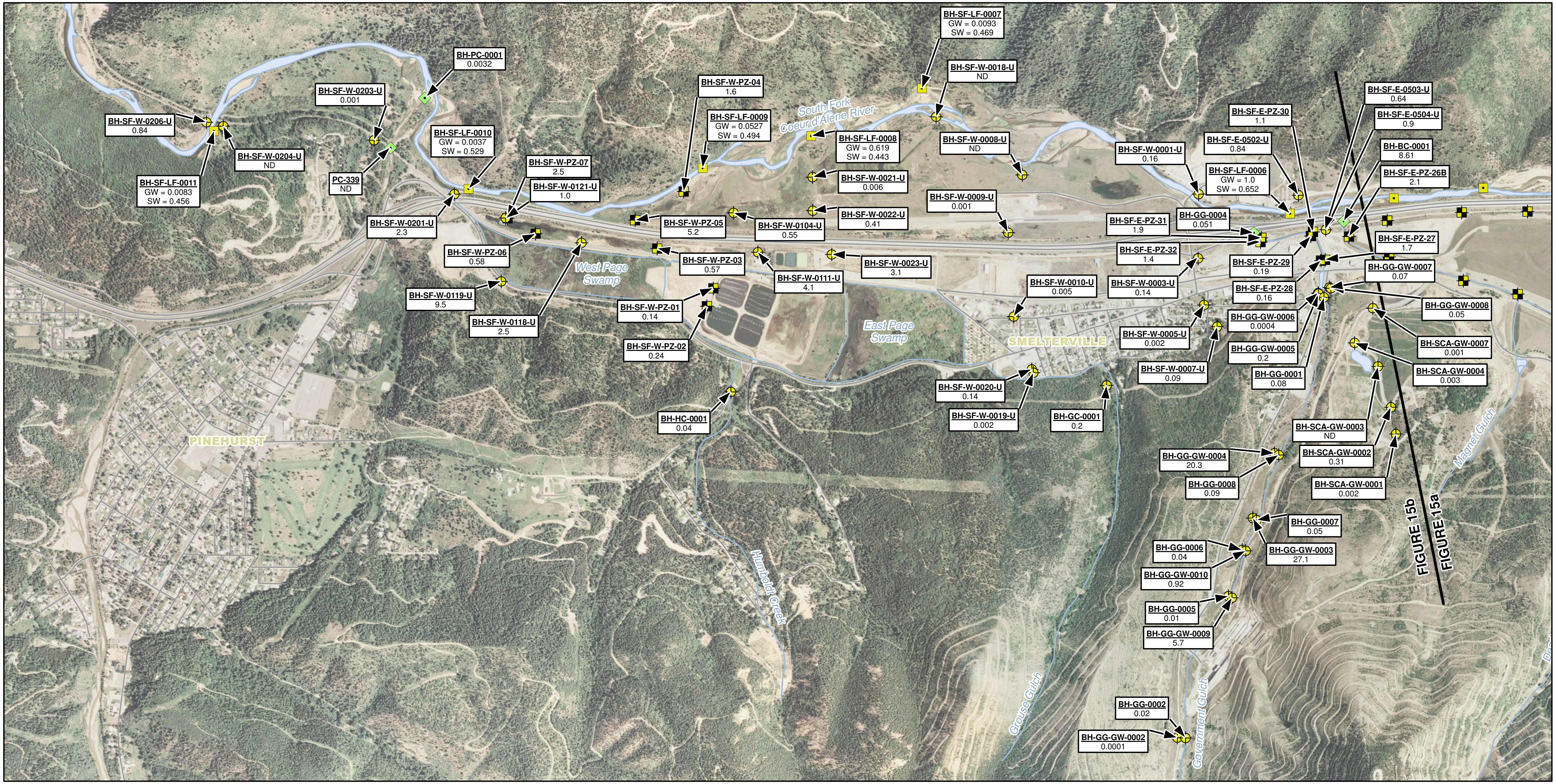
N 0 500 1,000 2,000 Feet

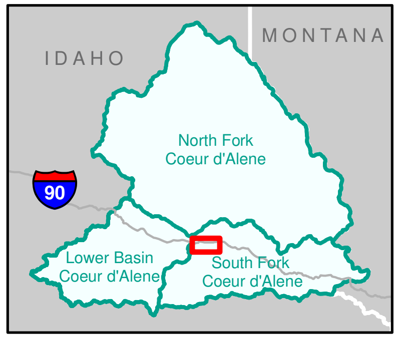
Source: NHDPlus (Rivers, Waterbodies); Idaho Geospatial Data Clearinghouse (Roads 2008).

Figure 15a
Dissolved Manganese Summary
September 25, 2008
2008 OU2 Groundwater/Surface Water Interaction Monitoring
BUNKER HILL SUPERFUND SITE OU2

CH2MHILL

\\WOODY\PROJ\EPA\CDABASIN_382081\GIS\MAPFILES\OU2\GWSW\GWSW_DISSMN_E.MXD RDEMARIS 3/26/2009 17:59:49





Groundwater Monitoring Location

Tributary Surface Water Monitoring Location

SFCDR Surface Water Monitoring Location

Piezometer

Notes:
Concentrations shown in milligrams per liter (mg/L).
ND = Not Detected Above the Method Detection Limit
GW = Groundwater Concentration
SW = Surface Water Concentration

N

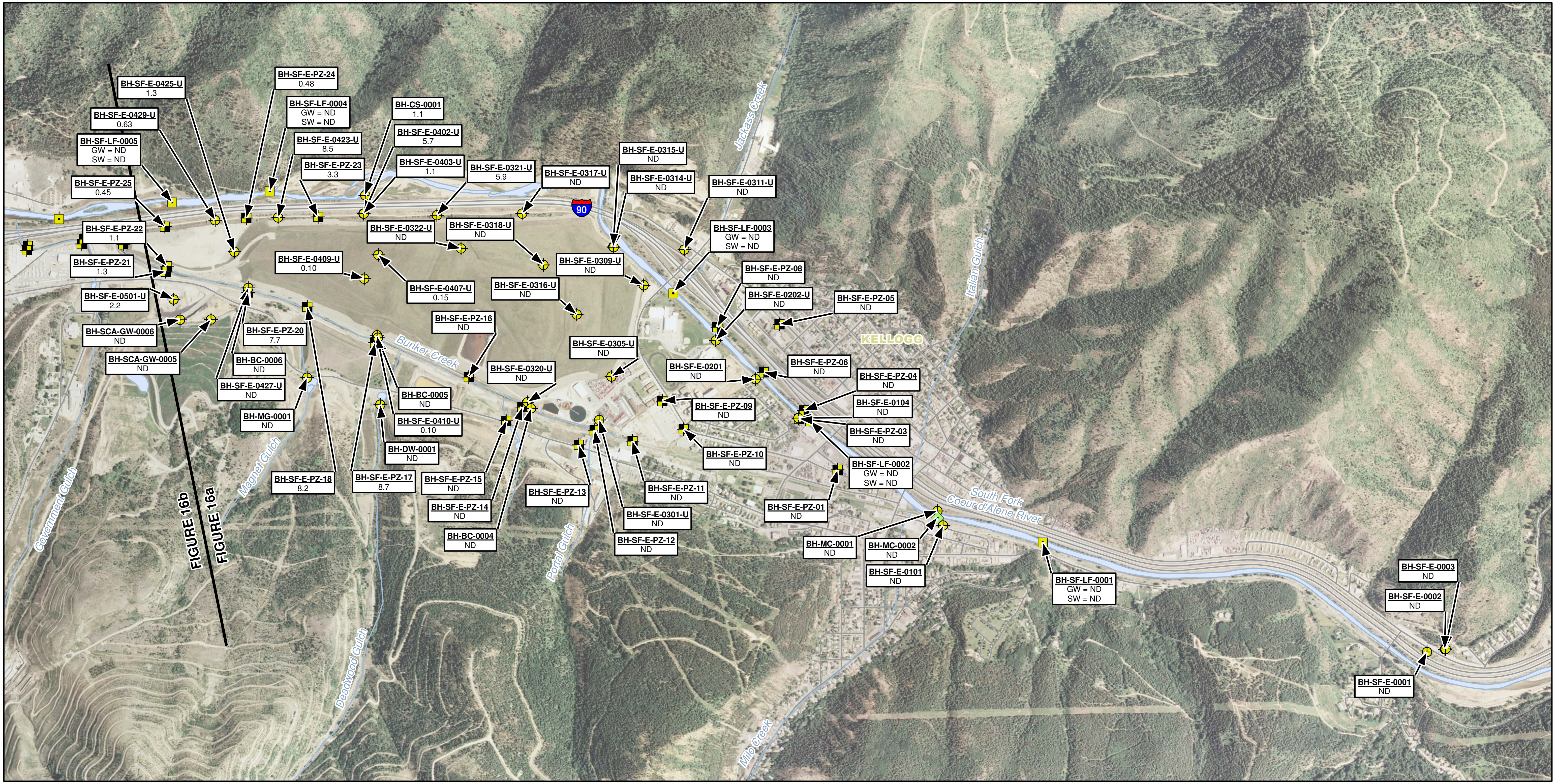
0 500 1,000 2,000 Feet

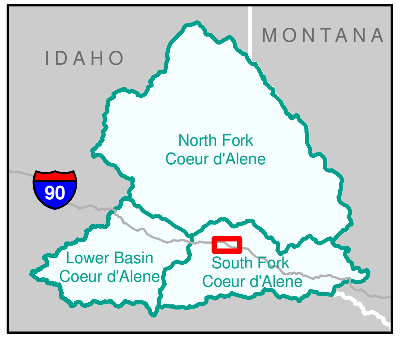
Source: NHDPlus (Rivers, Waterbodies); Idaho Geospatial Data Clearinghouse (Roads 2008).

Figure 15b
Dissolved Manganese Summary
September 25, 2008
2008 OU2 Groundwater/Surface Water Interaction Monitoring
BUNKER HILL SUPERFUND SITE OU2

CH2MHILL

\\WOODY\PROJ\EPA\CDABASIN_382081\GIS\MAPFILES\OU2\GWSW\GWSW_DISSMN_W.MXD RDEMARIS 3/26/2009 17:33:01





Groundwater Monitoring Location

Tributary Surface Water Monitoring Location

SFCDR Surface Water Monitoring Location

Piezometer

Notes:
Concentrations shown in milligrams per liter (mg/L).
ND = Not Detected Above the Method Detection Limit
GW = Groundwater Concentration
SW = Surface Water Concentration

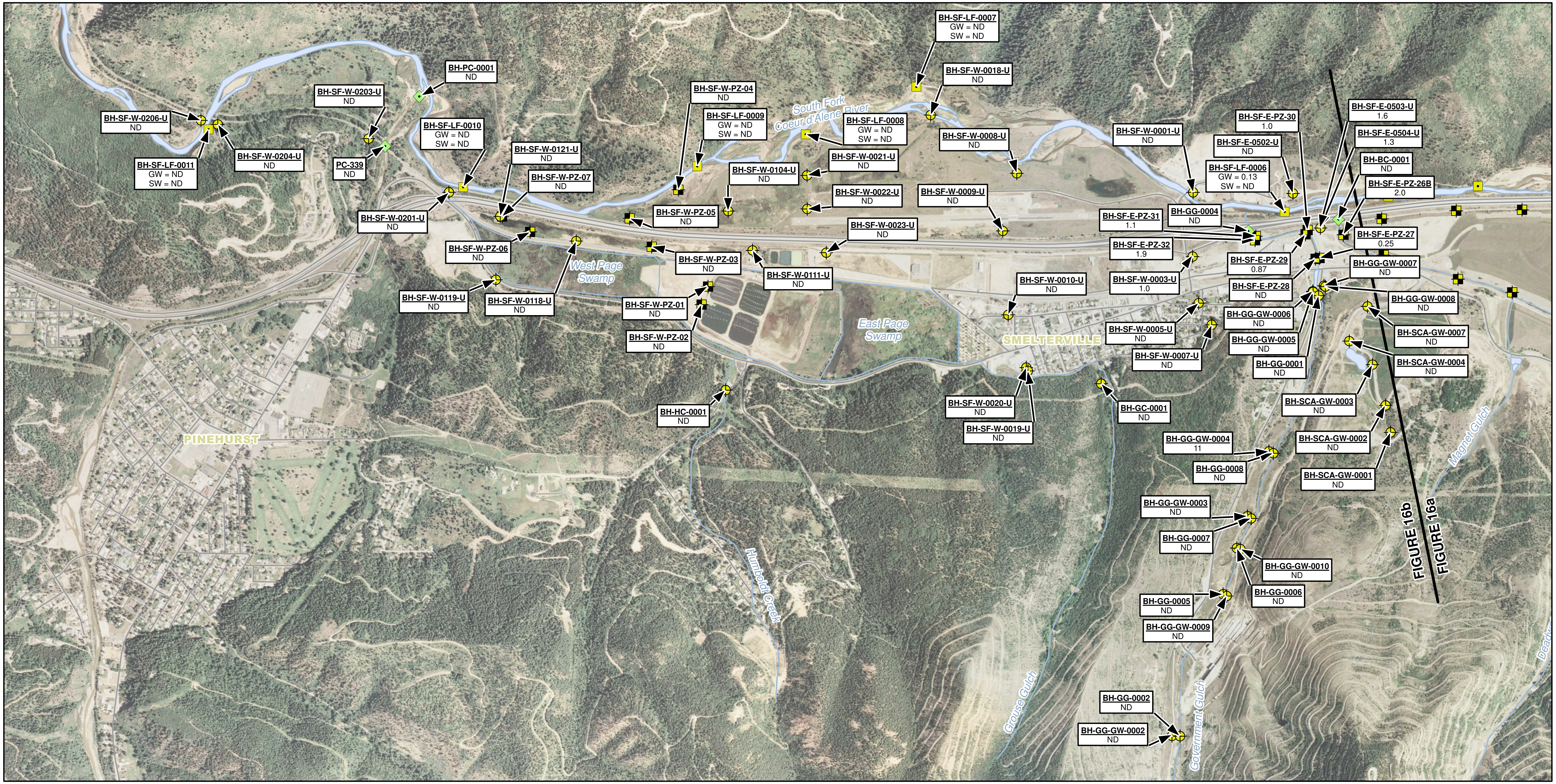
N 0 500 1,000 2,000 Feet

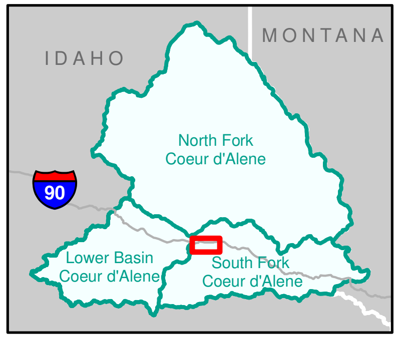
Source: NHDPlus (Rivers, Waterbodies); Idaho Geospatial Data Clearinghouse (Roads 2008).

Figure 16a
Dissolved Fluoride Summary
September 25, 2008
2008 OU2 Groundwater/Surface Water Interaction Monitoring
BUNKER HILL SUPERFUND SITE OU2

CH2MHILL

\\WOODY\PROJ\EPA\CDABASIN_382081\GIS\MAPFILES\OU2\GWSW\GWSW_DISSFL_E.MXD RDEMARIS 3/26/2009 18:13:58





- Groundwater Monitoring Location
- Tributary Surface Water Monitoring Location
- SFCDR Surface Water Monitoring Location
- Piezometer

Notes:
Concentrations shown in milligrams per liter (mg/L).
ND = Not Detected Above the Method Detection Limit
GW = Groundwater Concentration
SW = Surface Water Concentration

N

0 500 1,000 2,000 Feet

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

Figure 16b
Dissolved Fluoride Summary
September 25, 2008
2008 OU2 Groundwater/Surface Water Interaction Monitoring
BUNKER HILL SUPERFUND SITE OU2

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Attachment A

Field Parameter Summary Tables

Attachment A
Field Parameters - BH-SF-LF-0001
OU2 Groundwater/Surface Water Interaction Study
Bunker Hill Site OU2

Distance from Left Edge of Water (ft)	Spedific Conductance (uS/cm)	Temp (ºC)	pH
September 23, 2008			
8.1	--	--	--
11.5	178.0	12.1	7.70
18.3	230.0	12.5	7.61
25.1	233.0	12.6	7.65
31.9	233.2	12.6	7.70
38.7	233.5	12.6	7.71
45.5	233.5	12.6	7.73
52.3	233.0	12.6	7.75
59.1	233.5	12.6	7.76
65.9	232.7	12.6	7.77
72.7	232.0	12.6	7.79
75.5	--	--	--
September 24, 2008			
8.1	--	--	--
11.4	--	12.8	7.57
18.1	211.1	12.9	7.53
24.8	214.9	12.9	7.60
31.5	215.1	12.9	7.62
38.2	214.7	12.9	7.65
44.9	215.2	12.9	7.66
51.6	215.4	12.9	7.65
58.3	214.2	12.9	7.75
65.0	215.4	12.9	7.76
71.7	210.7	12.9	7.75
75.5	--	--	--
September 25, 2008			
8.1	--	--	--
11.4	193.5	12.6	7.67
18.1	202.3	12.8	7.73
24.8	206.6	12.8	7.75
31.5	206.8	12.8	7.74
38.2	206.9	12.8	7.73
44.9	206.9	12.8	7.71
51.6	206.9	12.8	7.73
58.3	206.4	12.9	7.75
65.0	206.9	12.8	7.74
71.7	206.1	12.9	7.76
75.5	--	--	--

Attachment A
Field Parameters - BH-SF-LF-0002
OU2 Groundwater/Surface Water Interaction Study
Bunker Hill Site OU2

Distance from Left Edge of Water (ft)	Spedific Conductance (uS/cm)	Temp (ºC)	pH
September 23, 2008			
--	--	--	--
66	224.8	13.0	7.80
59.3	224.8	13.0	7.80
52.6	225.6	13.1	7.81
45.9	226.5	13.1	7.82
39.2	228.3	13.2	7.82
32.5	230.1	13.2	7.84
25.8	231.0	13.3	7.87
19.1	231.2	13.3	7.89
12.4	232.0	13.4	7.93
5.7	228.8	13.5	7.97
--	--	--	--
September 24, 2008			
--	--	--	--
66.9	207.3	12.6	7.82
60.1	208.9	12.6	7.82
53.3	209.0	12.6	7.83
46.5	210.5	12.6	7.82
39.7	212.1	12.7	7.80
32.9	213.9	12.7	7.80
26.1	215.2	12.7	7.83
19.3	215.7	12.8	7.83
12.5	216.0	12.8	7.85
5.7	216.2	12.8	7.87
--	--	--	--
September 25, 2008			
--	--	--	--
66.9	201.4	12.9	7.74
60.1	201.8	12.9	7.76
53.3	200.9	12.9	7.75
46.5	203.3	12.9	7.75
39.7	204.4	13.0	7.73
32.9	206.3	13.0	7.75
26.1	207.7	13.0	7.76
19.3	208.3	13.1	7.76
12.5	202.8	13.1	7.78
5.7	209.0	13.2	7.82
--	--	--	--

Attachment A
Field Parameters - BH-SF-LF-0003
OU2 Groundwater/Surface Water Interaction Study
Bunker Hill Site OU2

Distance from Left Edge of Water (ft)	Spedific Conductance (uS/cm)	Temp (ºC)	pH
September 23, 2008			
--	--	--	--
73.5	225.4	13.0	7.85
66.5	226.2	13.8	7.83
59.5	226.2	13.8	7.80
52.5	226.7	13.7	7.80
45.5	226.6	13.6	7.80
38.5	228.4	13.5	7.81
31.5	228.8	13.4	7.81
24.5	229.0	13.3	7.81
17.5	228.9	13.2	7.85
10.5	228.8	13.1	7.82
--	--	--	--
September 24, 2008			
--	--	--	--
72.5	211.0	12.7	7.86
66.5	212.9	12.6	7.85
59.5	210.0	12.6	7.83
52.5	212.6	12.7	7.82
45.5	212.8	12.7	7.83
38.5	214.0	12.7	7.81
31.5	215.0	12.8	7.83
24.5	214.4	12.8	7.80
17.5	215.3	12.8	7.81
10.5	216.0	12.8	7.80
--	--	--	--
September 25, 2008			
--	--	--	--
73.5	204.4	12.9	7.87
66.5	204.3	12.9	7.86
59.5	204.6	12.9	7.85
52.5	205.2	12.9	7.84
45.5	206.0	12.9	7.84
38.5	206.5	13.0	7.83
31.5	207.2	13.0	7.86
24.5	208.0	13.0	7.86
17.5	208.5	13.0	7.87
10.5	207.1	13.1	7.87
--	--	--	--

Attachment A
Field Parameters - BH-SF-LF-0004
OU2 Groundwater/Surface Water Interaction Study
Bunker Hill Site OU2

Distance from Left Edge of Water (ft)	Spedific Conductance (uS/cm)	Temp (ºC)	pH
September 23, 2008			
--	--	--	--
5	270.0	13.7	7.32
11	259.4	13.7	7.36
17	248.8	13.8	7.40
23	242.3	13.8	7.43
29	238.0	13.8	7.44
35	235.0	13.9	7.47
41	233.2	14.0	7.47
47	232.3	14.1	7.49
53	230.2	14.1	7.47
59	230.3	14.1	7.49
--	--	--	--
September 24, 2008			
--	--	--	--
5	253.6	12.7	7.26
11	241.5	12.8	7.30
17	221.9	12.7	7.33
23	224.3	12.7	7.38
29	220.4	12.7	7.42
35	217.1	12.7	7.44
41	215.0	12.7	7.47
47	213.5	12.8	7.48
53	212.4	12.8	7.46
59	212.2	12.9	7.45
--	--	--	--
September 25, 2008			
--	--	--	--
5	260.8	12.6	7.35
11	247.6	12.7	7.36
17	239.9	12.7	7.40
23	232.5	12.7	7.43
29	228.0	12.8	7.46
35	225.7	12.8	7.46
41	223.5	12.9	7.48
47	221.8	12.9	7.50
53	221.0	12.9	7.51
59	220.2	12.9	7.50
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Attachment A
Field Parameters - BH-SF-LF-0005
OU2 Groundwater/Surface Water Interaction Study
Bunker Hill Site OU2

Distance from Left Edge of Water (ft)	Spedific Conductance (uS/cm)	Temp (ºC)	pH
September 23, 2008			
--	--	--	--
6.7	251.8	13.8	7.28
13	250.5	13.8	7.29
19.3	248.3	13.8	7.29
25.6	246.4	13.8	7.30
31.9	241.7	13.9	7.26
38.2	240.0	14.0	7.25
44.5	238.9	14.0	7.25
50.8	238.0	14.1	7.22
57.1	238.6	14.3	7.26
Braided Channel	236.8	14.0	7.43
--	--	--	--
September 24, 2008			
--	--	--	--
6.5	245.4	12.4	7.33
12.8	241.1	12.4	7.38
19.1	241.6	12.4	7.33
25.4	237.1	12.4	7.36
31.7	233.7	12.4	7.36
38	233.2	12.4	7.40
44.3	231.4	12.4	7.36
51.6	230.9	12.5	7.37
57.9	229.6	12.4	7.35
Braided Channel	220.9	12.8	7.39
--	--	--	--
September 25, 2008			
--	--	--	--
6.5	237.3	12.6	7.21
12.8	235.3	12.6	7.21
19.1	233.8	12.6	7.21
25.4	230.8	12.6	7.21
31.7	227.4	12.6	7.22
38	225.4	12.6	7.24
44.3	223.4	12.6	7.26
51.6	222.6	12.6	7.26
57.9	222.4	12.7	7.27
Braided Channel	218.8	13.0	7.35
--	--	--	--

Attachment A
Field Parameters - BH-SF-LF-0006
OU2 Groundwater/Surface Water Interaction Study
Bunker Hill Site OU2

Distance from Left Edge of Water (ft)	Spedific Conductance (uS/cm)	Temp (ºC)	pH
September 23, 2008			
--	--	--	--
7.7	591	13.6	7.15
13.1	635	13.8	7.15
18.5	462.6	13.5	7.22
23.9	341.5	13.5	7.22
29.3	293.2	13.4	7.26
34.7	277.4	13.5	7.22
40.1	268.1	13.5	7.21
45.5	265.7	13.5	7.21
50.9	262.7	13.7	7.23
56.3	259.5	14.1	7.27
--	--	--	--
September 24, 2008			
--	--	--	--
7.8	403.4	11.9	7.16
13.3	389.1	11.9	7.15
18.8	368.3	11.9	7.17
24.3	261.1	11.9	7.20
29.8	253.6	11.9	7.19
35.3	243.9	11.9	7.18
40.8	241.3	11.9	7.15
46.3	240.5	11.9	7.13
51.8	239.4	11.9	7.07
57.3	238.3	12.0	7.00
--	--	--	--
September 25, 2008			
--	--	--	--
7.8	606	13.2	7.12
13.3	593	13.2	7.17
18.8	487.5	13.0	7.21
24.3	332.3	12.9	7.23
29.8	290.7	12.9	7.26
35.3	271.7	12.9	7.25
40.8	265.5	12.9	7.28
46.3	253.9	12.9	7.29
51.8	257.6	12.9	7.29
57.3	256.7	12.9	7.28
--	--	--	--

Attachment A
Field Parameters - BH-SF-LF-0007
OU2 Groundwater/Surface Water Interaction Study
Bunker Hill Site OU2

Distance from Left Edge of Water (ft)	Spedific Conductance (uS/cm)	Temp (ºC)	pH
September 23, 2008			
--	--	--	--
39.5	298.8	12.0	7.41
35.5	299.7	12.0	7.41
31.5	299.5	12.0	7.41
27.5	299.0	12.1	7.41
23.5	298.6	12.1	7.40
19.5	298.5	12.1	7.40
15.5	298.1	12.1	7.40
11.5	297.4	12.1	7.41
7.5	296.7	12.1	7.43
3.5	295.0	12.3	7.51
--	--	--	--
September 24, 2008			
--	--	--	--
39.5	313.1	10.8	7.05
35.5	316.0	10.7	7.06
31.5	316.1	10.6	7.11
27.5	316.4	10.6	7.17
23.5	317.6	10.5	7.16
19.5	317.6	10.5	7.25
15.5	317.8	10.5	7.22
11.5	317.9	10.5	7.23
7.5	318.2	10.5	7.26
3.5	318.0	10.5	7.25
--	--	--	--
September 25, 2008			
--	--	--	--
39.5	294.4	12.2	7.33
35.5	295.5	12.1	7.32
31.5	296.0	12.1	7.34
27.5	296.1	12.1	7.34
23.5	296.3	12.1	7.35
19.5	296.4	12.1	7.35
15.5	296.4	12.1	7.35
11.5	296.3	12.1	7.35
7.5	296.3	12.1	7.35
3.5	296.3	12.1	7.37
--	--	--	--

Attachment A
Field Parameters - BH-SF-LF-0008
OU2 Groundwater/Surface Water Interaction Study
Bunker Hill Site OU2

Distance from Left Edge of Water (ft)	Spedific Conductance (uS/cm)	Temp (ºC)	pH
September 23, 2008			
--	--	--	--
68	285.3	11.6	7.51
61	286.2	11.5	7.45
54	288.2	11.4	7.41
47	288.0	11.4	7.36
40	289.5	11.3	7.37
33	289.1	11.3	7.34
26	289.3	11.3	7.36
19	289.2	11.3	7.34
12	289.7	11.3	7.37
5	288.6	11.4	7.36
--	--	--	--
September 24, 2008			
--	--	--	--
69	288.7	10.1	6.90
62	290.0	10.0	6.95
55	289.8	10.0	7.01
48	291.3	10.0	7.03
41	291.5	10.0	7.08
34	297.5	10.0	7.00
27	297.8	10.0	7.08
20	297.4	10.0	7.11
13	297.2	10.0	7.14
5	295.0	10.1	7.14
--	--	--	--
September 25, 2008			
--	--	--	--
69	288.8	11.5	7.26
62	288.8	11.6	7.27
55	287.7	11.5	7.28
48	287.9	11.6	7.29
41	288.7	11.5	7.30
34	288.8	11.6	7.30
27	288.3	11.6	7.30
20	288.3	11.6	7.31
13	288.5	11.6	7.31
5	288.1	11.7	7.30
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Attachment A
Field Parameters - BH-SF-LF-0009
OU2 Groundwater/Surface Water Interaction Study
Bunker Hill Site OU2

Distance from Left Edge of Water (ft)	Spedific Conductance (uS/cm)	Temp (ºC)	pH
September 23, 2008			
--	--	--	--
40.5	294.5	11.1	7.23
36.5	297.3	10.9	7.25
32.5	297.5	10.9	7.24
28.5	298.2	10.8	7.24
24.5	298.1	10.8	7.24
20.5	297.9	10.8	7.24
16.5	298.0	10.8	7.24
12.5	298.1	10.8	7.24
8.5	297.8	10.8	7.26
4.5	294.9	10.8	7.31
--	--	--	--
September 24, 2008			
--	--	--	--
40.5	272.3	10.1	6.31
36.5	274.2	9.9	6.46
32.5	276.9	9.8	6.55
28.5	276.9	9.8	6.65
24.5	276.8	9.8	6.73
20.5	277.7	9.7	6.77
16.5	277.7	9.7	6.82
12.5	277.5	9.7	6.85
8.5	277.5	9.7	6.87
4.5	277.7	9.7	6.89
--	--	--	--
September 25, 2008			
--	--	--	--
40.5	286.3	11.6	6.76
36.5	303.3	11.4	6.85
32.5	303.9	11.3	6.87
28.5	303.1	11.3	6.95
24.5	304.4	11.2	6.98
20.5	305.0	11.2	7.03
16.5	305.2	11.2	7.05
12.5	305.1	11.2	7.07
8.5	304.2	11.3	7.08
4.5	304.8	11.3	7.10
--	--	--	--

Attachment A
Field Parameters - BH-SF-LF-0010
OU2 Groundwater/Surface Water Interaction Study
Bunker Hill Site OU2

Distance from Left Edge of Water (ft)	Spedific Conductance (uS/cm)	Temp (ºC)	pH
September 23, 2008			
--	--	--	--
63.8	312.8	10.2	6.85
57.3	310.6	10.2	6.88
50.8	313.4	10.3	6.90
44.3	312.8	10.3	6.94
37.8	312.7	10.3	6.95
31.3	312.8	10.3	6.95
24.8	312.3	10.3	6.95
18.3	312.6	10.3	6.98
11.8	312.3	10.3	7.00
5.3	312.8	10.2	6.99
--	--	--	--
September 24, 2008			
--	--	--	--
63.8	284.2	9.4	6.68
57.3	283.6	9.4	6.76
50.8	283.3	9.4	6.79
44.3	282.6	9.4	3.82
37.8	282.7	9.4	6.83
31.3	282.4	9.4	6.86
24.8	282.4	9.4	6.91
18.3	282.1	9.4	6.91
11.8	282.3	9.4	6.90
5.3	282.2	9.4	6.94
--	--	--	--
September 25, 2008			
--	--	--	--
63.8	313.6	10.9	6.89
57.3	314.5	10.8	6.90
50.8	314.5	10.8	6.89
44.3	314.3	10.8	6.89
37.8	313.6	10.8	6.88
31.3	314.1	10.8	6.87
24.8	313.8	10.8	6.86
18.3	313.9	10.8	6.85
11.8	313.7	10.8	6.84
5.3	314.5	10.8	6.84
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Attachment A
Field Parameters - BH-SF-LF-0011
OU2 Groundwater/Surface Water Interaction Study
Bunker Hill Site OU2

Distance from Left Edge of Water (ft)	Spedific Conductance (uS/cm)	Temp (ºC)	pH
September 23, 2008			
--	--	--	--
6.0	275.5	9.8	6.74
12.8	278.6	9.8	6.72
19.6	279.7	9.8	6.68
26.4	280.1	9.8	6.63
33.2	280.9	9.8	6.58
40.0	280.9	9.8	6.55
46.8	281.6	9.8	6.49
53.6	282.4	9.8	6.45
60.4	283.0	9.8	6.34
67.2	283.4	9.8	6.24
--	--	--	--
September 24, 2008			
--	--	--	--
6	246.0	9.7	6.72
12.8	253.3	9.8	6.70
19.6	252.2	9.8	6.65
26.4	251.8	9.8	6.58
33.2	245.0	9.8	6.48
40.0	251.9	9.8	6.47
46.8	252.0	9.7	6.38
53.6	235.6	9.7	6.30
60.4	254.8	9.6	6.11
67.2	255.6	9.7	6.01
--	--	--	--
September 25, 2008			
--	--	--	--
6	269.7	10.7	6.85
12.8	274.0	10.8	6.85
19.6	274.4	10.8	6.83
26.4	274.2	10.8	6.83
33.2	274.1	10.8	6.83
40.0	274.9	10.8	6.83
46.8	275.4	10.8	6.82
53.6	275.4	10.8	6.77
60.4	276.4	10.8	6.78
67.2	273.0	10.8	6.76
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Attachment A
Field Parameters - BH-MC-0002
OU2 Groundwater/Surface Water Interaction Study
Bunker Hill Site OU2

Each Culvert	Spedific Conductance (uS/cm)	Temp (ºC)	pH
September 23, 2008			
1	**88.3**	**10**	**7.99**
2	88.2	9.9	7.86
3	88.6	9.8	7.87
4	88.7	9.8	7.86
September 24, 2008			
1	**83.5**	**10.4**	**7.87**
2	73.1	10.2	7.75
3	84.9	9.9	7.70
4	86.6	9.9	7.66
September 25, 2008			
1	**69.6**	**10.3**	**7.83**
2	76.4	10.3	7.74
3	71.3	10.0	7.64
4	71.6	10.0	7.58

Attachment A
Field Parameters - BH-GG-0004
OU2 Groundwater/Surface Water Interaction Study
Bunker Hill Site OU2

Distance from Left Edge of Water (ft)	Spedific Conductance (uS/cm)	Temp (ºC)	pH
September 23, 2008			
0	--	--	--
0.5	64.5	14.0	7.68
1.5	77.8	14.0	7.59
2.5	76.5	13.9	7.52
3.5	73.3	13.9	7.47
4.5	75.5	13.9	7.45
5.5	75.5	13.8	7.44
6.5	69.8	13.8	7.44
7.5	77.1	13.8	7.44
8.5	67.3	13.8	7.42
9.5	64.2	13.8	7.42
10	--	--	--
September 23, 2008			
0	--	--	--
0.5	77.8	12.0	7.16
1.5	65.4	12.0	7.10
2.5	71.9	12.0	7.13
3.5	34.4	12.0	7.11
4.5	22.5	12.0	7.13
5.5	41.4	12.0	7.15
6.5	71.6	11.9	7.17
7.5	72.3	11.9	7.16
8.5	74.0	11.9	7.17
9.5	72.7	11.9	7.17
10	--	--	--
September 23, 2008			
0	--	--	--
0.5	62.4	12.6	7.40
1.5	68.3	12.6	7.36
2.5	59.0	12.6	7.35
3.5	38.9	12.6	7.34
4.5	29.1	12.6	7.35
5.5	72.5	12.6	7.34
6.5	74.4	12.6	7.34
7.5	62.5	12.6	7.33
8.5	66.6	12.6	7.34
9.5	68.8	12.6	7.34
10	--	--	--

Attachment A
Field Parameters - BH-BC-0001
OU2 Groundwater/Surface Water Interaction Study
Bunker Hill Site OU2

Distance from Left Edge of Water (ft)	Spedific Conductance (uS/cm)	Temp (ºC)	pH
September 24, 2008			
0	--	--	--
0.5	2227.0	17.3	6.85
1.5	1116.0	17.4	6.88
2.5	1552.0	17.3	6.91
3.5	1394.0	17.3	6.94
4.5	1578.0	17.4	6.99
5.5	2071.0	17.4	7.04
September 25, 2008			
0	--	--	--
0.5	1280.0	15.2	6.68
1.5	888.0	15.2	6.69
2.5	1081.0	15.3	6.70
3.5	407.5	15.2	6.71
4.5	1001.0	15.3	6.73
5.5	1081.0	15.3	6.74
September 26, 2008			
0	--	--	--
0.5	1585.0	16.1	6.78
1.5	1581.0	16.1	6.75
2.5	1254.0	16.1	6.72
3.5	1621.0	16.1	6.72
4.5	1870.0	16.1	6.71
5.5	1681.0	16.1	6.71

Attachment A
Field Parameters - BH-PC-0001
OU2 Groundwater/Surface Water Interaction Study
Bunker Hill Site OU2

Distance from Left Edge of Water (ft)	Spedific Conductance (uS/cm)	Temp (ºC)	pH
September 23, 2008			
--	--	--	--
2.5	40.4	11.0	7.09
5.5	40.4	11.0	7.11
8.5	40.4	11.0	7.10
11.5	40.3	11	7.12
14.5	40.2	10.9	7.15
17.5	39.4	10.9	7.17
20.5	40.2	10.9	7.20
23.5	40.1	10.9	7.22
26.5	39.6	10.8	7.20
29.5	39.3	10.8	7.22
--	--	--	--
September 24, 2008			
--	--	--	--
2.5	39.9	10.5	6.80
5.5	39.9	10.6	6.79
8.5	39.9	10.6	6.78
11.5	39.9	10.6	6.81
14.5	39.8	10.6	6.79
17.5	39.8	10.6	6.74
20.5	39.8	10.6	6.77
23.5	39.8	10.5	6.73
26.5	39.5	10.4	6.78
29.5	36.5	10.1	6.42
--	--	--	--
September 25, 2008			
--	--	--	--
2.5	39.9	11.0	7.00
5.5	39.9	11.1	7.01
8.5	39.8	11.1	7.00
11.5	39.8	11.1	7.01
14.5	39.7	11.1	7.01
17.5	39.6	11.1	7.03
20.5	39.7	11.1	7.04
23.5	39.3	11.1	7.04
26.5	40.0	11.0	7.04
29.5	39.7	11.0	7.04
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Attachment A
Groundwater Field Parameters - In-Stream Minipiezometers
OU2 Groundwater/Surface Water Interaction Study
Bunker Hill Site OU2

Station	pH	Conductivity (uS/cm)	Dissolved Oxygen (mg/L)	Temp (ºC)
BH-SF-LF0001	7.57	186	13.29	12.75
BH-SF-LF0002	7.50	182	13.05	11.88
BH-SF-LF0003	7.45	183	13.00	12.48
BH-SF-LF0004	6.87	200	11.89	11.99
BH-SF-LF0005	6.90	210	9.39	11.82
BH-SF-LF0006	6.29	612	8.76	11.80
BH-SF-LF0007	6.82	244	8.82	12.32
BH-SF-LF0008	6.17	652	4.47	12.57
BH-SF-LF0009	5.80	162	7.84	10.41
BH-SF-LF0010	6.76	280	6.43	11.55
BH-SF-LF0011	6.11	69	6.77	9.14

Notes:
Groundwater field parameters measured on day three of the study.

Attachment B

Water Quality Summary Tables

Attachment B

Analytical Data Summary Table - Dissolved Metals

OU2 Groundwater/Surface Water Interaction Study

Param Group:				Diss	Diss	Diss	Diss	Diss	Diss	Diss	Diss	Diss	Diss	Diss	Diss	Diss	Diss	Diss	Diss	Diss	Diss	Diss	Diss	Diss	Diss	Diss
Parameter:				ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CALCIUM	CHROMIUM	COBALT	COPPER	IRON	LEAD	MAGNESIUM	MANGANESE	MERCURY	NICKEL	POTASSIUM	SELENIUM	SILVER	SODIUM	THALLIUM	VANADIUM	ZINC
Units:				UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
Object Name	Date Time	MATRIX	QC Type																							
BH-BC-0001	09/23/08	SW	N1	34 J	0.86 UJ	2.2	22	1.0 U	15	440,000	0.25 J	1.5	1.9 J	100 U	0.44 J	107,000	8,980	0.20 U	5.5	8,090	1.0 J	1.0 U	1,460 J	0.56 UJ	5.0 UJ	749
BH-BC-0001	09/24/08	SW	N1	200 U	1.8 UJ	3.1	21	1.0 U	19	348,000	0.38 UJ	1.1	2.1	100 U	0.65 UJ	80,500	6,720	0.072 J	7.0	4,990 UJ	2.2 UJ	1.0 U	2,800 J	0.38 UJ	1.2 J	1,360
BH-BC-0001	09/24/08	SW	FD1	200 U	1.7 UJ	3.5	21	1.0 U	19	352,000	0.41 UJ	1.2	2.0	100 U	0.65 UJ	81,100	6,840	0.077 J	7.1	5,030	2.1 UJ	1.0 U	2,820 J	0.38 UJ	1.3 J	1,380
BH-BC-0001	09/25/08	SW	N1	200 U	0.72 UJ	1.8	22	1.0 U	15	434,000	0.14 UJ	1.7	1.9 J	100 U	0.21 UJ	108,000	8,610	0.20 U	5.8	6,370	0.98 UJ	1.0 U	2,330 UJ	0.49 UJ	5.0 U	846
BH-GG-0004	09/23/08	SW	N1	200 U	0.99 UJ	0.37 J	30	1.0 U	49	7,280	0.099 J	1.4	1.9 J	100 U	0.94 J	1,790 UJ	56	0.20 U	2.8	900 J	5.0 U	1.0 U	972 J	1.0 U	5.0 UJ	1,640
BH-GG-0004	09/23/08	SW	FD1	200 U	0.90 UJ	0.30 J	31	1.0 U	48	7,540	0.14 J	0.59 UJ	2.0 J	3.3 UJ	0.96 J	1,850 UJ	55	0.20 U	2.7	914 J	5.0 U	1.0 U	1,040 J	1.0 U	5.0 UJ	1,580
BH-GG-0004	09/24/08	SW	N1	200 U	0.99 UJ	0.37 J	30	1.0 U	51	7,460	0.14 UJ	0.28 UJ	1.7 J	100 U	0.39 UJ	1,810 J	53	0.092 J	2.8	804 UJ	5.0 U	1.0 U	1,610 J	1.0 U	0.67 J	1,710
BH-GG-0004	09/25/08	SW	N1	200 U	0.92 UJ	0.33 UJ	31	1.0 U	52	7,410	0.055 UJ	0.27 UJ	1.8 J	100 U	0.54 UJ	1,820 UJ	51	0.20 U	2.8	852 J	5.0 U	1.0 U	1,450 UJ	1.0 U	5.0 U	1,760
BH-GG-0004	09/25/08	SW	FD1	200 U	0.94 UJ	0.34 UJ	31	1.0 U	52	7,380	0.037 J	0.27 UJ	1.8 J	100 U	0.64 UJ	1,800 UJ	52	0.20 U	2.8	876 J	5.0 U	1.0 U	800 UJ	1.0 U	0.79 J	1,760
BH-MC-0002	09/23/08	SW	N1	200 U	0.31 J	0.16 J	19	1.0 U	3.9	7,320	0.059 J	0.61 UJ	0.76 J	100 U	118	2,990 UJ	296	0.20 U	1.4	677 J	5.0 U	1.0 U	5,000 U	1.0 U	5.0 UJ	959
BH-MC-0002	09/24/08	SW	N1	200 U	0.23 J	0.13 J	21	1.0 U	4.6	7,760	0.052 J	0.44 UJ	0.96 J	100 U	95	3,140 J	337	0.20 U	1.4	657 UJ	5.0 U	1.0 U	979 J	1.0 U	0.48 J	1,110
BH-MC-0002	09/25/08	SW	N1	200 U	2.0 U	0.083 J	21	1.0 U	4.5	7,730	2.0 U	0.42 UJ	0.96 J	100 U	149	3,240 UJ	329	0.20 U	1.4	711 J	5.0 U	1.0 U	5,000 U	1.0 U	5.0 U	1,100
BH-PC-0001	09/23/08	SW	N1	200 U	4.3	0.26 J	12	1.0 U	0.093 UJ	3,480 J	2.0 U	1.0 U	0.23 J	13 UJ	0.13 UJ	1,150 UJ	4.3	0.20 U	0.47 J	547 UJ	5.0 U	1.0 U	1,400 J	1.0 U	0.19 UJ	57
BH-PC-0001	09/24/08	SW	N1	200 U	4.4	0.27 J	12	1.0 U	0.11 J	3,630 J	0.037 J	1.1	0.24 J	8.1 J	0.19 UJ	1,180 UJ	4.8	0.20 U	0.54 J	608 J	5.0 U	1.0 U	799 J	1.0 U	5.0 UJ	60
BH-PC-0001	09/25/08	SW	N1	200 U	4.5	0.26 UJ	13	1.0 U	0.11 UJ	3,610 J	0.087 UJ	1.0 U	0.24 J	7.1 UJ	0.16 UJ	1,160 UJ	3.2	0.20 U	0.43 J	591 J	5.0 U	1.0 U	1,860 UJ	1.0 U	0.18 J	66
BH-SF-LF-0001	09/23/08	SW	N1	200 U	5.6	0.44 J	58	1.0 U	4.8	22,400	0.13 J	0.37 UJ	0.59 J	3.8 J	4.2	10,900	40	0.20 U	0.76 J	1,690 J	5.0 U	1.0 U	6,410	1.0 U	5.0 UJ	610
BH-SF-LF-0001	09/24/08	SW	N1	200 U	5.6	0.49 J	58	1.0 U	4.8	21,400	0.12 UJ	0.096 UJ	0.70 J	9.3 J	8.1	9,530	40	0.20 U	0.68 J	1,350 UJ	5.0 U	1.0 U	4,470 J	1.0 U	0.56 J	623
BH-SF-LF-0001	09/25/08	SW	N1	200 U	5.7	0.44 UJ	61	1.0 U	5.2	20,900	2.0 U	0.12 UJ	0.62 J	18 UJ	5.2	9,110	39	0.20 U	0.79 J	1,400 J	5.0 U	1.0 U	4,180 UJ	1.0 U	5.0 U	656
BH-SF-LF-0001	09/25/08	WG	N1	200 U	6.3	0.35 J	63	1.0 U	5.4	20,800	2.0 U	0.047 UJ	0.89 UJ	8.7 J	3.6	8,840	10	0.20 U	0.67 J	1,420 J	5.0 U	1.0 U	3,980 UJ	1.0 U	5.0 UJ	704
BH-SF-LF-0002	09/23/08	SW	N1	200 U	5.3	0.45 J	57	1.0 U	4.8	21,800	0.13 J	0.12 UJ	0.67 J	11 J	6.2	10,500	45	0.20 U	0.70 J	1,650 J	5.0 U	1.0 U	5,020	1.0 U	5.0 UJ	609
BH-SF-LF-0002	09/24/08	SW	N1	200 U	5.4	0.51 J	57	1.0 U	4.9	21,000	0.13 UJ	0.12 UJ	0.66 J	10 J	5.9	9,430	46	0.20 U	0.74 J	1,360 UJ	5.0 U	1.0 U	4,410 J	1.0 U	0.69 J	648
BH-SF-LF-0002	09/25/08	SW	N1	200 U	5.4	0.45 UJ	61	1.0 U	5.0	20,900	0.053 J	0.10 UJ	0.66 J	2.5 J	6.0	9,320	47	0.20 U	0.79 J	1,390 J	5.0 U	1.0 U	3,500 UJ	1.0 U	0.72 J	657
BH-SF-LF-0002	09/25/08	WG	N1	200 U	6.3	0.41 J	68	1.0 U	5.5	20,200	2.0 U	0.14 UJ	0.86 UJ	10 J	4.1	8,290	2.0	0.20 U	0.75 J	1,360 J	5.0 U	0.023 UJ	3,830 UJ	1.0 U	5.0 UJ	716
BH-SF-LF-0003	09/23/08	SW	N1	200 U	5.3	0.48 J	57	1.0 U	4.7	21,100	0.14 J	1.2	0.67 J	5.8 J	5.6	10,300	47	0.20 U	0.76 J	1,640 J	5.0 U	1.0 U	4,970 J	1.0 U	5.0 UJ	616
BH-SF-LF-0003	09/24/08	SW	N1	200 U	5.5	0.44 J	58	1.0 U	5.0	20,800	0.080 UJ	1.1	0.62 J	5.7 J	5.7	9,340	49	0.20 U	0.79 J	1,320 UJ	5.0 U	1.0 U	4,300 J	1.0 U	5.0 U	658
BH-SF-LF-0003	09/25/08	SW	N1	200 U	5.6	0.40 UJ	60	1.0 U	5.2	21,100	2.0 U	0.10 UJ	0.58 J	100 U	5.6	9,310	44	0.20 U	0.74 J	1,420 J	5.0 U	1.0 U	4,660 UJ	1.0 U	5.0 U	695
BH-SF-LF-0003	09/25/08	WG	N1	200 U	6.1	0.42 J	61	1.0 U	4.6	19,800	2.0 U	0.060 UJ	0.87 UJ	15 J	2.3	8,520	3.1	0.20 U	0.69 J	1,410 J	5.0 U	1.0 U	3,630 UJ	1.0 U	5.0 UJ	616
BH-SF-LF-0004	09/23/08	SW	N1	200 U	5.1	0.68 J	57	1.0 U	6.7	23,000	0.080 J	2.1	0.71 J	117	3.7	11,100	188	0.20 U	1.6	1,680 J	5.0 U	1.0 U	4,900 J	1.0 U	5.0 UJ	982
BH-SF-LF-0004	09/24/08	SW	N1	47 J	4.9	0.68 J	56	1.0 U	7.4	22,600	2.0 U	0.40 UJ	0.71 J	166	5.7	9,960	207	0.20 U	1.6	1,530 J	5.0 U	1.0 U	5,170	1.0 U	5.0 UJ	1,090
BH-SF-LF-0004	09/25/08	SW	N1	200 U	5.1	0.71 J	57	1.0 U	7.3	22,600	0.11 UJ	0.40 UJ	0.64 J	163	5.9	9,620	216	0.20 U	1.5	1,350 UJ	5.0 U	1.0 U	4,490 J	1.0 U	5.0 U	1,090
BH-SF-LF-0004	09/25/08	WG	N1	200 U	4.9	0.24 J	39	1.0 U	6.0	21,600	2.0 U	0.85 UJ	1.2 UJ	199	10	9,370	640	0.20 U	4.7	1,670 J	5.0 U	1.0 U	4,580 UJ	1.0 U	5.0 UJ	1,290
BH-SF-LF-0005	09/23/08	SW	N1	200 U	5.0	0.80 J	56	1.0 U	7.0	23,400	0.063 J	0.46 UJ	0.72 J	169	5.3	11,000	229	0.20 U	1.7	1,700 J	5.0 U	1.0 U	5,870	1.0 U	5.0 UJ	1,060
BH-SF-LF-0005	09/24/08	SW	N1	200 U	5.1	0.74 J	57	1.0 U	7.7	23,500	0.088 UJ	0.50 UJ	0.67 J	205	5.9	10,400	254	0.094 J	1.7	1,460 UJ	5.0 U	1.0 U	4,540 J	1.0 U	0.26 J	1,200
BH-SF-LF-0005	09/25/08	SW	N1	200 U	5.2	0.73 UJ	59	1.0 U	8.1	23,200	2.0 U	0.49 UJ	0.67 J	180	6.1	10,500	254	0.20 U	1.7	1,530 J	5.0 U	1.0 U	4,380 UJ	1.0 U	5.0 U	1,270
BH-SF-LF-0005	09/25/08	WG	N1	200 U	5.7	0.36 J	46	1.0 U	4.3	24,300	2.0 U	0.044 UJ	1.1 UJ	100 U	1.0 U	9,280	12	0.20 U	1.5	1,370 J	5.0 U	1.0 U	3,990 UJ	1.0 U	5.0 UJ	946
BH-SF-LF-0006	09/23/08	SW	N1	200 U	4.6	0.71 J	55	1.0 U	8.8	37,400	0.15 J	0.54 UJ	0.73 J	145	4.7	14,000	537	0.20 U	2.1	1,870 J	5.0 U	1.0 U	5,320	0.046 UJ	5.0 UJ	1,110
BH-SF-LF-0006	09/24/08	SW	N1	200 U	4.9	0.71 J	56	1.0 U	9.6	28,800	0.099 UJ	0.54 UJ	0.65 J	162	5.7	11,500	405	0.097 J	2.0	1,530 UJ	5.0 U	1.0 U	4,370 J	0.034 UJ	0.23 J	1,240
BH-SF-LF-0006	09/25/08	SW	N1	31 J	4.8	0.68 UJ	56	1.0 U	10	41,500	0.035 J	0.62 UJ	0.74 J	161	4.6	14,400	652	0.20 U	2.2	1,730 J	5.0 U	1.0 U	4,750 UJ	0.038 UJ	0.95 J	1,300
BH-SF-LF-0006	09/25/08	WG	N1	160 UJ	3.4	0.22 J	60	0.089 J	208	97,000	2.0 U	1.4	2.7	11 UJ	34	23,800	1,000	0.20 U	13	4,460 J	5.0 U	1.0 U	4,250 UJ	0.31 UJ	5.0 UJ	6,590
BH-SF-LF-0007	09/23/08	SW	N1	200 U	4.8	0.53 J	54	1.0 U	8.5	31,500	0.10 J	1.4	0.56 J	42 J	0.87 UJ	12,900	389	0.20 U	1.9	1,800 J	5.0 U	1.0 U	4,910 J	0.055 UJ	5.0 UJ	1,100
BH-SF-LF-0007	09/24/08	SW	N1	41 J	4.6	0.55 J	55	1.0 U	9.4	36,400	2.0 U	0.57 UJ	0.60 J	108	4.0	13,500	554	0.20 U	2.0	1,750 J	5.0 U	1.0 U	4,340 J	0.039 UJ	5.0 UJ	1,230
BH-SF-LF-0007	09/24/08	SW	FD1	200 U	4.6	0.64 J	55	1.0 U	9.3	36,300	0.088 J	0.53 UJ	0.70 J	110	3.9	13,200	555	0.20 U	2.0	1,820 J	5.0 U	1.0 U	5,120	0.040 UJ	1.5 J-	1,230
BH-SF-LF-0007	09/25/08	SW	N1	32 J	4.8	0.57 UJ	58	1.0 U	9.8	33,200	2.0 U	0.54 UJ	0.54 J	88 UJ	4.5	12,600	469	0.20 U	2.2	1,630 J	5.0 U	1.0 U	4,200 UJ	1.0 U	0.74 J	1,280
BH-SF-LF-0007	09/25/08	WG	N1	200 U	1.9 UJ	0.14 J	91	1.0 U	3.7	29,600	2.0 U	0.076 UJ	0.59 UJ	27 UJ	0.12 U	8,850	9.3	0.20 U	0.81 J	1,380 J	5.0 U	1.0 U	4,960 UJ	1.0 U	5.0 UJ	388
BH-SF-LF-0008	09/23/08	SW	N1	57 UJ	4.5	0.56 J	55	1.0 U	8.1 J-	28,900	0.13 UJ	0.48 UJ	0.53 J	61 J	2.2	12,000	377	0.20 U	1.8	1,760 J	5.0 U	1.0 UJ	4,550 UJ	1.0 U	0.68 J	1,100
BH-SF-LF-0008	09/24/08	SW	N1	200 U	4.7	0.55 UJ	58	1.0 U	9.6	30,200	2.0 U	1.5	0.50 J	65 J	0.81 U	12,000	398	0.20 U	1.9	1,810 J	5.0 U	1.0 U	3,950 UJ	0.045 UJ	5.0 UJ	1,280
BH-SF-LF-0008	09/25/08	SW	N1	200 U	4.5	0.54 UJ	58	1.0 U	9.6	32,500	2.0 U	0.54 UJ	0.64 J	83 UJ	3.3	12,300	443	0.20 U	2.1	1,630 J	5.0 U	1.0 U	4,430 UJ	1.0 U	0.82 J	1,270
BH-SF-LF-0008	09/25/08	WG	N1	200 U	1.3 UJ	0.084 J	132	1.0 U	12	24,800	2.0 U	0.82 UJ	1.1 UJ	11 UJ	2.7	10,400	619	0.20 U	4.4	1,710 J	5.0 U	1.0 U	5,780	1.0 U	5.0 UJ	3,610
BH-SF-LF-0009	09/23/08	SW	N1	45 UJ	4.6	0.54 J	56	1.0 U	8.5 J-	30,600	0.037 J	0.48 UJ	0.53 J	61 J	2.4	12,700	383	0.20 U	1.9	1,790 J	5.0 U	1.0 UJ	5,720	1.0 U	0.63 J	1,140
BH-SF-LF-0009	09/23/08	SW	FD1	41 UJ	4.5	0.54 J	56	1.0 U	8.5 J-	30,200	0.059 UJ	0.49 UJ	0.53 J	60 J	1.8	12,500	386	0.20 U	1.8	1,830 J	5.0 U	1.0 UJ	4,560 UJ	1.0 U	0.58 J	1,150
BH-SF-LF-0009	09/24/08	SW	N1	200 U	4.8	0.54 J	58	1.0 U	9.6	29,300	0.16 UJ	0.50 UJ	0.61 J	92 J	3.8	11,600	366	0.072 J	2.0	1,550 UJ	5.0 U	1.0 U	4,540 J	1.0 U	0.62 J	1,270
BH-SF-LF-0009	09/25/08	SW	N1	200 U	4.4	0.52 UJ	58	1.0 U	10	34,400	0.11 UJ	0.58 UJ	0.49 J	81 UJ	3.4	12,700	494	0.087 U	2.1	1,630 J	5.0 U	1.0 U	4,070 UJ	1.0 U	1.0 J	1,320
BH-SF-LF-0009	09/25/08	SW	FD1	31 J	4.5	0.50 UJ	58	1.0 U	10	34,300	0.062 UJ	0.55 UJ	0.55 J	64 UJ	3.5	12,700	487	0.20 U	2.1	1,630 J	5.0 U	1.0 U	4,670 UJ	1.0 U	5.0 U	1,350
BH-SF-LF-0009	09/25/08	WG	N1	103 UJ	0.52 UJ	0.70 J	26	1.0 U	0.95 J	16,700	0.12 UJ	0.25 UJ	2.8	411	48	4,930 UJ	53	0.20 U	7.4	1,480 J	5.0 U	1.0 U	4,460 UJ	1.0 U	5.0 UJ	1,510
BH-SF-LF-0010	09/23/08	SW	N1	200 U	4.4	0.68 UJ	56 J	1.0 U	8.9	31,400	0.13 UJ	0.58 UJ	0.73 J	132	4.0	12,600	452	0.20 U	2.1	1,760 UJ	5.0 U	1.0 U	4,730 J	0.041 UJ	1.7 J	1,250
BH-SF-LF-0010	09/24/08	SW	N1	200 U	4.5	0.67 J	56	1.0 U	9.3	29,300	0.20 UJ	0.61 UJ	0.67 J	160	4.6	11,500	412	0.034 J	2.1	1,680 UJ	5.0 U	1.0 U	4,880 J	1.0 U	1.1 J	1,330
BH-SF-LF-0010	09/25/08	SW	N1	200 U	4.4	0.60 J	55	1.0 U	9.7	35,400	0.046 J	0.65 UJ	0.63 J	172	5.2	12,400	529	0.20 U	2.4	1,770 J	5.0 U	1.0 U	5,020	0.059 UJ	5.0 UJ	1,360
BH-SF-LF-0010	09/25/08	WG	N1	200 U	3.5	1.0 U	68	1.0 U	4.8	33,600	2.0 U	0.060 UJ	1.6 UJ	10 UJ	2.2	12,000	3.7	0.20 U	2.4	1,740 J	5.0 U	1.0 U	4,850 UJ	1.0 U	5.0 UJ	1,190
BH-SF-LF-0011	09/23/08	SW	N1	200 U	4.1	0.48 J	51	1.0 U	7.5	28,400	0.040 J	0.50 UJ	0.62 J	89 J	3.0	11,500	384	0.20 U	2.0	1,840 J	5.0 U	1.0 U	5,430	1.0 U	0.21 J	1,090
BH-SF-LF-0011	09/24/08	SW	N1	200 U	4.4	0.56 UJ	51	1.0 U	8.1	25,700	2.0 U	0.51 UJ	0.56 J	108	4.0	10,300	350	0.20 U	2.0	1,740 J	5.0 U	1.0 U	4,210 UJ	1.0 U	0.44 J	1,180
BH-SF-LF-0011	09/25/08	SW	N1	200 U	4.3	0.49 J	49	1.0 U	8.2	5,000 U	0.064 J	0.56 UJ	0.57 J	100 U	4.3	5,000 U	456	0.20 U	2.1	36 J	5.0 U	1.0 U	1,890 J	0.042 UJ	5.0 UJ	1,190
BH-SF-LF-0011	09/25/08	WG	N1	200 U	0.85 UJ	0.12 J	21	1.0 U	0.74 J	5,930	2.0 U	0.034 UJ	0.67 UJ	3.2 UJ	0.31 U	2,030 UJ	8.3	0.20 U	0.91 J	703 J	5.0 U	1.0 U	2,370 UJ	1.0 U	5.0 UJ	278

Attachment B

Analytical Data Summary Table - Total Metals

OU2 Groundwater/Surface Water Interaction Study

Param Group:				Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total
Parameter:				ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CALCIUM	CHROMIUM	COBALT	COPPER	IRON	LEAD	MAGNESIUM	MANGANESE	MERCURY	NICKEL	POTASSIUM	SELENIUM	SILVER	SODIUM	THALLIUM	VANADIUM	ZINC
Units:				UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
Object Name	Date'Time	MATRIX	QC Type																							
BH-BC-0001	09/24/08	SW	N1		2.0 U	3.8	23	1.0 U	22		0.69 UJ	1.5	5.0		12		7,480	0.20 U	7.1		1.9 UJ	0.049 UJ		0.69 UJ	1.4 J	1,440 J-
BH-BC-0001	09/24/08	SW	FD1		1.8 UJ	3.9	22	1.0 U	20		0.73 UJ	1.5	4.8		12		7,550	0.11 J	7.5		2.2 UJ	0.035 UJ		0.48 UJ	1.7 J	1,360 J-
BH-BC-0001	09/25/08	SW	N1		0.75 UJ	2.0	22	1.0 U	14 J+		0.28 UJ	1.8	2.8		0.98 UJ		9,520	0.20 U	5.9		1.1 UJ	1.0 U		0.52 UJ	0.56 J	910
BH-GG-0004	09/23/08	SW	N1		1.3 UJ	0.41 UJ	34	1.0 U	54		0.21 UJ	0.33 UJ	2.7		2.1 J+		62	0.20 U	3.1		5.0 U	0.025 UJ		0.099 UJ	5.0 U	1,740
BH-GG-0004	09/23/08	SW	FD1		1.1 UJ	0.46 UJ	33	1.0 U	53		0.18 UJ	0.33 UJ	2.6		2.0 J+		62	0.099 U	3.0		5.0 U	0.020 UJ		0.038 UJ	5.0 U	1,730
BH-GG-0004	09/24/08	SW	N1		0.95 UJ	0.35 UJ	30	1.0 U	50		0.16 UJ	0.32 UJ	2.1		1.5		59	0.20 U	2.8		5.0 U	1.0 U		0.049 UJ	0.65 J	1,610 J-
BH-GG-0004	09/25/08	SW	N1		1.0 UJ	0.41 UJ	31	1.0 U	51		0.091 UJ	0.30 UJ	2.2		1.6 J+		57	0.20 U	4.6		5.0 U	1.0 U		1.0 U	0.36 J	1,800
BH-GG-0004	09/25/08	SW	FD1		1.1 UJ	0.43 UJ	31	1.0 U	50		0.14 UJ	0.28 UJ	2.2		1.6 J+		55	0.20 U	2.8		5.0 U	1.0 U		1.0 U	0.37 J	1,750
BH-MC-0002	09/23/08	SW	N1		0.27 J	0.38 UJ	22	1.0 U	4.4 J+		0.16 UJ	0.45 UJ	1.9 J		197		374	0.20 U	1.7		5.0 U	0.030 UJ		1.0 U	5.0 U	1,130
BH-MC-0002	09/24/08	SW	N1		0.24 J	0.45 UJ	21	1.0 U	4.3 J+		0.073 UJ	0.42 UJ	1.9 J		207		354	0.20 U	1.5		5.0 U	0.027 UJ		1.0 U	0.21 J	1,130
BH-MC-0002	09/25/08	SW	N1		0.25 J	0.41 UJ	22	1.0 U	4.9		0.041 J	0.42 UJ	1.9 J		203		352	0.20 U	1.5		5.0 U	0.043 UJ		1.0 U	0.19 UJ	1,130
BH-PC-0001	09/23/08	SW	N1		4.8	0.26 J	13	1.0 U	0.12 UJ		0.042 J	1.0 U	0.38 J		0.78 UJ		4.6	0.20 U	0.50 J		5.0 U	1.0 U		1.0 U	5.0 U	63 J-
BH-PC-0001	09/24/08	SW	N1		4.7	0.24 UJ	13	1.0 U	0.12 UJ		0.046 J	0.030 UJ	0.23 J		0.68 UJ		3.5	0.20 U	0.49 J		5.0 U	1.0 U		1.0 U	5.0 U	65 J-
BH-PC-0001	09/25/08	SW	N1		5.1	0.37 UJ	14	1.0 U	0.13 UJ		0.15 UJ	0.035 UJ	0.38 J		1.0 U		4.1	0.20 U	0.62 J		5.0 U	1.0 U		0.10 UJ	5.0 UJ	71
BH-SF-LF-0001	09/23/08	SW	N1		6.1	0.52 UJ	63	1.0 U	5.1 J+		0.16 UJ	0.16 UJ	1.1 J		9.7 J+		49	0.20 U	0.88 J		5.0 U	1.0 U		1.0 U	5.0 U	685
BH-SF-LF-0001	09/24/08	SW	N1		5.7	0.56 UJ	62	1.0 U	5.1		0.14 UJ	0.14 UJ	0.96 J		16		47	0.082 J	0.85 J		5.0 U	1.0 U		1.0 U	0.45 J	641 J-
BH-SF-LF-0001	09/25/08	SW	N1		6.2	0.50 UJ	64	1.0 U	5.7		0.039 J	0.13 UJ	0.96 J		8.6		44	0.20 U	0.84 J		5.0 U	1.0 U		1.0 U	5.0 UJ	703
BH-SF-LF-0001	09/25/08	WG	N1	200 U						20,300				37 J		8,860				1,640 UJ			4,460 J			
BH-SF-LF-0002	09/23/08	SW	N1		5.6	0.50 UJ	60	1.0 U	5.5 J+		0.15 UJ	0.13 UJ	1.0 J		16 J+		54	0.20 U	1.1		5.0 U	1.0 U		1.0 U	5.0 U	689
BH-SF-LF-0002	09/24/08	SW	N1		5.4	0.46 UJ	60	1.0 U	5.1		0.12 UJ	0.13 UJ	0.86 J		11		49	0.20 U	0.86 J		5.0 U	1.0 U		1.0 U	0.43 J	653 J-
BH-SF-LF-0002	09/25/08	SW	N1		6.1	0.50 UJ	64	1.0 U	5.7		0.090 UJ	0.11 UJ	1.0 J		11		51	0.20 U	0.85 J		5.0 U	1.0 U		1.0 U	5.0 UJ	732
BH-SF-LF-0002	09/25/08	WG	N1	200 U						20,800				14 J		8,990				1,570 UJ			4,390 J			
BH-SF-LF-0003	09/23/08	SW	N1		5.8	0.59 UJ	61	1.0 U	5.2 J+		0.16 UJ	0.15 UJ	0.98 J		12 J+		53	0.20 U	0.84 J		5.0 U	1.0 U		1.0 U	5.0 U	698
BH-SF-LF-0003	09/24/08	SW	N1		5.6	0.44 U	60	1.0 U	5.0		0.11 U	0.12 U	0.84 J		9.9		49	0.20 U	0.80 J		5.0 U	1.0 U		1.0 U	0.41 J	644 J-
BH-SF-LF-0003	09/25/08	SW	N1		6.1	0.43 UJ	64	1.0 U	5.8		2.0 U	0.12 UJ	1.0 J		10		49	0.20 U	0.85 J		5.0 U	1.0 U		1.0 U	5.0 UJ	743
BH-SF-LF-0003	09/25/08	WG	N1	200 U						21,200				15 J		9,160				1,590 UJ			4,470 J			
BH-SF-LF-0004	09/23/08	SW	N1		5.4	0.78 UJ	60	1.0 U	6.9 J+		0.10 UJ	0.40 UJ	1.0 J		11 J+		219	0.032 U	1.7		5.0 U	1.0 U		1.0 U	0.15 J	1,120
BH-SF-LF-0004	09/24/08	SW	N1		5.2	0.80 UJ	58	1.0 U	7.3 J+		0.079 UJ	0.42 UJ	0.95 J		9.8 J+		237	0.20 U	1.6		5.0 U	1.0 U		1.0 U	5.0 U	1,190
BH-SF-LF-0004	09/25/08	SW	N1		5.7	0.88 UJ	64	1.0 U	8.6		0.033 J	0.45 UJ	1.1 J		10		237	0.20 U	1.8		5.0 U	1.0 U		1.0 U	5.0 UJ	1,280
BH-SF-LF-0004	09/25/08	WG	N1	104 J						21,900				458		9,590				1,780 UJ			4,570 J			
BH-SF-LF-0005	09/23/08	SW	N1		5.2	0.83 UJ	59	1.0 U	7.3 J+		0.091 UJ	0.50 UJ	0.96 J		11 J+		267	0.20 U	1.6		5.0 U	1.0 U		1.0 U	5.0 U	1,190
BH-SF-LF-0005	09/24/08	SW	N1		5.0	0.78 UJ	58	1.0 U	7.7		0.12 UJ	0.51 UJ	0.88 J		9.8		271	0.20 U	1.9		5.0 U	1.0 U		0.035 UJ	0.40 J	1,160 J-
BH-SF-LF-0005	09/25/08	SW	N1		5.6	0.88 UJ	62	1.0 U	8.8		0.035 J	0.53 UJ	0.99 J		16		276	0.20 U	1.9		5.0 U	1.0 U		1.0 U	5.0 UJ	1,320
BH-SF-LF-0005	09/25/08	WG	N1	168 J						97,300				22 J		24,700				4,320 UJ			5,370			
BH-SF-LF-0006	09/23/08	SW	N1		5.0	0.88 UJ	57	1.0 U	8.9 J+		0.17 UJ	0.59 UJ	1.1 J		12 J+		617	0.20 U	2.8		5.0 U	1.0 U		0.048 UJ	5.0 U	1,270
BH-SF-LF-0006	09/24/08	SW	N1		5.1	0.82 UJ	58	1.0 U	10		0.12 UJ	0.61 UJ	0.94 J		13		422	0.20 U	2.1		5.0 U	1.0 U		0.044 UJ	0.44 J	1,250 J-
BH-SF-LF-0006	09/25/08	SW	N1		5.5	1.2	63	1.0 U	12		0.054 J	0.71 UJ	1.3 J		23		719	0.20 U	2.4		5.0 U	1.0 U		0.048 UJ	5.0 UJ	1,480
BH-SF-LF-0006	09/25/08	WG	N1	167 J						102,000				20 J		25,600				4,440 UJ			5,480			
BH-SF-LF-0007	09/23/08	SW	N1		4.9	0.88 UJ	58	1.0 U	8.9 J+		0.16 UJ	0.56 UJ	1.1 J		13 J+		459	0.20 U	2.0		5.0 U	1.0 U		0.037 UJ	0.26 J	1,280
BH-SF-LF-0007	09/24/08	SW	N1		5.1	0.84 UJ	59	1.0 U	9.8 J+		2.0 U	0.62 UJ	1.1 J		12 J+		610	0.20 U	2.2		5.0 U	1.0 U		0.048 UJ	5.0 U	1,410
BH-SF-LF-0007	09/24/08	SW	FD1		5.0	0.78 UJ	59	1.0 U	9.6 J+		0.066 UJ	0.62 UJ	1.0 J		12 J+		607	0.20 U	2.2		5.0 U	1.0 U		0.044 UJ	5.0 U	1,410
BH-SF-LF-0007	09/25/08	SW	N1		5.4	0.83 UJ	61	1.0 U	11		0.071 UJ	0.63 UJ	1.0 J		13		493	0.14 U	2.1		5.0 U	1.0 U		0.049 UJ	5.0 UJ	1,400
BH-SF-LF-0007	09/25/08	WG	N1	492						31,500				565		9,630				1,590 UJ			4,290 J			
BH-SF-LF-0008	09/23/08	SW	N1		4.9	0.73 J	59	1.0 U	9.4		0.12 UJ	0.53 UJ	1.2 J		12		381	0.20 U	2.0		5.0 U	1.0 U		1.0 U	5.0 U	1,200 J-
BH-SF-LF-0008	09/24/08	SW	N1		4.9	0.69 UJ	59	1.0 U	9.4 J+		2.0 U	0.56 UJ	1.0 J		11 J+		422	0.20 U	2.0		5.0 U	1.0 U		0.034 UJ	0.20 J	1,390
BH-SF-LF-0008	09/25/08	SW	N1		5.2	0.86 UJ	63	1.0 U	11		0.044 J	0.60 UJ	1.0 J		13		478	0.20 U	2.1		5.0 U	1.0 U		0.042 UJ	5.0 UJ	1,380
BH-SF-LF-0008	09/25/08	WG	N1	200 U						25,700				28 J		10,600				1,930 UJ			6,220			
BH-SF-LF-0009	09/23/08	SW	N1		4.9	0.72 J	60	1.0 U	9.6		0.051 J	0.50 UJ	1.1 J		13		394	0.20 U	2.0		5.0 U	1.0 U		1.0 U	5.0 U	1,240 J-
BH-SF-LF-0009	09/23/08	SW	FD1		5.1	0.78 J	61	1.0 U	9.8		2.0 U	0.52 UJ	1.1 J		13		399	0.20 U	2.0		5.0 U	1.0 U		1.0 U	5.0 U	1,270 J-
BH-SF-LF-0009	09/24/08	SW	N1		4.8	0.72 UJ	62	1.0 U	10		0.21 UJ	0.57 UJ	0.94 J		11		384	0.057 U	2.1		5.0 U	1.0 U		0.038 UJ	0.33 J	1,290 J-
BH-SF-LF-0009	09/25/08	SW	N1		5.1	0.76 UJ	63	1.0 U	11		0.17 UJ	0.61 UJ	1.0 J		12		516	0.20 U	2.2		5.0 U	1.0 U		0.039 UJ	5.0 UJ	1,450
BH-SF-LF-0009	09/25/08	SW	FD1		5.1	0.77 UJ	63	1.0 U	11		0.13 UJ	0.59 UJ	1.0 J		11		526	0.20 U	2.2		5.0 U	1.0 U		0.040 UJ	5.0 UJ	1,440
BH-SF-LF-0009	09/25/08	WG	N1	448						17,200				1,950		5,240				1,850 UJ			4,690 J			
BH-SF-LF-0010	09/23/08	SW	N1		5.0	1.0	60	1.0 U	10		0.11 UJ	0.66 UJ	1.6 J		28		477	0.20 U	2.4		5.0 U	0.043 UJ		0.037 UJ	0.19 J	1,340
BH-SF-LF-0010	09/24/08	SW	N1		4.6	0.80 UJ	59	1.0 U	10		0.17 UJ	0.66 UJ	1.1 J		14		434	0.10 U	2.2		5.0 U	1.0 U		0.037 UJ	0.27 J	1,350 J-
BH-SF-LF-0010	09/25/08	SW	N1		4.9	0.92 UJ	62	1.0 U	11		0.15 UJ	0.72 UJ	1.4 J		22		587	0.20 U	2.6		5.0 U	0.022 UJ		0.035 UJ	5.0 UJ	1,520
BH-SF-LF-0010	09/25/08	WG	N1	200 U						34,000				92 J		12,100				1,920 UJ			4,900 J			
BH-SF-LF-0011	09/23/08	SW	N1		4.6	0.86 J	55	1.0 U	8.9		0.050 J	0.57 UJ	1.2 J		17		412	0.20 U	2.0		5.0 U	0.048 UJ		1.0 U	5.0 U	1,210 J-
BH-SF-LF-0011	09/24/08	SW	N1		4.5	0.68 UJ	53	1.0 U	8.8		0.095 UJ	0.58 UJ	0.99 J		13		382	0.15 U	2.1		5.0 U	1.0 U		1.0 U	0.41 J	1,210 J-
BH-SF-LF-0011	09/25/08	SW	N1		4.3	0.68 UJ	53	1.0 U	9.0		0.20 UJ	0.59 UJ	1.0 J		13		513	0.20 U	2.3		5.0 U	0.022 UJ		0.038 UJ	0.41 J	1,210 J-
BH-SF-LF-0011	09/25/08	WG	N1	200 U						6,150				43 J		2,120 UJ				959 UJ			2,900 J			

Attachment B

Analytical Data Summary Table - Alkalilnity, Anions, and Nutrients

OU2 Groundwater/Surface Water Interaction Study

Param Group:				Alkalinity			Anions			Nutrients				
Parameter:				Alkalinity, Bicarbonate as CaCO3	Alkalinity, Carbonate as CaCO3	Alkalinity, Total as CaCO3	Chloride	Fluoride	Sultate	Nitrate/ Nitrite-N	Total Kjeldahl Nitrogen as N	Ammonia-N	Dissolved Phosphorous	Total Phosphorous
Units:				MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	UG/L	UG/L
Object Name	Date'Time	MATRIX	QC Type											
BH-BC-0001	09/23/08	SW	N1	43.4	5.0 U	43.4	3.92	0.040 U	70.9	0.25 J	0.30 U	0.30 U		
BH-BC-0001	09/24/08	SW	N1	8.0	5.0 U	8.0 J	1.28	0.10 UJ	1,190 J	0.098 J	0.30 U	0.30 U	188	270
BH-BC-0001	09/24/08	SW	FD1	8.0	5.0 U	8.0 J	1.27	0.10 UJ	1,160 J	0.098 J	0.30 U	0.30 U	189	257
BH-BC-0001	09/25/08	SW	N1	8.3	5.0 U	8.3 J	1.02	0.040 U	1,530	0.095 J	0.30 U	0.30 U		152
BH-GG-0004	09/23/08	SW	N1	10.9	5.0 U	10.9 J	0.83	0.040 U	22.4	0.095 J	0.30 U	0.30 U		48.3
BH-GG-0004	09/23/08	SW	FD1	10.8	5.0 U	10.8 J	0.81	0.040 U	22.0	0.096 J	0.30 U	0.023 J		46.7
BH-GG-0004	09/24/08	SW	N1	44.6	5.0 U	44.6	4.02	0.10 UJ	60.1 J	0.10 J	0.30 U	0.30 U	40.4	50.1
BH-GG-0004	09/25/08	SW	N1	10.6	5.0 U	10.6 J	0.57	0.040 U	22.1	0.100 J	0.046 J	0.30 U		47.6
BH-GG-0004	09/25/08	SW	FD1	10.7	5.0 U	10.7 J	0.57	0.040 U	22.0	0.099 J	0.30 U	0.30 U		46.1
BH-MC-0002	09/23/08	SW	N1	16.5	5.0 U	16.5 J	0.45	0.040 UJ	22.6	0.13 J	0.078 J	0.30 U		7.1 J
BH-MC-0002	09/24/08	SW	N1	16.1	5.0 U	16.1 J	0.46	0.10 UJ	24.3 J	0.13 J	0.30 U	0.30 U	10 U	6.2 J
BH-MC-0002	09/25/08	SW	N1	15.8	5.0 U	15.8 J	0.45	0.10 UJ	22.1	0.12 J	0.30 U	0.30 U		8.0 J
BH-PC-0001	09/23/08	SW	N1	13.1	5.0 U	13.1 J	0.54	0.040 U	5.1	0.038 J	0.30 U	0.30 U	1.0 U	1.0 U
BH-PC-0001	09/24/08	SW	N1	12.7	5.0 U	12.7 J	0.52	0.10 UJ	5.1	0.045 J	0.075 J	0.30 U		11
BH-PC-0001	09/25/08	SW	N1	12.8	5.0 U	12.8 J	0.49	0.040 U	4.9	0.041 J	0.098 J	0.30 U		10.9
BH-SF-LF-0001	09/23/08	SW	N1	45.2	5.0 U	45.2	3.87	0.040 UJ	56.8	0.25 J	0.19 J	0.30 U		8.5 J
BH-SF-LF-0001	09/24/08	SW	N1	46.5	5.0 U	46.5	3.94	0.10 UJ	49.4 J	0.19 J	0.30 U	0.30 U	5.9 J	15
BH-SF-LF-0001	09/25/08	SW	N1	46.7	5.0 U	46.7	3.91	0.040 U	45.3	0.19 J	0.068 J	0.30 U		7.8 J
BH-SF-LF-0001	09/25/08	WG	N1	46.6	5.0 U	46.6	3.84	0.040 U	44.3	0.21 J				4.6 J
BH-SF-LF-0002	09/23/08	SW	N1	45.8	5.0 U	45.8	3.52	0.040 UJ	54.4	0.26 J	0.11 J	0.30 U		8.7 J
BH-SF-LF-0002	09/24/08	SW	N1	45.3	5.0 U	45.3	3.86	0.10 UJ	49.7 J	0.51	0.30 U	0.30 U	5.0 J	16
BH-SF-LF-0002	09/25/08	SW	N1	45.8	5.0 U	45.8	3.86	0.040 U	44.6	0.20 J	0.12 J	0.30 U		9.7 J
BH-SF-LF-0002	09/25/08	WG	N1	44.9	5.0 U	44.9	3.82	0.040 U	45.5	0.23 J				4.6 J
BH-SF-LF-0003	09/23/08	SW	N1	45.8	5.0 U	45.8	3.68	0.040 UJ	51.4	0.27 J	0.23 J	0.30 U		7.8 J
BH-SF-LF-0003	09/24/08	SW	N1	45.6	5.0 U	45.6	3.81	0.10 UJ	49.3 J	0.20 J	0.30 U	0.30 U	9.3 J	17
BH-SF-LF-0003	09/25/08	SW	N1	46.4	5.0 U	46.4	3.90	0.040 U	46.2	0.19 J	0.039 J	0.30 U		9.2 J
BH-SF-LF-0003	09/25/08	WG	N1	45.1	5.0 U	45.1	3.96	0.040 U	46.6	0.21 J				4.7 J
BH-SF-LF-0004	09/23/08	SW	N1	43.2	5.0 U	43.2	3.81	0.040 U	121	0.24 J	0.30 U	0.30 U		31.0
BH-SF-LF-0004	09/24/08	SW	N1	44.6	5.0 U	44.6	4.04	0.10 UJ	59.3	0.20 J	0.12 J	0.30 U		31.4
BH-SF-LF-0004	09/25/08	SW	N1	44.8	5.0 U	44.8	3.96	0.040 U	54.1	0.20 J	0.023 J	0.30 U	26.7	35.2
BH-SF-LF-0004	09/25/08	WG	N1	38.1	5.0 U	38.1	4.04	0.040 U	60.3	0.22 J				14.2
BH-SF-LF-0005	09/23/08	SW	N1	44.6	5.0 U	44.6	3.94	0.040 U	68.9	0.25 J	0.30 U	0.30 U		33.0
BH-SF-LF-0005	09/24/08	SW	N1	10.5	5.0 U	10.5 J	0.65	0.10 UJ	22.8 J	0.20 J	0.30 U	0.30 U	27	41.7
BH-SF-LF-0005	09/25/08	SW	N1	44.5	5.0 U	44.5	3.96	0.040 U	55.3	0.19 J	0.065 J	0.30 U		37.2

Attachment B

Analytical Data Summary Table - Alkalilnity, Anions, and Nutrients

OU2 Groundwater/Surface Water Interaction Study

Param Group:				Alkalinity			Anions			Nutrients				
Parameter:				Alkalinity, Bicarbonate as CaCO3	Alkalinity, Carbonate as CaCO3	Alkalinity, Total as CaCO3	Chloride	Fluoride	Sultate	Nitrate/ Nitrite-N	Total Kjeldahl Nitrogen as N	Ammonia-N	Dissolved Phosphorous	Total Phosphorous
Units:				MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	UG/L	UG/L
Object Name	Date'Time	MATRIX	QC Type											
BH-SF-LF-0005	09/25/08	WG	N1	38.6	5.0 U	38.6	3.86	0.040 U	60.9	0.25 J				13.3
BH-SF-LF-0006	09/23/08	SW	N1	8.1	5.0 U	8.1 J	0.92	0.040 U	2,040	0.10 J	0.30 U	0.30 U		36.5
BH-SF-LF-0006	09/24/08	SW	N1	43.9	5.0 U	43.9	4.00	0.10 UJ	84.4	0.20 J	0.14 J	0.30 U	24.3	42.2
BH-SF-LF-0006	09/25/08	SW	N1	42.6	5.0 U	42.6	3.87	0.040 U	119	0.18 J	0.30 U	0.30 U		55.6
BH-SF-LF-0006	09/25/08	WG	N1	34.8	5.0 U	34.8	3.41	0.13	302	0.14 J				8.3 J
BH-SF-LF-0007	09/23/08	SW	N1	42.4	5.0 U	42.4	3.60	0.040 UJ	87.3	0.23 J	0.13 J	0.30 U		33.8
BH-SF-LF-0007	09/24/08	SW	N1	42.6	5.0 U	42.6	3.84	0.10 UJ	107	0.21 J	0.30	0.30 U		32.6
BH-SF-LF-0007	09/24/08	SW	FD1	43.2	5.0 U	43.2	3.92	0.10 UJ	106	0.21 J	0.11 J	0.30 U		33.7
BH-SF-LF-0007	09/25/08	SW	N1	43.7	5.0 U	43.7	3.80	0.040 U	94.5	0.22 J	0.082 J	0.30 U		36.2
BH-SF-LF-0007	09/25/08	WG	N1	35.6	5.0 U	35.6	3.60	0.040 U	84.3	0.19 J				17.5
BH-SF-LF-0008	09/23/08	SW	N1	42.7	5.0 U	42.7	3.53	0.040 UJ	82.5	0.22 J	0.087 J	0.30 U	1.0 U	0.030 J
BH-SF-LF-0008	09/24/08	SW	N1	42.7	5.0 U	42.7	3.86	0.10 UJ	86.8	0.21 J	0.20 J	0.30 U		31.2
BH-SF-LF-0008	09/25/08	SW	N1	42.8	5.0 U	42.8	3.76	0.040 U	93.6	0.19 J	0.074 J	0.30 U		34.0
BH-SF-LF-0008	09/25/08	WG	N1	37.2	5.0 U	37.2	5.07	0.040 U	80.4	0.056 J				10 U
BH-SF-LF-0009	09/23/08	SW	N1	42.0	5.0 U	42.0	3.70	0.040 UJ	87.1	0.22 J	0.23 J	0.30 U	0.014 J	0.034 J
BH-SF-LF-0009	09/23/08	SW	FD1	41.3	5.0 U	41.3	3.66	0.040 UJ	84.5	0.22 J	0.15 J	0.30 U	0.013 J	0.034 J
BH-SF-LF-0009	09/24/08	SW	N1	42.2	5.0 U	42.2	3.99	0.10 UJ	82.2	0.22 J	0.19 J	0.30 U	17.2	34.8
BH-SF-LF-0009	09/25/08	SW	N1	41.8	5.0 U	41.8	3.87	0.040 U	98.3	0.19 J	0.051 J	0.30 U		32.4
BH-SF-LF-0009	09/25/08	SW	FD1	42.3	5.0 U	42.3	3.92	0.040 U	98.4	0.19 J	0.049 J	0.30 U		30.5
BH-SF-LF-0009	09/25/08	WG	N1	13.2	5.0 U	13.2 J	3.02	0.040 U	55.5	0.73				34.1
BH-SF-LF-0010	09/23/08	SW	N1	43.5	5.0 U	43.5	4.12	0.040 U	101	0.25 J	0.47	0.15 J	1.0 U	1.0 U
BH-SF-LF-0010	09/24/08	SW	N1	44.4	5.0 U	44.4	4.52	0.10 UJ	83.2	0.25 J	0.38	0.30 U	46.3	70.3
BH-SF-LF-0010	09/25/08	SW	N1	39.8	5.0 U	39.8	4.45	0.040 U	104	0.23 J	0.35	0.29 J		76.2
BH-SF-LF-0010	09/25/08	WG	N1	38.0	5.0 U	38.0	4.35	0.040 U	98.2	0.63				6.3 J
BH-SF-LF-0011	09/23/08	SW	N1	39.5	5.0 U	39.5	3.75	0.040 U	89.0	0.27 J	0.45	0.27 J	1.0 U	1.0 U
BH-SF-LF-0011	09/24/08	SW	N1	38.7	5.0 U	38.7	3.99	0.10 UJ	73.8	0.28 J	0.53	0.30 U		57.6
BH-SF-LF-0011	09/25/08	SW	N1	38.5	5.0 U	38.5	3.95	0.040 U	90.9	0.25 J	0.41	0.064 J		58.6
BH-SF-LF-0011	09/25/08	WG	N1	12.8	5.0 U	12.8 J	1.96	0.040 U	15.0	0.18 J				4.9 J