B&L Woodwaste Site
Pierce County, Washington

Phase 2 In Situ Pilot Study Monitoring Report

Prepared for

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List of Abbreviations and Acronyms

Abbreviation/ Acronym	**Definition**
bgs	Below ground surface
CAA	Cleanup Action Area
CAP	Cleanup Action Plan
CUL	Cleanup level
DO	Dissolved oxygen
DOC	Dissolved organic carbon
Ecology	Washington State Department of Ecology
Eh	Redox potential
GRWP	Groundwater Remediation Work Plan
µg/L	Micrograms per liter
µm	Micrometers
µXAS	Micro-x-ray absorption spectroscopy
µXRF	Micro-x-ray fluorescence
mg/kg	Milligrams per kilogram
mV	Millivolt

Abbreviation/ Acronym	**Definition**
ORP	Oxidation-reduction potential
PRB	Permeable reactive barrier
USEPA	U.S. Environmental Protection Agency
XANES	X-ray absorption near-edge structures
XAS	X-ray absorption spectroscopy
ZVI	Zerovalent iron

1.0 Introduction

In this Phase 2 In Situ Pilot Study Monitoring Report (Report) for the B&L Woodwaste Site (Site), the results of groundwater monitoring are presented from the second year following implementation of the Phase 2 In Situ Pilot Study (Pilot Study). The Pilot Study was requested by Washington State Department of Ecology (Ecology) and was designed to supplement the remedy specified in the 2008 Cleanup Action Plan (CAP) issued by Ecology (Ecology 2008). Elements of this work are described in the Phase 2 Pilot Study Work Plan (Work Plan), the Groundwater Remediation Work Plan (GRWP), and the GRWP Addendum (Floyd|Snider/AMEC 2011a, 2009a, and 2010a). In addition, this Report presents initial results of the solid phase speciation activities.

1.1 BACKGROUND

In 2010, Ecology made the decision to implement the CAP remedy for the areas outside the B&L Woodwaste Landfill (Landfill) using a hybrid approach. The remedial action for the Wetlands Cleanup Action Area (CAA) utilizes a combination of technologies. The goal of this approach, which is based on the results of an Engineering Alternatives Evaluation (Floyd|Snider/AMEC 2010b), is to first reduce the mass of arsenic in the groundwater plume by recovering groundwater (using groundwater recovery and treatment) from the highest concentration areas (i.e., areas with arsenic concentrations greater than approximately 500 micrograms per liter [µg/L]). Following reduction of the arsenic mass from these areas of the plume, an in situ treatment using reductive precipitation will be utilized to achieve site cleanup levels (CULs) in areas where arsenic contamination persists, following successful demonstration of area treatment in pilot scale.

Reductive precipitation permeable reactive barriers (PRBs) were successfully implemented to intercept contaminated groundwater at the leading edges of the arsenic plume at the Site following a Phase 1 Pilot Study demonstration (Floyd|Snider/AMEC 2011b; Floyd|Snider AMEC 2011c; Floyd|Snider/AMEC 2010c; Floyd|Snider/AMEC 2009b). Ecology has requested further demonstration of the technology to confirm that it is a proven and cost-effective remediation strategy for arsenic treatment application over a plume area. Because groundwater treatments are often injected across a plume area as transects that are similar to PRBs, the results of previous PRB monitoring may also be relevant to decision-making. Additionally, data from the dispersed, area treatment boring locations presented as part of the Pilot Study in this and subsequent reports may be used as a basis to design area treatment in the form of PRB-like transects.

1.2 PHASE 2 IN SITU PILOT STUDY AND MONITORING GOALS

To address the data objectives for the in situ remedial design and to develop a suitable design basis, the Pilot Study includes assessment of the effectiveness of treatment options in four representative treatment cell zones. The results of treatment based on the second year of monitoring are presented in this Report. The results demonstrate the relative effectiveness of the amendments and the dosages for plume area treatment under site conditions, and provide data to evaluate the permanence of treatment and potential maintenance requirements. These results will be used to support remedial approach and design decisions for the anticipated full-scale application and monitoring program during Phase 3 of CAP implementation.

The area of focus and goals of the Pilot Study are described in detail in the Work Plan and summarized here. The four Pilot Study treatment cells (refer to Figure 1.1) were designed to be located in an area of the plume anticipated to be representative of post-groundwater recovery arsenic concentrations and outside the expected influence of groundwater recovery wells. Therefore, an area in the central lobe of the arsenic plume was chosen.

The Pilot Study consists of testing two reagents in a field arrangement intended to determine the effectiveness of each for area treatment and to collect data needed for full-scale design while simultaneously beginning remediation of a portion of the plume. In order to effectively design and implement the full-scale in situ remedy for area treatment, the Pilot Study is intended to address the following data objectives:

- **Area (Plume) Treatment.** The data are intended to demonstrate reductive precipitation as effective for area treatment in addition to PRB application.
- **Amendment Selection.** The data are intended to assess whether a custom amendment is capable of achieving the cleanup goals specified in the CAP in a more cost-effective manner than EHC-M, which was the previous amendment used. The custom amendment consists of a sugar substrate, sulfate salts, and a pH buffer dissolved in water and injected as a liquid (Floyd|Snider/AMEC 2013).
- **Dosage.** The data are intended to assess the application rate of each amendment necessary for area treatment to achieve the CUL.
- **Permanence and Maintenance.** The study provides indications of the duration and long-term stability of treatment in reducing arsenic concentrations to less than the CUL, and whether repeat applications are needed to maintain the CUL.

To address these goals, groundwater monitoring time-series trends and solid-phase speciation investigation results are reviewed relative to the data objectives described above. It is expected that monitoring data will be used to provide a recommended remedial approach, based on the entire Pilot Study, to Ecology in a conclusion report to be submitted based on data collected in 2014.

2.0 Pilot Study Data Collection

In this section, Pilot Study data collection activities are summarized, including groundwater monitoring and solid-phase speciation investigation activities.

2.1 GROUNDWATER MONITORING

In accordance with the Work Plan, the monitoring program consisted of a Baseline Monitoring Event completed prior to initiating treatment injections, which was followed by quarterly monitoring events for 1 year. The results of first year monitoring are reported in the initial Phase 2 Pilot Study Report (Floyd|Snider/AMEC 2013). Subsequent monitoring, originally planned to be semiannual, was changed to annual in 2013 at Ecology's request.

Groundwater samples were collected from the four Pilot Study monitoring wells (D-5U, PD-140, PD-141, and PD-142) within the four treatment cells for all groundwater sampling events.

In Situ Pilot Study Event	Occurrence
Baseline Monitoring	September 26, 2011
Quarterly Event 1 Monitoring	January 12, 2012
Quarterly Event 2 Monitoring	March 12, 2012
Quarterly Event 3 Monitoring	June 20, 2012
Quarterly Event 4 Monitoring	October 5, 2012
Annual Monitoring	July 22, 2013

These events were carried out in general accordance with the Work Plan. Monitoring events included the monitoring of water quality parameters and the collection and analysis of groundwater samples for the following analyses:

- Total and dissolved arsenic (U.S. Environmental Protection Agency [USEPA] Method 200.8)
- Total and dissolved iron (USEPA Method 6010C)
- Sulfate (USEPA Method 300.0)
- Sulfide (USEPA Method 376.2)
- Dissolved organic carbon (DOC; USEPA Method 415.1)
- Field parameters: pH, dissolved oxygen (DO), oxidation-reduction potential (ORP), temperature, and specific conductivity.

Results of groundwater monitoring are discussed in the following sections. Analytical laboratory data reports are included in Appendix A.

2.2 SOLID PHASE SPECIATION

Data collection activities for the solid phase speciation portion of the Pilot Study are described in this section. Solid phase speciation research has focused on aquifer solids collected under anaerobic conditions from two direct-push soil borings in 2012 located within Treatment Cell D of the Pilot Study Treatment Area (IP-1D), where no zerovalent iron (ZVI) was employed, and the 12th Street East Treatment Zone (IP-2B), a PRB consisting of ZVI-containing EHC-M. Boring locations are illustrated on Figure 1.1. Sample cores were collected from IP-1D and IP-2B at depths of 13.5 to16.5 feet below ground surface (bgs) and 17 to 20 feet bgs, respectively. Soil samples were submitted for total arsenic, total iron, acid-volatile sulfide, and total solids analyses to characterize the soil and aid in collection of x-ray absorption spectroscopy (XAS) data (Floyd|Snider/AMEC 2013).

2.2.1 Sample Preparation

One 3-foot core of each aquifer sample (ZVI Sample IP-2B and non-ZVI PRB Sample IP-1D) was thawed inside of an anaerobic nitrogen/hydrogen(N_2/H_2)-atmosphere chamber at the University of Washington Department of Civil and Environmental Engineering. Each core was then dried inside the glove box and homogenized with an acid-washed plastic spoon in an acid-washed and furnaced (550°C for 4 hours) glass bowl. Dried samples were sieved with a plastic #200 sieve (Model SV-165#200, Gilson Company, Inc., Lewis Center, Ohio) to isolate the fine fraction. Sieving was done to concentrate the arsenic present in higher-surface area fines and to increase the likelihood of collecting usable XAS spectra. Sample material was spread out onto a piece of Kapton tape and sealed with additional Kapton tape. These samples were then sealed into a gas impermeable (ESCAL™) bag with an oxygen-scavenging sachet.

In addition, two synthetic minerals were precipitated in the lab for synchrotron analysis, to support potential comparison of in situ materials with known minerals with sorbed arsenic. Minerals chosen were representative of mineral coatings likely to be present in the aquifer sediment material at the Site: mackinawite (an iron monosulfide) and ferrihydrite (an iron (oxy)hydroxide). These minerals were spiked with sufficient arsenite solution to achieve adsorption onto the precipitates, while avoiding incorporation into the mineral matrix.

The ferrihydrite sample was created in an ambient atmosphere by dissolving iron(III) nitrate ($Fe(NO_3)_2$) salt in water and adjusting pH to 5.5. After letting the solution age for 24 hours, it was spiked with arsenite, tumbled for 48 hours, and vacuum filtered through a 22 micrometers (µm) cellulose filter and then a 0.2 µm polyethersulfone membrane filter. The solids collected on the filter were air-dried, knocked off the filter, and ground with an agate mortar and pestle. The resulting powder was spread out with a silicone spatula as a thin layer on Kapton tape, then covered with another piece of Kapton tape. This sample was stored inside of an ESCAL bag for transport.

The mackinawite (FeS) sample was produced inside of the N_2/H_2-atmosphere glove box by dissolving sodium sulfide (Na_2S) and iron(II) chloride ($FeCl_2$) in water. After letting the solution age for 29 hours, the pH was adjusted to 6.5 and kept stable for 26 hours. It was then spiked with arsenite, tumbled for 48 hours, and vacuum filtered through a 22 µm cellulose filter and then a 0.2 µm polyethersulfone membrane filter. The solids collected on the filter were air-dried inside the glove box. The resulting paste was spread out in a thin layer on a piece of Kapton tape, then covered with another piece of Kapton tape. This sample was then stored inside of an ESCAL bag, with an oxygen-scavenging packet, for transport.

2.2.2 Synchrotron Data Collection and Analysis

Aquifer sediment samples and synthetic mineral samples in Kapton tape were analyzed on Beamline 2-3 at the Stanford Synchrotron Radiation Lightsource, SLAC National Accelerator Laboratory in Menlo Park, California. Using this beamline, micro-x-ray absorption spectroscopy (µXAS) spectra were collected, along with micro-x-ray fluorescence (µXRF) element maps to elucidate the solid-phase local coordination environment of arsenic. µXAS scans were collected for arsenic and iron, while µXRF element maps were collected for the following elements: arsenic, iron, sulfur, silicon, phosphorus, chlorine, potassium, calcium, titanium, chromium, manganese, nickel, Copper, and zinc.

µXRF was used to create spatial maps of element locations and relative concentrations as indicated by fluorescence detector counts. The mapped domain was a square or rectangle with sides between 50 and 150 µm along the edge. The maps were composed of pixels (step size) sized 1 µm^2. Dwell time was 30 milliseconds (ms). Data were analyzed using the Microprobe Analysis Toolkit software (Webb 2006).

The spatial element maps generated by µXRF were used to determine ideal locations for µXAS analysis. Because of the low concentrations of arsenic in the soil, relative to the instrument's detection ability, µXAS data were collected from the locations with the highest fluorescence counts of arsenic. Once these locations were determined, between 6 and 7 scans were generated for arsenic and 2 to 6 scans were generated for iron. Arsenic scans were collected from an energy of 11,640 to 11,900 electronvolts (eV), surrounding the arsenic K-edge (11,867 eV). Iron scans were collected from an energy of 7,090 to 7,160 eV, surrounding the iron K-edge (7,111 eV). All data were calibrated by shifting energies a constant value, determined by the adjustment of iron and arsenate foil standards scans to their proper, known K-edge. All data were analyzed using the SIXPack/IFEFFIT software (Webb 2006).

3.0 Pilot Study Results

In this section, the groundwater monitoring results from second year Pilot Study monitoring are presented, with discussion trends including the first year monitoring results. Solid phase speciation results are presented, with implications for the long-term stability of the treatment.

Groundwater monitoring is intended to provide the information necessary to address the objectives of the Pilot Study, namely the relative effectiveness of the tested reagents and dosages in achieving the CUL for area-wide plume treatment, as well as the duration of treatment and potential need for maintenance. To assess effectiveness, the change in arsenic concentration in response to treatment was monitored. In addition, groundwater parameters were monitored to assess the geochemical conditions necessary for the removal of arsenic from groundwater by reductive precipitation. These conditions can be divided into two primary components: (1) sulfate reducing conditions (i.e., lowered redox potential [Eh] resulting from sufficient DOC for microbial metabolism and/or release of hydrogen gas from ZVI), and (2) the constituents required to precipitate iron sulfides, that is, sufficient sulfate and iron.

Solid-phase speciation results are intended to elucidate the mechanisms of arsenic removal from groundwater, and the chemical forms in which it is sequestered.

Refer to Section 4.0 for further discussion and recommendations.

3.1 DATA QUALITY REVIEW

A Compliance Screening, Tier I data quality review was performed on the metals and conventionals data resulting from laboratory analysis. The analytical data for metals were validated in accordance with the 1994 and 2004 USEPA CLP National Functional Guidelines for Inorganic Data Review (USEPA 1994 and 2004). The analytical data for conventionals were validated based on guidance and quality control criteria documented in the analytical methods. A data quality review was not performed on the arsenic speciation or synchrotron data.

The laboratory noted that the sample cooler temperature (7 ºC) for the soil sample delivery group VJ05, was outside of the laboratory standard of 4±2 ºC. Based on professional judgment, no sample results are qualified based on cooler temperature, as the samples were delivered with minimal holding time (6 hours between sample collection and sample delivery). The method blanks had no detections. The matrix spike and laboratory control sample recoveries and sample/sample duplicate relative percent differences all met USEPA requirements.

The data are determined to be of acceptable quality for use.

3.2 EHC-M TREATMENT CELLS A AND B

Groundwater conditions within Treatment Cells A and B have been monitored for chemical constituents and physiochemical parameters that are used to evaluate the effectiveness of treatment and conditions suitable for iron sulfide precipitation. Results from the Pilot Study injection treatment groundwater monitoring of Treatment Cells A (D-5U; 0.2 percent EHC-M treatment) and B (PD-140; 0.1 percent EHC-M treatment) are presented in Tables 3.1 and 3.2. Trends in groundwater constituents used to evaluate the progress of in situ remediation (total arsenic, sulfate, iron, and DOC) are illustrated on Figure 3.1. Total arsenic results from compliance monitoring events in April and October 2013, are also included for wells for which this information was available (D-5U and PD-141).

3.2.1 Arsenic

Arsenic concentrations have continued to decrease since the last reported event in October 2012 at D-5U and have essentially remained stable at PD-140. Under site conditions, total arsenic concentrations are comparable to dissolved arsenic concentrations indicating that the majority of arsenic is in the dissolved phase. Results of arsenic speciation indicate that trivalent arsenic (As(III)) continues to be the predominant arsenic species measured.

The concentration of total arsenic at D-5U has decreased from 34.2 µg/L in October 2012 to 12.4 µg/L in the most recent available data from October 2013, which represents a 64 percent decrease for this period. The concentration of total arsenic measured in D-5U during the Baseline Monitoring Event in September 2011 was 88.2 µg/L, so the overall decrease in total arsenic has been approximately 86 percent over the Pilot Study.

The concentration of total arsenic at PD-140 has decreased modestly since the last event and the trend is essentially stable. The concentration decreased from 11.1 µg/L to 9.6 µg/L. The concentration of total arsenic measured at PD-140 during the September 2011 Baseline Monitoring Event was 21.7 µg/L, so that the overall decrease in total arsenic has been approximately 56 percent over the Pilot Study.

Concentrations have not yet met the site-wide arsenic CUL criteria of 5 µg/L in either treatment zone.

3.2.2 Sulfate-Reducing Conditions and Iron Sulfide Constituents

The EHC-M amendment product injected into Cells A and B is intended to introduce sulfate and ferrous iron (Fe(II)) into groundwater, release hydrogen gas to chemically lower redox potential, and stimulate microbial activity to further depress redox potential and reduce sulfate to sulfide. Indications of these processes are inferred by the trends of these constituents and related parameters.

Total iron concentrations have remained stable in D-5U and increased greatly in PD-140. Groundwater in the Pilot Study area contained sufficiently elevated iron concentrations prior to the Pilot Study so that introduction of iron is not considered necessary for iron sulfide precipitation. The concentration of total iron measured in D-5U during the Baseline Monitoring Event in September 2011 was 108,000 µg/L. Since the Pilot Study treatment in October 2011, concentrations have only varied slightly at D-5U, and the most recent concentration measured in July 2013 is 108,000 µg/L. In contrast, the concentration of dissolved iron measured at PD-140 has increased to 109,000 µg/L from the September 2011 baseline measurement of 28,400 µg/L.

Sulfate concentrations have declined from their apparent peak in the last monitoring event at D-5U, and have continued a trend of substantially increasing since the last monitoring event in PD-140. Prior to the Pilot Study, groundwater in the study area did not contain sufficient sulfate concentrations necessary for arsenic remediation using iron sulfide precipitation, so increasing the sulfate concentration is considered a critical treatment component. The concentrations of sulfate measured during the Baseline Monitoring Event (September 2011) at D-5U and PD-140 were 1,100 µg/L and 500 µg/L, respectively. At D-5U, the concentration of sulfate appears to have peaked at 18,400 µg/L in the previous monitoring event in October 2012, and has since declined to 5,400 µg/L. At PD-140, the concentration of sulfate increased from its previous high of 151,000 µg/L in October 2012, to a new high of 261,000 µg/L. The continued increase in sulfate concentration at PD-140, in the lower dosage area for EHC-M and nearly 2 years following treatment, suggests that some of the measured sulfate may have been transported in groundwater from Treatment Cells C and D.

ORP measurements in millivolts (mV) indicating redox potential relative to the standard hydrogen electrode for wells in both treatment cells decreased markedly in the most recent monitoring event. The ORP measured at D-5U decreased from 24 mV to -115 mV, while the ORP at PD-140 decreased from -40 mV to -123 mV. These measurements do not directly indicate sulfate-reducing conditions (because ORP is a summary measure of the electric potential of the groundwater system, which does not specifically quantify the sulfur-specific redox couples); the presence of sulfide in groundwater suggests sulfate-reducing conditions were attained in water as measured at D-5U. Sulfide was measured at a concentration close to the detection limit of 50 µg/L (64 µg/L) at D-5U and not detected at PD-140 in the most recent event. Because sulfide readily precipitates with Fe(II), the presence of sulfide in solution indicates that conditions are favorable for sulfate reduction and precipitation of mineral phases that can sequester arsenic. Sulfide was not detected in groundwater during the Baseline Monitoring Event in Treatment Cells A or B at concentrations greater than the method reporting limit of 50 µg/L.

DOC concentrations in both D-5U and PD-140 continued to remain relatively steady since the previous monitoring event. The concentration at D-5U decreased from 64,600 µg/L to 60,000 µg/L, while the concentration at PD-140 decreased from 25,800 µg/L to 21,600 µg/L. The concentration at wells in both treatment cells had initially responded to treatment with increases of approximately 10,000 to 15,000 µg/L. In both treatment cells, the increase was followed by a steady decline and leveling off to approximately pre-treatment concentrations.

3.3 CUSTOM REAGENT TREATMENT CELLS C AND D

Groundwater conditions in Treatment Cells C and D were monitored for chemical constituents and physiochemical parameters that are used to evaluate the effectiveness of treatment and conditions suitable for iron sulfide precipitation. Results from the Pilot Study groundwater monitoring of Treatment Cells C (PD-141; 0.07 percent custom reagent) and D (PD-142; 0.14 percent custom reagent) are presented in Tables 3.3 and 3.4. Trends in groundwater constituents used to evaluate the progress of in situ remediation are illustrated on Figure 3.1.

3.3.1 Arsenic

Arsenic concentrations have increased at PD-141 since the last reported event in October 2012 and have essentially remained stable at PD-140 over this period. Under site conditions, total arsenic concentrations are comparable to dissolved arsenic concentrations, indicating that the majority of arsenic is in the dissolved phase. Results of arsenic speciation indicate that As(III) continues to be the predominant arsenic species measured.

The concentration of total arsenic at PD-141 increased from 230 µg/L in October 2012 to 394 µg/L in July 2013, and then decreased to 302 µg/L in the most recent available data from October 2013. The concentration of total arsenic measured in PD-141 during the Baseline Monitoring Event in September 2011 was 158 µg/L, so the overall increase in total arsenic has been approximately 91 percent over the course of the Pilot Study. The increase in arsenic in this location may be related to minor changes in the dynamics of the arsenic plume and local groundwater flow directions, potentially associated with upgradient remedy components.

The concentration of total arsenic at PD-142 has decreased modestly since the last event and the trend is essentially stable. The concentration decreased from 38 µg/L in October 2012 to 35.5 µg/L in July 2013. The concentration of total arsenic measured at PD-142 during the September 2011 Baseline Monitoring Event was 40 µg/L, so that the overall decrease in total arsenic has been approximately 11 percent over the Pilot Study.

3.3.2 Sulfate-Reducing Conditions and Iron Sulfide Constituents

The custom reagent amendment product injected into Treatment Cells C and D also introduces sulfate into groundwater and stimulates native microbial communities to reduce sulfate to sulfide. Pre-existing elevated iron concentrations were expected to provide sufficient iron for iron sulfide precipitation. Indications of these processes are inferred by the concentration trends of treatment constituents and related parameters.

Iron concentrations in both treatment cells have remained relatively consistent over the course of the Pilot Study, with increases in total iron observed following treatment. The concentration of total iron measured at PD-141 during the Baseline Monitoring Event in September 2011 was 93,300 µg/L. The concentration of total iron at PD-141 was 112,000 µg/L in October 2012 and 115,000 µg/L in July 2013. Similarly, the concentration of total iron measured at PD-142 in September 2011 was 84,500 µg/L. Since the Pilot Study treatment, concentrations have increased and were measured at 105,000 µg/L in October 2012, and at 104,000 µg/L in July 2013.

Sulfate was not detected at concentrations greater than the detection limit of 50 µg/L in PD-141 or PD-142 in either of the last two monitoring events. Sulfate was measured at low concentrations (up to 11,500 µg/L at PD-141 and up to 800 µg/L at PD-142) following treatment, concentrations that were far lower than expected based on the mass of sulfate salt injected. As noted previously, increased sulfate concentrations are considered a critical component of effective arsenic treatment in this system.

ORP measurements for wells in both treatment cells decreased in the most recent monitoring event. The ORP measured at PD-141 decreased from -37 mV to -119 mV, while the ORP at PD-142 decreased from -17 mV to -110 mV. These measurements do not directly indicate sulfate-reducing conditions (because ORP is a summary measure of the electric potential of the groundwater system, which does not specifically quantify the sulfur-specific redox couples). Sulfide was not detected at concentrations greater than the detection limit of 50 µg/L in either PD-141 or PD-142 in the most recent event. Sulfide was previously measured at concentrations of up to 326 µg/L at PD-141; sulfide has not been detected at PD-142 throughout the study.

3.4 SOLID PHASE SPECIATION RESULTS

Results of the investigation of solid-phase arsenic speciation include the results of soil analyses for total arsenic, total iron, acid-volatile sulfide, and total solids; element maps and corresponding correlation plots collected using µXRF; and x-ray absorption near-edge structures (XANES) collected using µXAS.

3.4.1 Soil Arsenic, Iron, and Acid-Volatile Sulfide Results

Results for total arsenic, total iron, and acid-volatile sulfides are presented in Table 3.5. Analyses of these analytes were performed primarily for planning synchrotron data collection and secondarily to assess evidence for iron sulfides as a removal mechanism in aquifer solids. The low arsenic results of less than 2 milligrams per kilogram (mg/kg) in both samples indicated that collection of usable XAS spectra would be difficult, because the absorption signal/noise ratio is relatively low at low concentrations. To mitigate the low arsenic concentrations, sieved samples were used for synchrotron data collection, because the total arsenic concentration is generally greater in the higher-surface-area fine fraction. Total iron results were as expected and indicated that sufficient iron was present for data collection. Acid-volatile sulfide results were approximately 10 times greater in IP-1D (20.6 mg/kg), from Treatment Cell D, than in IP-2B (1.87 mg/kg), from the EHC-M PRB at 12th Street East. These results are consistent with the presence of iron sulfide precipitate in the aquifer solids, but do not provide conclusive evidence of iron sulfide precipitate.

3.4.2 Element Mapping and Correlation Analysis

Element maps for iron, arsenic, and sulfur from Sub-samples Z1 and Z4 collected from Sample IP-2B, and from Sub-samples NZ2 and NZ4, collected from Sample IP-1D, are shown in Appendix B. These results are representative of the data collected, though not necessarily representative of the aquifer solids, because these areas were selected based on the presence of elevated arsenic suitable for collecting µXAS spectra.

The maps show mineral grains and grain coatings at the scale of 3,000 to 10,000 µm with color intensities indicating the relative fluorescence counts for iron, sulfur, and arsenic. The maps are accompanied with plots of correlation between fluorescence counts for iron, sulfur, and arsenic. The four map sets were selected because they illustrate spatial correlations between iron and sulfur, which provide evidence for the presence of iron sulfide precipitate. In the case of NZ2, arsenic is highly correlated with iron and sulfur, and in the case of Z1, arsenic is partially correlated with iron and sulfur, but this correlation is not strongest in the area of the mineral grain with the highest intensity of iron and sulfur counts, as might be expected. In the Z4 map and the NZ4 map, arsenic counts are clustered in a separate location adjacent to the apparent iron sulfide precipitate cluster.

Points of interest corresponding to the locations with the greatest fluorescence counts of arsenic were selected for arsenic and iron µXAS analyses, described below.

3.4.3 Near-Edge Structures and Speciation

Arsenic XANES results from points of interest in the element maps, normalized for relative absorption and plotted versus energy, are shown in Appendix B along with reference spectra from literature sources. The valence state of arsenic in the sample is indicated by the energy of the absorption peak, with higher energies of absorption corresponding to more oxidized arsenic species. Similar scans of As(III) and arsenate (As(V)) done by others are shown for reference.

The results show that arsenic is present in the solid phase as both As(III) and As(V). Arsenic at the points of interest in Sub-samples Z1 and NZ2 is in the form As(III), while arsenic at the points of interest in Sub-samples Z4 and NZ4 is in the form of As(V). As shown in the table below, both arsenic valence states were found in aquifer solids from both treatment with ZVI-containing EHC-M and non-ZVI-containing custom reagent, both in locations correlated with iron and sulfur and in locations not correlated with iron and sulfur.

Sub-sample ID	Treatment	Correlated with Iron and Sulfur	Species
Z1	EHC-M	No	As(III)
Z4	EHC-M	No	As(V)
NZ2	Custom Reagent	Yes	As(III)
NZ4	Custom Reagent	No	As(V)

Iron x-ray XANES results from points of interest in the element maps, normalized for relative absorption and plotted versus energy, are shown in Appendix B along with reference spectra of potentially-relevant iron minerals from literature sources. The valence state of iron in the sample can be interpreted based on the energy of the multiple absorption peaks. The presence of a pre-edge peak at approximately 7,113 eV in samples such as Z4 suggests the presence of Fe(II) compounds consistent with iron sulfides. Further analysis using quantitative methods such as linear combination fitting (LCF) may help identify iron minerals with greater certainty.

4.0 Evaluation and Recommendations

In this section, an evaluation of the results is presented relative to the remedial design factors as a basis for recommendations regarding remediation of the Outside Area following the second year of Pilot Study monitoring.

4.1 EVALUATION OF REMEDIAL DESIGN FACTORS

The Pilot Study was intended to test the selected treatments under field conditions to identify the optimal dosage; evaluate the delivery systems; and improve the understanding of the effectiveness, stability, adverse effects, and necessary monitoring to support the design of the full-scale remedy. Two treatment amendments were tested at two concentrations in a field arrangement intended to determine the effectiveness of each while simultaneously beginning remediation of a portion of the plume.

Pilot study remedial design factors, described in Section 1.2, are considered in this section based on available data. It is expected that additional data will be collected and evaluated prior to design and implementation of the full-scale in situ remedy for area treatment. Recommendations are provided in the following sections.

4.1.1 Area (Plume) Treatment

Indications that remediation has been successful in the monitoring wells representative of Treatment Cells A and B suggest that the EHC-M treatment can be successful in attaining CULs when used as an area treatment. The use of one monitoring well to assess plume conditions for approximately 0.1 acre of plume (the approximate size of the treatment cells) is a reasonable basis for drawing this conclusion, because it represents greater density than is likely to be utilized to assess groundwater compliance following plume remediation.

4.1.2 Amendment Selection

Based on available data, EHC-M would be proposed as the selected amendment. The results for EHC-M demonstrate arsenic removal from groundwater to concentrations that approach the CUL through apparent precipitation of iron sulfides. Substantially greater effectiveness in decreasing arsenic concentrations has been observed in the EHC-M Treatment Cells A and B than in the custom reagent Treatment Cells C and D. The arsenic concentrations in the two EHC-M treatment cells, Treatment Cells A and B, were last measured at 9.6 and 12.4 µg/L, concentrations that approach the CUL level of 5 µg/L and suggest that the treatment can achieve cleanup objectives. Further monitoring of EHC-M treatment cells will provide an opportunity to assess whether these reagents are capable of attaining the CUL and to further assess remedial design factors.

The custom reagent, as applied and under site conditions, has been successful only in a temporary depression of arsenic in Treatment Cell D (PD-142), followed by rebound close to starting concentrations within 1 year. This result suggests that the custom reagent has the potential to be effective if applied under different conditions.

4.1.3 Dosage

The Pilot Study data provide indications of the range of dosages of EHC-M that may be effective in achieving CULs but do not yet provide conclusive data in this regard. The results indicate that the 0.2 percent EHC-M amendment is currently the most effective dosage, based on arsenic concentration change (88.2 to 12.4 µg/L) and percentage of decrease in arsenic concentration (86 percent over the course of the study). The 0.1 percent treatment did not result in as much of a decrease in arsenic (44 percent over the course of the study), but resulted in a slightly lower final arsenic concentration (9.6 µg/L). Given the different starting concentrations, the available data suggest that a range of treatment dosages may be appropriate for different areas of the plume. Further monitoring would aid in fine-tuning EHC-M dosage. Additional testing of higher custom reagent dosages may be appropriate if a modified custom reagent is applied in future testing.

4.1.4 Permanence and Maintenance

Reductive precipitation treatment is expected to provide stable, long-term sequestration of arsenic within iron sulfide mineral phases. Solid-phase speciation results provide direct evidence that arsenic is sequestered in iron sulfide phases, which are more stable over the long-term, especially under iron-reducing conditions, and which may form the precursor to incorporation in crystalline iron sulfide phases. Based on this finding, it is believed that in situ treatment using reductive precipitation under site conditions will result in a permanent long-term remedy.

Permanence and maintenance needs of the treatment, however, cannot yet be fully assessed based on Pilot Study results. Monitoring of key geochemical parameters in the treatment areas and maintenance injections in recalcitrant areas are expected to be necessary for operations and maintenance of in situ treatment for a number of years. Further Pilot Study monitoring is expected to provide a clearer picture of monitoring and maintenance needs.

4.2 RECOMMENDATIONS AND PROPOSED SCHEDULE

Based on the second year of results of the Pilot Study, collection of additional data would be useful to better assess the technology’s capacity to achieve CULs, the proper dosage(s), the permanence of the treatment, and the maintenance needs of treatment. The following next steps are recommended in order to prepare for an effective design and implementation of the full-scale in situ remedy for area treatment.

Treatment Cells A and B: The current groundwater monitoring program of these treatment cells should be continued for an additional monitoring event in 2014 to observe the effect of potential further changes in sulfate concentration on arsenic concentrations relative to the CUL, provide a clearer comparison of effectiveness at the two dosages, and to provide more indications of the duration of EHC-M treatment constituents and the permanence of treatment (i.e., potential for rebound).

Treatment Cells C and D: Based on the lack of treatment effectiveness for the custom treatment under site conditions, the custom reagent applied is unlikely to be selected for wider use at the site. Under the current anticipated schedule, however, a decision on the Outside Area remedial approach is not needed until approximately 2017. If it could be applied successfully, the cost of the custom reagent is expected to be considerably less than that of EHC-M. Therefore, it is recommended that additional field pilot testing, if appropriate based on recommendations to be provided at the conclusion of the Pilot Study in 2014, be postponed until the 2015–2016 timeframe. This additional time may allow the emerging technology of arsenic treatment by reductive precipitation to be developed and tested at other sites, and perhaps other reagents to become available.

It is recommended that the current monitoring program of Treatment Cells C and D be continued for an additional monitoring event in 2014 to observe the medium-term effects of the custom reagent, and provide additional comparative data for evaluation of Treatment Cells A and B.

5.0 References

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Pierce County, Washington

Phase 2 In Situ
Pilot Study Monitoring Report

Tables

Table 3.1
Treatment Cell A—D-5U Groundwater Monitoring Results

		Monitoring Event					
Constituent	**Unit**	**9/26/2011**	**1/12/2012**	**3/12/2012**	**6/20/2012**	**10/5/2012**	**7/22/2013**
Total Metals							
Arsenic	µg/L	88.2	70	46	35.7	34.2	15.1
Arsenic (III)	µg/L	75.2	54.3	46.3	36.0 H	17.0	10.0
Arsenic (V)[1]	µg/L	14.4	14.8	3.2 U	3.2 U	12.7	2.6
Inorganic Arsenic	µg/L	89.7	69.1	49.4	31.0	--	--
Calcium	µg/L	117,000	117,000	116,000	122,000	120,000	122,000
Iron	µg/L	108,000	110,000	103,000	109,000	109,000	108,000
Magnesium	µg/L	55,500	55,900	55,300	58,100	58,000	58,700
Potassium	µg/L	6,040	5,820	5,340	5,670	5,780	5,900
Sodium	µg/L	41,400	43,900	39,600	45,700	45,200	47,700
Dissolved Metals							
Arsenic	µg/L	87.4	68	45	34.9	37.0	14.6
Iron	µg/L	103,000	108,000	103,000	109,000	111,000	108,000
Conventionals							
Alkalinity	µg/L $CaCO_3$	692,000	674,000	714,000	670,000	710,000	734,000
Bicarbonate	µg/L $CaCO_3$	692,000	674,000	714,000	670,000	710,000	734,000
Carbonate	µg/L $CaCO_3$	1,000 U	1,000 U	1,000 U	1,000 U	1,000 U	1,000 U
Chloride	µg/L	14,200	32,400	32,300	31,500	30,400	28,600
Dissolved Organic Carbon	µg/L	64,800	75,200	73,200	59,600	64,600	60,000
Hydroxide	µg/L $CaCO_3$	1,000 U	1,000 U	1,000 U	1,000 U	1,000 U	1,000 U
N-Nitrate	µg-N/L	500 JB	100	100 U	100 U	100 U	100 U
N-Nitrite	µg-N/L	500 U	100 U	100 U	100 U	100 U	100 U
Sulfate	µg/L	1,100	700	1,800	2,200	18,400	5,400
Sulfide	µg/L	50 U	63	50 U	159	57	64
Field Parameters							
pH	pH units	6.28	6.57	6.36	6.79	6.27	6.2
Dissolved Oxygen	mg/L	1.17	0.74	0.82	0.36	0.89	2.01
Specific Conductivity	mS/cm	1.41	1.37	1.45	1.4	0.996	1.5
Temperature	°C	13.01	10.61	9.88	13.31	19.6	14.9
ORP	mV	21[2]	-41	-44	-66	24	-115

Notes:

--	Constituent not analyzed for.
1	Calculated data value.
2	Potential error with field water quality instrument.

Abbreviations:

$CaCO_3$	Calcium carbonate
°C	Degree Celsius
µg-N/L	Equivalent nitrogen micrograms per liter
µg/L	Micrograms per liter
mg/L	Milligrams per liter
mS/cm	Millisiemens per centimeter
mV	Millivolt
ORP	Oxidation-reduction potential

Qualifiers:

H	Estimated due to presence of blank contamination.
JB	Estimated due to presence of blank contamination.
U	Not detected.

Table 3.2
Treatment Cell B—PD-140 Groundwater Monitoring Results

Constituent	Unit	Monitoring Event					
		9/26/2011	**1/12/2012**	**3/12/2012**	**6/20/2012**	**10/5/2012**	**7/22/2013**
Total Metals							
Arsenic	µg/L	21.7	25.2	21.3	13.5	11.1	9.6
Arsenic (III)	µg/L	20.8	25.3	23.8	11.1 H	4.99	6.54
Arsenic (V)[1]	µg/L	5 U	1.6 U	1.6 U	0.9	6.75	2.60
Inorganic Arsenic	µg/L	23.6	25.6	22.8	12.1	--	--
Calcium	µg/L	40,000	62,500	61,800	56,800	70,500	116,000
Iron	µg/L	28,800	60,400	59,600	53,400	69,400	110,000
Magnesium	µg/L	22,700	31,800	30,500	27,700	33,800	57,400
Potassium	µg/L	6,600	5,270	4,760	4,260	4,840	5,700
Sodium	µg/L	35,900	38,800	35,800	36,700	38,400	48,600
Dissolved Metals							
Arsenic	µg/L	21.8	25.8	21.6	13.7	10.5	8.8
Iron	µg/L	28,400	56,900	57,900	54,400	70,000	109,000
Conventionals							
Alkalinity	µg/L $CaCO_3$	289,000	382,000	415,000	327,000	356,000	523,000
Bicarbonate	µg/L $CaCO_3$	289,000	382,000	415,000	327,000	356,000	523,000
Carbonate	µg/L $CaCO_3$	1,000 U	1,000 U	1,000 U	1,000 U	1,000 U	1,000 U
Chloride	µg/L	31,200	19,900	17,800	14,900	14,400	20,200
Dissolved Organic Carbon	µg/L	19,700	35,600	34,000	25,400	25,800	21,600
Hydroxide	µg/L $CaCO_3$	1,000 U	1,000 U	1,000 U	1,000 U	1,000 U	1,000 U
N-Nitrate	µg-N/L	500 JB	100 U	100	100 U	100 U	100 U
N-Nitrite	µg-N/L	500 U	100 U	100 U	100 U	100 U	100 U
Sulfate	µg/L	500	800	4,600	24,400	151,000	261,000
Sulfide	µg/L	50 U	50 U	50 U	71	50 U	50 U
Field Parameters							
pH	pH units	6.45	6.60	6.50	6.34	6.31	6.26
Dissolved Oxygen	mg/L	0.73	0.82	1.19	0.64	3.78	2.48
Specific Conductivity	mS/cm	0.67	0.93	0.95	0.85	0.987	1.5
Temperature	°C	11.69	9.02	9.04	12.77	11.96	12.5
ORP	mV	9	-41	-45	-46	-40	-123

Notes:

--	Constituent not analyzed for.
1	Calculated data value.

Abbreviations:

$CaCO_3$	Calcium carbonate
°C	Degree Celsius
µg-N/L	Equivalent nitrogen micrograms per liter
µg/L	Micrograms per liter
mg/L	Milligrams per liter
mS/cm	Millisiemens per centimeter
mV	Millivolt
ORP	Oxidation-reduction potential

Qualifiers:

H	Holding time not met. Result is estimated.
JB	Estimated due to presence of blank contamination.
U	Not detected.

Table 3.3
Treatment Cell C—PD-141 Groundwater Monitoring Results

		Monitoring Event					
Constituent	**Unit**	**9/26/2011**	**1/12/2012**	**3/12/2012**	**6/20/2012**	**10/5/2012**	**7/22/2013**
Total Metals							
Arsenic	µg/L	158	222	215	264	230	394
Arsenic (III)	µg/L	124	169	177.0	195.0 H	160	321
Arsenic (V)[1]	µg/L	37.3	12.3	1.6 U	6.4 U	78.2	17.8
Inorganic Arsenic	µg/L	162	181	164.0	163.0	--	--
Calcium	µg/L	105,000	128,000	114,000	115,000	112,000	114,000
Iron	µg/L	93,300	112,000	96,300	108,000	112,000	115,000
Magnesium	µg/L	58,300	68,200	59,400	58,300	58,600	58,000
Potassium	µg/L	8,460	6,210	5,370	4,990	5,040	5,000
Sodium	µg/L	70,600	56,600	49,100	49,300	53,000	58,700
Dissolved Metals							
Arsenic	µg/L	165	204	207	240	233	344
Iron	µg/L	92,200	114,000	96,200	107,000	113,000	115,000
Conventionals							
Alkalinity	µg/L $CaCO_3$	682,000	774,000	692,000	684,000	721,000	651,000
Bicarbonate	µg/L $CaCO_3$	682,000	774,000	692,000	684,000	721,000	651,000
Carbonate	µg/L $CaCO_3$	1,000 U	1,000 U	1,000 U	1,000 U	1,000 U	1,000 U
Chloride	µg/L	42,500	40,100	39,900	35,800	34,400	37,300
Dissolved Organic Carbon	µg/L	55,600	88,600	60,400	48,800	69,200	46,800
Hydroxide	µg/L $CaCO_3$	1,000 U	1,000 U	1,000 U	1,000 U	1,000 U	1,000 U
N-Nitrate	µg-N/L	600 JB	100 U	100	100 U	100 U	100 U
N-Nitrite	µg-N/L	500 U	100 U	100 U	100 U	100 U	100 U
Sulfate	µg/L	2,700	11,500	800	1,100	100 U	100 U
Sulfide	µg/L	50 U	326	50 U	83	55	50 U
Field Parameters							
pH	pH units	6.33	6.13	6.41	6.89	6.27	6.24
Dissolved Oxygen	mg/L	0.55	0.52	3.08[2]	0.64	0.63	2.56
Specific Conductivity	mS/cm	1.43	1.43	1.47	1.31	1.11	1.4
Temperature	°C	12.22	8.62	9.14	14.93	18.11	14.3
ORP	mV	-17	-80	-8	-84	-37	-119

Notes:

--	Constituent not analyzed for.
1	Calculated data value.
2	Air bubbles were noted during measurement.

Abbreviations:

$CaCO_3$	Calcium carbonate
°C	Degree Celsius
µg-N/L	Equivalent nitrogen micrograms per liter
µg/L	Micrograms per liter
mg/L	Milligrams per liter
mS/cm	Millisiemens per centimeter
mV	Millivolt
ORP	Oxidation-reduction potential

Qualifiers:

H	Estimated due to presence of blank contamination.
JB	Estimated due to presence of blank contamination.
U	Not detected.

Table 3.4
Treatment Cell D—PD142 Groundwater Monitoring Results

Constituent	Unit	Monitoring Event					
		9/26/2011	1/12/2012	3/12/2012	6/20/2012	10/5/2012	7/22/2013
Total Metals							
Arsenic	µg/L	40	23	26	30.4	35.4	33.4
Arsenic (III)	µg/L	26.7	20.4	25.5	28.4 H	19	34.4
Arsenic (V)[1]	µg/L	5 U	1.74	1.6 U	3.2 U	13.9	2.6
Inorganic Arsenic	µg/L	31.4	22.2	24.7	28.9	--	--
Calcium	µg/L	113,000	105,000	108,000	109,000	98,600	99,400
Iron	µg/L	94,200	112,000	110,000	115,000	105,000	104,000
Magnesium	µg/L	66,100	57,100	58,300	59,300	53,500	53,700
Potassium	µg/L	11,400	5,090	4,770	4,920	4,540	4,600
Sodium	µg/L	69,000	46,100	43,100	48,200	44,000	44,800
Dissolved Metals							
Arsenic	µg/L	34	22	21	25.9	38	35.5
Iron	µg/L	84,500	108,000	103,000	108,000	106,000	103,000
Conventionals							
Alkalinity	µg/L $CaCO_3$	651,000	616,000	696,000	584,000	668,000	630,000
Bicarbonate	µg/L $CaCO_3$	651,000	616,000	696,000	584,000	668,000	630,000
Carbonate	µg/L $CaCO_3$	1,000 U	1,000 U	1,000 U	1,000 U	1,000 U	1,000 U
Chloride	µg/L	52,100	39,400	37,700	38,500	37,200	34,900
Dissolved Organic Carbon	µg/L	56,400	61,600	58,000	48,700	54,400	45,600
Hydroxide	µg/L $CaCO_3$	1,000 U	1,000 U	1,000 U	1,000 U	1,000 U	1,000 U
N-Nitrate	µg-N/L	600 JB	100 U	100	100 U	100 U	100 U
N-Nitrite	µg-N/L	500 U	100 U	100 U	100 U	100 U	100 U
Sulfate	µg/L	3,100	400	800	800	100 U	100 U
Sulfide	µg/L	50 U	50 U	50 U	50 U	50 U	50 U
Field Parameters							
pH	pH units	6.31	6.19	6.37	6.22	6.14	6.14
Dissolved Oxygen	mg/L	0.5	0.89	0.76	1.44	0.94	2.71
Specific Conductivity	mS/cm	1.42	1.33	1.42	1.34	1.25	1.4
Temperature	°C	13.11	7.9	10.15	14.39	12.34	14
ORP	mV	-18	-80	-32	-38	-17	-110

Notes:

--	Constituent not analyzed for.
1	Calculated data value.

Abbreviations:

$CaCO_3$	Calcium carbonate
°C	Degree Celsius
µg-N/L	Equivalent nitrogen micrograms per liter
µg/L	Micrograms per liter
mg/L	Milligrams per liter
mS/cm	Millisiemens per centimeter
mV	Millivolt
NA	Not analyzed
ORP	Oxidation-reduction potential

Qualifiers:

H	Estimated due to presence of blank contamination.
JB	Estimated due to presence of blank contamination.
U	Not detected.

Table 3.5

Selected Total Metals and Conventionals in Solid-Phase Speciation Soil Samples

		Sample ID	IP-1D	IP-2B
		Sample Date	9/11/2012	9/11/2012
Analyte	**CAS**	**Units**		
Conventionals				
Total Solids	--	%	75.2	80.1
Acid Volatile Sulfide	--	mg/kg	20.6	1.87
Metals				
Arsenic	7440-38-2	mg/kg	1.5	1.3
Lead	7439-89-6	mg/kg	10,600	10,800

Note:

-- Not applicable.

Abbreviations:

CAS	CAS Registry Number
mg/kg	Milligrams per kilogram

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Figures

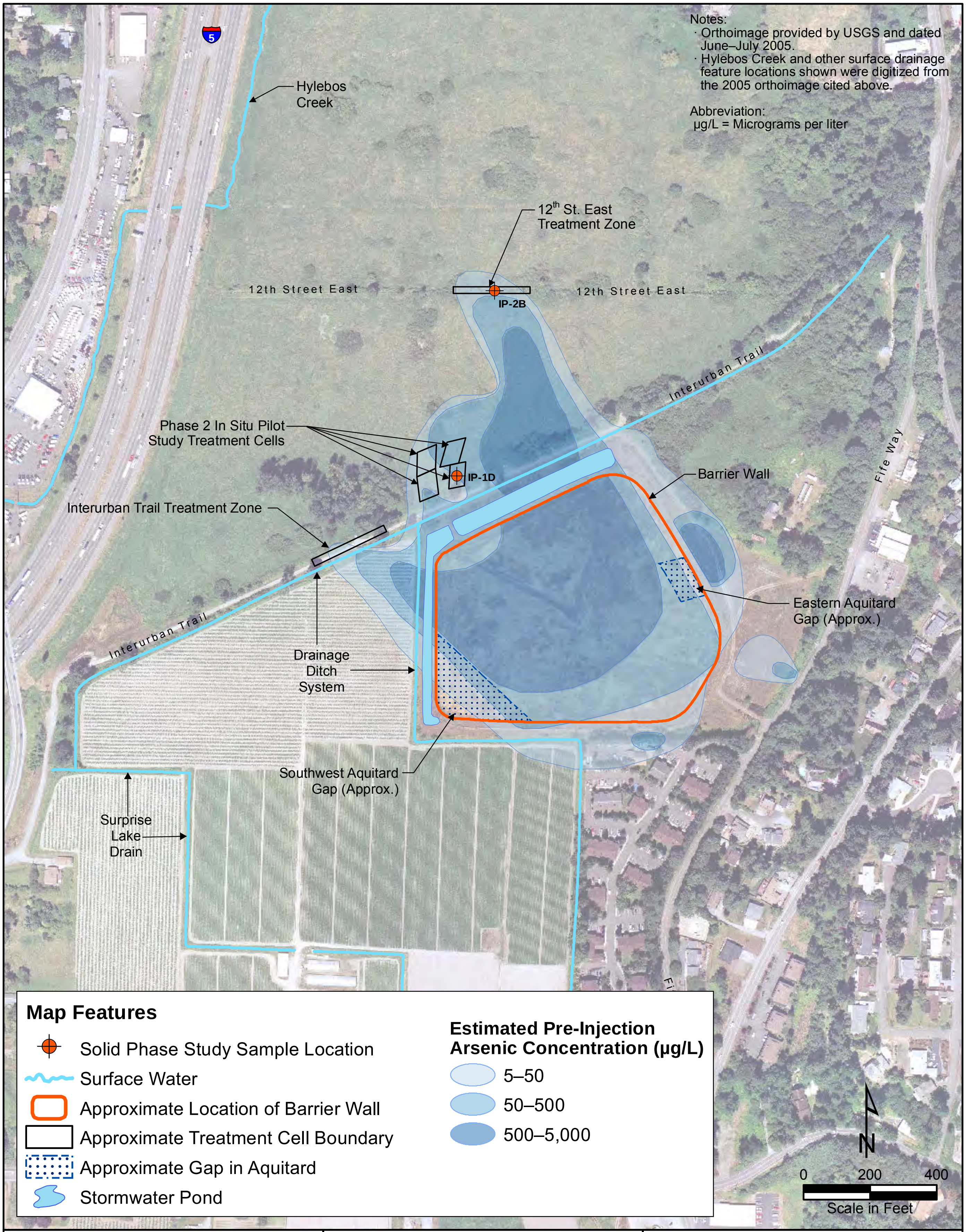

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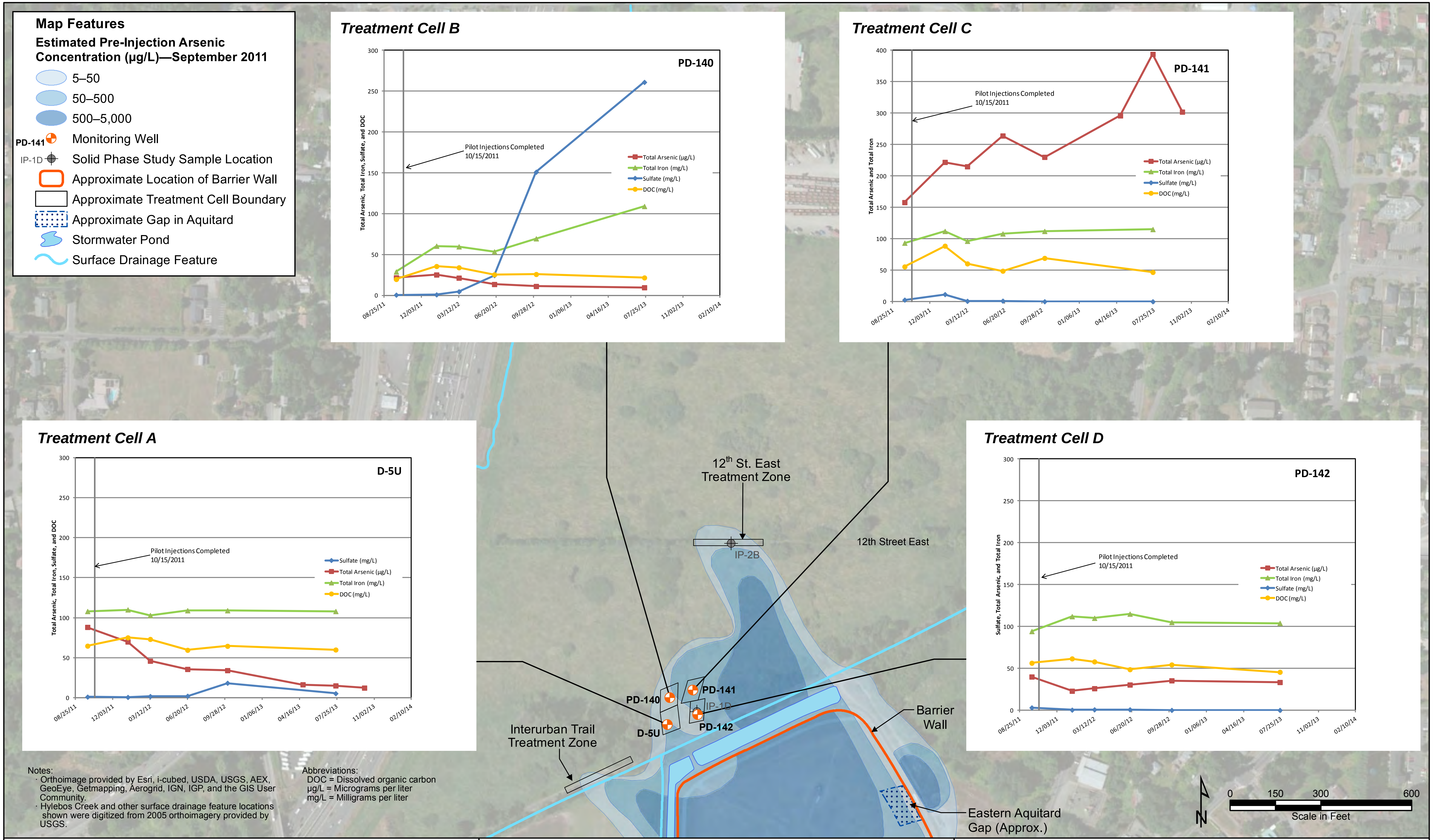
Figure 1.1
Site Layout

I:\GIS\Projects\B&L-O&M\MXD\Phase II In Situ Pilot Study - 2014\Figure 1.1 (Site Map Showing Plume Extent).mxd
2/14/2014



Notes:
- Orthoimage provided by Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community.
- Hylebos Creek and other surface drainage feature locations shown were digitized from 2005 orthoimagery provided by USGS.

Abbreviations:
DOC = Dissolved organic carbon
µg/L = Micrograms per liter
mg/L = Milligrams per liter

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Figure 3.1
In Situ Pilot Study
Monitoring Results

I:\GIS\Projects\B&L-O&M\MXD\Phase II In Situ Pilot Study - 2014\Figure 3.1 (GW Chemical Trends - In-situ Pilot Study).mxd
2/14/2014

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Pierce County, Washington

Phase 2 In Situ Pilot Study Monitoring Report

Appendix A
Analytical Laboratory Data Reports

Analytical Resources, Incorporated
Analytical Chemists and Consultants

September 26, 2012

Brett Beaulieu
Floyd Snider
600 Union Street, Suite 600
Seattle, WA 98101-2341

RE: B&L Wood Waste, 1431
ARI Job No.: VJ05

Dear Brett:

Please find enclosed the original Chain-of-Custody (COC) record, sample receipt documentation, and the final results for samples from the project referenced above. Analytical Resources, Inc. (ARI) accepted two soil samples on September 11, 2012. For details regarding sample receipt, please refer to the enclosed Cooler Receipt Form.

The samples were analyzed for total metals and acid-volatile sulfide, as requested.

There were no anomalies associated with the analyses of these samples.

An electronic copy of this report and all associated raw data will remain on file with ARI. If you have any questions or require additional information, please contact me at your convenience.

Sincerely,

ANALYTICAL RESOURCES, INC.

Cheronne Oreiro
Project Manager
-For-
Susan D. Dunnihoo
Director, Client Services
sue@arilabs.com
206-695-6207

cc: eFile VJ05

Enclosures

Chain of Custody Record & Laboratory Analysis Request

Analytical Resources, Incorporated
Analytical Chemists and Consultants
4611 South 134th Place, Suite 100
Tukwila, WA 98168
206-695-6200 206-695-6201 (fax)

ARI Assigned Number: VS05
Turn-around Requested: STD
Page: 1 of 1
ARI Client Company: FLOYD SNIDER
Phone: 206 292 2078
Date: 9/11/12
Ice Present? Y
Client Contact: BRETT BEAULIEU
No. of Coolers: 1
Cooler Temps: 7.3
Client Project Name: B+L WOODWASTE
Client Project #: 1431
Samplers: BRETT BEAULIEU

Sample ID	Date	Time	Matrix	No. Containers	Analysis Requested: TOTAL AS	TOTAL Fe							Notes/Comments
IP-1D	9/11/12	10 00	SOIL	1	X								
IP-2B	9/11/12	13:30	SOIL	1	X								

Comments/Special Instructions
PLEASE CALL BRETT RE: SULFUR ANALYSIS

	Relinquished by	Received by	Relinquished by	Received by
(Signature)				
Printed Name	BRETT BEAULIEU	Jennifer Millsap		
Company	FLOYDISNIDER	ARI		
Date & Time	9/11/12 16:00	9/11/12 1600		

Limits of Liability: *ARI will perform all requested services in accordance with appropriate methodology following ARI Standard Operating Procedures and the ARI Quality Assurance Program. This program meets standards for the industry. The total liability of ARI, its officers, agents, employees, or successors, arising out of or in connection with the requested services, shall not exceed the Invoiced amount for said services. The acceptance by the client of a proposal for services by ARI release ARI from any liability in excess thereof, not withstanding any provision to the contrary in any contract, purchase order or co-signed agreement between ARI and the Client.*

Sample Retention Policy: All samples submitted to ARI will be appropriately discarded no sooner than 90 days after receipt or 60 days after submission of hardcopy data, whichever is longer, unless alternate retention schedules have been established by work-order or contract.

Analytical Resources, Incorporated
Analytical Chemists and Consultants

Cooler Receipt Form

ARI Client: Floyd Snider
COC No(s) ______ [✓ NA]
Assigned ARI Job No VJ05

Project Name: B+L Woodwaste
Delivered by Fed-Ex UPS Courier [✓ Hand Delivered] Other ______
Tracking No. ______ [✓ NA]

Preliminary Examination Phase:

Were intact, properly signed and dated custody seals attached to the outside of to cooler?	YES	[✓ NO]
Were custody papers included with the cooler?	[✓ YES]	NO
Were custody papers properly filled out (ink, signed, etc)	[✓ YES]	NO

Temperature of Cooler(s) (°C) (recommended 2 0-6 0 °C for chemistry) 7.3
If cooler temperature is out of compliance fill out form 00070F
Temp Gun ID# 90877952
Cooler Accepted by JM Date 9/11/12 Time 1600

Complete custody forms and attach all shipping documents

Log-In Phase:

Was a temperature blank included in the cooler? YES [✓ NO]
What kind of packing material was used? Bubble Wrap [✓ Wet Ice] Gel Packs Baggies Foam Block Paper Other: ______

Was sufficient ice used (if appropriate)?	NA	YES	[✓ NO]
Were all bottles sealed in individual plastic bags?		YES	[✓ NO]
Did all bottles arrive in good condition (unbroken)?		[✓ YES]	NO
Were all bottle labels complete and legible?		[✓ YES]	NO
Did the number of containers listed on COC match with the number of containers received?		[✓ YES]	NO
Did all bottle labels and tags agree with custody papers?		[✓ YES]	NO
Were all bottles used correct for the requested analyses?		[✓ YES]	NO
Do any of the analyses (bottles) require preservation? (attach preservation sheet, excluding VOCs)	[✓ NA]	YES	NO
Were all VOC vials free of air bubbles?	[✓ NA]	YES	NO
Was sufficient amount of sample sent in each bottle?		[✓ YES]	NO
Date VOC Trip Blank was made at ARI	[✓ NA]	______	

Was Sample Split by ARI [✓ NA] YES Date/Time ______ Equipment ______ Split by: ______

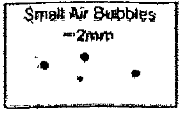
Samples Logged by JM Date 9/12/12 Time 755

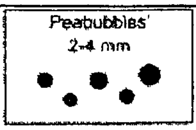
*** Notify Project Manager of discrepancies or concerns ***

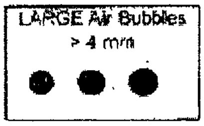
Sample ID on Bottle	Sample ID on COC	Sample ID on Bottle	Sample ID on COC

Additional Notes, Discrepancies, & Resolutions:

By Date


Small Air Bubbles ~2mm


Peabubbles 2-4 mm


LARGE Air Bubbles > 4 mm

Small → "sm"
Peabubbles → "pb"
Large → "lg"
Headspace → "hs"

Analytical Resources, Incorporated
Analytical Chemists and Consultants

Cooler Temperature Compliance Form

VJ05

Cooler#: 1 **Temperature(°C):** 7.3

Sample ID	**Bottle Count**	**Bottle Type**
All samples associated		
with this job were		
received at a temp		
greater than 6°C.		

Cooler#: **Temperature(°C):**

Sample ID	**Bottle Count**	**Bottle Type**

Cooler#: **Temperature(°C):**

Sample ID	**Bottle Count**	**Bottle Type**

Cooler#: **Temperature(°C):**

Sample ID	**Bottle Count**	**Bottle Type**

Completed by: JM Date: 9/12/12 Time: 754

Subject: Acid-volatile sulfide
From: Brett Beaulieu <Brett.Beaulieu@floydsnider.com>
Date: 9/12/2012 2:49 PM
To: 'Cheronne Oreiro' <cheronneo@arilabs.com>

Hi Cheronne,

I would like to add acid-volatile sulfide analysis for the two samples that I dropped off yesterday, IP-1D and IP-2B, for the B&L Woodwaste Site.

Thanks!

Brett Beaulieu, LHG
FLOYD|SNIDER
Two Union Square
601 Union Street, Suite 600
Seattle, WA 98101
tel 206 292 2078
fax 206 682 7867
brett.beaulieu@floydsnider.com

Sample ID Cross Reference Report

ANALYTICAL RESOURCES INCORPORATED

ARI Job No: VJ05
Client: Floyd-Snider
Project Event: 1431
Project Name: B&L Woodwaste

	Sample ID	ARI Lab ID	ARI LIMS ID	Matrix	Sample Date/Time	VTSR
1.	IP-1D	VJ05A	12-17329	Soil	09/11/12 10:00	09/11/12 16:00
2.	IP-2B	VJ05B	12-17330	Soil	09/11/12 13:30	09/11/12 16:00

Printed 09/12/12 Page 1 of 1

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
Page 1 of 1

Sample ID: IP-1D
SAMPLE

Lab Sample ID: VJ05A
LIMS ID: 12-17329
Matrix: Soil
Data Release Authorized:
Reported: 09/20/12

QC Report No: VJ05-Floyd-Snider
Project: B&L Woodwaste
1431
Date Sampled: 09/11/12
Date Received: 09/11/12

Percent Total Solids: 71.6%

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	LOQ	mg/kg-dry	Q
3050B	09/17/12	200.8	09/18/12	**7440-38-2**	**Arsenic**	0.3	**1.5**	
3050B	09/17/12	6010C	09/19/12	**7439-89-6**	**Iron**	7	**10,600**	

U-Analyte undetected at given LOQ
LOQ-Limit of Quantitation

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
Page 1 of 1

Sample ID: IP-2B
SAMPLE

Lab Sample ID: VJ05B
LIMS ID: 12-17330
Matrix: Soil
Data Release Authorized:
Reported: 09/20/12

QC Report No: VJ05-Floyd-Snider
Project: B&L Woodwaste
1431
Date Sampled: 09/11/12
Date Received: 09/11/12

Percent Total Solids: 79.1%

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	LOQ	mg/kg-dry	Q
3050B	09/17/12	200.8	09/18/12	**7440-38-2**	**Arsenic**	0.2	**1.3**	
3050B	09/17/12	6010C	09/19/12	**7439-89-6**	**Iron**	6	**10,800**	

U-Analyte undetected at given LOQ
LOQ-Limit of Quantitation

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
Page 1 of 1

Sample ID: LAB CONTROL

Lab Sample ID: VJ05LCS
LIMS ID: 12-17329
Matrix: Soil
Data Release Authorized:
Reported: 09/20/12

QC Report No: VJ05-Floyd-Snider
Project: B&L Woodwaste
1431
Date Sampled: NA
Date Received: NA

BLANK SPIKE QUALITY CONTROL REPORT

Analyte	Analysis Method	Spike Found	Spike Added	% Recovery	Q
Arsenic	200.8	26.2	25.0	105%	
Iron	6010C	202	200	101%	

Reported in mg/kg-dry

N-Control limit not met
NA-Not Applicable, Analyte Not Spiked
Control Limits: 80-120%

ANALYTICAL
RESOURCES
INCORPORATED

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
Page 1 of 1

Sample ID: METHOD BLANK

Lab Sample ID: VJ05MB
LIMS ID: 12-17329
Matrix: Soil
Data Release Authorized:
Reported: 09/20/12

QC Report No: VJ05-Floyd-Snider
Project: B&L Woodwaste
1431
Date Sampled: NA
Date Received: NA

Percent Total Solids: NA

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	LOQ	mg/kg-dry	Q
3050B	09/17/12	200.8	09/18/12	7440-38-2	Arsenic	0.2	0.2	U
3050B	09/17/12	6010C	09/19/12	7439-89-6	Iron	5	5	U

U-Analyte undetected at given LOQ
LOQ-Limit of Quantitation

FORM-I

SAMPLE RESULTS-CONVENTIONALS
VJ05-Floyd-Snider

**ANALYTICAL
RESOURCES
INCORPORATED**

Matrix: Soil
Data Release Authorized:
Reported: 09/26/12

Project: B&L Woodwaste
Event: 1431
Date Sampled: 09/11/12
Date Received: 09/11/12

Client ID: IP-1D
ARI ID: 12-17329 VJ05A

Analyte	Date	Method	Units	RL	Sample
Total Solids	09/19/12 091912#1	SM2540B	Percent	0.01	75.20
Acid Volatile Sulfide	09/25/12 092512#1	EPA 1991	mg/kg	1.31	20.6

RL	Analytical reporting limit
U	Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
VJ05-Floyd-Snider

Matrix: Soil
Data Release Authorized:
Reported: 09/26/12

Project: B&L Woodwaste
Event: 1431
Date Sampled: 09/11/12
Date Received: 09/11/12

Client ID: IP-2B
ARI ID: 12-17330 VJ05B

Analyte	Date	Method	Units	RL	Sample
Total Solids	09/19/12 091912#1	SM2540B	Percent	0.01	80.10
Acid Volatile Sulfide	09/25/12 092512#1	EPA 1991	mg/kg	1.26	1.87

RL	Analytical reporting limit
U	Undetected at reported detection limit

MS/MSD RESULTS-CONVENTIONALS
VJ05-Floyd-Snider

Matrix: Soil
Data Release Authorized:
Reported: 09/26/12

Project: B&L Woodwaste
Event: 1431
Date Sampled: 09/11/12
Date Received: 09/11/12

Analyte	**Date**	**Units**	**Sample**	**Spike**	**Spike Added**	**Recovery**
ARI ID: VJ05A Client ID: IP-1D						
Acid Volatile Sulfide	09/25/12	mg/kg	20.6	173	186	81.9%

REPLICATE RESULTS-CONVENTIONALS
VJ05-Floyd-Snider

Matrix: Soil
Data Release Authorized:
Reported: 09/26/12

Project: B&L Woodwaste
Event: 1431
Date Sampled: 09/11/12
Date Received: 09/11/12

Analyte	**Date**	**Units**	**Sample**	**Replicate(s)**	**RPD/RSD**
ARI ID: VJ05A Client ID: IP-1D					
Total Solids	09/19/12	Percent	75.20	74.50	0.9%
Acid Volatile Sulfide	09/25/12	mg/kg	20.6	24.3	16.5%

LAB CONTROL RESULTS-CONVENTIONALS
VJ05-Floyd-Snider

Matrix: Soil
Data Release Authorized:
Reported: 09/26/12

Project: B&L Woodwaste
Event: 1431
Date Sampled: NA
Date Received: NA

Analyte/Method	**QC ID**	**Date**	**Units**	**LCS**	**Spike Added**	**Recovery**
Acid Volatile Sulfide EPA 1991	PREP	09/25/12	mg/kg	6.70	6.97	96.1%

METHOD BLANK RESULTS-CONVENTIONALS
VJ05-Floyd-Snider

Matrix: Soil
Data Release Authorized:
Reported: 09/26/12

Project: B&L Woodwaste
Event: 1431
Date Sampled: NA
Date Received: NA

Analyte	**Date**	**Units**	**Blank**
Total Solids	09/19/12	Percent	< 0.01 U
Acid Volatile Sulfide	09/25/12	mg/kg	< 0.05 U

Analytical Resources, Incorporated
Analytical Chemists and Consultants

August 22, 2013

Brett Beaulieu
Floyd Snider
600 Union Street, Suite 600
Seattle, WA 98101-2341

RE: B&L O&M
ARI Job No.: WY38

Dear Brett:

Please find enclosed the original Chain-of-Custody (COC) record, sample receipt documentation, and the final results for samples from the project referenced above. Analytical Resources, Inc. (ARI) accepted eight water samples on July 22, 2013. For further details regarding sample receipt, please refer to the enclosed Cooler Receipt Form.

The samples were analyzed for total metals, dissolved metals, and conventional-chemistry parameters, as requested on the COC. The analysis for arsenic speciation was subcontracted to Applied Speciation Laboratories in Bothell, WA. Analysis was performed using IC-ICP-CRC-MS, a modification from historic methodology. All subcontracted data have been included in this report.

An electronic copy of this report and all associated raw data will remain on file with ARI. If you have any questions or require additional information, please contact me at your convenience.

Sincerely,

ANALYTICAL RESOURCES, INC.

Kelly Bottem
Client Services Manager
kellyb@arilabs.com
206-695-6211

cc: eFile WY38

Enclosures

Chain of Custody Record & Laboratory Analysis Request

ARI Assigned Number: WY38	Turn-around Requested: Std	Page: 1	of 1
ARI Client Company: Floyd | Snider	Phone: 206-292-2078	Date: 7/22/13	Ice Present? Y
Client Contact: Brett Beaulieu		No. of Coolers: 1	Cooler Temps: 5.9
Client Project Name: B+L O+M			
Client Project #:	Samplers: K. Andersen		

Analytical Resources, Incorporated
Analytical Chemists and Consultants
4611 South 134th Place, Suite 100
Tukwila, WA 98168
206-695-6200 206-695-6201 (fax)

					Analysis Requested								Notes/Comments	
Sample ID	Date	Time	Matrix	No. Containers	As + Fe (total) EPA 6061B	As + Fe (dissl) EPA 6061B	cations	sulfide	sulfate + anions	alkalinity	DOC EPA 415.1	Sulfide EPA 376.2	As speciation	
BLW-GW-IT-PD142	7/22/13	1035	GW	5	X		X	X	X	X		X		
BLW-GW-IT-PD142-F		1035		3		X					X		X	
BLW-GW-IT-PD140		1150		5	X		X	X	X	X		X		
BLW-GW-IT-PD140-F		1150		3		X					X		X	
BLW-GW-IT-PD141		1305		5	X		X	X	X	X		X		
BLW-GW-IT-PD141-F		1305		3		X					X		X	
BLW-GW-IT-DSU		1415		5	X		X	X	X	X		X		
BLW-GW-IT-DSU-F		1415		3		X					X		X	

Comments/Special Instructions	Relinquished by	Received by	Relinquished by	Received by
	(Signature)	(Signature)	(Signature)	(Signature)
	Printed Name: Kristin Andersen	Printed Name: A. Volgardsen	Printed Name:	Printed Name:
	Company: Floyd | Snider	Company: ARI	Company:	Company:
	Date & Time: 7/22/13 1801	Date & Time: 7/22/13 1601	Date & Time:	Date & Time:

Limits of Liability: *ARI will perform all requested services in accordance with appropriate methodology following ARI Standard Operating Procedures and the ARI Quality Assurance Program. This program meets standards for the industry. The total liability of ARI, its officers, agents, employees, or successors, arising out of or in connection with the requested services, shall not exceed the Invoiced amount for said services. The acceptance by the client of a proposal for services by ARI release ARI from any liability in excess thereof, not withstanding any provision to the contrary in any contract, purchase order or co-signed agreement between ARI and the Client.*

Sample Retention Policy: All samples submitted to ARI will be appropriately discarded no sooner than 90 days after receipt or 60 days after submission of hardcopy data, whichever is longer, unless alternate retention schedules have been established by work-order or contract.

Analytical Resources, Incorporated
Analytical Chemists and Consultants

Cooler Receipt Form

ARI Client FloydSnider
COC No(s) ______ [✓ NA]
Assigned ARI Job No WY38
Project Name B+L O+M
Delivered by: Fed-Ex UPS Courier [✓ Hand Delivered] Other ______
Tracking No ______ [✓ NA]

Preliminary Examination Phase:

Were intact, properly signed and dated custody seals attached to the outside of to cooler? YES [✓ NO]
Were custody papers included with the cooler? [✓ YES] NO
Were custody papers properly filled out (ink, signed, etc.) [✓ YES] NO
Temperature of Cooler(s) (°C) (recommended 2.0-6.0 °C for chemistry) 5.9
If cooler temperature is out of compliance fill out form 00070F
Temp Gun ID# 90877952
Cooler Accepted by: AV Date: 7/22/13 Time: 1601

Complete custody forms and attach all shipping documents

Log-In Phase:

Was a temperature blank included in the cooler? YES [✓ NO]
What kind of packing material was used? [✓ Bubble Wrap] [✓ Wet Ice] Gel Packs Baggies Foam Block Paper Other: ______
Was sufficient ice used (if appropriate)? NA [✓ YES] NO
Were all bottles sealed in individual plastic bags? YES [✓ NO]
Did all bottles arrive in good condition (unbroken)? [✓ YES] NO
Were all bottle labels complete and legible? [✓ YES] NO
Did the number of containers listed on COC match with the number of containers received? [✓ YES] NO
Did all bottle labels and tags agree with custody papers? [✓ YES] NO
Were all bottles used correct for the requested analyses? [✓ YES] NO
Do any of the analyses (bottles) require preservation? (attach preservation sheet, excluding VOCs) NA [✓ YES] NO
Were all VOC vials free of air bubbles? [✓ NA] YES NO
Was sufficient amount of sample sent in each bottle? [✓ YES] NO
Date VOC Trip Blank was made at ARI [✓ NA] ______
Was Sample Split by ARI: [✓ NA] YES Date/Time: ______ Equipment: ______ Split by: ______

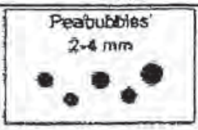
Samples Logged by AV Date: 7/23/13 Time: 757

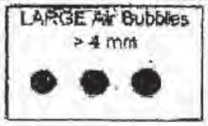
***** Notify Project Manager of discrepancies or concerns *****

Sample ID on Bottle	Sample ID on COC	Sample ID on Bottle	Sample ID on COC

Additional Notes, Discrepancies, & Resolutions:

By: Date:





Small → "sm"
Peabubbles → "pb"
Large → "lg"
Headspace → "hs"

PRESERVATION VERIFICATION 07/23/13
Page 1 of 1

ANALYTICAL RESOURCES INCORPORATED

ARI Job No: **WY38**

Inquiry Number: NONE
Analysis Requested: 07/23/13
Contact: Beaulieu, Brett
Client: Floyd-Snider
Logged by: AV
Sample Set Used: Yes-043
Validatable Package: No
Deliverables:

PC: Kelly
VTSR: 07/22/13

Project #:
Project: B+L O+M
Sample Site:
SDG No:
Analytical Protocol: In-house

LOGNUM ARI ID	CLIENT ID	CN >12	WAD >12	NH3 <2	COD <2	FOG <2	MET <2	PHEN <2	PHOS <2	TKN <2	NO23 <2	TOC <2	S2 >9	TPHD <2	Fe2+ <2	DMET FLT	DOC FLT	PARAMETER	ADJUSTED TO	LOT NUMBER	AMOUNT ADDED	DATE/BY
13-15422 **WY38A**	BLW-GW-IT-PD142						TOT pass					pass	Fail				Y	~~S2~~ S2	~~>12~~ >12	~~9681C~~ 9681C	~~4ml~~ 4mL	~~7/23/13 RR~~ 7/23/13 RR
13-15423 **WY38B**	BLW-GW-IT-PD140						TOT pass					pass	Fail				Y	↓	↓	↓	↓	↓
13-15424 **WY38C**	BLW-GW-IT-PD141						TOT pass					pass	Fail				Y	↓	↓	↓	↓	↓
13-15425 **WY38D**	BLW-GW-IT-D5U						TOT pass					pass	Fail				Y	↓	↓	↓	↓	↓
13-15426 **WY38E**	BLW-GW-IT-PD142-F						DIS pass									Y						
13-15427 **WY38F**	BLW-GW-IT-PD140-F						DIS pass									Y						
13-15428 **WY38G**	BLW-GW-IT-PD141-F						DIS pass									Y						
13-15429 **WY38H**	BLW-GW-IT-D5U-F						DIS pass									Y						

S_2 preserved with ZnOAc, lab to adjust Ph.

Checked By AV Date 7/23/13

Sample ID Cross Reference Report

ANALYTICAL
RESOURCES
INCORPORATED

ARI Job No: WY38
Client: Floyd-Snider
Project Event: N/A
Project Name: B+L O+M

	Sample ID	ARI Lab ID	ARI LIMS ID	Matrix	Sample Date/Time	VTSR
1.	BLW-GW-IT-PD142	WY38A	13-15422	Water	07/22/13 10:35	07/22/13 16:01
2.	BLW-GW-IT-PD140	WY38B	13-15423	Water	07/22/13 11:50	07/22/13 16:01
3.	BLW-GW-IT-PD141	WY38C	13-15424	Water	07/22/13 13:05	07/22/13 16:01
4.	BLW-GW-IT-D5U	WY38D	13-15425	Water	07/22/13 14:15	07/22/13 16:01
5.	BLW-GW-IT-PD142-F	WY38E	13-15426	Water	07/22/13 10:35	07/22/13 16:01
6.	BLW-GW-IT-PD140-F	WY38F	13-15427	Water	07/22/13 11:50	07/22/13 16:01
7.	BLW-GW-IT-PD141-F	WY38G	13-15428	Water	07/22/13 13:05	07/22/13 16:01
8.	BLW-GW-IT-D5U-F	WY38H	13-15429	Water	07/22/13 14:15	07/22/13 16:01

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
Page 1 of 1

Sample ID: BLW-GW-IT-PD142
SAMPLE

Lab Sample ID: WY38A
LIMS ID: 13-15422
Matrix: Water
Data Release Authorized:
Reported: 07/29/13

QC Report No: WY38-Floyd-Snider
Project: B+L O+M

Date Sampled: 07/22/13
Date Received: 07/22/13

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	mg/L	Q
200.8	07/24/13	200.8	07/25/13	**7440-38-2**	**Arsenic**	0.0005	**0.0334**	
3010A	07/24/13	6010C	07/26/13	**7440-70-2**	**Calcium**	0.05	**99.4**	
3010A	07/24/13	6010C	07/26/13	**7439-89-6**	**Iron**	0.05	**104**	
3010A	07/24/13	6010C	07/26/13	**7439-95-4**	**Magnesium**	0.05	**53.7**	
3010A	07/24/13	6010C	07/26/13	**7440-09-7**	**Potassium**	0.5	**4.6**	
3010A	07/24/13	6010C	07/26/13	**7440-23-5**	**Sodium**	0.5	**44.8**	

U-Analyte undetected at given RL
RL-Reporting Limit

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
Page 1 of 1

Sample ID: BLW-GW-IT-PD142
DUPLICATE

Lab Sample ID: WY38A
LIMS ID: 13-15422
Matrix: Water
Data Release Authorized:
Reported: 07/29/13

QC Report No: WY38-Floyd-Snider
Project: B+L O+M

Date Sampled: 07/22/13
Date Received: 07/22/13

MATRIX DUPLICATE QUALITY CONTROL REPORT

Analyte	Analysis Method	Sample	Duplicate	RPD	Control Limit	Q
Arsenic	200.8	0.0334	0.0339	1.5%	+/- 20%	
Calcium	6010C	99.4	98.8	0.6%	+/- 20%	
Iron	6010C	104	103	1.0%	+/- 20%	
Magnesium	6010C	53.7	53.3	0.7%	+/- 20%	
Potassium	6010C	4.6	4.5	2.2%	+/- 20%	
Sodium	6010C	44.8	44.8	0.0%	+/- 20%	

Reported in mg/L

*-Control Limit Not Met
L-RPD Invalid, Limit = Detection Limit

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
Page 1 of 1

Sample ID: BLW-GW-IT-PD142
MATRIX SPIKE

Lab Sample ID: WY38A
LIMS ID: 13-15422
Matrix: Water
Data Release Authorized:
Reported: 07/29/13

QC Report No: WY38-Floyd-Snider
Project: B+L O+M

Date Sampled: 07/22/13
Date Received: 07/22/13

MATRIX SPIKE QUALITY CONTROL REPORT

Analyte	Analysis Method	Sample	Spike	Spike Added	% Recovery	Q
Arsenic	200.8	0.0334	0.0569	0.0250	94.0%	
Calcium	6010C	99.4	109	10.0	96.0%	H
Iron	6010C	104	105	2.00	50.0%	H
Magnesium	6010C	53.7	61.6	10.0	79.0%	H
Potassium	6010C	4.6	14.6	10.0	100%	
Sodium	6010C	44.8	56.0	10.0	112%	H

Reported in mg/L

N-Control Limit Not Met
H-% Recovery Not Applicable, Sample Concentration Too High
NA-Not Applicable, Analyte Not Spiked

Percent Recovery Limits: 75-125%

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
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Sample ID: BLW-GW-IT-PD140
SAMPLE

Lab Sample ID: WY38B
LIMS ID: 13-15423
Matrix: Water
Data Release Authorized:
Reported: 07/29/13

QC Report No: WY38-Floyd-Snider
Project: B+L O+M

Date Sampled: 07/22/13
Date Received: 07/22/13

Prep Meth	**Prep Date**	**Analysis Method**	**Analysis Date**	**CAS Number**	**Analyte**	**RL**	**mg/L**	**Q**
200.8	07/24/13	200.8	07/25/13	**7440-38-2**	**Arsenic**	0.0002	**0.0096**	
3010A	07/24/13	6010C	07/26/13	**7440-70-2**	**Calcium**	0.05	**116**	
3010A	07/24/13	6010C	07/26/13	**7439-89-6**	**Iron**	0.05	**110**	
3010A	07/24/13	6010C	07/26/13	**7439-95-4**	**Magnesium**	0.05	**57.4**	
3010A	07/24/13	6010C	07/26/13	**7440-09-7**	**Potassium**	0.5	**5.7**	
3010A	07/24/13	6010C	07/26/13	**7440-23-5**	**Sodium**	0.5	**48.6**	

U-Analyte undetected at given RL
RL-Reporting Limit

ANALYTICAL RESOURCES INCORPORATED

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Sample ID: BLW-GW-IT-PD141
SAMPLE

Lab Sample ID: WY38C
LIMS ID: 13-15424
Matrix: Water
Data Release Authorized:
Reported: 07/29/13

QC Report No: WY38-Floyd-Snider
Project: B+L O+M

Date Sampled: 07/22/13
Date Received: 07/22/13

Prep Meth	**Prep Date**	**Analysis Method**	**Analysis Date**	**CAS Number**	**Analyte**	**RL**	**mg/L**	**Q**
200.8	07/24/13	200.8	07/26/13	**7440-38-2**	**Arsenic**	0.001	**0.394**	
3010A	07/24/13	6010C	07/26/13	**7440-70-2**	**Calcium**	0.05	**114**	
3010A	07/24/13	6010C	07/26/13	**7439-89-6**	**Iron**	0.05	**115**	
3010A	07/24/13	6010C	07/26/13	**7439-95-4**	**Magnesium**	0.05	**58.0**	
3010A	07/24/13	6010C	07/26/13	**7440-09-7**	**Potassium**	0.5	**5.0**	
3010A	07/24/13	6010C	07/26/13	**7440-23-5**	**Sodium**	0.5	**58.7**	

U-Analyte undetected at given RL
RL-Reporting Limit

INORGANICS ANALYSIS DATA SHEET
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Sample ID: BLW-GW-IT-D5U
SAMPLE

Lab Sample ID: WY38D
LIMS ID: 13-15425
Matrix: Water
Data Release Authorized:
Reported: 07/29/13

QC Report No: WY38-Floyd-Snider
Project: B+L O+M

Date Sampled: 07/22/13
Date Received: 07/22/13

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	mg/L	Q
200.8	07/24/13	200.8	07/25/13	**7440-38-2**	**Arsenic**	0.0002	**0.0151**	
3010A	07/24/13	6010C	07/26/13	**7440-70-2**	**Calcium**	0.05	**122**	
3010A	07/24/13	6010C	07/26/13	**7439-89-6**	**Iron**	0.05	**108**	
3010A	07/24/13	6010C	07/26/13	**7439-95-4**	**Magnesium**	0.05	**58.7**	
3010A	07/24/13	6010C	07/26/13	**7440-09-7**	**Potassium**	0.5	**5.9**	
3010A	07/24/13	6010C	07/26/13	**7440-23-5**	**Sodium**	0.5	**47.7**	

U-Analyte undetected at given RL
RL-Reporting Limit

INORGANICS ANALYSIS DATA SHEET
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Sample ID: BLW-GW-IT-PD142-F
SAMPLE

Lab Sample ID: WY38E
LIMS ID: 13-15426
Matrix: Water
Data Release Authorized:
Reported: 07/29/13

QC Report No: WY38-Floyd-Snider
Project: B+L O+M

Date Sampled: 07/22/13
Date Received: 07/22/13

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	mg/L	Q
200.8	07/24/13	200.8	07/25/13	**7440-38-2**	**Arsenic**	0.0002	**0.0355**	
6010C	07/24/13	6010C	07/26/13	**7439-89-6**	**Iron**	0.05	**103**	

U-Analyte undetected at given RL
RL-Reporting Limit

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DISSOLVED METALS
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Sample ID: BLW-GW-IT-PD142-F
DUPLICATE

Lab Sample ID: WY38E
LIMS ID: 13-15426
Matrix: Water
Data Release Authorized:
Reported: 07/29/13

QC Report No: WY38-Floyd-Snider
Project: B+L O+M

Date Sampled: 07/22/13
Date Received: 07/22/13

MATRIX DUPLICATE QUALITY CONTROL REPORT

Analyte	Analysis Method	Sample	Duplicate	RPD	Control Limit	Q
Arsenic	200.8	0.0355	0.0347	2.3%	+/- 20%	
Iron	6010C	103	103	0.0%	+/- 20%	

Reported in mg/L

*-Control Limit Not Met
L-RPD Invalid, Limit = Detection Limit

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Sample ID: BLW-GW-IT-PD142-F
MATRIX SPIKE

Lab Sample ID: WY38E
LIMS ID: 13-15426
Matrix: Water
Data Release Authorized:
Reported: 07/29/13

QC Report No: WY38-Floyd-Snider
Project: B+L O+M

Date Sampled: 07/22/13
Date Received: 07/22/13

MATRIX SPIKE QUALITY CONTROL REPORT

Analyte	Analysis Method	Sample	Spike	Spike Added	% Recovery	Q
Arsenic	200.8	0.0355	0.0593	0.025	95.2%	
Iron	6010C	103	104	2.00	50.0%	H

Reported in mg/L

N-Control Limit Not Met
H-% Recovery Not Applicable, Sample Concentration Too High
NA-Not Applicable, Analyte Not Spiked

Percent Recovery Limits: 75-125%

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INORGANICS ANALYSIS DATA SHEET
DISSOLVED METALS
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Sample ID: BLW-GW-IT-PD140-F
SAMPLE

Lab Sample ID: WY38F
LIMS ID: 13-15427
Matrix: Water
Data Release Authorized:
Reported: 07/29/13

QC Report No: WY38-Floyd-Snider
Project: B+L O+M

Date Sampled: 07/22/13
Date Received: 07/22/13

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	mg/L	Q
200.8	07/24/13	200.8	07/25/13	**7440-38-2**	**Arsenic**	0.0002	**0.0088**	
6010C	07/24/13	6010C	07/26/13	**7439-89-6**	**Iron**	0.05	**109**	

U-Analyte undetected at given RL
RL-Reporting Limit

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INORGANICS ANALYSIS DATA SHEET
DISSOLVED METALS
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Sample ID: BLW-GW-IT-PD141-F
SAMPLE

Lab Sample ID: WY38G
LIMS ID: 13-15428
Matrix: Water
Data Release Authorized:
Reported: 07/29/13

QC Report No: WY38-Floyd-Snider
Project: B+L O+M

Date Sampled: 07/22/13
Date Received: 07/22/13

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	mg/L	Q
200.8	07/24/13	200.8	07/26/13	**7440-38-2**	**Arsenic**	0.001	**0.344**	
6010C	07/24/13	6010C	07/26/13	**7439-89-6**	**Iron**	0.05	**115**	

U-Analyte undetected at given RL
RL-Reporting Limit

INORGANICS ANALYSIS DATA SHEET
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Sample ID: BLW-GW-IT-D5U-F
SAMPLE

Lab Sample ID: WY38H
LIMS ID: 13-15429
Matrix: Water
Data Release Authorized:
Reported: 07/29/13

QC Report No: WY38-Floyd-Snider
Project: B+L O+M

Date Sampled: 07/22/13
Date Received: 07/22/13

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	mg/L	Q
200.8	07/24/13	200.8	07/25/13	**7440-38-2**	**Arsenic**	0.0002	**0.0146**	
6010C	07/24/13	6010C	07/26/13	**7439-89-6**	**Iron**	0.05	**108**	

U-Analyte undetected at given RL
RL-Reporting Limit

FORM-I

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
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Sample ID: METHOD BLANK

Lab Sample ID: WY38MB
LIMS ID: 13-15423
Matrix: Water
Data Release Authorized:
Reported: 07/29/13

QC Report No: WY38-Floyd-Snider
Project: B+L O+M

Date Sampled: NA
Date Received: NA

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	mg/L	Q
200.8	07/24/13	200.8	07/25/13	7440-38-2	Arsenic	0.0002	0.0002	U
3010A	07/24/13	6010C	07/26/13	7440-70-2	Calcium	0.05	0.05	U
3010A	07/24/13	6010C	07/26/13	7439-89-6	Iron	0.05	0.05	U
3010A	07/24/13	6010C	07/26/13	7439-95-4	Magnesium	0.05	0.05	U
3010A	07/24/13	6010C	07/26/13	7440-09-7	Potassium	0.5	0.5	U
3010A	07/24/13	6010C	07/26/13	7440-23-5	Sodium	0.5	0.5	U

U-Analyte undetected at given RL
RL-Reporting Limit

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
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Sample ID: LAB CONTROL

Lab Sample ID: WY38LCS
LIMS ID: 13-15423
Matrix: Water
Data Release Authorized:
Reported: 07/29/13

QC Report No: WY38-Floyd-Snider
Project: B+L O+M

Date Sampled: NA
Date Received: NA

BLANK SPIKE QUALITY CONTROL REPORT

Analyte	Analysis Method	Spike Found	Spike Added	% Recovery	Q
Arsenic	200.8	0.0244	0.0250	97.6%	
Calcium	6010C	9.80	10.0	98.0%	
Iron	6010C	2.05	2.00	102%	
Magnesium	6010C	10.2	10.0	102%	
Potassium	6010C	9.9	10.0	99.0%	
Sodium	6010C	9.8	10.0	98.0%	

Reported in mg/L

N-Control limit not met
Control Limits: 80-120%

INORGANICS ANALYSIS DATA SHEET
DISSOLVED METALS
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Sample ID: METHOD BLANK

Lab Sample ID: WY38MB
LIMS ID: 13-15427
Matrix: Water
Data Release Authorized:
Reported: 07/29/13

QC Report No: WY38-Floyd-Snider
Project: B+L O+M

Date Sampled: NA
Date Received: NA

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	mg/L	Q
200.8	07/24/13	200.8	07/25/13	7440-38-2	Arsenic	0.0002	0.0002	U
6010C	07/24/13	6010C	07/26/13	7439-89-6	Iron	0.05	0.05	U

U-Analyte undetected at given RL
RL-Reporting Limit

INORGANICS ANALYSIS DATA SHEET
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Sample ID: LAB CONTROL

Lab Sample ID: WY38LCS
LIMS ID: 13-15427
Matrix: Water
Data Release Authorized:
Reported: 07/29/13

QC Report No: WY38-Floyd-Snider
Project: B+L O+M

Date Sampled: NA
Date Received: NA

BLANK SPIKE QUALITY CONTROL REPORT

Analyte	Analysis Method	Spike Found	Spike Added	% Recovery	Q
Arsenic	200.8	0.0237	0.0250	94.8%	
Iron	6010C	2.02	2.00	101%	

Reported in mg/L

N-Control limit not met
Control Limits: 80-120%

SAMPLE RESULTS-CONVENTIONALS
WY38-Floyd-Snider

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Matrix: Water
Data Release Authorized:
Reported: 08/05/13

Project: B+L O+M
Event: NA
Date Sampled: 07/22/13
Date Received: 07/22/13

Client ID: BLW-GW-IT-PD142
ARI ID: 13-15422 WY38A

Analyte	**Date Batch**	**Method**	**Units**	**RL**	**Sample**
Alkalinity	07/23/13 072313#1	SM 2320	mg/L CaCO3	1.0	630
Carbonate	07/23/13	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Bicarbonate	07/23/13	SM 2320	mg/L CaCO3	1.0	630
Hydroxide	07/23/13	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Chloride	07/30/13 073013#1	EPA 300.0	mg/L	1.0	34.9
N-Nitrate	07/23/13 072313#1	EPA 300.0	mg-N/L	0.1	< 0.1 U
N-Nitrite	07/23/13 072313#1	EPA 300.0	mg-N/L	0.1	< 0.1 U
Sulfate	07/30/13 073013#1	EPA 300.0	mg/L	0.1	< 0.1 U
Sulfide	07/25/13 072513#1	EPA 376.2	mg/L	0.050	< 0.050 U

RL Analytical reporting limit
U Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
WY38-Floyd-Snider

Matrix: Water
Data Release Authorized:
Reported: 08/05/13

Project: B+L O+M
Event: NA
Date Sampled: 07/22/13
Date Received: 07/22/13

Client ID: BLW-GW-IT-PD140
ARI ID: 13-15423 WY38B

Analyte	Date Batch	Method	Units	RL	Sample
Alkalinity	07/23/13 072313#1	SM 2320	mg/L CaCO3	1.0	523
Carbonate	07/23/13	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Bicarbonate	07/23/13	SM 2320	mg/L CaCO3	1.0	523
Hydroxide	07/23/13	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Chloride	07/30/13 073013#1	EPA 300.0	mg/L	0.5	20.2
N-Nitrate	07/23/13 072313#1	EPA 300.0	mg-N/L	0.1	< 0.1 U
N-Nitrite	07/23/13 072313#1	EPA 300.0	mg-N/L	0.1	< 0.1 U
Sulfate	07/30/13 073013#1	EPA 300.0	mg/L	10.0	261
Sulfide	07/25/13 072513#1	EPA 376.2	mg/L	0.050	< 0.050 U

RL Analytical reporting limit
U Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
WY38-Floyd-Snider

ANALYTICAL RESOURCES INCORPORATED

Matrix: Water
Data Release Authorized:
Reported: 08/05/13

Project: B+L O+M
Event: NA
Date Sampled: 07/22/13
Date Received: 07/22/13

Client ID: BLW-GW-IT-PD141
ARI ID: 13-15424 WY38C

Analyte	Date Batch	Method	Units	RL	Sample
Alkalinity	07/23/13 072313#1	SM 2320	mg/L CaCO3	1.0	651
Carbonate	07/23/13	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Bicarbonate	07/23/13	SM 2320	mg/L CaCO3	1.0	651
Hydroxide	07/23/13	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Chloride	07/30/13 073013#1	EPA 300.0	mg/L	1.0	37.3
N-Nitrate	07/23/13 072313#1	EPA 300.0	mg-N/L	0.1	< 0.1 U
N-Nitrite	07/23/13 072313#1	EPA 300.0	mg-N/L	0.1	< 0.1 U
Sulfate	07/30/13 073013#1	EPA 300.0	mg/L	0.1	< 0.1 U
Sulfide	07/25/13 072513#1	EPA 376.2	mg/L	0.050	< 0.050 U

RL	Analytical reporting limit
U	Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
WY38-Floyd-Snider

Matrix: Water
Data Release Authorized
Reported: 08/05/13

Project: B+L O+M
Event: NA
Date Sampled: 07/22/13
Date Received: 07/22/13

Client ID: BLW-GW-IT-D5U
ARI ID: 13-15425 WY38D

Analyte	Date Batch	Method	Units	RL	Sample
Alkalinity	07/23/13 072313#1	SM 2320	mg/L CaCO3	1.0	734
Carbonate	07/23/13	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Bicarbonate	07/23/13	SM 2320	mg/L CaCO3	1.0	734
Hydroxide	07/23/13	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Chloride	07/30/13 073013#1	EPA 300.0	mg/L	1.0	28.6
N-Nitrate	07/23/13 072313#1	EPA 300.0	mg-N/L	0.1	< 0.1 U
N-Nitrite	07/23/13 072313#1	EPA 300.0	mg-N/L	0.1	< 0.1 U
Sulfate	07/30/13 073013#1	EPA 300.0	mg/L	0.2	5.4
Sulfide	07/25/13 072513#1	EPA 376.2	mg/L	0.050	0.064

RL	Analytical reporting limit
U	Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
WY38-Floyd-Snider

Matrix: Water
Data Release Authorized:
Reported: 08/05/13

Project: B+L O+M
Event: NA
Date Sampled: 07/22/13
Date Received: 07/22/13

Client ID: BLW-GW-IT-PD142-F
ARI ID: 13-15426 WY38E

Analyte	**Date Batch**	**Method**	**Units**	**RL**	**Sample**
Dissolved Organic Carbon	07/24/13 072413#1	EPA 9060	mg/L	1.50	45.6

RL Analytical reporting limit
U Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
WY38-Floyd-Snider

Matrix: Water
Data Release Authorized:
Reported: 08/05/13

Project: B+L O+M
Event: NA
Date Sampled: 07/22/13
Date Received: 07/22/13

Client ID: BLW-GW-IT-PD140-F
ARI ID: 13-15427 WY38F

Analyte	Date Batch	Method	Units	RL	Sample
Dissolved Organic Carbon	07/24/13 072413#1	EPA 9060	mg/L	1.50	21.6

RL Analytical reporting limit
U Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
WY38-Floyd-Snider

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Matrix: Water
Data Release Authorized:
Reported: 08/05/13

Project: B+L O+M
Event: NA
Date Sampled: 07/22/13
Date Received: 07/22/13

Client ID: BLW-GW-IT-PD141-F
ARI ID: 13-15428 WY38G

Analyte	Date Batch	Method	Units	RL	Sample
Dissolved Organic Carbon	07/24/13 072413#1	EPA 9060	mg/L	1.50	46.8

RL	Analytical reporting limit
U	Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
WY38-Floyd-Snider

Matrix: Water
Data Release Authorized:
Reported: 08/05/13

Project: B+L O+M
Event: NA
Date Sampled: 07/22/13
Date Received: 07/22/13

Client ID: BLW-GW-IT-D5U-F
ARI ID: 13-15429 WY38H

Analyte	Date Batch	Method	Units	RL	Sample
Dissolved Organic Carbon	07/25/13 072513#1	EPA 9060	mg/L	1.50	60.0

RL Analytical reporting limit
U Undetected at reported detection limit

METHOD BLANK RESULTS-CONVENTIONALS
WY38-Floyd-Snider

ANALYTICAL RESOURCES INCORPORATED

Matrix: Water
Data Release Authorized:
Reported: 08/05/13

Project: B+L O+M
Event: NA
Date Sampled: NA
Date Received: NA

Analyte	Method	Date	Units	Blank	ID
Chloride	EPA 300.0	07/30/13	mg/L	< 0.1 U	
N-Nitrate	EPA 300.0	07/23/13	mg-N/L	< 0.1 U	
N-Nitrite	EPA 300.0	07/23/13	mg-N/L	< 0.1 U	
Sulfate	EPA 300.0	07/30/13	mg/L	< 0.1 U	
Sulfide	EPA 376.2	07/25/13 07/25/13	mg/L	< 0.050 U < 0.050 U	
Dissolved Organic Carbon	EPA 9060	07/24/13 07/25/13	mg/L	< 1.50 U < 1.50 U	

LAB CONTROL RESULTS-CONVENTIONALS
WY38-Floyd-Snider

ANALYTICAL RESOURCES INCORPORATED

Matrix: Water
Data Release Authorized:
Reported: 08/05/13

Project: B+L O+M
Event: NA
Date Sampled: NA
Date Received: NA

Analyte/Method	QC ID	Date	Units	LCS	Spike Added	Recovery
Sulfide	ICVL	07/25/13	mg/L	0.530	0.509	104.1%
EPA 376.2	PREP	07/25/13		7.48	7.23	103.5%

STANDARD REFERENCE RESULTS-CONVENTIONALS
WY38-Floyd-Snider

ANALYTICAL RESOURCES INCORPORATED

Matrix: Water
Data Release Authorized:
Reported: 08/05/13

Project: B+L O+M
Event: NA
Date Sampled: NA
Date Received: NA

Analyte/SRM ID	Method	Date	Units	SRM	True Value	Recovery
Alkalinity ERA #P114506	SM 2320	07/23/13	mg/L CaCO3	32.6	32.1	101.6%
Chloride ERA 210312	EPA 300.0	07/30/13	mg/L	3.1	3.0	103.3%
N-Nitrate ERA #220912	EPA 300.0	07/23/13	mg-N/L	3.1	3.0	103.3%
N-Nitrite ERA 490412	EPA 300.0	07/23/13	mg-N/L	3.1	3.0	103.3%
Sulfate ERA 240312	EPA 300.0	07/30/13	mg/L	3.1	3.0	103.3%
Dissolved Organic Carbon ERA #0408-13-02	EPA 9060	07/24/13 07/25/13	mg/L	21.7 21.6	20.0 20.0	108.5% 108.0%

REPLICATE RESULTS-CONVENTIONALS
WY38-Floyd-Snider

ANALYTICAL RESOURCES INCORPORATED

Matrix: Water
Data Release Authorized:
Reported: 08/05/13

Project: B+L O+M
Event: NA
Date Sampled: 07/22/13
Date Received: 07/22/13

Analyte	Method	Date	Units	Sample	Replicate(s)	RPD/RSD
ARI ID: WY38A	**Client ID: BLW-GW-IT-PD142**					
Alkalinity	SM 2320	07/23/13	mg/L CaCO3	630	631	0.2%
Carbonate	SM 2320	07/23/13	mg/L CaCO3	< 1.0	< 1.0	NA
Bicarbonate	SM 2320	07/23/13	mg/L CaCO3	630	631	0.2%
Hydroxide	SM 2320	07/23/13	mg/L CaCO3	< 1.0	< 1.0	NA
Chloride	EPA 300.0	07/30/13	mg/L	34.9	37.3	6.6%
N-Nitrate	EPA 300.0	07/23/13	mg-N/L	< 0.1	< 0.1	NA
N-Nitrite	EPA 300.0	07/23/13	mg-N/L	< 0.1	< 0.1	NA
Sulfate	EPA 300.0	07/30/13	mg/L	< 0.1	< 0.1	NA
Sulfide	EPA 376.2	07/25/13	mg/L	< 0.050	< 0.050	NA
ARI ID: WY38E	**Client ID: BLW-GW-IT-PD142-F**					
Dissolved Organic Carbo	EPA 9060	07/24/13	mg/L	45.6	46.2	1.3%

MS/MSD RESULTS-CONVENTIONALS
WY38-Floyd-Snider

Matrix: Water
Data Release Authorized:
Reported: 08/05/13

Project: B+L O+M
Event: NA
Date Sampled: 07/22/13
Date Received: 07/22/13

Analyte	**Method**	**Date**	**Units**	**Sample**	**Spike**	**Spike Added**	**Recovery**
ARI ID: WY38A	**Client ID: BLW-GW-IT-PD142**						
Chloride	EPA 300.0	07/30/13	mg/L	34.9	75.8	40.0	102.2%
N-Nitrate	EPA 300.0	07/23/13	mg-N/L	< 0.1	2.0	2.0	100.0%
N-Nitrite	EPA 300.0	07/23/13	mg-N/L	< 0.1	1.8	2.0	90.0%
Sulfate	EPA 300.0	07/30/13	mg/L	< 0.1	1.8	2.0	90.0%
Sulfide	EPA 376.2	07/25/13	mg/L	< 0.050	6.47	7.23	89.5%
ARI ID: WY38E	**Client ID: BLW-GW-IT-PD142-F**						
Dissolved Organic Carbon	EPA 9060	07/24/13	mg/L	45.6	66.0	20.0	102.0%

APPLIED SPECIATION AND CONSULTING, LLC

18804 Northcreek Parkway Bothell, WA, 98011
Tel: (425) 483-3300 Fax: (425) 483-9818
www.appliedspeciation.com

August 16, 2013

Kelly Bottem
Analytical Resources Inc.
4611 S. 134th Place Suite 100
Tukwila, WA 98168
(206) 695-6211

Re: B+L O+M (Project WY38)

Ms. Bottem,

Attached is the report associated with four (4) aqueous samples submitted for arsenite and arsenate quantitation on July 23, 2013. The samples were received the same day in a sealed cooler at 11.1°C. Arsenite and arsenate speciation analysis was performed via ion chromatography inductively coupled plasma collision reaction cell mass spectrometry (IC-ICP-CRC-MS). Any issues associated with the analyses are addressed in the following report.

If you have any questions, please feel free to contact me at your convenience.

Sincerely,

Russell Gerads
Vice President
Applied Speciation and Consulting, LLC

Applied Speciation and Consulting, LLC

Report Prepared for:

Kelly Bottem
Analytical Resources Inc.
4611 S. 134th Place Suite 100
Tukwila, WA 98168

August 16, 2013

1. Sample Reception

Four (4) aqueous samples were submitted for arsenite and arsenate quantitation on July 23, 2013. The samples were received the same day as the submittal date, as indicated on the attached chain of custody (COC) forms, in a sealed cooler at 11.1°C.

The samples were received in a laminar flow clean hood, void of trace metals contamination and ultra-violet radiation, and assigned discrete sample identifiers. Immediately upon reception an aliquot of each sample was filtered (0.45µm) into a polypropylene centrifuge tube, and all filtrates and original sample bottles were then stored in a secure, monitored refrigerator (maintained at a temperature of 4°C) until the analyses could occur.

The pH of all samples was measured upon reception to confirm that field preservation was properly applied. The pH for all samples was 6 indicating that either the sample matrix buffered the preservative or it was not applied. An aliquot of the sample identified as 13-15426-WY38G was taken and preserved in accordance with the recommended field preservation technique presented by Applied Speciation and Consulting. The pH of the sample aliquot after laboratory preservation was the optimal 4.5.

2. Sample Preparation

All sample preparation is performed in laminar flow clean hoods known to be free from trace metals contamination. All applied water for dilutions and sample preservatives are also monitored for contamination to account for any biases associated with the sample results.

Arsenic Speciation Analysis by IC-ICP-CRC-MS Upon sample reception an aliquot of each sample was filtered with a syringe filter (0.45µm) directly into an autosampler vial. No further sample preparation was performed.

3. Sample Analysis

All sample analysis is preceded by a minimum of a five-point calibration curve spanning the entire concentration range of interest. Calibration curves are performed at the beginning of each analytical day. All calibration curves, associated with each species of interest, are standardized by linear regression resulting in a response factor. All sample results are **instrument blank corrected** to account for any operational biases.

Prior to sample analysis, all calibration curves are verified using second source standards which are identified as initial calibration verification standards (ICV).

Ongoing instrument performance is identified by the analysis of continuing calibration verification standards (CCV) and continuing calibration blanks (CCB) at a minimal interval of every ten analytical runs.

Arsenic Speciation Analysis by IC-ICP-CRC-MS All samples for arsenite and arsenate quantitation were analyzed by ion chromatography inductively coupled plasma collision reaction cell mass spectrometry (IC-ICP-CRC-MS) on July 23, 2013. Aliquots of each sample are injected onto an anion exchange column and are mobilized by an alkaline (pH > 7) gradient. The eluting arsenic species are then introduced into a radio frequency (RF) plasma where energy-transfer processes cause desolvation, atomization, and ionization. The ions are extracted from the plasma through a differentially-pumped vacuum interface and travel through a pressurized chamber (CRC) containing a specific collision gas. Polyatomic interferences, due to their inherently larger size, collide more frequently with the collision gas and therefore may be separated from the analyte of interest via kinetic energy discrimination (KED). A solid-state detector detects ions transmitted through the mass analyzer on the basis of their mass-to-charge ratio (m/z), and the resulting current is processed by a data handling system.

Retention times for each eluting species are compared to known standards for species identification.

4. Analytical Issues

The overall analyses went well and no significant analytical issues were encountered. All quality control parameters associated with these samples were within acceptance limits.

The estimated method detection limits (eMDLs) for arsenite and arsenate have been generated from replicate analyses of the lowest standard in the calibration curve. Not all arsenic species are present in preparation blanks; therefore, eMDL calculations based on preparation blanks may be artificially biased low for these species.

If you have any questions regarding this report, please feel free to contact me.

Sincerely,

Russell Gerads
Vice President
Applied Speciation and Consulting, LLC

Arsenic Speciation Results for ARI
Project Name: B+L O+M
Contact: Kelly Bottem

Report Date: August 16, 2013
Report Generated by: Russell Gerads
Applied Speciation and Consulting, LLC

Sample Results

Sample ID	Date Sampled	Dilution	As(III)	As(V)
13-15426-WY38E	7/22/13	1000	34.4	ND (<2.6)
13-15427-WY-38F	7/22/13	1000	6.54	ND (<2.6)
13.15428-WY38G	7/22/13	1000	321	17.8
13-15429-WY38H	7/22/13	1000	10.0	ND (<2.6)

All results reflect the applied dilution and are reported in µg/L

ND = Not detected at the applied dilution

WY38 R (PF3[illegible]

Arsenic Speciation Results for ARI
Project Name: B+L O+M
Contact: Kelly Bottem

Report Date: August 16, 2013
Report Generated by: Russell Gerads
Applied Speciation and Consulting, LLC

Quality Control Summary - Preparation Blank Summary

Analyte	Units	PBW1	PBW2	PBW3	PBW4	Mean	StdDev	eMDL* at 1000x	RL at 1000x
As(III)	µg/L	0.000	0.000	0.000	0.000	0.000	0.000	2.5	20
As(V)	µg/L	0.000	0.000	0.000	0.000	0.000	0.000	2.6	20

eMDL = Estimated Method Detection Limit; RL = Reporting Limit

*Please see narrative regarding eMDL calculations

Quality Control Summary - Certified Reference Materials

Analyte	Units	CRM	True Value	Result	Recovery
As(III)	µg/L	ICV	5.000	5.272	105.4
As(V)	µg/L	ICV	5.000	5.018	100.4

WY38; 39R 8- 9/6/13

Arsenic Speciation Results for ARI
Project Name: B+L O+M
Contact: Kelly Bottem

Report Date: August 16, 2013
Report Generated by: Russell Gerads
Applied Speciation and Consulting, LLC

Quality Control Summary - Matrix Duplicates

Analyte	Units	Sample ID	Rep 1	Rep 2	Mean	RPD
As(III)	µg/L	13.15428-WY38G	320.71	325.72	323.22	1.6
As(V)	µg/L	13.15428-WY38G	17.78	16.84	17.31	5.5

NC = Value was not calculated due to one or more concentrations below the eMDL

Quality Control Summary - Matrix Spike/ Matrix Spike Duplicate

Analyte	Units	Sample ID	Spike Conc	MS Result	Recovery	Spike Conc	MSD Result	Recovery	RPD
As(III)	µg/L	13.15428-WY38G	2000	2238	95.7	2000	2243	96.0	0.3
As(V)	µg/L	13.15428-WY38G	2000	1969	97.6	2000	1984	98.4	0.8

WY38:40R BC 9/6/13

SUBCONTRACTOR ANALYSIS REQUEST
CUSTODY TRANSFER 07/23/13

ANALYTICAL RESOURCES INCORPORATED

ARI Project: WY38

Laboratory: Applied Speciation & Consulting
Lab Contact: Russell Gerads
Lab Address: 18804 Northcreek Parkway
Bothell, WA 98011
Phone: 425-483-3300
Fax: 425-483-9818

ARI Client: Floyd-Snider
Project ID: B+L O+M
ARI PM: Kelly Bottem
Phone: 206-695-6211
Fax: 206-695-6201
Email: subdata@arilabs.com

Analytical Protocol: In-house
Special Instructions:

Requested Turn Around:
Email Results (Y/N):

Limits of Liability. *Subcontractor is expected to perform all requested services in accordance with appropriate methodology following Standard Operating Procedures that meet standards for the industry. The total liability of ARI, its officers, agents, employees, or sucessors, arising out of or in connection with the requested services, shall not exceed the negotiated amount for said services. The agreement by the Subcontractor to perform services requested by ARI releases ARI from any liability in excess thereof, not withstanding any provision to the contrary in any contract, purchase order or co-signed agreement between ARI and the Subcontractor.*

ARI ID	Client ID/ Add'l ID	Sampled	Matrix	Bottles	Analyses
13-15426-WY38E	BLW-GW-IT-PD142-F	07/22/13 10:35	Water	1	Arsenic Speciation
Special Instructions: Field Filtered, EDTA Preservation					
13-15427-WY38F	BLW-GW-IT-PD140-F	07/22/13 11:50	Water	1	Arsenic Speciation
Special Instructions: Field Filterd, EDTA Preservation					
13-15428-WY38G	BLW-GW-IT-PD141-F	07/22/13 13:05	Water	1	Arsenic Speciation
Special Instructions: Field Filtered, EDTA Preservation					
13-15429-WY38H	BLW-GW-IT-D5U-F	07/22/13 14:15	Water	1	Arsenic Speciation
Special Instructions: Field Filtered, EDTA Preservation					

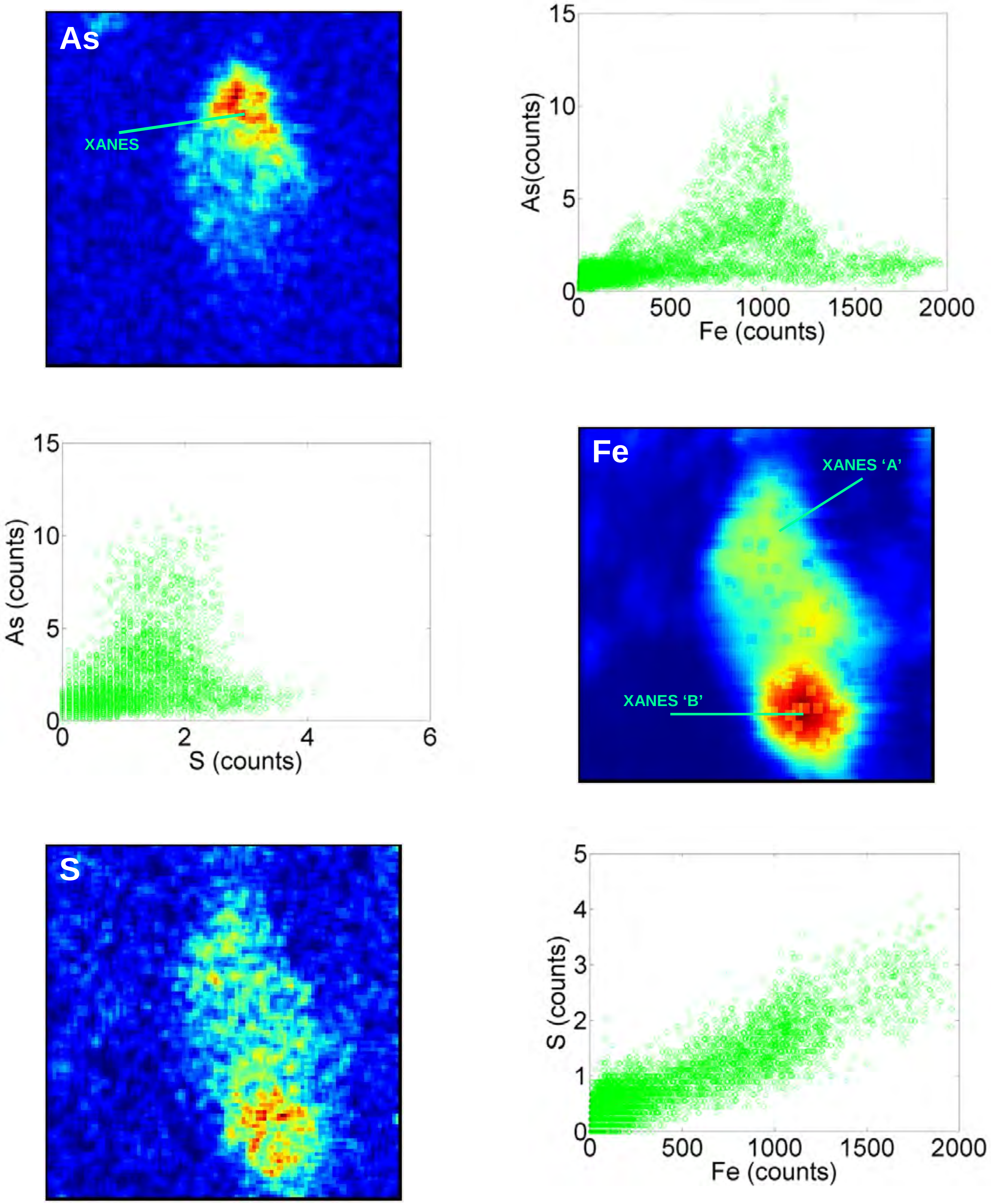
Carrier	Airbill		Date
Relinquished by	Company ARI	Date 7/23/13	Time 1345
Received by	Company ASC	Date 7/23/13	Time 1345 11.1°C

*cooler full of ice

B&L Woodwaste Site
Pierce County, Washington

Phase 2 In Situ Pilot Study Monitoring Report

Appendix B
Solid Phase Speciation Results



Note:

1. Map dimensions are 100 µm x 100 µm.

Abbreviations:

As = Arsenic
Fe = Iron
µm = Micrometer
µXRF = Micro-x-ray fluorescence
S = Sulfur
XANES = X-ray absorption near-edge structures

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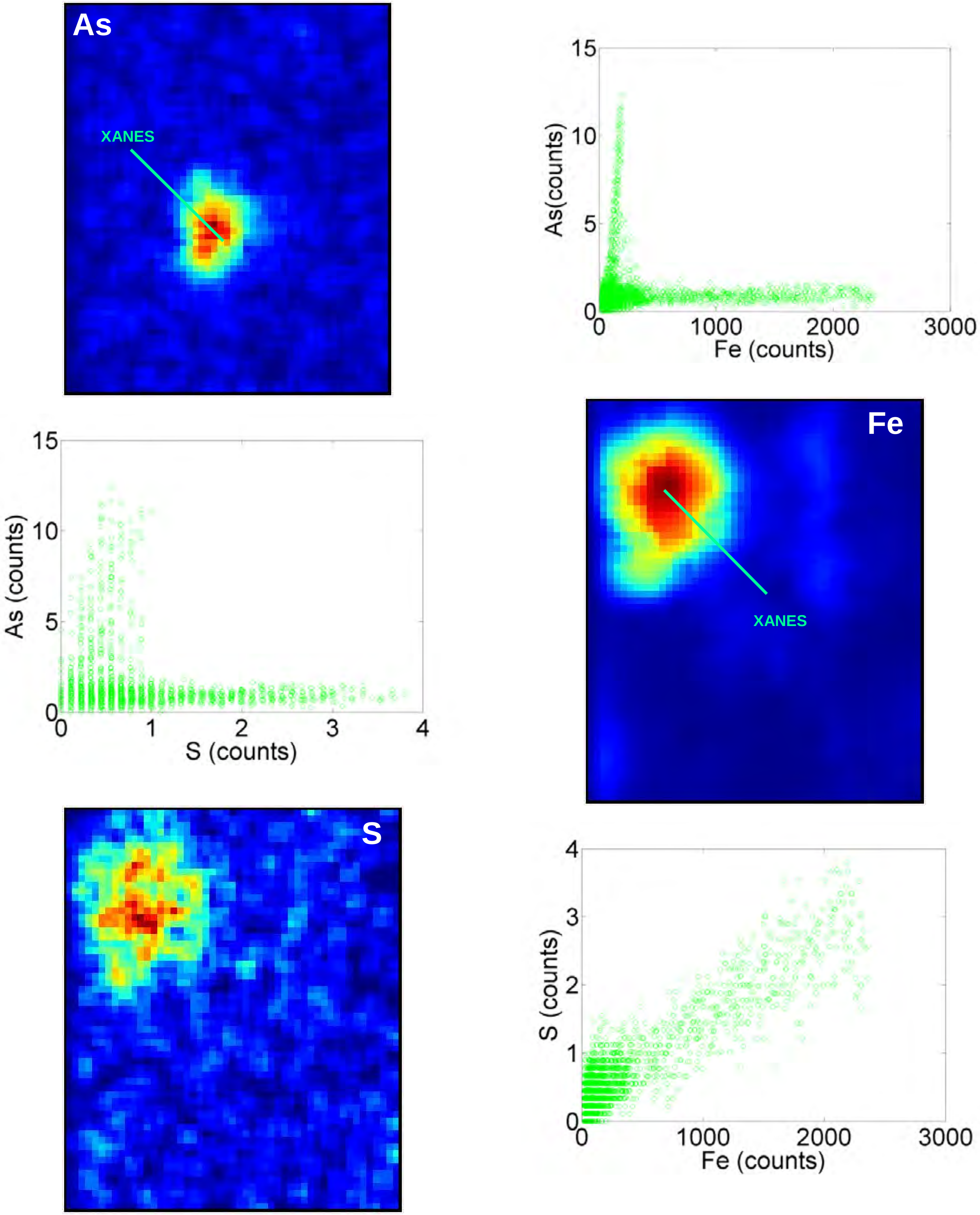
Phase 2 In Situ Pilot Study
Monitoring Report
B&L Woodwaste Site
Pierce County, Washington

Figure B.1
Z1 µXRF Maps and
Correlation Plots



Note:
1. Map dimensions are 50 µm x 60 µm.

Abbreviations:
As = Arsenic
Fe = Iron
µm = Micrometer
µXRF = Micro-x-ray fluorescence
S = Sulfur
XANES = X-ray absorption near-edge structures

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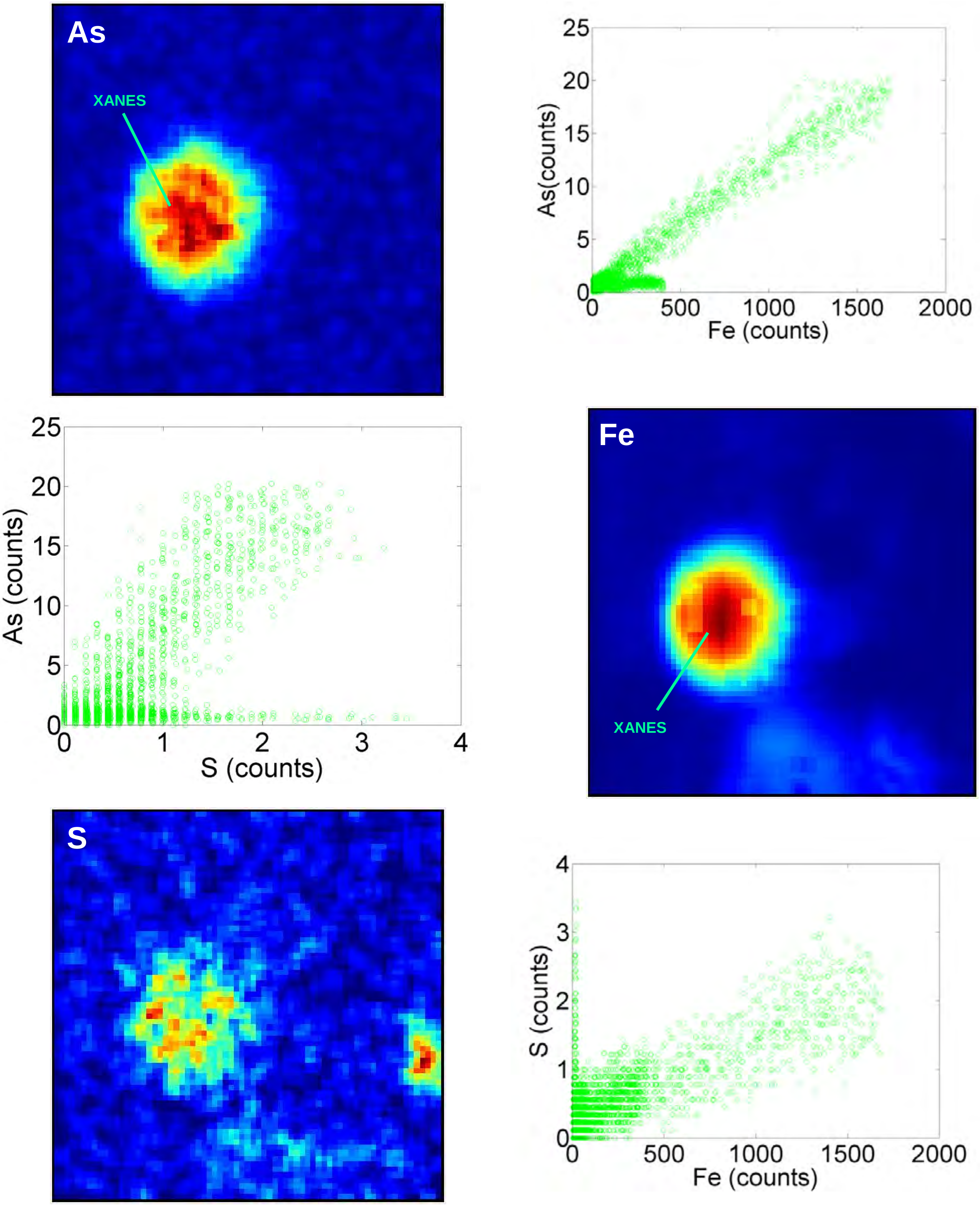
Pierce County, Washington

Figure B.2
Z4 µXRF Maps and
Correlation Plots



Note:
1. Map dimensions are 70 µm x 70 µm.

Abbreviations:
As = Arsenic
Fe = Iron
µm = Micrometer
µXRF = Micro-x-ray fluorescence
S = Sulfur
XANES = X-ray absorption near-edge structures

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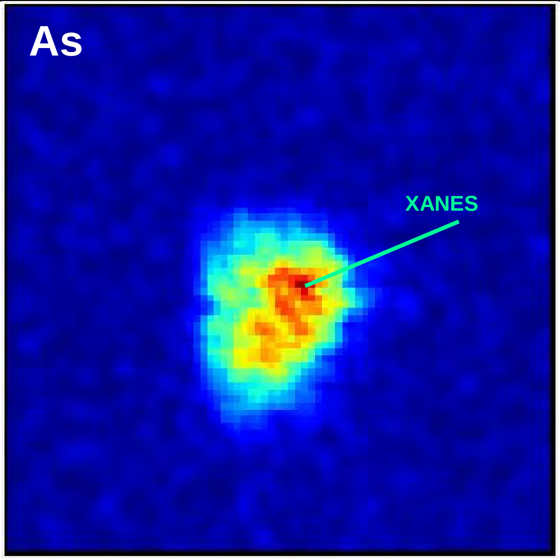
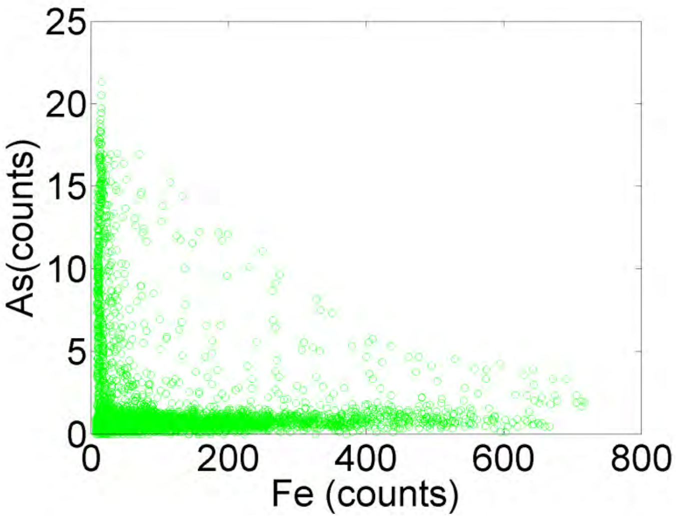
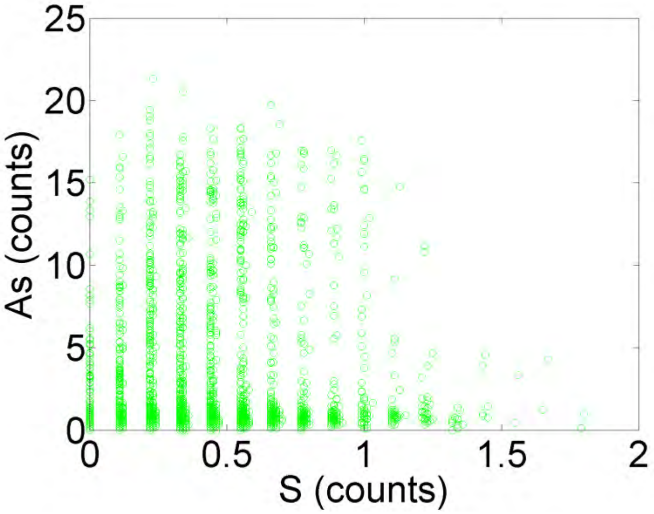
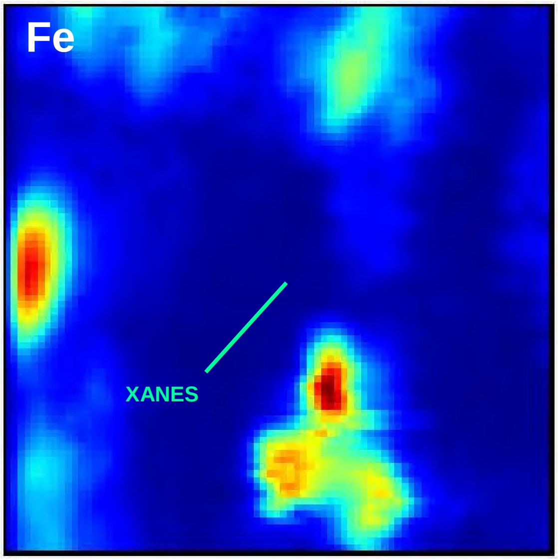
B&L Woodwaste Site
Pierce County, Washington

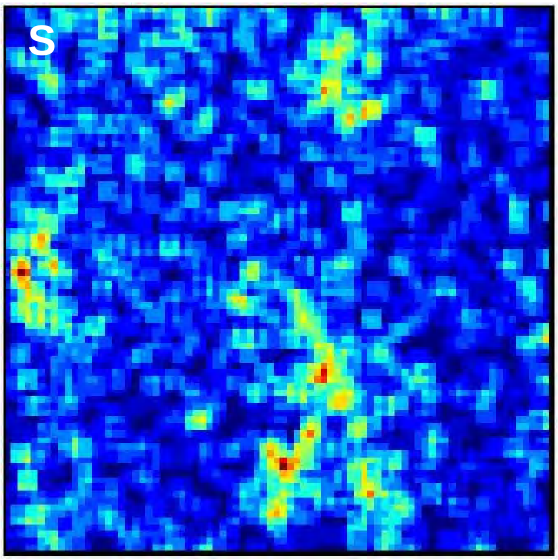
Figure B.3
NZ2 µXRF Maps and
Correlation Plots

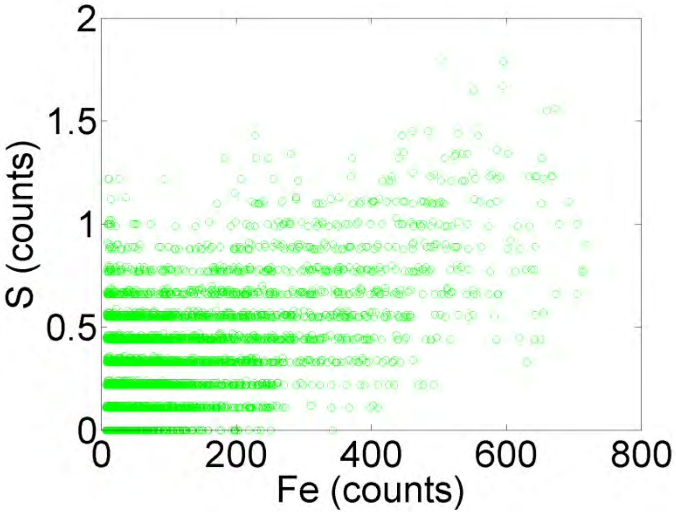












Note:
1. Map dimensions are 50 µm x 60 µm.

Abbreviations:
As = Arsenic
Fe = Iron
µm = Micrometer
µXRF = Micro-x-ray fluorescence
S = Sulfur
XANES = X-ray absorption near-edge structures

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Figure B.4
NZ4 µXRF Maps and Correlation Plots

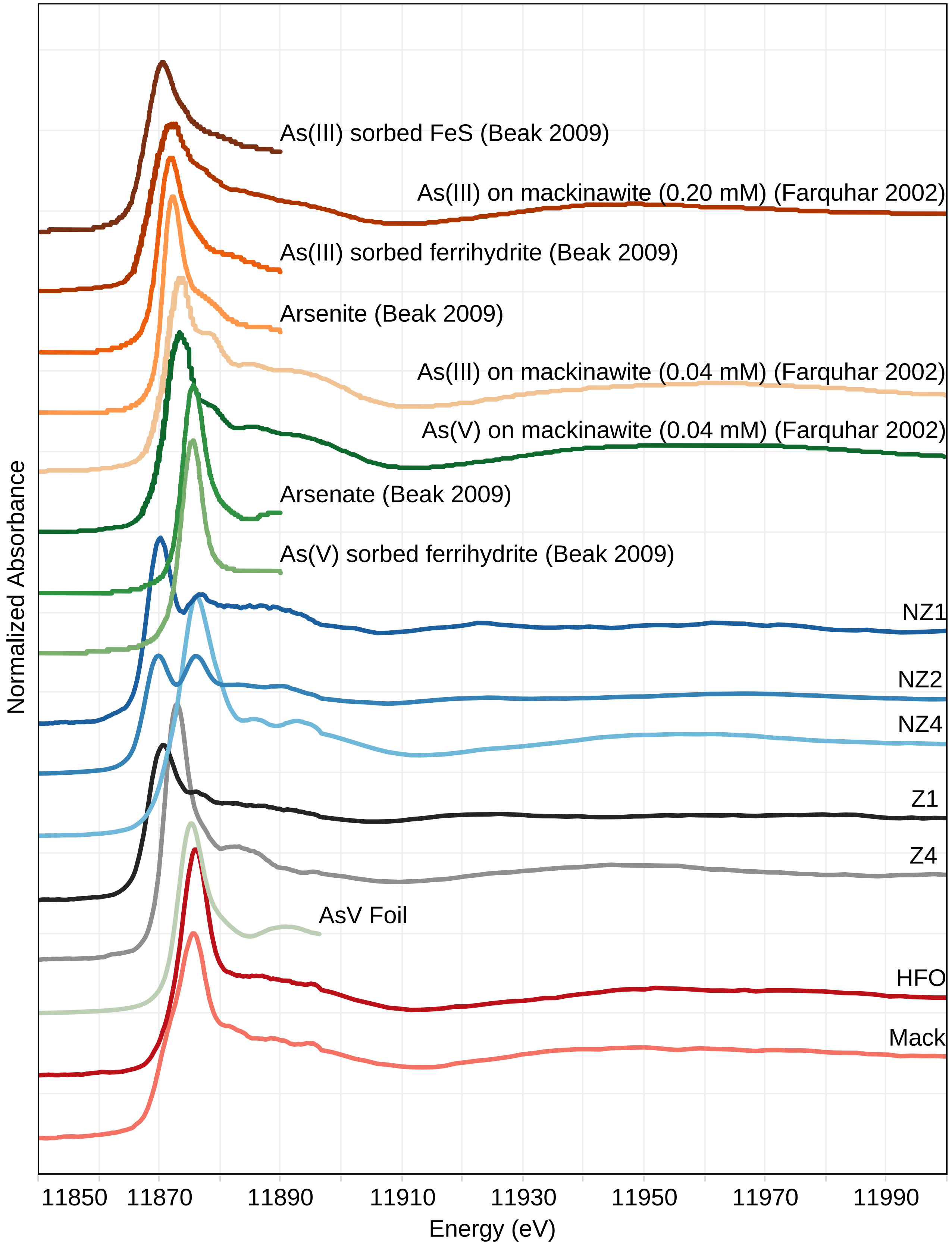

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Figure B.5
Arsenic XANES

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2/13/2013

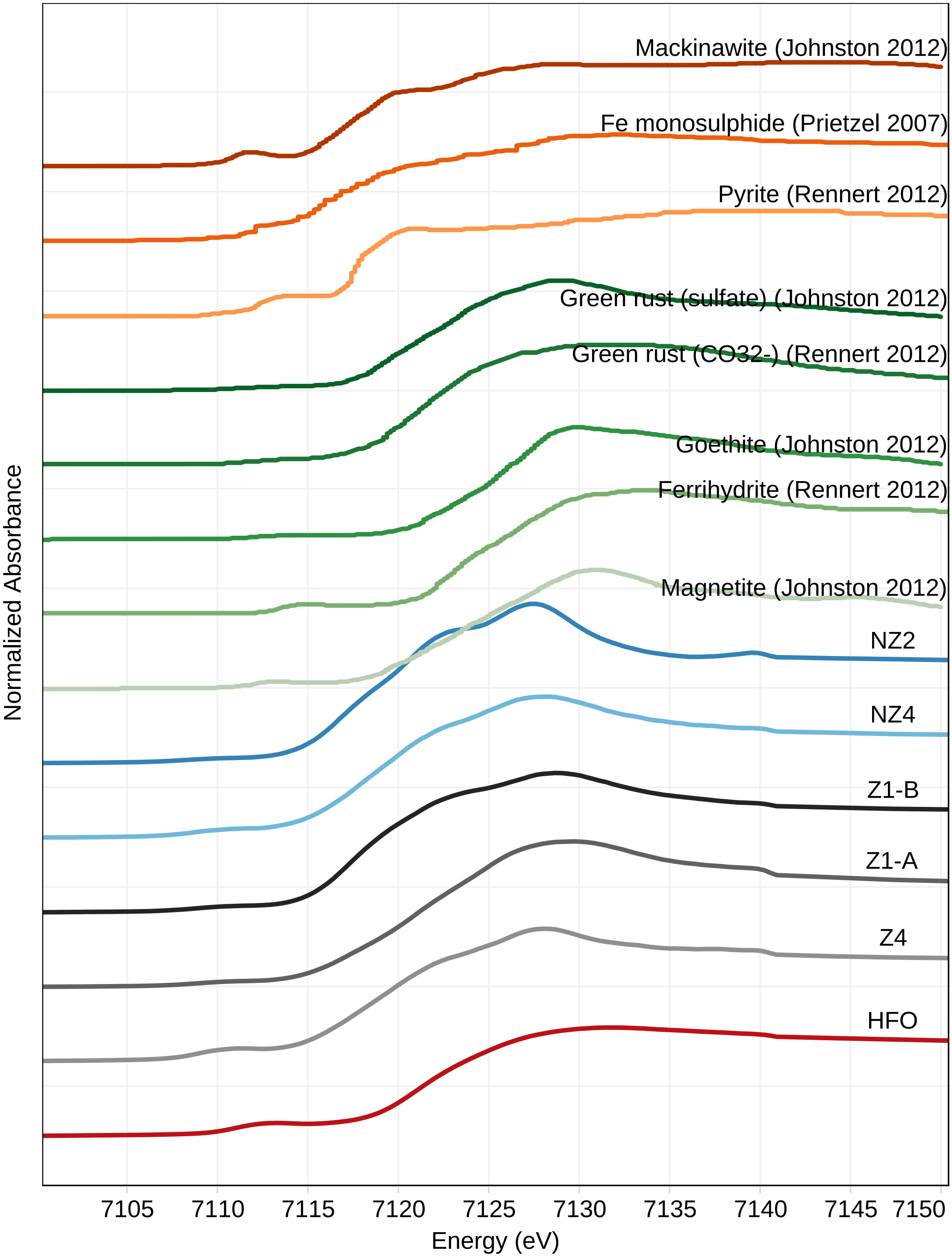

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Figure B.6
Iron XANES

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2/13/2013