Spring 5-2021

SILVER BOW CREEK/BUTTE AREA NPL SITE BUTTE PRIORITY SOILS OPERABLE UNIT

Atlantic Richfield Company

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Draft Final Revised

Butte Reduction Works (BRW) Smelter Area Mine Waste Remediation and Contaminated Groundwater Hydraulic Control Site Pre-Design Investigation (PDI) Evaluation Report

Atlantic Richfield Company

Revision 0 May 2021

RESPONSE TO AGENCY COMMENTS
FOR THE
BUTTE PRIORITY SOILS OPERABLE UNIT (BPSOU) BUTTE REDUCTION WORKS (BRW) SMELTER AREA MINE WASTE REMEDIATION AND CONTAMINATED GROUNDWATER HYDRAULIC CONTROL SITE
PRE-DESIGN INVESTIGATION (PDI) EVALUATION REPORT
DATED OCTOBER 6, 2020

General Document Comments

EPA General Comment 1: *Appendix D to the Consent Decree pg. 11 outlines the following components to be included in the PDI Evaluation Report:*

> *(b) Following the PDI, SDs shall submit a PDI Evaluation Report, for EPA approval, in consultation with DEQ. This report must include:*
> *(1) Summary of the investigations performed;*
> *(2) Summary of investigation results;*
> *(3) Summary of validated data (i.e., tables and graphics);*
> *(4) Data validation reports and laboratory data reports;*
> *(5) Narrative interpretation of data and results;*
> *(6) Results of statistical and modeling analyses, if completed;*
> *(7) Photographs documenting the work conducted, if required or voluntarily obtained; and*
> *(8) Conclusions and recommendations for RD, including design parameters and criteria.*

The report does a good job meeting most of the eight requirements above but falls short on the interpretation of the results (5) and contains no conclusions or recommendations (8). The only interpretation is the LeapFrog model. No interpretation of the other data (hydrocarbon, SPLP, potential off-site sources, etc.) has been presented. The PDI Evaluation Report appears to be a work in progress that will be appended with future data. Presumably the additional interpretations and conclusions/recommendations will be completed once additional data have been collected. Please clarify.

> **Atlantic Richfield Company Response:** Atlantic Richfield agrees that the BRW Pre-Design Investigation Evaluation Report (PDI ER) will be appended with future data as the pre-design site investigations are still ongoing for the BRW Smelter Area Mine Waste Remediation and Contaminated Groundwater Hydraulic Control Site (Site). The conclusions and recommendations for remedial design, based on the results from the Phase I Site Investigation, are included in Section 5.0.
>
> As stated in Section 1.4 and outlined in Table 1, additional investigations are planned for the Site. At the completion of the investigations, Atlantic Richfield will incorporate the results, including an updated interpretation of the results, into the BRW PDI Evaluation Report and submit to Agencies for review.

EPA General Comment 2: *The document represents a good attempt to combine three of the request for changes (RFC) to the Phase I investigation into a single report. However, at times it was difficult to keep straight all of the different stages (i.e. RFCs) and the changes that were* *made for each one. For instance, EPA in the comments to RFC-02 (BRW PHASE I QAPP RFC-02 RESPONSE TO AGENCY COMMENTS dated 1/15/2020), Atlantic Richfield Company (AR) agreed to perform SPLP on splits at a ratio of 4:1. The EPA comment and AR response are reproduced below.*

> ***EPA Specific Comment 6****: Section 3.0, Step 4, Additional Soil Sampling (SPLP) -The SPLP method provides a best-case leaching scenario due to the high solution:soil ratio of 20:1 used in the test. More recent EPA leaching procedures (i.e. LEAF), include multiple solution:soil ratios to account for the dilution effect. Please perform a modified SPLP procedure using a 4:1 ratio in addition to the standard SPLP on select samples to determine the effect of the ratio on the results.*
>
> ***Atlantic Richfield Response****: Text will be edited to state that a modified Synthetic Precipitation Leaching Procedure (SPLP) will be performed using a 4:1 ratio (in addition to the standard SPLP analysis using a 20:1 ratio). The modified and standard SPLP analyses will be performed with sample splits for at least 8 sample locations.*

Is RFC-02 (BRW-2019-2) part of Phase II? Do the results in Table 4 include results for 4:1 ratio? A few wells/boreholes were apparently installed in 2019 for the express purpose of collecting SPLP data (e.g. BRW19-PZ26-SPLP and BRW19-BH35-SPLP). Were these data collected? Please clarify in Table 4 and in the text. If the modified SPLP has not yet been conducted, please state that it will be performed as part of Phase II. An upfront discussion of which RFCs or parts of RFCs are included in Phase II would be helpful. Please clarify in the text. Section 1.0 (pg. 1) after the bullets would be a good place for brief summaries or bullets of what will be included in Phases II and III.

> **Atlantic Richfield Company Response:** Generally, additional text has been added to Section 1.0 and its subsections to clarify what data are planned to be collected as part of the Phase II and Phase III. Specifically, responses to comment are:
>
> - The second RFC to the BRW Phase I QAPP (RFC BRW-2019-02) was revised and submitted as the BRW Phase II QAPP.
> - The results in Table 4 do not include results for SPLP analysis with the 4:1 ratio. This analysis will be done as part of the Phase II Site Investigation. Additional detail has been added to Table 3 on the SPLP analysis method.

EPA General Comment 3*: The hydrocarbon releases are regulated under the State of Montana Risk-Based Corrective Action (RBCA) procedures. RBCA can be evaluated under three tiers. Presumably, AR is evaluating the COC concentrations at the site against the RBSL lookup tables under Tier 1. A Tier 1 evaluation typically includes;*

> *…conducting a field investigation to determine the maximum concentrations of COCs in soil and groundwater associated with the release, developing a conceptual site model (CSM) to identify potentially complete exposure pathways*

> *and receptors, and comparing the maximum COC concentrations to the Tier 1 RBSL Tables to determine which pathways are considered complete.*

The first (field investigation) and third (comparing to RBSLs) items have been included, but not the second item (CSM). Section 3.2 of the DEQ guidance covers the required elements of a CSM.

In the removal areas, the hydrocarbons will be removed along with the mining waste. However, there are RBSL exceedances outside of the proposed removal area (for example, in the above-ground storage tank area). What is AR's plan to do for these areas? The hydrocarbon-impacted groundwater may also be remediated in conjunction with the Consent Decree-required groundwater capture and treatment, but this needs to be evaluated.

Please prepare a separate RBCA evaluation (as an Appendix) which outlines the RBCA process, the future site use(s), and how the proposed remedial action will meet Tier 1 RBCA criteria.

> **Atlantic Richfield Company Response:** Atlantic Richfield has completed a risk evaluation for the organic-impacted materials within the Site following the Montana Department of Environmental Quality (Montana DEQ) Risk-Based Corrective Action (RBCA) Guidance for Petroleum Releases (RBCA Guidance). Appendix F includes a Technical Memorandum (Tech Memo) that presents the RBCA evaluation completed to the extent possible. The Tech Memo includes a summary of the Montana DEQ RBCA process, a conceptual site model (CSM) based on the anticipated future Site conditions, and a comparison of Site-specific data to the Montana DEQ risk-based screening levels (RBSLs).
>
> The RBCA evaluation was completed to the extent possible based on the data collected during the Phase I Site Investigation. For the current RBCA evaluation, the data collected from the Site are compared to Tier 1 and Tier 2 RBSLs to determine whether additional evaluation is needed. Due to the complexity of the Site, Atlantic Richfield intends to complete a Tier 3 evaluation and develop site-specific action levels for soil and groundwater impacted with organic pollutants within the Site. Once the Phase II and Phase III Site Investigations are completed, the RBCA evaluation in the Tech Memo will be revised to include a Tier 3 evaluation and proposed site-specific action levels. The revised Tech Memo will be resubmitted with the revised BRW PDI ER for Agency review and approval.

Specific Document Comments

EPA Specific Comment 1: <u>Pg. 6, Section 2.1.2, 3rd bullet.</u> *The DQO Section of the QAPP outlines a procedure for selecting samples for SPLP analyses using lead and nitrate concentrations. Was this technique abandoned? If so why? Please update text to explain.*

> **Atlantic Richfield Company Response:** Additional information was added to Table 4 detailing the logic used to collect samples for SPLP analysis.

EPA Specific Comment 2: *Section 2.2 and Section 3.2.3 – Water quality results are to be compared to the remedial goals presented in decision documents. For groundwater, the remedial goals are presented in the 2006 ROD, Table 8-1. For surface water, the remedial goals are presented in the 2020 ROD Amendment Table 1. For constituents not listed in a decision document, refer to the latest revision of DEQ-7 dated June 2019.*

> **Atlantic Richfield Company Response:** Text, figures, and tables have been updated to compare water quality results to either the groundwater and/or the chronic surface water standards presented in the 2020 BPSOU Consent Decree (BPSOU CD) for each contaminant of concern (COC).

EPA Specific Comment 3: *Section 2.4 – First Paragraph: Text references Figure 15 for known utilities; the correct reference is Figure 16.*

> **Atlantic Richfield Company Response:** Text has been updated to reference the correct figure.

EPA Specific Comment 4: *Section 3.2.3 – Groundwater Chemistry: Please re-write this section to more clearly present the extent of groundwater contamination in the area both by location and at depth. The text breaks wells up into three categories: 1 – wells and piezometers that never exceeded aquatic life standards or human health standards; 2 – wells and piezometers that exceeded the chronic aquatic life standard for at least one COC during at least one event but stayed below the human health standards; and 3 – wells and piezometers that exceeded at least one human health standard for at least one event. There are missing wells/piezometers that should have been included in these categories. There is also some confusing language regarding the number of times a particular well/piezometer were sampled, and a general lack of special analysis as described here for each of the three groupings:*

1. *For this first category the description implies that each of these wells were sampled over all three events. The text should clarify that they were each only sampled for two events (BRW18-PZ15 during 2018 and 2019 events and MW-03A-MPC during 2019 and 2020 events). Additionally, although MW-03A-MPC had no exceedances at a depth of 22' to 33', MW03-MPC had arsenic exceedance over 2 orders of magnitude greater than 03A at a depth of 3.5' to 13.5' in an adjacent well. Results should be interpreted with depth considerations as well as location.*
2. *BRW18-PZ14, MW02-MPC, and MW01-MPC had at least one exceedance of the chronic aquatic standard but not of human health but were left out of the group listed in the text. These should be included with this group.*
3. *In 2020, BRW19 locations HCW36, 37, 38, and 42 all had exceedances of the human health standard for at least one COC and were adjacent to 'PZ' stations that did not have exceedances of human health. HCW samples were collected in shallower groundwater than the 'PZ' samples. This proximity and groundwater depth should be discussed in the results interpretation to more clearly delineate the extent of contaminated groundwater in the area.*

> **Atlantic Richfield Company Response:** Atlantic Richfield has simplified the text to reference the applicable figures and tables for results of the groundwater sampling. The information is presented clearly in the tables and figures.
>
> Regarding the delineation of impacted groundwater with respect to depth, additional data are needed to delineate the extents of impacted groundwater within the Site. These data will be collected during the Phase II and Phase III Site Investigations. At the completion of the Site investigations, Atlantic Richfield will update this BRW PDI ER to include further interpretation on the extents of impacted groundwater within the Site, including spatial and seasonal variability.

EPA Specific Comment 5: Pg. 14, Section 3.3.1, 2nd paragraph *– Please indicate which RBSLs (commercial vs residential) are being used. This section should be a summary of the RBCA Appendix, requested above.*

> **Atlantic Richfield Company Response:** The information originally contained within this section is now in Appendix F. Additional detail has been added to the text, tables, and figures indicating which RBSLs were used.

EPA Specific Comment 6: Section 5.3 *– The proposed preservation of the ore bins would require a significant change in the tailings, waste, and contaminated soil removal area depicted on Figure BRW-1 of the Future Remedial Elements (FRE) statement of work (SOW). This change needs further discussion to evaluate potential impacts to the efficacy of the remedy.*

> **Atlantic Richfield Company Response:** Figure BRW-1 of the Future Remedial Elements Statement of Work (FRESOW) is a conceptual illustration. The FRESOW requires an excavation that maintains an average width of 275 feet (north to south) beginning at the toe of the railroad and extending north into the Site. A cultural resource inventory is currently in progress, and waste removal and regrading design will accommodate preserving historical features (e.g., the manganese ore bins and slag walls) to the extent possible. Additional text has been added to Section 5.3 of the report to clarify the intended steps of the ongoing evaluation, the results of which will be incorporated into this BRW PDI ER once Site investigation activities are completed.

Specific Document Comments (Figures)

EPA Specific Comment 7: Figure 2 (Wetland Delineation)*: It is unclear how AR differentiated where the wetlands were located based on the borings. Each site had two samples but only one sample location is shown on Figure 2. For example, why is the wetland not 5-feet further to the east of PT12? The individual forms show 12A is a wetland but 12B is not. Where exactly were each of these tests taken? Please include each of the boring locations on the figure.*

> **Atlantic Richfield Company Response:** Additional field work is required to properly respond to EPA's comment. Atlantic Richfield will further evaluate the wetland delineation, update the Waters of the U.S. Delineation Report (Appendix E), and provide

a response to EPA's comment prior to the Intermediate 60% Remedial Design Report for the Site.

EPA Specific Comment 8: *Figure 21 – The location of the new piezometer west of BRW18-PZ01 is only about 50 feet away from PZ01. Should this new well show groundwater impacts above DEQ-7 criteria, at least one additional well will be required further west to define the extent of the groundwater plume. It might make more sense to step out far enough to get a clean well and then work backwards to define the plume, unless you have reason to believe that the source is very localized to the PZ01 area. Please discuss.*

Why are Phase III boreholes identified now? If you know you will need these, why not do them as part of Phase II? Shouldn't Phase III be used to fill data gaps identified during Phase II? Please explain.

Please explain the southern detour of the excavation footprint around the ore bins area. Do you have reason to preserve the ore bins? If they are left in place will they be stable and safe? If the area is developed would they not need to be torn out anyway? Please discuss the justification for the proposed footprint.

Atlantic Richfield Company Response:

Location of New Piezometer West of BRW18-PZ01: The location of the new piezometer west of BRW18-PZ01 is at the western boundary of the Site and is intended to complete the characterization of impacted groundwater within the Site. However, additional piezometers further west of BRW18-PZ01 are now proposed as part of the Phase III Site Investigation and have been added to Figure 18 (previously Figure 21). These piezometers are located nearly at the eastern boundary of the pentachlorophenol (PCP) impact to the groundwater in the area from the Montana Pole and Treatment Plant (MPTP) (based on the *Fourth Five-Year Review Report for the Montana Pole and Treating Plant Site Report*). The purpose of these piezometers is to (1) determine the baseline groundwater conditions between the Site and MPTP; (2) evaluate the potential interaction between the MPTP and the BRW hydraulic control and future construction dewatering; and (3) evaluate loading to Silver Bow Creek. Atlantic Richfield believes the piezometers installed/proposed for Phase II and Phase III Site Investigations are sufficient to characterize the impacted groundwater within the Site and evaluate the metals loading to Silver Bow Creek so that the BRW hydraulic control can be properly designed to protect Silver Bow Creek.

Phase III Boreholes: The Phase III boreholes listed are a direct result of the data gaps identified from the Leapfrog model for the Site. To meet the remedial design schedule, a data gap evaluation was completed with the Leapfrog model prior to importing data collected from the Phase II Site Investigation. As a result, Atlantic Richfield conservatively identified locations where data were needed to complete the delineation of waste material within the Site. Additional detail on the data gap evaluation is included in Appendix C.

> The Phase III boreholes were included with the Phase III QAPP because at the time the BRW PDI ER was submitted to Agencies, the Phase II QAPP had been approved by Agencies and a significant portion of the field work was completed. Atlantic Richfield included the additional boreholes in the Phase III QAPP, instead of an RFC to the Phase II QAPP, to simplify field work procedures and protocols (i.e., avoid having two QAPPs that field teams were required to follow at the same time). The Phase III QAPP was necessary as it identifies slightly different Data Quality Objectives (DQOs) than previous investigations. The Phase III QAPP is meant to be the final Site investigation necessary to complete the characterization and remedial design for the Site.
>
> **Ore Bins:** The FRESOW requires an excavation that maintains an average width of 275 feet (north to south) beginning at the toe of the railroad and extending north into the Site. A cultural resource inventory is currently in progress, and waste removal and regrading design will accommodate preserving historical features (e.g., the manganese ore bins and slag walls) to the extent possible. Additional text has been added to Section 5.3 of the report to clarify the intended steps of ongoing evaluation, the results of which will be incorporated into this BRW PDI ER once Site investigation activities are completed.

Specific Document Comments (Tables)

EPA Specific Comment 9: *<u>Table 2</u> - indicates that SPLP analyses were conducted for borehole BRW18-BH08, but no data are presented in Table 4. Please either add the data to Table 4 or correct Table 2.*

> **Atlantic Richfield Company Response:** Table 2 has been corrected.

EPA Specific Comment 10: *<u>Table 3, Soil Nitrate Analyses</u> – What is the rationale for analyzing soil nitrate only on samples with "elevated iron concentrations"? The reference to Section 2.4.1 of the BRW QAPP appears to reference Section 2.4.1 DQO Step 5 of Appendix A to the Butte Reduction Works (BRW) Phase I Quality Assurance Project Plan (QAPP) Request for Change (RFC) BRW-2019-03. This section does not mention iron, but does discuss lead at concentrations exceeding 3,140 mg/kg. Should the note in Table 3 refer to lead and not iron? Please clarify or correct Table 3 to read "lead" instead of "iron".*

> **Atlantic Richfield Company Response:** Table 3 has been updated to read "lead" instead of "iron."

EPA Specific Comment 11: *<u>Table 4</u> – Please rename this table to Soil ICP and SPLP Analytical Results Summary. An additional column is needed to indicate whether or not each sample fails the waste criteria in accordance with the FRE SOW Table 1. What is the purpose in reporting the SPLP results in two different units? There is much more soil data in Appendix A that is not presented in table in the main report. What is the reasoning for presenting the SPLP data, but not the ICP results for sample not analyzed for SPLP? The cadmium SPLP results column needs additional decimal places.*

Atlantic Richfield Company Response: Table 4 has been renamed, an additional column has been added to indicate whether or not each sample fails the waste identification criteria per the BPSOU Scope of Work (SOW) (Appendix D to the BPSOU CD), SPLP results are reported only in micrograms per liter, and the cadmium results include additional significant figures.

The results of samples submitted to the lab for metals analysis, along with the results of X-ray fluorescence analyses, are shown in the lithology logs (Appendix B) and included within the electronic database (Attachment F to Appendix A). Additionally, please note that all Inductively Coupled Plasma (ICP) data used to generate the Leapfrog Model are included within data tables in the Leapfrog Model, and it would be redundant to present these data for a second time in one report.

EPA Specific Comment 12: *Table 6 – Human health criteria use total metals, not dissolved metals. Please revise. Also, there is no purpose in including the acute criteria at the bottom of the table. Please remove the acute criteria. Please move the footnote beginning "Note: A hardness value of 138 µl/L…" to the sub-table in the lower left corner of this page. Also add an asterisk to silver in this sub-table. Please limit the number of significant figures for calculated standards to those presented in DEQ-7 which is usually three or four.*

Atlantic Richfield Company Response: The standards at the top of the table have been updated to reflect the groundwater and chronic surface water standards in the BPSOU CD (see response to EPA Specific Comment 2). Additionally, the remaining items identified above have been incorporated into the table (i.e., the acute criteria has been removed, the footnote has been moved, and the number of significant figures has been updated to reflect those presented in the Montana Circular DEQ-7, dated June 2019).

EPA Specific Comment 13: *Table 7 – A lot of manipulation has been conducted to screen out "outliers" without any discussion in the text of the report. Although screening is indicated in the footnotes, no discussion of the procedures, criteria, or purpose of the screening is included. Please include this discussion or remove the outlier screening.*

Atlantic Richfield Company Response: Additional detail has been added to Section 3.2.2 of the report describing how the outliers were identified through visual screening of patterns observed in hydrographs, comparison with concurrent data collected with transducers, and professional judgement.

EPA Specific Comment 14: *Tables 8-10 – Please indicate which RBSLs were used in the comparison. Were the surface soil RBSLs for commercial or residential land use? Please discuss potential future land use in the requested RBCA Appendix.*

Atlantic Richfield Company Response: These tables are now included in Appendix F, and additional detail has been added to the tables indicating which RBSLs were used. A discussion on the potential future end land use is included in Appendix F.

Specific Document Comments (Appendix C, ICP to XRF Tech Memo)

EPA Specific Comment 15: <u>Table 2</u> *– The footer indicates a total of 5 pages, but there is no page 1. Is a page missing or is the footer wrong? Please repair as needed.*

> **Atlantic Richfield Company Response:** The footer has been corrected.

EPA Specific Comment 16: <u>Section 2.2.1</u> *– We were unable to recreate the outlier analysis results as described. There were several result pairs removed (as indicated in gray shaded cells in Table 2) where the residual was less than 2 and greater than -2. There were some pairs that were not removed where the residual was greater than 2 or less than -2. Either the description of the methodology is incomplete or there are transcription errors. Please review and present the results in more detail.*

> **Atlantic Richfield Company Response:** Atlantic Richfield reviewed the outlier analysis and it appears that the inconsistency between Agencies' analysis and Atlantic Richfield's analysis is a result of the selection of independent and dependent values (i.e., x-value and y-value). As with the correlation and regression analyses, the outlier analysis was performed with the XRF concentrations set as the independent value (x-value) and the ICP concentrations set as the dependent value (y-value). This detail has been added to the text.

EPA Specific Comment 17: <u>Section 3.2</u> *– The y-intercept should not be set to zero for the purpose of avoiding negative concentrations. This alters all of the values. Instead, negative results should be set to zero individually. Please revise.*

> **Atlantic Richfield Company Response:** The regression analysis for cadmium and lead has been updated as requested by Agencies. The y-intercept is no longer set to zero; instead, any negative values are set to zero individually.

EPA Specific Comment 18: <u>Table 1</u> *–EPA was unable to recreate some of the values in Table 1. Some of these are due to resetting the incept to zero. Others were likely due to the differences in the outlier results. Please review for transcription errors. The values from Table 1 in the report are presented below, followed by a similar table with values obtained during the review. Discrepancies are in red. Original Table 1 values are below.*

	Number of Samples	*Correlation Coefficient*		*Coefficient of Determination*	*Regression*		*Upper 95% Regression*	
		All Data	*Outliers Removed*		*Slope*	*y-intercept*	*Slope*	*y-intercept*
		r	*r*	*r2*	*m*	*b*	*m*	*b*
Arsenic	*127*	*0.8*	*0.96*	*0.92*	*0.86*	*13.7*	*0.91*	*38*
Cadmium	*130*	*0.65*	*0.76*	*0.58*	*0.35*	*0*	*0.4*	*0*
Copper	*130*	*0.8*	*0.94*	*0.88*	*1.11*	*-34*	*1.19*	*221*
Lead	*133*	*0.77*	*0.95*	*0.91*	*1.52*	*0*	*1.6*	*0*
Zinc	*131*	*0.76*	*0.93*	*0.86*	*0.87*	*195*	*0.93*	*433*

Table 1 results obtained during review

	Number of Samples	Correlation Coefficient		Coefficient of Determination	Regression		Upper 95% Regression	
		All Data	Outliers Removed		Slope	y-intercept	Slope	y-intercept
		r	r	r2	m	b	m	b
Arsenic	129	0.80	0.90	0.81	1.11	7.3	1.21	44.3
Cadmium	131	0.48	0.56	0.32	0.71	-3.8	0.89	-1.4
Copper	129	0.80	0.93	0.86	1.55	-403	1.66	-99.5
Lead	133	0.74	0.95	0.91	1.56	-144	1.64	-26.1
Zinc	131	0.76	0.84	0.71	1.16	-53.7	1.29	269

Atlantic Richfield Company Response: Atlantic Richfield has reviewed and updated the regression and outlier analyses (see responses to EPA Specific Comments 16 and 17). As a result, Table 1 has been updated as well as the Leapfrog Model for BRW. If further discussion is needed regarding Atlantic Richfield's regression and/or outlier analysis, Atlantic Richfield recommends Agencies propose a technical meeting to discuss.

End Comments.

SILVER BOW CREEK/BUTTE AREA NPL SITE
BUTTE PRIORITY SOILS OPERABLE UNIT

Draft Final Revised

Butte Reduction Works (BRW) Smelter Area Mine Waste Remediation and Contaminated Groundwater Hydraulic Control Site Pre-Design Investigation (PDI) Evaluation Report

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Revision 0 May 2021

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DOCUMENT MODIFICATION SUMMARY

Draft	Internal Atlantic Richfield Company Review	- 8/21/2020
Draft Final	Agency Review	- 10/06/2020
Draft Final Revised	Internal Atlantic Richfield Company Review	- 3/26/2021
Draft Final Revised	Agency Review	- 5/13/2021

ACRONYMS

Term	Definition
ARM	Administrative Rules of Montana
Atlantic Richfield	Atlantic Richfield Company
ATO	Alluvium, Tailings, and Organic Soil
BPSOU	Butte Priority Soils Operable Unit
BSB	Butte-Silver Bow
BRW	Butte Reduction Works
CD	Consent Decree
COC	Contaminant of Concern
DEQ	Montana Department of Environmental Quality
eV	Electron-Volt
FEWA	Functionally Effective Wetland Area
ICP-OES	Inductively Coupled Plasma - Optical Emission Spectrometry
LiDAR	Light Detection and Ranging
LNAPL	Light Non-Aqueous Phase Liquid
MASW	Multichannel Analysis of Surface Waves
MWR	Mine Waste Repository
NRDP	Natural Resource Damage Program
O&M	Operation and Maintenance
PCB	Polychlorinated Biphenyls
PCP	Pentachlorophenol
PDI	Pre-Design Investigation
PID	Photoionization Detector
Pioneer	Pioneer Technical Services, Inc.
ppm	Parts per Million
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
RA	Remedial Action
RBCA	Risk-Based Corrective Action
RBSL	Risk-Based Screening Level
RD	Remedial Design
RDWP	Remedial Design Work Plan
RFC	Request for Change
ROD	Record of Decision
SBC	Silver Bow Creek
SPLP	Synthetic Precipitation Leaching Procedure
TI	Technical Impracticability
USACE	U.S. Army Corps of Engineers
XRF	X-Ray Fluorescence

1.0 INTRODUCTION

The Butte Reduction Works (BRW) Smelter Area Mine Waste Remediation and Contaminated Groundwater Hydraulic Control Site (Site) is one of 9 further remedial elements addressed in the *Butte Priority Soils Operable Unit Consent Decree* (EPA, 2020), referred to herein as BPSOU CD. In general, the BPSOU CD requires the removal of waste within a 275-foot average width corridor along the southern portion of the Site (referred to herein as the waste removal corridor). The BPSOU CD also specifies that "*An excavation surface (subject to EPA approval, in consultation with DEQ) shall be developed during design and will consider the results of the predesign investigation. The excavation surface will define the vertical extent of removal within the removal corridor.*" The BPSOU CD also generally requires the management of groundwater through hydraulic control and, after removing the waste material, Silver Bow Creek (SBC) will be rerouted from its current path through the slag canyon on the northern portion of the Site through the excavated area (Figure 1).

To begin determining the excavation surface within the waste removal corridor and the nature and extent of impacted groundwater within the Site, Atlantic Richfield Company (Atlantic Richfield) conducted the BRW Phase I Site Investigation (Phase I Site Investigation) according to the *Butte Reduction Works (BRW) Phase I Quality Assurance Project Plan (QAPP)* (Atlantic Richfield, 2021a) (referred to herein as BRW Phase I QAPP).

This Pre-Design Investigation (PDI) Evaluation Report summarizes and evaluates the results of the sampling and field activities conducted as specified in the BRW Phase I QAPP and associated request for changes (RFCs). From August 2018 through February 2020, personnel from Pioneer Technical Services, Inc. (Pioneer) completed the Phase I Site Investigation sampling and field activities to inform the remedial design (RD) of the Site.

This PDI Evaluation Report follows requirements listed in the BPSOU Statement of Work (Appendix D to the BPSOU CD) and contains the following components:

- Summary of the work performed (Section 2.0).
- Summary of work results (Section 2.0).
- Summary of validated data (Section 2.0, Appendix A, and Appendix B).
- Data validation reports and laboratory data reports (Appendix A).
- Narrative interpretation of data and results (Section 3.0).
- Results of statistical and modeling analyses (Section 3.0 and Appendix C).
- Photographs documenting the work conducted (Appendix A).
- Conclusion and recommendations for the RD, including design parameters and criteria (Section 4.0).

There are two additional investigations planned for the Site. A Phase II Site Investigation will focus on collecting additional data regarding the groundwater within the Site. A Phase III Site Investigation will focus on collecting data to finalize the excavation design surface and collect data regarding the geotechnical considerations at the Site. Atlantic Richfield will incorporate the results of these two investigations, including an updated interpretation of the results, into this PDI Evaluation Report and resubmit to Agencies for review as the RD progresses. Additional details on these planned investigations are included in Section 1.5.

1.1 Site Background and Description

The Site covers approximately 24 acres in Butte, Montana, to the immediate west of Montana Street between SBC and the BNSF Railway Company railroad line (Figure 1 and Figure 2). Currently, the Site is used by Butte-Silver Bow (BSB) for construction-related materials mixing and storage and for asphalt plant operations.

Historically, the Site included several different smelting and concentrating configurations and was also used by the Domestic Manganese and Development Company (Sanborn, 1943). The Site contains a complex distribution of materials (including slag, tailings, manganese waste, demolition debris, foundations, and other historic structures) as well as impacted soil and groundwater arising from past operations and from upstream sources that released metals and mineral processing waste onto the Site.

1.2 Remedial Design

The BRW remedial action (RA) includes removing tailings, waste, contaminant of concern (COC)-impacted soil, and slag within the SBC 100-year floodplain reconstruction area to a depth to be determined during the RD activities. The conceptual RD is shown on Figure 3 and will include the following additional elements:

- Removing waste (as defined by the BPSOU CD Waste Identification Screening Criteria and listed in Table 1) from the Site in the waste removal corridor that will contain a new channel for SBC to a depth determined during the RD.
- Managing soil and groundwater within the Site impacted by organic pollutants, as appropriate and in a manner that is complementary with the remedy. Organic pollutants (petroleum compounds, polychlorinated biphenyls (PCBs), pentachlorophenol (PCP), and dioxins) are secondary concerns for the Site. Soil and groundwater within the Site that have been impacted by these pollutants will be properly addressed/managed as part of the remedy. However, additional remediation of the soil and groundwater impacted with organic pollutants (i.e., treatment of organic pollutant sources) is not required by the BPSOU CD.
- Realigning SBC and constructing the bank-full channel and 100-year floodplain.
- Regrading and constructing caps over the tailings, waste, impacted soil, and slag left in place.
- Hydraulically managing COC-impacted groundwater from the Site to prevent discharge of COC-impacted groundwater to surface water and sediment in BPSOU generally and within the Site specifically.

1.3 Previous Investigations

A number of investigations have previously occurred at the Site, and a detailed discussion of the Site description, history, and previous investigations is included in the *BRW Remedial Design Work Plan (RDWP)* (Atlantic Richfield, 2021b) and the BRW PDI Work Plan included as an attachment to the RDWP. Figure 4 shows the locations of investigation activities and existing monitoring wells installed as part of previous investigations.

1.4 Summary of Phase I Site Investigation

The Phase I Site Investigation sought to fill four main design data gaps and was completed in three stages from August 2018 through February 2020, according to the procedures and protocols detailed in the BRW Phase I QAPP (and associated RFC documents, RFC BRW-2019-01 and RFC BRW-2019-03, included with the BRW Phase I QAPP). The second RFC to the BRW Phase I QAPP (RFC BRW-2019-02) was revised and submitted as the BRW Phase II QAPP discussed below in Section 1.5.

1. **Stage 1: Initial Phase I Site Investigation** (August 2018 to March 2019).

2. **Stage 2: Additional Groundwater Sampling** (October 2019 to November 2019) (RFC BRW-2019-01).

3. **Stage 3: Hydrocarbon Investigation** (December 2019 to February 2020) (RFC BRW-2019-03).

The four objectives of the Phase I Site Investigation activities listed below are detailed in the BRW Phase I QAPP and associated RFCs:

1. **Solid Materials Characterization:** Collect additional information to estimate the volume, distribution, and properties of solid materials within the Site including slag, demolition debris, and impacted materials (including alluvium, tailings, and organic soil [ATO]). Locate and identify historic infrastructure and/or certain conditions (i.e., wetlands) within the Site that may affect constructability of remedial elements.

   The collected data will be used to improve the characterization of materials within the Site and will be used to guide the excavation, SBC reconstruction, hydraulic control, and end land use elements of the RD for the Site.

2. **Groundwater Characterization:** Collect additional information about the groundwater elevations, potentiometric surface, and direction of groundwater flow (including seasonal groundwater changes); the spatial variability of groundwater chemistry within the alluvial aquifer at the Site; and the aquifer geometry.

   The collected data will be used to improve the characterization of groundwater within the Site, to guide a subsequent hydrogeological investigation (i.e., Phase II Site Investigation), and to guide the excavation, SBC reconstruction, and hydraulic control elements of the RD for the Site.

3. **Organic Pollutants:** Collect additional information to estimate the nature and extent of soil and groundwater within the Site impacted by organic pollutants (petroleum compounds and PCBs). The collected data will be used to improve the characterization of soil and groundwater impacted by organic pollutants (petroleum compounds and PCB), and the data will be used to develop a plan to manage the impacted soil and groundwater within the Site as part of the RD.
4. **SBC Realignment:** Collect survey data related to the bottom invert at the upstream and downstream tie-in locations of SBC. The data will be used to design the excavation surface used to realign SBC as shown on Figure 3. Data from the prior three objectives (solid materials, groundwater, and organic pollutants), along with data collected from a subsequent hydrogeological investigation (i.e., Phase II Site Investigation), will be used to evaluate placing a liner along the channel of the relocated SBC.

Table 2 lists the design data gaps and details how this Phase I Site Investigation and the subsequent planned investigations will meet those objectives. The data gaps identified in Table 2 were originally identified in the BPSOU Statement of Work (Appendix D to the BPSOU CD).

1.5 Additional Site Investigation Activities

Two additional investigations are planned for the Site.

1. **Phase II Site Investigation:** focused on collecting additional design-related data regarding the aquifer (e.g., the saturated zone beneath the water table) within the Site. The Phase II Site Investigation had four objectives: conducting two pumping tests, a pre- and post-pumping test groundwater analysis, a loading analysis on SBC, and a slag demolition investigation. Field activities began in June 2019 and were concluded in April 2021. The data collected from the investigation activities are expected to fill the data gaps related to the leachability of solid materials, groundwater characterization and hydraulic control design, characterization of soil and groundwater within the Site impacted by organic pollutants (petroleum compounds, PCB, PCP, and dioxins), and SBC realignment design (Table 2). The Site activities and data collection for the Phase II Site Investigation are detailed in the BRW Phase II QAPP (Atlantic Richfield, 2021c; referred to herein as BRW Phase II QAPP).

2. **Phase III Site Investigation:** will focus on collecting design-related data to finalize the excavation design surface and hydraulic control design as well as to collect data regarding the geotechnical considerations at the Site. The Phase III Site Investigation has four objectives: additional solid material characterization, geotechnical investigation, groundwater water characterization, and SBC COC-loading analysis. An additional objective is to establish a baseline for groundwater conditions (hydraulic gradient and chemistry) between the Montana Pole and Treating Plant site and the Site to inform the design of the future BRW hydraulic control and/or construction dewatering efforts that will take place during the RA. The Phase III Site Investigation aims to fill the remaining data gaps and conclude data collection so that the design team can finalize the Site characterization and proceed with the RD (Table 2).

> Details of the investigation activities are outlined in the BRW Phase III QAPP (Atlantic Richfield, 2021d; referred to herein as BRW Phase III QAPP). Prior to the approval of the BRW Phase III QAPP, Agencies approved RFC 01 and RFC 02 to the BRW Phase II QAPP which enabled a supplemental groundwater and surface water sampling event to occur during low-groundwater conditions and within the allotted timeframe of the Site Investigation schedule. The Data Quality Objectives detailed in the BRW Phase III QAPP cover the supplemental sampling event, and the data validation and interpretation associated with the supplemental sampling event will be included with the additional data collected during the Phase III Site Investigation.

Table 2 provides a summary of each investigation's planned activities in relation to fulfilling design-related data gaps and objectives identified for the Site. Additional detail on the field investigation and RD supporting documents is included in the BRW RDWP (Atlantic Richfield, 2021b) and the BRW PDI Work Plan included as an attachment to the RDWP.

Atlantic Richfield will incorporate the results, including an updated interpretation of the results, into this PDI Evaluation Report and resubmit to Agencies for review as part of the RD process.

2.0 SUMMARY OF WORK PERFORMED

2.1 Solid Materials Characterization

Generally, the following activities were completed to estimate the volume, distribution, and properties of solid materials within the Site as part of the Phase I Site Investigation:

- Excavated 15 test pits and drilled 60 boreholes (Figure 5).
- Documented lithology of test pits and boreholes to determine the distribution of materials (Appendix B).
- Collected soil samples from lithological layers and had them analyzed for COCs (i.e., arsenic, cadmium, copper, mercury, lead, and zinc) and additional constituents of concern (e.g., manganese, trace elements, organic pollutants, etc.) to determine the properties of solid materials including the chemical stability/leachability of these solid materials within the Site.

Field X-ray fluorescence (XRF) analysis was used as a guide to determine the depth of test pits and boreholes. The field samples were collected in a ziplock bag and mixed prior to analysis with the XRF unit. The samples were not dried before analysis since these samples were meant for field screening information only.

Pioneer laboratory XRF samples were analyzed with the XRF unit in the Pioneer field office at 244 Anaconda Road in Butte, Montana. These samples were dried, screened, and placed in a small plastic cup with a mylar film cover prior to analysis. Only XRF samples prepared/analyzed in the Pioneer field office were considered official sample results and used for data interpretation.

The target of the investigation included solid materials both within and adjacent to the waste removal corridor (Figure 3). The purpose of including materials adjacent to the waste removal corridor was to identify other potential source areas within the Site to facilitate decision making for response actions in the area, including design-level information to optimize the balance between any potential additional source removal outside the waste removal corridor (Figure 3) and hydraulic control.

In addition to the work performed above, the following efforts were completed to locate and identify historic infrastructure and/or certain conditions (i.e., wetlands) within the Site that may affect constructability of remedial elements:

- Collected measurements and photographs to document the remaining infrastructure at the Site.
- Conducted a geophysical Multichannel Analysis of Surface Waves (MASW) seismic survey to confirm the existence and location of a subsurface flume(s)/culvert(s) within the Site (Section 2.1.4 and Appendix D).
- Conducted a wetlands assessment to determine functionally effective wetland area (FEWA) units (defined as delineated wetland acreage adjusted by an overall rating for functional value) (Appendix E).

The sections below provide additional detail on the work performed for the solid materials characterization.

2.1.1 Test Pits

In the Initial Phase I Site Investigation (Stage 1), 12 test pits were excavated and sampled to refine the location of durable historical infrastructure, evaluate any remaining manganese impacts, and determine the distribution and properties of solid materials within the Site. Three additional test pits were excavated during the Hydrocarbon Investigation (Stage 3) to determine the presence and distribution of petroleum-impacted materials and solid materials within the Site. The location of each test pit is shown on Figure 5.

Test pits were dug with an excavator until the equipment hit refusal (i.e., could not excavate through material), to the equipment limitations, or until other Site-specific limitations were encountered (e.g., groundwater, sidewall stability became insufficient, etc.). The field logs note whether the excavator encountered refusal or groundwater at the final depth. The field data sheets and logbook entries are included in the Phase I Data Summary Report (Appendix A). The final depth and lithology of each test pit are also shown in the Lithology Logs (Appendix B).

Samples were collected following the procedures and protocols detailed in the BRW Phase I QAPP and associated RFCs. Generally, samples were collected using a disposable hand scoop by scraping soil from the sidewall or collecting it from the appropriate excavated piles or from the excavator bucket. Samples were then placed in the appropriate sampling containers. For each lithological layer, Pioneer lab XRF samples were collected in a ziplock bag, mixed in the field, and then prepped (dried, screened, and placed in a small plastic cup with a mylar film cover) and analyzed at the Pioneer field office using an XRF field unit. Select samples were submitted to the laboratory for specified metals analyses by inductively coupled plasma – optical emission spectrometry (ICP-OES) (Table 3 and Table 4). The XRF and ICP-OES results for each soil sample collected from the test pits are shown in the Lithology Logs (Appendix B).

During the Initial Phase I Site Investigation (Stage 1), selected samples (from each major type of impacted materials including poured slag, demolition debris, tailings, peat/organic soil, and alluvium) were collected and sent for Synthetic Precipitation Leaching Procedure (SPLP) analysis to Energy Laboratories. Samples were selected based on visual inspection of impacted materials, the total number of SPLP samples per lithologic unit, the concentration action levels as described in the BRW Phase I QAPP, and/or professional judgement by the Quality Assurance Officer (QAO), Mike Borduin from Pioneer. Analytical results for each sample submitted for SPLP analysis are summarized in Table 5 and included in the Phase I Data Summary Report (Appendix A).

Additional petroleum-compound samples were collected and are further discussed in Section 2.3. No water samples were collected for laboratory analysis. The field sheets, logbook entries, and laboratory results for each test pit are included in the Phase I Data Summary Report (Appendix A).

2.1.2 Boreholes

Sixty boreholes were drilled to refine the distribution and properties of solid materials and evaluate the presence of petroleum compounds. Boreholes were drilled using either a Geoprobe or sonic drill rig, both of which collected nearly continuous core from which to record lithology and collect samples. The borehole locations are shown on Figure 5 and detailed in Table 3. The 60 borehole locations include the 23 locations marked with a “BH” designation, the 24 groundwater piezometers installed during the Initial Phase I Site Investigation (Stage 1) identified with a “PZ” designation, and the 13 hydrocarbon monitoring piezometers installed during the Hydrocarbon Investigation (Stage 3) identified with a “HCW” designation. Lithology for each borehole (with or without installed piezometers) is shown in the Lithology Logs (Appendix B). The field sheets and logbook entries are included in the Phase I Data Summary Report (Appendix A).

Samples were collected from 51 of the 60 boreholes following the procedures and protocols detailed in the BRW Phase I QAPP. Generally, during the Initial Phase I Site Investigation (Stage 1), samples were collected as follows:

- For each lithological layer of at least 2 feet in thickness (as observed in the core), samples were collected in the appropriate sampling containers and submitted to the laboratory for metals analysis by ICP-OES (Table 3 and Table 4).
- For lithological layers of less than 2 feet in thickness, Pioneer lab XRF samples were collected in a ziplock bag for XRF analyses at the Pioneer field office.

- Selected samples (from each major type of impacted materials including poured slag, demolition debris, tailings, peat/organic soil, and alluvium) were collected and sent for SPLP analysis to Energy Laboratories. Samples were selected based on visual inspection of impacted materials, the total number of SPLP samples per lithologic unit, the concentration action levels as described in the BRW Phase I QAPP, and/or professional judgement by the QAO, Mike Borduin from Pioneer. Additional detail on sample selection and the analytical results for each sample submitted for SPLP analysis are summarized in Table 5.
- Additional samples were collected and submitted for laboratory analyses and are further discussed in Section 2.3.

A slightly different sampling methodology was required for the Hydrocarbon Investigation (Stage 3), which included collecting samples near the saturated layer (in the capillary fringe) for laboratory analysis (Section 2.3) and additional guidelines for unpaired and paired piezometer locations.

- For paired locations (i.e., a location within approximately 5 feet of a deeper previously completed investigation point), each lithology layer was recorded and no samples were collected if the lithology was similar to the paired location, as determined by field personnel based on material type, lithological layer thickness, and recovery. There were 9 paired locations drilled during the Hydrocarbon Investigation (Stage 3).
- For unpaired locations, lithology was recorded and a Pioneer lab XRF sample was collected from each discrete lithological layer for XRF analyses at the Pioneer field office. Additionally, a confirmation sample of the first lithological layer that passed the Waste Identification Screening Criteria (BPSOU CD), based on field XRF analyses, was collected and submitted for metals analyses via ICP-OES (Table 3 and Table 4).
- Additional samples were collected and submitted for laboratory analyses as further discussed in Section 2.3.

The field sheets, logbook entries, and laboratory results for each borehole are included in the Phase I Data Summary Report (Appendix A). The XRF and ICP-OES results for each soil sample collected from the boreholes are shown in the Lithology Logs (Appendix B).

2.1.3 Quantification of Existing Durable Historic Infrastructure

Most of the durable historic infrastructure at the Site was removed after the industrial operations were discontinued. However, some infrastructure items were not demolished or were partially demolished and remain, or potentially remain, at the Site. Additional quantification of the existing durable historic infrastructure was necessary to characterize the existing infrastructure that remains within the Site. Measurements and photographs were taken to document the remaining infrastructure at the Site, and the details are listed in Table 6 and shown on Figure 6. On Figure 6, the demolished or removed infrastructure is shown in gray, the potentially remaining infrastructure is shown in yellow, and the remaining infrastructure is shown in green.

2.1.4 Geophysical Investigation

In September 2018, a geophysical MASW seismic survey was completed to confirm the existence and location of a subsurface flume(s)/culvert(s) within the Site. Site observations and historical research indicated there may be at least two remaining flumes/culverts within the Site: the Blacktail Creek flume and the historic SBC channel south culvert (Table 6 and Figure 7).

Pioneer completed MASW surveys along three separate transects at the Site. Pioneer positioned the east and west MASW survey transect lines to intersect the approximate location of the flume(s) and to cross as much of the southern part of the Site as possible. The Middle Transect was positioned near an exposed brick roof of one flume or culvert. Based on the analysis of the MASW survey and background information, the historic flume can be traced across the Site from the exposed brick and slag tunnel near the west end of the Site through a void identified in the Middle Transect, the exposed brick roof of the flume in the middle of the Site, and finally the void identified in the East Transect. Additional detail on this investigation can be found in Appendix D.

2.1.5 Wetland Delineation Survey

In June of 2019, Pioneer conducted a wetlands assessment to determine FEWA units (defined as delineated wetland acreage adjusted by an overall rating for functional value) at the Site. The full wetland delineation report is included in Appendix E. For the purpose of the FEWA evaluation, methods set forth in the U.S. Army Corps of Engineers (USACE) *Wetland Delineation Manual* (Environmental Laboratory, 1987) and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region* (USACE, 2010) were used.

For functional assessment purposes, the Site was divided into 2 areas based on current conditions. The first area is immediately west of Montana Street consisting of the “Slag Canyon” and BSB maintenance materials area and is identified as the “BRW-BSB” site and is 19.0 acres. The overall FEWA rating for the BRW-BSB site was 0.9 out of 3.0 with a low or very low rating for all functional categories except for Sediment Stabilization and Erosion Control, which was rated high. In total, 0.06 acres of wetland areas were identified and mapped within the BRW-BSB site.

The second area is located to the west of the BRW-BSB site and is identified as “BRW-LAO” and is 4.2 acres. The overall FEWA rating for the BRW-LAO site was 1.68 out of 3.0. The BRW-LAO site scored a high reading for Hydrologic Support and Sediment Stabilization/Erosion Control. The BRW-LAO site scored moderately for the following:

- Production Export/Food Chain Support.
- Wildlife Diversity/Abundance: Breeding.
- Wildlife Diversity/Abundance: Wintering.
- Threatened and Endangered Species Habitat.

The BRW-LAO site scored low for the following:

- Floodflow Alteration.
- Water Purification.
- Aquatic Diversity/Abundance.
- Wildlife Diversity/Abundance: Migration.

In total, 3.14 acres of wetland areas were identified and mapped within the BRW-LAO site.

2.2 Groundwater Characterization

In the Initial Phase I Site Investigation (Stage 1), piezometers were installed in 24 locations to fill data gaps regarding groundwater elevations, potentiometric surface, and direction of groundwater flow within the Site, as well as seasonal groundwater elevation change (Table 2). Additional work was completed to characterize groundwater chemistry and spatial variability as well as aquifer geometry (i.e., identify depths to bedrock). Additionally, during the Hydrocarbon Investigation (Stage 3), piezometers were installed in 4 unpaired locations and in 9 locations paired with existing piezometers to refine the spatial extent of petroleum compounds and associated concentrations (Section 2.3). Each piezometer location is shown on Figure 5. Piezometers that were anticipated to encounter difficult drilling conditions were installed with a sonic drill rig, and the remainder were installed using a Geoprobe. The construction for each piezometer is shown on the Lithology Logs in Appendix B, and the field logs for each piezometer are in the Phase I Data Summary Report (Appendix A).

Beginning in January 2019, monthly groundwater levels have been collected from the locations identified in Table 3 using an electronic depth to water indicator tape (E-tape). Monthly groundwater levels continued to be collected from locations in Table 3 for a minimum of two years (i.e., until January 2021). For the additional piezometers installed during the Hydrocarbon Investigation (Stage 3), monthly groundwater levels began in January 2020 and will continue to be collected for the remainder of the two years (i.e., until January 2021). Transducers were installed in select piezometers (listed in Table 3), and data from these transducers are downloaded as part of the monthly groundwater level monitoring efforts. Table 7 is a summary of the analytical results for groundwater sampling. Table 8 lists the monthly groundwater level data from January 2019 to February 2020. Figure 8 shows the manually recorded groundwater elevation variations over time, Figure 9 shows the groundwater contours during low water conditions (February 2019), and Figure 10 shows the groundwater contours during high water conditions (April 2019). Figure 9 and Figure 10 show monitoring locations that inform the contours shown on each figure. These monitoring locations (Contour Data Points) are listed in the upper left corner of Figure 9 and Figure 10. Standard deviation data are used within kriging algorithms that generate the same shading shown in each figure. The standard deviation values used to generate shading are highlighted in green within Table 8. Transducer data from January 2019 to February 2020 can be found in Appendix A.

During all three stages of the Phase I Site Investigation, groundwater samples were collected from specified locations and submitted to the laboratory for specified analyses (Table 3 and

Table 4). Investigation points subject to hydrocarbon analyses are detailed in Appendix F. Figure 11, Figure 12, and Figure 13 show groundwater contours during high groundwater conditions (April 2019) and groundwater contours during low groundwater conditions (February 2019) with the analytical results from 2018, 2019, and 2020 sampling, respectively. The remedial goal for surface water is to meet the performance standards identified in Table 1 of the 2020 Record of Decision (ROD) Amendment (Appendix A to the BPSOU CD), while the remedial goal for groundwater is to meet the Table 8-1 standards for groundwater in the 2006 ROD (Appendix A to the BPSOU CD) for areas outside of the groundwater Technical Impracticability (TI) zone. While the BRW Site is located within the BPSOU TI zone, the figures compare the COC concentrations to both the groundwater standards and the chronic surface water performance standards presented in the BPSOU CD applicable for the Site. Silver is not included in the table as there currently is only an acute surface water standard for silver, and acute standards are not applicable for this Site. While not applicable to groundwater at the Site, the chronic surface water performance standards and groundwater standards have been compared to groundwater concentrations in each figure for purposes of designing hydraulic control. Analytical results for groundwater sampling are in the Phase I Data Summary Report (Appendix A). Note that only the locations sampled during each stage of the Phase I Site Investigation are shown on the corresponding figure.

2.3 Organic Pollutants

The Hydrocarbon Investigation (Stage 3) specifically focused on defining the nature and extent of soil and groundwater within the Site that have been impacted by organic pollutants (petroleum compounds and PCB); however, data were collected during all three stages of the Phase I Site Investigation to help estimate the nature and extent of impacted soil and groundwater within the Site.

During the Initial Phase I Site Investigation (Stage 1), field personnel used photoionization detectors (PIDs) and visual and olfactory observations to screen for the presence of petroleum compounds in heavy vehicular traffic areas, maintenance areas, areas with historical or present-day industrial activities, visually stained or aromatic areas, borehole cores, and test pit material. The PIDs used were a MiniRae 3000 with a 10.6 electron-volt (eV) lamp and an UltraRae 3000 with an 9.6 eV lamp. Two different lamps were used to differentiate between the different types of petroleum compounds being encountered in the field and provide the team with additional information when selecting laboratory samples to be collected and submitted for laboratory analyses (Table 3 and Table 4). Additionally, groundwater samples were collected from piezometers where soil samples had a positive PID detection during drilling activities, and the samples were submitted for laboratory analyses (Table 3 and Table 4). Groundwater samples were also collected from select piezometers during the Additional Groundwater Sampling (Stage 2), and the samples were submitted for laboratory analyses (Table 3 and Table 4).

While activities in the first two stages of the Phase I Site Investigation collected relevant data, the Hydrocarbon Investigation (Stage 3) focused specifically on defining the nature and extent of the soil and groundwater within the Site impacted by organic pollutants (petroleum compounds and PCB) and identifying if light non-aqueous phase liquid (LNAPL) was present. Thirteen piezometers were installed at strategic locations to better delineate groundwater impacts and detect potential LNAPL (Figure 5). The piezometer screens were installed across the water table (i.e., approximately 5 feet above and 10 feet below the groundwater table) to detect potential LNAPL. The construction for each piezometer is shown on the Lithology Logs in Appendix B. Additionally, 3 test pits were excavated to help delineate the potential impacted soil near borehole BRW18-BH11. The final depth and lithology of each test pit is shown in the Lithology Logs.

During the Hydrocarbon Investigation (Stage 3), field personnel continued to use PIDs and visual and olfactory observations to screen for the presence of petroleum compounds in borehole cores and test pit material. Based on the field screening, the following samples were collected as follows:

- For all unpaired locations:
    - If the presence of petroleum compounds was detected (via sight, smell, and/or detection with a PID) in the cores from the sonic rig or in the test pit soil, a representative sample was generally collected for laboratory analyses (Table 3 and Table 4).
    - For all boreholes and test pits, a soil sample was collected, when possible, near the top of the saturated layer (in the capillary fringe) for laboratory analyses (Table 3 and Table 4) even if there was no evidence of petroleum compounds.
- For paired locations (i.e., a location within approximately 5 feet of a deeper previously completed investigation point), samples were not collected if that location was previously sampled for petroleum compounds.

Once all the hydrocarbon piezometers were installed, groundwater samples were collected from existing and newly installed piezometers and submitted for laboratory analyses (Table 3 and Table 4).

The results of the laboratory analyses are included in the Risk-Based Corrective Action (RBCA) (DEQ, 2018a) evaluation in Appendix F.

2.3.1 Records Review

Historical and contemporary records were reviewed in an attempt to determine the source of organic pollutants within the Site. These records included Montana Department of Environmental Quality (DEQ) reports from the following neighboring sites with documented releases of organic pollutants:

- 400 Oxford Street: Location of a leaking underground storage tank managed by the DEQ in 1995 (DEQ, 2019).
- 759 South Montana Street: Formerly the location of a Cenex Convenience Store. The site received reimbursement from the Petroleum Tank Release Compensation Board for releases in 1990 and 2006 (DEQ, 2018b).

2.3.2 Treatment and Disposal of Petroleum-Impacted Soil from Field Activities

During the Initial Phase I Site Investigation (Stage 1), a temporary bermed containment area, lined with low-density polyethylene plastic sheeting (“visqueen”), was set up on the Site to temporarily store soil generated from drilling and potholing activities with detectable petroleum compounds. Per the RFC to the Butte Mine Waste Repository Operation and Maintenance (O&M) Manual (BPSOU-MWR OMM-RFC-01) (Atlantic Richfield, 2019a), the soil was transported from the Site to the Butte Mine Waste Repository (MWR) for treatment and disposal.

The petroleum compounds in the soil are currently being treated using landfarming techniques (landfarming), which are being conducted in accordance with the Administrative Rules of Montana (ARM) Title 17, Chapter 50, Sub-Chapter 16, Landfarm License and Operation Standards (ARM 17.50.16). BSB constructed a bermed area on the upper deck of the Butte MWR to landfarm the material. Atlantic Richfield is monitoring the concentrations in the soil until the total hydrocarbon concentrations (the sum of total extractable hydrocarbons plus total petroleum hydrocarbons) are below 100 parts per million (ppm) (the required threshold for disposal at the Butte MWR [Atlantic Richfield, 2015]) and to determine if the soil will meet the Tier 1 risk-based screening levels (RBSLs) listed in the Montana RBCA Guidance for Petroleum Releases (RBCA Guidance) (DEQ, 2018a). Table 9 lists the analytical results to date compared to the Tier 1 residential surface soil RBSLs, the most stringent RBSLs in the RBCA Guidance. Analytical results to date are compared to the Tier 1 residential surface soil (less than 10 feet to groundwater) RBSLs to determine if these limits are achievable with landfarming techniques, which will help inform future remedial activities at the Site.

Current measurements indicate that the total hydrocarbon concentrations from the soil contained at the Butte MWR (Table 9) have decreased from approximately 920 ppm to 194 ppm, and the only remaining analyte that exceeds the residential surface soil RBSL is benzo(a)pyrene with a concentration of 0.19 ppm (limit is 0.13 ppm). The analytical results were evaluated against the residential RBSLs to determine if the levels can be achieved with landfarming techniques, which will help to inform future remedial activities for the Site (Atlantic Richfield, 2019a).

2.4 Site Survey

The Site survey with known utilities is shown on Figure 14. The survey data for the Site include an existing ground surface, stream elevations at the general upstream and downstream tie-in locations, critical utility locations, and other general Site conditions. Due to the consistently changing conditions at the Site (i.e., BSB’s operations), the current existing ground surface was estimated from Light Detection and Ranging (LiDAR) data collected in 2017 with the storage piles removed.

OneCall tickets were created for the Site. Representatives from BSB, NorthWestern Energy, and Century Link were notified and provided markings for on-Site utilities. In accordance with Atlantic Richfield’s overhead utility and ground disturbance defined practice, utility locations were confirmed using blind sweeping and potholing methods.

3.0 INTERPRETATION OF RESULTS

The following sections provide an interpretation of the results from the work performed for the Phase I Site Investigation in relation to the data gaps and objectives identified in Table 2. Please note that additional interpretation of the Phase II and Phase III Site Investigations will be incorporated into this PDI Evaluation Report and resubmitted to Agencies for review as the RD progresses.

3.1 Solid Material Characterization

The Phase I Site Investigation collected substantial design-related data to estimate the volume, distribution, and properties of solid materials within the Site. Solid materials collected in the field were categorized into four broad waste categories:

- Slag – A stone and glass-like waste product that results from the smelting of ore. Slag tends to have a black appearance within the Site and is difficult to dig and drill through.
- Demolition Debris – Material from previously demolished structures. Soil is mixed with timbers, brick, concrete, asphalt, and nails.
- ATO – The ATO waste category is an acronym for alluvium, tailings, and organic soil. Alluvium is a general term that describes deposits of clay, silt, sand, and gravel. Tailings typically refers to waste rock that was pulverized to a fine sand. Organic soil describes subsurface native dirt that lies near or below waste in a soil column with high organic content.
- Other – This category describes material that was stockpiled by BSB and material that lies above waste at the top of a soil column. Generally, “Other” is material that was not identified as slag, demolition debris, or ATO.

Waste categories are further discussed in the Leapfrog Model (Appendix C, XRF to ICP and Model Inputs Tech Memorandums). Detail will be added to these descriptions including porosity, hydraulic conductivity, organic content, sorbtive properties, and other parameters after additional opportunistic solid material design-related data are collected during the Phase II and Phase III Site Investigations (Section 1.0).

Initial interpretations of the results are provided below. Additional opportunistic solid material design-related data will be collected during the Phase II and Phase III Site Investigations (Section 1.0).

3.1.1 Volume, Distribution, and Properties of Solid Materials

Based on the results summarized in Sections 2.1.1 and 2.1.2, the Leapfrog Works software was used to estimate the volume, distribution, and properties (i.e., COC concentrations) of solid materials (slag, demolition debris, ATO, and other). The software was further used to identify the volume and distribution of impacted and unimpacted ATO.

Observations of slag and demolition debris were noted in the borehole logs from the Phase I Site Investigation, the BRW Smelter Site Test Pit Report (NRDP, 2016), and the installation of existing monitoring wells. These observations were imported into the Leapfrog Works software to generate the models depicting the distribution of slag and demolition debris. Figure 15 and Figure 16 show the distribution of slag and demolition debris, respectively, within the Site.

To estimate the quantity and distribution of waste material within the Site (i.e., material above the waste identification criteria in the BPSOU CD) and within the waste removal corridor, chemical properties (i.e., COC concentration data from soil samples collected during the Phase I Site Investigation) were imported into the Leapfrog Works software (Appendix C). The XRF concentration data were adjusted to the regression for the upper 95% confidence interval, referred to as the upper 95% regression, using paired samples with the ICP-OES concentration data prior to being imported. Figure 17 shows the interpreted volume of material that exceeds the waste criteria and Figure 18 shows the interpreted volume of material that passes the waste criteria. The approximate volume of slag, demolition debris, and waste materials within the Site and within the conceptual removal area are shown in Table 10. Further details on how these models were generated are discussed in Appendix C.

3.1.2 Constructability Considerations

The remaining infrastructure within the Site, including the location of the subsurface flume/culvert, was identified and summarized in Section 2.1.3 and 2.1.4 above. No additional interpretation is necessary.

3.2 Groundwater Characterization

The purpose of groundwater characterization within the Phase I Site Investigation was to collect preliminary information about the groundwater elevations, potentiometric surface, and direction of groundwater flow (including seasonal groundwater changes); the spatial variability of groundwater chemistry within the alluvial aquifer at the Site; and the aquifer geometry. This initial data collection effort within the Phase I Site Investigation was completed to advise the Phase II Site Investigation. Because this information is preliminary, limited interpretation is provided below.

3.2.1 Groundwater Elevations, Potentiometric Surface, and Direction of Flow

The groundwater elevation, groundwater contours, and direction of flow were inferred based on the results from the Phase I Site Investigation. Groundwater elevations were calculated by subtracting the depth to water measurement (recorded during the monthly water level readings) from the surveyed measuring point elevation (typically the north side of the inner casing) for each investigation point. The groundwater contours were created by interpolating the groundwater elevations with kriging algorithms (Figure 9). Based on the potentiometric surfaces, the groundwater generally flows from the southeast to the northwest, towards SBC. A relationship exists between the groundwater at the Site and SBC; however, the extent of the relationship is unclear and will be addressed after interpretation of the Phase II Site Investigation data.

3.2.2 Seasonal Groundwater Elevation Change

Figure 8 shows the manually recorded groundwater elevation variations over the first year of data collection. Generally, the highest groundwater elevations were observed in March, April, and October, while the lowest groundwater elevations were observed in the winter months (December through February). Figure 9 shows the lowest groundwater contours (February 2019) and Figure 10 shows the highest groundwater contours (April 2019).

Outlier Determination

As indicated in Table 8 and on Figure 8, professional judgement was used to identify manual groundwater level measurement outliers. Since the overall seasonal water elevation trends are the targeted information that will be used to advise the design of the BRW hydraulic control and construction dewatering, individual measurements are not as important, and the professional judgement focused on quality data regarding the seasonal trends. The outlier measurements included groundwater elevations that did not follow the general seasonal trends of the majority of wells/piezometers at the Site (where no transducer measurements were available) and/or were notably different from trends recorded from transducers.

The seasonal variation in groundwater elevations across the Site is relatively slight. The standard deviation for the depth to water measurements taken at wells/piezometers where no outliers were identified ranged from approximately 0.20 feet to 0.35 feet (Table 8). Figure 8 shows how the groundwater elevations increased slightly in the spring, fell in the early summer, rose slightly again in the fall, and declined in the winter. The majority of the wells/piezometers followed this pattern and overall, the change in elevation was consistent across the Site.

For those wells/piezometers without transducers (identified in Table 3), the outlier identification was conducted visually. The groundwater elevations were plotted on a graph similar to that shown on Figure 8. Where the change in groundwater elevation between the preceding and following month did not match the overall pattern observed in the other wells/piezometers for that month, the manual groundwater level measurement was identified as an outlier. Any depth to water measurement identified as an outlier was compared to the field logbook (Appendix A) to ensure the value matched that in the logbook. The outlier designation was then confirmed as a matter of professional judgement by the QAO, Mike Borduin from Pioneer.

The April depth to groundwater measurement for BRW18-PZ06 (8.33 feet [Table 8]) provides an excellent example of the outlier determination process for locations with no transducer. In relation to the March (4.15 feet) and May (3.86 feet) depth to water measurements, the magnitude of the change in elevation is significantly greater than that shown at the other wells/piezometers. Additionally, the groundwater elevation increased from March to April for the majority of the other wells/piezometers. The 8.33-foot depth to water measurement in BRW18-PZ06 would have resulted in a significant drop in groundwater elevation. This change was not observed in any of the nearby wells/piezometers. These discrepancies qualified the April monthly depth to groundwater measurement as an outlier.

For those wells/piezometers with transducers (identified in Table 3), the monthly depth to water measurement was compared to the data collected by the transducer as well as to the transducer data of other wells/piezometers at the Site. Where the manual depth to groundwater measurement could not be reconciled with the transducer data, the point was identified as an outlier. The outliers were either close to the transducer data, but did not meet the 0.05-foot acceptable drift tolerance, or were significantly different than the transducer data. In the latter case, accounting for changes in the placement of the transducer after it was removed and replaced, could not reconcile the manual depth to water measurement.

Moving forward, efforts have been made to improve the accuracy of the manual groundwater measurements including using the same meter each month, if possible, and confirming the measured water level with both a traditional water level meter and the water level meter with an interface probe.

3.2.3 Groundwater Chemistry

A summary of the analytical results for groundwater sampling is shown in Table 7. Hydrocarbon analytical results are included in Table 5, Table 6, and Table 7 of Appendix F. Figure 11, Figure 12, and Figure 13 show the analytical results from 2018, 2019, and 2020 sampling, respectively. The figures indicate the elements are above either the groundwater and/or the chronic surface water standards listed in the BPSOU CD applicable to the Site.

Additional data are needed to delineate the extents of impacted groundwater within the Site. These data will be collected during the Phase II and Phase III Site Investigations (Section 1.5). At the completion of the Site investigations, Atlantic Richfield will update this PDI Evaluation Report to include further interpretation on the extents of impacted groundwater within the Site, including spatial and seasonal variability, and resubmit to Agencies for review as part of the RD process.

3.3 Organic Pollutants

Atlantic Richfield has completed a risk evaluation for the petroleum-impacted materials within the Site following the RBCA Guidance (DEQ, 2018a). The RBCA evaluation is included in Appendix F.

The RBCA evaluation (Appendix F) was completed to the extent possible based on the data collected during the Phase I Site Investigation. For the current RBCA evaluation, the data collected from the Site were compared to Tier 1 and Tier 2 RBSLs to determine whether additional evaluation was needed. Due to the complexity of the Site, Atlantic Richfield intends to complete a Tier 3 evaluation and develop Site-specific action levels for soil and groundwater impacted with organic pollutants within the Site. Once the Phase II and Phase III Site Investigations are completed, the RBCA evaluation will be revised to include a Tier 3 evaluation and proposed Site-specific action levels and resubmitted with the revised PDI Evaluation Report.

All groundwater samples collected as part of the Phase I Site Investigation have had non-detectable concentrations of PCBs. Additional groundwater sampling of petroleum compounds, PCB, PCP, and dioxins will occur in Phase II and Phase III Site Investigations. Additional soil sampling will occur as part of the Phase III Site Investigation to determine if there are soils impacted with PCBs within the Site. Based on historical information, it is not anticipated that soil will be impacted with PCP or dioxins within the Site. As the design progresses, Site-specific action levels may be determined based on data evaluation results from Site investigations.

3.4 Silver Bow Creek Realignment

3.4.1 SBC Bottom Invert at Upstream and Downstream Tie-in Locations

The SBC runs east to west through the Site. The SBC bottom invert at the upstream and downstream tie-in locations for the preliminary stream alignment was surveyed and the results are shown on Figure 14. Tie-in locations may be re-surveyed to account for changes in stream dynamics or other design modifications based on current field conditions. No additional interpretation is necessary for this objective.

3.4.2 Evaluation of Potential Lining of Relocated SBC

Based on the data collected from the Phase I Site Investigation, Atlantic Richfield has not yet determined or evaluated the potential need for lining of the relocated SBC. Additional data are needed to evaluate the groundwater conditions within the Site and potential hydraulic control options. This data will be collected during the Phase II Site Investigation, which will focus on the groundwater and aquifer characteristics of the Site (Section 1.0).

4.0 REMAINING DATA GAPS

Initial data were collected during the Phase I Site Investigation to help fulfill the following objectives from Table 2:

- Solid Material Characterization:
    - Determine the volume and distribution of slag and solid materials that fail the waste criteria within the Site.
    - Determine the leachability of metals within the soils that will remain within the Site after removal of waste materials to properly design the BRW hydraulic control.
    - Assess the geotechnical properties of the soils within the Site for constructability considerations.
- Groundwater Characterization:
    - Define the spatial variability of groundwater chemistry within the Site.
    - Define the hydraulic conductivity and transmissivity of the aquifer within the Site.
    - Define the aquifer geometry within the Site.
    - Evaluate the interaction between groundwater and surface water (SBC).

- Organic Pollutants:
    - Define the spatial variability of groundwater and soil within the Site that is impacted with organic pollutants (petroleum compounds, PCB, PCP, and dioxins).
    - Develop a plan to manage the impacted groundwater and soil within the Site.

Based on the data collected from the Phase I Site Investigation, these objectives were not completely met and additional data will be collected during additional Site investigation activities (Section 1.0).

The sections below detail the Site activities, data collection, and data interpretation to be completed to fulfill the above data gaps and the RD. As the Site investigations are completed and the RD progresses, Atlantic Richfield intends to incorporate the data, interpretation of results, and subsequent RD recommendations into this PDI Evaluation Report and resubmit to Agencies for review.

4.1 Solid Materials Characterization

Additional data will be collected during the Phase II and Phase III Site Investigations to fulfill the following data gaps:

- Determine the volume and distribution of solid materials that fail the waste criteria within the Site to complete the design of an excavation surface.
- Determine the volume, distribution, and general physical properties of slag throughout the Site to help inform the potential effectiveness of methods that may be employed to remove the slag during construction.
- Determine the leachability of metals within the soils that will remain within the Site after removal of waste materials to properly design the BRW hydraulic control.
- Assess the geotechnical properties of the soils within the Site for constructability considerations.

The Site activities and data collection planned for the Phase II Site Investigation are detailed in the BRW Phase II QAPP. The Site activities and data collection planned for the Phase III Investigation are outlined in the BRW Phase III QAPP.

4.1.1 Volume and Distribution of Waste Materials

As part of creating the Leapfrog model (Section 3.1.1), an evaluation was completed to determine where additional data may be needed to refine the waste volumes and complete the design of an excavation surface. Figure 19 shows the locations of the completed investigation points for the Phase II Site Investigation in addition to some proposed locations for the Phase III Site Investigation (reference Appendix C for additional information on how these points were selected). During the Phase II and Phase III Site Investigations, field personnel will record the lithology and samples will be collected for metals analysis (Atlantic Richfield, 2021c, Atlantic Richfield, 2021d). Once data are collected from these additional locations (Phase II and Phase

III), the Leapfrog model will be updated following the general procedures used to create the model (Appendix C), and the excavation surface will be completed. Additionally, the results from the Leapfrog model will be incorporated into the groundwater conceptual model to help develop a complete understanding of the Site.

4.1.2 Volume, Distribution, and Properties of Slag

The Phase II Site Investigation includes a slag demolition investigation that is meant to collect additional data to refine the volume and distribution of slag within the Site, along with collecting appropriate information to inform the potential effectiveness of methods that may be employed to remove the slag. Once data are collected from the slag demolition investigation, the Leapfrog model will be updated to refine the volume and distribution of slag within the Site following the general procedures used to create the model (Appendix C). The extents of slag within the Site along with information regarding the physical properties of the slag will be included in the RD reports to help inform the potential effectiveness of removal methods.

4.1.3 Leachability of Metals

The leachability of metals within the soils that will remain within the Site after removal of waste materials will be estimated by collecting soil samples during both the Phase II and Phase III Site Investigations and submitting these samples for SPLP analysis. The results from the SPLP analysis will be incorporated into the Leapfrog model, which will then be used to estimate the volume and distribution of materials with leachable quantities of COCs that will remain after the removal of waste materials. This information will then be used to design the BRW hydraulic control.

4.1.4 Geotechnical Properties

During the Phase III Site Investigation, a geotechnical analysis of Site conditions will be completed for soils that will be encountered during RA activities and soils that may remain in place after the RA is complete. The data and construction recommendations obtained will be incorporated into the Intermediate (60%) RD Report and will support the excavation design and future Site design.

4.2 Groundwater Characterization and Hydraulic Control

Additional data will be collected during the Phase II and Phase III Site Investigations to fulfill the following data gaps:

- Define the spatial variability of groundwater chemistry within the Site.
- Define the hydraulic conductivity and transmissivity of the aquifer within the Site.
- Define the aquifer geometry within the Site.

Additional data will be collected during the Phase II and Phase III Site Investigations to help delineate the extents of impacted groundwater within the Site. Data collected from two pumping tests conducted during the Phase II Site Investigation will be used to define the hydraulic conductivity, transmissivity, and geometry of the aquifer within the Site. The Site activities and data collection planned for the Phase II Site Investigation are detailed in the BRW Phase II QAPP. The Site activities and data collection planned for the Phase III Site Investigation are outlined in the BRW Phase III QAPP.

The data collected from the Phase II and Phase III Site Investigations, including the updated Leapfrog model, will be incorporated into a groundwater conceptual model that will be used to evaluate options and select designs for the BRW hydraulic control.

The general steps in completing this model will include, at a minimum, the following:

1. Development of a groundwater conceptual model and numerical model to provide estimates of the following:
    a. Flux of groundwater and load of COCs traveling through the Site.
    b. Interaction with adjacent surface water in SBC.
    c. Location and volume of materials that leach notable quantity of COCs.
    d. Location and quantities of upgradient COCs entering the Site.
2. Construction and calibration of the numerical groundwater model that has sufficient detail to estimate effects from the following:
    a. Seasonal and long-term groundwater elevation fluctuations.
    b. Effectiveness of various construction dewatering technologies (pumping wells, dewatering trenches, French drains, etc.).
    c. Removal of groundwater from storage during construction dewatering.
    d. Winter operations.
    e. Quantity of water requiring treatment during construction.
    f. Evaluation of the preferred sequence of impacted materials excavation.
3. Evaluation of options for construction dewatering and hydraulic control will include the following:
    a. Effectiveness at meeting normal flow groundwater standards in SBC at different times of the year.
    b. Effectiveness of limiting impacts from groundwater to sediments located in the bed of SBC.
    c. Interactions of the relocated SBC with groundwater and hydraulic control.
    d. Estimates of the quantity of water requiring short-term and long-term treatment at Butte Treatment Lagoons.
4. Other relevant design information.

4.3 Organic Pollutants

Additional data will be collected during the Phase II and Phase III Site Investigations to fulfill the following data gaps:

- Define the spatial variability of groundwater and soil within the Site that is impacted with organic pollutants (petroleum compounds, PCB, PCP, and dioxins).
- Develop a plan to manage the impacted groundwater and soil within the Site.

The Site activities and data collection planned for the Phase II Site Investigation are detailed in the BRW Phase II QAPP. The Site activities and data collection planned for the Phase III Site Investigation are outlined in the BRW Phase III QAPP.

Additional soil and groundwater samples will be collected during both the Phase II and Phase III Site Investigations and submitted for analysis of organic pollutants (petroleum compounds, PCB, PCP, and dioxins) (Atlantic Richfield, 2021c and Atlantic Richfield, 2021d). With the additional data, Atlantic Richfield intends to complete a Tier 3 evaluation and develop Site-specific action levels for soil and groundwater impacted with organic pollutants within the Site. The Tier 3 evaluation will incorporate results from the groundwater conceptual model. Once the Site-specific action levels are established, Atlantic Richfield will determine the adequate management plan for impacted groundwater and soil within the Site. This management plan will be incorporated into the Intermediate (60%) RD Report.

5.0 SUMMARY OF REMEDIAL DESIGN RECOMMENDATIONS

5.1 Waste Removal Extents

The BPSOU Statement of Work (Appendix D to the BPSOU CD) requires removal of all tailings, waste, contaminated soil, and slag within the waste removal corridor that exceed the Waste Identification Screening Criteria (BPSOU CD). Figure 17 shows all material that fails the Waste Identification Screening Criteria, with additional information contained in Appendix C. The width of the waste removal corridor will be an average of 275 feet beginning at the toe of the railroad extending north into the Site, and the depth of removal will be determined based on the results of the Site investigations and will be agreed upon during the RD.

5.2 Waste Characterization for Proper Disposal

Waste material to be removed from the Site contains concentrations of COCs (arsenic, cadmium, copper, lead, mercury, and zinc) above the waste identification criteria in the BPSOU CD. A suitable repository location will be determined following completion of a repository siting study.

Based on the initial results from the RBCA evaluation (Appendix F), the majority of the petroleum-impacted soils exceeding the DEQ RBSLs are within the southern part of the Site and will be removed as part of the excavation within the waste removal corridor. These soils may need to be segregated during excavation and sampled prior to disposal at a repository. Based on the petroleum compound concentrations, the soils may require treatment prior to disposal. The Phase II and III Site Investigation activities will collect additional data to help refine the delineation of petroleum-impacted soils within the Site and to help develop a plan to manage the petroleum-impacted soils. The Phase II and III Site Investigation activities will collect additional data from soil and groundwater within the Site impacted by organic pollutants, characterize aquifer characteristics of the Site, and evaluate the impact of pumping on natural attenuation processes and fate and transport of the organic pollutants (Section 1.0). Additional detail on the extent and volume of soils impacted with organic pollutants and the management of the impacted soils, including the soils outside of the waste removal corridor, will be provided in this PDI Evaluation Report at the completion of the Phase II and Phase III Site Investigations.

5.3 Preservation and Demolition of Existing Durable Historic Infrastructure

Efforts will be made to preserve the majority of the slag walls and the ore bins within the Site. The slag wall surrounding the Site is considered a historic and cultural resource (ADLC-BSB, 1993) and must be preserved to the greatest extent possible. While the ore bins have not been designated as a historic and cultural resource, they are unique structures that provide a glimpse into the history of the Site for future interpretation/education. The preservation of the ore bins is dependent on further evaluation of waste removal within the Site to ensure the remedy is effective, results from a current cultural resource inventory to be conducted in 2021, and completion of a structural evaluation to determine if the feature is safe to preserve.

To assess the possibility that the ore bins, and other identified historic structures, might remain, Atlantic Richfield will complete a cultural resource inventory of the Site to determine the historical significance of the various remaining structures. Atlantic Richfield will then determine the amount of materials that will need to be left in place (both materials that fail the waste criteria and those which are leachable to groundwater) to preserve the historic features. To determine if historical features will be preserved, Atlantic Richfield will weigh the findings of the cultural resource inventory against the potential effects on the remedy and other relevant information (e.g., geotechnical stability, etc.).

To complete this evaluation, additional information is needed from the Phase II and Phase III Site Investigations. Once these Site investigations are complete, Atlantic Richfield will incorporate the results, including a determination on whether the ore bins should be preserved, into this PDI Evaluation Report and submit to Agencies for review and approval.

Some existing infrastructure within the Site, such as the Blacktail Creek flume, will need to be demolished or stabilized for safety and for the end land use features to be constructed. There are pieces of infrastructure that may be challenging to remove with typical heavy equipment, specifically the stack foundation, the Blacktail Creek Flume, the slag wall (particularly on the east side of the Site), and remaining building foundations. Additional information will be collected on the durability of slag during the Phase II Investigation and the construction materials and dimensions of these structures will be provided for contractor consideration within planned construction documents. These structures are mainly made of slag, wood, concrete, and rebar and it is anticipated that these demolition materials will be taken to the selected repository.

5.4 Wetland Protection and Mitigation Recommendations

Approximately five years following construction, the Site will be re-delineated, and re-evaluated to determine the post-construction FEWA scores in accordance with the "no net loss" Superfund goal for wetlands. Due to the nature of the projects, it is anticipated that from pre- to post-construction, wetland acreage and function will improve. If there is a net wetland loss, Atlantic Richfield will assess options for mitigation/offset within the upper Clark Fork River Superfund Sites watershed.

5.5 Utility Avoidance

It is anticipated that most of the on-Site utilities will be moved, rerouted, or abandoned while other utilities will be avoided during construction. The overhead electrical distribution line, including the underground portion that provides power to the BSB asphalt plant and crusher, will be abandoned beginning from the southern Site boundary. The sewer, natural gas, communications, and water lines servicing the BSB asphalt plant and crusher will be abandoned up to their connections at Montana Street.

The main utility lines along Montana Street and the BPSOU subdrain pump system alternate discharge line, will be avoided. The BPSOU subdrain pump system primary force main will be moved/rerouted during construction. Details on how the BPSOU subdrain pump system primary force main will be moved/rerouted, along with plans to maintain the line through construction, will be described later in the RD. New utilities will be installed to service any end land use amenities, these utilities will be described later in the RD.

5.1 Hydraulic Control

The Phase II Site Investigation will focus on the groundwater and aquifer characteristics of the Site and include the collection of data to design hydraulic controls. Because the Phase I Site Investigation collected preliminary information to design the Phase II Site Investigation, no RD recommendations are provided at this time.

6.0 REFERENCES

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FIGURES

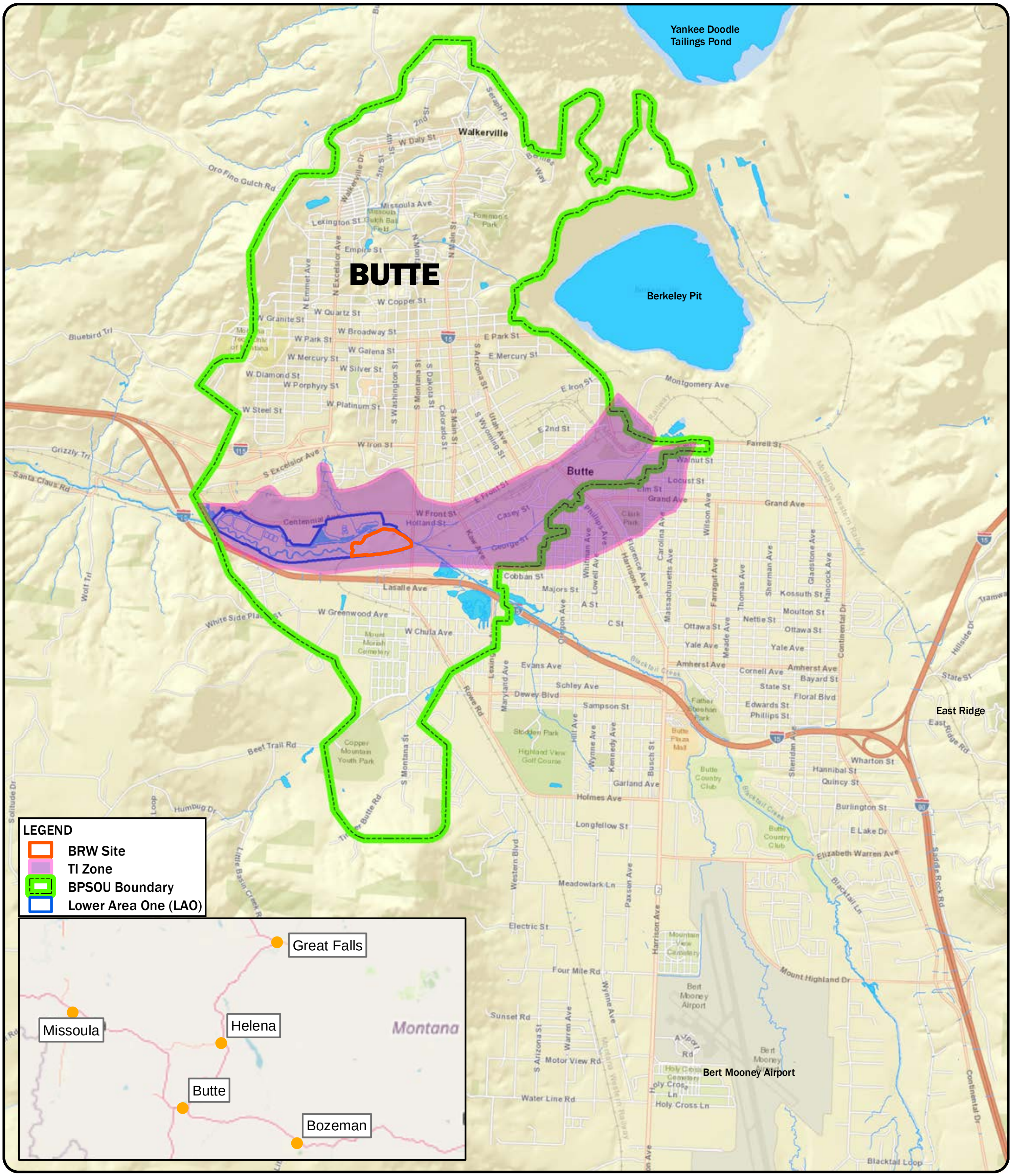

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FIGURE 1

SITE LOCATION MAP

PIONEER TECHNICAL SERVICES, INC.

Date: 5/11/2021

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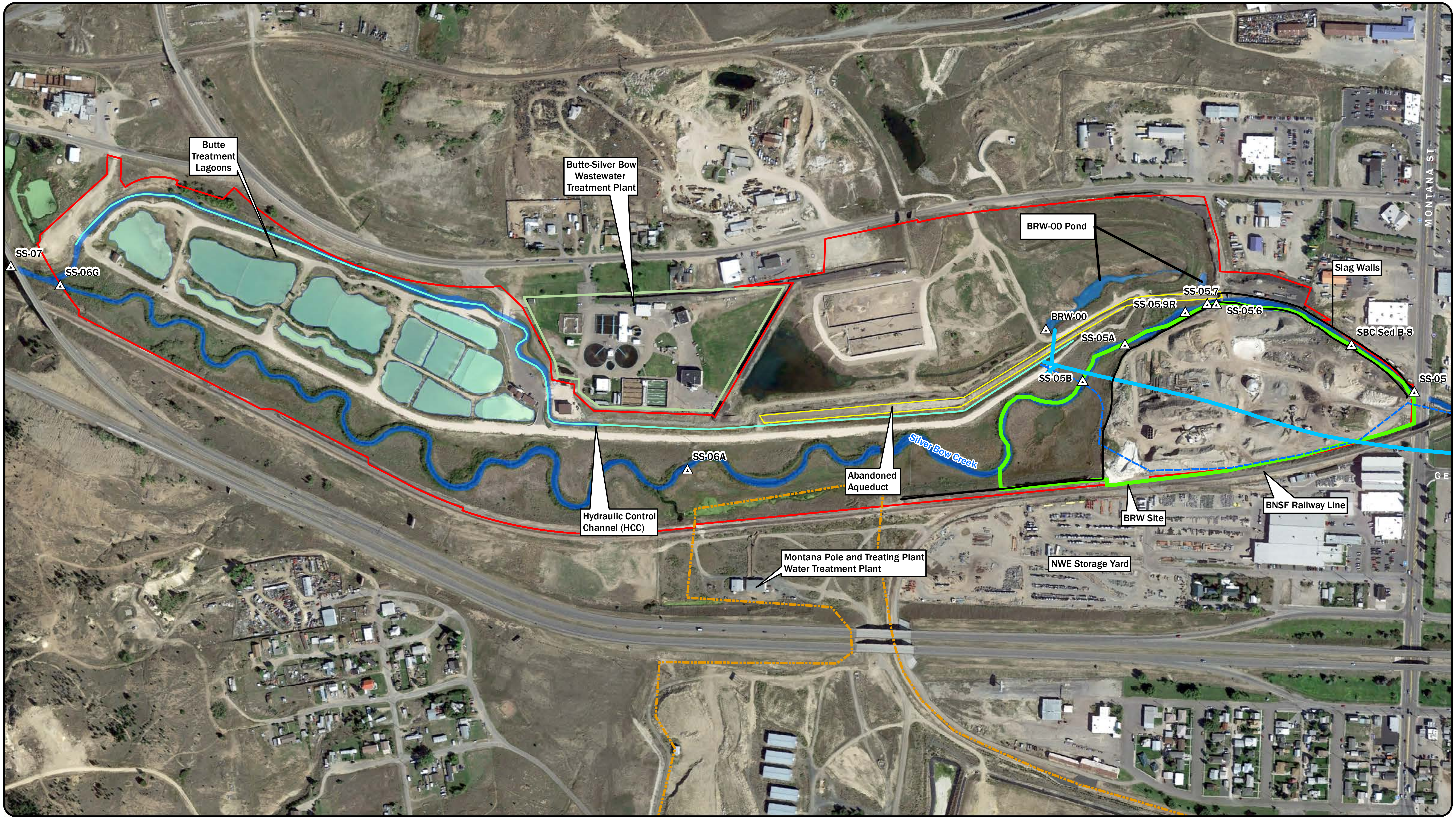

△ Surface Water Monitoring Points

- - - BPSOU Subdrain Pump System Primary Force Main

━ BPSOU Subdrain Pump System Alternative Discharge Line

— Hydraulic Control Channel

— Slag Walls

🟩 BRW Site Boundary

▢ BTL/LAO

🟥 LAO Boundary

▢ Butte-Silver Bow Wastewater Treatment Plant Boundary

▢ Abandoned Aqueduct

▢ MPTP NPL Site

N

DISPLAYED AS:
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FIGURE 2

PIONEER TECHNICAL SERVICES, INC.

LOWER AREA ONE AND BRW SMELTER AREA SITE MAP

DATE: 5/11/2021

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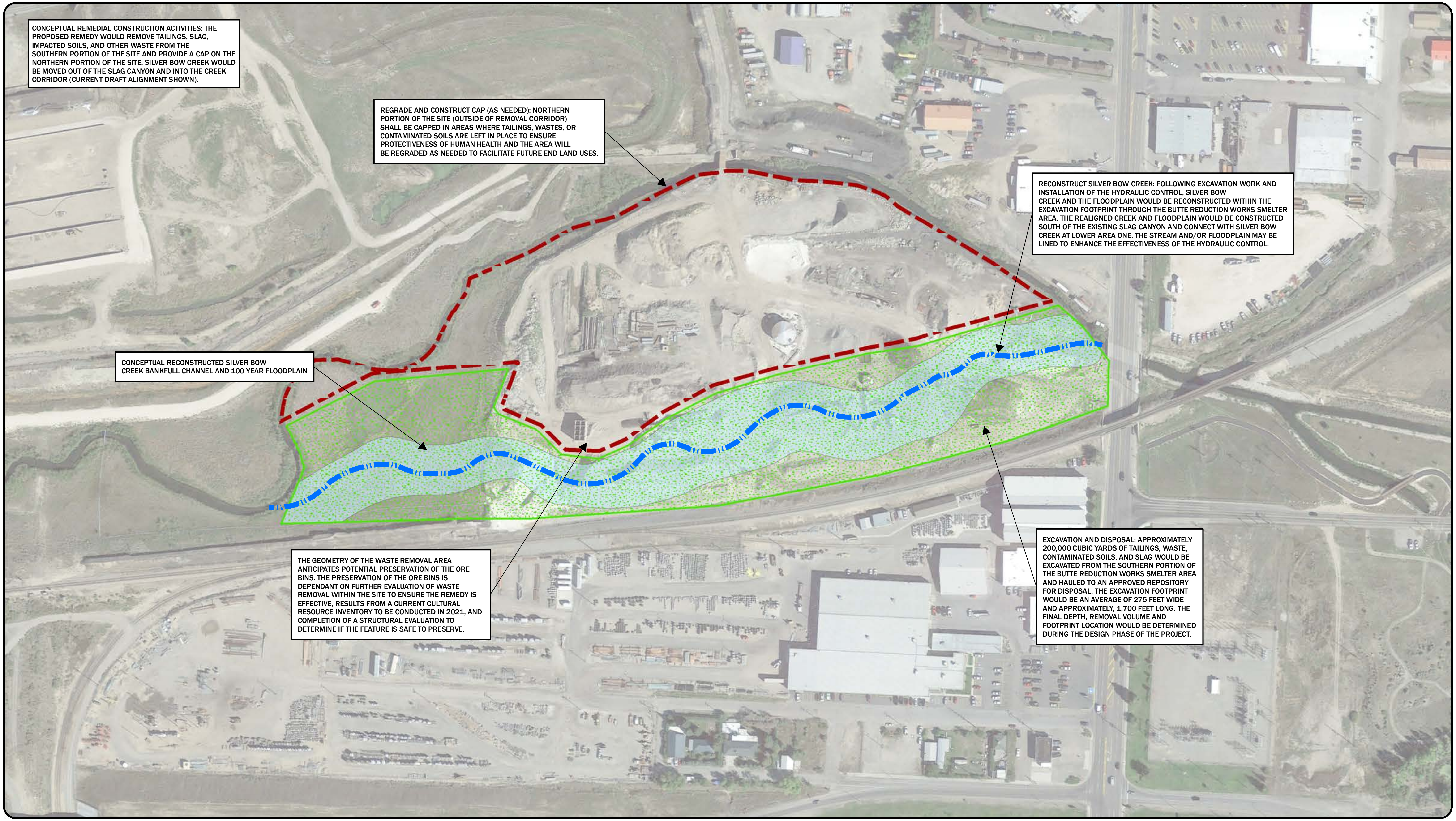

CONCEPTUAL REMEDIAL CONSTRUCTION ACTIVITIES: THE PROPOSED REMEDY WOULD REMOVE TAILINGS, SLAG, IMPACTED SOILS, AND OTHER WASTE FROM THE SOUTHERN PORTION OF THE SITE AND PROVIDE A CAP ON THE NORTHERN PORTION OF THE SITE. SILVER BOW CREEK WOULD BE MOVED OUT OF THE SLAG CANYON AND INTO THE CREEK CORRIDOR (CURRENT DRAFT ALIGNMENT SHOWN).

REGRADE AND CONSTRUCT CAP (AS NEEDED): NORTHERN PORTION OF THE SITE (OUTSIDE OF REMOVAL CORRIDOR) SHALL BE CAPPED IN AREAS WHERE TAILINGS, WASTES, OR CONTAMINATED SOILS ARE LEFT IN PLACE TO ENSURE PROTECTIVENESS OF HUMAN HEALTH AND THE AREA WILL BE REGRADED AS NEEDED TO FACILITATE FUTURE END LAND USES.

RECONSTRUCT SILVER BOW CREEK: FOLLOWING EXCAVATION WORK AND INSTALLATION OF THE HYDRAULIC CONTROL, SILVER BOW CREEK AND THE FLOODPLAIN WOULD BE RECONSTRUCTED WITHIN THE EXCAVATION FOOTPRINT THROUGH THE BUTTE REDUCTION WORKS SMELTER AREA. THE REALIGNED CREEK AND FLOODPLAIN WOULD BE CONSTRUCTED SOUTH OF THE EXISTING SLAG CANYON AND CONNECT WITH SILVER BOW CREEK AT LOWER AREA ONE. THE STREAM AND/OR FLOODPLAIN MAY BE LINED TO ENHANCE THE EFFECTIVENESS OF THE HYDRAULIC CONTROL.

CONCEPTUAL RECONSTRUCTED SILVER BOW CREEK BANKFULL CHANNEL AND 100 YEAR FLOODPLAIN

THE GEOMETRY OF THE WASTE REMOVAL AREA ANTICIPATES POTENTIAL PRESERVATION OF THE ORE BINS. THE PRESERVATION OF THE ORE BINS IS DEPENDANT ON FURTHER EVALUATION OF WASTE REMOVAL WITHIN THE SITE TO ENSURE THE REMEDY IS EFFECTIVE, RESULTS FROM A CURRENT CULTURAL RESOURCE INVENTORY TO BE CONDUCTED IN 2021, AND COMPLETION OF A STRUCTURAL EVALUATION TO DETERMINE IF THE FEATURE IS SAFE TO PRESERVE.

EXCAVATION AND DISPOSAL: APPROXIMATELY 200,000 CUBIC YARDS OF TAILINGS, WASTE, CONTAMINATED SOILS, AND SLAG WOULD BE EXCAVATED FROM THE SOUTHERN PORTION OF THE BUTTE REDUCTION WORKS SMELTER AREA AND HAULED TO AN APPROVED REPOSITORY FOR DISPOSAL. THE EXCAVATION FOOTPRINT WOULD BE AN AVERAGE OF 275 FEET WIDE AND APPROXIMATELY, 1,700 FEET LONG. THE FINAL DEPTH, REMOVAL VOLUME AND FOOTPRINT LOCATION WOULD BE DETERMINED DURING THE DESIGN PHASE OF THE PROJECT.

N

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DATUM: NAD 83
UNITS: INTN'L FT
SOURCE: PIONEER/CAD-EARTH

0 100 200 400
Feet

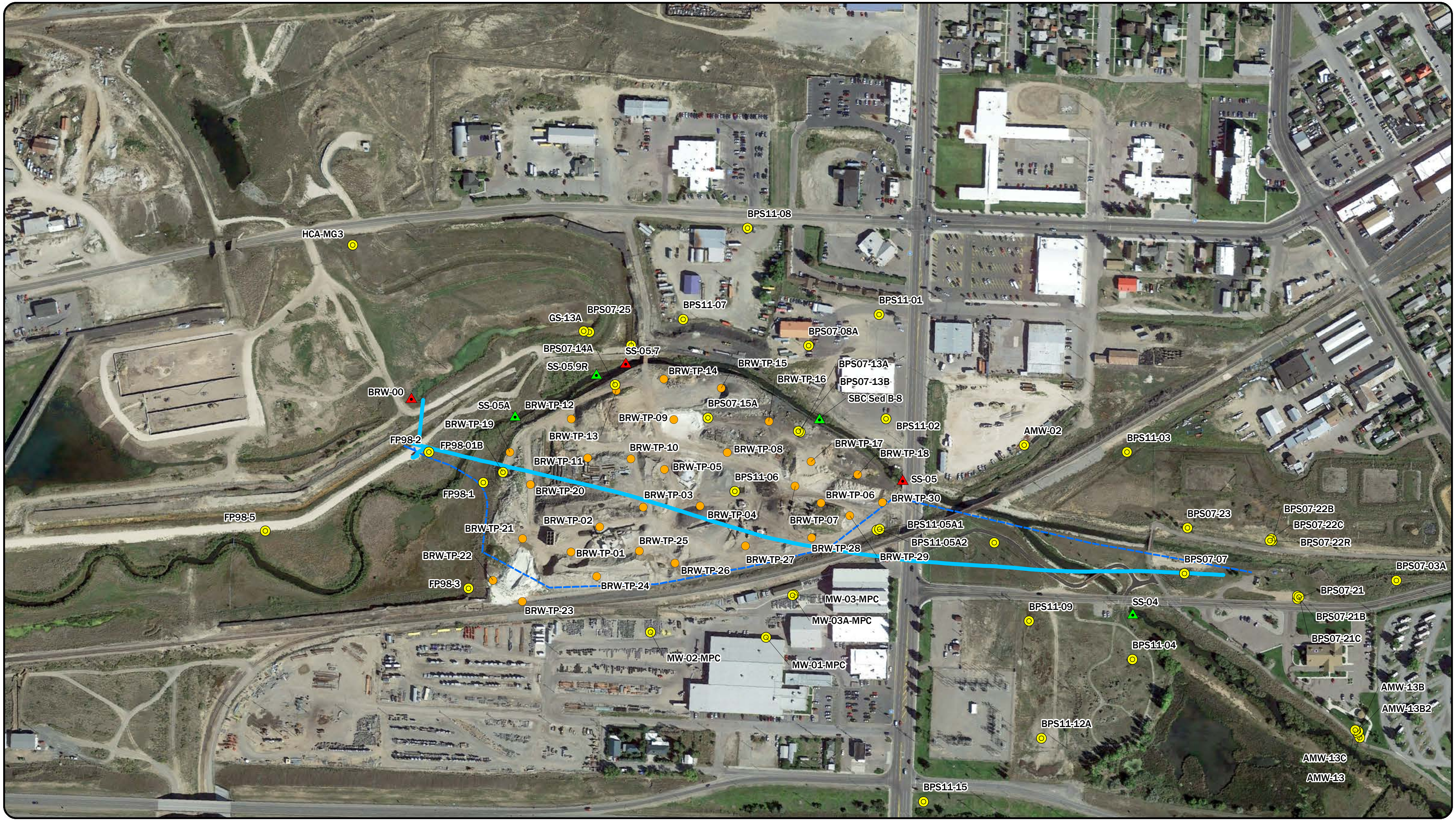
FIGURE 3

PIONEER TECHNICAL SERVICES, INC.

BRW SMELTER AREA CONCEPTUAL REMEDIAL ACTION PLAN

DATE: 5/11/2021

Path: Z:\Shared\Active Projects\ARCO\BPSOU\BRW\GIS\Z_PDI Evaluation Report_PI\BRW_PI_PDIER_008_RDPln_20.mxd



- ◎ Existing Monitoring Wells
- ▲ Staff Gage
- ▲ Staff Gages Equipped with Transducers
- ● Test Pits (Natural Resource Damage Program, 2016)

━━ BPSOU Subdrain Pump System Alternative Discharge Line (approximate alignment)

- - - BPSOU Subdrain Pump System Primary Force Main (approximate alignment)

Note:
Locations shown were installed prior to commencing BRW Phase I Site Investigation activites.

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTN'L FEET
SOURCE: PIONEER

0 150 300 600
Feet

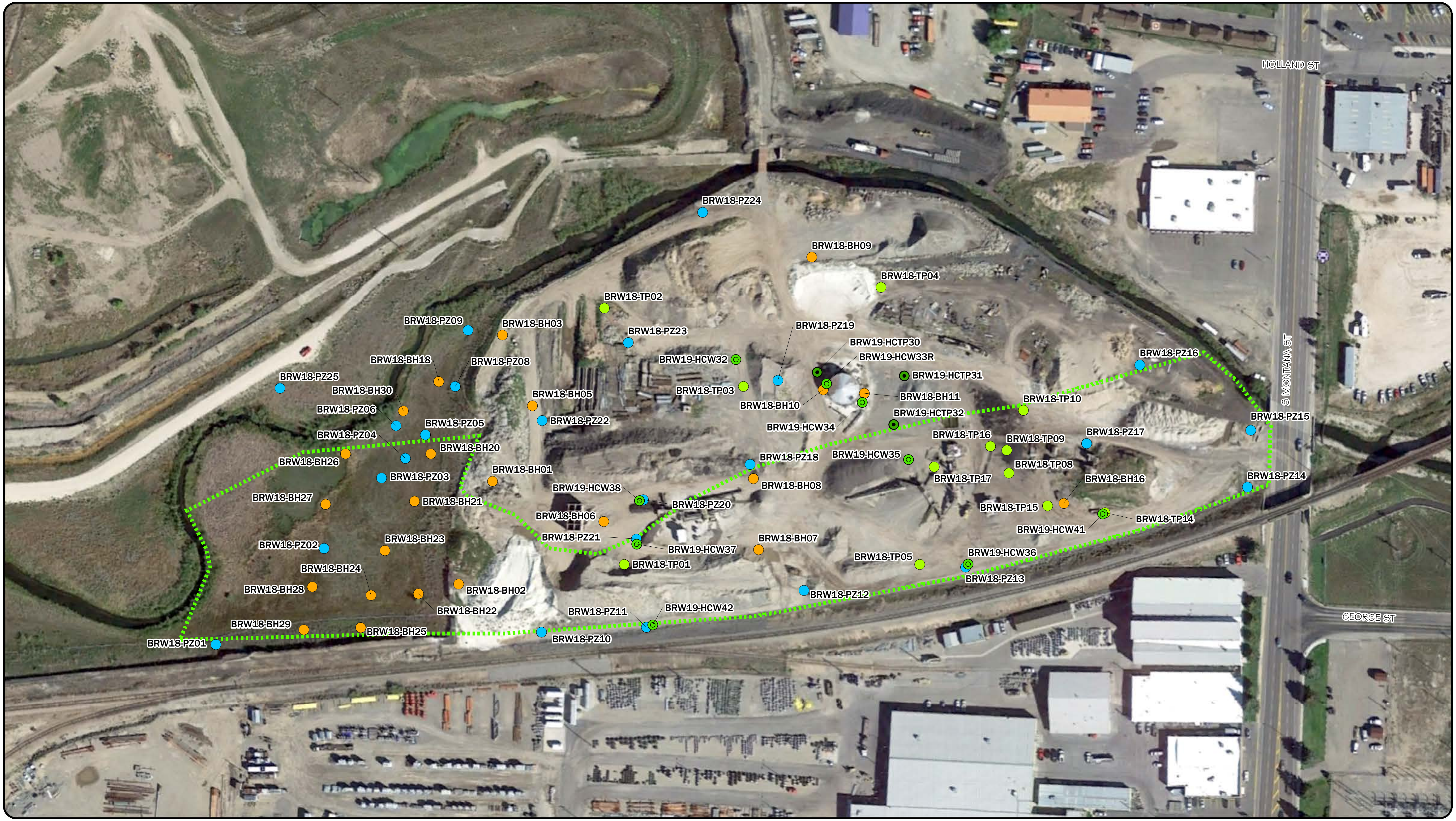
FIGURE 4

PREVIOUS INVESTIGATIONS

PIONEER
TECHNICAL SERVICES, INC.

DATE: 5/12/2021

Path: Z:\Shared\Active Projects\ARCO\BPSOU\BRW\GIS\Z_PDI Evaluation Report_PI\BRW_PI_PDIER_005_PrevInv_20.mxd



PHASE I LOCATIONS
- 🟠 Phase I Borehole
- 🔵 Phase I Piezometer
- 🟢 Phase I Test Pit

HYDROCARBON INVESTIGATION
- ◎ Hydrocarbon Piezometer
- ⊙ Hydrocarbon Test Pit
- ⬚ Preliminary Waste Removal Corridor

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTN'L FEET
SOURCE: PIONEER/CADEARTH 2014

0 75 150 300
Feet

FIGURE 5

PIONEER TECHNICAL SERVICES, INC.

BRW PHASE I
SITE INVESTIGATION LOCATIONS

DATE: 5/11/2021

Path: Z:\Shared\Active Projects\ARCO\BPSOU\BRW\GIS\Z_PDI Evaluation Report_PI\BRW_PI_PDIER_010_PrevSamp_20.mxd

🟨 Potentially Remaing Infrastructure

⬜ Demolished Historic Infrastructure

🟩 Confirmed Remaining Infrastructure

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/GOOGLE

0 50 100 200
Feet

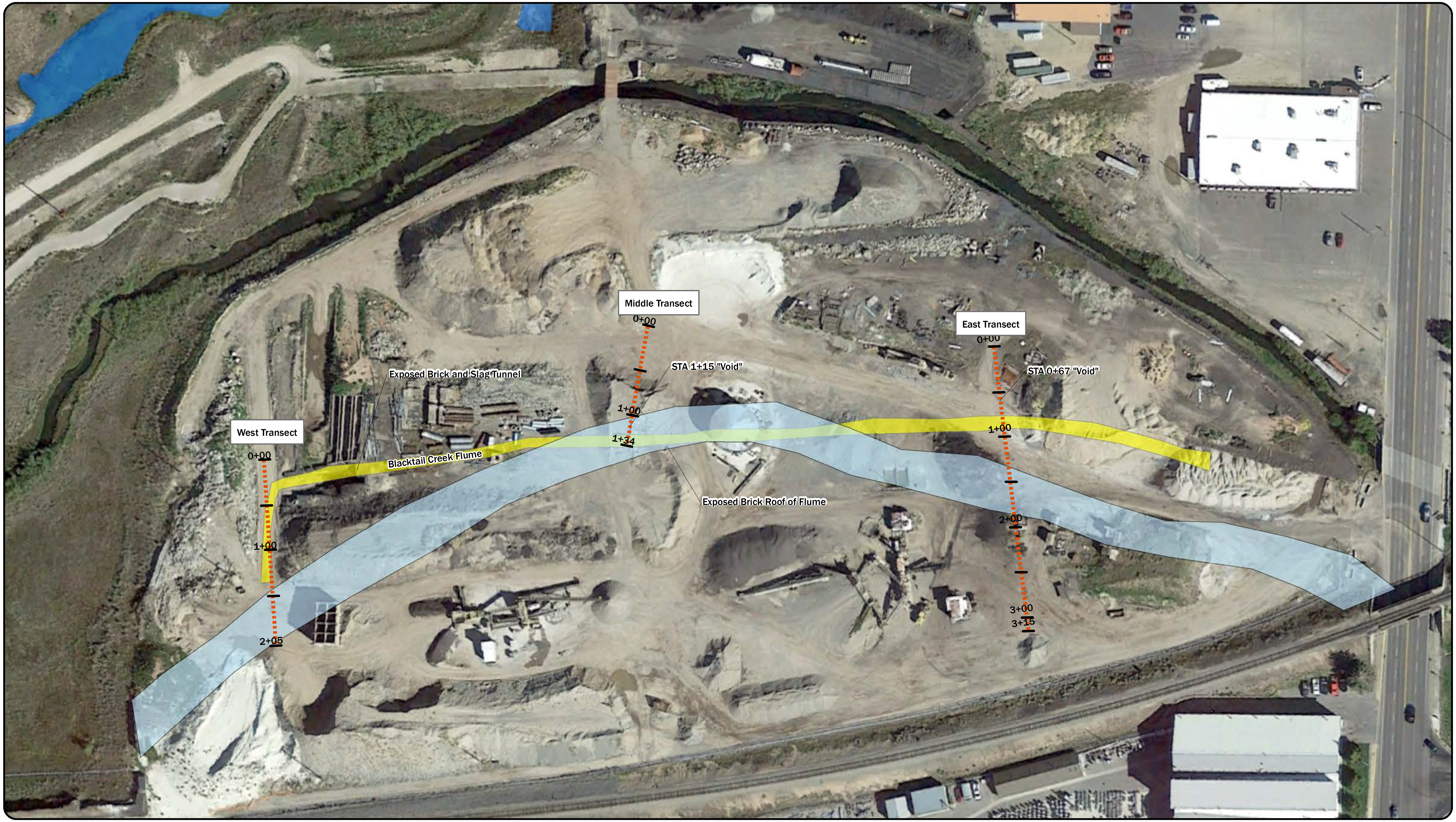
FIGURE 6

PIONEER TECHNICAL SERVICES, INC.

EXISTENCE OF DURABLE HISTORIC INFRASTRUCTURE WITHIN BUTTE REDUCTION WORKS SITE

DATE: 5/11/2021

Path: Z:\Shared\Active Projects\ARCO\BPSOU\BRW\GIS\Z_PDI Evaluation Report_PI\BRW_PI_PDIER_004_Infra_20.mxd



🟨 Blacktail Creek Flume (Sanborn, 1890)

🟦 Historic Silver Bow Creek Channel South Culvert (Baker and Harper, 1889)

Multichannel Analysis of Surface Waves (MASW) seismic survey alignments

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/GOOGLE

0 50 100 200
Feet

FIGURE 7

SUBSURFACE FLUME(S) / CULVERT(S) WITHIN THE SITE

PIONEER
TECHNICAL SERVICES, INC.

DATE: 8/2018

Path: Z:\Shared\Active Projects\ARCO\BPSOU\BRW\GIS\Z_PDI Evaluation Report_PI\BRW_PI_PDIER_003_Subflume_20.mxd

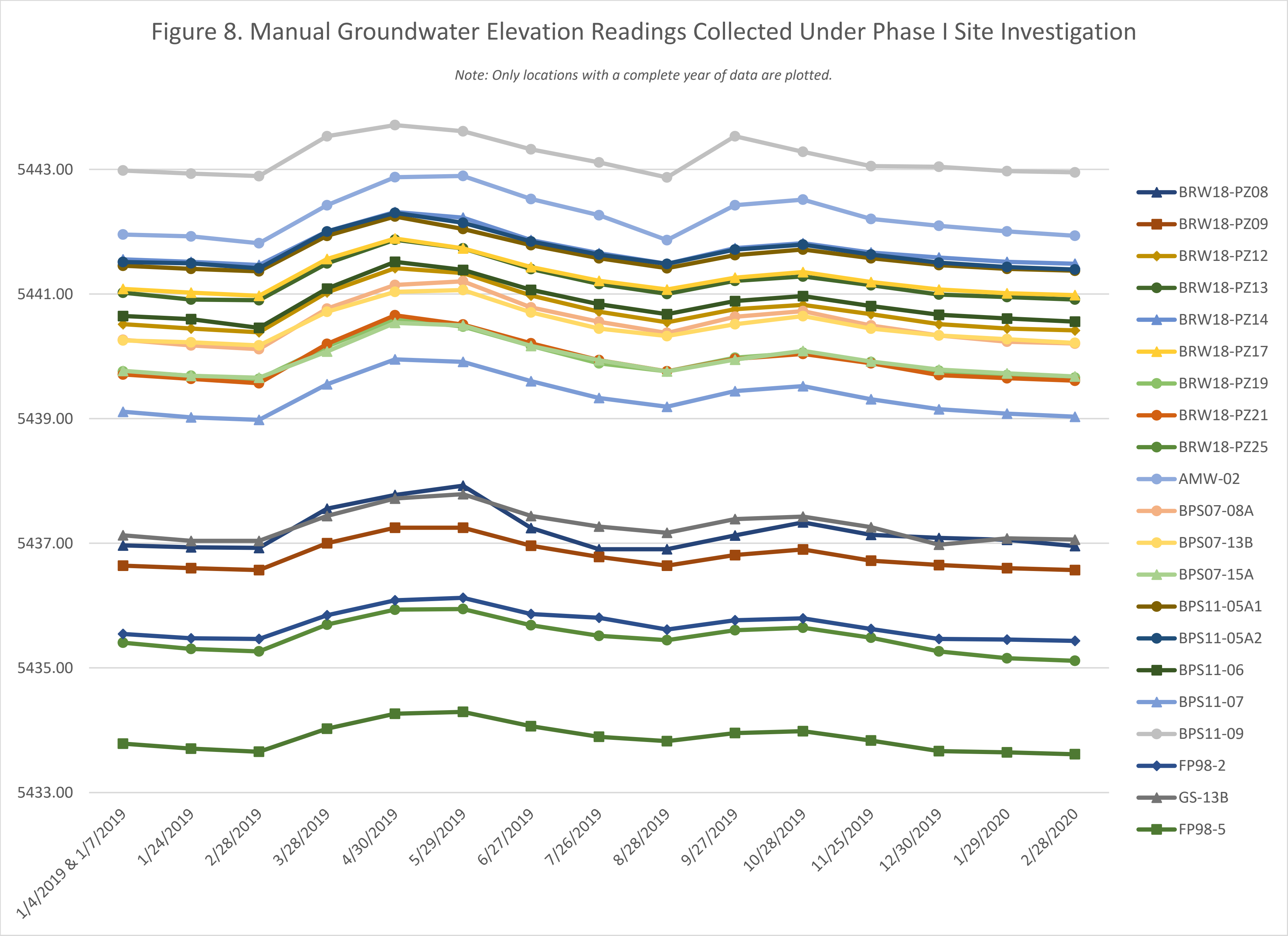


Figure 8. Manual Groundwater Elevation Readings Collected Under Phase I Site Investigation
Note: Only locations with a complete year of data are plotted.
5443.00
5441.00
5439.00
5437.00
5435.00
5433.00
1/4/2019 & 1/7/2019
1/24/2019
2/28/2019
3/28/2019
4/30/2019
5/29/2019
6/27/2019
7/26/2019
8/28/2019
9/27/2019
10/28/2019
11/25/2019
12/30/2019
1/29/2020
2/28/2020
BRW18-PZ08
BRW18-PZ09
BRW18-PZ12
BRW18-PZ13
BRW18-PZ14
BRW18-PZ17
BRW18-PZ19
BRW18-PZ21
BRW18-PZ25
AMW-02
BPS07-08A
BPS07-13B
BPS07-15A
BPS11-05A1
BPS11-05A2
BPS11-06
BPS11-07
BPS11-09
FP98-2
GS-13B
FP98-5

Contour Data Points

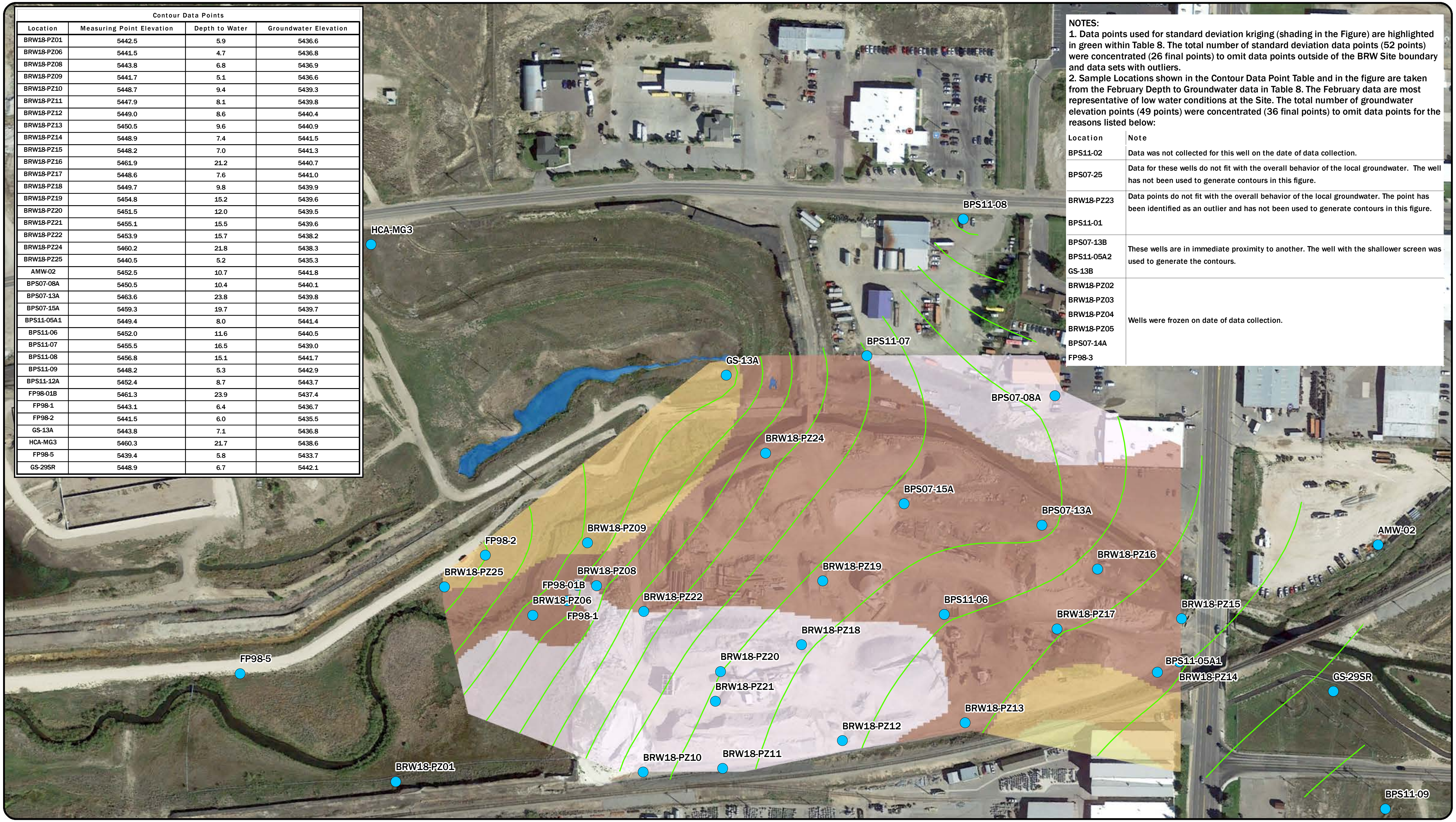
Location	Measuring Point Elevation	Depth to Water	Groundwater Elevation
BRW18-PZ01	5442.5	5.9	5436.6
BRW18-PZ06	5441.5	4.7	5436.8
BRW18-PZ08	5443.8	6.8	5436.9
BRW18-PZ09	5441.7	5.1	5436.6
BRW18-PZ10	5448.7	9.4	5439.3
BRW18-PZ11	5447.9	8.1	5439.8
BRW18-PZ12	5449.0	8.6	5440.4
BRW18-PZ13	5450.5	9.6	5440.9
BRW18-PZ14	5448.9	7.4	5441.5
BRW18-PZ15	5448.2	7.0	5441.3
BRW18-PZ16	5461.9	21.2	5440.7
BRW18-PZ17	5448.6	7.6	5441.0
BRW18-PZ18	5449.7	9.8	5439.9
BRW18-PZ19	5454.8	15.2	5439.6
BRW18-PZ20	5451.5	12.0	5439.5
BRW18-PZ21	5455.1	15.5	5439.6
BRW18-PZ22	5453.9	15.7	5438.2
BRW18-PZ24	5460.2	21.8	5438.3
BRW18-PZ25	5440.5	5.2	5435.3
AMW-02	5452.5	10.7	5441.8
BPS07-08A	5450.5	10.4	5440.1
BPS07-13A	5463.6	23.8	5439.8
BPS07-15A	5459.3	19.7	5439.7
BPS11-05A1	5449.4	8.0	5441.4
BPS11-06	5452.0	11.6	5440.5
BPS11-07	5455.5	16.5	5439.0
BPS11-08	5456.8	15.1	5441.7
BPS11-09	5448.2	5.3	5442.9
BPS11-12A	5452.4	8.7	5443.7
FP98-01B	5461.3	23.9	5437.4
FP98-1	5443.1	6.4	5436.7
FP98-2	5441.5	6.0	5435.5
GS-13A	5443.8	7.1	5436.8
HCA-MG3	5460.3	21.7	5438.6
FP98-5	5439.4	5.8	5433.7
GS-29SR	5448.9	6.7	5442.1

NOTES:

1. Data points used for standard deviation kriging (shading in the Figure) are highlighted in green within Table 8. The total number of standard deviation data points (52 points) were concentrated (26 final points) to omit data points outside of the BRW Site boundary and data sets with outliers.

2. Sample Locations shown in the Contour Data Point Table and in the figure are taken from the February Depth to Groundwater data in Table 8. The February data are most representative of low water conditions at the Site. The total number of groundwater elevation points (49 points) were concentrated (36 final points) to omit data points for the reasons listed below:

Location	Note
BPS11-02	Data was not collected for this well on the date of data collection.
BPS07-25	Data for these wells do not fit with the overall behavior of the local groundwater. The well has not been used to generate contours in this figure.
BRW18-PZ23 BPS11-01	Data points do not fit with the overall behavior of the local groundwater. The point has been identified as an outlier and has not been used to generate contours in this figure.
BPS07-13B BPS11-05A2 GS-13B	These wells are in immediate proximity to another. The well with the shallower screen was used to generate the contours.
BRW18-PZ02 BRW18-PZ03 BRW18-PZ04 BRW18-PZ05 BPS07-14A FP98-3	Wells were frozen on date of data collection.



LEGEND

● Sample Locations

— Feb. 2019 Groundwater Contours (NAVD 88) (1-foot interval)

STANDARD DEVIATION (FEET) IN DEPTH TO WATER

🟩	0.12' - 0.15'
🟨	0.15' - 0.2'
🟧	0.2' - 0.25'
🟫	0.25' - 0.3'
⬜	0.3' - 0.34'

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/CAD EARTH 2014

0 100 200 400
Feet

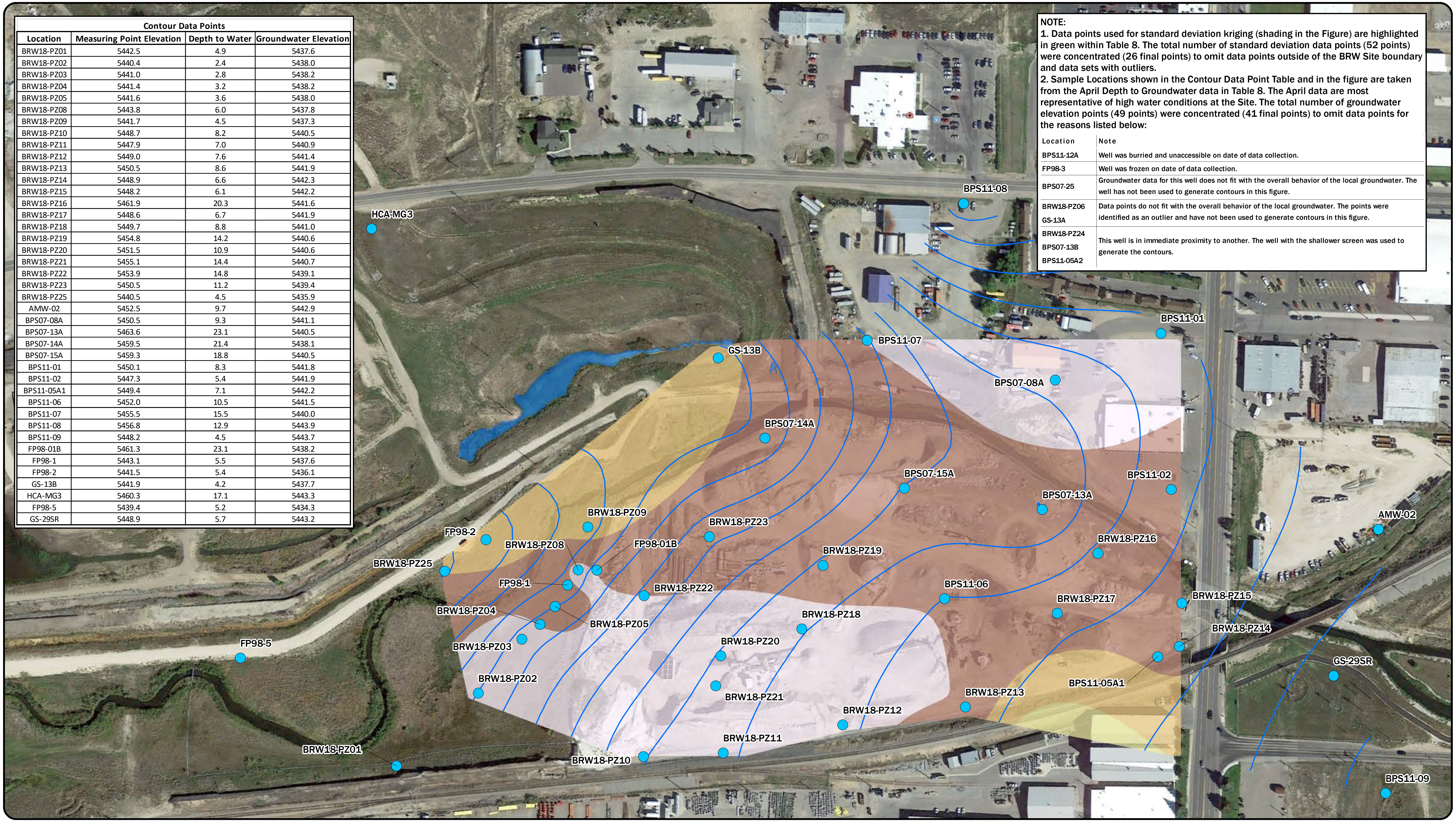
FIGURE 9

GROUNDWATER CONTOURS FOR LOW WATER CONDITIONS (FEB. 2019)

PIONEER TECHNICAL SERVICES, INC.

DATE: 5/12/2021

Path: Z:\Shared\Active Projects\ARCO\BPSOU\BRW\GIS\Z_PDI Evaluation Report_PI\BRW_PI_PDIER_007_GW_Low_20.mxd



Contour Data Points

Location	Measuring Point Elevation	Depth to Water	Groundwater Elevation
BRW18-PZ01	5442.5	4.9	5437.6
BRW18-PZ02	5440.4	2.4	5438.0
BRW18-PZ03	5441.0	2.8	5438.2
BRW18-PZ04	5441.4	3.2	5438.2
BRW18-PZ05	5441.6	3.6	5438.0
BRW18-PZ08	5443.8	6.0	5437.8
BRW18-PZ09	5441.7	4.5	5437.3
BRW18-PZ10	5448.7	8.2	5440.5
BRW18-PZ11	5447.9	7.0	5440.9
BRW18-PZ12	5449.0	7.6	5441.4
BRW18-PZ13	5450.5	8.6	5441.9
BRW18-PZ14	5448.9	6.6	5442.3
BRW18-PZ15	5448.2	6.1	5442.2
BRW18-PZ16	5461.9	20.3	5441.6
BRW18-PZ17	5448.6	6.7	5441.9
BRW18-PZ18	5449.7	8.8	5441.0
BRW18-PZ19	5454.8	14.2	5440.6
BRW18-PZ20	5451.5	10.9	5440.6
BRW18-PZ21	5455.1	14.4	5440.7
BRW18-PZ22	5453.9	14.8	5439.1
BRW18-PZ23	5450.5	11.2	5439.4
BRW18-PZ25	5440.5	4.5	5435.9
AMW-02	5452.5	9.7	5442.9
BPS07-08A	5450.5	9.3	5441.1
BPS07-13A	5463.6	23.1	5440.5
BPS07-14A	5459.5	21.4	5438.1
BPS07-15A	5459.3	18.8	5440.5
BPS11-01	5450.1	8.3	5441.8
BPS11-02	5447.3	5.4	5441.9
BPS11-05A1	5449.4	7.1	5442.2
BPS11-06	5452.0	10.5	5441.5
BPS11-07	5455.5	15.5	5440.0
BPS11-08	5456.8	12.9	5443.9
BPS11-09	5448.2	4.5	5443.7
FP98-01B	5461.3	23.1	5438.2
FP98-1	5443.1	5.5	5437.6
FP98-2	5441.5	5.4	5436.1
GS-13B	5441.9	4.2	5437.7
HCA-MG3	5460.3	17.1	5443.3
FP98-5	5439.4	5.2	5434.3
GS-29SR	5448.9	5.7	5443.2

NOTE:

1. Data points used for standard deviation kriging (shading in the Figure) are highlighted in green within Table 8. The total number of standard deviation data points (52 points) were concentrated (26 final points) to omit data points outside of the BRW Site boundary and data sets with outliers.
2. Sample Locations shown in the Contour Data Point Table and in the figure are taken from the April Depth to Groundwater data in Table 8. The April data are most representative of high water conditions at the Site. The total number of groundwater elevation points (49 points) were concentrated (41 final points) to omit data points for the reasons listed below:

Location	Note
BPS11-12A	Well was burried and unaccessible on date of data collection.
FP98-3	Well was frozen on date of data collection.
BPS07-25	Groundwater data for this well does not fit with the overall behavior of the local groundwater. The well has not been used to generate contours in this figure.
BRW18-PZ06 GS-13A	Data points do not fit with the overall behavior of the local groundwater. The points were identified as an outlier and have not been used to generate contours in this figure.
BRW18-PZ24 BPS07-13B BPS11-05A2	This well is in immediate proximity to another. The well with the shallower screen was used to generate the contours.

LEGEND

● Sample Locations

April 2019 Groundwater Contours (NAVD 88) (1-foot interval)

STANDARD DEVIATION (FEET) IN DEPTH TO WATER

🟩 0.12' - 0.15'
🟨 0.15' - 0.2'
🟧 0.2' - 0.25'
🟫 0.25' - 0.3'
⬜ 0.3' - 0.34'

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/CAD EARTH 2014

0 100 200 400
Feet

FIGURE 10

GROUNDWATER CONTOURS FOR HIGH WATER CONDITIONS (APRIL 2019)

PIONEER TECHNICAL SERVICES, INC.

DATE: 5/12/2021

Path: Z:\Shared\Active Projects\ARCO\BPSOU\BRW\GIS\Z_PDI Evaluation Report_PI\BRW_PI_PDIER_020_GW_Hi_20.mxd

Notes:

(1) Hardness of 138 mg/L was used for Chronic Aquatic Life Standard.

(2) Groundwater concentrations are compared to Groundwater Standards (2006 ROD, Table 8-1). Groundwater concentrations are also compared to In-Stream Chronic Surface Water Performance Standards (2020 ROD Amendment, Table 1) for the purposes of designing the hydraulic control.

(3) Only those locations sampled during 2018 as part of the Stage 1: Initial Site Investigation are shown on figure.

- 🔵 Below CD Chronic Standard
- 🟢 Above CD Chronic Surface Water Standard
- 🔴 Above CD Chronic Surface Water Standard and Groundwater Standard

LABEL KEY

🔵 BRW18-PZ15 = Piezometer Name

🟢 BRW18-PZ10 = Piezometer Name
Cd-Cu = Elements Above CD Chronic Surface Water Standard

🔴 BRW18-PZ09 = Piezomenter Name
Cu-Fe-Zn = Elements Above CD Chronic Surface Water Standard Only
As-Cd = Elements Above Groundwater Standard

April 2019 Groundwater Contours (NAVD 88)
Feb. 2019 Groundwater Contours (NAVD 88)

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTN'L FT
SOURCE: PIONEER/CAD EARTH 2014

0 75 150 300
Feet

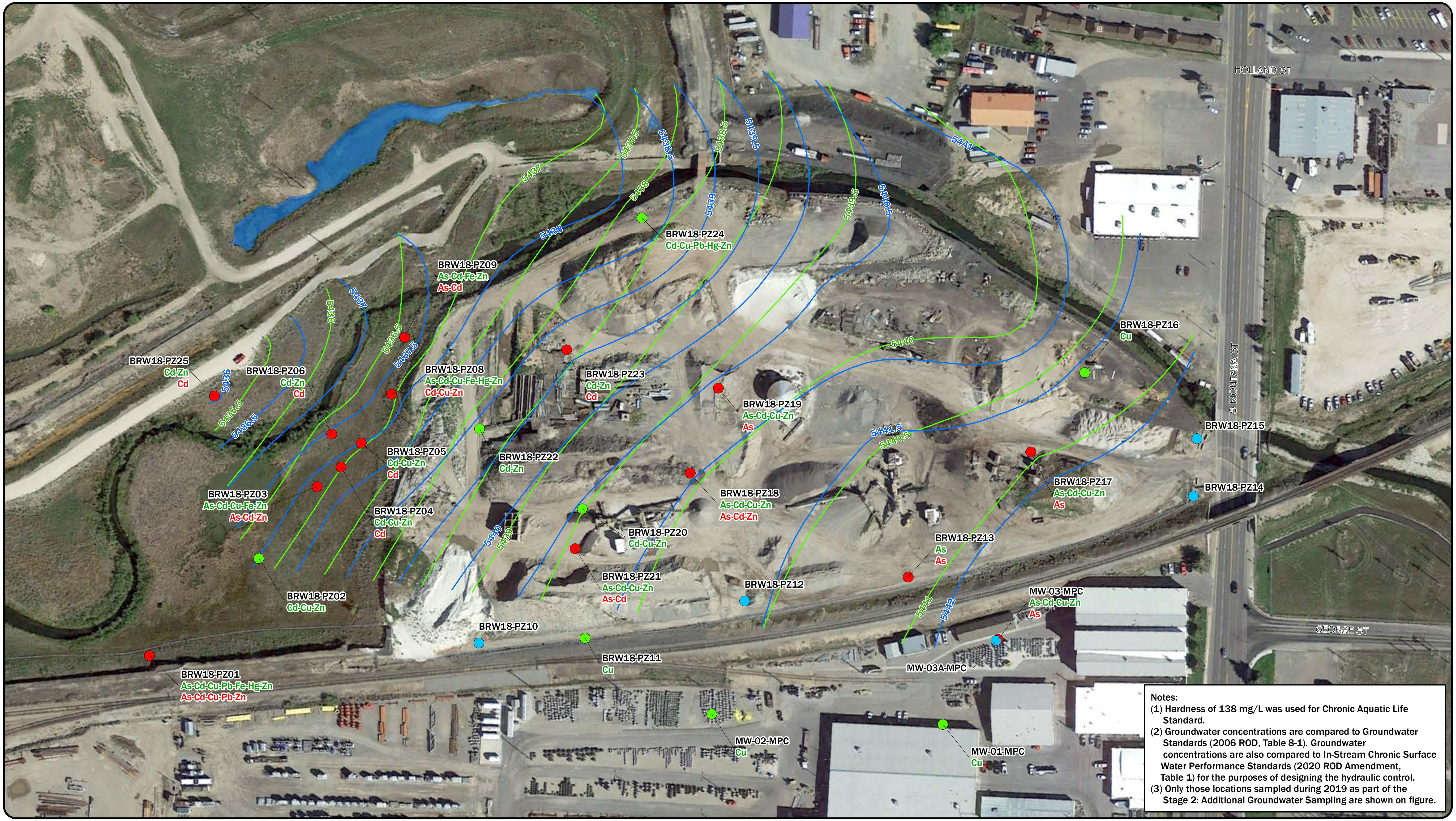
FIGURE 11

COMPARING 2018 GW QUALITY TO CONSENT DECREE STANDARDS

PIONEER TECHNICAL SERVICES, INC.

DATE: 5/12/2021

Path: Z:\Shared\Active Projects\ARCO\BPSOU\BRW\GIS\Z_PDI Evaluation Report_PI\BRW_PI_PDIER_012_2018Comp_20.mxd



Notes:

(1) Hardness of 138 mg/L was used for Chronic Aquatic Life Standard.

(2) Groundwater concentrations are compared to Groundwater Standards (2006 ROD, Table 8-1). Groundwater concentrations are also compared to In-Stream Chronic Surface Water Performance Standards (2020 ROD Amendment, Table 1) for the purposes of designing the hydraulic control.

(3) Only those locations sampled during 2019 as part of the Stage 2: Additional Groundwater Sampling are shown on figure.

🔵 Below CD Chronic Standard

🟢 Above CD Chronic Surface Water Standard

🔴 Above CD Chronic Surface Water Standard and Groundwater Standard

LABEL KEY

🔵 BRW18-PZ15 = Piezometer Name

🟢 BRW18-PZ10 = Piezometer Name
Cd-Cu = Elements Above CD Chronic Surface Water Standard

🔴 BRW18-PZ09 = Piezomenter Name
Cu-Fe-Zn = Elements Above CD Chronic Surface Water Standard Only
As-Cd = Elements Above Groundwater Standard

April 2019 Groundwater Contours (NAVD 88)

Feb. 2019 Groundwater Contours (NAVD 88)

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTN'L FT
SOURCE: PIONEER/CAD EARTH 2014

0 75 150 300
Feet

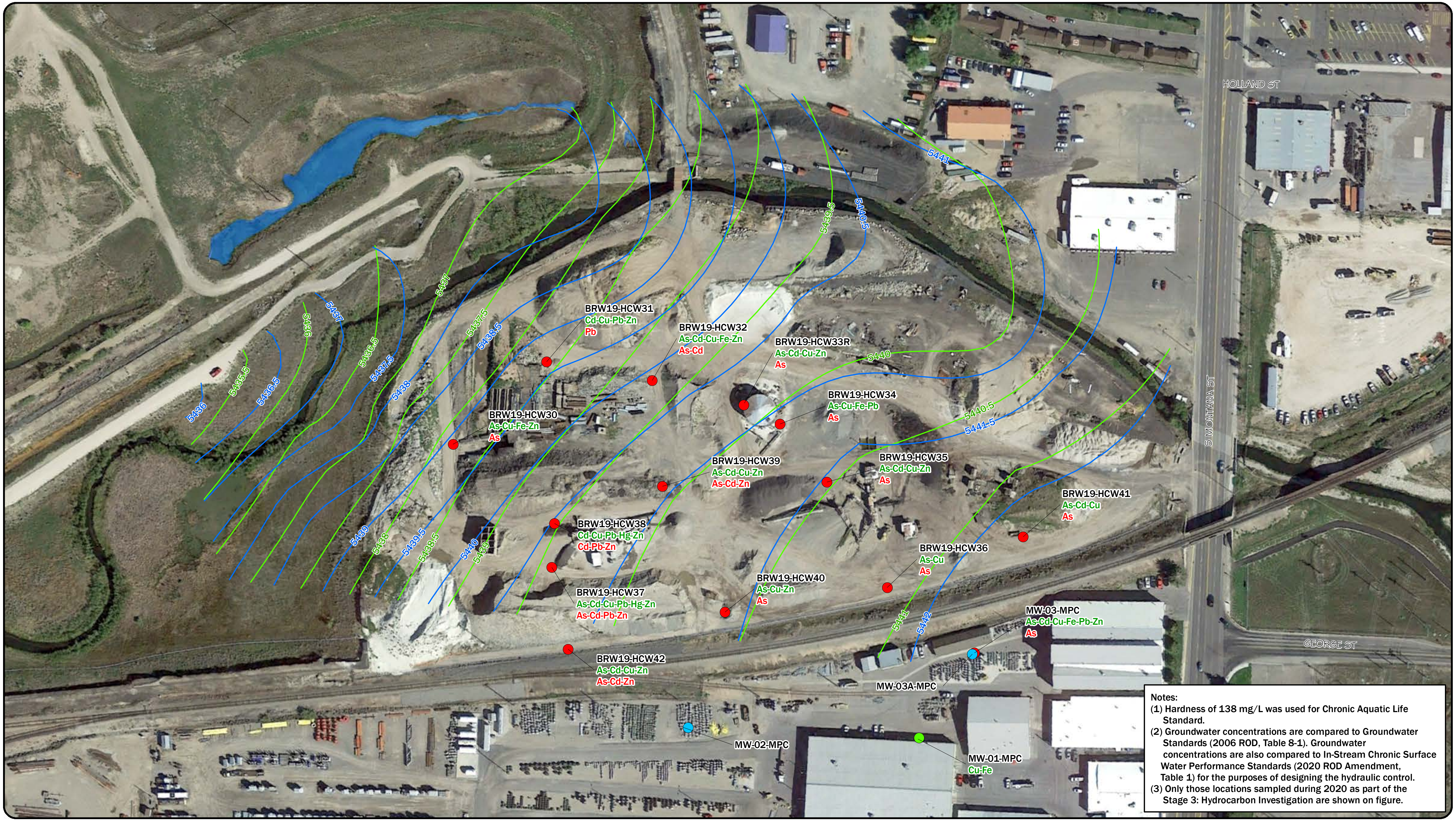
FIGURE 12

COMPARING 2019 GW QUALITY TO CONSENT DECREE STANDARDS

PIONEER TECHNICAL SERVICES, INC.

DATE: 5/12/2021

Path: Z:\Shared\Active Projects\ARCO\BPSOU\BRW\GIS\Z_PDI Evaluation Report_PI\BRW_PI_PDIER_013_2019Comp_20.mxd



Notes:
(1) Hardness of 138 mg/L was used for Chronic Aquatic Life Standard.
(2) Groundwater concentrations are compared to Groundwater Standards (2006 ROD, Table 8-1). Groundwater concentrations are also compared to In-Stream Chronic Surface Water Performance Standards (2020 ROD Amendment, Table 1) for the purposes of designing the hydraulic control.
(3) Only those locations sampled during 2020 as part of the Stage 3: Hydrocarbon Investigation are shown on figure.

● Below CD Chronic Standard
● Above CD Chronic Surface Water Standard
● Above CD Chronic Surface Water Standard and Groundwater Standard

LABEL KEY
● BRW18-PZ15 = Piezometer Name
● BRW18-PZ10 = Piezometer Name
Cd-Cu = Elements Above CD Chronic Surface Water Standard
● BRW18-PZ09 = Piezomenter Name
Cu-Fe-Zn = Elements Above CD Chronic Surface Water Standard Only
As-Cd = Elements Above Groundwater Standard

April 2019 Groundwater Contours (NAVD 88)
Feb. 2019 Groundwater Contours (NAVD 88)

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTN'L FT
SOURCE: PIONEER/CAD EARTH 2014

0 75 150 300
Feet

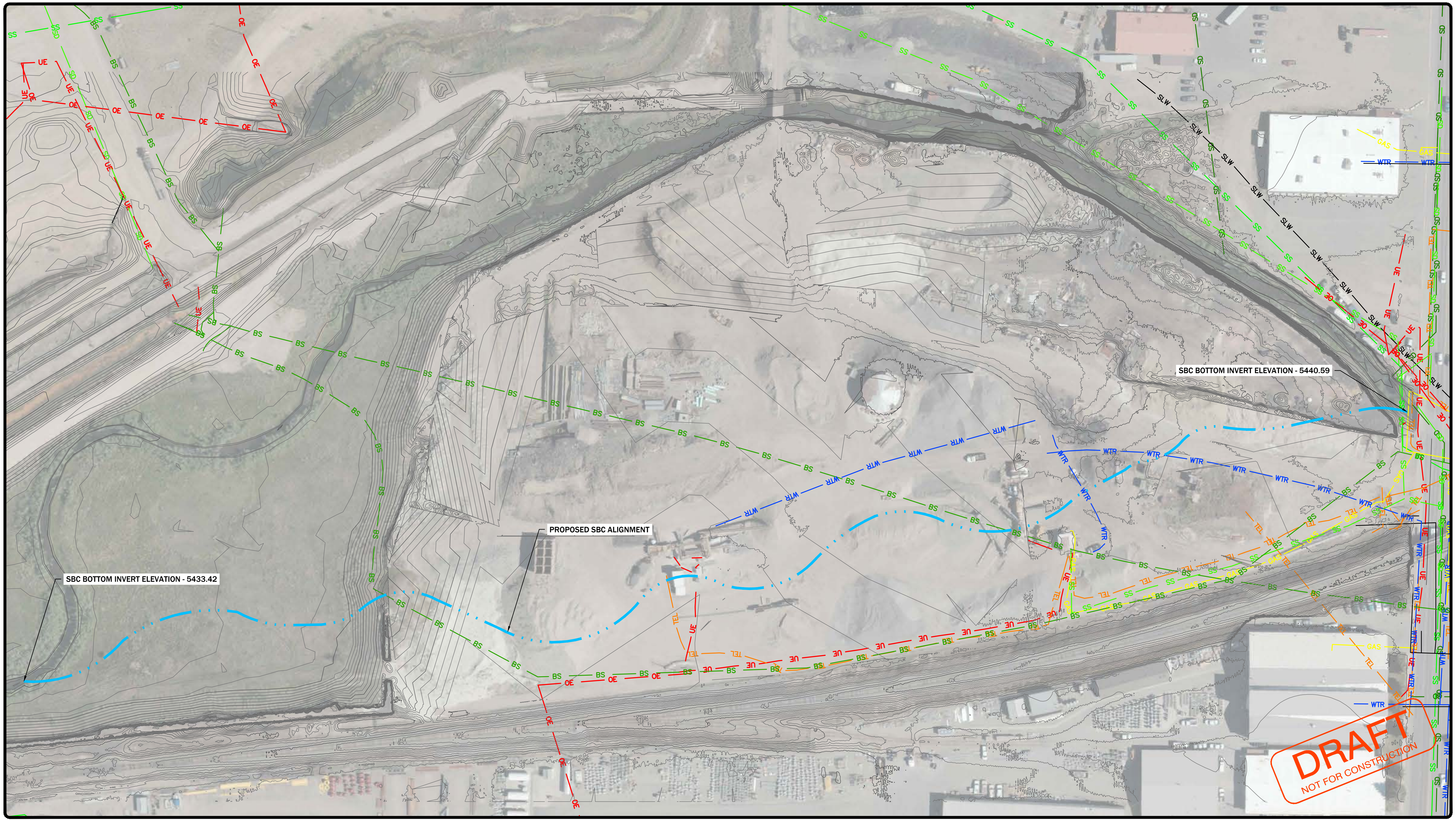
FIGURE 13

COMPARING 2020 GW QUALITY TO CONSENT DECREE STANDARDS

PIONEER TECHNICAL SERVICES, INC.

DATE: 5/12/2021

Path: Z:\Shared\Active Projects\ARCO\BPSOU\BRW\GIS\Z_PDI Evaluation Report_PI\BRW_PI_PDIER_014_2020Comp_20.mxd



LEGEND:

BS	BPSOU SUBDRAIN LINE
WTR	WATER LINE
GAS	GAS LINE
TEL	TELEPHONE LINE
UE	UNDERGROUND ELECTRIC LINE
SLW	SILVER LAKE WATER LINE
SS	SANITARY SEWER LINE
SD	STORM DRAIN LINE
OE	OVERHEAD ELECTRIC LINE

NOTE:

1. UTILITY LOCATIONS SHOW ARE APPROXIMATE. THE APPROXIMATE UTILITY LOCATIONS SHOWN ARE BASED ON PHOTOGRAMMETRY, RECORDS PROVIDED BY THE UTILITY OWNERS, THIRD PARTY UTILITY LOCATES, AND/OR POTHOLE ACTIVITIES. ALL UTILITY LOCATIONS SHOWN ARE LIMITED TO THE ACCURACY OF THE LOCATION METHODS. ADDITIONAL UTILITY VERIFICATION WILL BE REQUIRED TO FURTHER DEFINE THE UTILITY LOCATIONS AS NECESSARY TO COMPLETE THE FUTURE REMEDIAL ACTION WORK.
2. THE CONTOURS SHOWN ON THIS FIGURE DO NOT REPRESENT CURRENT CONDITIONS. THESE CONTOURS ESTIMATE THE GROUND SURFACE FOLLOWING THE REMOVAL OF MATERIALS IMPORTED BY BUTTE-SILVER BOW.

N

DISPLAYED AS:
COORD SYS/ZONE: MSP
DATUM: NAD 83
UNITS: FEET
SOURCE: PIONEER

SCALE IN FEET
0 60 120

FIGURE 14

PIONEER
TECHNICAL SERVICES, INC.
1101 SOUTH MONTANA
BUTTE, MONTANA 59701
(406) 782-5177

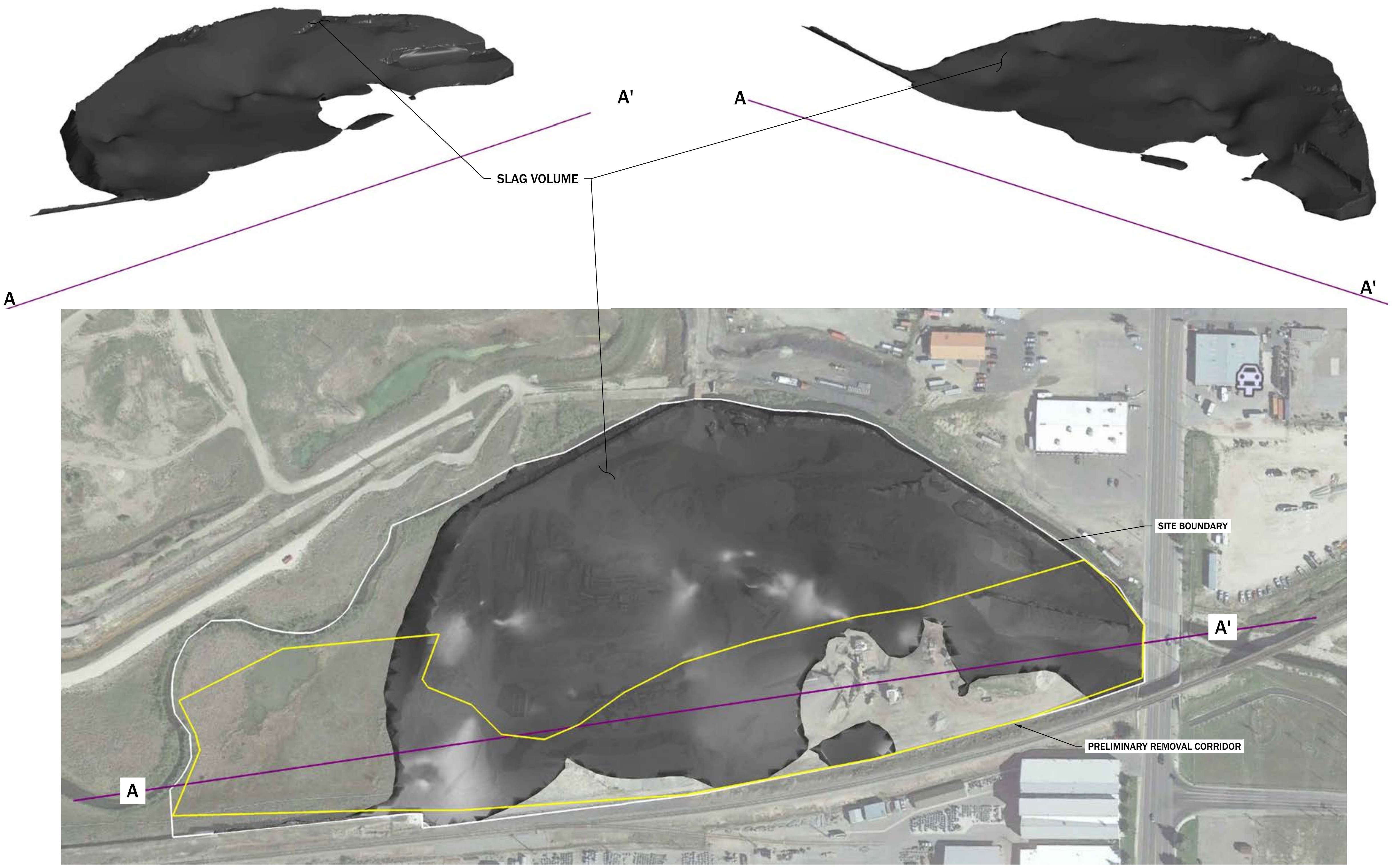
SITE SURVEY
AND
UTILITIES

DATE: 4/2021

4/19/2021 12:55:32 PM Z:\SHARED\ACTIVE PROJECTS\ARCO\BPSOU\BRW\CADD\FIGURES\BRW-30-CO-PLN-003-19.DWG

ROTATED VIEW 1 (A-A')

ROTATED VIEW 2 (A-A')



NOTE:

1. THIS FIGURE AND MODELED VOLUMES WERE GENERATED USING LEAPFROG WORKS. THE VOLUME IS A MODELED APPROXIMATION BASED ON THE BOREHOLE AND TEST PIT DATA COLLECTED DURING THE BRW PHASE I SITE INVESTIGATION AS WELL AS OBSERVATIONS FROM PREVIOUS INVESTIGATIONS AND THE INSTALLATION OF OLDER MONITORING WELLS. THE ROTATED VIEWS HAVE BEEN SCALED SO THE ELEVATION (Z) AXIS IS 5 TIMES GREATER THAN THE NORTHING (Y) AND EASTING (X) AXES.
2. THE PROPOSED REMOVAL CORRIDOR SHOWN IS PRELIMINARY AND ONLY SHOWN AS A REFERENCE AT THIS POINT. THE REMOVAL CORRIDOR AND EXCAVATION SURFACE WILL BE REFINED FURTHER DURING THE REMEDIAL DESIGN AND WILL BE SUBMITTED FOR AGENCIES' REVIEW AND APPROVAL.

N

	DISPLAYED AS:
COORD SYS/ZONE:	NA
DATUM:	NA
UNITS:	NA
SOURCE:	PIONEER/GOOGLE

SCALE IN FEET
0 N.T.S.

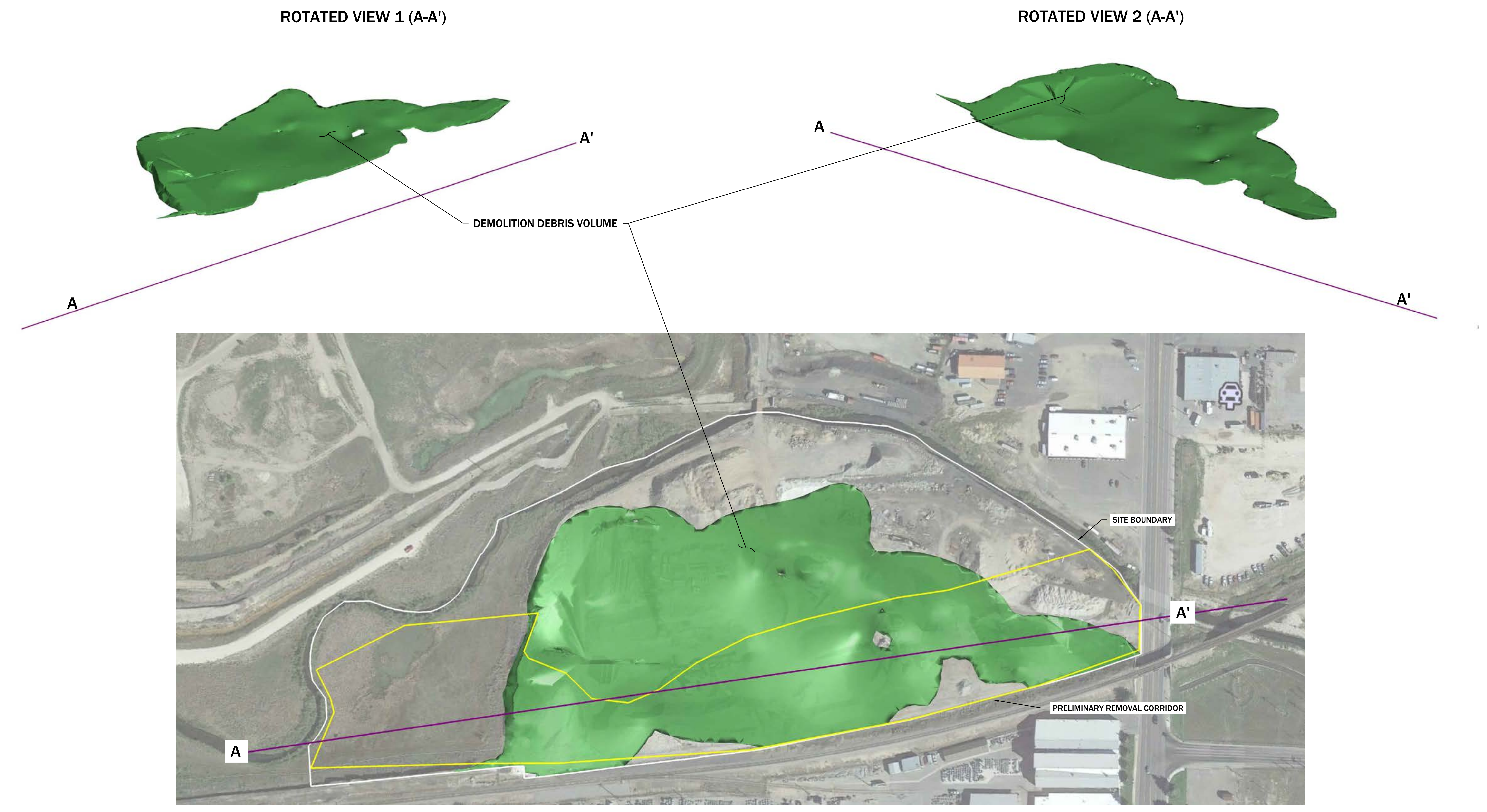
FIGURE 15

PIONEER
TECHNICAL SERVICES, INC.
1101 SOUTH MONTANA
BUTTE, MONTANA 59701
(406) 782-5177

SLAG DISTRIBUTION WITHIN THE SITE

DATE: 5/2021

5/11/2021 4:26:19 PM Z:\SHARED\ACTIVE PROJECTS\ARCO\BPSOU\BRW\CADD\FIGURES\BRW_FG_PLN-002-20.DWG



NOTE:

1. THIS FIGURE AND MODELED VOLUMES WERE GENERATED USING LEAPFROG WORKS. THE VOLUME IS A MODELED APPROXIMATION BASED ON THE BOREHOLE AND TEST PIT DATA COLLECTED DURING THE BRW PHASE I SITE INVESTIGATION AS WELL AS OBSERVATIONS FROM PREVIOUS INVESTIGATIONS AND THE INSTALLATION OF OLDER MONITORING WELLS. THE ROTATED VIEWS HAVE BEEN SCALED SO THE ELEVATION (Z) AXIS IS 5 TIMES GREATER THAN THE NORTHING (Y) AND EASTING (X) AXES.
2. THE PROPOSED REMOVAL CORRIDOR SHOWN IS PRELIMINARY AND ONLY SHOWN AS A REFERENCE AT THIS POINT. THE REMOVAL CORRIDOR AND EXCAVATION SURFACE WILL BE REFINED FURTHER DURING THE REMEDIAL DESIGN AND WILL BE SUBMITTED FOR AGENCIES' REVIEW AND APPROVAL.

N

DISPLAYED AS:	
COORD SYS/ZONE:	NA
DATUM:	NA
UNITS:	NA
SOURCE:	PIONEER/GOOGLE

SCALE IN FEET
0 N.T.S.

FIGURE 16

PIONEER
TECHNICAL SERVICES, INC.
1101 SOUTH MONTANA
BUTTE, MONTANA 59701
(406) 782-5177

DEMOLITION DEBRIS DISTRIBUTION WITHIN THE SITE

DATE: 5/2021

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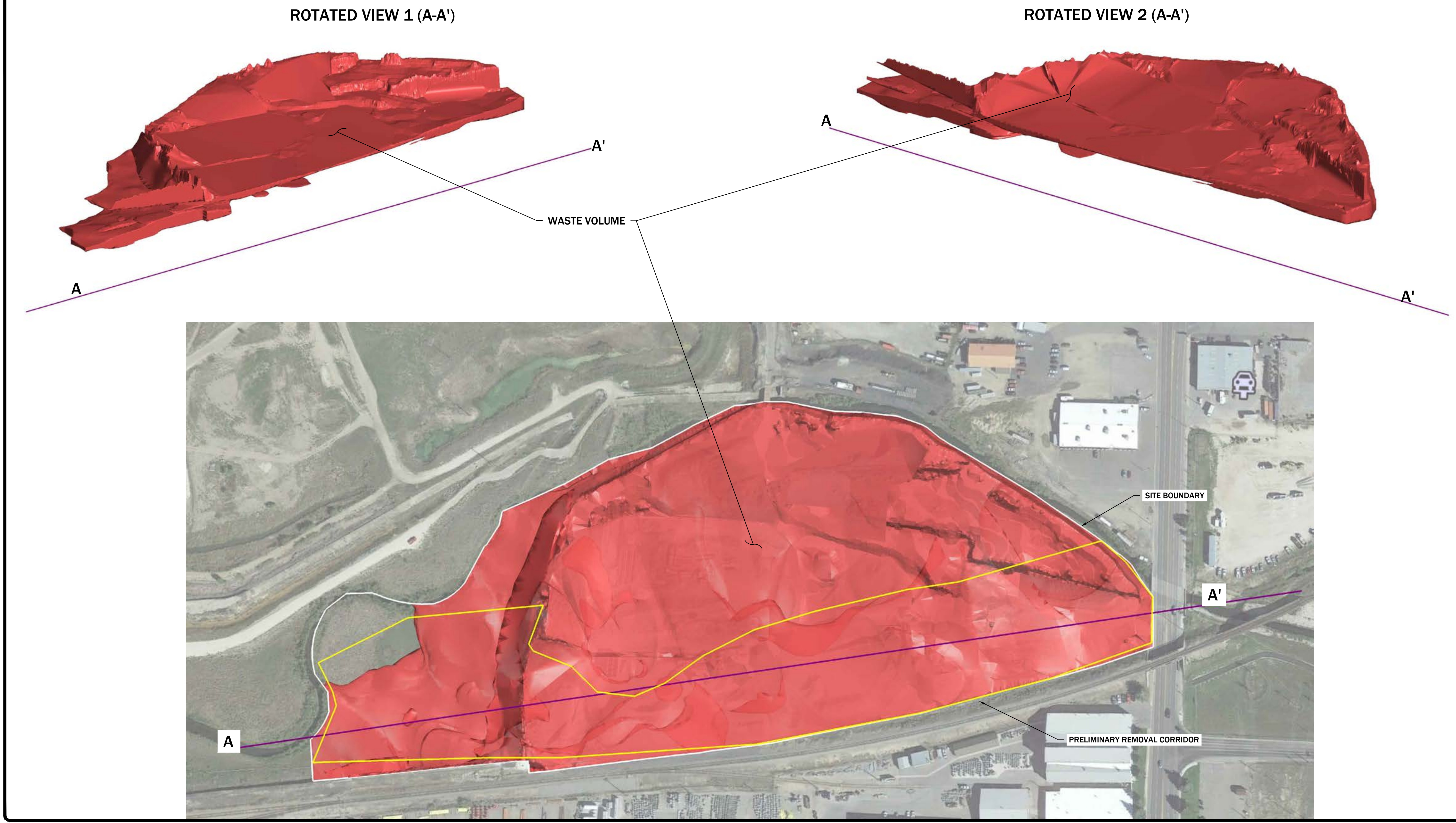

NOTE:

1. THIS FIGURE AND MODELED VOLUMES WERE GENERATED USING LEAPFROG WORKS. THE VOLUME IS A MODELED APPROXIMATION BASED ON THE BOREHOLE AND TEST PIT DATA COLLECTED DURING THE BRW PHASE I SITE INVESTIGATION AS WELL AS OBSERVATIONS FROM PREVIOUS INVESTIGATIONS AND THE INSTALLATION OF OLDER MONITORING WELLS. THE ROTATED VIEWS HAVE BEEN SCALED SO THE ELEVATION (Z) AXIS IS 5 TIMES GREATER THAN THE NORTHING (Y) AND EASTING (X) AXES.
2. THE PROPOSED REMOVAL CORRIDOR SHOWN IS PRELIMINARY AND ONLY SHOWN AS A REFERENCE AT THIS POINT. THE REMOVAL CORRIDOR AND EXCAVATION SURFACE WILL BE REFINED FURTHER DURING THE REMEDIAL DESIGN AND WILL BE SUBMITTED FOR AGENCIES' REVIEW AND APPROVAL.
3. "WASTE" IN THIS FIGURE IS DEFINED AS MATERIAL THAT HAS CONCENTRATIONS ABOVE THE WASTE IDENTIFICATION CRITERIA IN THE BPSOU CD (TABLE 1). ONLY WASTE WITHIN THE PRELIMINARY REMOVAL CORRIDOR WILL BE REMOVED, IF PRACTICABLE.

	DISPLAYED AS:
COORD SYS/ZONE:	NA
DATUM:	NA
UNITS:	NA
SOURCE:	PIONEER/GOOGLE

SCALE IN FEET
0 N.T.S.

FIGURE 17

PIONEER
TECHNICAL SERVICES, INC.
1101 SOUTH MONTANA
BUTTE, MONTANA 59701
(406) 782-5177

WASTE DISTRIBUTION WITHIN THE SITE

DATE: 5/2021

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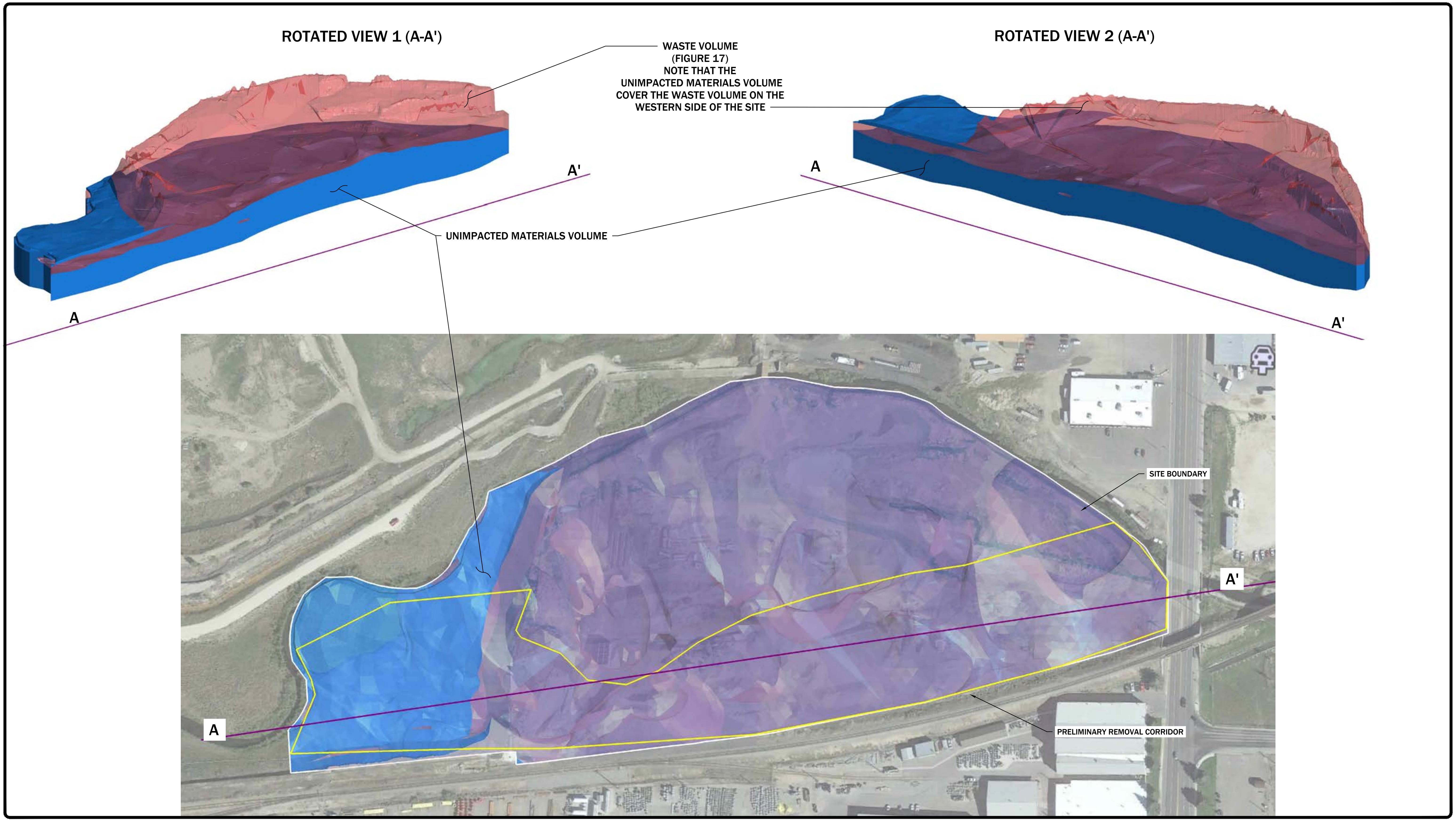

NOTE:

1. THIS FIGURE AND MODELED VOLUMES WERE GENERATED USING LEAPFROG WORKS. THE VOLUME IS A MODELED APPROXIMATION BASED ON THE BOREHOLE AND TEST PIT DATA COLLECTED DURING THE BRW PHASE I SITE INVESTIGATION AS WELL AS OBSERVATIONS FROM PREVIOUS INVESTIGATIONS AND THE INSTALLATION OF OLDER MONITORING WELLS. THE ROTATED VIEWS HAVE BEEN SCALED SO THE ELEVATION (Z) AXIS IS 5 TIMES GREATER THAN THE NORTHING (Y) AND EASTING (X) AXES.
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N

DISPLAYED AS:
COORD SYS/ZONE: NA
DATUM: NA
UNITS: NA
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 N.T.S.

FIGURE 18

UNIMPACTED MATERIALS DISTRIBUTION WITHIN THE SITE

PIONEER
TECHNICAL SERVICES, INC.
1101 SOUTH MONTANA
BUTTE, MONTANA 59701
(406) 782-5177

DATE: 5/2021

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PHASE I LOCATIONS
- 🟠 Phase I Borehole
- 🔵 Phase I Piezometer
- 🟢 Phase I Test Pit

HYDROCARBON INVESTIGATION
- ◎ Hydrocarbon Piezometer
- ⊙ Hydrocarbon Test Pit

PHASE II LOCATIONS
- ⊙ Pumping Test Piezometer
- ⊙ Southern Boundary Piezometer
- ⊙ Paired Piezometer
- ⊕ Pumping Well

PROPOSED PHASE III LOCATIONS
- ◆ Phase III Waste Characterization Boreholes
- ● Geotech Analysis Boreholes
- ○ Phase III Piezometers*

▨ Preliminary Waste Removal Corridor

*Solid material characterization information collected during the installation of the Phase III Piezometers will be used only to inform the design of the BRW hydraulic control.

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTN'L FEET
SOURCE: PIONEER/CADEARTH 2014

0 75 150 300
Feet

FIGURE 19

PIONEER TECHNICAL SERVICES, INC.

PHASE I, PHASE II AND PHASE III SITE INVESTIGATION POINTS

DATE: 5/12/2021

Path: Z:\Shared\Active Projects\ARCO\BPSOU\BRW\GIS\Z_PDI Evaluation Report_PI\BRW_PI_PDIER_017_PII_PIII_20.mxd

TABLES

Table 1
Waste Identification Criteria

If three of the six contaminant criteria listed are exceeded or any one contaminant is above 5,000 mg/kg then, the material is considered tailings, waste, or contaminated soil.

Arsenic	200 mg/kg
Cadmium	20 mg/kg
Copper	1,000 mg/kg
Lead	1,000 mg/kg
Mercury	10 mg/kg
Zinc	1,000 mg/kg
Any single analyte above 5,000 mg/kg	

From Field Screen Criteria and Procedures Phase 7 and 8 Remedial Action, SSTOU Subareas 4, Reach R and S (Pioneer 2011). Four of six contaminants need to be below the criteria for area to pass (see DEQ’s “Field Screening Criteria and Procedures Remedial Action SSTOU Subarea 3, Reaches M, N, & O” (January 2013)

Table 2. Data Gaps Summary

Data Gap Categories	Objectives	Phase I Site Investigation	Additional GW Sampling	Hydrocarbon Investigation	Phase II Site Investigation	Supplemental GW & SW Sampling	Phase III Site Investigation	Phase I Site Investigation (Phase I QAPP)	Additional Groundwater Sampling (Phase I QAPP, RFC 01)	Hydrocarbon Investigation (Phase I QAPP, RFC 03)	Phase II Site Investigation (Phase II QAPP)	Supplemental Groundwater and Surface Water Sampling (Phase II QAPP, RFC 01 and RFC 02)	Phase III Site Investigation (Phase III QAPP)
Solid Material Characterization	Volume and Distribution of Solid Materials												
	Slag	O		O	✓		+	**Laboratory and XRF data, soil lithology logs, and photographic logs from test pits and boreholes were used to determine the volume and distribution of solid materials within the BRW Site.**	**NA**	**Laboratory and XRF data, soil lithology logs, and photographic logs from hydrocarbon monitoring well boreholes and test pits were used to augment and refine the volume and distribution of solid materials within the BRW Site.**	Laboratory and XRF data, soil lithology logs, and photographic logs from new piezometer boreholes and slag investigation test pits were used to augment and refine the volume and distribution of solid materials within the BRW Site.	NA	A final series of boreholes will be constructed to fill any design-related data gaps pertaining to the volume and distribution of impacted materials within the BRW site.
	Demolition Debris	✓		+	+		+						
	Impacted Materials (including Tailings, Alluvium, and Organic Soils)	O		O	O		✓						
	Unimpacted Materials	✓		+	+		+						
	Properties of Solid Materials												
	Metals Concentrations	O		O	O		✓	**The test pit and borehole samples were analyzed using an XRF field unit. Select samples were sent for laboratory ICP (metals concentrations) and SPLP analysis (leachability).**	**NA**	**Test pit and borehole samples were analyzed using an XRF field unit. Select samples were sent for laboratory ICP (metals concentrations) analyses.**	Borehole samples were analyzed using an XRF field unit or sent for laboratory ICP analysis. Select samples were sent for laboratory SPLP (leachability) analyses.	NA	Borehole samples will be analyzed using an XRF field unit or sent for laboratory ICP analysis. Select samples will be sent for laboratory SPLP (leachability) analyses.
	Leachability of Metals	O			✓		+						
	Constructability Considerations												
	Geotechnical Considerations				O		✓	**NA**	**NA**	**NA**	The slag investigation collected data on the physical parameters of the slag and examined means of removing the slag.	NA	Additional boreholes will be drilled during a geotechnical investigation to determine properties of the underlying soil and then evaluate the geotechnical requirements of the end-land use plan and excavation design.
	Location of Subsurface Flume/Culvert	✓						**The geophysical MASW Seismic Survey confirmed the existence and location of the subsurface flume/culvert.**			NA		NA
	Remaining Infrastructure	✓						**Measurements and photographs documented the remaining infrastructure at the BRW Site. Observations from test pits were used to determine the existence of any durable historic infrastructure.**					
Groundwater Characterization and Hydraulic Control	Chemistry and Spatial Variability	O	O	O	O	O	✓	**Laboratory results from groundwater samples collected from newly installed piezometers were used to determine the spatial variability of the groundwater chemistry within the BRW Site. Low-flow sampling parameters were used to estimate the hydraulic conductivity of the screened aquifer interval. Monthly groundwater levels and transducer data were used to evaluate groundwater elevations, potentiometric surfaces, and seasonal groundwater change. Lithology logs from the piezometer construction and groundwater elevations were used to determine the aquifer geometry.**	**Additional groundwater sampling and laboratory analyses of the Phase I piezometers and select upgradient existing monitoring wells were used to augment and refine the spatial variability of the groundwater chemistry, the hydraulic conductivity of the screened aquifer. Manual groundwater level measurements were used to augment and refine the groundwater elevations, potentiometric surfaces, and seasonal groundwater change.**	**Laboratory results from groundwater samples collected from newly installed hydrocarbon monitoring wells and existing monitoring wells were used to augment and refine the spatial variability of the groundwater chemistry within the BRW Site. Low-flow sampling parameters were used to estimate the hydraulic conductivity of the screened aquifer interval. Lithology logs from the piezometer construction and manual water level measurements were used to determine the aquifer geometry as well as refine and augment the groundwater elevations, potentiometric surfaces, and seasonal groundwater change.**	New piezometers were installed, and lithology logs from the piezometer construction and manual groundwater level measurements were used to augment and refine the aquifer geometry. Two pumping test(s) were conducted to determine the transmissivity, hydraulic conductivity, stativity, presence of hydraulic barriers and/or sources of storage, preferential flow, anisotropy, and heterogeneity of the aquifer, role of confining and/or less conductive units, well efficiency, specific yield, and other relevant information specific to the remedial design. Additional groundwater sampling was conducted before and after the pumping test and samples were submitted for laboratory analyses. These samples were used to refine and augment the spatial variability of the groundwater chemistry within the BRW Site. Manual groundwater level measurements collected duirng sampling were used to augment and refine the groundwater elevations, potentiometric surface, and direction of flow. A network of surface water and groundwater monitoring points were used to determine the impact of BRW groundwater on subsections of SBC as well as assess the potential impacts of the dewatering activities on nearby sites. This work included the installation of additional staff gages in SBC, stream gaging, and sampling for COC and Radon-222 to monitor the groundwater and surface water flux and COC loading.	Manual groundwater level measurements and groundwater samples were collected from select piezometers and monitoring wells during low-groundwater and surface water conditions to help refine and augment the spatial variability of the groundwater chemistry within the BRW Site. Low-flow sampling parameters were used to estimate the hydraulic conductivity of the screened aquifer interval. Monthly groundwater levels were used to evaluate groundwater elevations, potentiometric surfaces, and seasonal groundwater change. A network of surface water and groundwater monitoring points were used to determine the impact of BRW groundwater on subsections of SBC during low-groundwater and surface water conditions. This work included monitoring of stream gages, sampling for COCs, and Radon-222 tracing tests to monitor groundwater flux, surface water flux, and COC loading.	Groundwater elevations and groundwater samples will be collected from select piezometers and monitoring wells during a representative range of seasonal groundwater and surface water conditions (such as high- and low-groundwater and surface water conditions) to help refine and augment the spatial variability of the groundwater chemistry within the BRW Site. Low-flow sampling parameters will be used to estimate the hydraulic conductivity of the screened aquifer interval. Monthly groundwater levels will be recorded to evaluate groundwater elevations, potentiometric surfaces, and seasonal groundwater change. Additional piezometers will be installed to provide a potential early detection network to ensure that notable concentrations of PCP from the Montana Pole and Treating Plant Site (located to the west of the BRW Site) do not migrate during construction dewatering and/or as a result of implementing the BRW hydraulic control. A network of surface water and groundwater monitoring points will be used to determine the impact of BRW groundwater on subsections of SBC during a representative range of seasonal groundwater and surface water conditions (such as high- and low-groundwater and surface water conditions). This work will include monitoring of stream gages, sampling for COCs, and Radon-222 tracing tests to monitor groundwater flux, surface water flux, and COC loading.
	Conductivity and Transmissivity (Impacted Groundwater Volume)	O	O	O	✓	+	+						
	Groundwater Elevations, Potentiometric Surface, and Direction of Flow	✓	+	+	+	+	+						
	Seasonal Groundwater Elevation Change	✓	+	+	+	+	+						
	Evaluation of Groundwater Impact to SBC				O	O	✓						
	Aquifer Geometry	O		O	✓		+						
Organic Pollutants	Chemistry and Spatial Variability	O	O	O	✓	+	+	**Laboratory analyses and PID screening of soil samples from test pits and boreholes and groundwater samples from select piezometers were used to determine the chemistry and spatial variability of hydrocarbons.**	**Additional groundwater sampling and laboratory analyses at those piezometers and monitoring wells that previously contained organic pollutants were collected to refine the chemistry and spatial variability of organic pollutants.**	**Groundwater sampling and laboratory analyses of the hydrocarbon monitoring wells and select existing monitoring wells were conducted to refine the chemistry and spatial variability of organic pollutants and help define appropriate Site-specific action levels and determine the proper management plan for soils and groundwater impacted with organic pollutants within the BRW Site.**	Data was collected to refine the chemistry and spatial variability of organic pollutants and help define appropriate Site-specific action levels and determine the proper management plan for soils and groundwater impacted with organic pollutants within the BRW Site. Soil from the newly installed piezometers were screened with PIDs for the presence of hydrocarbons with select samples sent for laboratory analyses. Groundwater samples were taken and submitted for laboratory analysis.	Groundwater sampling and laboratory analyses of select existing wells/piezometers were conducted to refine the chemistry and spatial variability of organic pollutants and help define appropriate Site-specific action levels and determine the proper management plan for soils and groundwater impacted with organic pollutants within the BRW Site.	Data will be collected to refine the chemistry and spatial variability of organic pollutants and help define appropriate Site-specific action levels and determine the proper management plan for soils and groundwater impacted with organic pollutants within the BRW Site. Soil from the newly installed piezometers will be screened with PIDs for the presence of hydrocarbons with select samples sent for laboratory analyses. Groundwater samples will be taken from select wells and submitted for laboratory analysis.
	Plan to Manage Impacted Soil and/or Groundwater	O	O	O	✓	+	+						
Silver Bow Creek (SBC) Realignment	SBC Bottom Invert at Upstream and Downstream Tie-in Locations	✓						**The survey team determined the bottom invert at the upstream and downstream tie-in locations on SBC.**	**NA**	**NA**	NA	NA	NA
	Evaluation of Potential Lining of Relocated SBC	O	O	O	O	O	✓	**Soil and groundwater chemistry information will be used to determine if a liner will be needed based on the excavation design and the potential impact to the relocated SBC.**	**The additional groundwater data will be used to refine the decision to line the SBC channel.**	**The additional groundwater data will be used to refine the decision to line the SBC channel.**	The additional soil and groundwater chemistry data and the results of the pumping test will be used to determine the excavation design and will guide the decision of whether to line the SBC channel.	The additional groundwater data will be used to refine the decision to line the SBC channel.	The additional groundwater data will be used to refine the decision to line the SBC channel.

	Objective not covered during indicated investigation phase.
✓	Objective met during indicated investigation phase.
O	Objective partially met during indicated investigation phase.
+	Additional data gathered during indicated investigation phase to refine a completed objective.

Acronym Table

BRW - Butte Reduction Works	ICP - Inductively Coupled Plasma	PID - Photoionization Detector	RFC - Request for Change
COC - Contaminant of Concern	MASW - Multichannel Analysis of Surface Waves	QAPP - Quality Assurance Project Plan	SPLP - Synthetic Precipitation Leaching Procedure
GW - Groundwater	NA - Not applicable	SBC - Silver Bow Creek	XRF - X-ray fluorescence

Table 3. Investigation Points

Location	Northing (approximate) (NAVD83)	Easting (approximate) (NAVD83)	Completed Depth (ft) (bgs)	Installation Method	Measuring Point Elevation (NAVD88)	Water Level Monitoring		Analytes Techniques (Listed in Table 3)		
						Monthly Manual Water Levels	Transducer	Sampling/Analysis Completed (BRW Phase I QAPP)	Additional Sampling/Analysis (RFC)	Hydrocarbon Investigation Sampling 2019/2020
Phase I Site Investigation - Borehole and Piezometer										
BRW18-PZ01	651078.742	1194833.302	31.4	Geoprobe	5442.507	X		1, 3, 5, 6, 9, 11, 12	1, 2, 3	--
BRW18-PZ02	651239.586	1195014.445	40.0	Geoprobe	5440.438	X		1, 3, 5, 6, 9, 10, 11, 12, 18	1, 2, 3, 7, 8	--
BRW18-PZ03	651357.942	1195110.567	24.0	Geoprobe	5441.043	X		1, 3, 5, 6, 9, 11, 12, 18	1, 2, 3	--
BRW18-PZ04	651390.834	1195150.379	32.9	Geoprobe	5441.373	X		1, 3, 5, 6, 9, 11, 12	1, 2, 3	--
BRW18-PZ05	651430.306	1195183.837	24.0	Geoprobe	5441.63	X	X	1, 3, 5, 6, 9, 10, 11, 12, 18	1, 2, 3, 7, 8	--
BRW18-PZ06	651445.383	1195134.846	28.0	Geoprobe	5441.454	X		1, 3, 5, 6, 9, 10, 11, 12, 18	1, 2, 3	--
BRW18-PZ07*	-	-	-	Geoprobe	-	X		-	--	--
BRW18-PZ08	651510.975	1195233.984	31.6	Geoprobe	5443.765	X		1, 3, 5, 6, 9, 10, 11, 12, 18	1, 2, 3, 7, 8	--
BRW18-PZ09	651605.22	1195255.402	29.7	Geoprobe	5441.701	X	X	1, 3, 5, 6, 9, 10, 11, 12, 18	1, 2, 3, 7, 8	--
BRW18-PZ10	651099.615	1195378.376	40.0	Sonic	5448.721	X		1, 3, 5, 6, 7, 9, 11, 12	1, 2, 3, 7, 8	--
BRW18-PZ11	651107.607	1195553.959	35.0	Sonic	5447.874	X		1, 3, 5, 6, 7, 9, 11, 12	1, 2, 3, 7, 8	--
BRW18-PZ12	651169.202	1195817.936	25.0	Sonic	5448.986	X	X	1, 3, 5, 6, 7, 9, 11, 12, 15, 17	1, 2, 3, 7, 8	--
BRW18-PZ13	651208.551	1196088.545	35.0	Sonic	5450.491	X		1, 3, 5, 6, 7, 9, 10, 11, 12	1, 2, 3, 7, 8	--
BRW18-PZ14	651342.374	1196560.244		Sonic	5448.876	X		1, 3, 5, 6, 9, 11, 12	1, 2, 3	--
BRW18-PZ15	651437.605	1196565.884	35.0	Sonic	5448.239	X	X	1, 3, 5, 6, 9, 11, 12, 18	1, 2, 3	--
BRW18-PZ16	651547.251	1196380.329	49.5	Sonic	5461.915	X		1, 3, 5, 6, 9, 11, 12, 18	1, 2, 3	--
BRW18-PZ17	651415.53	1196291.027	40.0	Sonic	5448.562	X		1, 3, 5, 6, 9, 11, 12, 18	1, 2, 3	--
BRW18-PZ18	651380.511	1195727.666	30.0	Sonic	5449.737	X		1, 3, 5, 6, 7, 9, 11, 12, 15, 17	1, 2, 3, 7, 8	--
BRW18-PZ19	651521.13	1195774.28	39.5	Sonic	5454.818	X		1, 3, 5, 6, 7, 9, 10, 11, 12, 15, 17, 18	1, 2, 3, 7, 8	--
BRW18-PZ20	651321.476	1195549.121	39.0	Sonic	5451.467	X		1, 3, 5, 6, 7, 9, 11, 12, 15, 17, 18	1, 2, 3, 7, 8	--
BRW18-PZ21	651255.676	1195537.421	45.0	Sonic	5455.079	X		1, 3, 5, 6, 7, 9, 11, 12, 15, 17, 18	1, 2, 3, 7, 8	--
BRW18-PZ22	651453.869	1195379.491	40.0	Sonic	5453.88	X		1, 3, 5, 6, 7, 9, 10, 11, 12, 15, 17, 18	1, 2, 3, 7, 8	--
BRW18-PZ23	651584.449	1195523.487	35.0	Sonic	5450.547	X		1, 3, 5, 6, 7, 9, 10, 11, 12, 15, 17, 18	1, 2, 3, 7, 8	--
BRW18-PZ24	651802.847	1195648.059	44.5	Sonic	5460.152	X		1, 3, 5, 6, 7, 9, 10, 11, 12, 15, 17, 18	1, 2, 3, 7, 8	--
BRW18-PZ25	651508.006	1194940.45	26.9	Geoprobe	5440.455	X		1, 3, 5, 6, 9, 11, 12	1, 2, 3, 8	--
Phase I Site Investigation - Borehole Only										
BRW18-BH01	651352.331	1195296.146	45.0	Sonic	5455.429	-	-	9, 11, 12, 15, 17, 18	--	--
BRW18-BH02	651179.937	1195239.621	45.0	Sonic	5453.063	-	-	9, 10, 11, 12, 18	--	--
BRW18-BH03	651596.986	1195312.829	35.0	Sonic	5456.519	-	-	9, 10, 11, 12, 18	--	--
BRW18-BH04*	-	-	-	Sonic	-	-	-	-	--	--
BRW18-BH05	651284.776	1195482.726	35.0	Sonic	5453.224	-	-	9, 10, 11, 12, 15, 17, 18	--	--
BRW18-BH06	651237.893	1195742.042	35.0	Sonic	5450.546	-	-	9, 11, 12, 18	--	--
BRW18-BH07	651356.852	1195732.978	29.5	Sonic	5447.126	-	-	9, 11, 12	--	--
BRW18-BH08	651727.735	1195830.941	34.5	Sonic	5448.104	-	-	9, 10, 11, 12, 15, 17	--	--
BRW18-BH09	651505.663	1195850.214	45.0	Sonic	5460.889	-	-	9, 10, 11, 12, 18	--	--
BRW18-BH10	651499.545	1195919.218	34.5	Sonic	5449.938	-	-	9, 11, 12, 18	--	--
BRW18-BH11	651501.9075	1195915.071	35.0	Sonic	5449.37	-	-	9, 11, 12, 15, 17, 18	--	--
BRW18-BH12*	-	-	-	Sonic	-	-	-	-	--	--
BRW18-BH13*	-	-	-	Sonic	-	-	-	-	--	--
BRW18-BH14*	-	-	-	Sonic	-	-	-	-	--	--
BRW18-BH15*	-	-	-	Sonic	-	-	-	-	--	--
BRW18-BH16	651315.116	1196252.848	30.0	Sonic	5447.336	-	-	9, 10, 11, 12, 18	--	--
BRW18-BH17*	-	-	-	Geoprobe	-	-	-	-	--	--
BRW18-BH18	651519.165	1195206.485	15.0	Geoprobe	5438.517	-	-	9, 11, 12	--	--
BRW18-BH19*	-	-	-	Geoprobe	-	-	-	-	--	--
BRW18-BH20	651397.995	1195193.001	15.0	Geoprobe	5438.78	-	-	9, 11, 12	--	--
BRW18-BH21	651318.642	1195165.739	15.0	Geoprobe	5439.169	-	-	9, 11, 12	--	--
BRW18-BH22	651163.673	1195172.509	15.0	Geoprobe	5439.176	-	-	9, 11, 12	--	--
BRW18-BH23	651236.101	1195116.212	15.0	Geoprobe	5438.756	-	-	9, 11, 12	--	--
BRW18-BH24	651161.259	1195092.959	15.0	Geoprobe	5438.655	-	-	9, 11, 12	--	--
BRW18-BH25	651107.051	1195075.519	15.0	Geoprobe	5440.844	-	-	9, 11, 12	--	--
BRW18-BH26	651398.34	1195050.553	20.0	Geoprobe	5438.061	-	-	9, 11, 12, 18	--	--
BRW18-BH27	651313.446	1195016.772	15.0	Geoprobe	5438.024	-	-	9, 10, 11, 12, 18	--	--
BRW18-BH28	651176.5474	1194979.969	15.0	Geoprobe	5438	-	-	9, 10, 11, 12, 18	--	--
BRW18-BH29	651103.823	1194980.539	32.25	Geoprobe	5440.398	-	-	9, 11, 12	--	--
BRW18-BH30	651470.17	1195146.972	15.0	Geoprobe	5438.535	-	-	9, 11, 12	--	--
Phase I Site Investigation - Test Pit										
BRW18-TP01	651213.015	1195516.909	6.4	Excavator	5446.11	-	-	9, 11, 12, 15, 17	--	--
BRW18-TP02	651642.045	1195483.431	4.2	Excavator	5451.77	-	-	9, 11, 12, 15, 17	--	--
BRW18-TP03	651510.907	1195716.302	1.3	Excavator	5448.93	-	-	9, 11	--	--
BRW18-TP04	651677.297	1195946.956	8.7	Excavator	5456.42	-	-	9, 11, 12, 13	--	--
BRW18-TP05	651213.137	1196011.393	8.3	Excavator	5448.098	-	-	9, 10, 11, 12	--	--
BRW18-TP06*	-	-	-	Excavator	-	-	-	-	--	--
BRW18-TP07*	-	-	-	Excavator	-	-	-	-	--	--
BRW18-TP08	651365.692	1196160.862	7.8	Excavator	5448.38	-	-	9, 11, 12	--	--
BRW18-TP09	651404.072	1196157.424	4.5	Excavator	5449.99	-	-	9, 11, 12, 18	--	--
BRW18-TP10	651470.841	1196185.261	10.0	Excavator	5450.896	-	-	9, 11, 12	--	--
BRW18-TP11*	-	-	-	Excavator	-	-	-	-	--	--
BRW18-TP12*	-	-	-	Excavator	-	-	-	-	--	--
BRW18-TP13*	-	-	-	Excavator	-	-	-	-	--	--
BRW18-TP14	651299.332	1196321.834	7.0	Excavator	5447.68	-	-	9, 11, 12	--	--
BRW18-TP15	651310.926	1196225.651	7.4	Excavator	5447.875	-	-	9, 11, 12	--	--
BRW18-TP16	651410.639	1196130.199	5.8	Excavator	5449	-	-	9, 11, 12, 13	--	--
BRW18-TP17	651376.512	1196036.062	8.5	Excavator	5449.446	-	-	9, 11, 12, 15, 17	--	--
Existing Monitoring Well										
AMW-02	651600.325	1196999.195	Previously installed.	Previously installed.	5452.535	X		-	-	-
BPS07-08A	651929.321	1196286.302			5450.465	X		-	-	-
BPS07-13A	651644.07	1196257.928			5463.576	X	X	-	-	1, 3, 7, 8
BPS07-13B	651647.091	1196252.7			5464.695	X	X	-	-	-
BPS07-14A	651801.248	1195646.003			5459.521	X	X	-	-	-
BPS07-15A	651691.018	1195953.511			5459.327	X	X	-	-	-
BPS07-25	651930.286	1195699.868			5449.082	X	X	-	-	-
BPS11-01	652032.368	1196519.817			5450.083	X		-	-	-
BPS11-02	651688.164	1196542.272			5447.272	X		-	-	-
BPS11-05A1	651319.583	1196512.368			5449.384	X	X	-	-	1, 3, 7, 8
BPS11-05A2	651322.717	1196521.57			5449.463	X	X	-	-	-
BPS11-06	651447.563	1196042.035			5452.047	X	X	-	-	-
BPS11-07	652017.086	1195871.594			5455.461	X		-	-	-
BPS11-08	652318.313	1196084.168			5456.821	X		-	-	-
BPS11-09	651018.769	1197015.151			5448.202	X		-	-	-
BPS11-12A	650631.208	1197056.639			5452.35	X		-	-	-
FP98-01B	651510.418	1195275.85			5461.322	X	X	-	-	-
FP98-1	651477.165	1195210.874			5443.134	X	X	-	-	-
FP98-2	651577.814	1195030.654			5441.485	X		-	-	-
GS-13A	651974.405	1195561.746			5443.808	X		-	-	-
GS-13B	651978.132	1195542.628			5441.888	X		-	-	-
HCA-MG3	652262.562	1194778.683			5460.346	X		-	-	-
FP98-3	651126.853	1195161.744			5445.89	X		-	-	-
FP98-5	651316.642	1194489.866			5439.444	X		-	-	-
GS-29SR	651277.677	1196900.372			5448.852	X		-	-	-
MW-03-MPC	651110.26	1196245.854			5447.219	X		-	1, 2, 3, 5, 6, 7, 8	1, 3, 4, 7, 8
MW-03A-MPC	651103.305	1196232.691			5447.32	X		-	1, 2, 3, 5, 6, 7, 8	1, 3, 4, 7, 8
MW-02-MPC	650982.18	1195763.225			5447.228	X		-	1, 2, 3, 5, 6, 7, 8	1, 3, 4, 7, 8
MW-01-MPC	650964.968	1196145.405			5449.474	X		-	1, 2, 3, 5, 6, 7, 8	1, 3, 4, 7, 8

Table 2 continued on next page

Table 3. Investigation Points

Location	Northing (approximate) (NAVD83)	Easting (approximate) (NAVD83)	Completed Depth (ft) (bgs)	Installation Method	Measuring Point Elevation (NAVD88)	Water Level Monitoring		Analytes Techniques (Listed in Table 3)		
						Monthly Manual Water Levels	Transducer	Sampling/Analysis Completed (BRW Phase I QAPP)	Additional Sampling/Analysis (RFC)	Hydrocarbon Investigation Sampling 2019/2020
Existing Surface Water Location										
SS-04	651043.324	1197358.411	NA	NA	5441.221	X		-	-	-
SS-05	651486.675	1196597.156			5440.64	X	X	-	-	-
SS-05.6	651869.3	1195726.017			5437.82	X		-	-	-
SS-05.7	651873.925	1195681.573			5437.382	X		-	-	-
SS-05.9R	651837.145	1195584.494			5437.52	X		-	-	-
SS-05A	651699.092	1195315.54			5436.408	X	X	-	-	-
SS-05B	651536.415	1195128.34			5436.127	X		-	-	-
SBC Sed B-8	651690.285	1196322.308			5438.242	X	X	-	-	-
BRW-00	651757.701	1194972.438			5443.65	X	X	-	-	-
Hydrocarbon Investigation Monitoring Wells (Boreholes and Piezometers)										
BRW19-HCW30	651450.512	1195374.595	24.4	Sonic	5452.078	X		-	-	1, 3, 7, 8, 11, 15, 16
BRW19-HCW31	651587.172	1195529.212	20.0	Sonic	5448.683	X		-	-	1, 3, 7, 8, 11, 15, 16
BRW19-HCW32	651556.205	1195703.74	40.0	Sonic	5451.852	X		-	-	1, 3, 7, 8, 9, 11, 12, 15, 16
BRW19-HCW33R	651518.728	1195856.517	35.0	Sonic	5450.066	X		-	-	1, 3, 7, 8, 9, 11, 12, 15, 16
BRW19-HCW34	651484.16	1195915.517	25.0	Sonic	5449.928	X		-	-	1, 3, 7, 8, 11, 15, 16
BRW19-HCW35	651388.386	1195992.905	35.0	Sonic	5450.738	X		-	-	1, 3, 7, 8, 9, 11, 12, 15, 16
BRW19-HCW36	651213.42	1196092.762	20.0	Sonic	5449.042	X		-	-	1, 3, 4, 7, 8, 11
BRW19-HCW37	651247.068	1195537.854	25.0	Sonic	5452.519	X		-	-	1, 3, 7, 8, 11, 15, 16
BRW19-HCW38	651319.592	1195542.237	24.5	Sonic	5448.493	X		-	-	1, 3, 7, 8, 11, 15, 16
BRW19-HCW39	651381.324	1195720.769	20.0	Sonic	5447.932	X		-	-	1, 3, 7, 8, 11, 15, 16
BRW19-HCW40	651172.988	1195824.474	20.0	Sonic	5447.048	X		-	-	1, 3, 4, 7, 8, 11, 15, 16
BRW19-HCW41	651297.441	1196317.743	30.0	Sonic	5447.894	X		-	-	1, 3, 4, 7, 8, 9, 11, 12, 15, 16
BRW19-HCW42	651111.543	1195564.831	20.0	Sonic	5446.222	X		-	-	1, 3, 4, 7, 8, 11, 15, 16
Hydrocarbon Investigation Test Pits										
BRW19-HCTP30	651534.86	1195839.943	13.2	Excavator	5448.606	-	-	-	-	9, 15, 16
BRW19-HCTP31	651528.667	1195985.678	13.3	Excavator	5448.631	-	-	-	-	9, 15, 16
BRW19-HCTP32	651447.184	1195967.89	9.0	Excavator	5447.884	-	-	-	-	9, 15, 16
Previously Installed Test Pits (BRW Smelter Site Test Pit Report [NRDP, 2016a])										
BRW-TP-01	651246.385	1195500.553	14	Excavator	-	-	-	-	-	-
BRW-TP-02	651329.4567	1195595.127	13.5	Excavator	-	-	-	-	-	-
BRW-TP-03	651394.6361	1195739.544	16	Excavator	-	-	-	-	-	-
BRW-TP-04	651398.4702	1195927.414	13.5	Excavator	-	-	-	-	-	-
BRW-TP-05	651519.8827	1195809.835	13	Excavator	-	-	-	-	-	-
BRW-TP-06	651408.6944	1196327.436	7.5	Excavator	-	-	-	-	-	-
BRW-TP-07	651464.9275	1196241.808	9	Excavator	-	-	-	-	-	-
BRW-TP-08	651576.1158	1196016.876	12	Excavator	-	-	-	-	-	-
BRW-TP-09	651684.7481	1195840.508	12	Excavator	-	-	-	-	-	-
BRW-TP-10	651554.3894	1195698.647	17	Excavator	-	-	-	-	-	-
BRW-TP-11	651558.2235	1195555.508	15	Excavator	-	-	-	-	-	-
BRW-TP-12	651686.59	1195501.54	16	Excavator	-	-	-	-	-	-
BRW-TP-13	651780.6001	1195650.082	12	Excavator	-	-	-	-	-	-
BRW-TP-14	651818.9408	1195807.279	8	Excavator	-	-	-	-	-	-
BRW-TP-15	651788.2682	1195997.705	7.5	Excavator	-	-	-	-	-	-
BRW-TP-16	651678.3579	1196154.902	12	Excavator	-	-	-	-	-	-
BRW-TP-17	651545.4432	1196294.207	12	Excavator	-	-	-	-	-	-
BRW-TP-18	651503.2683	1196448.848	5.8	Excavator	-	-	-	-	-	-
BRW-TP-19	651576.7	1195297.89	4.5	Excavator	-	-	-	-	-	-
BRW-TP-20	651470.0396	1195366.36	6.5	Excavator	-	-	-	-	-	-
BRW-TP-21	651291.116	1195340.8	16	Excavator	-	-	-	-	-	-
BRW-TP-22	651153.0891	1195242.392	5.5	Excavator	-	-	-	-	-	-
BRW-TP-23	651082.7977	1195339.522	9.5	Excavator	-	-	-	-	-	-
BRW-TP-24	651165.8694	1195584.903	15.5	Excavator	-	-	-	-	-	-
BRW-TP-25	651250.19	1195726.04	1.8	Excavator	-	-	-	-	-	-
BRW-TP-26	651209.3223	1195844.342	5	Excavator	-	-	-	-	-	-
BRW-TP-27	651266.8335	1196076.943	9.5	Excavator	-	-	-	-	-	-
BRW-TP-28	651293.672	1196296.763	15	Excavator	-	-	-	-	-	-
BRW-TP-29	651366.5195	1196422.01	10	Excavator	-	-	-	-	-	-
BRW-TP-30	651411.2504	1196530.642	7	Excavator	-	-	-	-	-	-

Table 4. Sample Collection, Preservation, and Holding Times

Group	Analytical Lab/Company	Analyte	Analytical Method	CRQL	Holding Time	Container Size	Preservation[1]	Justification
		Groundwater Field Parameters						
(1)	Pioneer	Water level	NA	NA	NA	NA	NA	Confirm stabilization during sampling and general water chemistry.
		Temperature						
		Specific conductance (SC)						
		Dissolved Oxygen (DO)						
		pH						
		Oxidation Reduction Potential (ORP)						
(2)	Pioneer	Ferrous iron and total iron (Chemetrics V-2000 Photometer)	NA	NA	NA	NA	NA	Identify iron characteristics in groundwater to help identify areas with increased metals mobility.
		Groundwater Laboratory Samples						
(3)	PACE		EPA 200.8 (Rev 5.4)	Total / Dissolved	6 Months	2, 250-mL high-density polyethylene (HDPE) bottles	Acidified with HNO$_3$, field filtered with 0.45 µm filter (dissolved).	Define extent of unimpacted and impacted groundwater at the site, and compare quality of groundwater coming into the site from the upgradient side to the downgradient groundwater coming from the site.
		Total recoverable and dissolved arsenic (As)		0.5 µg/L / 1.0 µg/L[2]				
		Total recoverable and dissolved cadmium (Cd)		0.08 µg/L / 1.0 µg/L[2]				
		Total recoverable and dissolved copper (Cu)		1.0 µg/L / 2.0 µg/L[2]				
		Total recoverable and dissolved lead (Pb)		0.1 µg/L / 1.0 µg/L[2]				
		Total recoverable and dissolved zinc (Zn)		5.0 µg/L / 2.0 µg/L[2]				
		Total recoverable and dissolved silver (Ag)		0.2 µg/L / 0.15 µg/L[2]				
		Total recoverable and dissolved iron (Fe)		50.0 µg/L / 200.0 µg/L[2]				
		Total recoverable and dissolved mercury (Hg)	EPA 245.1	0.01 µg/L / 2.0 µg/L[3]	28 Days			
		Total recoverable phosphate (PO4)	EPA 365.1	50 µg/L[5]	29 Days	1, 250-mL high-density polyethylene (HDPE) bottle	Acidified with H2SO4	
		Nitrate (NO2) and Nitrite (NO3)	EPA 353.2	100 µg/L / 2.0 µg/L[5]	28 Days	1, 250-mL high-density polyethylene (HDPE) bottle	Acidified with H2SO4	
(4)	Energy Laboratories	Polychlorinated Biphenyl (PCB)	EPA 8082A	0.08 µg/L[3]	7 Days	1-L amber glass	Raw	Identify if PCBs exist in the BRW area at concentrations above regulatory action limits.
(5)	Energy Laboratories	Dissolved Calcium (Ca)	EPA 200.7 (Rev 4.4)/ EPA 200.8 (Rev 5.4)	5000 µg/L[2]	6 Months	250-mL HDPE bottle	Acidified with HNO$_3$, field filtered with 0.45 µm filter (dissolved).	Establish basic chemical water type and also general "fingerprinting" of water from different sources to identify source areas for impacted groundwater.
		Dissolved Potassium (K)		5000 µg/L[2]				
		Dissolved Silica (SiO$_2$)		200 µg/L[3]				
		Dissolved Sodium (Na)		5000 µg/L[2]				
		Dissolved Aluminum (Al)		9.0 µg/L[4]				
		Dissolved Barium (Ba)		3.0 µg/L[4]				
		Dissolved Boron (B)		50 µg/L[3]				
		Dissolved Cobalt (Co)		50 µg/L[2]				
		Dissolved Magnesium (Mg)		5000 µg/L[2]				
		Dissolved Manganese (Mn)		15 µg/L[2]				
		Dissolved Molybdenum (Mo)		1 µg/L[3]				
		Dissolved Nickel (Ni)		2.0 µg/L[4]				
		Dissolved Strontium (Sr)		20.0 µg/L[4]				
		Dissolved Vanadium (V)		50 µg/L[2]				
		Dissolved Cerium (Ce)		1 µg/L[3]				
		Dissolved Lithium (Li)		100 µg/L[3]				
		Dissolved Palladium (Pd)		10 µg/L[3]				
		Dissolved Rubidium (Rb)		10 µg/L[3]				
		Dissolved Tungsten (W)		100 µg/L[3]				
		Dissolved Uranium (U)		0.2 µg/L[4]				
		Bicarbonate (HCO$_3$)	SM 2320B	4 mg/L[3]	14 Days	250-mL HDPE bottle	Raw	
		Carbonate (CO$_3$)		4 mg/L[3]				
		Alkalinity, Total (as CaCO$_3$)		4 mg/L[3]				
		Bromide (Br)	EPA 300.1 (Rev 1.0)	0.5 mg/L[3]	28 Days			
		Chloride (Cl)		1 mg/L[3]				
		Sulfate (SO4)		1 mg/L[3]				
		Fluoride (F)	A4500-F C	0.2 mg/L[4]	28 Days	250-mL HDPE bottle	Raw	
		Total Hardness	SM 2340B (calculation)	1 mg/L[3]	None	None	None	
		Total Dissolved Solids (TDS)	SM 1030E (calculation)	1 mg/L[3]				
(6)	Energy Laboratories	Dissolved Arsenic [As (III)]	EPA 1632A	5 µg/L[3]	28 Days	250-mL HDPE bottle	Acidified with HCl, field filtered with 0.45 µm filter (dissolved).	Speciate arsenic to determine mobilization potential.
		Dissolved Arsenic [As (V)]		5 µg/L[3]				
		Total Arsenic (As)	EPA 200.8 (Rev 5.4)	1 µg/L[4]	6 Months	250-mL HDPE bottle	Unfiltered, acidified with HNO$_3$.	
(7)	Energy Laboratories	Volatile Petroleum Hydrocarbons (VPH)	MAVPH (Rev 1.1)	Various depending on analyte detected.[3]	14 Days	3, 40-mL clear glass VOA vials	Unfiltered, acidified with HCl.	Identify if hydrocarbons exist in the BRW area at concentrations above regulatory action limits.
		EPH Fractionation with Polycyclic Aromatic Hydrocarbons (PAHs)	Montana Method EPH (PAHs: 8270C or 8270D)	Various depending on analyte detected.[3]	14 Days	2, 1-L amber glass	Unfiltered, acidified with H$_2$SO$_4$.	Identify if hydrocarbons exist in the BRW area at concentrations above regulatory action limits, and determine breakdown of petroleum components.
(8)	Energy Laboratories	Lead Scavengers (1, 2 dichloroethane and 1, 2 dibromoethane)	EPA 8011, EPA 8260A	Various depending on analyte detected.[3]	14 Days	6, 40-mL clear glass VOA vials	Unfiltered, acidified with HCl.	Identify if lead scavengers exist in the BRW area and in the production water at concentrations above regulatory limits.
		Soil Field Readings						
(9)	Pioneer XRF	Arsenic (As)	NA	NA	NA	NA	NA	Provide auxiliary input to visual observations in determining the depth of each test pit and borehole. Refine estimates of total metals mass in the BRW Site.
		Cadmium (Cd)						
		Calcium (Ca)						
		Chromium (Cr)						
		Copper (Cu)						
		Iron (Fe)						
		Lead (Pb)						
		Manganese (Mn)						
		Mercury (Hg)						
		Silver (Ag)						
		Zinc (Zn)						
(10)	Pioneer	Soil Nitrate Test	NA	NA	NA	NA	NA	Provide additional information to select SPLP samples. Nitrate analysis will only be conducted on samples with elevated lead concentrations (anticipated to be greater than 3,140 mg/kg) as determined by XRF or laboratory ICP-OES (see Section 2.4.1 of BRW QAPP for additional detail).
(11)	Pioneer PID	Volatile Organic Compounds	NA	NA	NA	NA	NA	Screen soils for potential hydrocarbon impact. Refine estimates of hydrocarbons in the BRW Site.
		Soil Laboratory Samples						
(12)	PACE General Parameters	pH	Method 9045D	0.10 S.U.[5]	15 Minutes	4 oz. amber glass container	None	Determine general chemistry of impacted materials in the BRW Site. Collect one general parameters sample for each impacted material horizon (e.g., poured slag, tailings, etc.), observed peat/organic soil, and underlying alluvium.
		SC	Method ASA10-3.3	10 umhos/cm[5]	28 Days	8 oz. amber glass container	None	
	ICP-OES	Arsenic (As)	SW-846 6010D	1.0 mg/kg[5]	6 Months	4 oz. amber glass container	None	Refine estimates of total metals mass in the BRW Site. **Major material horizon: (**greater than two feet in thickness), collect one ICP-OES sample. **Minor material horizon** (less than 2 feet in thickness)**:** Additional samples for minor material horizons (i.e., less than two feet in thickness) may be taken at the discretion of field personnel.
		Cadmium (Cd)		0.15 mg/kg[5]				
		Calcium (Ca)		25.0 mg/kg[5]				
		Chromium (Cr)		0.50 mg/kg[5]				
		Copper (Cu)		0.50 mg/kg[5]				
		Iron (Fe)		2.5 mg/kg[5]				
		Lead (Pb)		0.50 mg/kg[5]				
		Manganese (Mn)		0.25 mg/kg[5]				
		Silver (Ag)		0.5 mg/kg[5]				
		Zinc (Zn)		1.0 mg/kg[5]				
		Mercury (Hg)	EPA Method 7471	0.02 mg/kg[5]	28 Days		≤6°C	
(13)	PACE	Asbestos	EPA 600	NA	None	4 oz. amber glass container	None	Identify any demolition debris with potential asbestos.
(14)	Energy Laboratories	Polychlorinated Biphenyl (PCB)	EPA 8082A	0.8-0.160 mg/kg[2]	14 Days	4 oz. amber glass container	None	spillage.
(15)	Energy Laboratories	Volatile Petroleum Hydrocarbons (VPH)	MAVPH (Rev 1.1)	Various depending on analyte detected.[3]	7 Days	4 oz. amber glass container	None	Identify if hydrocarbons exist in the BRW area at concentrations above regulatory action limits.
		EPH Fractionation with Polycyclic Aromatic Hydrocarbons (PAHs)	Montana Method EPH (PAHs: 8270C or 8270D)	Various depending on analyte detected.[3]	14 Days			Identify if hydrocarbons exist in the BRW area at concentrations above regulatory action limits, and determine breakdown of petroleum components. Laboratory to perform silica gel cleanup to remove potential interferences to diesel range organics (DRO).
(16)	Energy Laboratories	Lead Scavengers (1, 2 dichloroethane and 1, 2 dibromoethane)	EPA 8011, EPA 8260A	Various depending on analyte detected.[3]	14 Days	2, 4 oz. amber glass container	None	Identify if lead scavengers exist in the BRW area at concentrations above regulatory action limits.
(17)	Torkelson Geochemistry	High Resolution Gas Chromatography with Flame Ionization Detector (Pristane/Phytane Ratio)	EPA 8015M	NA	14 Days	4 oz. amber glass container	None	To determine relative age of petroleum components encountered. Atlantic Richfield is not requesting Agency approval on hydrocarbon age dating.
(18)	Energy Laboratories SPLP	SPLP solids to be analyzed for (7), above. SPLP leachate to be analyzed for (2) (dissolved only) and (3) (only for EPA 200.7/200.8), above. Extraction fluid #2 shall be used. Lab to use the 20:1 liquid to solid ratio. Laboratory to report final extraction pH. Additional Instructions for Slag Material Analysis: (1) Run SPLP analysis twice. The second test was run using the same exact sample material that was run through the first SPLP analysis. (2) Decant all fluid possible between first and second test. (3) Samples were not crushed prior to SPLP analysis.	SW1312	See CRQL's listed above for applicable analytical method.	180 Days	1 Quart	None	Determine the leachability of COCs from impacted materials (i.e., slag, tailings, demolition debris). See BRW QAPP Section 2.4.1 for details on selecting SPLP samples.

[1] In addition to the preservation listed, all samples will be cooled to 4 ± 2°C. Not all analyses require this but because multiple containers will be collected at most sites, all samples will be cooled.

[2] ARCO, 1992. Clark Fork River Superfund Site Investigations (CFRSSI) Standard OperatingProcedures (SOPs). September 1992.

[3] Energy Laboratories' Applicable Reporting Limit

[4] DEQ, 2019. Circular DEQ-7 Montana Numeric Water Quality Standards. Montana Department of Environmental Quality. June 2019.

[4*] Energy Laboratories Applicable Reporting Limit for one analyte, Indeno (1,2,3-cd)pyrene (0.1µg/L), is higher than the Circular DEQ-7 Reporting Limit for that analyte (0.08µg/L).
Atlantic Richfield will work with Energy laboratories to improve the reporting limits to meet the DEQ-7 standard if possible.

[5] Pace Analytical Practical Quantitation Limit (PQL)

Units:
µg/L - Microgram per liter
S.U. - Standard Unit
umhos/cm or µS/cm - microsiemen per centimeter
mg/L - milligram per liter
mg/kg - milligram per kilogram

Table 5. Soil ICP and SPLP Analytical Results Summary.

						Arsenic (ICP) (mg/kg)	Arsenic (D - SPLP) (µg/L)	Cadmium (ICP) (mg/kg)	Cadmium* (D - SPLP) (µg/L)	Copper (ICP) (mg/kg)	Copper* (D - SPLP) (µg/L)	Lead (ICP) (mg/kg)	Lead* (D - SPLP) (µg/L)	Zinc (ICP) (mg/kg)	Zinc* (D - SPLP) (µg/L)	Waste Criteria Result (Pass/Fail)
					Groundwater Standards (2006 ROD, Table 8-1)	**-**	**10**	**-**	**5**	**-**	**1,300**	**-**	**15.00**	**-**	**2,000**	**-**
					Waste Criteria (mg/kg)	**200**	**-**	**20**	**-**	**1000**	**-**	**1000**	**-**	**1000**	**-**	**-**
Location	Sample Interval	Initial Geologic Unit Classification	ReClassified Geologic Unit	Lithology	Additonal Sample Selection Notes**											
BRW18-PZ03	5.0' - 9.9'	Alluvium	ATO	SP	Interval with the 2nd highest copper concentration for alluvium. Interval with highest copper concentration did not have sufficient sample volume for lab analysis [BRW18-PZ06(4.8-5.3)].	**2,010**	2	10	1.78	**18,700**	262	974	2	**4,260**	471	Fail
BRW18-BH28	5.9' - 8.6'	Alluvium	ATO	SW	Interval with the 3rd highest copper concentration for alluvium.	**1,910**	3	**30**	3.81	**27,200**	295	689	8.2	**10,900**	533	Fail
BRW18-BH05	15.0' - 17.5'	Alluvium	Slag	GC	Interval selected based on overall concentrations and material type.	**447**	**45**	2	0.26	**6,810**	36	**1,650**	**15.4**	**11,500**	28	Fail
BRW18-BH05	12.3' - 13.7'	Alluvium	Other	ML	Interval selected based on overall concentrations and material type.	151	3	<1	<0.07	**5,000**	8	**1,350**	0.9	**6,620**	<8	Fail
BRW18-BH26	6.5' - 6.8'	Alluvium	ATO	CL	Interval selected based on overall concentrations and material type.	**511**	<1	9	2.27	**3,820**	80	**21,600**	**249**	**25,300**	368	Fail
BRW18-PZ21	12.5' - 15.0'	Alluvium	Slag	SM	Interval selected based on both high chromium and iron concentrations.	100	<1	7	0.66	**4,740**	46	**3,690**	**30.3**	**38,600**	133	Fail
BRW18-PZ21	31.0' - 31.7'	Alluvium	ATO	SM	Interval selected based on both high chromium and iron concentrations.	9	7	<1	0.13	171	20	29	3	352	25	Pass
BRW18-BH09	36.8' - 37.4'	Alluvium	ATO	SW	Interval selected based on both high chromium and iron concentrations.	26	**128**	<1	0.08	85	8	48	5	219	14	Pass
BRW18-PZ09	13.0' - 13.6'	Alluvium	ATO	GM	Interval selected based on both high chromium and iron concentrations.	6	3	10	**6.86**	22	7	21	1.7	188	99	Pass
BRW18-PZ15	18.3' - 18.8'	Alluvium	ATO	SP	Interval selected based on both high chromium and iron concentrations.	2	2	<1	<0.07	10	3	11	2	142	22	Pass
BRW18-PZ19	12.6' - 14.5'	Demolition Debris	Slag	SW	Interval with highest copper concentration for demolition debris.	**540**	**337**	4	<0.05	**2,310**	19	405	1.7	**5,150**	<8	Fail
BRW18-PZ21	6.2' - 10.0'	Demolition Debris	Demolition Debris	GM	Interval with 2nd highest copper concentration for demolition debris.	**351**	**14**	8	0.70	**4,860**	13	615	<0.3	**7,120**	34	Fail
BRW18-BH06	5.5' - 5.7'	Demolition Debris	Demolition Debris	SW	Interval with highest lead concentration and no detectable nitrate for demolition debris.	**343**	**127**	11	<0.05	968	5	**1,820**	0.7	**7,850**	<8	Fail
BRW18-BH10	0.0' - 3.5'	Demolition Debris	Other	SP	Interval with 3rd highest lead concentration and no detectable nitrate for demolition debris. Interval with 2nd highest lead concentration and no detectable nitrate was already collected based on copper concentration [BRW18-PZ19(12.6-14.5)].	155	**80**	5	<0.05	551	10	**1,690**	13.0	**3,860**	14	Pass
BRW18-BH11	0.0' - 10.0'	Demolition Debris	Demolition Debris	ML	Interval with 4th highest lead concentration and no detectable nitrate for demolition debris.	**398**	**297**	9	<0.05	**1,010**	7	**1,450**	4.5	**4,260**	<8	Fail
BRW18-BH02	2.5' - 10.8'	Demolition Debris	Other	ML	Interval with 5th highest lead concentration and no detectable nitrate for demolition debris.	**940**	**23**	7	4.47	**1,790**	394	956	1.4	**1,710**	**3,100**	Fail
BRW18-BH10	3.5' - 4.8'	Demolition Debris	Demolition Debris	CL	Interval with 6th highest lead concentration and no detectable nitrate for demolition debris.	**448**	**198**	11	<0.05	**1,190**	9	**1,890**	13.1	**8,940**	16	Fail
BRW18-PZ21	0.0' - 6.2'	Demolition Debris	Other	GM	Interval with 8th highest lead concentration and no detectable nitrate for demolition debris. Interval with 7th highest lead concentration and no detectable nitrate was already collected based on copper concentration [BRW18-PZ21(6.2-10.0)].	**234**	**89**	9	0.12	**1,420**	6	454	<0.3	**11,700**	<8	Fail
BRW18-BH05	2.7' - 4.7'	Demolition Debris	Demolition Debris	ML/GM	Sample submitted due to unique lithology.	23	**33**	<1	<0.05	207	13	172	3.3	468	10	Pass
BRW18-TP09	3.5' - 4.5'	Demolition Debris	Demolition Debris	SM	Interval with highest lead concentration, no detectable nitrate, and sufficient sample volume.	**270**	**44**	**31**	0.20	195	3	609	<0.3	**2,220**	<8	Fail
BRW18-PZ23	0.0' - 5.0'	Other	Other	ML/SC	Interval with highest copper concentration for other.	**218**	3	6	1.79	**11,000**	31	255	0.5	**1,780**	51	Fail
BRW18-PZ13	0.0' - 2.7'	Other	Slag	GM/SM	Interval with 2nd highest copper concentration for other.	93	**325**	<1	<0.07	**1,520**	16	115	0.6	**9,120**	13	Fail
BRW18-PZ02	1.2' - 2.0'	Other	ATO	OL	Interval with highest lead concentration and no detectable nitrate for other.	185	10	8	0.08	83	3	**1,030**	6.5	**3,780**	10	Pass
BRW18-BH16	0.0' - 1.3'	Other	Other	ML	Interval with 2nd highest lead concentration and no detectable nitrate for other.	136	**212**	5	0.08	312	22	542	4.7	**1,240**	10	Pass
BRW18-BH28	0.0' - 1.5'	Other	ATO	OH	Interval with 4th highest lead concentration and no detectable nitrate for other. Interval with 3rd highest lead concentration and no detectable nitrate for other was already collected based on copper concentration [BRW18-PZ13(0.0-2.7)].	21	**32**	<1	<0.07	76	19	18	2.5	86	<8	Pass
BRW18-BH03	0.0' - 1.3'	Other	Other	OL	Interval with 6th highest lead concentration and no detectable nitrate for other. Interval with 5th highest lead concentration and no detectable nitrate for other was already collected based on copper concentration [BRW18-PZ23(0.0-5.0)].	27	**32**	2	<0.07	315	26	214	1.9	628	<8	Pass
BRW18-PZ06	0.5' - 2.5'	Other	ATO	GM	Interval with 8th highest lead concentration and no detectable nitrate for other. Interval with 7th highest lead concentration and no detectable nitrate did not have sufficient volume for lab analysis [BRW-BH26(0.0-0.9)].	26	**20**	<1	<0.07	69	7	48	2.9	124	<8	Pass
BRW18-PZ22	35.0' - 37.6'	Other	ATO	SP	Interval with 9th highest lead concentration and no detectable nitrate for other.	42	**23**	3	0.24	910	25	69	4.8	**1,060**	28	Pass
BRW18-PZ23	30.7' - 31.1'	Other	ATO	ML	Interval with 10th highest lead concentration and no detectable nitrate for other.	3	4	3	0.18	27	2	31	2.6	222	23	Pass
BRW18-PZ15	8.0' - 8.9'	Other	ATO	SP	Sample submitted due to upgradient location to help spatial distribution of samples.	13	**55**	<1	0.24	96	30	17	10.6	112	54	Pass

<X = Value less than detection limit (value in cell (X) is the detection limit)

Above Groundwater Standards (2006 ROD, Table 8-1)

Above Waste Identification Criteria (BPSOU SOW; EPA, 2020)

Waste Identification Criteria (Pass/Fail) - If three of the six contaminant criteria listed are exeeded or any one contaminant is above 5,000 mg/kg then, then material is waste.

Table 3 contains additional information on analytical method used, including sample preparation.

****Sample Selection Criteria from Phase I QAPP:**

Criteria from Phase I QAPP:

(1) For tailings, slag, demolition debris, and other materials (not including alluvium) from boreholes, up to 8 samples from each material with the highest lead concentrations and no detectable nitrate concentrations will be sent to the laboratory for SPLP analysis. In addition, up to 8 samples (up to 2 from each material) with the highest copper concentrations will be sent to the analytical laboratory for SPLP analysis.

(2) For alluvium from boreholes, up to 8 samples with the highest chromium and iron concentrations will be sent to the analytical laboratory for SPLP analysis. In addition, up to 2 samples with the highest copper concentrations will be sent to the analytical laboratory for SPLP analysis.

(3) The lead, chromium, iron, and copper concentrations will be based on XRF or ICP-OES results.

(4) If multiple similar samples (i.e., same locations or same material) meet the criteria above for SPLP analysis, field personnel will determine the appropriate samples to be submitted to the laboratory to get results representative of a variety of materials and locations.

Additonal Notes:

(1) Concentrations shown in table are from laboratory analysis conducted prior to SPLP analysis.

(2) To determine samples with the highest chromium and iron concentrations, the concentrations for chromium and iron were ranked numerically for each sample (with "1" representing the highest concentration). Then the rankings for chromium and iron were summed to generate a cumulative ranking value, and the lowest values were selected.

(3) The "Initial Geological Unit Classification" were based on initial field observations. After review, the geological units were reclassified to simplify the remedial design.

(4) Slag samples were not analyzed for nitrate. Due to nature of material the test could not be completed. Additionally, slag samples generally focused on larger rock materials as opposed to smaller gravel.

(5) Only seven samples were sent for demolition debris due to similar material types.

(6) No soil samples representing other material from test pits were submitted for SPLP analysis. Samples collected in the field were insufficient volume to send to the lab. [Deviations Table (Appendix A, Table 1)]

(7) Only one soil sample, representing demolition debris material from test pits, was submitted for analysis via SPLP due to insufficient sample volume. [Deviations Table (Appendix A, Table 1)]

Table 5. Soil ICP and SPLP Analytical Results Summary.

						Arsenic (ICP) (mg/kg)	Arsenic (D - SPLP) (µg/L)	Cadmium (ICP) (mg/kg)	Cadmium* (D - SPLP) (µg/L)	Copper (ICP) (mg/kg)	Copper* (D - SPLP) (µg/L)	Lead (ICP) (mg/kg)	Lead* (D - SPLP) (µg/L)	Zinc (ICP) (mg/kg)	Zinc* (D - SPLP) (µg/L)	Waste Criteria Result (Pass/Fail)
					Groundwater Standards (2006 ROD, Table 8-1)	**-**	**10**	**-**	**5**	**-**	**1,300**	**-**	**15.00**	**-**	**2,000**	**-**
					Waste Criteria (mg/kg)	**200**	**-**	**20**	**-**	**1000**	**-**	**1000**	**-**	**1000**	**-**	**-**
Location	Sample Interval	Initial Geologic Unit Classification	ReClassified Geologic Unit	Lithology	Additonal Sample Selection Notes**											
BRW18-PZ20	7.6' - 12.5'	Slag	Slag - First	GP	Interval with highest copper concentration for slag.	58	10	3	<0.07	**10,300**	33	**1,260**	**16.5**	**12,200**	63	Fail
BRW18-PZ20	7.6' - 12.5'	Slag	Slag - Second	GP	-	NA	9	NA	<0.05	NA	5	NA	3.7	NA	20	-
BRW18-PZ24	9.5' - 14.5'	Slag	Slag - First	GW	Interval with 2nd highest copper concentration for slag.	**263**	3	<1	<0.07	**4,240**	12	224	0.9	**8,800**	20	Fail
BRW18-PZ24	9.5' - 14.5'	Slag	Slag - Second	GW	-	NA	8	NA	<0.05	NA	20	NA	1.5	NA	23	-
BRW18-BH06	7.7' - 10.0'	Slag	Slag - First	GW	Interval with highest lead concentration for slag.	18	4	2	<0.07	**1,520**	8	693	7	**12,000**	27	Fail
BRW18-BH06	7.7' - 10.0'	Slag	Slag - Second	GW	-	NA	2	NA	<0.05	NA	7	NA	8.8	NA	42	-
BRW18-BH06	11.1' - 15.0'	Slag	Slag - First	GP	Interval with 2nd highest lead concentration for slag.	20	<1	2	0.20	**2,480**	11	593	2	**13,700**	707	Fail
BRW18-BH06	11.1' - 15.0'	Slag	Slag - Second	GP	-	NA	<1	NA	0.19	NA	8	NA	0.7	NA	636	-
BRW18-PZ20	12.5' - 15.0'	Slag	Slag - First	GP	Interval with 3rd highest lead concentration for slag.	67	4	2	<0.07	**4,080**	70	**1,600**	**34.2**	**5,780**	69	Fail
BRW18-PZ20	12.5' - 15.0'	Slag	Slag - Second	GP	-	NA	4	NA	<0.05	NA	84	NA	**52.0**	NA	124	-
BRW18-BH01	10.1' - 16.8'	Slag	Slag - First	GP/SP	Interval with 4th highest lead concentration for slag.	**267**	**31**	3	<0.07	**5,770**	21	679	6	**9,820**	14	Fail
BRW18-BH01	10.1' - 16.8'	Slag	Slag - Second	GP/SP	-	NA	**33**	NA	0.08	NA	12	NA	3.6	NA	18	-
BRW18-PZ20	15.0' - 20.0'	Slag	Slag - First	GP	Interval with 5th highest lead concentration for slag.	97	4	4	<0.07	**4,390**	87	**1,960**	**37.9**	**10,900**	139	Fail
BRW18-PZ20	15.0' - 20.0'	Slag	Slag - Second	GP	-	NA	3	NA	0.21	NA	72	NA	**41.2**	NA	194	-
BRW18-PZ12	1.5' - 2.9'	Slag	Slag - First	GW	Interval with 6th highest lead concentration for slag.	**352**	**247**	5	0.11	**4,480**	93	**4,120**	**102**	**13,700**	72	Fail
BRW18-PZ12	1.5' - 2.9'	Slag	Slag - Second	GW	-	NA	**227**	NA	0.16	NA	92	NA	**141**	NA	116	-
BRW18-PZ23	10.0' - 14.2'	Slag	Slag - First	GW	Interval with 8th highest lead concentration for slag. Interval with 7th highest lead concentration was already collected based on copper concentration [BRW18-PZ20(7.6-12.5)].	**498**	**16**	<1	0.24	**4,780**	20	340	2	**4,410**	48	Fail
BRW18-PZ23	10.0' - 14.2'	Slag	Slag - Second	GW	-	NA	8	NA	0.08	NA	6	NA	0.6	NA	16	-
BRW18-PZ19	16.0' - 19.8'	Slag	Slag - First	GM	Interval with 9th highest lead concentration for slag.	181	**15**	10	0.09	**4,260**	21	1,000	9	**20,700**	39	Fail
BRW18-PZ19	16.0' - 19.8'	Slag	Slag - Second	GM	-	NA	**31**	NA	0.19	NA	102	NA	**60.7**	NA	160	-
BRW18-PZ08	6.6' - 7.2'	Tailings	ATO	MH	Interval with highest copper concentration for tailings.	**801**	6	6	**9.19**	**12,200**	**37,300**	**3,640**	**547**	**2,650**	1,780	Fail
BRW18-PZ02	5.3' - 5.7'	Tailings	ATO	CH	Interval with 2nd highest copper concentration for tailings.	**790**	**263**	13	4.96	**4,020**	155	803	10.8	**3,270**	**4,070**	Fail
BRW18-PZ24	25.4' - 26.3'	Tailings	ATO	CH	Interval with highest lead concentration and no detectable nitrate for tailings.	**881**	**32**	**38**	0.68	**2,540**	215	**15,200**	**33.8**	**16,100**	30	Fail
BRW18-BH27	6.4' - 9.2'	Tailings	ATO	OH	Interval with 3rd highest lead concentration and no detectable nitrate for tailings. Interval with 2nd highest lead concentration and no detectable nitrate was already collected based on copper concentration [BRW18-PZ02(5.3-5.7)].	106	**13**	7	0.23	364	41	**1,820**	9.0	**2,970**	13	Pass
BRW18-PZ09	3.8' - 5.1'	Tailings	ATO	OL	Interval with 6th highest lead concentration and no detectable nitrate for tailings. Interval with 4th highest lead concentration and no detectable nitrate was already collected based on copper concentration [BRW18-PZ08(6.6-7.2)], and interval with 5th highest lead concentration and no detectable nitrate did not have sufficient volume for lab analysis [BRW18-BH23(6.0-6.3)].	**2,190**	7	**63**	**308**	**22,700**	**1,440**	**6,310**	**1,280**	**11,000**	**27,600**	Fail
BRW18-PZ05	6.8' - 8.8'	Tailings	ATO	CL	Interval with 8th highest lead concentration and no detectable nitrate for tailings. Interval with 7th highest lead concentration did not have sufficient volume for lab analysis [BRW18-BH27(6.0-6.4)].	80	7	4	1.07	447	31	**2,720**	**28.2**	**1,310**	51	Pass
BRW18-PZ06	7.0' - 9.1'	Tailings	ATO	ML/MH	Interval with 11th highest lead concentration and no detectable nitrate for tailings. Intervals with 9th and 10th highest lead concentrations and no detectable nitrates did not have sufficient volume for lab analysis [BRW18-BH11(10.0-15.0) and BRW18-PZ09(5.9-6.2)].	**750**	**26**	9	0.53	**7,340**	112	640	3.5	**2,650**	71	Fail
BRW18-PZ02	7.2' - 8.3'	Tailings	ATO	OH	Interval with 12th highest lead concentration and no detectable nitrate for tailings.	**434**	**15**	**21**	0.90	**3,860**	37	**22,800**	**95.0**	**21,700**	64	Fail
BRW18-PZ19	19.8' - 20.9'	Tailings	ATO	SM	Interval with 13th highest lead concentration and no detectable nitrate for tailings.	**229**	**28**	13	0.46	**3,390**	27	991	3.8	**7,220**	14	Fail
BRW18-PZ08	8.5' - 9.5'	Tailings	ATO	MH	Interval with 14th highest lead concentration and no detectable nitrate for tailings.	148	10	4	0.89	819	32	**1,630**	6.0	**1,310**	27	Pass

<X = Value less than detection limit (value in cell (X) is the detection limit)

Above In-Stream Chronic Surface Water Performance Standards (2020 ROD Amendment, Table 1)

Above Waste Identification Criteria (BPSOU SOW; EPA, 2020)

Waste Identification Criteria (Pass/Fail) - If three of the six contaminant criteria listed are exeeded or any one contaminant is above 5,000 mg/kg then, then material is waste.

Table 3 contains additional information on analytical method used, including sample preparation.

****Sample Selection Criteria from Phase I QAPP:**

Criteria from Phase I QAPP:

(1) For tailings, slag, demolition debris, and other materials (not including alluvium) from boreholes, up to 8 samples from each material with the highest lead concentrations and no detectable nitrate concentrations will be sent to the laboratory for SPLP analysis. In addition, up to 8 samples (up to 2 from each material) with the highest copper concentrations will be sent to the analytical laboratory for SPLP analysis.

(2) For alluvium from boreholes, up to 8 samples with the highest chromium and iron concentrations will be sent to the analytical laboratory for SPLP analysis. In addition, up to 2 samples with the highest copper concentrations will be sent to the analytical laboratory for SPLP analysis.

(3) The lead, chromium, iron, and copper concentrations will be based on XRF or ICP-OES results.

(4) If multiple similar samples (i.e., same locations or same material) meet the criteria above for SPLP analysis, field personnel will determine the appropriate samples to be submitted to the laboratory to get results representative of a variety of materials and locations.

Additonal Notes:

(1) Concentrations shown in table are from laboratory analysis conducted prior to SPLP analysis.

(2) To determine samples with the highest chromium and iron concentrations, the concentrations for chromium and iron were ranked numerically for each sample (with "1" representing the highest concentration). Then the rankings for chromium and iron were summed to generate a cumulative ranking value, and the lowest values were selected.

(3) The "Initial Geological Unit Classification" were based on initial field observations. After review, the geological units were reclassified to simplyfy the remedial design.

(4) Slag samples were not analyzed for nitrate. Due to nature of material the test could not be completed. Additionally, slag samples generally focused on larger rock materials as opposed to smaller gravel.

(5) Only seven samples were sent for demolition debris due to similar material types.

(6) No soil samples representing other material from test pits were submitted for SPLP analysis. Samples collected in the field were insufficient volume to send to the lab. [Deviations Table (Appendix A, Table 1)]

(7) Only one soil sample, representing demolition debris material from test pits, was submitted for analysis via SPLP due to insufficient sample volume. [Deviations Table (Appendix A, Table 1)]

Table 6. Summary of Historic Infrastructure

Process/System	Description	Remaining Equipment/Data Gaps	QAPP Actions	QAPP Observations
Butte Reduction Works				
Concentrator Plant	The second class ore was sent to the concentrator prior to being smelted in the furnaces. The concentrator consisted of various equipment includ crushers, trommels, jigs, slime classifiers, chilean mills, and tables used to separate the ore from waste rock.	Based on historical information, equipment was demolished or removed shortly after the BRW discontinued operations in 1910. Previous site investigations support the assumption that the concentrator was demolished. However, a foundation for the tailings elevator may still remain.	No actions proposed for Phase I.	No actions proposed for Phase I.
Settling Tanks and Tables	The settling tanks and tables were most likely part of the slime plant which were used to thicken the slimes from the concentrator.	Based on present-day aerial imagery and previous site investigations, infrastructure from the slime plant remains.	**Measurements and photographs** of visible infrastructure will be collected.	Settling ponds are about 5 feet high and about 104 feet long and width is about 15-20 feet. Mostly made of slag. Photos will be included in the PDI Evaluation Report.
Open Ore Kilns	Two open ore kilns were built of blocks of slag with a stack centered between the two kilns.	Based on historical information, equipment was most likely demolished sometime between 1900 and 1914. Previous site investigations support the assumption that the kilns were demolished. However, a foundation for the stack may still remain.	No actions proposed for Phase I.	No actions proposed for Phase I.
Roasting Furnaces (Main Calcine Furnace Building & Calcine Furnace Building No. 2)	The fine material, or screenings, was put through the roasting (e.g., calcining or desulphurizing) furnaces prior to going to the matte furnaces. The calcine department consisted of two buildings with a total of seven furnaces. The buildings were a steel frame construction, and the furnaces were built of steel and brick with no subsurface support/foundation. The flue dust from the furnaces was captured via an extensive system of elevated flues and dust chambers and sent to the main stack.	Based on historical information, equipment was demolished or removed shortly after the BRW discontinued operations in 1910. Previous site investigations support the assumption that the roasting furnaces were demolished and no foundation remains for the Main Calcine Furnace Building. However, a foundation remains for the Calcine Furnace Building No.2 based on present-day aerial imagery. Additionally, a foundation for the stacks may still remain.	A test pit (**BRW18-TP02**) will be excavated to determine the foundation depth for the Calcine Furnace Building No. 2 (Table 2 and Figure 5).	Total depth of BRW18-TP02 was 4.2 feet due to slag. Pockets of tailings with bigger chunks of slag were observed towards the bottom of the test pit. Photos will be included in the PDI Evaluation Report.
Blast Furnaces	The coarse ore material went directly to blast furnaces. The furnaces were built of steel and brick with no subsurface support/foundation. The building was steel frame construction. The flue dust from the furnaces was captured via an extensive system of elevated flues and dust chambers and sent to the main stack.	Based on historical information, equipment was demolished or removed shortly after the BRW discontinued operations in 1910. Could no confirm if a foundation still exists based on available information. Additionally, a foundation for the stack may still remain.	No actions proposed for Phase I. Unable to excavate a test pit due to current location of Butte-Silver Bow's equipment.	No actions proposed for Phase I.
Matte Furnaces	The fine ore from the roasting furnaces is sent to the three reverberatory matting-furnaces. The heated gases from the furnaces pass through Worthington boilers. The flue dust from the furnaces was captured via an extensive system of elevated flues and dust chambers and sent to the main stack.	Based on historical information, equipment was demolished or removed shortly after the BRW discontinued operations in 1910. It appear foundation for the matte furnace building may remain based on historical imagery.	A test pit (**BRW18-TP03**) will be excavated to determine the foundation depth for the Matte Furnace Building (Table 2 and Figure 5).	Total depth of BRW18-TP03 was 1.3 feet due to slag foundation.
Converting Department	The matte from the furnaces was taken to the converting department. The converter building was steel frame construction with an earth floor. The equipment was primarily built with steel and required no subsurface foundation/support. The converters were connected to the elevated flue and dust chamber via a movable hood and fumes were sent to the main stack.	Based on historical information, equipment was demolished or removed shortly after the BRW discontinued operations in 1910. Previous site investigations support the assumption that the converter building and equipment was demolished.	No actions proposed for Phase I.	No actions proposed for Phase I.
Stack	An extensive system of flues and dust chambers collected and sent the flue dust from the equipment to main stack. The stack stood on a slag base 12.5-feet thick. The reinforced concrete base was 42.5-feet by 42.5-feet and 8-feet thick. The stack was 340-feet high, including the concrete base.	Based on historical information, the stack was partially demolished after the BRW discontinued operations in 1910 and was completely demolished after the manganese plant ceased operations with the exception of the slag and concrete bases which still exist today.	No actions proposed for Phase I.	No actions proposed for Phase I.
Tracks & Conveyors	There were multiple elevated tracks, conveyors, and tramways used to transport ore, coal, matte, and copper.	Based on historical information, equipment was demolished or removed shortly after the BRW discontinued operations in 1910.	No actions proposed for Phase I.	No actions proposed for Phase I.
Storage Bins	There were multiple storage bins used for ore and coal at the BRW. The ore bins would most likely have been above ground to allow material to fall out of the bins and onto conveyors, tracks, etc.	Based on historical information, equipment was demolished or removed shortly after the BRW discontinued operations in 1910. However, there is an ore bin located on the southwest portion of the site that still remains.	**Measurements and photographs** of the remaining ore bins will be collected.	Storage bin is about 44 feet long, 16 feet high, and 16 feet wide. Structure mostly concrete, falling apart, with rebar and what looks like 4-inch channel iron running through it. Photos will be included in the PDI Evaluation Report.
Blacktail Creek Flume	The Blacktail Creek Flume was built to channel clean water from Blacktail Creek to the concentrator. The majority of the structure is located underground and is most likely constructed of slag and brick.	Based on aerial imagery and previous site investigations, a portion of the flume remains on the west side of the site. Therefore, it is assumed that a significant portion of the flume may still exist.	A **Geophysical Multichannel Analysis of Surface Waves (MASW) seismic survey** will be completed to locate the Blacktail Creek Flume (Figure 6).	The Geophysical Multichannel Analysis of Surface Waves (MASW) seismic survey was completed. See Appendix C for additional information.
Historic Silver Bow Creek Channel South Culvert	To direct Silver Bow Creek around the tailings, a culvert was built of pilings and plank sidewalls. This culvert was rebuilt and extended during the operations at BRW.	There is little information available on the final construction and alignment of the south culvert.	A **Geophysical Multichannel Analysis of Surface Waves (MASW) seismic survey** will be completed to attempt to verify if the culvert remains (Figure 6).	The Geophysical Multichannel Analysis of Surface Waves (MASW) seismic survey was completed. See Appendix C for additional information.
Misc. Mechanical Systems	Pump House: Consisted of a well, pumps, an iron flue, and stack.	Based on historical information, equipment was demolished or removed shortly after the BRW discontinued operations in 1910. Could not confirm if a foundation remains based on available information. Additionally, a foundation for the stack may still remain.	A test pit (**BRW18-TP01**) will be excavated to determine if a foundation remains and if possible the thickne of the foundation (Table 2 and Figure 5).	Total depth of BRW18-TP01 was 6.4 feet. A brick structure on top of slag was observed at the bottom of the test pit.
	Machine Shop: Constructed with a steel truss roof and contained the blowers for the blast furnaces.	Based on historical information, equipment was demolished or removed shortly after the BRW discontinued operations in 1910. Could not confirm if a foundation remains based on available information.	No actions proposed for Phase I.	No actions proposed for Phase I.
	Motor Repair Shop	Based on historical information, equipment was demolished or removed shortly after the BRW discontinued operations in 1910. Could not confirm if a foundation remains based on available information.	No actions proposed for Phase I.	No actions proposed for Phase I.
	Sampling Works: Ore was sampled as it arrived to the BRW.	Based on historical information, equipment was demolished or removed shortly after the BRW discontinued operations in 1910. Could no confirm if a foundation remains based on available information.	No actions proposed for Phase I. Unable to excavate a test pit due to location underneath a Butte Silver-Bow materials storage pile.	No actions proposed for Phase I.
	Crusher House	Based on historical information, the crusher house was demolished sometime between 1900 and 1914.	No actions proposed for Phase I.	No actions proposed for Phase I.
	Blister Building: The building was a steel frame building with multiple engines, generators, and compressors.	Based on historical information, building was demolished shortly after the BRW discontinued operations in 1910. Based on present-day aerial imagery and previous site investigations, there are remaining concrete structures most likely from engines, generators, compressors etc. located within the building.	**Measurements and photographs** of visible infrastructure will be collected.	Blister building looks like its about 8-10 feet tall, looks like there are about 4 sets of pillars left, that are about 7 feet wide. Length is roughly 30 feet or so. Looks like mostly concrete, rebar, and 4-inch channel. Photos will be included in the PDI Evaluation Report.
	Electric Motor: Assumed to power/move the coal elevators.	Based on historical information, equipment was demolished or removed shortly after the BRW discontinued operations in 1910. Could not confirm if a foundation remains based on available information.	No actions proposed for Phase I.	No actions proposed for Phase I.
Domestic Manganese				
Kilns	The Domestic Manganese kilns were built over the location of the dust chambers for BRW operations which were built of steel frames with a slag base. The building contained two rotary kilns and was constructed of steel frame trusses and posts with wood, concrete, and earth floors.	Based on historical research and previous site investigations, most structures were removed during the 1970s with some remaining infrastructure observed in the early 1990s. Could not confirm if a foundation remains based on available information.	**Measurements and photographs** of visible infrastructure will be collected. Two test pits (**BRW18-TP09 & BRW18-TP16**) will be excavated to determine if a foundation remains and if possible the thickness of the foundation as well as identify if any remaining flue dust is present (Table 2 and Figure 4).	There are 4 structures, roughly 10 feet tall, 7 feet wide, and 13 feet in length. There are 4 concrete structures with rebar, and one of them has steel on the top in the concrete. BRW18-TP09 consisted of demolition debris, railroad ties, and a concrete foundation with a metal lid. BRW18-TP16 consisted of demolition debris, brick, wire, and white ash. Photos will be included in the PDI Evaluation Report.
Ore Mill	The building was constructed of wood posts.	Based on historical research and previous site investigations, most structures were removed during the 1970s with some remaining infrastructure observed in the early 1990s. Additionally, it appears that there were some pumps, conveyors, and crushers beneath the surface that may still remain.	**Measurements and photographs** of visible infrastructure will be collected. Test pits (**BRW18-TP08 & BRW18-TP12**) will be excavated to determine if subsurface structures or equipment remains (Table 2 and Figure 5). One borehole (**BRW18-PZ13**) will be drilled to determine if infrastructure remains (Table 2 and Figure 5).	BRW18-TP08 consisted of demolition debris and tailings (white sand). BRW18-TP12 was not excavated. BRW18-PZ13 consisted of slag and brick within the first 5 feet of core collected.
Transformer Yard	No equipment/construction description available.	Based on historical research, structures were removed during the 1970s. However, there is a concern that PCBs may still exist from the transformer operation.	One borehole will be drilled to determine if PCBs are present (**BRW18-BH13**) (Table 2 and Figure 12).	BRW18-BH13 was not drilled due to proximity to asphalt plant. No samples were collected for PCB's.
Misc. Buildings	The buildings once included a carpenter shop, garages, and an office.	Based on historical research, the structures were removed during the 1970s. Based on previous site investigations, the foundations most likely remain.	No actions proposed for Phase I.	No actions proposed for Phase I.

Purpose: To identify the potentially remaining durable historic infrastructure with the goal of identifying areas for design related test pit locations.

Observations: There are structures that remain at the BRW Site from both the BRW Smelter and the Domestic Manganese plant. The test pit locations indicated in the table are identified on Figure 5.

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Table 7: Summary of Groundwater Analytical Results

			Aluminum	Arsenic		Cadmium		Copper		Iron		Lead		Mercury		Zinc	
			D (µg/L)	TR (µg/L)	D (µg/L)	TR (µg/L)	D (µg/L)	TR (µg/L)	D (µg/L)	TR (µg/L)	D (µg/L)	TR (µg/L)	D (µg/L)	TR (µg/L)	D (µg/L)	TR (µg/L)	D (µg/L)
Groundwater Standards (2006 ROD, Table 8-1)			-	-	**10**	-	**5**	-	**1,300**	-	-	-	**15**	-	**2**	-	**2,000**
In-Stream Chronic Surface Water Performance Standards (2020 ROD Amendment, Table 1)			**87**	**10**	-	**1.0**	-	**12.3**	-	**1,000**	-	**4.79**	-	**0.05**	-	**157**	-
Piezometer**	**Date**	**SI**															
BRW18-PZ01	12/4/2018	10' - 15'	**264**	**470**	**260**	**41**	**40**	**18,700**	**18,900**	**108,000**	110,000	**150**	**130**			**15,300**	**14,800**
	10/22/2019			**440**	**280**	**19**	**18**	**7,400**	**7,700**	**53,400**	55,900	**110**	**100**	**0.86**	0.87	**7,100**	**7,000**
BRW18-PZ02	12/5/2018	10' - 15'	<9	3.0	2.9	**3.6**	3.6	**82**	84	150	62	1.4	0.30			**320**	350
	10/24/2019			2.5	2.2	**4.1**	3.9	**83**	74	180	<12	1.2	0.096	0.016	<0.0039	**370**	360
BRW18-PZ03	12/4/2018	5' - 10'	<9	**12**	**11**	**7.4**	**7.5**	**600**	630	140	140	2.8	0.46			**6,000**	**6,500**
	10/22/2019			**25**	**23**	**7.0**	**7.0**	**380**	400	**1,500**	1,500	1.7	0.65	0.010	<0.0039	**9,800**	**9,700**
BRW18-PZ04	12/4/2018	12.5' - 17.5'	<9	6.0	2.4	**6.0**	**5.7**	**67**	43	620	53	3.6	<0.039			**520**	530
	10/22/2019			2.8	2.6	**4.9**	**5.2**	**40**	33	980	930	0.11	0.050	0.016	0.0090	**490**	530
BRW18-PZ05	12/4/2018	14.4' - 19.4'	<9	2.8	1.1	**7.7**	**7.1**	**22**	7.6	**1,600**	13	**5.0**	0.042			**570**	520
	10/18/2019			1.6	1.3	**6.5**	**7.0**	**16**	14	320	<12	1.1	<0.046	0.020	0.0040	**520**	530
BRW18-PZ06	12/3/2018	14.7' - 19.7'	<9	1.6	1.5	**8.9**	**8.6**	3.9	2.9	69	7.4	0.36	0.077			**730**	770
	10/18/2019			2.7	1.6	**7.8**	**7.8**	4.8	3.2	220	<12	0.76	<0.046	0.0090	<0.0039	**750**	700
BRW18-PZ08	12/3/2018	5.3' - 10.3'	**203**	2.1	2.0	0.62	0.57	5.3	3.1	61	24	0.22	0.074			38	38
	10/17/2019			**12**	8.2	**130**	**140**	**70,900**	**55,800**	**117,000**	109,000	3.1	0.45	**0.90**	0.66	**36,700**	**36,900**
BRW18-PZ09	12/3/2018	12' - 17'	<9	**50**	**38**	**23**	**21**	**17**	4.2	**1,900**	1,600	3.5	0.11			**1,500**	1,500
	10/17/2019			**110**	**95**	**9.7**	**9.4**	12	3.8	**2,300**	2,200	1.3	0.097	0.019	0.0070	**1,500**	1,300
BRW18-PZ10	11/28/2018	15' - 20'	12	3.6	3.3	**1.4**	1.3	**16**	10	410	7.1	0.46	<0.039			74	74
	10/21/2019			2.5	2.5	0.96	1.1	11	9.0	190	81	0.20	<0.046	0.014	<0.0039	66	75
BRW18-PZ11	11/29/2018	19.5' - 24.5'	3.4	4.2	4.0	0.79	0.73	**43**	30	320	13	0.52	0.069			35	31
	10/21/2019			3.0	2.9	0.70	0.75	**49**	47	160	<12	0.23	<0.046	<0.0039	<0.0039	40	37
BRW18-PZ12	11/28/2018	17' - 22'	<9	**20**	5.8	**19**	**19**	**1,900**	**1,600**	**3,900**	3,500	3.8	0.042			**3,300**	**3,200**
	10/21/2019			2.0	2.0	0.45	0.47	8.0	8.6	20	<12	0.094	<0.046	0.0040	<0.0039	48	49
BRW18-PZ13	11/28/2018	19' - 24'	<9	**61**	**59**	0.29	0.30	**16**	11	45	9.6	0.077	<0.039			17	12
	10/21/2019			**35**	**35**	0.32	0.36	6.1	6.1	<12	<12	0.43	<0.046	<0.0039	<0.0039	29	29
BRW18-PZ14	11/29/2018	17.5' - 22.5'	<9	2.7	2.2	**1.3**	1.3	2.4	0.89	320	15	0.39	<0.039			95	98
	10/15/2019			2.8	2.5	0.84	0.74	2.5	0.80	200	<12	0.26	<0.046	<0.0039	<0.0039	88	80
BRW18-PZ15	10/29/2018	20' - 25'	<9	1.9	2.0	0.66	0.68	0.82	0.62	43	14	0.19	0.057			87	93
	10/15/2019			1.5	1.5	0.56	0.57	0.74	0.52	<12	<12	<0.046	<0.046	0.0040	<0.0039	94	100
BRW18-PZ16	11/29/2018	32.5' - 37.5'	<9	6.0	6.0	**1.2**	1.1	**100**	100	100	6.6	0.57	0.057			120	130
	10/21/2019			8.2	8.1	0.52	0.48	**70**	64	78	<12	0.43	0.052	0.0060	<0.0039	70	66
BRW18-PZ17	11/29/2018	15' - 20'	<9	**43**	**43**	**2.9**	2.8	**68**	68	22	6.9	<0.039	<0.039			**230**	260
	10/15/2019			**41**	**40**	**3.7**	3.7	**120**	120	<12	<12	0.17	<0.046	<0.0039	<0.0039	**310**	320

	Chronic Aquatic
Cadmium	1.0
Copper	12.3
Lead	4.79
Zinc	157

	Chronic= exp.{mc[ln(hardness)]+bc}	
	mc	bc
Cadmium	0.7977	-3.909
Copper	0.8545	-1.702
Lead	1.273	-4.705
Zinc	0.8473	0.884

☐	Below Standard or Goal
🟨	Above In-Stream Chronic Surface Water Performance Standard
🟥	Above Groundwater Standard

Acronyms Table	
SI	Screened Interval
TR	Total Recoverable
D	Dissolved

Note: A hardness value of 138 mg/L (reported as $CaCO_3$) from USGS Station 12323240 (SS-04) on February 19, 2014 was used.
All Site COCs are listed in Table 6 except Silver. Silver only has an acute standard, which is not applicable for the Site.
<X = Value less than detection limit (value in cell (X) is the detection limit)

Table 7: Summary of Groundwater Analytical Results

			Aluminum	Arsenic		Cadmium		Copper		Iron		Lead		Mercury		Zinc	
			D (µg/L)	TR (µg/L)	D (µg/L)	TR (µg/L)	D (µg/L)	TR (µg/L)	D (µg/L)	TR (µg/L)	D (µg/L)	TR (µg/L)	D (µg/L)	TR (µg/L)	D (µg/L)	TR (µg/L)	D (µg/L)
Groundwater Standards (2006 ROD, Table 8-1)			-	-	**10**	-	**5**	-	**1,300**	-	-	-	**15**	-	**2**	-	**2,000**
In-Stream Chronic Surface Water Performance Standards (2020 ROD Amendment, Table 1)			**87**	**10**	-	**1.0**	-	**12.3**	-	**1,000**	-	**4.79**	-	**0.05**	-	**157**	-
Piezometer**	**Date**	**SI**															
BRW18-PZ18	11/27/2018	17' - 22'	<9	**87**	**89**	**44**	**37**	**1,300**	1,100	27	<5.4	0.097	<0.039			**15,000**	**11,900**
	10/25/2019			**97**	**93**	**53**	**51**	**1,200**	1,100	<12	<12	<0.046	0.048	0.011	0.0090	**13,300**	**12,500**
BRW18-PZ19	11/27/2018	22' - 27'	<9	9.9	9.8	**5.9**	**6.0**	**62**	50	290	13	3.9	0.37			**650**	560
	10/25/2019			**14**	**15**	**4.7**	4.7	**40**	38	71	<12	0.57	0.096	0.010	<0.0039	**480**	500
BRW18-PZ20	11/30/2018	22.5' - 27.5'	<9	5.1	4.4	**2.9**	3.0	**93**	75	400	180	2.70	0.20			**250**	240
	10/25/2019			6.9	5.8	**2.7**	2.6	**99**	81	240	34	1.3	0.16	0.013	<0.0039	**230**	220
BRW18-PZ21	11/26/2018	25' - 30'	<9	**31**	**30**	**11**	**10**	**82**	72	84	39	0.25	0.072			**850**	810
	10/25/2019			**36**	**37**	**14**	**14**	**140**	140	<12	<12	<0.046	<0.046	0.048	0.0080	**1,100**	1,000
BRW18-PZ22	11/30/2018	24' - 29'	<9	3.1	2.9	**4.3**	4.3	9.7	7.6	200	7.7	0.81	0.040			**450**	420
	10/25/2019			2.2	2.2	**3.8**	3.6	11	11	17	<12	0.11	0.11	0.0090	<0.0039	**410**	400
BRW18-PZ23	11/27/2018	22.5' - 27.5'	<9	3.7	4.0	**8.4**	**8.7**	1.4	1.1	43	13	0.54	0.29			**1,200**	1,200
	10/24/2019			4.0	4.2	**9.0**	**8.8**	3.6	3.1	58	<12	0.49	0.075	0.010	<0.0039	**1,400**	1,300
BRW18-PZ24	11/28/2018	34' - 39'	<9	**11**	9.8	**1.7**	1.8	**59**	30	**1,300**	11	**14**	0.70			**360**	290
	10/24/2019			10	9.0	**1.6**	1.5	**36**	14	920	<12	**9.6**	0.31	**0.11**	<0.0039	**330**	260
BRW18-PZ25	12/5/2018	14.8' - 19.8'	<9	2.3	1.9	**8.4**	**8.2**	3.0	2.0	250	12	0.47	0.19			**540**	510
	10/22/2019			2.7	2.4	**5.3**	**5.3**	2.9	2.1	270	<12	0.56	<0.046	0.0050	<0.0039	**380**	380
BRW19-HCW30	2/4/2020	9.0'-24.0'		**270**	**220**	0.069	<0.030	**16**	0.67	**29,400**	25,200	2.20	0.068	0.0080	<0.0039	**180**	140
BRW19-HCW31	1/28/2020	4.5'-19.5'		5.7	5.7	**4.2**	4.7	**1,200**	1,100	34	<12	**15**	**16**	0.014	0.0060	**1,900**	1,800
BRW19-HCW32	1/20/2020	6.0'-21.0'		**110**	**66**	**6.0**	**5.6**	**170**	92	**3,400**	2,300	2.20	0.17	0.011	<0.0039	**1,100**	880
BRW19-HCW33R	2/5/2020	4.0'-19.0'		**53**	**49**	**4.2**	4.3	**160**	140	620	460	1.30	0.75	0.010	0.0070	**390**	380
BRW19-HCW34	2/5/2020	5.0'-20.0'		**170**	**160**	0.12	<0.030	**45**	0.97	**22,300**	21,300	**7.9**	0.26	0.025	<0.0039	140	100
BRW19-HCW35	2/4/2020	4.0'-19.0'		**52**	**48**	**1.6**	1.7	**58**	53	25	<12	0.11	<0.046	<0.0039	<0.0039	**160**	150
BRW19-HCW36	2/5/2020	3.0'-18.0'		**27**	**27**	0.76	0.77	**49**	42	63	<12	0.11	<0.046	<0.0039	<0.0039	59	59
BRW19-HCW37	2/5/2020	10.0'-25.0'		**30**	**27**	**12**	**11**	**280**	200	470	350	**30**	**23**	**0.087**	0.026	**5,900**	**5,200**
BRW19-HCW38	2/6/2020	6.0'-21.0'		6.5	4.5	**15**	**16**	**820**	720	370	280	**78**	**62**	**0.051**	0.017	**5,400**	**5,100**
BRW19-HCW39	2/5/2020	3.0'-18.0'		**42**	**38**	**43**	**49**	**410**	430	520	420	0.52	<0.046	0.0070	0.0080	**13,500**	**13,300**
BRW19-HCW40	1/28/2020	2.0'-17.0'		**14**	**11**	1.0	1.0	**74**	52	710	470	0.72	<0.046	<0.0039	<0.0039	**200**	190
BRW19-HCW41	1/28/2020	3.0'-18.0'		**15**	**15**	**2.1**	2.1	**62**	56	110	<12	0.40	<0.046	<0.0039	<0.0039	98	95
BRW19-HCW42	1/28/2020	3.0'-18.0'		**16**	**16**	**8.2**	**8.4**	**510**	490	70	<12	0.21	<0.046	<0.0039	<0.0039	**2,500**	**2,300**
MW-01-MPC	10/23/2019	3.0'-13.0'		2.3	1.6	0.14	0.11	**33**	19	660	37	1.20	0.24	0.014	<0.0039	33	24
	1/30/2020			4.0	2.4	0.22	0.056	**26**	4.4	**1,100**	<12	0.82	<0.046	0.0050	<0.0039	27	7.1
MW-02-MPC	10/23/2019	3.0'-12.5'		1.6	1.7	0.060	0.057	**15**	15	<12	<12	<0.046	<0.046	<0.0039	<0.0039	4.5	5.2
	1/30/2020			1.4	1.6	0.056	0.057	11	10	26	<12	0.074	<0.046	<0.0039	<0.0039	4.1	4.3
MW-03A-MPC	10/23/2019	22'-33'		8.1	8.6	0.42	0.36	2.4	1.8	140	<12	0.77	<0.046	<0.0039	<0.0039	27	23
	1/30/2020			7.6	7.8	0.33	0.38	1.2	13	<12	14	<0.046	<0.046	<0.0039	0.010	22	24
MW-03-MPC	10/23/2019	3.5'-13.5'		**1,400**	**1,400**	**1.6**	1.5	**700**	730	43	16	1.1	0.99	0.0090	0.0080	**660**	690
	1/30/2020			**1,500**	**1,300**	**2.5**	1.8	**780**	580	**1,200**	<12	**9.4**	0.52	0.012	0.0040	**810**	570

	Chronic Aquatic
Cadmium	1.0
Copper	12.3
Lead	4.79
Zinc	157

	Chronic= exp.{mc[ln(hardness)]+bc}	
	mc	bc
Cadmium	0.7977	-3.909
Copper	0.8545	-1.702
Lead	1.273	-4.705
Zinc	0.8473	0.884

☐	Below Standard or Goal
🟨	Above In-Stream Chronic Surface Water Performance Standard
🟥	Above Groundwater Standard

Acronyms Table	
SI	Screened Interval
TR	Total Recoverable
D	Dissolved

Note: A hardness value of 138 mg/L (reported as $CaCO_3$) from USGS Station 12323240 (SS-04) on February 19, 2014 was used.

All Site COCs are listed in Table 6 except Silver. Silver only has an acute standard, which is not applicable for the Site.

<X = Value less than detection limit (value in cell (X) is the detection limit)

Table 8. Monthly Depths to Groundwater

Location	Measuring Point Elevation	Transducer	Depth to Groundwater (ft)																			
			1/4/2019 & 1/7/2019	1/24/2019	2/28/2019	3/28/2019	4/30/2019	5/29/2019	6/27/2019	7/26/2019	8/28/2019	9/27/2019	10/28/2019	11/25/2019	12/30/2019	1/29/2020	2/28/2020	Average	Average (no outliers)	Standard Deviation[6]	Standard Deviation (no outliers)
BRW18-PZ01	5442.507		6.73[1]	5.81	**5.87**	5.07	4.86	**4.76**	5.22	5.45	5.56	5.41	5.36	5.54	5.76	5.81	5.88	5.54	5.45	0.47	0.36
BRW18-PZ02	5440.438		FROZEN	FROZEN	FROZEN	FROZEN	**2.42**	2.48	2.86	3.15	**3.31**	3.18	3.02	3.19	FROZEN	FROZEN	FROZEN	2.95	-	0.32	-
BRW18-PZ03	5441.043		FROZEN	FROZEN	FROZEN	FROZEN	**2.81**	2.83	3.32	3.62	3.76	3.49	3.39	3.58	**3.78**	FROZEN	FROZEN	3.40	-	0.34	-
BRW18-PZ04	5441.373		4.01	FROZEN	FROZEN	FROZEN	**3.20**	3.24	3.61	3.85	4.05	3.81	3.71	3.87	4.05	**4.08**	FROZEN	3.77	-	0.30	-
BRW18-PZ05	5441.63	X	4.30	FROZEN	FROZEN	FROZEN	3.61	**3.55**	3.9	4.15	4.31	4.12	4.02	4.21	4.32	**4.34**	FROZEN	4.08	-	0.27	-
BRW18-PZ06	5441.454		4.56	4.62	**4.70**	4.15	8.33[1]	**3.86**	4.17	4.45	4.52	4.37	4.29	4.46	4.62	4.69	4.73	4.70	4.44	1.00	0.24
BRW18-PZ08	5443.765		6.80	6.83	6.84	6.21	5.99	**5.84**	6.52	**6.86**	**6.86**	6.64	6.43	6.63	6.68	6.71	6.81	6.58	-	0.31	-
BRW18-PZ09	5441.701	X	5.06	5.10	**5.13**	4.70	**4.45**	**4.45**	4.74	4.92	5.06	4.89	4.80	4.98	5.05	5.10	5.13	4.90	-	0.22	-
BRW18-PZ10	5448.721		9.25	9.32	**9.41**	8.68	**8.24**	8.35	8.74	9.03	6.24[1]	9.07	8.92	9.11	9.28	9.33	9.38	8.82	9.01	0.77	0.36
BRW18-PZ11	5447.874		7.93	8.02	**8.08**	7.37	**6.96**	7.06	7.45	9.70[1]	7.89	7.67	7.61	7.75	7.95	8.00	8.05	7.83	7.70	0.60	0.35
BRW18-PZ12	5448.986	X	8.47	8.54	**8.60**	7.96	**7.57**	7.65	8.01	8.27	8.44	8.23	8.16	8.31	8.47	8.54	8.57	8.25	-	0.32	-
BRW18-PZ13	5450.491		9.47	9.58	**9.59**	9.00	**8.62**	8.76	9.09	9.33	9.49	9.28	9.21	9.35	9.50	9.54	9.58	9.29	-	0.29	-
BRW18-PZ14	5448.876		7.32	7.36	**7.41**	6.87	**6.56**	6.65	7.01	7.22	7.39	7.14	7.06	7.21	7.29	7.36	7.39	7.15	-	0.26	-
BRW18-PZ15	5448.239	X	9.85[1]	6.89	**6.95**	6.39	**6.07**	6.15	6.50	8.71[1]	6.60	6.63	7.51[1]	6.68	6.80	6.88	6.91	7.03	6.62	0.97	0.28
BRW18-PZ16	5461.915		21.08	21.14	**21.19**	20.60	**20.30**	20.35	20.68	19.93[1]	21.09	20.85	20.74	20.96	21.05	21.10	21.16	20.81	20.88	0.37	0.29
BRW18-PZ17	5448.562		7.48	7.54	**7.59**	7.00	**6.67**	6.83	7.13	7.35	7.49	7.30	7.21	7.37	7.49	7.55	7.58	7.31	-	0.28	-
BRW18-PZ18	5449.737		9.68	9.76	**9.80**	6.22[1]	**8.77**	8.91	9.23	9.48	9.64	9.54	9.35	9.52	9.67	9.75	9.78	9.27	9.49	0.87	0.31
BRW18-PZ19	5454.818		15.06	15.13	**15.18**	14.66	**14.22**	14.34	14.65	14.93	15.06	14.84	14.76	14.91	15.05	15.12	15.16	14.87	-	0.29	-
BRW18-PZ20	5451.467		11.83	11.89	**11.97**	11.34	**10.91**	11.03	11.37	11.62	11.80	NO ENTRY	11.49	11.64	11.83	11.88	11.93	11.61	-	0.33	-
BRW18-PZ21	5455.079		15.37	15.44	**15.51**	14.88	**14.42**	14.57	14.87	15.14	15.32	15.12	15.04	15.19	15.38	15.43	15.47	15.14	-	0.32	-
BRW18-PZ22	5453.88		15.58	15.63	**15.68**	15.14	**14.77**	14.84	15.19	15.43	15.59	15.38	15.28	14.46[1]	15.58	15.62	15.67	15.32	15.38	0.36	0.29
BRW18-PZ23	5450.547		11.93	**12.01**	12.5[1]	11.54	**11.15**	11.23	11.55	11.80	11.94	11.74	11.64	11.81	11.94	11.97	12.01	11.78	11.73	0.32	0.27
BRW18-PZ24	5460.152		21.74	**21.86**	21.83	21.37	**21.01**	21.02	21.37	21.58	21.72	21.51	20.42[1]	21.79	21.71	21.75	21.80	21.50	21.58	0.39	0.27
BRW18-PZ25	5440.455		5.05	5.15	5.19	4.76	4.52	**4.51**	4.77	4.94	5.01	4.85	4.81	4.97	5.19	**5.30**	5.34	4.96	-	0.25	-
AMW-02	5452.535		10.58	10.61	**10.72**	10.11	9.66	**9.64**	10.01	10.27	10.67	10.11	10.02	10.33	10.44	10.53	10.60	10.29	-	0.34	-
BPS07-08A	5450.465		10.20	10.29	**10.35**	9.70	9.32	**9.26**	9.68	9.91	10.09	9.83	9.74	9.97	10.13	10.23	10.26	9.93	-	0.33	-
BPS07-13A	5463.576	X	24.65[1]	23.69	**23.75**	23.17	**23.10**	23.82[1]	23.29	23.53	23.65	23.42	24.13[1]	24.30[1]	24.41[1]	23.63	23.71	23.75	23.49	0.44	0.22
BPS07-13B	5464.695	X	24.44	24.47	**24.52**	23.98	23.66	**23.63**	23.99	24.25	24.37	24.18	24.05	24.25	24.36	24.42	24.48	24.20	-	0.28	-
BPS07-14A	5459.521	X	FROZEN	FROZEN	FROZEN	FROZEN	**21.38**	21.48	21.79	22.10	20.75[1]	22.05	20.32[1]	**22.13**	FROZEN	FROZEN	FROZEN	21.50	21.82	0.62	0.30
BPS07-15A	5459.327	X	19.56	19.64	**19.67**	19.25	**18.79**	18.83	19.16	19.39	19.57	19.38	19.24	19.41	19.54	19.60	19.65	19.38	-	0.27	-
BPS07-25[2]	5449.082	X	11.64	10.81	10.84	10.35	10.88	10.88	10.36	11.45	10.69	11.36	10.39	10.62	10.03	10.79	10.83	10.79	-	0.42	-
BPS11-01	5450.083		FROZEN	FROZEN	9.43[1]	FROZEN	8.26	**8.24**	8.63	8.89	**9.08**	8.76	8.72	8.98	FROZEN	BURIED	BURIED	8.78	8.70	0.36	0.29
BPS11-02	5447.272		FROZEN	FROZEN	NO ENTRY	FROZEN	**5.41**	5.44	5.79	6.03	6.22	5.95	5.80	6.02	FROZEN	**6.25**	FROZEN	5.88	-	0.28	-
BPS11-05A1	5449.384	X	7.93	7.98	**8.02**	7.45	**7.14**	7.34	7.60	7.81	7.97	7.76	7.67	7.81	7.92	7.98	8.01	7.76	-	0.26	-
BPS11-05A2	5449.463	X	7.95	7.97	**8.05**	7.46	**7.16**	7.32	7.62	7.83	7.98	7.75	7.67	7.83	7.96	8.03	8.07	7.78	-	0.27	-
BPS11-06	5452.047	X	11.40	11.45	**11.59**	10.96	**10.53**	10.66	10.98	11.21	11.37	11.16	11.08	11.24	11.38	11.44	11.49	11.20	-	0.30	-
BPS11-07	5455.461		16.35	16.44	16.48	15.91	**15.51**	15.55	15.86	16.13	16.27	16.02	15.94	16.15	16.31	16.38	16.43	16.12	-	0.30	-
BPS11-08	5456.821		FROZEN	15.02	**15.13**	FLOODED	**12.94**	13.17	13.67	14.06	14.40	14.02	14.06	14.45	14.80	15.03	FROZEN	14.23	-	0.69	-
BPS11-09	5448.202		5.22	5.27	**5.31**	4.67	**4.49**	4.59	4.88	5.09	5.33	4.67	4.92	5.15	5.16	5.23	5.25	5.02	-	0.28	-
BPS11-12A	5452.35		8.58	8.62	**8.65**	BURIED	BURIED	**7.95**	8.23	8.50	8.63	8.38	8.33	8.46	8.53	8.60	8.60	8.47	-	0.19	-
FP98-01B	5461.322	X	23.85	23.88	**23.94**	23.49	23.14	**23.13**	23.48	23.71	23.87	23.67	23.58	23.73	21.86[1]	23.89	23.92	23.54	23.66	0.52	0.26
FP98-1	5443.134	X	FROZEN	7.86[1]	6.41	5.68	5.50	**5.30**	6.07	6.43	**6.45**	6.98[1]	6.01	6.34	6.40	6.34	6.45	6.30	6.12	0.61	0.39
FP98-2	5441.485		5.94	6.01	6.02	5.64	5.40	**5.36**	5.62	5.68	5.87	5.72	5.69	5.86	6.02	**6.03**	6.05	5.79	-	0.22	-
GS-13A	5443.808		7.08	**7.09**	7.05	6.54	6.77[1]	**6.35**	6.79	6.86	6.87	6.62	6.64	6.96	6.99	6.98	7.08	6.84	6.85	0.22	0.22
GS-13B	5441.888		4.76	4.85	4.85	4.45	4.17	**4.10**	4.45	4.62	4.72	4.50	4.46	4.63	**4.91**	4.81	4.83	4.61	-	0.24	-
HCA-MG3	5460.346		21.15	21.43	**21.70**	20.83	17.07	**15.76**	16.79	17.16	18.79	16.61[3]	17.51	20.18	20.99	21.43	21.76	19.28	19.47	2.15	2.10
FP98-3	5445.89		NO ENTRY	FROZEN	FROZEN	FROZEN	FROZEN	DRY	DRY	DRY	DRY	DRY	DRY	DRY	FROZEN	FROZEN	6.88	6.88	-	-	-
FP98-5	5439.444		5.66	5.74	5.79	5.42	5.18	**5.15**	5.38	5.55	5.62	5.49	5.46	5.61	5.78	**5.80**	5.83	5.56	-	0.21	-
GS-29SR	5448.852		6.66	6.69	**6.74**	5.62[1]	**5.65**	5.91	6.29	6.55	7.01	6.33	6.27	6.54	6.56	6.59	6.70	6.41	6.46	0.39	0.34
BRW19-HCW40	5447.048		-	-	-	-	-	-	-	-	-	-	-	-	-	8.90	8.93	8.92	-	-	-
BRW19-HCW42	5446.222		-	-	-	-	-	-	-	-	-	-	-	-	-	8.10	8.14	8.12	-	-	-
BRW19-HCW36	5449.042		-	-	-	-	-	-	-	-	-	-	-	-	-	9.65	9.68	9.67	-	-	-
BRW19-HCW41	5447.894		-	-	-	-	-	-	-	-	-	-	-	-	-	8.49	8.52	8.51	-	-	-
BRW19-HCW31	5448.683		-	-	-	-	-	-	-	-	-	-	-	-	-	11.86	11.90	11.88	-	-	-
BRW19-HCW32	5451.852		-	-	-	-	-	-	-	-	-	-	-	-	-	15.02	15.05	15.04	-	-	-
BRW19-HCW35	5450.738		-	-	-	-	-	-	-	-	-	-	-	-	-	11.85	11.88	11.87	-	-	-
BRW19-HCW39	5447.932		-	-	-	-	-	-	-	-	-	-	-	-	-	9.47	9.50	9.49	-	-	-
BRW19-HCW30	5452.078		-	-	-	-	-	-	-	-	-	-	-	-	-	16.01	16.03	16.02	-	-	-
BRW19-HCW37	5452.519		-	-	-	-	-	-	-	-	-	-	-	-	-	14.96	15.00	14.98	-	-	-
BRW19-HCW38	5448.493		-	-	-	-	-	-	-	-	-	-	-	-	-	10.99	11.04	11.02	-	-	-
BRW19-HCW33R	5450.066		-	-	-	-	-	-	-	-	-	-	-	-	-	12.28	12.14	12.21	-	-	-
BRW19-HCW34	5449.928		-	-	-	-	-	-	-	-	-	-	-	-	-	11.46	11.52	11.49	-	-	-
MW-01-MPC[4,5]	5449.474		-	-	-	-	-	-	-	8.82	6.35	6.17	7.54	8.67	9.15	7.97	9.23	7.99	-	1.13	-
MW-02-MPC[5]	5447.228		-	-	-	-	-	-	-	6.16	7.92[1]	7.59[1]	**6.11**	6.25	6.47	**6.54**	6.60	6.71	6.36	0.63	0.19
MW-03-MPC[5]	5447.219		-	-	-	-	-	-	-	5.67	5.76	5.6	**5.56**	5.73	5.85	**5.90**	5.91	5.75	-	0.12	-
MW-03A-MPC[5]	5447.32		-	-	-	-	-	-	-	5.65	5.83	5.64	**5.56**	5.71	5.54[3]	**5.88**	5.96	5.72	5.75	0.14	0.13

[1] Data point does not fit with the overall behavior of the local groundwater. The point has been identified as an outlier and has not been used to generate contours in any figures.

[2] Groundwater in this location does not match the behavior of any other location. This is likely due to the influence of the nearby Hydraulic Control Channel (HCC). The data from this location has not been used to generate contours in any figures

[3] Datapoint does not appear to fit with the overall behavior of the local groundwater. However, it has not been identified as an outlier. It has been used to generate contours in figures.

[4] Groundwater in this location does not match the behavior of any other location. **[REASON UNKNOWN]**. The data from this location has not been used to generate contours in any figures

[5] Access agreements at the Northwestern Energy property were obtained in July 2019.

[6] Highlighted values were used to generate shading (kriging) shown in Figures 9 and 10. These values are within the BRW Site boundary and do not have data set outliers.

Blue Text	Lowest groundwater elevation for this well (highest DTW measurement).
Red Text	Highest groundwater elevation for this well (lowest DTW measurement).

*Depth to Water is measured in feet from top of PVC or top of steel casing (if no PVC casing is present). The measuring point elevations have been surveyed and are listed in the indicated column.

Table 9. Hydrocarbon Impacted Soil Treatment Results

Sample ID			**BRW18-LFCHK-11022018**	**BRW19-LFBK(0-0.162)-03212019**	**BRW19-LFS(0-0.25)-03212019**	**BRW19-HCC-071119**	**BRW19-HCCBCK-071119**	**BRW19-BCKUG-080119**	**BRW19-BCKDG-080119**	**BRW19-HCC-10282019**	**BRW19-BCK-10282019**
Date of Collection			11/2/2018	3/12/2019	3/12/2019	7/11/2019	7/11/2019	8/1/2019	8/1/2019	10/28/2019	10/28/2019
Sample Type			Landfarm Soil Sample (Initial Laboratory Analysis)	Background Soil Sample	Landfarm Soil Sample	Landfarm Soil Sample *(Additional soil was added to landfarm on July 11, 2019.)*	Background Soil Sample	Background Soil Sample - Upgradient	Background Soil Sample - Downgradient	Landfarm Soil Sample	Background Soil Sample
Method of Collection			5-point composite	5-point composite	5-point composite	5-point composite	5-point composite	5-point composite	5-point composite	5-point composite	5-point composite
Sample Depth			0-2" bgs	0-2" bgs	0-3" bgs	0-6" bgs	0-6" bgs	0-6" bgs	0-6" bgs	See Logbook	See Logbook
Analyte		**Method**	**Result (mg/kg-dry)**	**Result (mg/kg-dry)**	**Result (mg/kg-dry)**	**Result (mg/kg-dry)**	**Result (mg/kg-dry)**	**Result (mg/kg-dry)**	**Result (mg/kg-dry)**	**Result (mg/kg-dry)**	**Result (mg/kg-dry)**
Arsenic (As)		EPA 6010.20	199	211	162	160	105	N/A	N/A	142	141
Barium (Ba)			N/A	145	173	141	193	N/A	N/A	140	156
Cadmium (Cd)			3	5	3	3	6	N/A	N/A	3.4	4.5
Chromium (Cr)			N/A	13	18	31	31	N/A	N/A	45	22
Lead (Pb)			243	3170	215	N/A	N/A	N/A	N/A	461	2850
Selenium (Se)			N/A	<0.4	<0.4	<0.4	<0.4	N/A	N/A	<0.8	<0.9
Silver (Ag)			N/A	12	5	7	8	N/A	N/A	6.3	10.8
Mercury (Hg)		SW-7471B	N/A	1.3	0.69	0.71	0.69	N/A	N/A	0.65	1.1
Butte MWR O&M Manual Threshold[1]											
Total Hydrocarbons (TEH plus TPH)	100 ppm	Calculation	919.6	17	70.3	220	152	N/A	N/A	193.6	86
Montana Risk-Based Screening Levels (RBSL)[2]											
Volatile Petroleum Hydrocarbons (VPH)											
C5-C8 Aliphatics	52 ppm	MA-VPH	<1.1	<1.1	<1.1	<0.99	<0.98	N/A	N/A	0.84	<0.36
C9-C12 Aliphatics	77 ppm		1.5	<0.78	3.6	<0.71	<0.70	N/A	N/A	0.67	<0.22
C9-C10 Aromatics	130 ppm		<0.16	<0.16	<0.16	<0.14	<0.14	N/A	N/A	<0.11	<0.11
Total Purgeable Hydrocarbons	N/A		1.6	<0.93	4.3	<0.84	<0.83	N/A	N/A	1.6	<0.43
MTBE	0.078* ppm		<0.0097	<0.015	<0.015	<0.013	<0.013	N/A	N/A	<0.012	<0.012
Benzene	0.07 ppm		<0.0051	<0.024	<0.025	<0.022	<0.022	N/A	N/A	<0.0073	<0.0075
Toluene	21 ppm		<0.0051	<0.018	<0.029	<0.017	<0.016	N/A	N/A	<0.0048	<0.0049
Ethylbenzene	6.4 ppm		<0.0034	<0.029	<0.030	<0.010	<0.0099	N/A	N/A	<0.011	<0.012
Xylenes	72 ppm		<0.0082	<0.034	<0.0082	<0.0092	<0.0092	N/A	N/A	0.094	<0.0042
Naphthalene	4.3 ppm		<0.011	<0.062	0.079	<0.016	<0.016	N/A	N/A	<0.021	<0.021
Lead Scavengers											
1, 2-Dibromoethane (EBD)	0.000086* ppm	SW-8011	N/A	<0.000062	<0.00006	<0.00011	<0.00011	N/A	N/A	<0.00011	<0.00011
1, 2-Dichloroethane (DCA)	0.019 ppm	SW-8260B	N/A	<0.0027	<0.0027	<0.0024	<0.0024	N/A	N/A	<0.0025	<0.0025
Extractable Petroleum Hydrocarbons (EPH)											
EPH Screen, Fractionate	200 ppm	SW-8015M	1070	17	233	494	222	94	242	--	--
C9-C18 Aliphatics	110 ppm	MA-EPH	55	N/A	<1.4	<1.2	<1.1	N/A	<1.1	<1.2	<1.2
C19-C36 Aliphatics	24000 ppm		393	N/A	27	87	89	N/A	29	60	26
C11-C22 Aromatics	370 ppm		457	N/A	32	94	53	N/A	31	79	39
Total Extractable Hydrocarbons	N/A		918	N/A	66	220	152	N/A	67	192	86
Acenaphthene	27 ppm		N/A	N/A	N/A	0.016	0.032	N/A	<0.0025	<0.0050	<0.0053
Anthracene	2200 ppm		N/A	N/A	N/A	0.064	0.092	N/A	0.0092	0.054	0.032
Benz(a)anthracene	1.3 ppm		N/A	N/A	N/A	0.24	0.34	N/A	0.037	0.14	0.092
Benzo(a)pyrene	0.13** ppm		N/A	N/A	N/A	0.27	0.44	N/A	0.055	0.19	0.12
Benzo(b)fluoranthene	1.3 ppm		N/A	N/A	N/A	0.35	0.51	N/A	0.059	0.22	0.13
Benzo(k)fluoranthene	13 ppm		N/A	N/A	N/A	0.11	0.17	N/A	0.029	0.084	0.058
Chrysene	130 ppm		N/A	N/A	N/A	0.28	0.4	N/A	0.051	0.16	0.12
Dibenzo(a,h)anthracene	0.13** ppm		N/A	N/A	N/A	0.054	0.091	N/A	0.013	0.055	0.028
Fluoranthene	85 ppm		N/A	N/A	N/A	0.53	0.69	N/A	0.078	0.32	0.19
Fluorene	35 ppm		N/A	N/A	N/A	0.021	0.038	N/A	<0.0028	0.027	0.015
Indenol(1, 2, 3-cd)pyrene	1.3 ppm		N/A	N/A	N/A	0.23	0.38	N/A	0.045	0.19	0.11
Naphthalene	4.3 ppm		N/A	N/A	N/A	0.013	0.021	N/A	0.0074	<0.0055	<0.0057
Pyrene	83 ppm		N/A	N/A	N/A	0.41	0.61	N/A	0.075	0.28	0.19
1-Methylnaphthalene	2.1 ppm		N/A	N/A	N/A	<0.0024	0.014	N/A	<0.0024	<0.0048	<0.0050
2-Methynaphthalene	6.9 ppm		N/A	N/A	N/A	0.0077	0.012	N/A	<0.0069	<0.0052	<0.0054

Red text - analytical result above applicable Butte MWR O&M Manual Threshold or RBSL

<X = Value less than approximate detection limit (value in cell (X) is the approximate detection limit). Method detection limits vary slightly between each sample event.

N/A - Analysis not performed

[1] Source: *Butte Mine Waste Repository (MWR) Operations and Maintenance (O&M) Manual (Atlantic Richfield, 2015)*

[2] Source: *Montana Risk-Based Corrective Action Guidance for Petroleum Releases, Table 1 - Residential RBSLs with Less Than 10-feet to Groundwater (DEQ, 2018)*

*The best achievable practical quantitation limit (0.20) is greater than the RBSL; therefore, if the compound is detected, an additional evaluation may be necessary.

**The best achievable practical quantitation limit (0.33) is greater than the RBSL; therefore, if the compound is detected, an additional evaluation may be necessary.

Table 10: Approximate Volumes of Materials Within BRW Site

Material Type	Volume within the Site Boundary	Volume within the Preliminary Removal Corridor (Figure 3)$^{(3)}$
	Cubic Yards	Cubic Yards
Alluvium, Tailings, and Organic Soil (ATO) - All	798,000	408,000
Slag	305,000	43,000
Demolition Debris	57,000	26,000
Other (e.g., general fill from BSB Operations)	49,000	21,000
ATO - Waste	95,000	49,000
Waste$^{(2)}$	506,000	139,000
Material to Be Removed During Remedial Action$^{(4)}$	NA	147,000

Notes:

(1) The volumes depicted in this table are approximate and are based on the modeling done in the Leapfrog Works software.

(2) The waste material volume includes the volume of slag, demolition debris, other, and ATO-Waste. Additionally, the upper 95% regression is used to adjust the XRF data.

(3) The excavated material is preliminary. The removal corridor and excavation surface will be refined further during the remedial design and will be submitted for Agencies' review and approval.

(4) The material to be removed during the remedial action includes only the material captured by the preliminary waste excavation surface, which captures waste in the removal corridor and incorporates construction feasible side slopes and grade along the deepest parts of the surface. The preliminary waste excavation surface does not include the material to be removed to accommodate the stream design or to accommodate end land use features. Additional details on the surface and its evaluation in Leapfrog can be found in Appendix C of the main document.

Appendix A
Phase I Data Summary Report

Provided Separately

Appendix B
Lithology Logs

PIONEER TECHNICAL SERVICES, INC.

Borehole Log

Borehole Name: **BRW18-BH01**

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): NA ft
Water Level from MP: NA ft
Date:NA
Time:NA

Logged By: K. Jackson, J. Flammang

Date Drilled: 10/12/2018

Casing Type/Dia: None

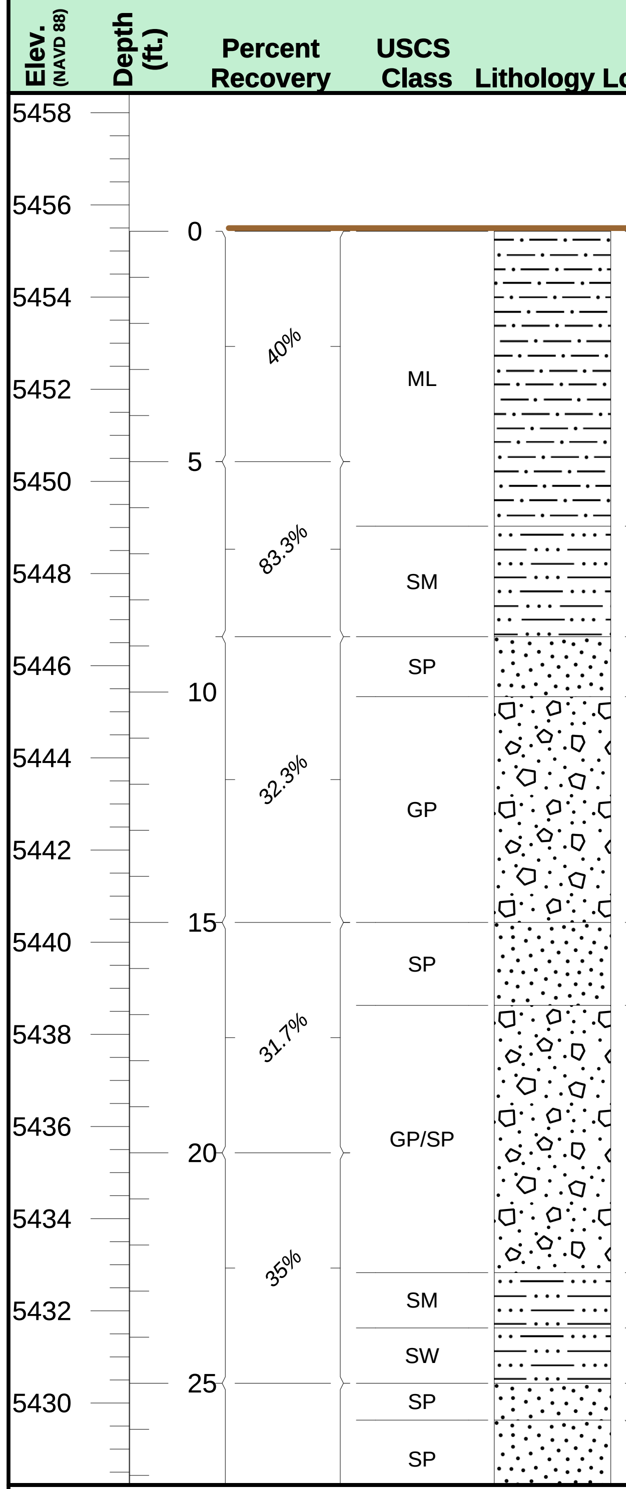
Borehole Diameter: 4"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length: None

Ground Elevation: 5455.43 ft (NAVD 88)



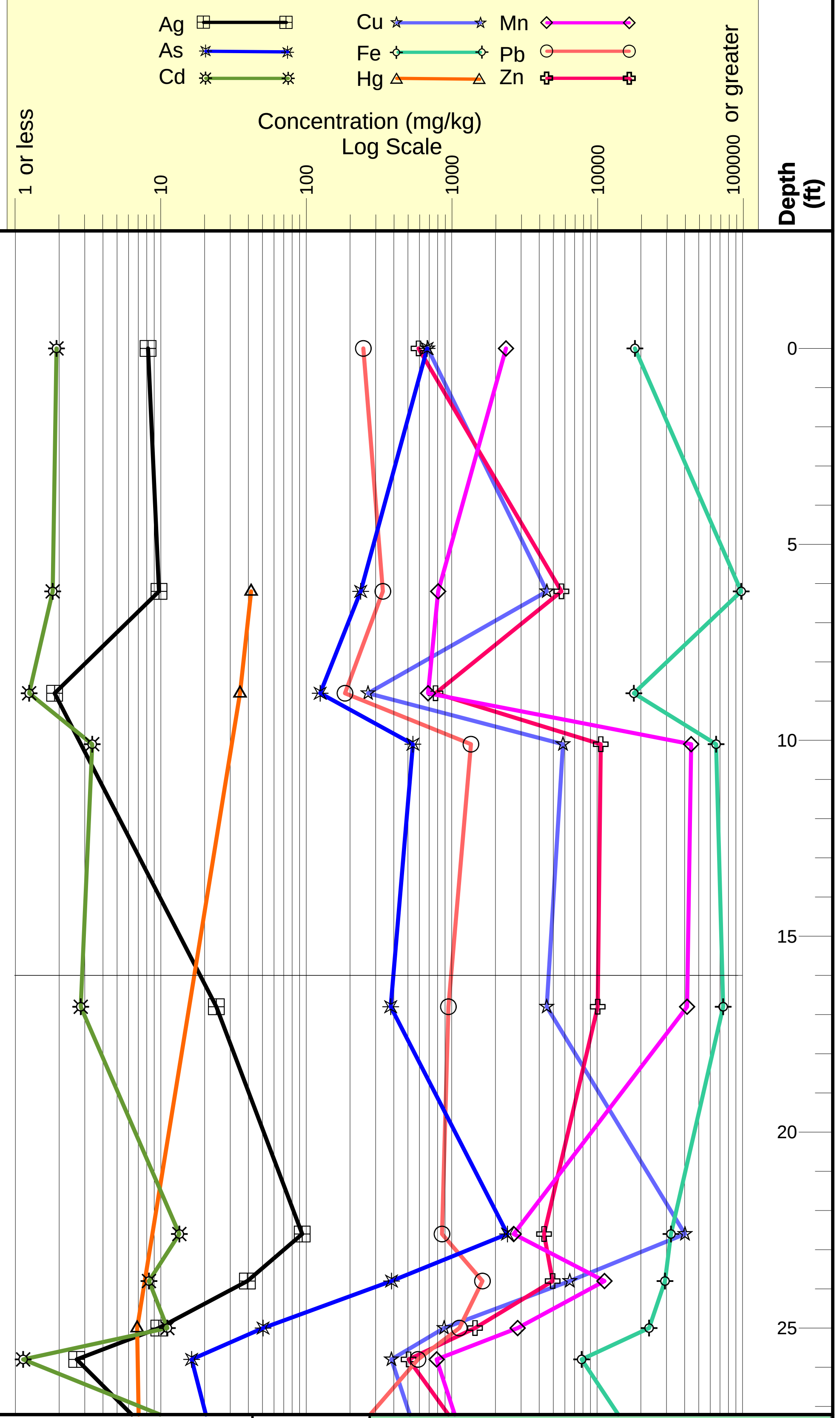
Ground Level

USCS Class	Lithology Log
ML	Loose, dry, black gray red brown, SANDY SILT with coarse to cobble-gravel, construction debris (asphalt, brick concrete, topsoil), chunk of slag [Note from the field sheet: Length Represented was miscalculated for the 5-foot to 8.8-foot core. The Length Represented for the lithology for the 5-foot to 8.8-foot core should be divided at 6.4' (not 6.2' as listed in the field sheet).]
SM	Loose, dry (powder), gray, SILTY SAND with trace amounts of coarse to cobble gravel, slag
SP	Loose, moist, brown black, medium SAND with coarse gravel, micaceous
GP	Loose, moist wet, black, coarse to cobbles-GRAVEL, no fines, slag
SP	Loose, wet, black, silty fine to medium SAND, crushed slag
GP/SP	Loose, wet, black, fine to cobble-GRAVEL, slag, no fines
SM	Loose, wet, brown with red layer 1", fine SILTY SAND
SW	Loose, wet, brown, coarse SILTY SAND with coarse gravel
SP	Loose, very wet (standing water), medium brown, fine SAND, micaceous
SP	Loose, wet, medium brown, coarse SAND with trace amounts of

Headspace Reading

Depth (ft)	PID (MR) ppm	PID (uR) ppm	TEH mg/kg
0–25	110.9	12.1	150
	110.0	18.55	NS

XRF or ICP Data from Collected Core



Lithology

Bedrock	Sandy Clay
Clay	Sandy Gravel
Clayey Sand	Sandy Silt
Clayey Silt	Silt
Gravel	Silty Clay
Sand	Silty Sand

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Latitude: 45.9952624(NAD 83) Decimal Degrees
Longitude:-112.5442724 (NAD 83) Decimal Degrees
Northing:651352.33 IF
Easting:1195296.15 IF
Ground Elevation:5455.43 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Borehole Log

Borehole Name: **BRW18-BH01**

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): NA ft
Water Level from MP: NA ft

Date:NA
Time:NA

Logged By: K. Jackson, J. Flammang

Date Drilled: 10/12/2018

Casing Type/Dia: None

Borehole Diameter: 4"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length: None

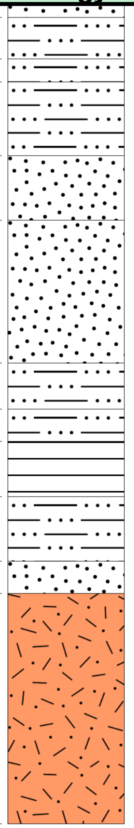
Ground Elevation: 5455.43 ft (NAVD 88)

Elev. (NAVD 88): 5428, 5426, 5424, 5422, 5420, 5418, 5416, 5414, 5412

Depth (ft.): 30, 35, 40, 45

Percent Recovery	USCS Class	
55%		coarse gravel, micaceous
	SM	Loose, wet, medium brown, fine SILTY SAND, micaceous
	SM	Medium stiff, moist, gray with orange layering, coarse SILTY SAND
	SP	Loose, moist, medium brown, fine SILTY SAND, micaceous
70%	SW	Loose, wet moist, brown, coarse SAND with little to no fines, micaceous
	SW	Loose, wet, black with brown laminating layers , coarse-SAND to fine gravel, micaceous
90%	SW	Loose, moist, brown, coarse SILTY SAND with nodules of silt and trace amounts of coarse gravel, micaceous
	SW	Medium dense, brown, fine to medium SILTY SAND with coarse-GRAVEL mixed
	CL/ML	Medium soft, green brown, medium to high plasticity, silty CLAY, micaceous
	SW	Loose, moist, brown orange, coarse SILTY SAND with coarse gravel
	SP	Loose, moist, purple, fine to medium SAND with little fines and nodules of silt, micaceous
68.3%	DG	Hard, dry, black orange brown, 1" layer of sand at top silty medium sand. DECOMPOSED GRANITE-WEATHERED BEDROCK

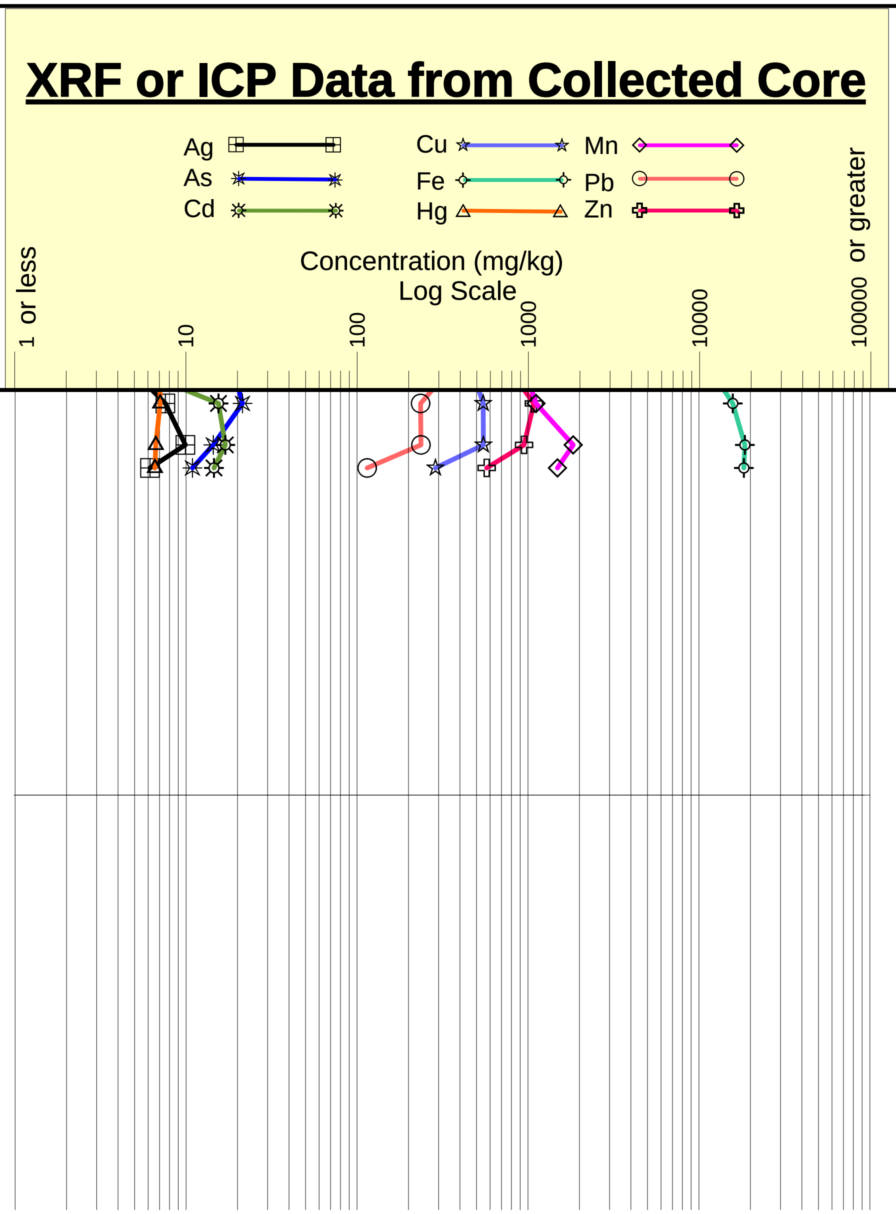
Lithology Log



Headspace Reading

Depth (ft)	PID (MR) ppm	PID (uR) ppm	TEH mg/kg
30			
35			
40			
45			

XRF or ICP Data from Collected Core



Depth (ft): 30, 35, 40, 45

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

Bedrock	Sandy Clay
Clay	Sandy Gravel
Clayey Sand	Sandy Silt
Clayey Silt	Silt
Gravel	Silty Clay
Sand	Silty Sand

Latitude: 45.9952624(NAD 83) Decimal Degrees
Longitude:-112.5442724 (NAD 83) Decimal Degrees
Northing:651352.33 IF
Easting:1195296.15 IF
Ground Elevation:5455.43 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Borehole Log

Borehole Name: BRW18-BH02

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): NA ft
Water Level from MP: NA ft
Date:NA
Time:NA

Logged By: K. Jackson, J. Flammang

Date Drilled: 10/17/2018

Casing Type/Dia: None

Borehole Diameter: 4"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length: None

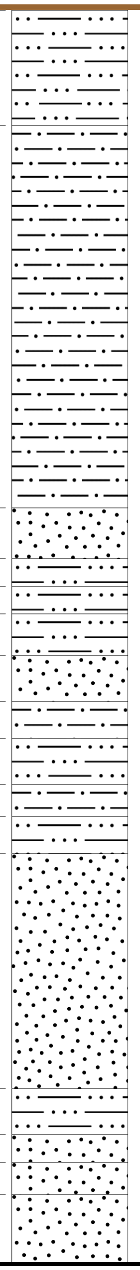
Ground Elevation: 5453.06 ft (NAVD 88)

Elev. (NAVD 88): 5456, 5454, 5452, 5450, 5448, 5446, 5444, 5442, 5440, 5438, 5436, 5434, 5432, 5430, 5428, 5426

Depth (ft.): 0, 5, 10, 15, 20, 25

Ground Level

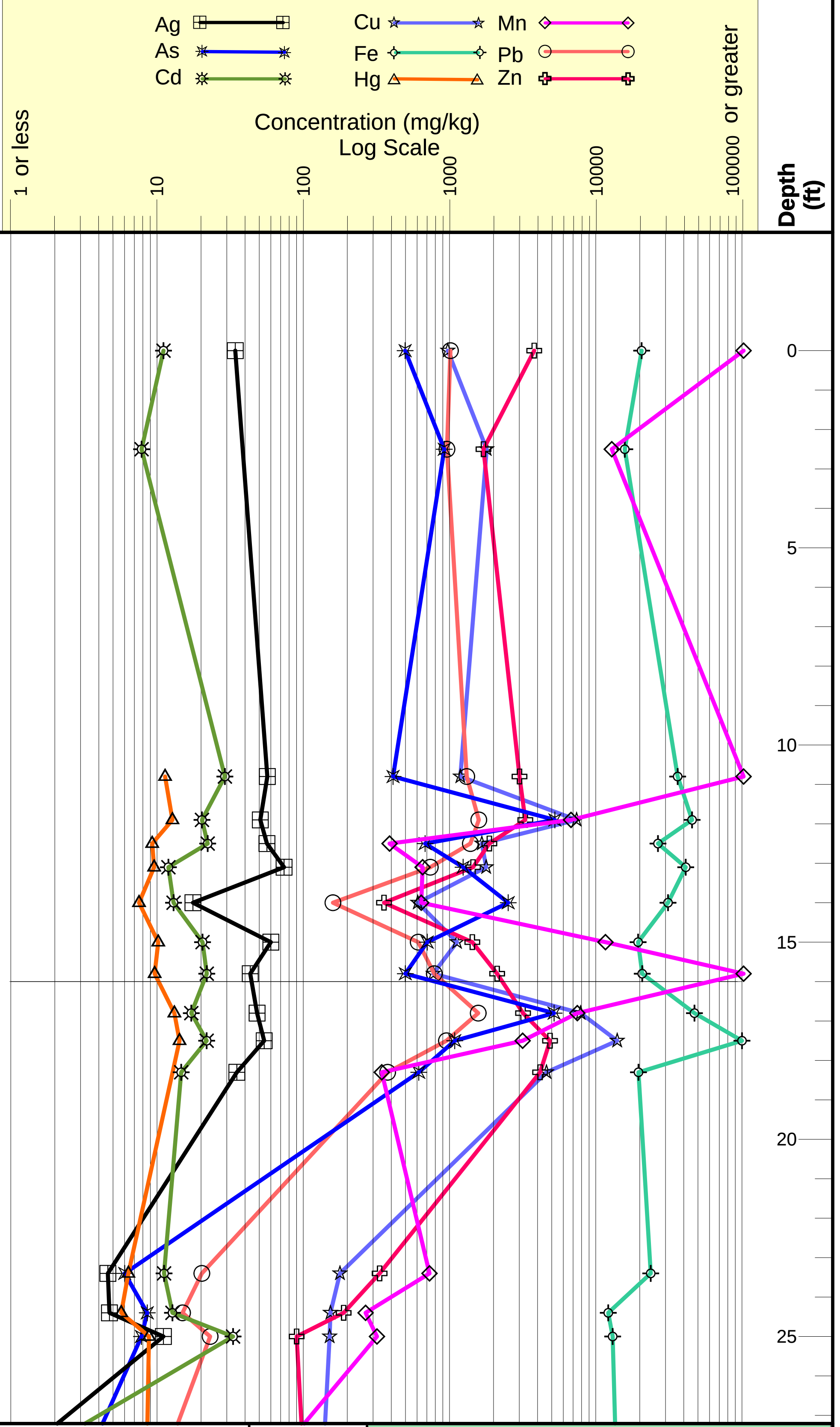
Percent Recovery	USCS Class	Lithology Log
40%	SM	Loose, dry, black, fine SILTY SAND, organics
	ML	Loose, dry, yellow white (powder) black gray, SANDY SILT, construction debris (wood)
50%		
66.7%	OL/SM	Loose, dry, black, fine SILTY SAND with a nodule of sandy silt, organics (topsoil)
	SM	Loose, dry, dark orange, SILTY SAND with trace amounts of coarse gravel
	SM	Loose, moist, yellow gray, fine to coarse SILTY SAND
	SM	Loose, moist, dark brown, coarse SILTY SAND with small amount of fine gravel and small clay layer at top
	SM	Loose, moist, medium brown, silty medium SAND
76.7%	ML	Loose, moist, yellow gray, SANDY SILT with wood debris at top
	SM	Loose, moist, black, fine SILTY SAND, organics, wood debris
	ML	Loose, moist, orange dark brown with 5" black yellow gray at bottom, fine SANDY SILT
	SP	Loose, wet, black with pockets of red, medium SILTY SAND with coarse sand and traces of coarse gravel
	SW	Loose, wet, light to dark gray with lamination layer of red at top, fine to coarse SAND with trace amount of fine gravel, micaceous
65%		
	SW	Soft/loose, red gray brown, fine SILTY SAND with nodules of clay (silty clay), micaceous
	SM	Loose, moist, red brown, fine to medium SAND with nodules of silty (brown) sand, micaceous
	SP	Loose, moist, brown orange, fine to medium SAND, micaceous



Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
ND	ND	NS

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Latitude: 45.9947838(NAD 83) Decimal Degrees
Longitude:-112.5444684 (NAD 83) Decimal Degrees
Northing:651179.94 IF
Easting:1195239.62 IF
Ground Elevation:5453.06 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Borehole Log

Borehole Name: BRW18-BH02

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): NA ft
Water Level from MP: NA ft
Date:NA
Time:NA

Logged By: K. Jackson, J. Flammang

Date Drilled: 10/17/2018

Casing Type/Dia: None

Borehole Diameter: 4"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

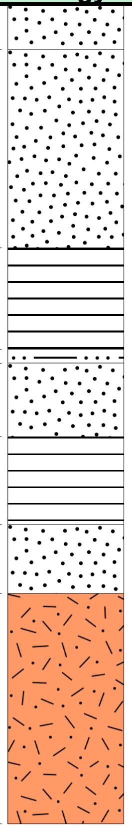
Screen Type/Length: None

Ground Elevation: 5453.06 ft (NAVD 88)

Elev. (NAVD 88): 5424, 5422, 5420, 5418, 5416, 5414, 5412, 5410

Depth (ft.): 30, 35, 40, 45

Percent Recovery: 50%, 50%, 76.7%, 66.7%

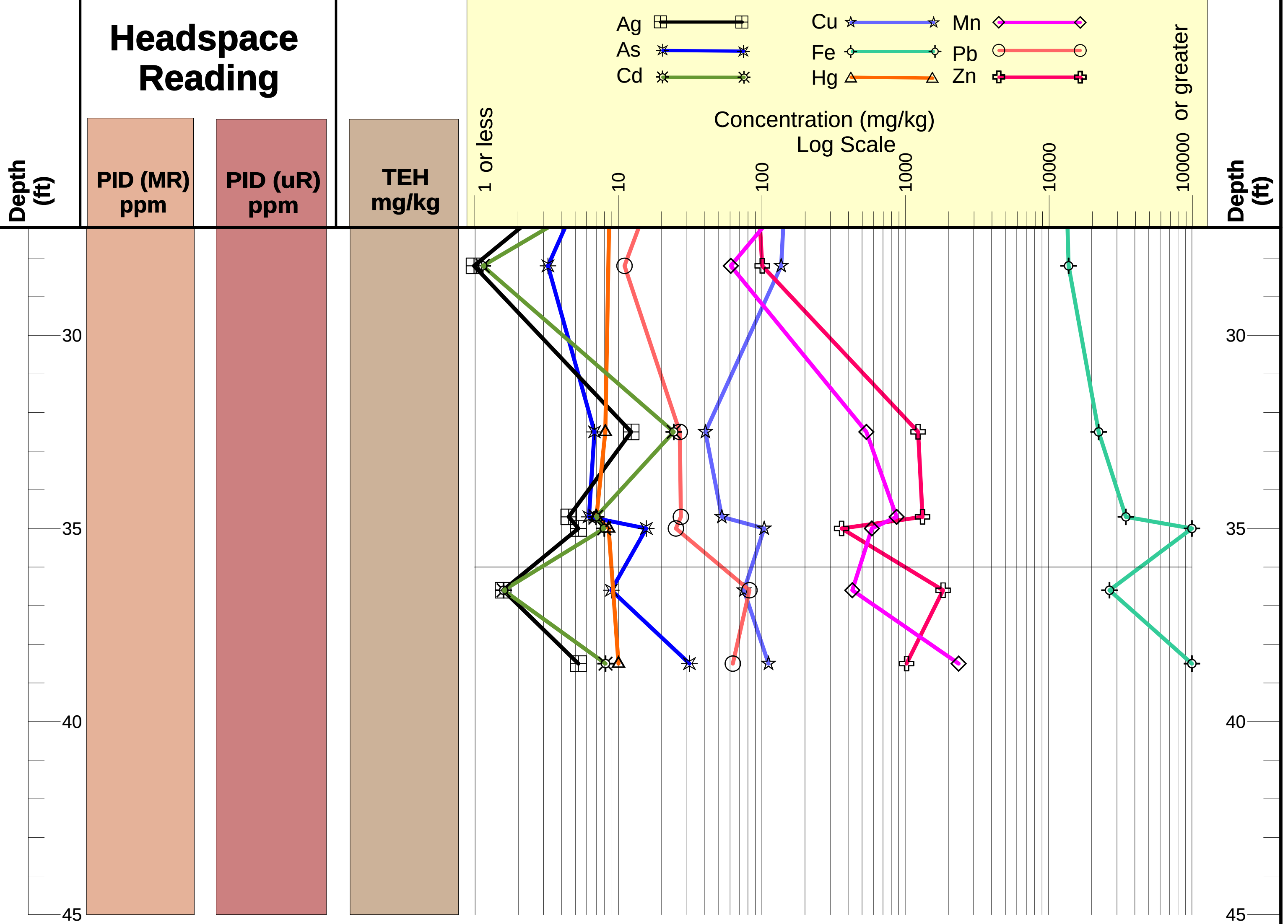


USCS Class	Lithology Log
OL/SW	Loose soft, brown red orange gray with lamination of dark red, fine SAND and silty clay (gray) layers
SW	Loose, most, brown purple, coarse SAND with trace amounts of coarse gravel, micaceous
CH	Medium stiff, moist, black orange gray (orange lamination between black and gray), high plasticity, fat-CLAY, inorganic
SM	Loose, moist, gray with black lamination layer, SILTY SAND with trace amounts of coarse gravel
SW	Loose, moist, orange brown, medium SAND with nodule of silty sand 1/2 way down interval and trace amounts of coarse gravel, micaceous
CH	Soft, moist, gray with lamination of orange and red at top, high plasticity, fat-CLAY
SW	Loose, moist, brown with red and black lamination layering towards top of interval, coarse SAND with trace amounts of coarse gravel, micaceous
DG	Loose, moist, orange light gray black, silty sand with trace amounts of clay, micaceous. WEATHERED BEDROCK.

Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

🟧	Bedrock		Sandy Clay
	Clay		Sandy Gravel
	Clayey Sand		Sandy Silt
	Clayey Silt		Silt
	Gravel		Silty Clay
	Sand		Silty Sand

Latitude: 45.9947838(NAD 83) Decimal Degrees
Longitude:-112.5444684 (NAD 83) Decimal Degrees
Northing:651179.94 IF
Easting:1195239.62 IF
Ground Elevation:5453.06 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Borehole Log

Borehole Name: **BRW18-BH03**

Project: BRW Phase I Site Investigation	Location: Butte, MT
Well Owner: Atlantic Richfield Co.	Depth to Water (bgs): NA ft Water Level from MP: NA ft Date:NA Time:NA
Logged By: K. Jackson, J. Flammang	Date Drilled: 9/25/2018
Casing Type/Dia: None	Borehole Diameter: 4"
Drilling Company: O'Keefe Drilling	Drilling Method: Sonic
Screen Type/Length: None	

Ground Elevation: 5456.52 ft (NAVD 88)

Ground Level

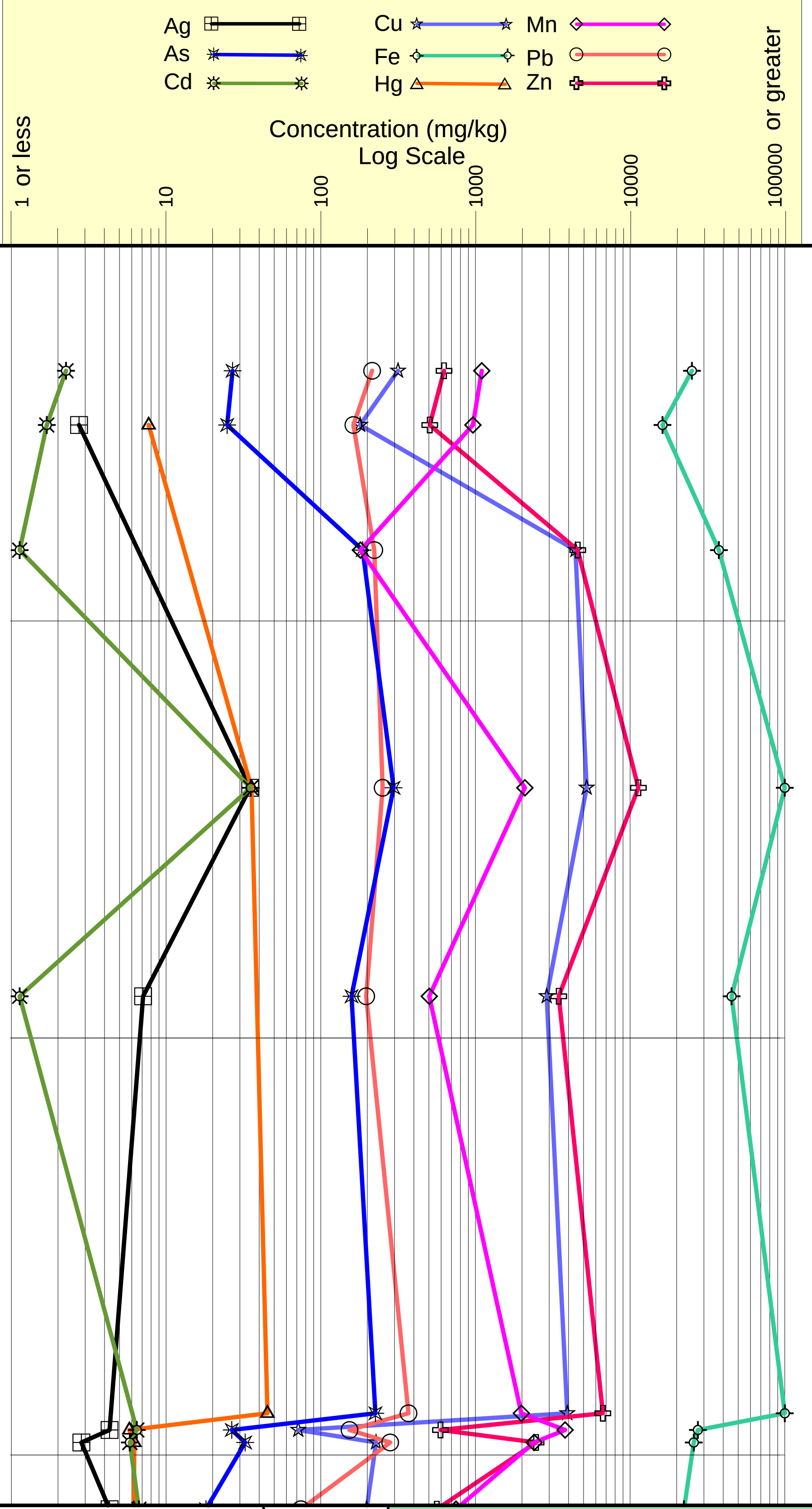
Elev. (NAVD 88)	Depth (ft.)	Percent Recovery	USCS Class	Lithology Log
5456.52	0	64%	OL	Soft, dry, brown, low plasticity, fines-clay SILT with fine and coarse gravel mixed, organics
			CL	Hard, dry, brown light brown black white orange gray, low plasticity, fines-silt CLAY, rine at 3"
	5	62.9%	GW	Loose, wet (used water), black brown, coarse to cobble-GRAVEL, slag, used to much water for fines
	10	15%	GW	Loose, wet (water pouring out of core), black white rock, fine to coarse-GRAVEL, slag
	15	11.7%	CL	Soft, very wet (standing water), gray with orange lighter color staining towards top, fines-silt CLAY with coarse gravel
	20	0%	N/A	Void-no recovery (driller said)
	25		GP	Hard (rock), wet, black brown, cobble-GRAVEL, maybe slag
			CL OH	Soft, wet (standing water), gray with lamination of lighter material, medium plasticity, fines-clay SILT

Elevation scale: 5458, 5456, 5454, 5452, 5450, 5448, 5446, 5444, 5442, 5440, 5438, 5436, 5434, 5432, 5430

Headspace Reading

Depth (ft)	PID (MR) ppm	PID (uR) ppm	TEH mg/kg
10	ND	ND	NS

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

Bedrock	Sandy Clay
Clay	Sandy Gravel
Clayey Sand	Sandy Silt
Clayey Silt	Silt
Gravel	Silty Clay
Sand	Silty Sand

Latitude: 45.9959349(NAD 83) Decimal Degrees
Longitude:-112.5442442 (NAD 83) Decimal Degrees
Northing:651596.99 IF
Easting:1195312.83 IF
Ground Elevation:5456.52 ft (NAVD 88)

T3N R8W S24

Borehole Log

Borehole Name: BRW18-BH03

PIONEER TECHNICAL SERVICES, INC.

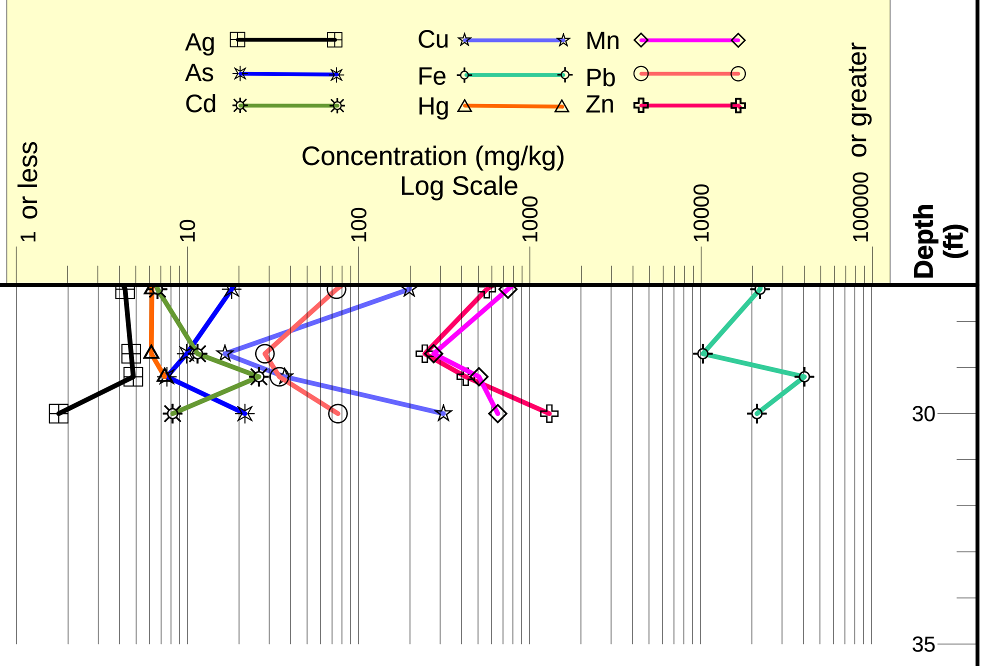
Project: BRW Phase I Site Investigation	Location: Butte, MT
Well Owner: Atlantic Richfield Co.	Depth to Water (bgs): NA ft Water Level from MP: NA ft Date:NA Time:NA
Logged By: K. Jackson, J. Flammang	Date Drilled: 9/25/2018
Casing Type/Dia: None	Borehole Diameter: 4"
Drilling Company: O'Keefe Drilling	Drilling Method: Sonic
Screen Type/Length: None	

Ground Elevation: 5456.52 ft (NAVD 88)

Elev. (NAVD 88)	Depth (ft.)	Percent Recovery	USCS Class	Lithology Log	Description
5428		73.3%	GM		Soft, wet (standing water), black, high plasticity, fines-silt CLAY with gravelly sand near bottom (not sampled, possible slough), organics, micaceous
			SP		Soft, wet (standing water), gray with lighter material towards bottom, fine SILTY SAND with occasional layers of silt, organic layer top 1"
			SW		Soft, moist, light orange gray near top with pockets of red, fine SAND
5426	30				Soft, wet, brown with lighter colored material, medium SAND with fine gravel and some clay mixed
5424		0%	N/A		Loose, saturated, medium brown, sand with small gravel, chunks of medium brown silty clay. Core bag broke as drillers tried to fill it, picked up core from ground and put in 5-gallon bucket, filled four 1-gallon bags with core for logging purposes but no lab samples collected. Ran sand plus clay as 2 separate samples on XRF (more conservative results displayed).
5422	35				

Depth (ft)	Headspace Reading: PID (MR) ppm	PID (uR) ppm	TEH mg/kg
30			
35			

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

Bedrock	Sandy Clay
Clay	Sandy Gravel
Clayey Sand	Sandy Silt
Clayey Silt	Silt
Gravel	Silty Clay
Sand	Silty Sand

Latitude: 45.9959349(NAD 83) Decimal Degrees
Longitude:-112.5442442 (NAD 83) Decimal Degrees
Northing:651596.99 IF
Easting:1195312.83 IF
Ground Elevation:5456.52 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Borehole Log

Borehole Name: BRW18-BH05

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): NA ft
Water Level from MP: NA ft
Date:NA
Time:NA

Logged By: K. Jackson, J. Flammang

Date Drilled: 9/25/2018

Casing Type/Dia: None

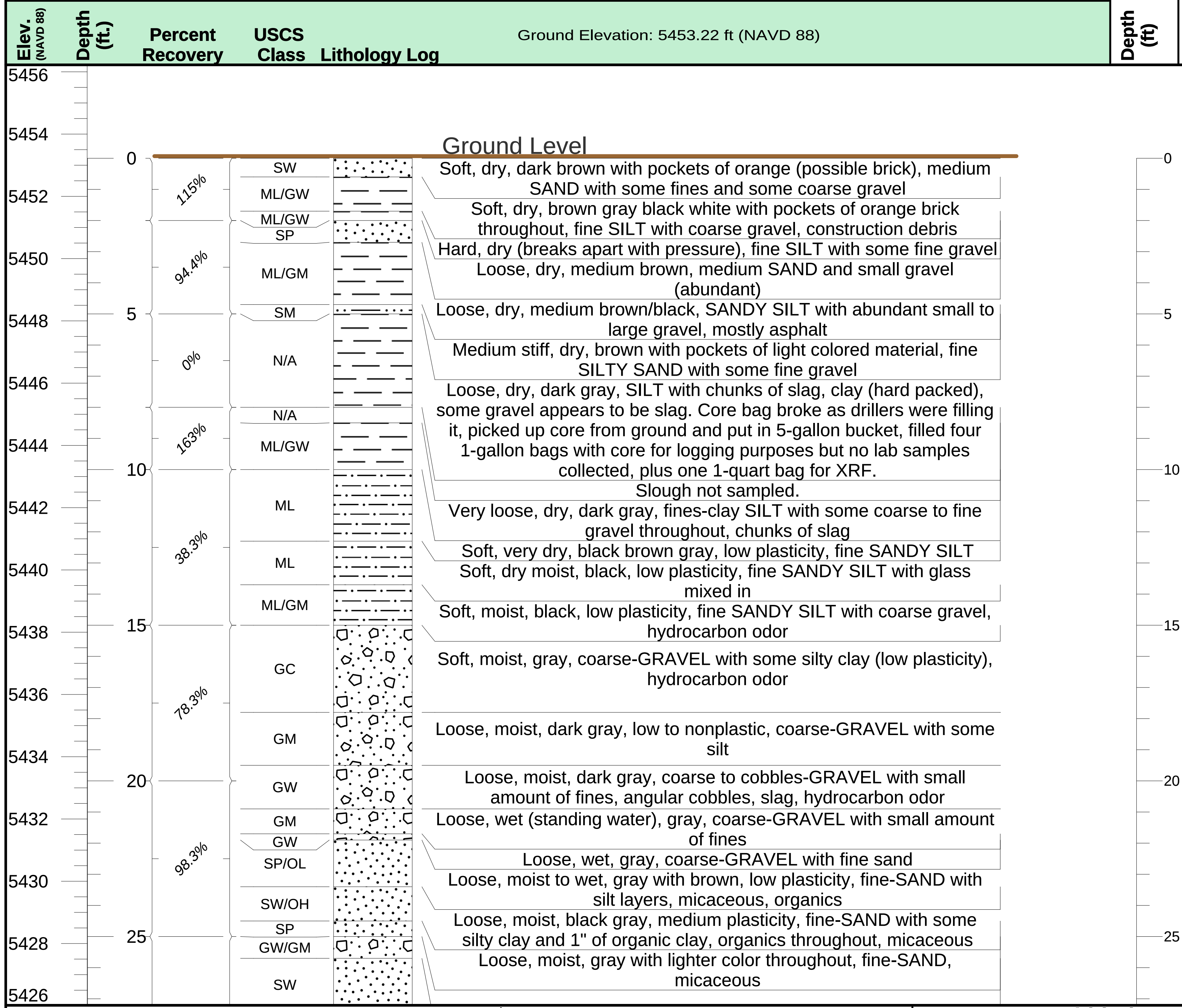
Borehole Diameter: 4"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length: None

Ground Elevation: 5453.22 ft (NAVD 88)



USCS Class

- SW
- ML/GW
- ML/GW
- SP
- ML/GM
- SM
- N/A
- N/A
- ML/GW
- ML
- ML
- ML/GM
- GC
- GM
- GW
- GM
- GW
- SP/OL
- SW/OH
- SP
- GW/GM
- SW

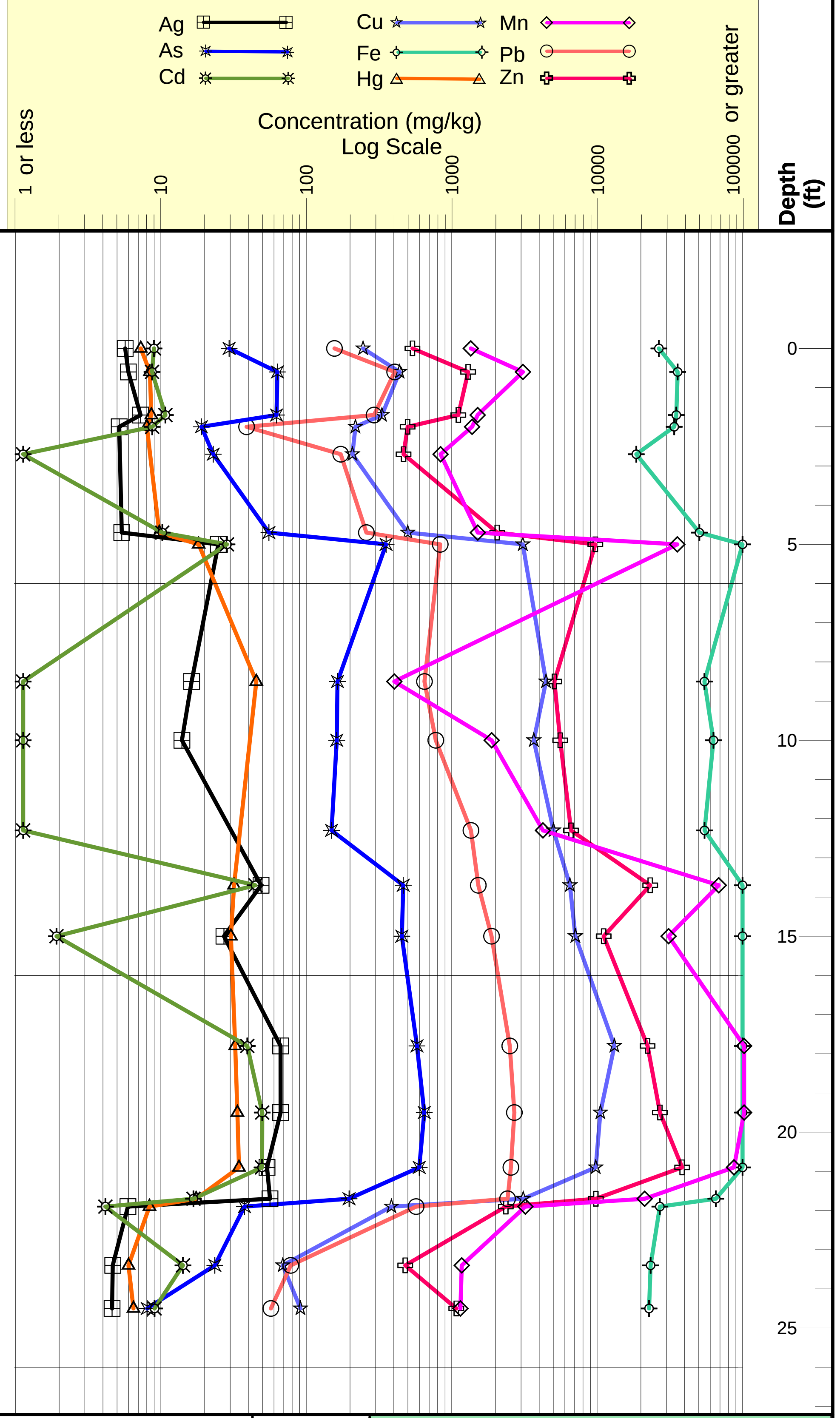
Lithology Log

- Soft, dry, dark brown with pockets of orange (possible brick), medium SAND with some fines and some coarse gravel
- Soft, dry, brown gray black white with pockets of orange brick throughout, fine SILT with coarse gravel, construction debris
- Hard, dry (breaks apart with pressure), fine SILT with some fine gravel
- Loose, dry, medium brown, medium SAND and small gravel (abundant)
- Loose, dry, medium brown/black, SANDY SILT with abundant small to large gravel, mostly asphalt
- Medium stiff, dry, brown with pockets of light colored material, fine SILTY SAND with some fine gravel
- Loose, dry, dark gray, SILT with chunks of slag, clay (hard packed), some gravel appears to be slag. Core bag broke as drillers were filling it, picked up core from ground and put in 5-gallon bucket, filled four 1-gallon bags with core for logging purposes but no lab samples collected, plus one 1-quart bag for XRF.
- Slough not sampled.
- Very loose, dry, dark gray, fines-clay SILT with some coarse to fine gravel throughout, chunks of slag
- Soft, very dry, black brown gray, low plasticity, fine SANDY SILT
- Soft, dry moist, black, low plasticity, fine SANDY SILT with glass mixed in
- Soft, moist, black, low plasticity, fine SANDY SILT with coarse gravel, hydrocarbon odor
- Soft, moist, gray, coarse-GRAVEL with some silty clay (low plasticity), hydrocarbon odor
- Loose, moist, dark gray, low to nonplastic, coarse-GRAVEL with some silt
- Loose, moist, dark gray, coarse to cobbles-GRAVEL with small amount of fines, angular cobbles, slag, hydrocarbon odor
- Loose, wet (standing water), gray, coarse-GRAVEL with small amount of fines
- Loose, wet, gray, coarse-GRAVEL with fine sand
- Loose, moist to wet, gray with brown, low plasticity, fine-SAND with silt layers, micaceous, organics
- Loose, moist, black gray, medium plasticity, fine-SAND with some silty clay and 1" of organic clay, organics throughout, micaceous
- Loose, moist, gray with lighter color throughout, fine-SAND, micaceous

Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
370	30	656
88	1.95	26
75	NA	23
160	2.6	ND

XRF or ICP Data from Collected Core



Lithology

Bedrock	Sandy Clay
Clay	Sandy Gravel
Clayey Sand	Sandy Silt
Clayey Silt	Silt
Gravel	Silty Clay
Sand	Silty Sand

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Latitude: 45.9956157(NAD 83) Decimal Degrees
Longitude:-112.5440272 (NAD 83) Decimal Degrees
Northing:651478.57 IF
Easting:1195363.4 IF
Ground Elevation:5453.22 ft (NAVD 88)

T3N R8W S24

Borehole Log

Borehole Name: BRW18-BH05

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): NA ft
Water Level from MP: NA ft
Date:NA
Time:NA

Logged By: K. Jackson, J. Flammang

Date Drilled: 9/25/2018

Casing Type/Dia: None

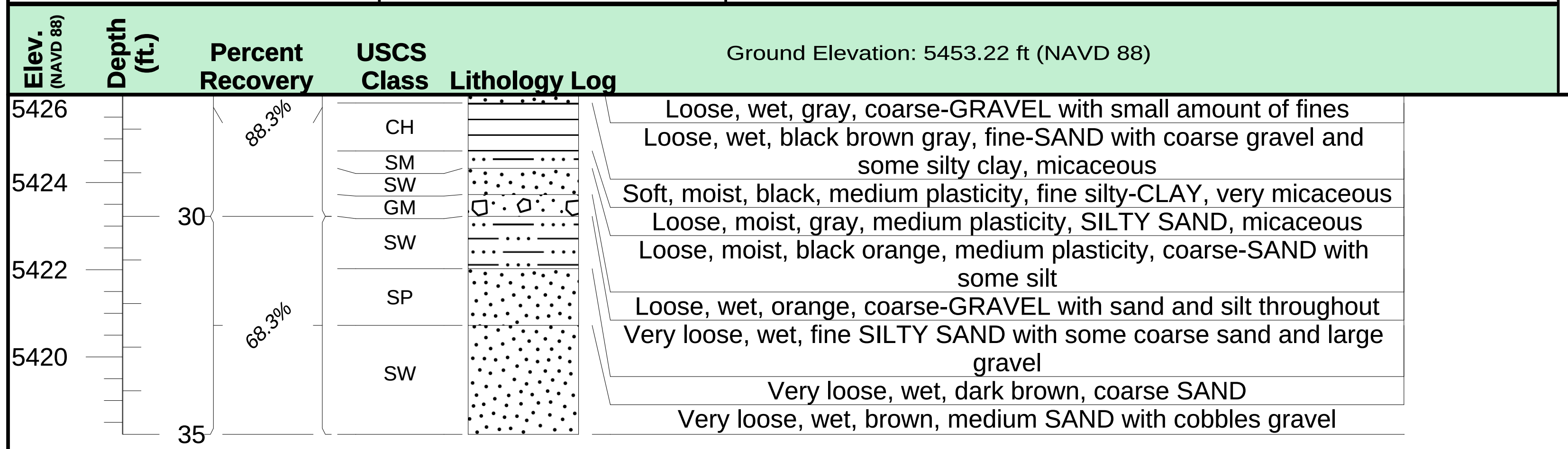
Borehole Diameter: 4"

Drilling Company: O'Keefe Drilling

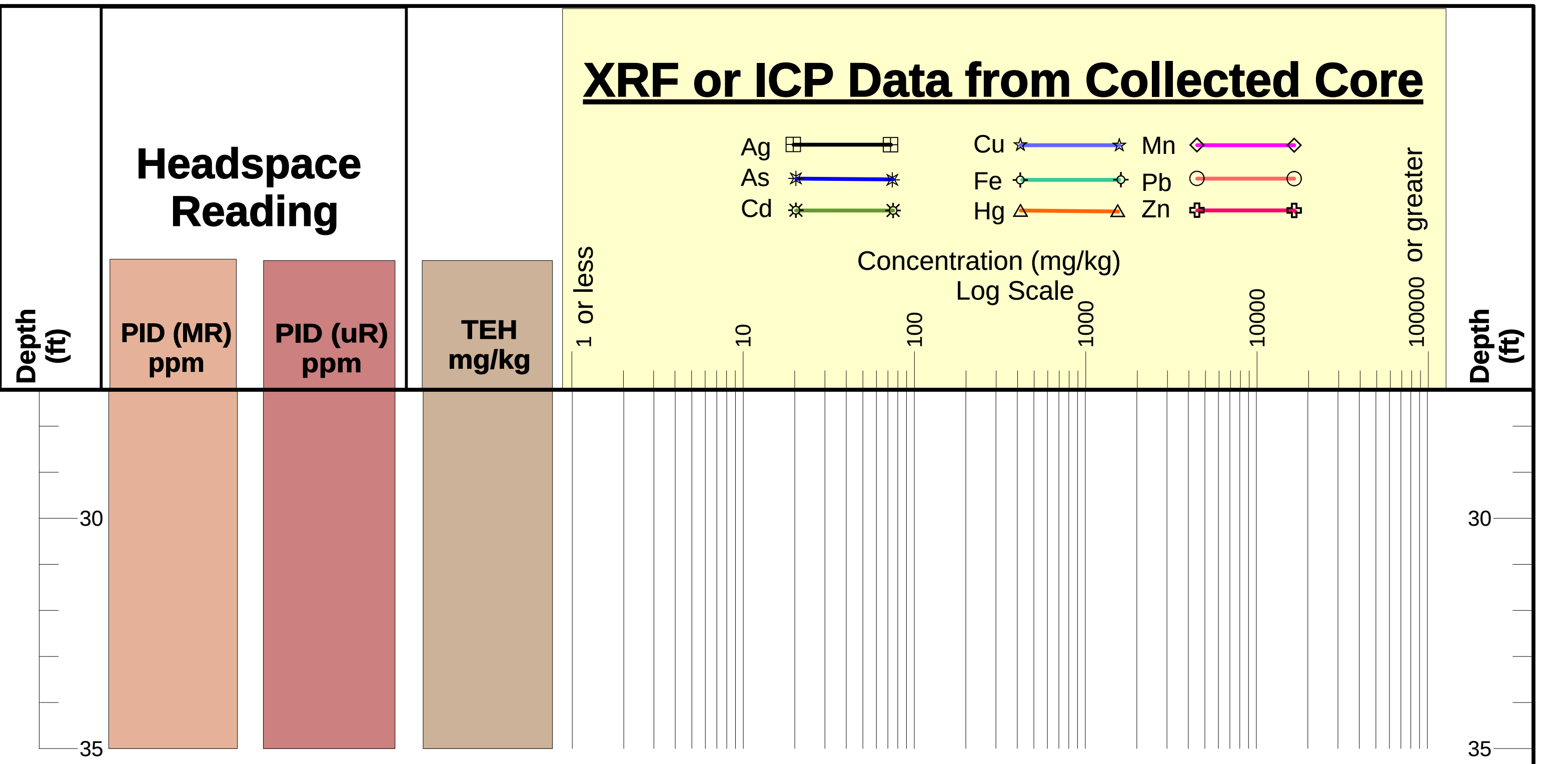
Drilling Method: Sonic

Screen Type/Length: None

Ground Elevation: 5453.22 ft (NAVD 88)



- Loose, wet, gray, coarse-GRAVEL with small amount of fines
- Loose, wet, black brown gray, fine-SAND with coarse gravel and some silty clay, micaceous
- Soft, moist, black, medium plasticity, fine silty-CLAY, very micaceous
- Loose, moist, gray, medium plasticity, SILTY SAND, micaceous
- Loose, moist, black orange, medium plasticity, coarse-SAND with some silt
- Loose, wet, orange, coarse-GRAVEL with sand and silt throughout
- Very loose, wet, fine SILTY SAND with some coarse sand and large gravel
- Very loose, wet, dark brown, coarse SAND
- Very loose, wet, brown, medium SAND with cobbles gravel



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

- ▨ Bedrock
- ☐ Clay
- ☐ Clayey Sand
- ☐ Clayey Silt
- ☐ Gravel
- ☐ Sand
- ☐ Sandy Clay
- ☐ Sandy Gravel
- ☐ Sandy Silt
- ☐ Silt
- ☐ Silty Clay
- ☐ Silty Sand

Latitude: 45.9956157(NAD 83) Decimal Degrees
Longitude:-112.5440272 (NAD 83) Decimal Degrees
Northing:651478.57 IF
Easting:1195363.4 IF
Ground Elevation:5453.22 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Borehole Log

Borehole Name: BRW18-BH06

Project: BRW Phase I Site Investigation
Location: Butte, MT
Well Owner: Atlantic Richfield Co.
Depth to Water (bgs): NA ft
Water Level from MP: NA ft
Date:NA
Time:NA
Logged By: K. Jackson, J. Flammang
Date Drilled: 10/2/2018
Casing Type/Dia: None
Borehole Diameter: 4"
Drilling Company: O'Keefe Drilling
Drilling Method: Sonic
Screen Type/Length: None

Ground Elevation: 5450.55 ft (NAVD 88)

Elev. (NAVD 88): 5452, 5450, 5448, 5446, 5444, 5442, 5440, 5438, 5436, 5434, 5432, 5430, 5428, 5426, 5424

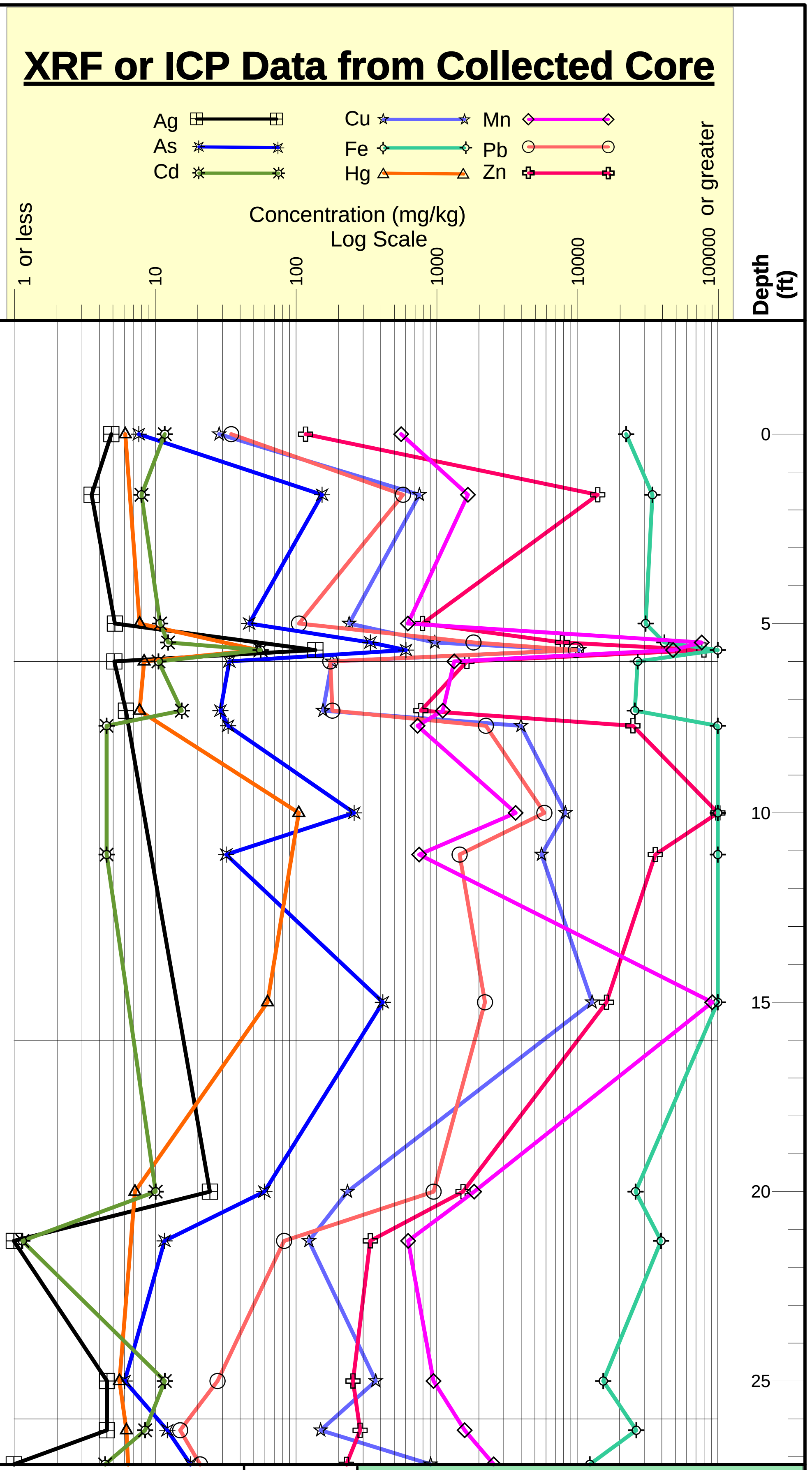
Depth (ft.): 0, 5, 10, 15, 20, 25

Ground Level

Percent Recovery	USCS Class	Lithology Log
56.7%	ML/GM	Loose, dry, dark brown white, SANDY SILT with coarse gravel, more dense towards bottom
	SW	Loose, dry, black, SILTY SAND with coarse gravel, possible asphalt with concrete chunks
200%	SW	Loose, dry, brown light brown, silty fine SAND with coarse gravel
	SW	Loose, dry, black, SILTY SAND with fine gravel, construction debris (asphalt)
119%	ML	Loose, dry, gray, fine SANDY SILT with coarse gravel, dry slag, powdery
	SM	Loose, wet, black, coarse-SAND with silt and coarse gravel, dry slag, possible slough
	SM	Loose, moist, black, fine SILTY SAND, micaceous
	SM	Loose, moist, black brown, fine SILTY SAND with coarse gravel
	SW/GW	Loose, dry to wet, black, fine SAND to coarse-GRAVEL with angular rock
55%	SM	Medium stiff, wet, black, fine SILTY SAND, hydrocarbon odor
16.7%	GP	Loose, wet, black, fine to coarse-GRAVEL with angular black rock, slag
50%	CH	Medium stiff, moist, gray, high plasticity, fine fat-CLAY, micaceous
	OH	Medium stiff, moist, black, medium plasticity, fines-clay SILT, organics throughout, micaceous
	SW	Loose, wet, gray dark brown, fine SILTY SAND with trace amounts of fine gravel, micaceous
	CH	Soft, wet, brown with lamination of red layers, medium plasticity, silty

Headspace Reading

Depth (ft)	PID (MR) ppm	PID (uR) ppm	TEH mg/kg
	137.5	11.0	NS



Lithology

Bedrock	Sandy Clay
Clay	Sandy Gravel
Clayey Sand	Sandy Silt
Clayey Silt	Silt
Gravel	Silty Clay
Sand	Silty Sand

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Latitude: 45.9950971(NAD 83) Decimal Degrees
Longitude:-112.5435282 (NAD 83) Decimal Degrees
Northing:651284.78 IF
Easting:1195482.73 IF
Ground Elevation:5450.55 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Borehole Log

Borehole Name: **BRW18-BH06**

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): NA ft
Water Level from MP: NA ft
Date:NA
Time:NA

Logged By: K. Jackson, J. Flammang

Date Drilled: 10/2/2018

Casing Type/Dia: None

Borehole Diameter: 4"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length: None

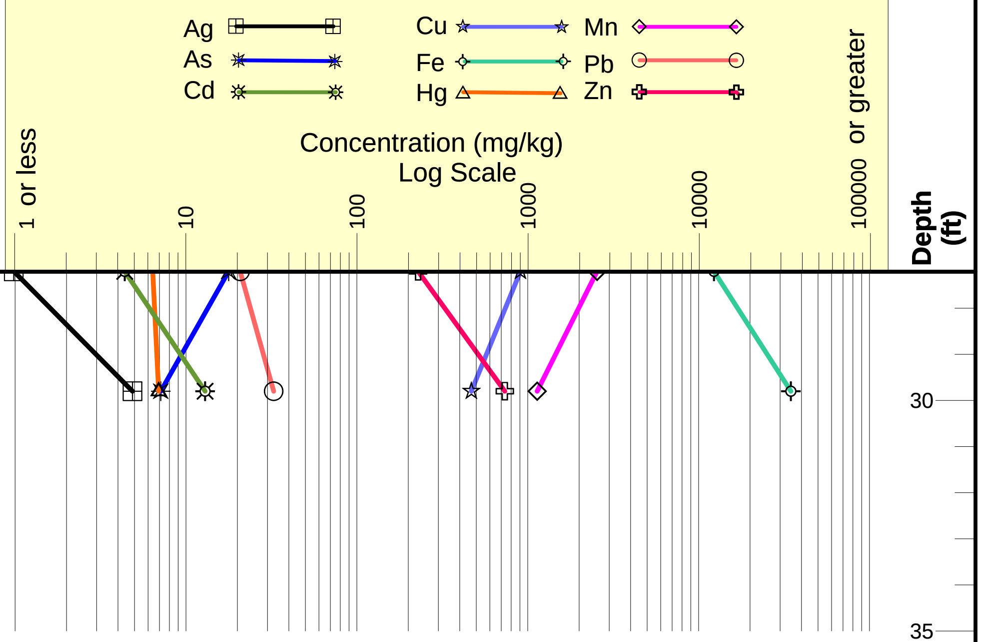
Ground Elevation: 5450.55 ft (NAVD 88)

Elev. (NAVD 88)	Depth (ft.)	Percent Recovery	USCS Class	Lithology Log
				CLAY, micaceous
5422		68.3%	SP	Loose, wet, brown with black staining, coarse SAND with coarse gravel, poorly graded, micaceous
	30		SM	Loose, moist, gray black, SANDY SILT with trace amounts of fine gravel
5420			SP	Black, coarse SAND, slag, slough
			SW	Very stiff, moist, brown green, low plasticity, fine SILTY SAND
5418		105%	SW	Loose, moist, red brown lighter gray, gravelly SAND with trace cobbles
			ML	Loose, moist, brown, low plasticity, fine SANDY SILT, micaceous
5416	35		SW	Loose, moist, brown, medium SAND with trace coarse gravel, micaceous

Headspace Reading

Depth (ft)	PID (MR) ppm	PID (uR) ppm	TEH mg/kg
30			
35			

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

Bedrock	Sandy Clay
Clay	Sandy Gravel
Clayey Sand	Sandy Silt
Clayey Silt	Silt
Gravel	Silty Clay
Sand	Silty Sand

Latitude: 45.9950971(NAD 83) Decimal Degrees
Longitude:-112.5435282 (NAD 83) Decimal Degrees
Northing:651284.78 IF
Easting:1195482.73 IF
Ground Elevation:5450.55 ft (NAVD 88)

T3N R8W S24

Borehole Log

Borehole Name: BRW18-BH07

PIONEER TECHNICAL SERVICES, INC.

Project: BRW Phase I Site Investigation
Location: Butte, MT
Well Owner: Atlantic Richfield Co.
Depth to Water (bgs): NA ft
Water Level from MP: NA ft
Date:NA
Time:NA
Logged By: K. Jackson, J. Flammang
Date Drilled: 10/2/2018
Casing Type/Dia: None
Borehole Diameter: 4"
Drilling Company: O'Keefe Drilling
Drilling Method: Sonic
Screen Type/Length: None

Ground Elevation: 5447.13 ft (NAVD 88)

Ground Level

Percent Recovery	USCS Class	Lithology Log
115%	SM	Loose, dry, dark brown, SILTY SAND with coarse gravel
	SW	Loose, dry, brown black, medium SAND with coarse gravel, construction debris (asphalt/concrete)
80.7%	SP	Loose, wet, black, coarse SAND with cobble gravel, slag
	SM	Loose, wet, light gray red purple, SILTY SAND with some clay, micaceous
	SW	Loose, dry (powder), red brown, coarse-SAND, micaceous
71.7%	SM	Loose, dry, SILTY SAND with trace amount of gravel, light weight (saw dust weight)
	SW	Loose, wet, black, coarse SAND with coarse gravel, slag
	SM	Soft, moist, dark brown, non-plastic, fine SAND with silt, micaceous
	SP	Loose, dry, brown gray, coarse SAND with fine gravel ,micaceous
	SM	Loose, moist, gray red brown, coarse SAND with trace amounts of coarse gravel and silt, micaceous
71.7%	SW	Loose, moist, brown, coarse SAND with coarse gravel, micaceous
	SW	Loose, moist, brown, course SAND with coarse gravel, micaceous
63.3%	SC	Loose, moist, brown, fine SILTY SAND with pockets of silty clay, micaceous, hydrocarbon odor
	SM	Loose to dense, moist, brown red, SILTY SAND with trace amounts of coarse gravel, micaceous
100%	SM	Loose, moist, medium brown, coarse SILTY SAND with trace amounts of small gravel and few fines, micaceous
	SP	Loose, moist, medium brown, coarse-SAND with minimal fines, slightly micaceous
	CL	Soft, moist, dark brown, medium-plastic, silty-CLAY, micaceous
	SP	Loose, moist, medium brown with orange staining, coarse-SAND with minimal fines
	CH	Soft, wet, medium brown, high plasticity, silty-CLAY, micaceous
	SW	Loose, wet, medium brown with one small black layer and red staining in top, medium-SAND with small gravel, micaceous
	SW	Loose, moist, brown red, coarse-SAND with trace amount of coarse

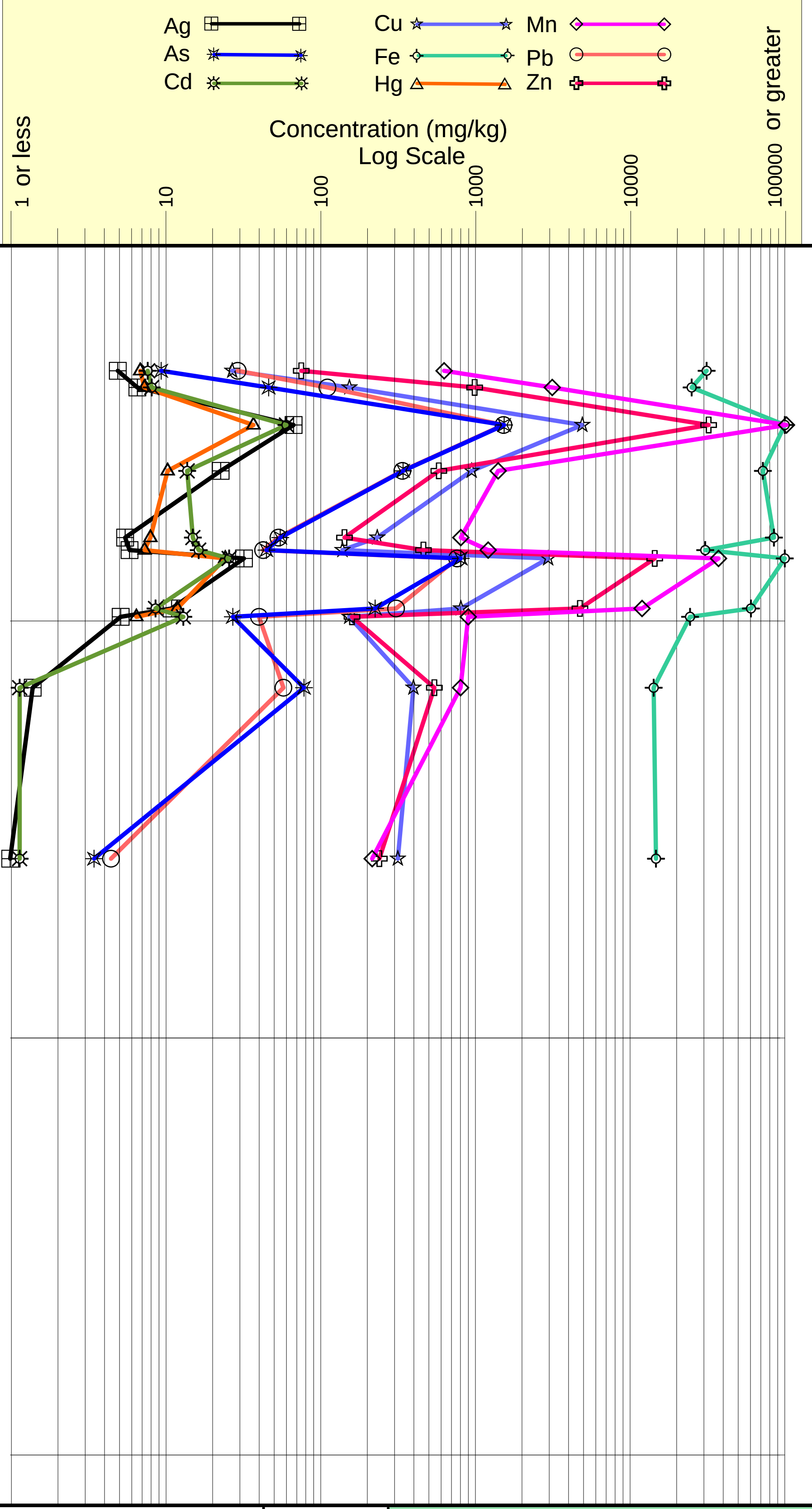
Elev. (NAVD 88): 5450, 5448, 5446, 5444, 5442, 5440, 5438, 5436, 5434, 5432, 5430, 5428, 5426, 5424, 5422, 5420

Depth (ft.): 0, 5, 10, 15, 20, 25

Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
ND	ND	NS

XRF or ICP Data from Collected Core



Lithology

Bedrock	Sandy Clay
Clay	Sandy Gravel
Clayey Sand	Sandy Silt
Clayey Silt	Silt
Gravel	Silty Clay
Sand	Silty Sand

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Latitude: 45.9949962(NAD 83) Decimal Degrees
Longitude:-112.5425011 (NAD 83) Decimal Degrees
Northing:651237.89 IF
Easting:1195742.04 IF
Ground Elevation:5447.13 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Borehole Log

Borehole Name: BRW18-BH07

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): NA ft
Water Level from MP: NA ft

Date:NA
Time:NA

Logged By: K. Jackson, J. Flammang

Date Drilled: 10/2/2018

Casing Type/Dia: None

Borehole Diameter: 4"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length: None

Ground Elevation: 5447.13 ft (NAVD 88)

Elev. (NAVD 88)	Depth (ft.)	Percent Recovery	USCS Class	Lithology Log	
5418	30	95%	SM/SW		gravel and pockets and nodules of silty clay, slightly micaceous Soft, moist, brown gray with red lamination layers, low plasticity, SILTY SAND with coarse gravel

Depth (ft)	Headspace Reading: PID (MR) ppm	Headspace Reading: PID (uR) ppm	TEH mg/kg	XRF or ICP Data from Collected Core	Depth (ft)
30					30

XRF or ICP Data from Collected Core

Ag As Cd Cu Fe Hg Mn Pb Zn

Concentration (mg/kg)
Log Scale

1 or less, 10, 100, 1000, 10000, 100000 or greater

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Latitude: 45.9949962(NAD 83) Decimal Degrees
Longitude:-112.5425011 (NAD 83) Decimal Degrees
Northing:651237.89 IF
Easting:1195742.04 IF
Ground Elevation:5447.13 ft (NAVD 88)

T3N R8W S24

Borehole Log

Borehole Name: **BRW18-BH08**

PIONEER TECHNICAL SERVICES, INC.

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): NA ft
Water Level from MP: NA ft
Date:NA
Time:NA

Logged By: K. Jackson, J. Flammang

Date Drilled: 9/28/2018

Casing Type/Dia: None

Borehole Diameter: 4"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length: None

Ground Elevation: 5448.1 ft (NAVD 88)

Ground Level

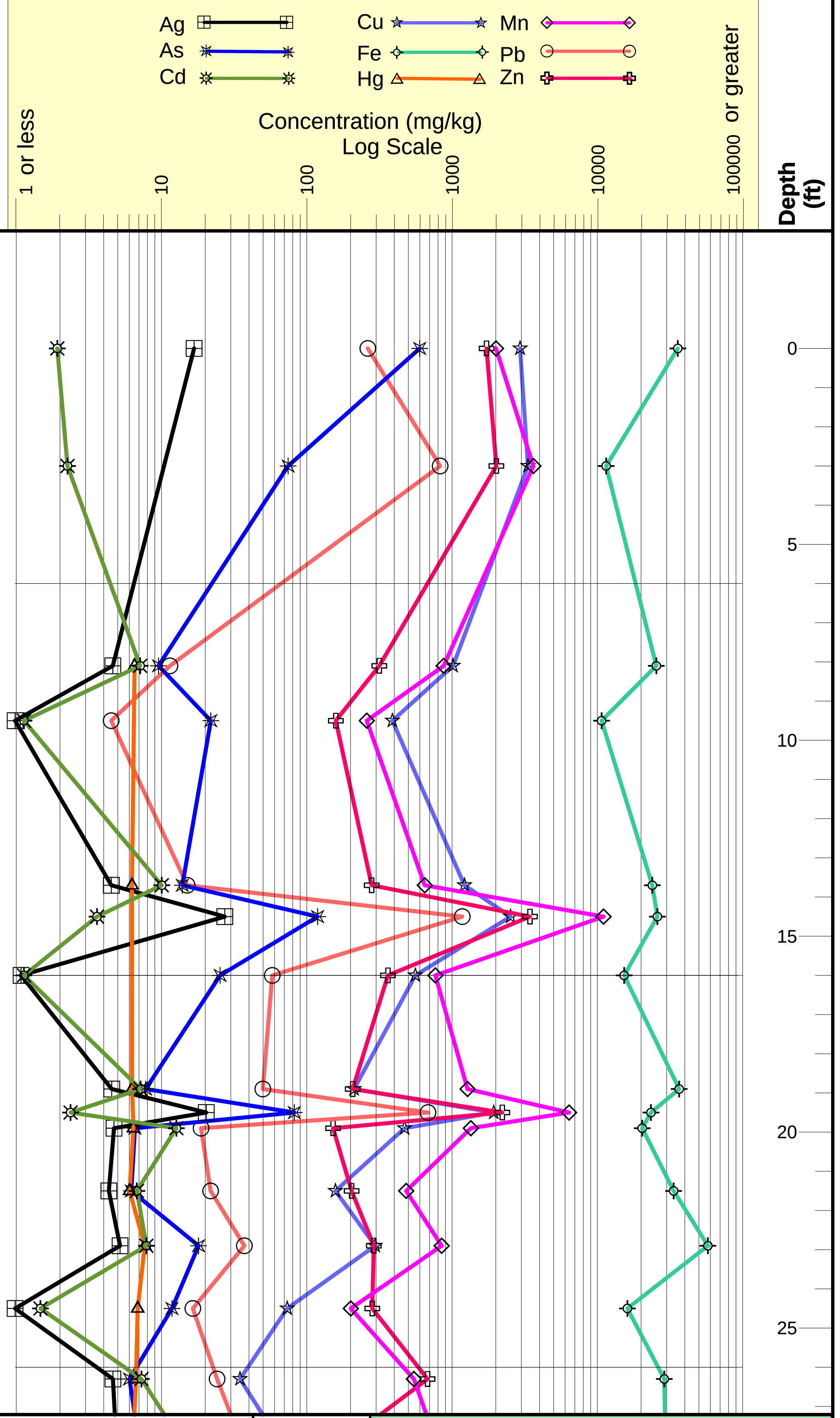
Percent Recovery: 83.3%, 108%, 46.2%, 51.7%, 70%, 95%

USCS Class	Lithology Log
SM	Loose to dense, dry, medium brown gray black white, medium to coarse-SAND with some silt, construction debris (asphalt brick concrete), chunk of slag
GW	Loose, wet, black, angular cobble-GRAVEL with coarse sand and trace amount of silt, hydrocarbon odor
SM	Medium stiff, wet, dark brown, fine SILTY SAND with trace amounts of gravel, hydrocarbon odor, micaceous
SW	Loose, moist, orange red brown, coarse-SAND with silt, some slag (possibly slough), micaceous
SM	Loose, moist, brown, fine SILTY SAND, micaceous
SW	Loose, wet, black, coarse-SAND with some coarse gravel, slag (potentially slough), hydrocarbon odor
SM	Loose, moist, brown, low plasticity, SILTY SAND with fine gravel, micaceous
SM	Soft, moist, brown, medium plasticity, SILTY SAND, micaceous
SP	Loose, wet, black, coarse-SAND with small to coarse gravel and minimal fines, pieces of slag (possible slough, not id by driller), hydrocarbon odor
SP	Loose, wet, medium brown, coarse-SAND with small gravel and some medium sand, hydrocarbon odor
CL/SC	Soft, wet, medium brown, silty-CLAY to medium-SAND with trace amounts of clay, red stained coarse sand scattered in pockets
SW	Loose, wet, medium brown, well graded coarse grained SAND with small to coarse gravel some clay in top 2".
	Medium stiff to stiff, dry, gray with green tinge red brown mottles,

Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
>15000	NA	234
>15000	NA	NS
1386	56	ND
1164	NA	221
497.7	NA	ND
>15000	NA	533
329.7	NA	NS
98.5	NA	ND

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

▨	Bedrock	▤	Sandy Clay
▤	Clay	▨	Sandy Gravel
▤	Clayey Sand	▤	Sandy Silt
▤	Clayey Silt	▤	Silt
▨	Gravel	▤	Silty Clay
▨	Sand	▤	Silty Sand

Latitude: 45.9953214(NAD 83) Decimal Degrees
Longitude:-112.5425549 (NAD 83) Decimal Degrees
Northing:651356.85 IF
Easting:1195732.98 IF
Ground Elevation:5448.1 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Borehole Log

Borehole Name: BRW18-BH08

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): NA ft
Water Level from MP: NA ft
Date:NA
Time:NA

Logged By: K. Jackson, J. Flammang

Date Drilled: 9/28/2018

Casing Type/Dia: None

Borehole Diameter: 4"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

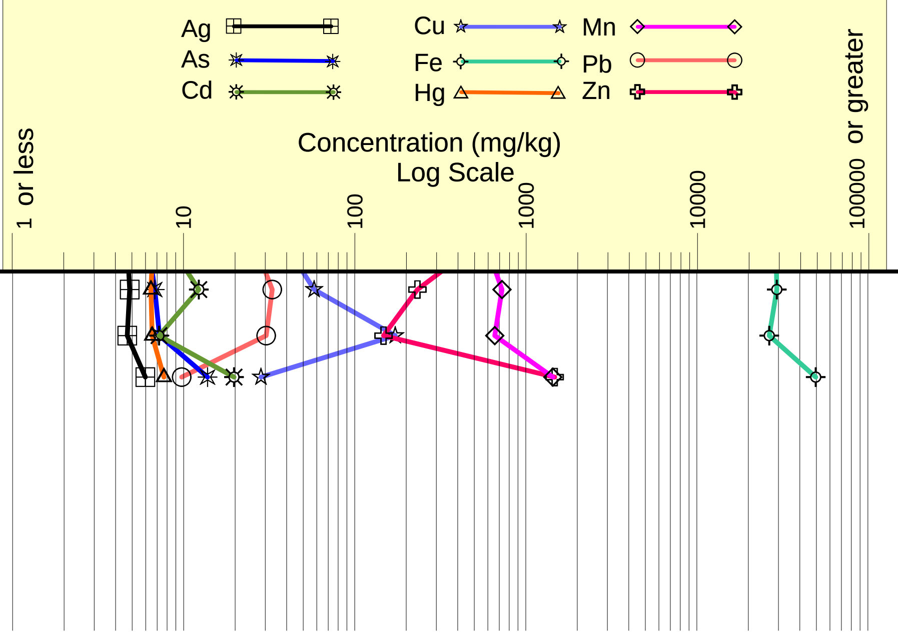
Screen Type/Length: None

Ground Elevation: 5448.1 ft (NAVD 88)

Headspace Reading

Elev. (NAVD 88)	Depth (ft.)	Percent Recovery	USCS Class	Lithology Log	PID (MR) ppm	PID (uR) ppm	TEH mg/kg
5420		100%	CL	medium plasticity, silty-CLAY with trace amounts of sand, no rock			
			SW	Loose, wet, medium brown, medium-SAND with coarse to small gravel and very few fines, well graded, micaceous	103.4	NA	ND
5418	30		SP	Loose, wet, medium orange brown, coarse-SAND with small to coarse gravel and very few fines, poorly graded	63.4	NA	NS
5416 5414	35	93.3%	DG	Loose, moist to 33.3" then dry, medium gray brown, coarse gravelly-sand with some clay and trace amounts of silt, micaceous, iron staining 29.5-34.5. DECOMPOSED GRANITE	Detect	NA	ND

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

Bedrock	Sandy Clay
Clay	Sandy Gravel
Clayey Sand	Sandy Silt
Clayey Silt	Silt
Gravel	Silty Clay
Sand	Silty Sand

Latitude: 45.9953214(NAD 83) Decimal Degrees
Longitude:-112.5425549 (NAD 83) Decimal Degrees
Northing:651356.85 IF
Easting:1195732.98 IF
Ground Elevation:5448.1 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

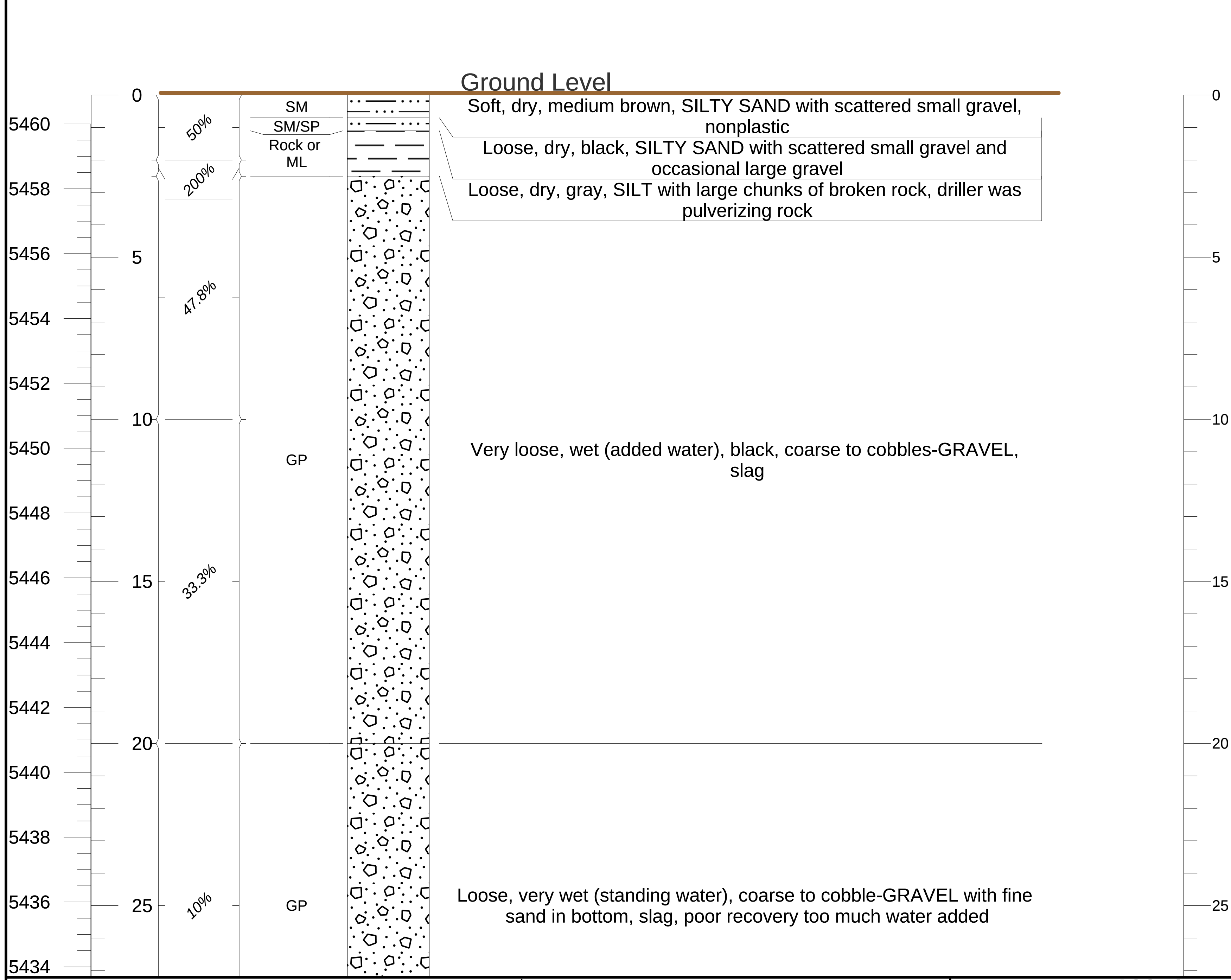
Borehole Log

Borehole Name: BRW18-BH09

Project: BRW Phase I Site Investigation	Location: Butte, MT
Well Owner: Atlantic Richfield Co.	Depth to Water (bgs): NA ft Water Level from MP: NA ft Date:NA Time:NA

Logged By: K. Jackson, J. Flammang	Date Drilled: 9/24/2018	Casing Type/Dia: None	Borehole Diameter: 4"
Drilling Company: O'Keefe Drilling	Drilling Method: Sonic	Screen Type/Length: None	

Elev. (NAVD 88) **Depth (ft.)** **Percent Recovery** **USCS Class** **Lithology Log** Ground Elevation: 5460.89 ft (NAVD 88) **Depth (ft)**



Soft, dry, medium brown, SILTY SAND with scattered small gravel, nonplastic

Loose, dry, black, SILTY SAND with scattered small gravel and occasional large gravel

Loose, dry, gray, SILT with large chunks of broken rock, driller was pulverizing rock

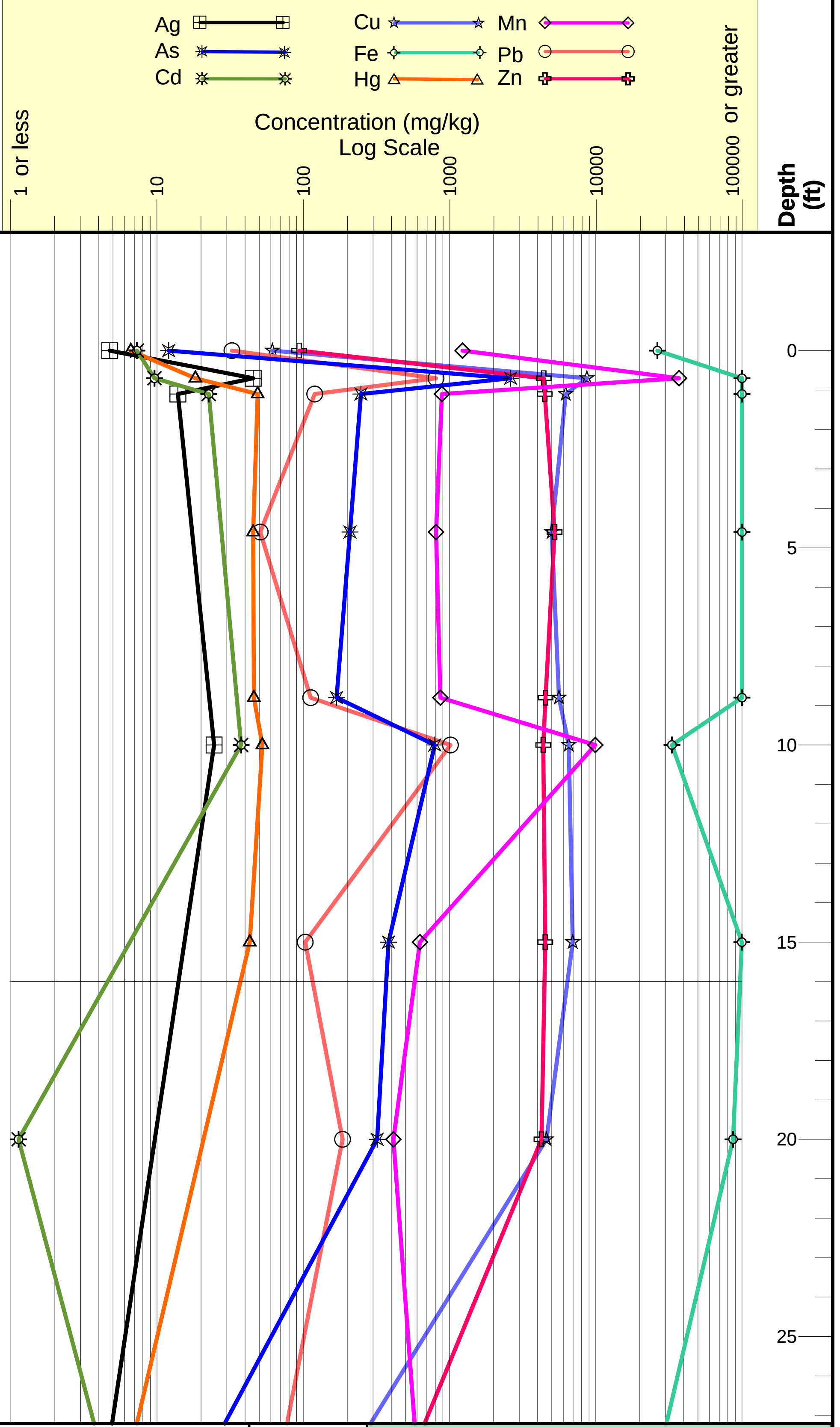
Very loose, wet (added water), black, coarse to cobbles-GRAVEL, slag

Loose, very wet (standing water), coarse to cobble-GRAVEL with fine sand in bottom, slag, poor recovery too much water added

Headspace Reading

PID (MR) ppm	**PID (uR) ppm**	**TEH mg/kg**
ND	ND	NS

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

▨	Bedrock	▤	Sandy Clay
▤	Clay	▨	Sandy Gravel
▤	Clayey Sand	▤	Sandy Silt
▤	Clayey Silt	▤	Silt
▨	Gravel	▤	Silty Clay
▨	Sand	▤	Silty Sand

Latitude: 45.9963485(NAD 83) Decimal Degrees
Longitude:-112.5422263 (NAD 83) Decimal Degrees
Northing:651727.73 IF
Easting:1195830.94 IF
Ground Elevation:5460.89 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Borehole Log

Borehole Name: BRW18-BH09

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): NA ft Date:NA
Water Level from MP: NA ft Time:NA

Logged By: K. Jackson, J. Flammang

Date Drilled: 9/24/2018

Casing Type/Dia: None

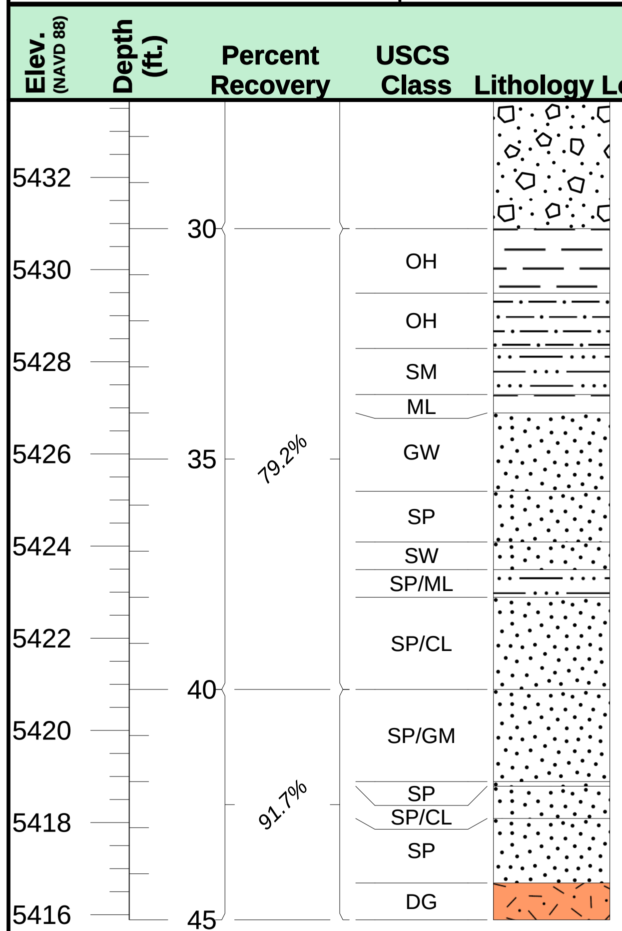
Borehole Diameter: 4"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length: None

Ground Elevation: 5460.89 ft (NAVD 88)



Medium stiff, moist, black gray, medium plasticity, fines-clay SILT, organics, micaceous

Very soft, wet, black gray red, high plasticity, fine clay SANDY SILT with trace amounts of gravel, micaceous

Loose, wet (saturated ground water), dark gray, fine SILTY SAND, micaceous

Loose, wet, purple orange dark brown with scattered lamination of lighter material throughout, fines-clay SILT

Loose, moist wet, orange, fine-SAND with some coarse gravel and nodules of clay throughout

Loose, moist, orange black red, medium to coarse-SAND with small amount of fines and trace coarse gravel, micaceous

Loose, moist, dark brown, medium-SAND with some coarse gravel and little fines, micaceous

Loose, moist, brown, low plasticity, fine SILTY SAND, micaceous

Loose, moist, brown, low plasticity, fine-SAND with some silty clay

Loose, moist, brown, fine-SAND with occasional layer of silt and coarse gravel towards bottom

Loose, moist, brown, fine-SAND, poorly graded, micaceous

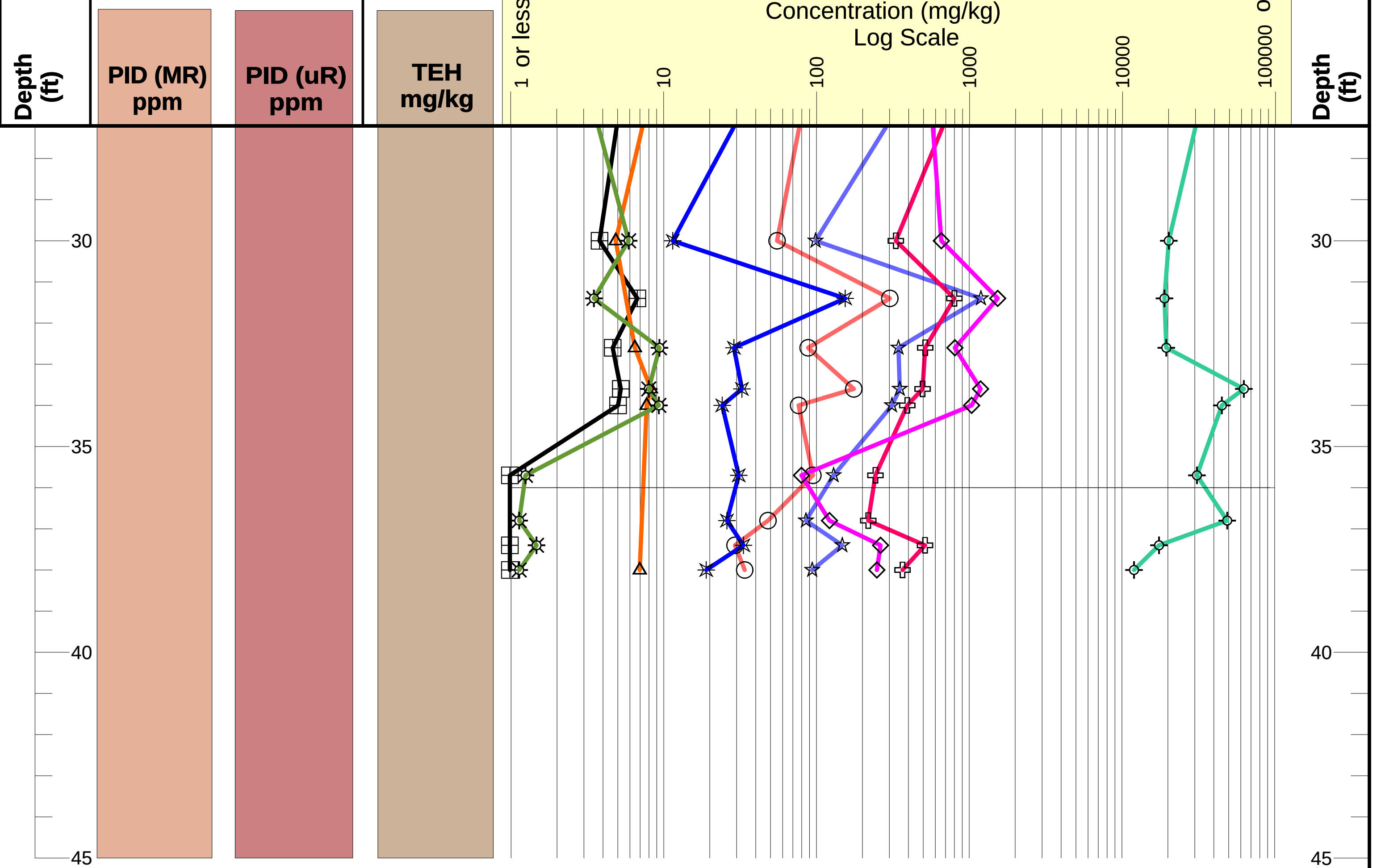
Stiff, moist, brown orange, slight to medium plasticity, fine-SAND to silty clay with trace amounts of coarse gravel, micaceous

Medium stiff, moist, brown, fine-SAND with trace amounts of coarse gravel, micaceous

Stiff hard, moist, white black orange with iron staining, clayey to coarse sand. BEDROCK-DECOMPOSED GRANITE.

Headspace Reading

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Latitude: 45.9963485(NAD 83) Decimal Degrees
Longitude:-112.5422263 (NAD 83) Decimal Degrees
Northing:651727.73 IF
Easting:1195830.94 IF
Ground Elevation:5460.89 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Borehole Log

Borehole Name: **BRW18-BH10**

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): NA ft
Water Level from MP: NA ft

Date:NA
Time:NA

Logged By: K. Jackson, J. Flammang

Date Drilled: 9/27/2018

Casing Type/Dia: None

Borehole Diameter: 4"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length: None

Ground Elevation: 5449.94 ft (NAVD 88)

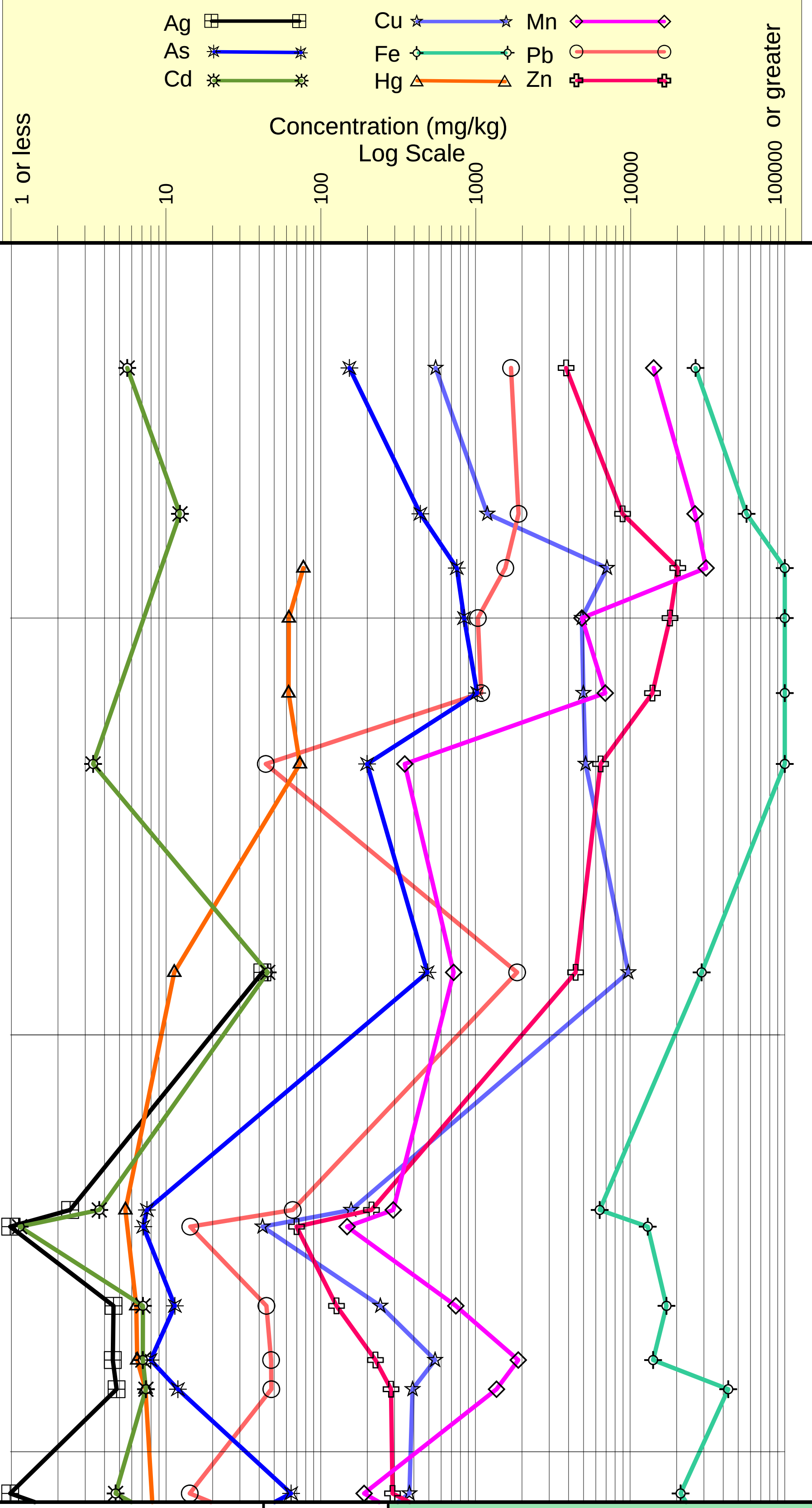
Ground Level

Percent Recovery	USCS Class	Lithology Log
50%	SP	Loose, dry, black brown, medium-SAND with coarse gravel throughout, low plasticity, construction debris
	CL	Loose, dry, black red gray, silty-CLAY with sand, brick asphalt concrete chunks, crystals throughout (needle like).
133%	GW	Loose, dry, black, cobble-GRAVEL with few fines, angular rock, slag
	GW	Loose, dry, black brown, medium SILTY SAND with coarse gravel, chunks of crystals
92.9%	GW	Loose, dry, dark gray, cobbles-GRAVEL with few fines, angular rock, slag
	SM	Loose, wet (water added), brown black, fine to medium SILTY SAND, big chunk of slag, crystals are present, micaceous
	GP	Loose, wet, white black, coarse to fine-GRAVEL with no fines, slag
	GP	Loose, wet, black brown, coarse to cobble-GRAVEL, slag with crystals present
41.7%	GP	Loose, wet, black, coarse to cobble-GRAVEL, slag
0%	SP	Very soft, wet, gray, fine-SAND, micaceous, tube was full of water and sat overnight to settle the materials out
80%	N/A	Slough (Not Sampled)
	SP	Very soft, moist, gray black brown, medium plasticity, fine-SAND with silt and trace amounts of clay
	SM	Loose, moist, gray with uniform red layers, medium-SAND with trace amounts of fine gravel and silt
	SW	Loose, moist, brown with black layers, medium-SAND with coarse gravel and some silt, micaceous, well graded
	SW	Loose, moist, brown red with stratified layers of black, medium-SAND with coarse gravel and silt, micaceous
	SW	Loose, moist, brown, medium-SAND with coarse gravel, slag throughout, micaceous, maybe slough

Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
ND	ND	NS

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Latitude: 45.9957418(NAD 83) Decimal Degrees
Longitude:-112.5421166 (NAD 83) Decimal Degrees
Northing:651505.66 IF
Easting:1195850.21 IF
Ground Elevation:5449.94 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Borehole Log

Borehole Name: BRW18-BH10

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): NA ft
Water Level from MP: NA ft
Date:NA
Time:NA

Logged By: K. Jackson, J. Flammang

Date Drilled: 9/27/2018

Casing Type/Dia: None

Borehole Diameter: 4"

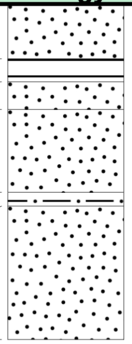
Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length: None

Ground Elevation: 5449.94 ft (NAVD 88)

Elev. (NAVD 88)	Depth (ft.)
5422	
5420	30
5418	
5416	
	35

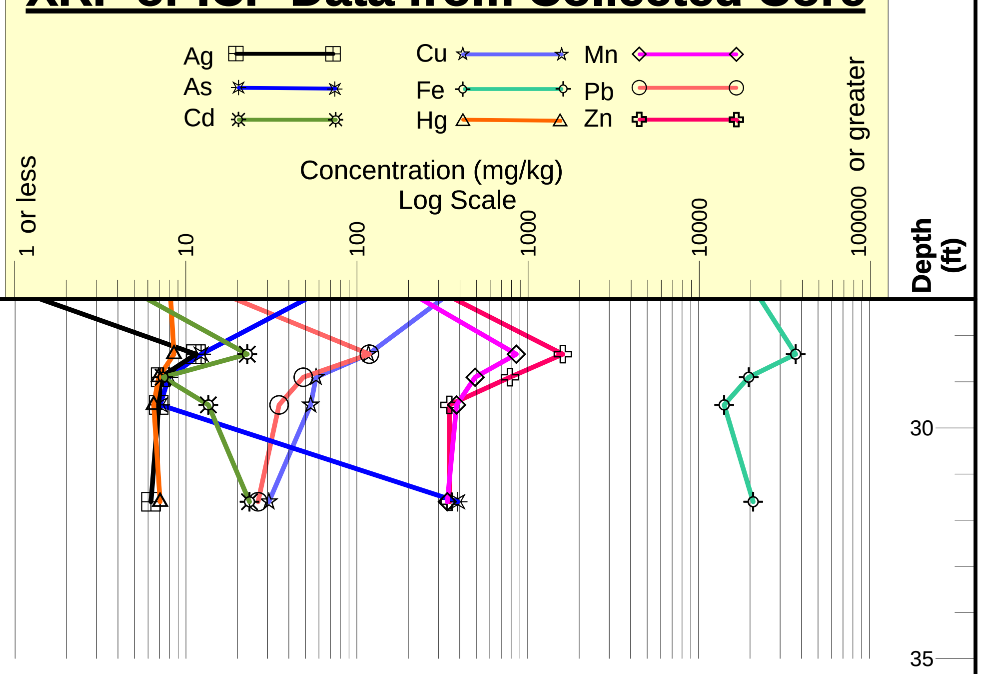


Percent Recovery	USCS Class	Lithology Log
66.7%	SP	Loose, wet, red brown, coarse-SAND with no fines, micaceous, crystals are present
	CH	Soft, wet, brown with pockets of black, high plasticity, fines-silt CLAY
	SM	Soft, wet, gray, fine SILTY SAND, micaceous
90%	SP	Loose, wet, dark brown gray, fine-SAND with pockets of clay and coarse gravel at bottom, poorly graded, micaceous
	ML/SP	Loose, moist, brown black red gray, SANDY SILT with coarse gravel, well graded (Not Sampled)
	SW	Very stiff, dry, orange brown, coarse-SAND with gravel

Headspace Reading

Depth (ft)	PID (MR) ppm	PID (uR) ppm	TEH mg/kg
30			
35			

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Latitude: 45.9957418(NAD 83) Decimal Degrees
Longitude:-112.5421166 (NAD 83) Decimal Degrees
Northing:651505.66 IF
Easting:1195850.21 IF
Ground Elevation:5449.94 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Borehole Log

Borehole Name: BRW18-BH11

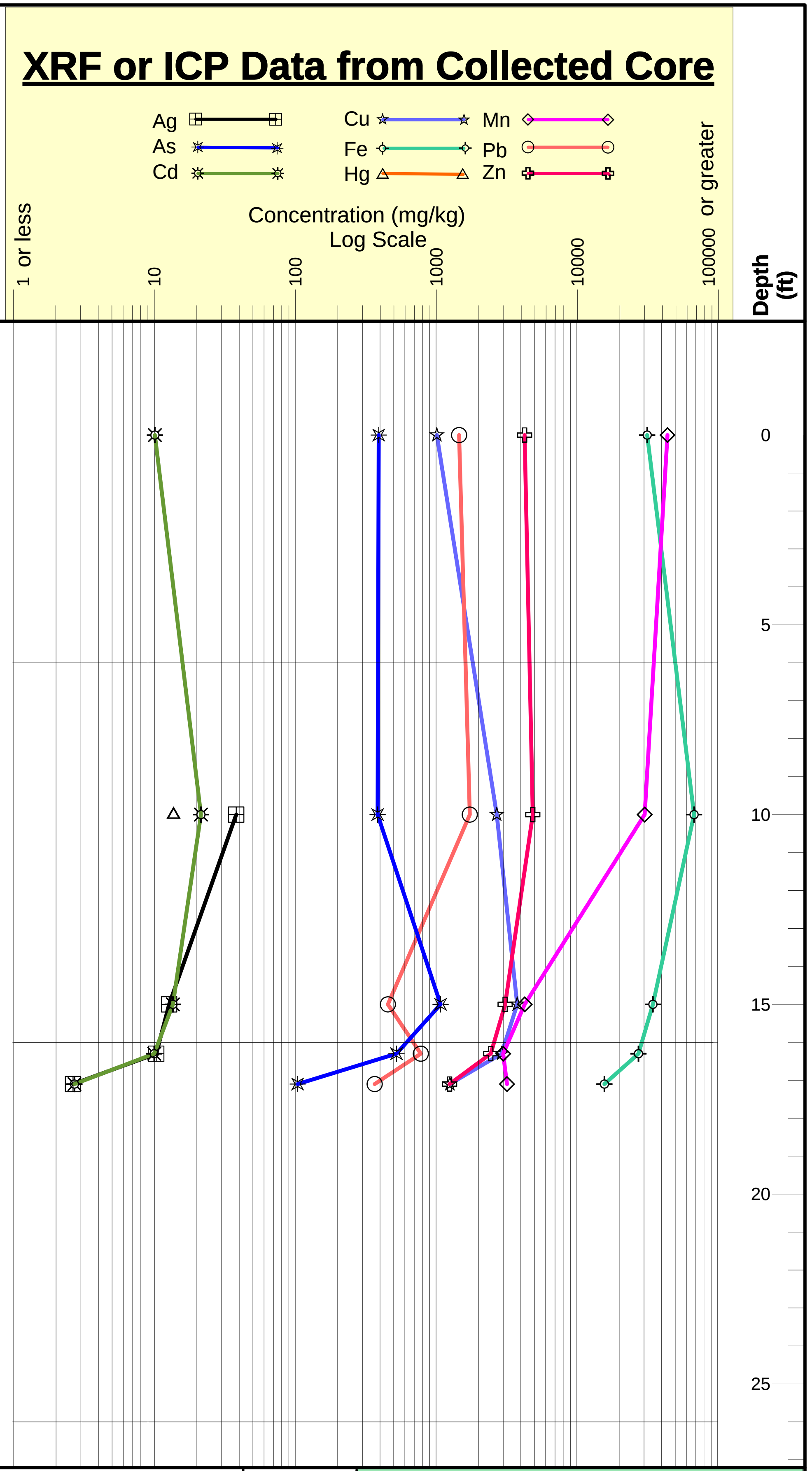
Project: BRW Phase I Site Investigation
Location: Butte, MT
Well Owner: Atlantic Richfield Co.
Depth to Water (bgs): NA ft
Water Level from MP: NA ft
Date:NA
Time:NA
Logged By: K. Jackson, J. Flammang
Date Drilled: 10/11/2018
Casing Type/Dia: None
Borehole Diameter: 4"
Drilling Company: O'Keefe Drilling
Drilling Method: Sonic
Screen Type/Length: None

Ground Elevation: 5449.37 ft (NAVD 88)

Ground Level

Percent Recovery	USCS Class	Lithology Log	PID (MR) ppm	PID (uR) ppm	TEH mg/kg
36.7% 21.7%	ML	Loose, dry, dark brown, slightly plastic, SANDY SILT with trace of coarse sand, white silty powder near bottom, organics, construction debris(asphalt/brick), hydrocarbon odor			
11.7%	CH	Loose, wet, black, medium plasticity, fines-silt/CLAY with trace amounts of coarse sand	158.0	32.58	NS
40%	CL	Very soft, wet(saturated), black with red staining, silty-CLAY, chunk of slag with brick, hydrocarbon odor	513.6	112.2	2880
	OL	Loose, wet(saturated), medium brown, sandy silty-CLAY, organics, hydrocarbon odor			
	SM	Loose, wet(saturated), brown red orange, medium-SAND with silty nodules of clay, micaceous	287.6	65.35	NS
0%	N/A	Fell out on ground, not classified due to QA challenges.	480.6	91.5	NS
	SM	Loose, wet(saturated), brown black, medium SILTY SAND coarse sand mixed, micaceous	111.8	9	ND
	CL	Loose, wet, orange, medium plasticity, silty-CLAY with lamination	22.9	3.075	NS

Headspace Reading



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Latitude: 45.9957324(NAD 83) Decimal Degrees
Longitude:-112.5418442 (NAD 83) Decimal Degrees
Northing:651499.55 IF
Easting:1195919.22 IF
Ground Elevation:5449.37 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Borehole Log

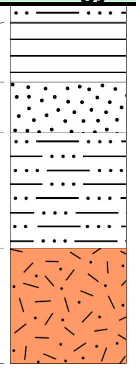
Borehole Name: **BRW18-BH11**

Project: BRW Phase I Site Investigation
Location: Butte, MT
Well Owner: Atlantic Richfield Co.
Depth to Water (bgs): NA ft
Water Level from MP: NA ft
Date:NA
Time:NA
Logged By: K. Jackson, J. Flammang
Date Drilled: 10/11/2018
Casing Type/Dia: None
Borehole Diameter: 4"
Drilling Company: O'Keefe Drilling
Drilling Method: Sonic
Screen Type/Length: None

Ground Elevation: 5449.37 ft (NAVD 88)

Elev. (NAVD 88)	Depth (ft.)	Percent Recovery	USCS Class
5422		66.7%	SM
			CH
5420			SM
	30		
5418		76.7%	SM
5416			DG
	35		

Lithology Log



layer of medium sand, micaceous

Loose, moist, medium brown, fine SILTY SAND with coarse gravel mixed, micaceous

Soft, moist, medium brown with orange staining throughout, high plasticity, fat-CLAY, micaceous

Loose, moist, orange brown purple, coarse-SAND with small silt with trace coarse gravel and purple clay

Loose, moist, brown purple dark green, medium SILTY-SAND with coarse gravel throughout, micaceous

Loose/hard, moist, brown orange, sandy silt. BEDROCK-DECOMPOSED GRANITE.

Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
7.7	2.325	NS
11.8	1.25	ND
2	0.75	ND

XRF or ICP Data from Collected Core

Ag, As, Cd, Cu, Fe, Hg, Mn, Pb, Zn

Concentration (mg/kg)
Log Scale

1 or less, 10, 100, 1000, 10000, 100000 or greater

Depth (ft): 30, 35

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

Bedrock	Sandy Clay
Clay	Sandy Gravel
Clayey Sand	Sandy Silt
Clayey Silt	Silt
Gravel	Silty Clay
Sand	Silty Sand

Latitude: 45.9957324(NAD 83) Decimal Degrees
Longitude:-112.5418442 (NAD 83) Decimal Degrees
Northing:651499.55 IF
Easting:1195919.22 IF
Ground Elevation:5449.37 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Borehole Log

Borehole Name: **BRW18-BH16**

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): NA ft Date:NA
Water Level from MP: NA ft Time:NA

Logged By: K. Jackson, J. Flammang

Date Drilled: 10/12/2018

Casing Type/Dia: None

Borehole Diameter: 4"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length: None

Elev. (NAVD 88) | Depth (ft.) | Percent Recovery | USCS Class | Lithology Log

Ground Elevation: 5447.34 ft (NAVD 88)

Elev.: 5450, 5448, 5446, 5444, 5442, 5440, 5438, 5436, 5434, 5432, 5430, 5428, 5426, 5424, 5422

Depth: 0, 5, 10, 15, 20, 25

Ground Level

Percent Recovery: 40%, 56.7%, 65%, 66.7%, 73.3%

USCS Class: SM, SM, SM, SP, SP, SW, SM, SW, SC, SP, SW, SW, SW, SM, SM-CL, SW, SC, SW

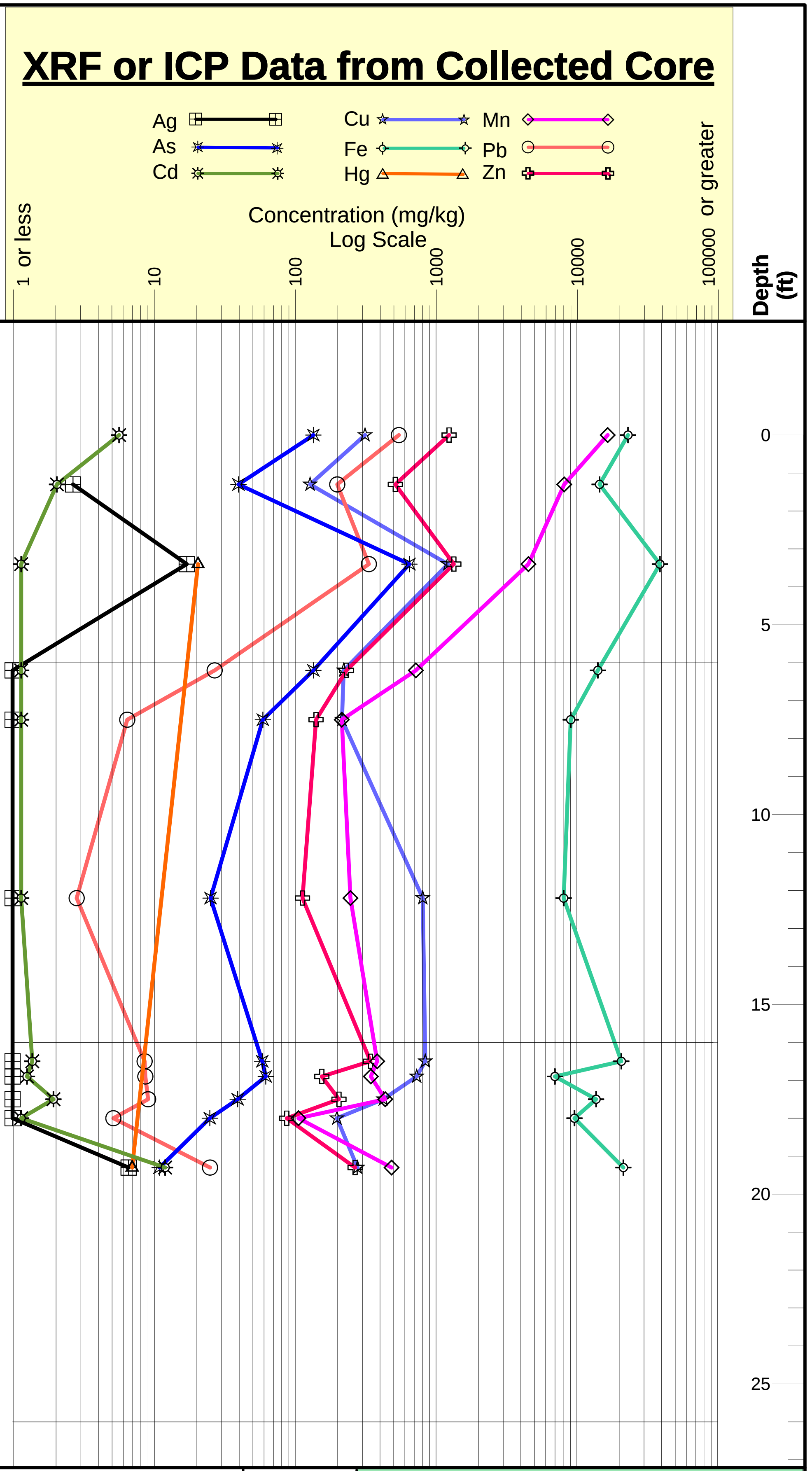
Lithology Log:

- Loose, dry, brown, SILTY SAND with trace amounts of fine gravel, micaceous
- Loose, dry, white (powder), SILTY SAND with trace amounts of fine gravel, construction debris(concrete)
- Loose, dry, black, SILTY SAND with trace amounts of coarse gravel, slag throughout, construction debris, asphalt
- Loose, moist, brown red with black stripes, medium-SAND with course gravel and small amount of silt, micaceous
- Loose, moist, brown, fine SILTY SAND with trace amount of fine gravel
- Loose, wet, brown with black staining, medium-SAND with trace amount of coarse gravel and few fines, micaceous
- Loose, moist, medium brown, SILTY-SAND with small amount of clay and gravel
- Loose, moist, medium brown orange, medium to coarse-SAND with trace of small gravel, micaceous
- Soft, wet, medium brown, medium to low plasticity, clayey-SAND
- Loose, wet, orange brown, coarse-SAND with small gravel
- Loose, moist, medium brown, medium to fine-SAND with trace amount of coarse sand
- Loose, moist, medium brown, medium to coarse-SAND with some small gravel
- Loose, moist, medium brown, medium to coarse-SAND with some small gravel
- Stiff, moist, medium brown, SILTY-SAND, hard packed
- Loose, moist, orange/brown, coarse to silty fine-SAND with small gravel and clay pockets that are iron stained
- Loose, moist, medium brown/purple with some iron staining and

Depth (ft): 0, 5, 10, 15, 20, 25

Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
ND	ND	NS



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Latitude: 45.9952623(NAD 83) Decimal Degrees
Longitude:-112.5405038 (NAD 83) Decimal Degrees
Northing:651315.12 IF
Easting:1196252.85 IF
Ground Elevation:5447.34 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Borehole Log

Borehole Name: BRW18-BH16

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): NA ft Date:NA
Water Level from MP: NA ft Time:NA

Logged By: K. Jackson, J. Flammang

Date Drilled: 10/12/2018

Casing Type/Dia: None

Borehole Diameter: 4"

Drilling Company: O'Keefe Drilling

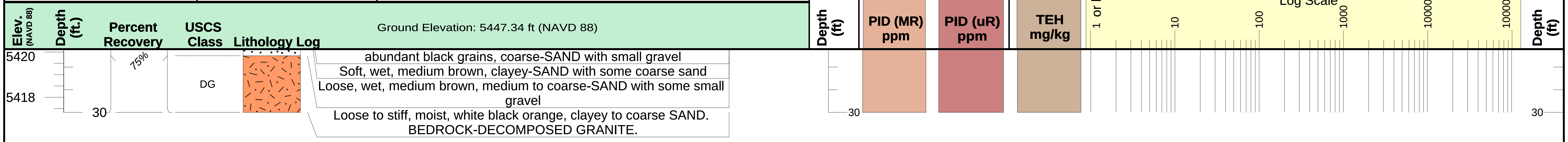
Drilling Method: Sonic

Screen Type/Length: None

Ground Elevation: 5447.34 ft (NAVD 88)

Headspace Reading

XRF or ICP Data from Collected Core



abundant black grains, coarse-SAND with small gravel

Soft, wet, medium brown, clayey-SAND with some coarse sand

Loose, wet, medium brown, medium to coarse-SAND with some small gravel

Loose to stiff, moist, white black orange, clayey to coarse SAND. BEDROCK-DECOMPOSED GRANITE.

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Latitude: 45.9952623(NAD 83) Decimal Degrees
Longitude:-112.5405038 (NAD 83) Decimal Degrees
Northing:651315.12 IF
Easting:1196252.85 IF
Ground Elevation:5447.34 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Borehole Log

Borehole Name: BRW18-BH18

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): NA ft
Water Level from MP: NA ft
Date:NA
Time:NA

Logged By: K. Jackson, J. Flammang

Date Drilled: 9/18/2018

Casing Type/Dia: None

Borehole Diameter: 3.25"

Drilling Company: Pioneer

Drilling Method: Direct Push

Screen Type/Length: None

Ground Elevation: 5438.52 ft (NAVD 88)

Ground Level

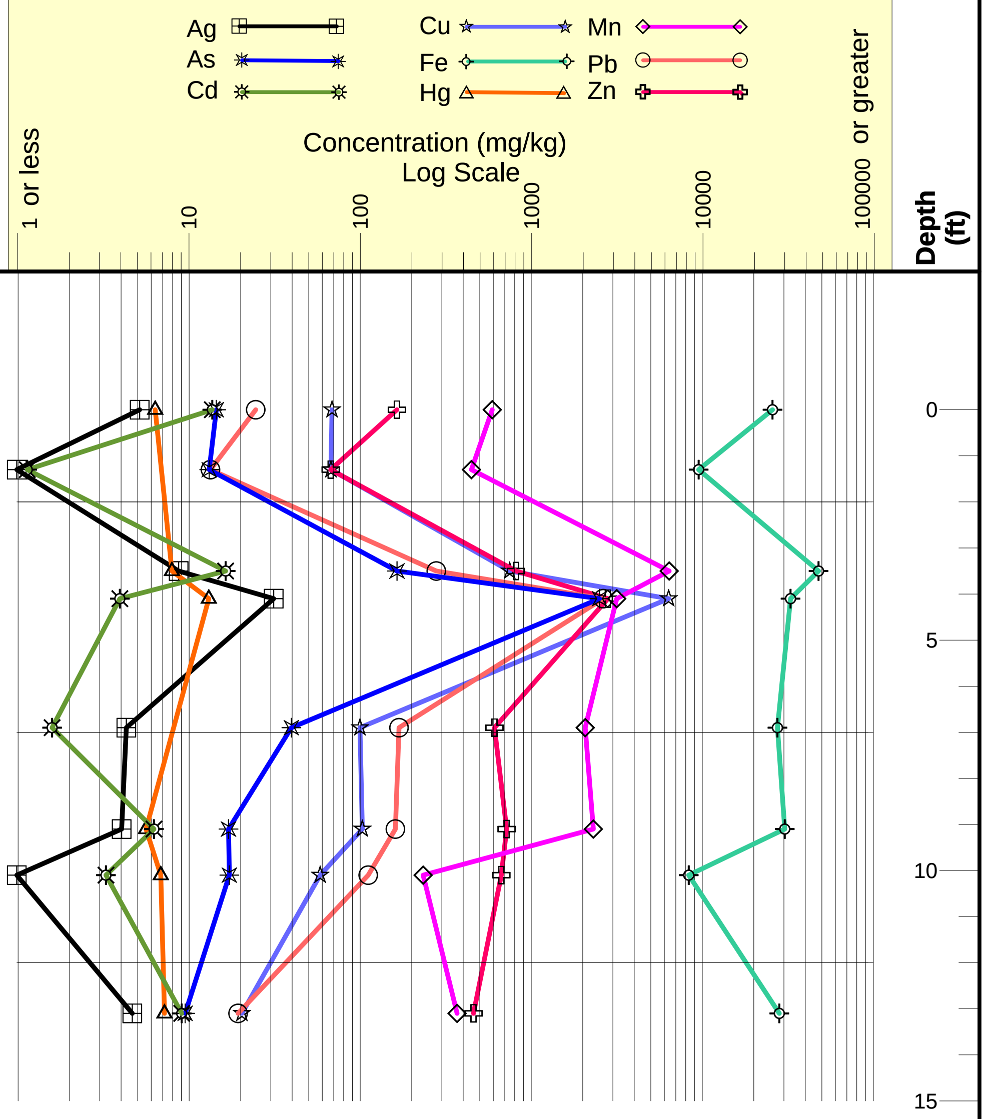
Percent Recovery	USCS Class	Lithology Log
75%	OL	Very stiff, dry, brown, fines-clay SILT with some fine gravel, low plasticity, organics (1" of root mass at top)
	GM	Dense, moist, brown black, fine to coarse-GRAVEL with some fines and big rock at 21"
	SW	Medium dense, moist, dark gray with pockets of black orange, coarse-SAND
70%	SP	Loose to medium dense, moist, red orange with lamination of gray, coarse to fine-SAND with coarse gravel near bottom
	ML	Soft, moist, gray with orange outside color, fines-clay/SILT, low plasticity, micaceous
	ML	Soft, moist, black/gray with orange layer in top 2", fines-clay SILT, medium plasticity, micaceous
70.8%	SP	Very soft, moist, black gray brown, medium-SAND with coarse gravel
	GP	Medium dense, moist, red with seems of orange and light gray, fine-GRAVEL with sand

Elev. (NAVD 88): 5440, 5438, 5436, 5434, 5432, 5430, 5428, 5426, 5424
Depth (ft.): 0, 5, 10, 15

Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
ND	ND	NS

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

- Bedrock
- Clay
- Clayey Sand
- Clayey Silt
- Gravel
- Sand
- Sandy Clay
- Sandy Gravel
- Sandy Silt
- Silt
- Silty Clay
- Silty Sand

Latitude: 45.9957102(NAD 83) Decimal Degrees
Longitude:-112.5446506 (NAD 83) Decimal Degrees
Northing:651519.17 IF
Easting:1195206.49 IF
Ground Elevation:5438.52 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

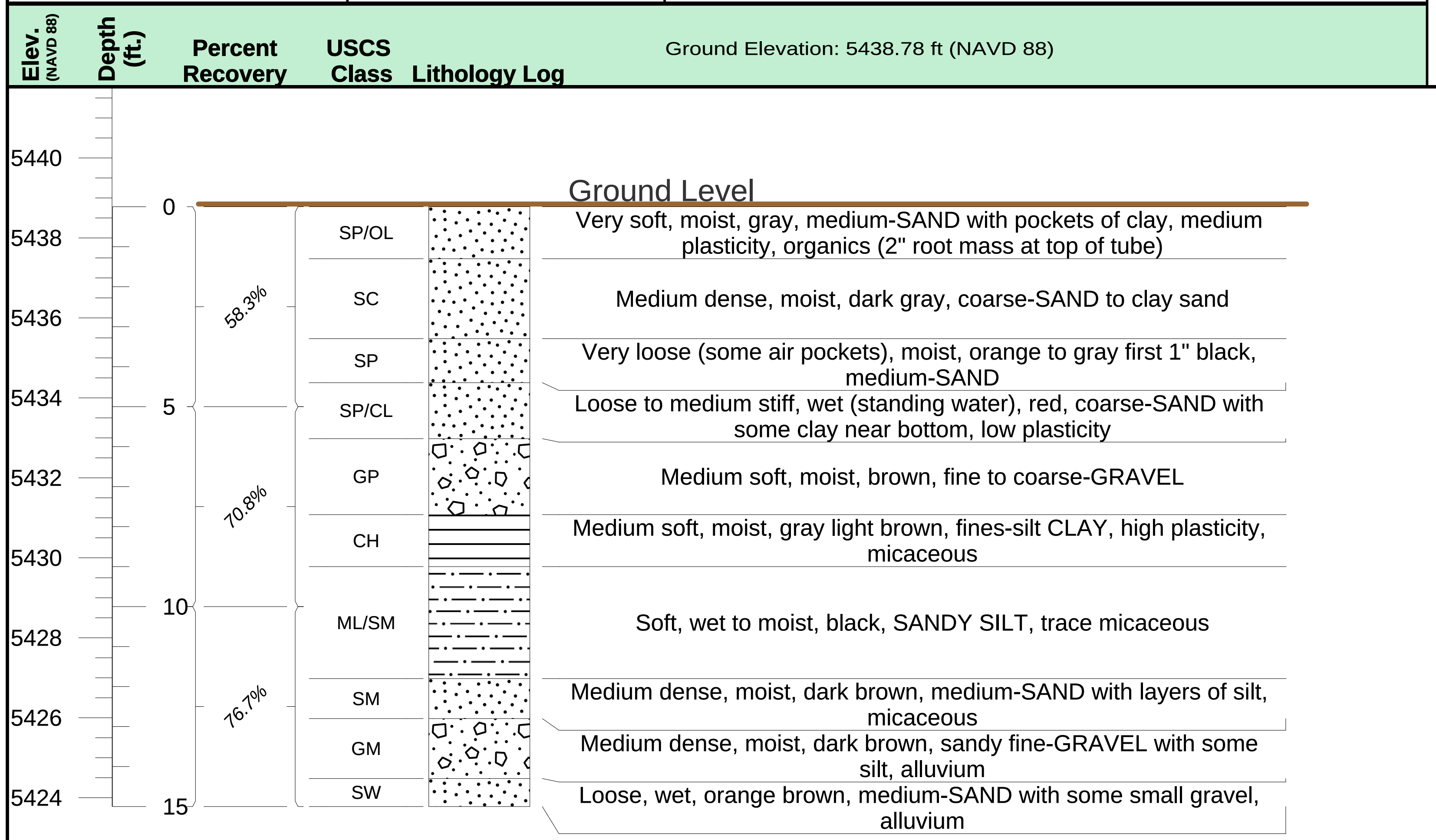
Borehole Log

Borehole Name: BRW18-BH20

Project: BRW Phase I Site Investigation	Location: Butte, MT	
Well Owner: Atlantic Richfield Co.	Depth to Water (bgs): NA ft Water Level from MP: NA ft	Date:NA Time:NA

Logged By: K. Jackson, J. Flammang	Date Drilled: 9/17/2018	Casing Type/Dia: None	Borehole Diameter: 3.25"
Drilling Company: Pioneer	Drilling Method: Direct Push	Screen Type/Length: None	

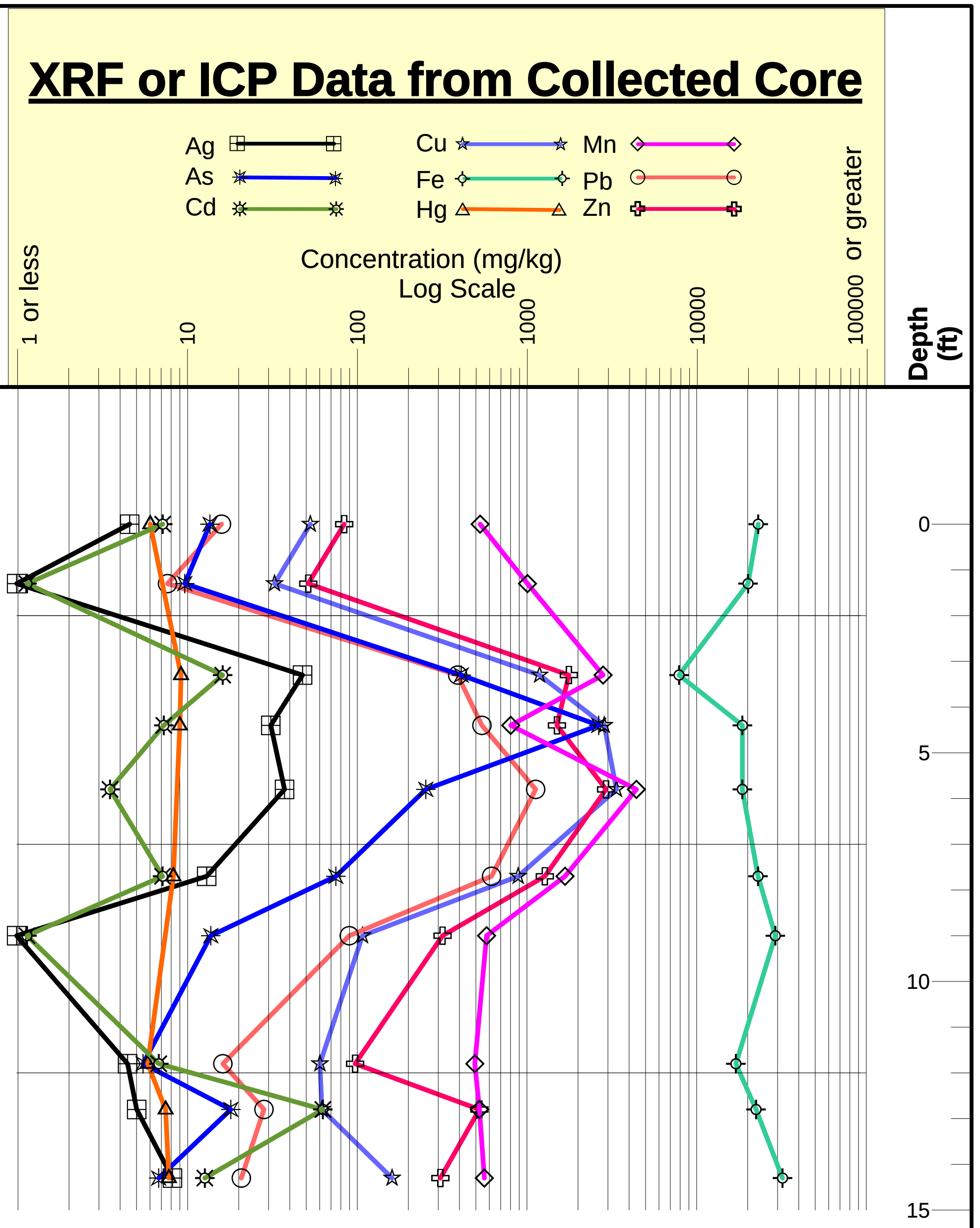
Ground Elevation: 5438.78 ft (NAVD 88)



USCS Class	Lithology Log
SP/OL	Very soft, moist, gray, medium-SAND with pockets of clay, medium plasticity, organics (2" root mass at top of tube)
SC	Medium dense, moist, dark gray, coarse-SAND to clay sand
SP	Very loose (some air pockets), moist, orange to gray first 1" black, medium-SAND
SP/CL	Loose to medium stiff, wet (standing water), red, coarse-SAND with some clay near bottom, low plasticity
GP	Medium soft, moist, brown, fine to coarse-GRAVEL
CH	Medium soft, moist, gray light brown, fines-silt CLAY, high plasticity, micaceous
ML/SM	Soft, wet to moist, black, SANDY SILT, trace micaceous
SM	Medium dense, moist, dark brown, medium-SAND with layers of silt, micaceous
GM	Medium dense, moist, dark brown, sandy fine-GRAVEL with some silt, alluvium
SW	Loose, wet, orange brown, medium-SAND with some small gravel, alluvium

Headspace Reading

Depth (ft)	PID (MR) ppm	PID (uR) ppm	TEH mg/kg
0–15	ND	ND	NS



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

🟧	Bedrock	▤	Sandy Clay
▤	Clay	▨	Sandy Gravel
▨	Clayey Sand	▤	Sandy Silt
▤	Clayey Silt	▭	Silt
▨	Gravel	▤	Silty Clay
▨	Sand	▤	Silty Sand

Latitude: 45.9953766(NAD 83) Decimal Degrees
Longitude:-112.5446851 (NAD 83) Decimal Degrees
Northing:651397.99 IF
Easting:1195193 IF
Ground Elevation:5438.78 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Borehole Log

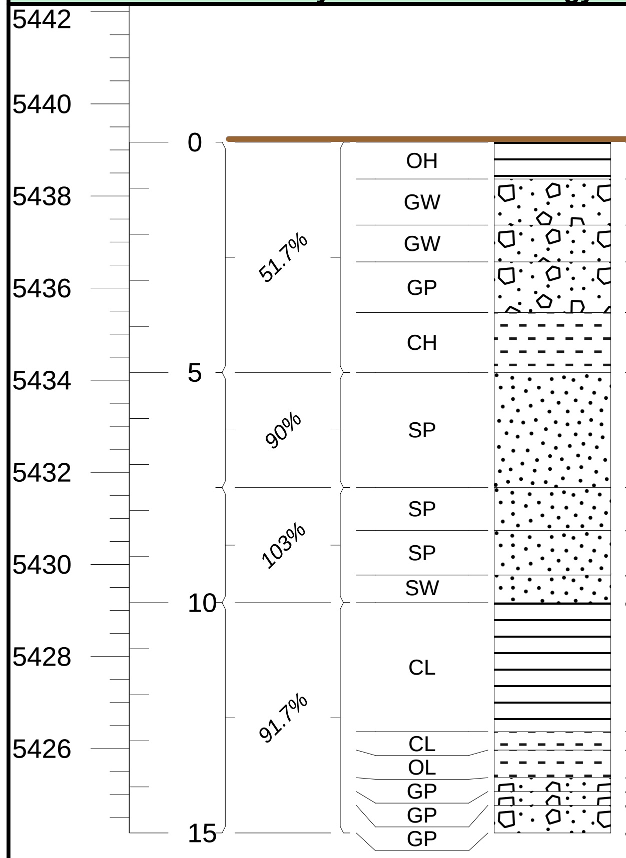
Borehole Name: BRW18-BH21

Project: BRW Phase I Site Investigation
Location: Butte, MT
Well Owner: Atlantic Richfield Co.
Depth to Water (bgs): NA ft
Water Level from MP: NA ft
Date:NA
Time:NA
Logged By: K. Jackson, J. Flammang
Date Drilled: 9/13/2018
Casing Type/Dia: None
Borehole Diameter: 3.25"
Drilling Company: Pioneer
Drilling Method: Direct Push
Screen Type/Length: None

Ground Elevation: 5439.17 ft (NAVD 88)

Ground Level

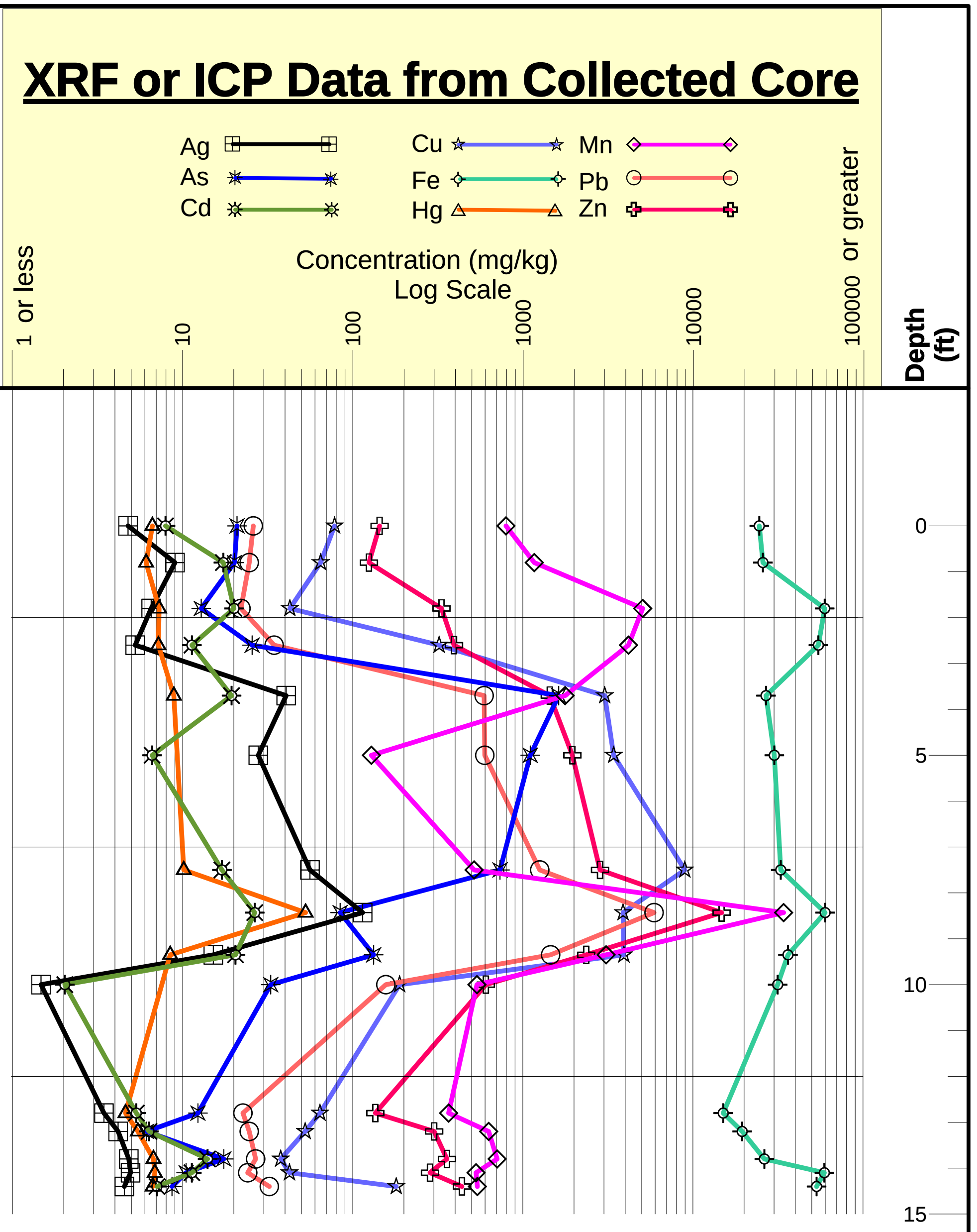
USCS Class	Lithology Log
OH	Stiff, moist, gray, silty-CLAY, organics (roots)
GW	Stiff, moist, gray, sandy-GRAVEL, organics (roots)
GW	Soft, moist, brown, silty GRAVEL.
GP	Stiff, moist, fine to coarse-GRAVEL
CH	Stiff, moist, mottled gray and dark medium tan, SANDY CLAY
SP	Stiff, moist, medium brown, medium-SAND with trace amounts of small gravel, poorly graded-alluvium
SP	Soft, moist, gray with red staining and some orange, medium-SAND with trace amounts of small gravel, poorly graded
SP	Stiff, moist, brown orange, medium to fine-SAND with layer of slightly coarser orange sand, poorly graded
SW	Soft, moist, medium brown gray, coarse-SAND with trace amounts of small gravel and small layer of silty clay
CL	Soft, moist, dark gray, silty-CLAY, micaceous
CL	Soft, moist, dark gray, SANDY CLAY
OL	Soft, moist, dark gray black, SANDY CLAY, organics
GP	Moist, dark brown, sandy GRAVEL, alluvium
GP	Soft, brown, sandy-GRAVEL, alluvium
GP	Soft, moist, brown, sandy-GRAVEL with rocks, alluvium



Headspace Reading

Depth (ft)	PID (MR) ppm	PID (uR) ppm	TEH mg/kg
	ND	ND	NS

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

Bedrock	Sandy Clay
Clay	Sandy Gravel
Clayey Sand	Sandy Silt
Clayey Silt	Silt
Gravel	Silty Clay
Sand	Silty Sand

Latitude: 45.9951562(NAD 83) Decimal Degrees
Longitude:-112.5447802 (NAD 83) Decimal Degrees
Northing:651318.64 IF
Easting:1195165.74 IF
Ground Elevation:5439.17 ft (NAVD 88)

T3N R8W S24

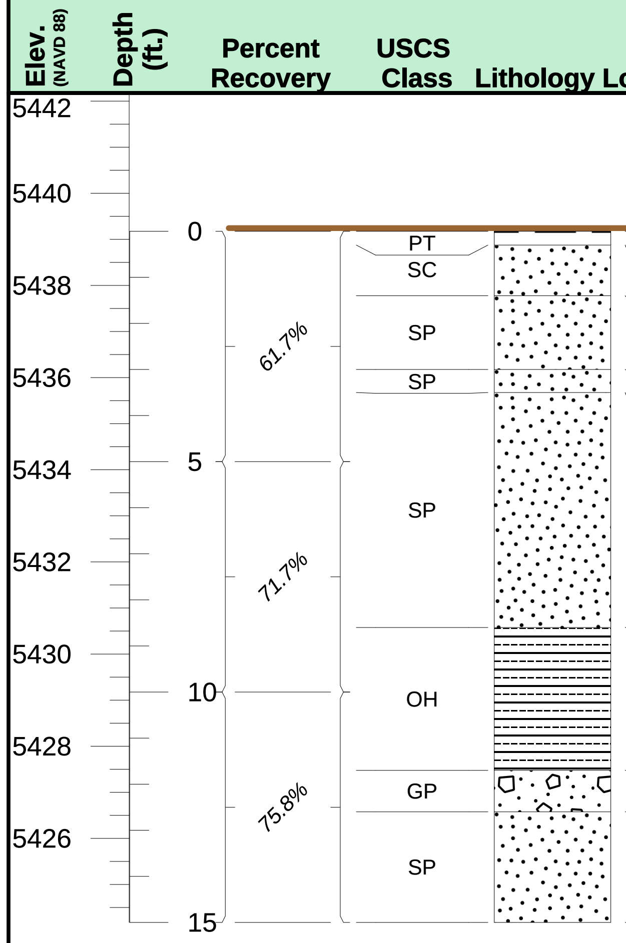
PIONEER TECHNICAL SERVICES, INC.

Borehole Log

Borehole Name: BRW18-BH22

Project: BRW Phase I Site Investigation
Location: Butte, MT
Well Owner: Atlantic Richfield Co.
Depth to Water (bgs): NA ft Date:NA
Water Level from MP: NA ft Time:NA
Logged By: K. Jackson, J. Flammang
Date Drilled: 9/13/2018
Casing Type/Dia: None
Borehole Diameter: 3.25"
Drilling Company: Pioneer
Drilling Method: Direct Push
Screen Type/Length: None

Ground Elevation: 5439.18 ft (NAVD 88)



Ground Level

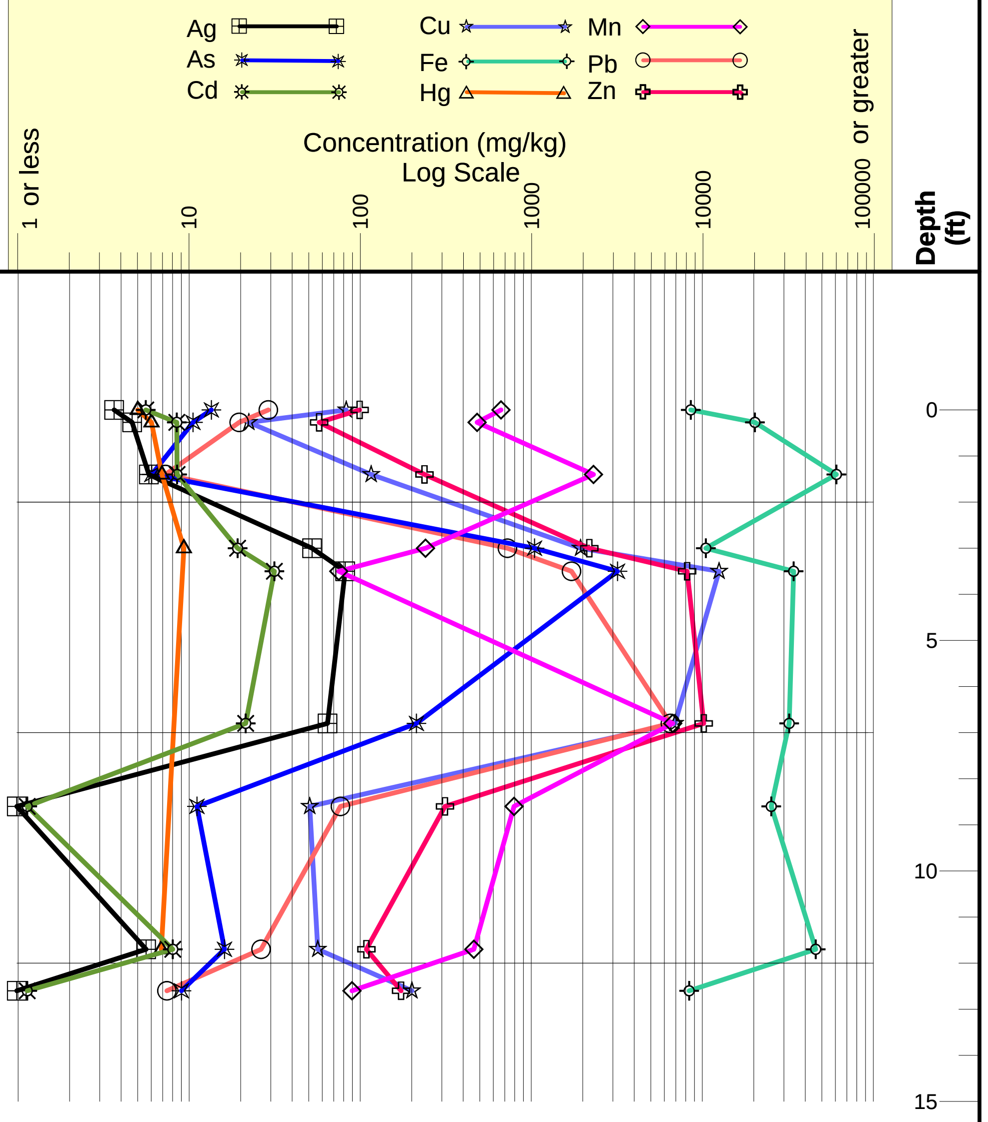
USCS Class	Lithology Log
PT	Moist (damp), reddish black, clayey-SILT, pine needles moss, organic/humus with vegetation on top
SC	Medium stiff, moist, medium tan, clayey-SAND, homogenous
SP	Stiff, moist (damp), medium brown, coarse to medium-SAND with gravel
SP	Very stiff, gray with some lenses of lighter brown, coarse to medium-SAND with gravel
SP	Stiff, moist, orange red medium brown gray, coarse to medium-SAND with gravel
OH	Stiff to medium stiff, moist (damp), black, medium plasticity, SILTY CLAY with some fine to medium sand, organic
GP	Soft, moist, black, poorly graded-GRAVELS with fines and silt
SP	Soft, wet (visible water), brown, medium to coarse-SAND, iron stained in top 6"

Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
ND	ND	NS

Depth (ft): 0, 5, 10, 15

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

- Bedrock
- Clay
- Clayey Sand
- Clayey Silt
- Gravel
- Sand
- Sandy Clay
- Sandy Gravel
- Sandy Silt
- Silt
- Silty Clay
- Silty Sand

Latitude: 45.9947321(NAD 83) Decimal Degrees
Longitude:-112.5447298 (NAD 83) Decimal Degrees
Northing:651163.67 IF
Easting:1195172.51 IF
Ground Elevation:5439.18 ft (NAVD 88)

T3N R8W S24

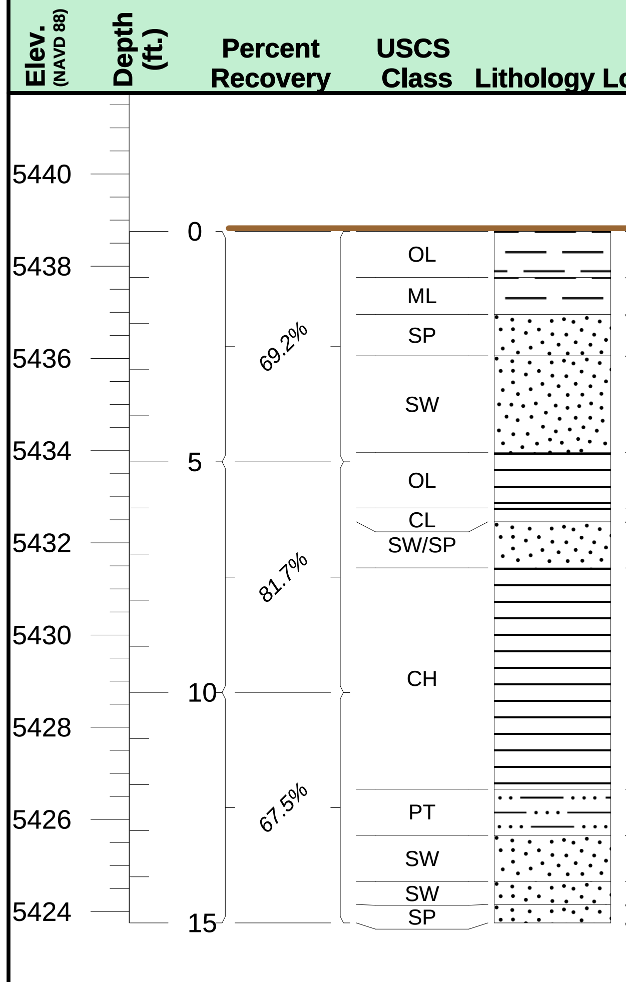
Borehole Log

Borehole Name: BRW18-BH23

Pioneer Technical Services, Inc.

Project: BRW Phase I Site Investigation
Location: Butte, MT
Well Owner: Atlantic Richfield Co.
Depth to Water (bgs): NA ft
Water Level from MP: NA ft
Date:NA
Time:NA
Logged By: K. Jackson, J. Flammang
Date Drilled: 9/13/2018
Casing Type/Dia: None
Borehole Diameter: 3.25"
Drilling Company: Pioneer
Drilling Method: Direct Push
Screen Type/Length: None

Ground Elevation: 5438.76 ft (NAVD 88)

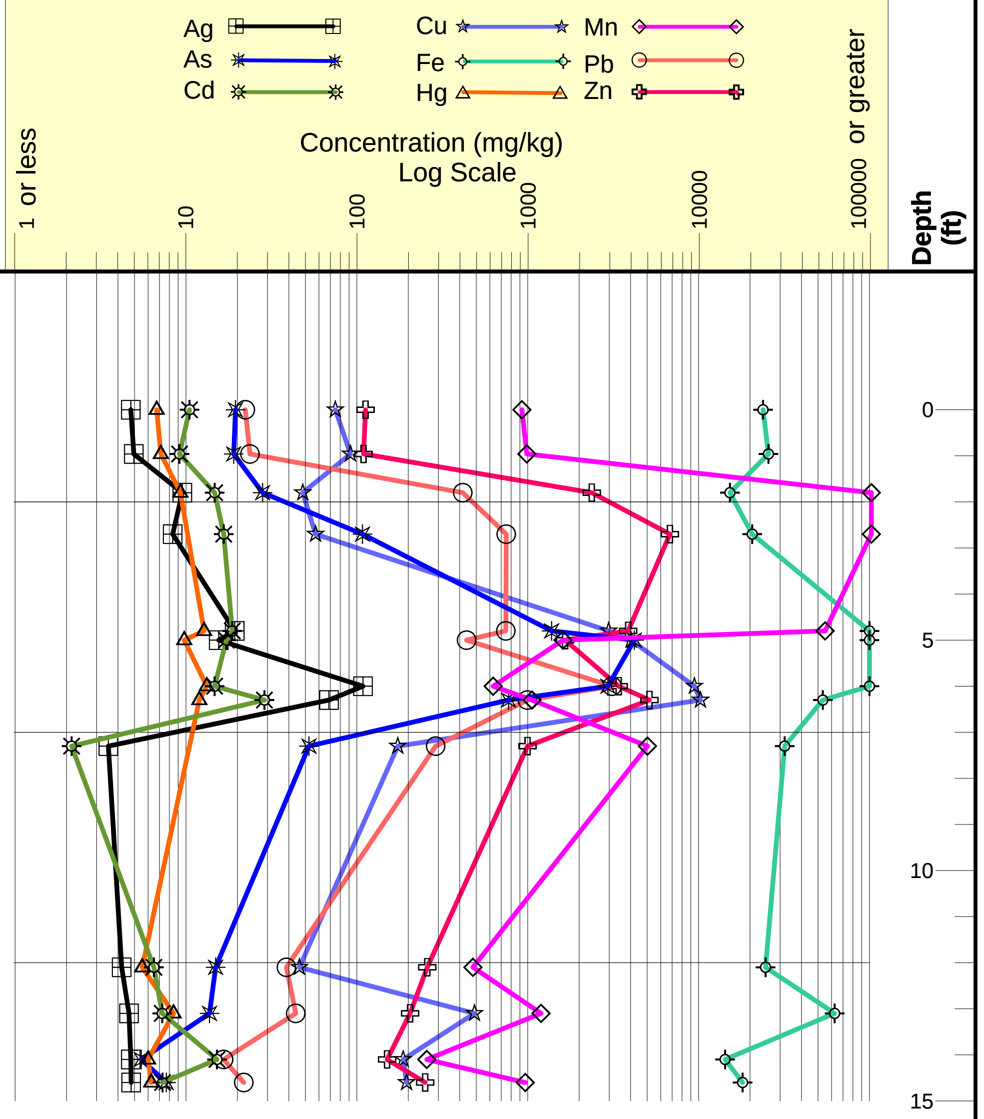


USCS Class	Lithology Log
OL	Soft, dry, gray, SILT with small amount of gravel, scattered roots organics, homogenous
ML	Hard, dry, grayish brown with some bleaching, clayey-SILT with gravel, micaceous
SP	Moist, medium brown to tan, fine-SAND
SW	Moist, layered tan to orange then to gray, fine-SAND with slightly clayey sands
OL	Soft, moist, dark brown with laminations of light orange gray dark orange, fines-silt CLAY, organic, homogeneous
CL	Very soft, moist, orange, fines-silt CLAY, homogenous
SW/SP	Loose, gray dark red, gravely-SAND
CH	Soft, moist, medium gray, fines-silt CLAY homogenous
PT	Medium stiff, moist, black, SILTY SAND with small amount of clay, top is rich organic material, marshy odor
SW	Stiff, moist, medium to coarse-SAND, well graded
SW	Stiff, moist, brown, medium to coarse-SAND with angular rock, well graded
SP	Stiff, moist, medium-SAND, homogeneous, little rock

Headspace Reading

Depth (ft)	PID (MR) ppm	PID (uR) ppm	TEH mg/kg
0–15	ND	ND	NS

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

Bedrock	Sandy Clay
Clay	Sandy Gravel
Clayey Sand	Sandy Silt
Clayey Silt	Silt
Gravel	Silty Clay
Sand	Silty Sand

Latitude: 45.9949246(NAD 83) Decimal Degrees
Longitude:-112.5449624 (NAD 83) Decimal Degrees
Northing:651236.1 IF
Easting:1195116.21 IF
Ground Elevation:5438.76 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Borehole Log

Borehole Name: **BRW18-BH24**

Project: BRW Phase I Site Investigation	Location: Butte, MT
Well Owner: Atlantic Richfield Co.	Depth to Water (bgs): NA ft Water Level from MP: NA ft Date:NA Time:NA
Logged By: K. Jackson, J. Flammang	Date Drilled: 9/13/2018
Casing Type/Dia: None	Borehole Diameter: 3.25"
Drilling Company: Pioneer	Drilling Method: Direct Push
Screen Type/Length: None	

Ground Elevation: 5438.65 ft (NAVD 88)

Ground Level

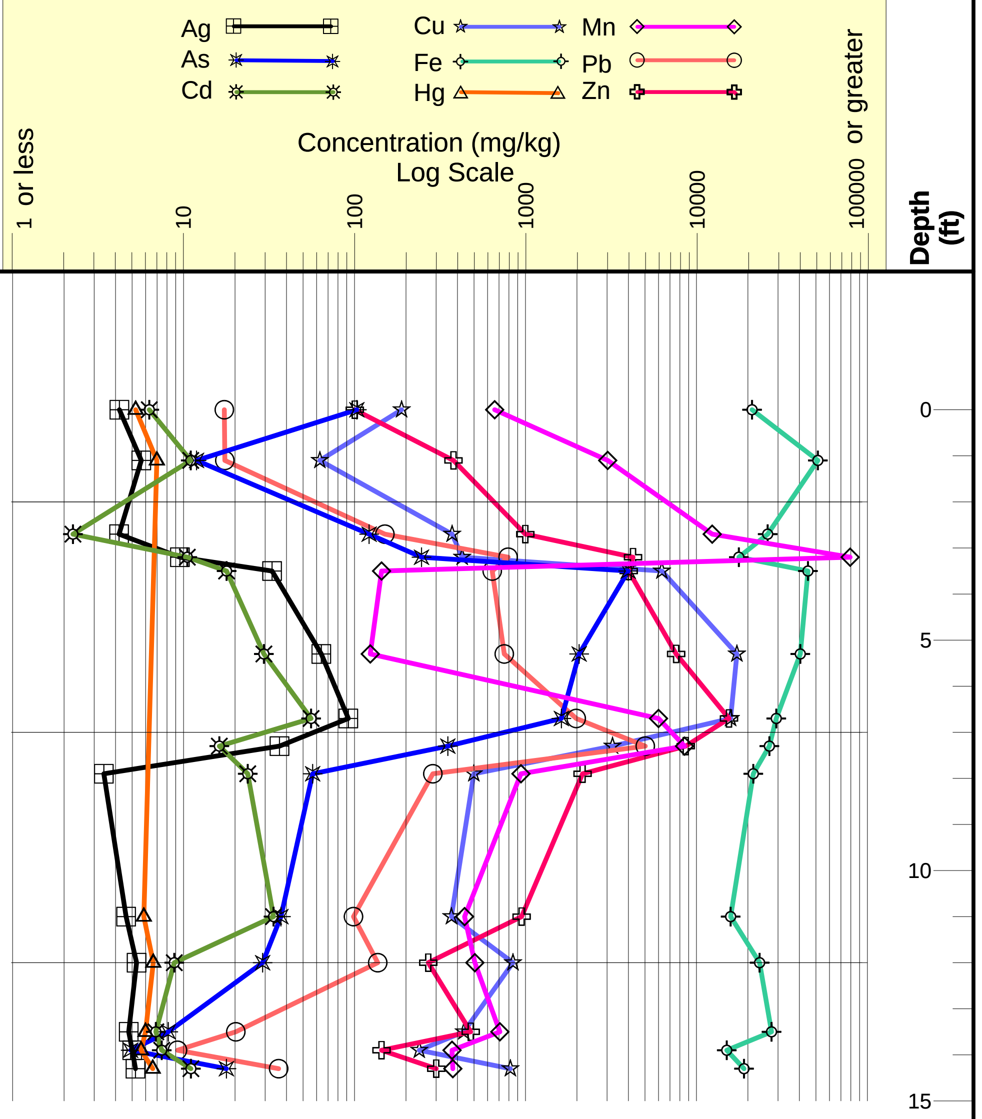
Depth (ft.)	Percent Recovery	USCS Class	Lithology Log
0	53.3%	CL	Gray, sandy-CLAY with gravel, organics
		GP	Firm, dark gray, silty-GRAVEL with sand, poorly graded
		ML	Firm, dry (flakey), light gray, clayey fine-SAND
		SM	Moist, black gray, SILTY SAND, organics
		SP	Soft, wet, orange brown, coarse-SAND with small gravel
5	51.7%	SW	Medium stiff, wet to moist, red brown, medium-SAND, homogenous
		OL	Stiff, moist, dark brown black, sandy CLAY with some silt, no gravel, black-medium grained sand layers (possible granulated slag)
		SP	Soft, moist, black, medium-SAND
		OH	Soft, moist to wet, dark black brown, silty-CLAY with organics (roots) particularly at top
10	56.7%	MH	Stiff, moist, dark brown, SANDY SILT, micaceous
		SP	Stiff, moist, medium brown slightly medium orange brown, gravelly-SAND
		MH	Stiff, moist, clayey SANDY SILT, micaceous
		SP	Dense, moist, fine to medium-SAND
15		SP	Soft, moist, orange/red, coarse-SAND with scattered gravel, poorly graded

Elev. (NAVD 88): 5440, 5438, 5436, 5434, 5432, 5430, 5428, 5426, 5424

Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
ND	ND	NS

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

▨	Bedrock		Sandy Clay
	Clay		Sandy Gravel
	Clayey Sand		Sandy Silt
	Clayey Silt		Silt
	Gravel		Silty Clay
	Sand		Silty Sand

Latitude: 45.994717(NAD 83) Decimal Degrees
Longitude:-112.5450424 (NAD 83) Decimal Degrees
Northing:651161.26 IF
Easting:1195092.96 IF
Ground Elevation:5438.65 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Borehole Log

Borehole Name: **BRW18-BH25**

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): NA ft
Water Level from MP: NA ft

Date:NA
Time:NA

Logged By: K. Jackson, J. Flammang

Date Drilled: 9/13/2018

Casing Type/Dia: None

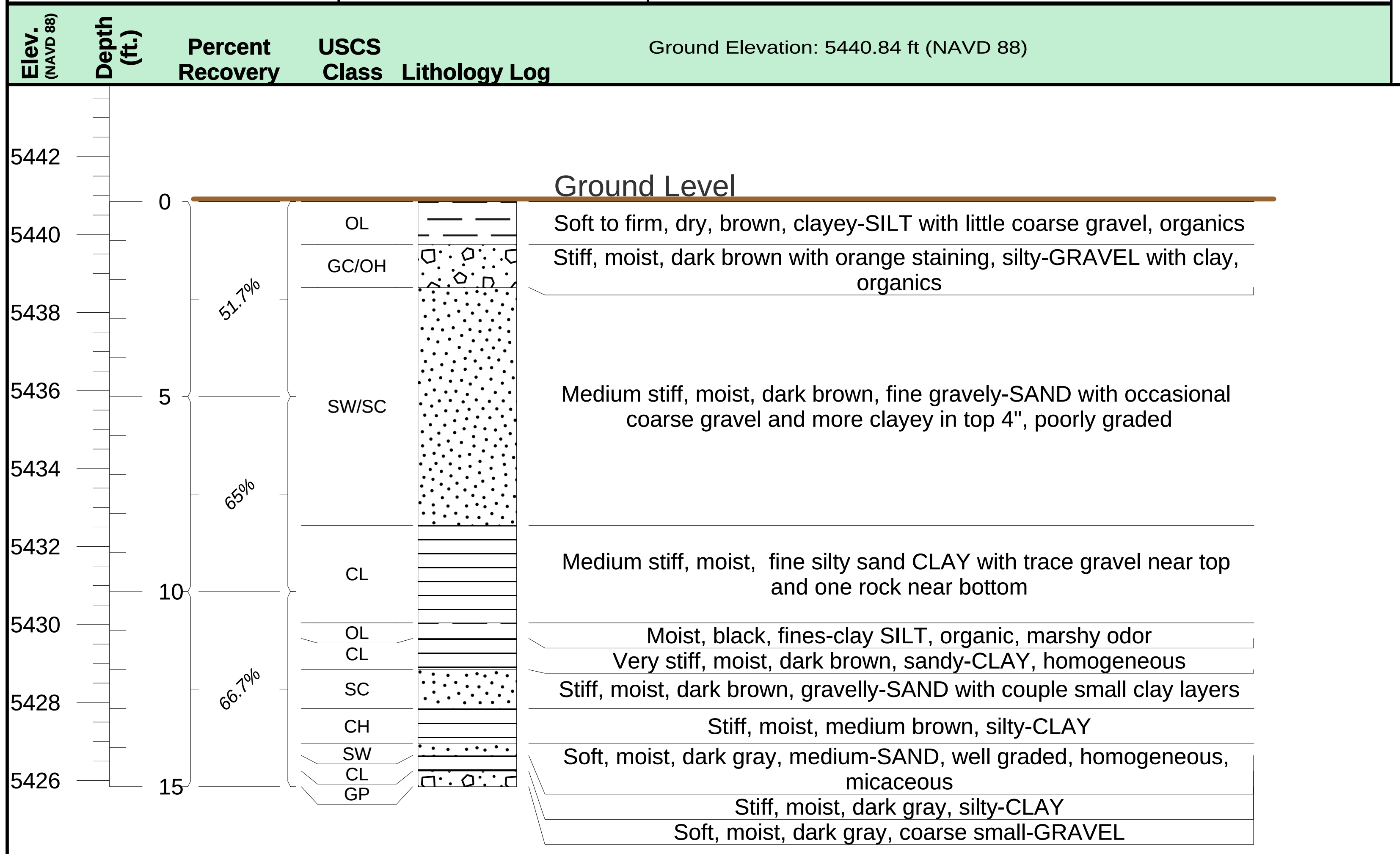
Borehole Diameter: 3.25"

Drilling Company: Pioneer

Drilling Method: Direct Push

Screen Type/Length: None

Ground Elevation: 5440.84 ft (NAVD 88)

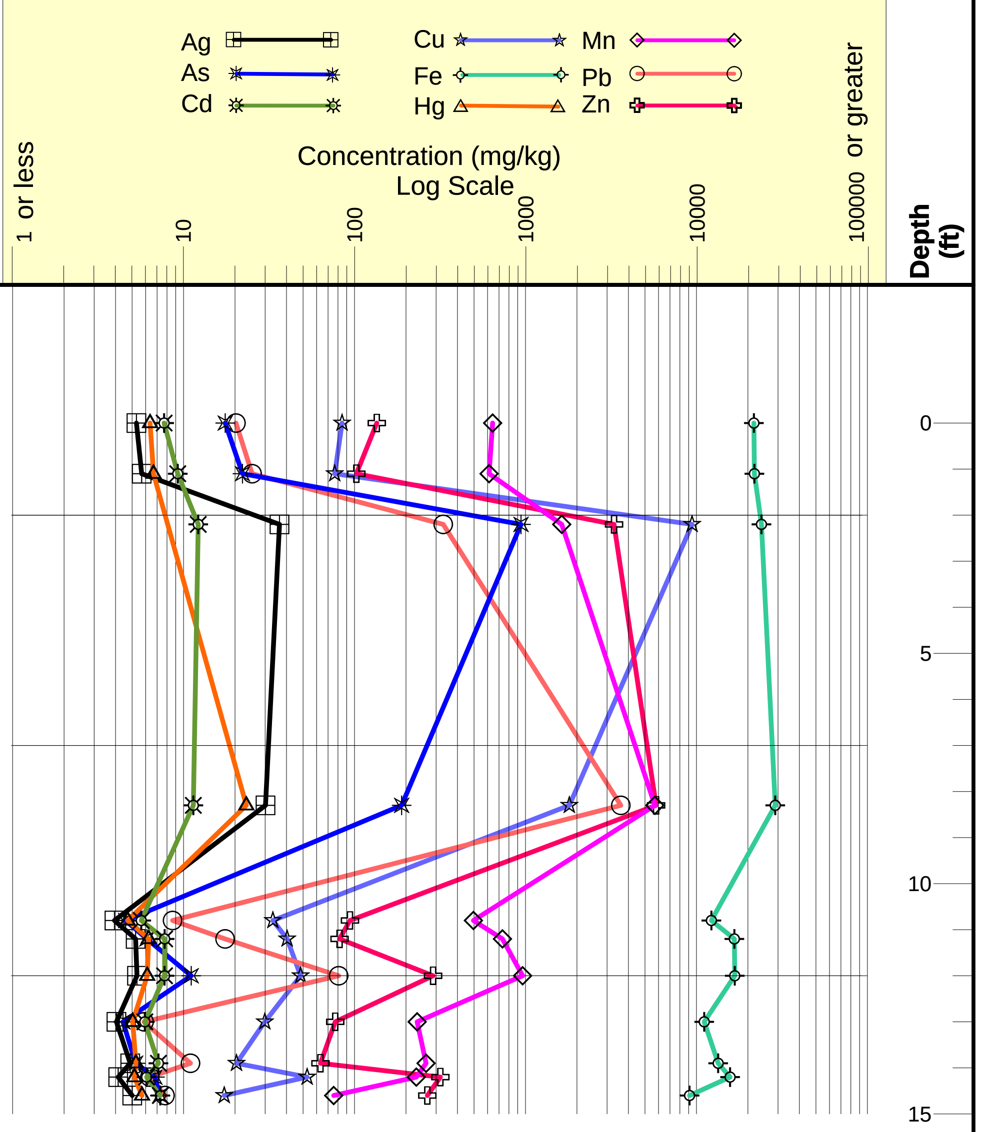


USCS Class	Lithology Log
OL	Soft to firm, dry, brown, clayey-SILT with little coarse gravel, organics
GC/OH	Stiff, moist, dark brown with orange staining, silty-GRAVEL with clay, organics
SW/SC	Medium stiff, moist, dark brown, fine gravely-SAND with occasional coarse gravel and more clayey in top 4", poorly graded
CL	Medium stiff, moist, fine silty sand CLAY with trace gravel near top and one rock near bottom
OL	Moist, black, fines-clay SILT, organic, marshy odor
CL	Very stiff, moist, dark brown, sandy-CLAY, homogeneous
SC	Stiff, moist, dark brown, gravelly-SAND with couple small clay layers
CH	Stiff, moist, medium brown, silty-CLAY
SW	Soft, moist, dark gray, medium-SAND, well graded, homogeneous, micaceous
CL	Stiff, moist, dark gray, silty-CLAY
GP	Soft, moist, dark gray, coarse small-GRAVEL

Headspace Reading

Depth (ft)	PID (MR) ppm	PID (uR) ppm	TEH mg/kg
10–12	ND	ND	NS

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

- Bedrock
- Clay
- Clayey Sand
- Clayey Silt
- Gravel
- Sand
- Sandy Clay
- Sandy Gravel
- Sandy Silt
- Silt
- Silty Clay
- Silty Sand

Latitude: 45.9945665(NAD 83) Decimal Degrees
Longitude:-112.5451027 (NAD 83) Decimal Degrees
Northing:651107.05 IF
Easting:1195075.52 IF
Ground Elevation:5440.84 ft (NAVD 88)

T3N R8W S24

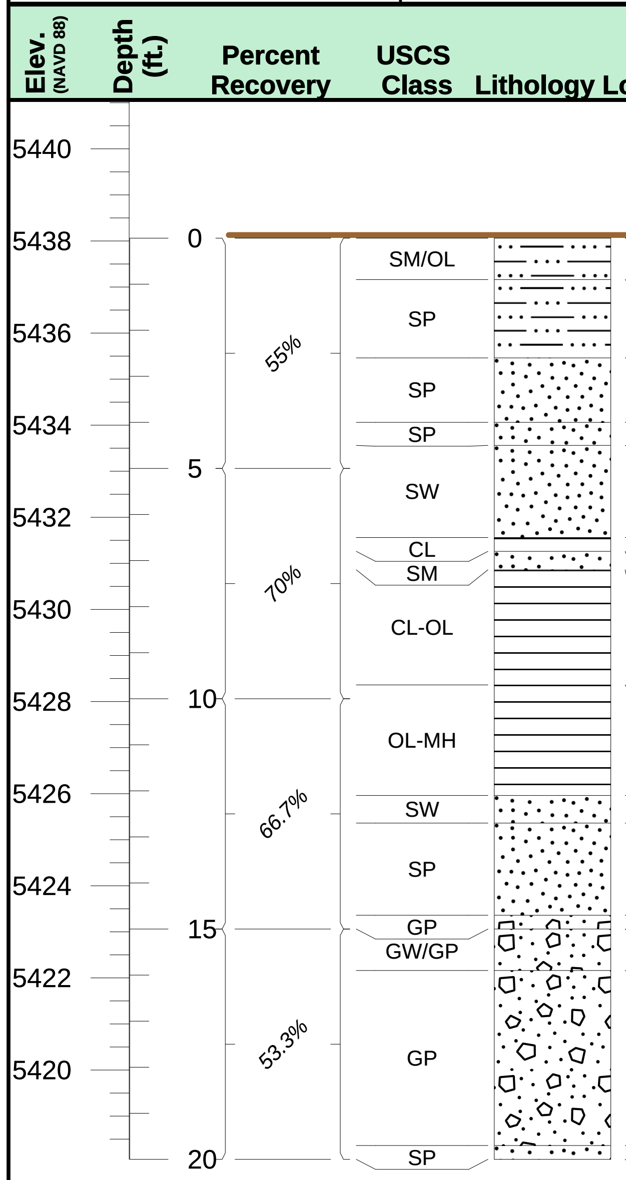
PIONEER TECHNICAL SERVICES, INC.

Borehole Log

Borehole Name: **BRW18-BH26**

Project: BRW Phase I Site Investigation
Location: Butte, MT
Well Owner: Atlantic Richfield Co.
Depth to Water (bgs): NA ft Date:NA
Water Level from MP: NA ft Time:NA
Logged By: K. Jackson, J. Flammang
Date Drilled: 9/14/2018
Casing Type/Dia: None
Borehole Diameter: 3.25"
Drilling Company: Pioneer
Drilling Method: Direct Push
Screen Type/Length: None

Ground Elevation: 5438.06 ft (NAVD 88)

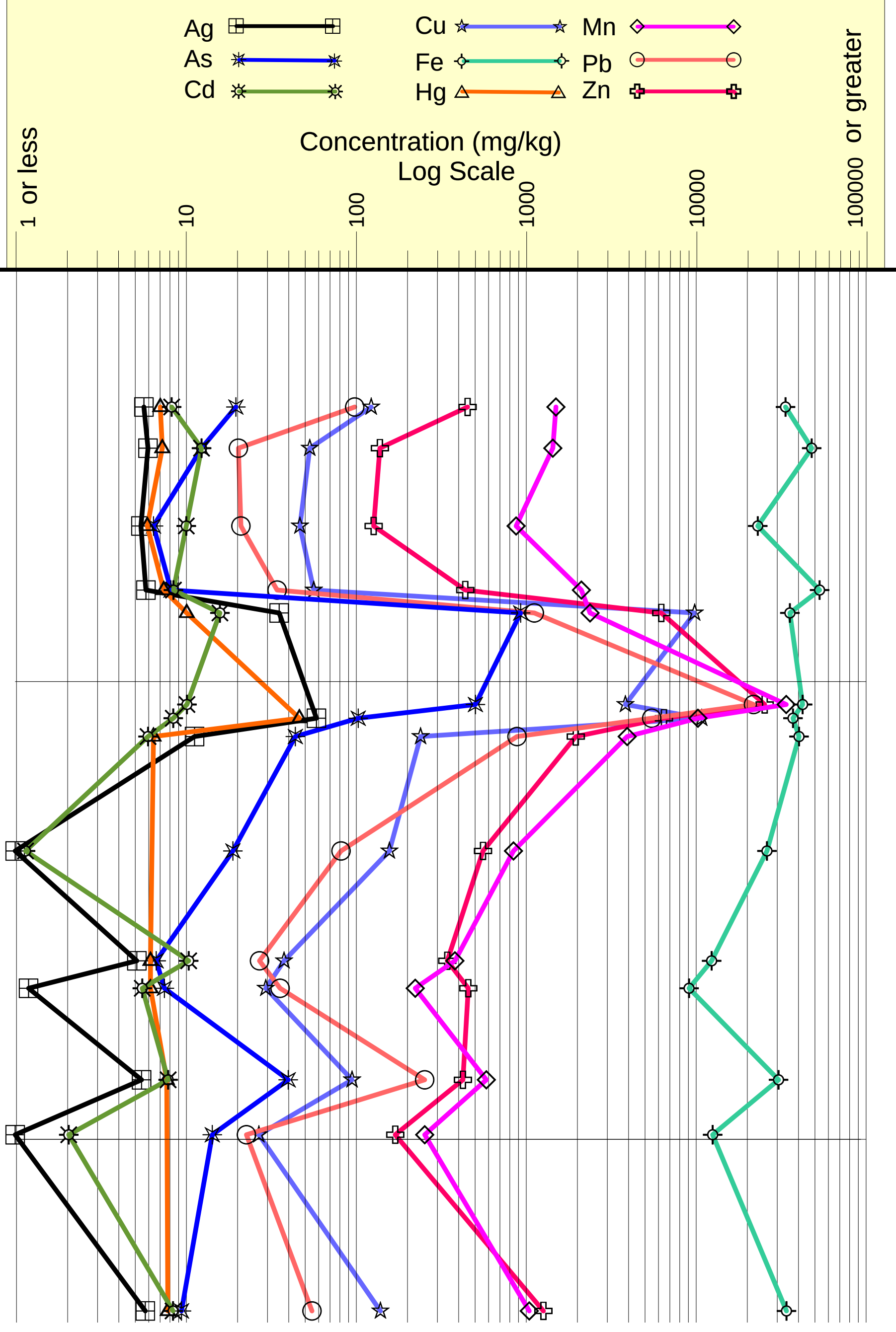


USCS Class	Lithology Log
SM/OL	Medium stiff, dry, medium tan, SILTY SAND with some small gravel, organics at top
SP	Medium stiff to stiff, slightly moist, medium brown white, SILTY SAND with lenses of white clay sand with gravel, micaceous
SP	Stiff, slightly moist, yellow-brown SAND with small gravel, large rock up to 2", and rock less than 2"in core
SP	Stiff, moist, yellow brown, medium-SAND with small gravel, micaceous
SW	Soft, moist, medium brown, medium-SAND with very few fines, homogeneous, well sorted
CL	Medium stiff, wet, medium brown, sandy-CLAY with some silt and sand at top
SM	Medium stiff, wet, red brown, fine SILTY SAND, homogeneous, well sorted
CL-OL	Stiff, gray to black, gray CLAY with black gray laminated very small layers to mottled some with gray from upper part ,organics
OL-MH	Stiff, moist to wet, dark gray to gray black, silty-CLAY, slightly micaceous
SW	Medium stiff, moist, SAND with minimal gravel, well graded, organics
SP	Moist to wet, orange, SAND with gravel and minimal silt, poorly graded, thin layer of orange clay (14.5' to 14.7')
GP	Soft, wet, brown, coarse-GRAVEL with minimal fines, poorly graded
GW/GP	Stiff, wet, brown red orange, coarse-GRAVEL with fine gravel
GP	Stiff, moist, brick red, coarse-GRAVEL, poorly graded
SP	Soft, brick red, medium SAND with gray clay at bottom, poorly graded

Headspace Reading

Depth (ft)	PID (MR) ppm	PID (uR) ppm	TEH mg/kg
0–20	ND	ND	NS

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

- Bedrock
- Clay
- Clayey Sand
- Clayey Silt
- Gravel
- Sand
- Sandy Clay
- Sandy Gravel
- Sandy Silt
- Silt
- Silty Clay
- Silty Sand

Latitude: 45.9953624(NAD 83) Decimal Degrees
Longitude:-112.5452454 (NAD 83) Decimal Degrees
Northing:651398.34 IF
Easting:1195050.55 IF
Ground Elevation:5438.06 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Borehole Log

Borehole Name: BRW18-BH27

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): NA ft
Water Level from MP: NA ft

Date:NA
Time:NA

Logged By: K. Jackson, J. Flammang

Date Drilled: 9/14/2018

Casing Type/Dia: None

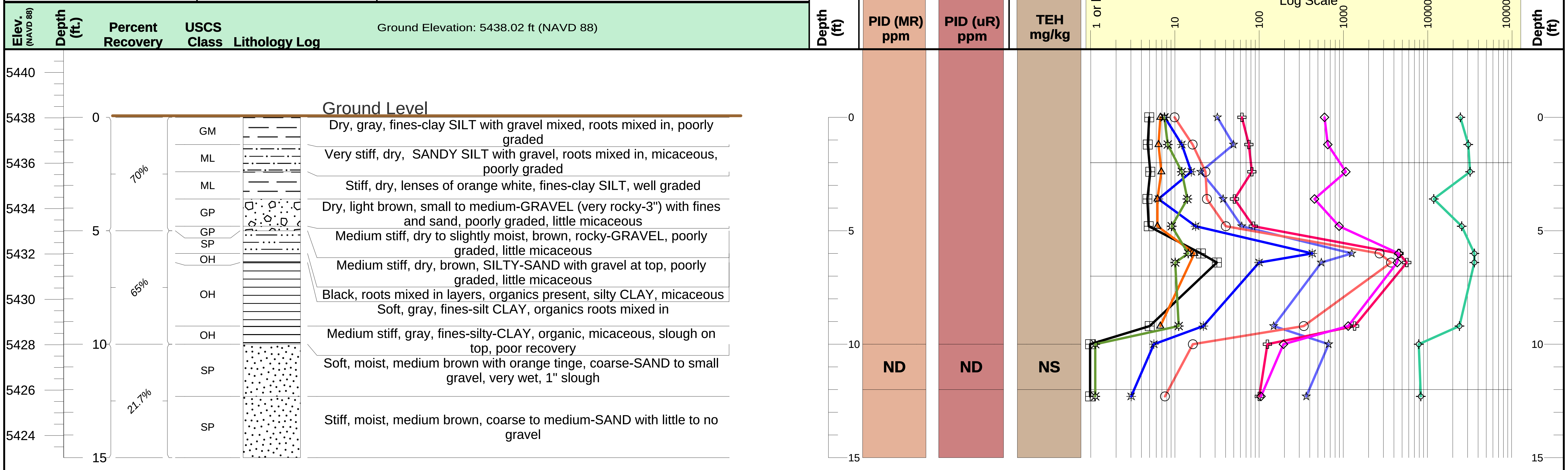
Borehole Diameter: 3.25"

Drilling Company: Pioneer

Drilling Method: Direct Push

Screen Type/Length: None

Ground Elevation: 5438.02 ft (NAVD 88)



USCS Class	Lithology Log
GM	Dry, gray, fines-clay SILT with gravel mixed, roots mixed in, poorly graded
ML	Very stiff, dry, SANDY SILT with gravel, roots mixed in, micaceous, poorly graded
ML	Stiff, dry, lenses of orange white, fines-clay SILT, well graded
GP	Dry, light brown, small to medium-GRAVEL (very rocky-3") with fines and sand, poorly graded, little micaceous
GP	Medium stiff, dry to slightly moist, brown, rocky-GRAVEL, poorly graded, little micaceous
SP	Medium stiff, dry, brown, SILTY-SAND with gravel at top, poorly graded, little micaceous
OH	Black, roots mixed in layers, organics present, silty CLAY, micaceous
OH	Soft, gray, fines-silt CLAY, organics roots mixed in
OH	Medium stiff, gray, fines-silty-CLAY, organic, micaceous, slough on top, poor recovery
SP	Soft, moist, medium brown with orange tinge, coarse-SAND to small gravel, very wet, 1" slough
SP	Stiff, moist, medium brown, coarse to medium-SAND with little to no gravel

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

- Bedrock
- Clay
- Clayey Sand
- Clayey Silt
- Gravel
- Sand
- Sandy Clay
- Sandy Gravel
- Sandy Silt
- Silt
- Silty Clay
- Silty Sand

Latitude: 45.995126(NAD 83) Decimal Degrees
Longitude:-112.5453653 (NAD 83) Decimal Degrees
Northing:651313.45 IF
Easting:1195016.77 IF
Ground Elevation:5438.02 ft (NAVD 88)

T3N R8W S24

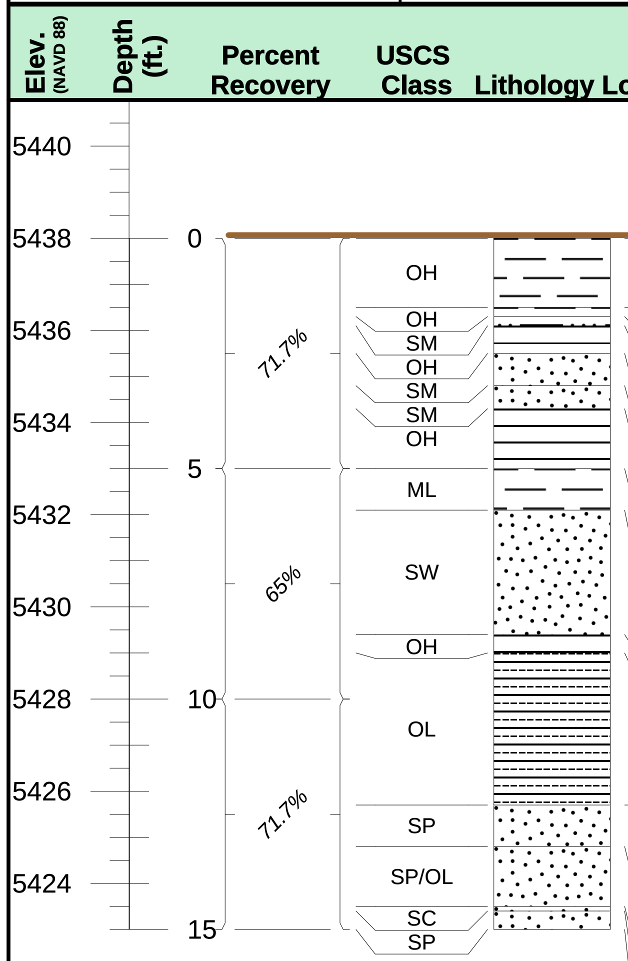
PIONEER TECHNICAL SERVICES, INC.

Borehole Log

Borehole Name: BRW18-BH28

Project: BRW Phase I Site Investigation
Location: Butte, MT
Well Owner: Atlantic Richfield Co.
Depth to Water (bgs): NA ft Date:NA
Water Level from MP: NA ft Time:NA
Logged By: K. Jackson, J. Flammang
Date Drilled: 9/14/2018
Casing Type/Dia: None
Borehole Diameter: 3.25"
Drilling Company: Pioneer
Drilling Method: Direct Push
Screen Type/Length: None

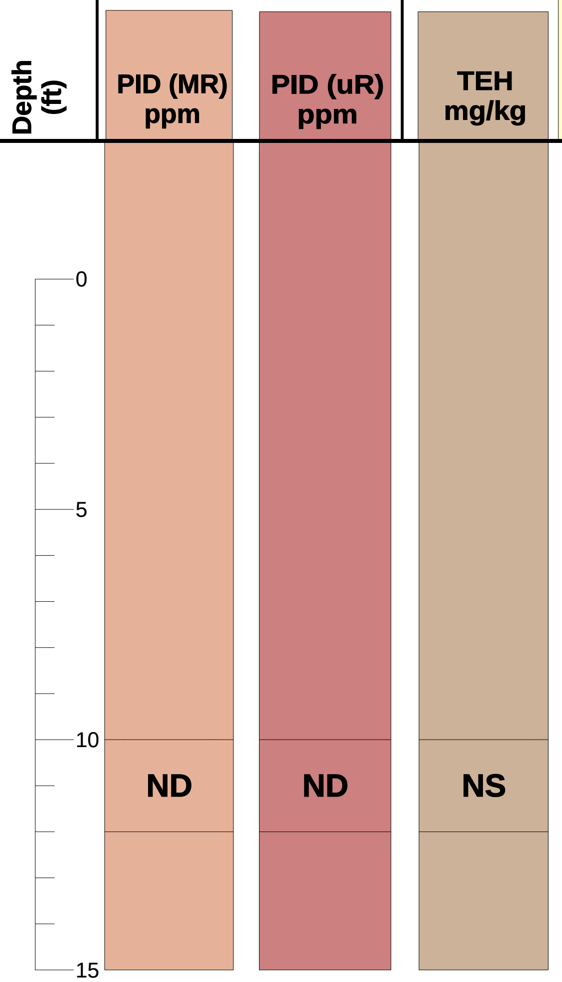
Ground Elevation: 5438 ft (NAVD 88)



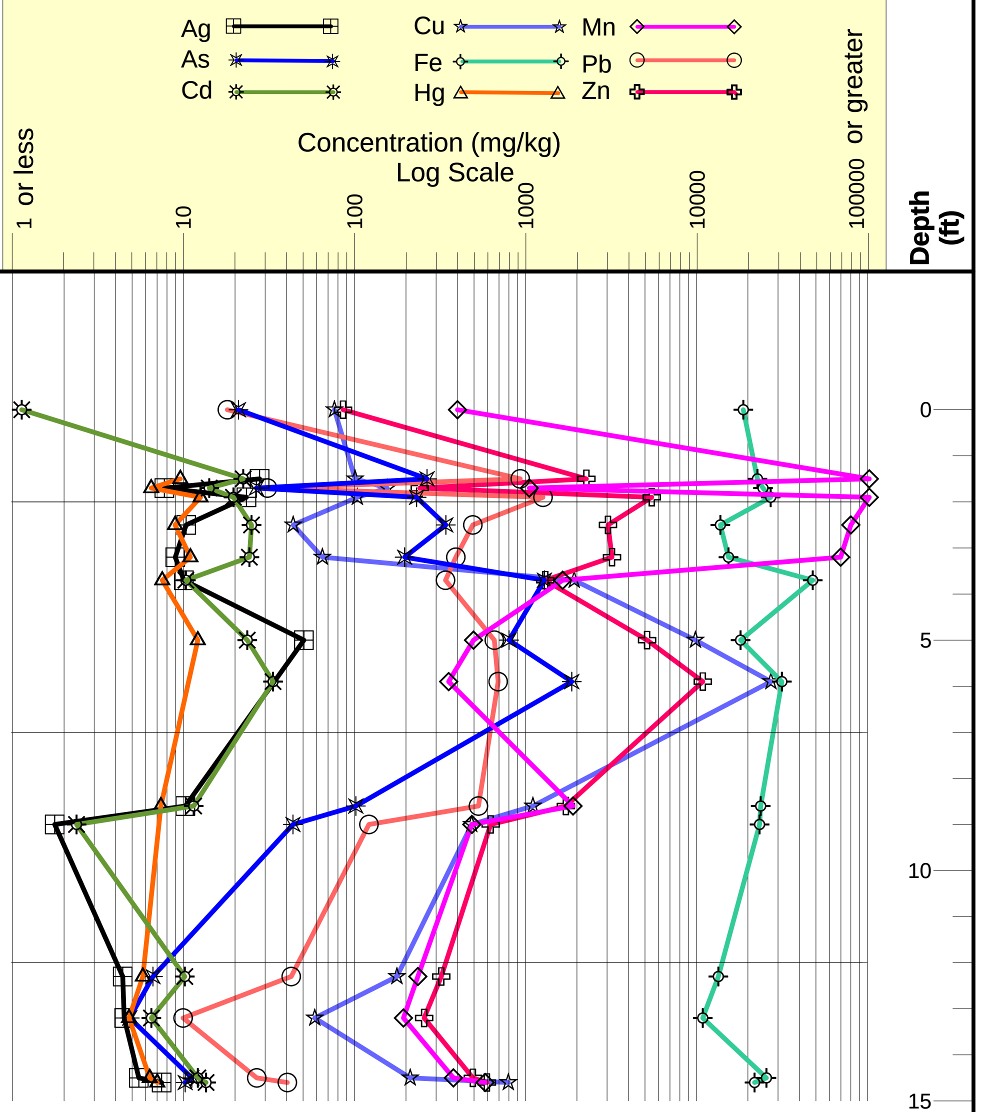
Ground Level

USCS Class	Lithology Log
OH	Medium firm, dry, gray, organics, roots mixed throughout
OH	Medium stiff, dark brown black, organics
SM	Medium firm, tan gray, fines-SILTY SAND
OH	Lenses of gray, CLAY at top sand at bottom, roots mixed in the bottom inch
SM	Dense, moist, orange stains gray thin layers, fine-SAND
SM	Dense, moist, gray, fine-SAND
OH	Medium stiff, black gray thin layers, fines-silt CLAY with orange staining in end cap
ML	Soft, wet to moist, yellowish brown orange staining, fines-clayey SILT with fine sands
SW	Medium stiff, gray brown, well graded-SAND with coarse gravel to more fine sand
OH	Medium stiff, gray, fines-silt CLAY, organic
OL	Medium stiff, moist, gray black, medium plasticity, fines- SILTY CLAY with small amount of gravel, woody debris, micaceous
SP	Stiff, moist, brownish black (12.3' to 12.53'), brownish gray (12.53' to 12.75'), grayish yellow brown (12.75' to 12.98'), grayish yellow brown (12.98' to 13.2'), gravely-SAND with no gravel just sand from 12.98' to 13.2'
SP/OL	Medium stiff, moist, clayey to silty fine-SAND with pieces of wood in it, roots scattered, micaceous
SC	Medium stiff, moist, black laminating overlaying brick red, fines-clayey SAND
SP	Soft, wet, yellowish brown, coarse-SAND to coarse gravel, poorly graded

Headspace Reading



XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

Bedrock	Sandy Clay
Clay	Sandy Gravel
Clayey Sand	Sandy Silt
Clayey Silt	Silt
Gravel	Silty Clay
Sand	Silty Sand

Latitude: 45.9947468(NAD 83) Decimal Degrees
Longitude:-112.5454891 (NAD 83) Decimal Degrees
Northing:651176.55 IF
Easting:1194979.97 IF
Ground Elevation:5438 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Borehole Log

Borehole Name: **BRW18-BH29**

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): NA ft
Water Level from MP: NA ft

Date:NA
Time:NA

Logged By: K. Jackson, J. Flammang

Date Drilled: 9/17/2018

Casing Type/Dia: None

Borehole Diameter: 3.25"/2.25"

Drilling Company: Pioneer

Drilling Method: Direct Push

Screen Type/Length: None

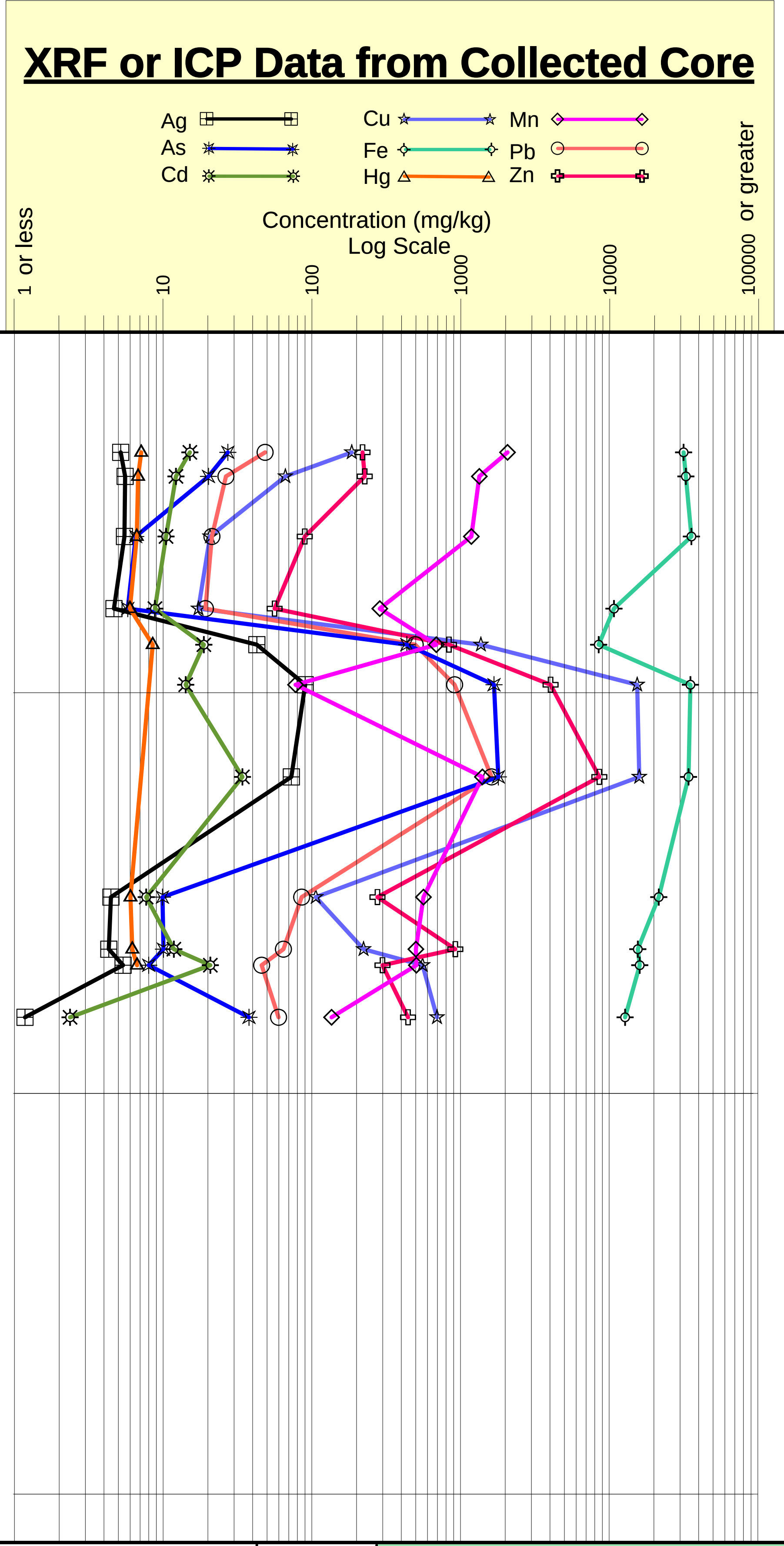
Ground Elevation: 5440.4 ft (NAVD 88)

Ground Level

Percent Recovery	USCS Class	Lithology Log
66.7%	SM	Soft, dry, black, coarse-SAND with 1/2" root mass at top, roots mixed throughout
	SP	Soft, dry to moist, dark gray, coarse-SAND
	SM	Hard, dry, light gray, sand to SILTY SAND with up to cobbles, no plasticity, potential rock
	ML	Medium stiff, moist, dark gray/orange, SANDY SILT, low plasticity
55.8%	SP	Loose, wet, orange/brown, coarse-SAND, poorly graded-alluvium
	SM	Loose, wet, med gray, coarse SILTY SAND, couple small 1/4"-1/2" seam layering of gray silty sand (more silt).
	SP	Loose to med dense, wet to moist, medium brown, coarse to medium-SAND with 1/4" seam brown clay layer
58.3%	CH	Medium stiff, moist, black/gray, highly plastic, fines-silt/CLAY, micaceous
	CH	Medium stiff, moist, black, high plasticity, fines-silty/CLAY with fine sand, micaceous
	GP	Stiff, loose, moist, dark gray, medium-SAND
	GP	Very soft, wet (standing water), gray, medium-SAND
0%	N/A	Core was not account for this interval. See Field Notes.
71.9%	OL	Soft, wet, brown, fines-clayey SILT with medium sand, organics
	ML	Soft, wet, black, clayey-SILT, marshy smell
	CH	Soft, moist, brown, fines-fat CLAY silt, micaceous
	SM	Soft, moist, brown, fine SILTY SAND, micaceous
	SP	Loose, moist, orange tan, fine-SAND with trace coarse gravel at bottom, poorly graded, micaceous
60.4%	SP	Loose, moist, red black, medium-SAND with coarse gravel mixed
	SM	Soft, moist, brown, slight plastic, fine SILTY SAND with trace coarse

Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
ND	ND	NS



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

▨	Bedrock	- - -	Sandy Clay
☰	Clay	⁘	Sandy Gravel
⁘	Clayey Sand	⁘	Sandy Silt
☰	Clayey Silt	☰	Silt
⁘	Gravel	☰	Silty Clay
⁘	Sand	⁘	Silty Sand

Latitude: 45.9945475(NAD 83) Decimal Degrees
Longitude:-112.5454757 (NAD 83) Decimal Degrees
Northing:651103.82 IF
Easting:1194980.54 IF
Ground Elevation:5440.4 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Borehole Log

Borehole Name: **BRW18-BH29**

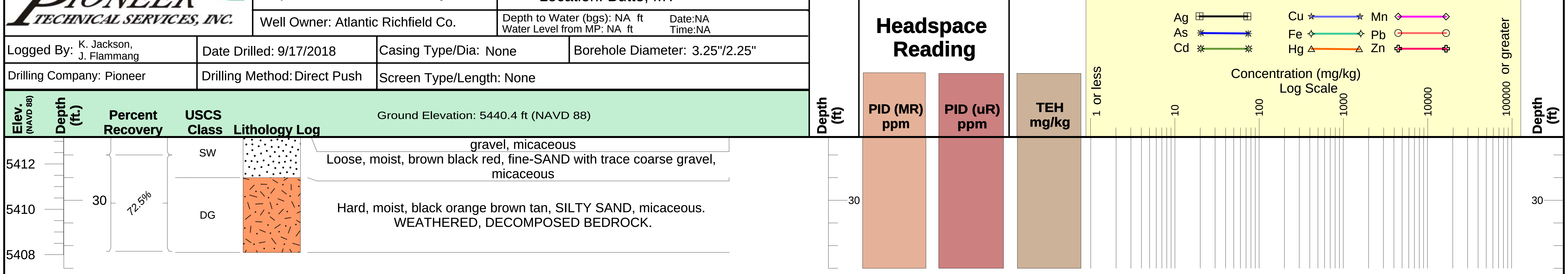
Project: BRW Phase I Site Investigation	Location: Butte, MT
Well Owner: Atlantic Richfield Co.	Depth to Water (bgs): NA ft Water Level from MP: NA ft Date:NA Time:NA

Logged By: K. Jackson, J. Flammang	Date Drilled: 9/17/2018	Casing Type/Dia: None	Borehole Diameter: 3.25"/2.25"
Drilling Company: Pioneer	Drilling Method: Direct Push	Screen Type/Length: None	

Headspace Reading

XRF or ICP Data from Collected Core

Ground Elevation: 5440.4 ft (NAVD 88)



gravel, micaceous

Loose, moist, brown black red, fine-SAND with trace coarse gravel, micaceous

Hard, moist, black orange brown tan, SILTY SAND, micaceous. WEATHERED, DECOMPOSED BEDROCK.

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

🟧	Bedrock	▨	Sandy Clay
☰	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
☰	Clayey Silt	▨	Silt
▨	Gravel	☰	Silty Clay
▨	Sand	▨	Silty Sand

Latitude: 45.9945475(NAD 83) Decimal Degrees
Longitude:-112.5454757 (NAD 83) Decimal Degrees
Northing:651103.82 IF
Easting:1194980.54 IF
Ground Elevation:5440.4 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Borehole Log

Borehole Name: BRW18-BH30

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): NA ft
Water Level from MP: NA ft
Date:NA
Time:NA

Logged By: K. Jackson, J. Flammang

Date Drilled: 9/17/2018

Casing Type/Dia: None

Borehole Diameter: 3.25"

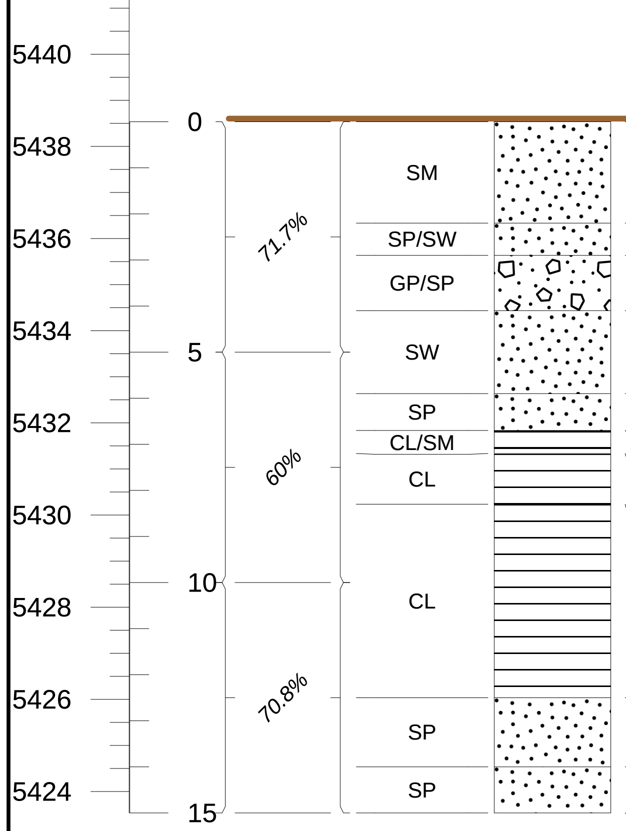
Drilling Company: Pioneer

Drilling Method: Direct Push

Screen Type/Length: None

Elev. (NAVD 88) | **Depth (ft.)** | **Percent Recovery** | **USCS Class** | **Lithology Log**

Ground Elevation: 5438.53 ft (NAVD 88)



Ground Level

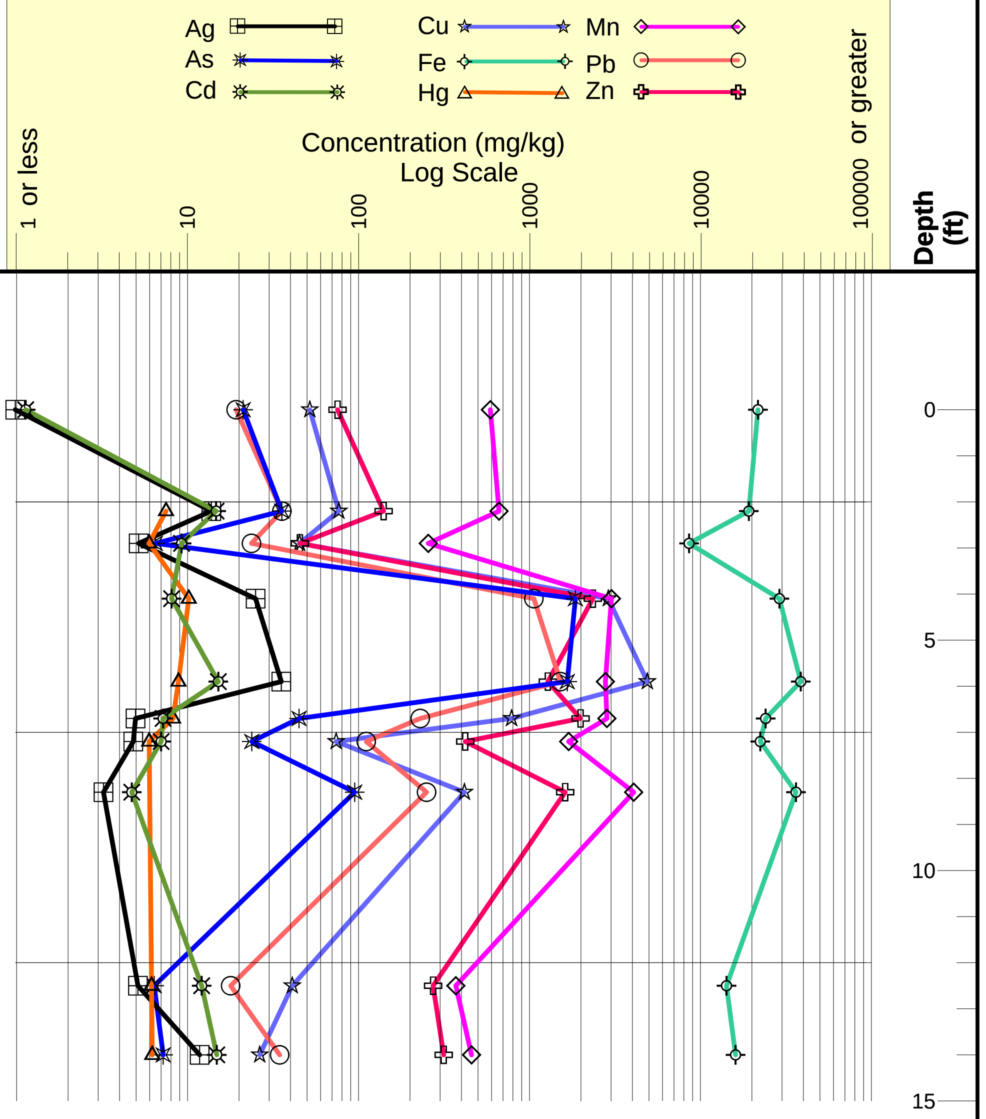
SM	Hard, dry, brown with occasional pockets of lighter silt medium plastic, fine-SAND with root mass (1")
SP/SW	Stiff, moist, brown, coarse-SAND with fine gravel towards bottom
GP/SP	Loose, dry to moist, light brown, coarse-GRAVEL with sandy layer
SW	Medium dense, moist, red (iron staining), medium to coarse-SAND with trace of small gravel
SP	Dense, moist, orange brown, medium-SAND with 1" layer of brick sand at top-alluvium
CL/SM	Soft, moist, gray, medium plasticity, silty CLAY with 1" gray medium-sand, organic, slight hydrocarbon or oil odor
CL	Soft, moist, med brown with laminated gray and brown layers 1/16" thick, medium plasticity, fines-silt/CLAY
CL	Soft, moist, dark brown with dark gray molts, fines-silty CLAY with trace amounts of sand at base, micaceous, scattered roots
SP	Very loose, moist, medium gray medium brown, silty to coarse-SAND with some small gravel-alluvium
SP	Loose, moist, medium brown, medium to coarse-SAND with scattered small gravel, alluvium

Depth (ft): 0, 5, 10, 15

Headspace Reading

PID (MR) ppm	**PID (uR) ppm**	**TEH mg/kg**
ND	ND	NS

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS = Not Sampled

Lithology

🟧	Bedrock	▨	Sandy Clay
▤	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▤	Clayey Silt	▭	Silt
▨	Gravel	▤	Silty Clay
▨	Sand	▨	Silty Sand

Latitude: 45.9955696(NAD 83) Decimal Degrees
Longitude:-112.5448772 (NAD 83) Decimal Degrees
Northing:651470.17 IF
Easting:1195146.97 IF
Ground Elevation:5438.53 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Piezometer Log

Piezometer Name: BRW18-PZ01

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 2.85 ft
Water Level from MP: 5.51 ft

Date:12/4/2018
Time:1:45

Logged By: K. Jackson, J. Flammang

Date Drilled: 9/20/2018

Casing Type/Dia: PVC/1.5"

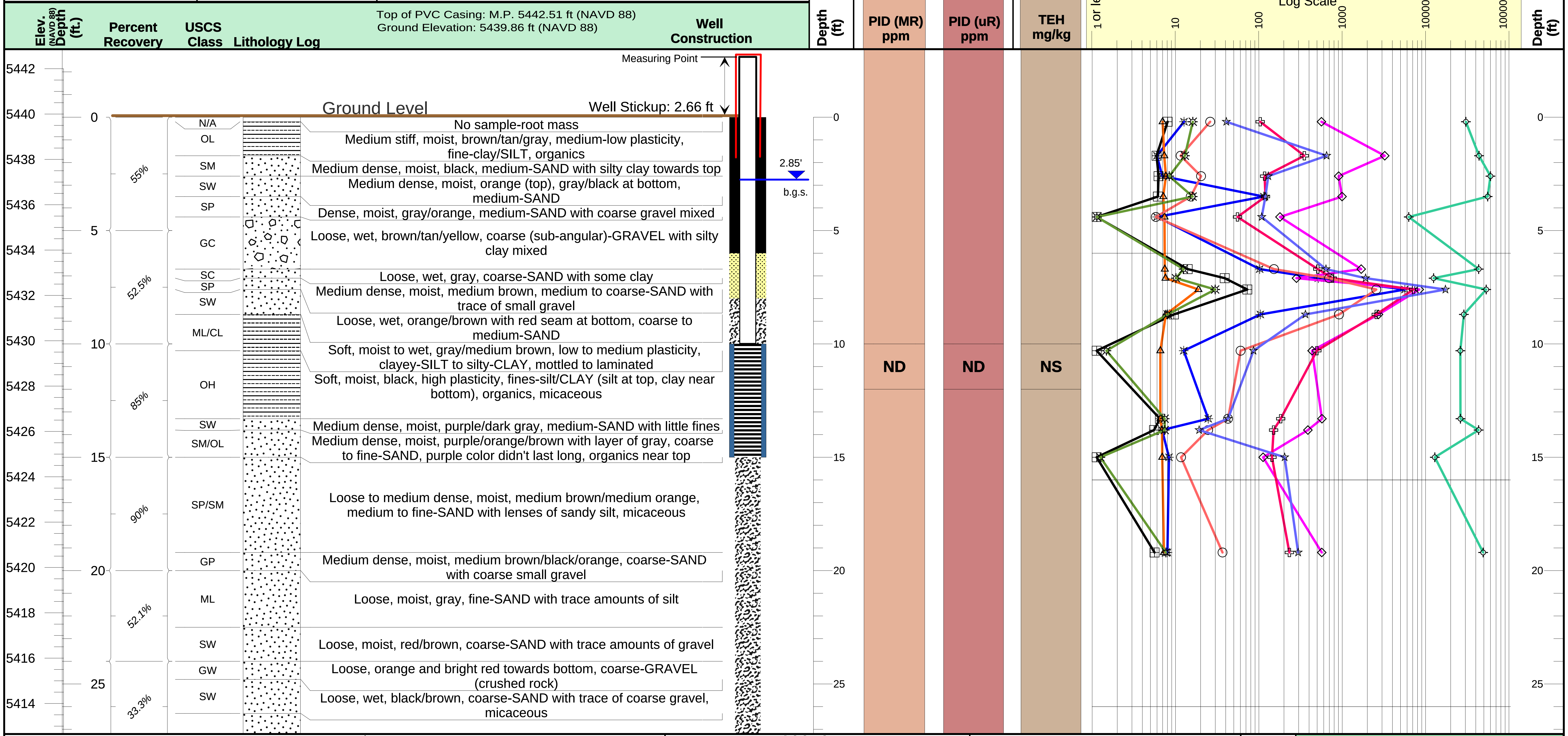
Borehole Diameter: 3.25"/2.25"

Drilling Company: Pioneer

Drilling Method: Direct Push

Screen Type/Length:PVC/5' With 10/20 Sand Filter Prepack

Top of PVC Casing: M.P. 5442.51 ft (NAVD 88)
Ground Elevation: 5439.86 ft (NAVD 88)



Percent Recovery	USCS Class	Lithology Log
55%	N/A	No sample-root mass
	OL	Medium stiff, moist, brown/tan/gray, medium-low plasticity, fine-clay/SILT, organics
	SM	Medium dense, moist, black, medium-SAND with silty clay towards top
	SW	Medium dense, moist, orange (top), gray/black at bottom, medium-SAND
	SP	Dense, moist, gray/orange, medium-SAND with coarse gravel mixed
52.5%	GC	Loose, wet, brown/tan/yellow, coarse (sub-angular)-GRAVEL with silty clay mixed
	SC	Loose, wet, gray, coarse-SAND with some clay
	SP	Medium dense, moist, medium brown, medium to coarse-SAND with trace of small gravel
	SW	Loose, wet, orange/brown with red seam at bottom, coarse to medium-SAND
	ML/CL	Soft, moist to wet, gray/medium brown, low to medium plasticity, clayey-SILT to silty-CLAY, mottled to laminated
85%	OH	Soft, moist, black, high plasticity, fines-silt/CLAY (silt at top, clay near bottom), organics, micaceous
	SW	Medium dense, moist, purple/dark gray, medium-SAND with little fines
	SM/OL	Medium dense, moist, purple/orange/brown with layer of gray, coarse to fine-SAND, purple color didn't last long, organics near top
90%	SP/SM	Loose to medium dense, moist, medium brown/medium orange, medium to fine-SAND with lenses of sandy silt, micaceous
	GP	Medium dense, moist, medium brown/black/orange, coarse-SAND with coarse small gravel
52.1%	ML	Loose, moist, gray, fine-SAND with trace amounts of silt
	SW	Loose, moist, red/brown, coarse-SAND with trace amounts of gravel
	GW	Loose, orange and bright red towards bottom, coarse-GRAVEL (crushed rock)
33.3%	SW	Loose, wet, black/brown, coarse-SAND with trace of coarse gravel, micaceous

Driller: K. Manchester
Monitoring Well License # 518

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:6.0-8.0 ft
Screen Interval:10.0-15.0 ft
below ground surface
(b.g.s.)
photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

- Bedrock
- Clay
- Clayey Sand
- Clayey Silt
- Gravel
- Sand
- Sandy Clay
- Sandy Gravel
- Sandy Silt
- Silt
- Silty Clay
- Silty Sand

Well Construction

- Screen
- Bentonite
- ☐ PVC Casing
- 10/20 Sand Filter Pack
- Natural Completion
- Prepack
- Steel Protective Casing

Latitude: 45.9944630648(NAD 83) Decimal Degrees
Longitude:-112.546051012 (NAD 83) Decimal Degrees
Northing:651078.74 IF
Easting:1194833.3 IF
Ground Elevation:5439.86 ft (NAVD 88)
Measuring Point Elevation:5442.51 ft (NAVD 88)
T3N R8W S24

Piezometer Log

Piezometer Name: BRW18-PZ01

PIONEER TECHNICAL SERVICES, INC.

Project: BRW Phase I Site Investigation	Location: Butte, MT
Well Owner: Atlantic Richfield Co.	Depth to Water (bgs): 2.85 ft Water Level from MP: 5.51 ft Date:12/4/2018 Time:1:45

Logged By: K. Jackson, J. Flammang	Date Drilled: 9/20/2018	Casing Type/Dia: PVC/1.5"	Borehole Diameter: 3.25"/2.25"
Drilling Company: Pioneer	Drilling Method: Direct Push	Screen Type/Length:PVC/5' With 10/20 Sand Filter Prepack	

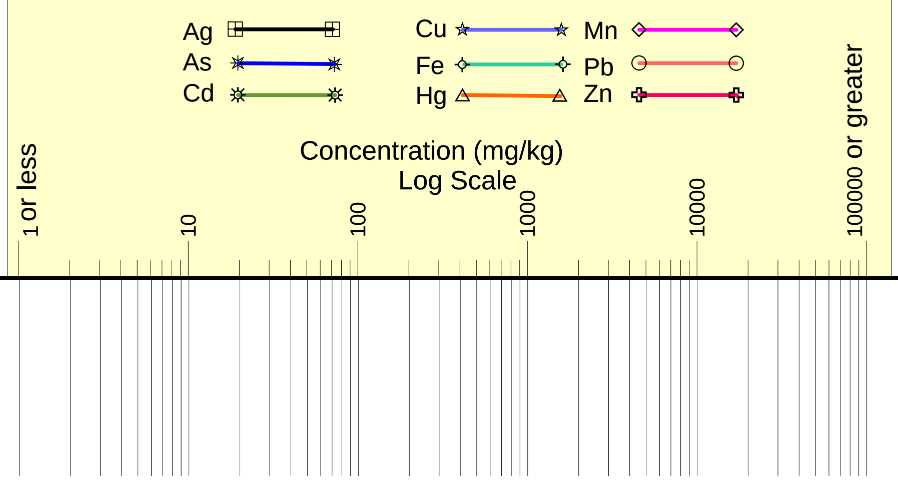
Top of PVC Casing: M.P. 5442.51 ft (NAVD 88)
Ground Elevation: 5439.86 ft (NAVD 88)

Elev. (NAVD 88)	Depth (ft.)	Percent Recovery	USCS Class	Lithology Log	Well Construction	Depth (ft)
5412		82.1%	SP	Loose, moist, brown, medium-SAND with trace amounts of gravel, micaceous		
			ML	Soft, moist, brown, slightly plastic, fine silty-SAND with a red rock at bottom		
5410	30		GW/ML	Hard, moist to dry, black/white/brown, DECOMPOSED/WEATHERED BEDROCK		30

Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg

XRF or ICP Data from Collected Core



Depth (ft)

30

Driller: K. Manchester
Monitoring Well License # 518

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:6.0-8.0 ft
Screen Interval:10.0-15.0 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Well Construction

▤	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
□	PVC Casing	🟦	Prepack
		⊓	Steel Protective Casing

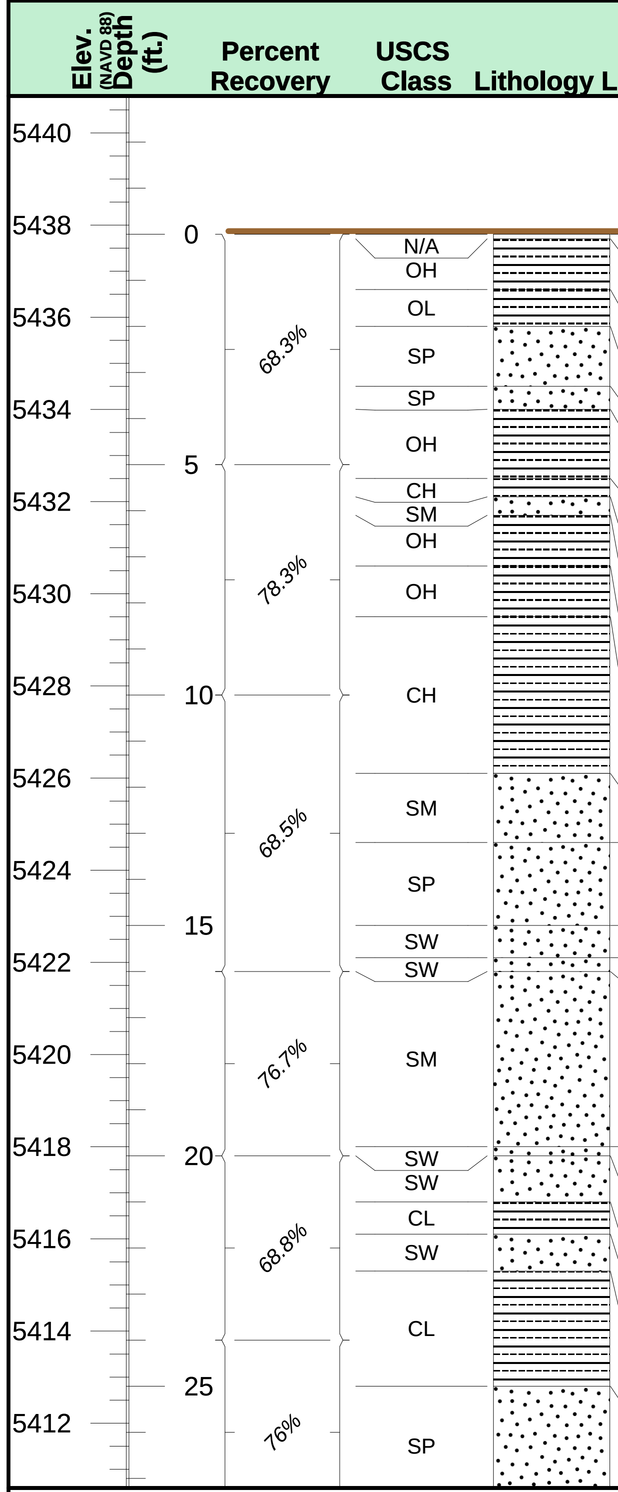
Latitude: 45.9944630648(NAD 83) Decimal Degrees
Longitude:-112.546051012 (NAD 83) Decimal Degrees
Northing:651078.74 IF
Easting:1194833.3 IF
Ground Elevation:5439.86 ft (NAVD 88)
Measuring Point Elevation:5442.51 ft (NAVD 88)
T3N R8W S24

Piezometer Log

Piezometer Name: BRW18-PZ02

Project: BRW Phase I Site Investigation
Location: Butte, MT
Well Owner: Atlantic Richfield Co.
Depth to Water (bgs): 0.65 ft
Water Level from MP: 3.31 ft
Date:12/5/2018
Time:12:30
Logged By: K. Jackson, J. Flammang
Date Drilled: 9/20/2018
Casing Type/Dia: PVC/1.5"
Borehole Diameter: 3.25"/2.25"
Drilling Company: Pioneer
Drilling Method: Direct Push
Screen Type/Length:PVC/5' With 10/20 Sand Filter Prepack

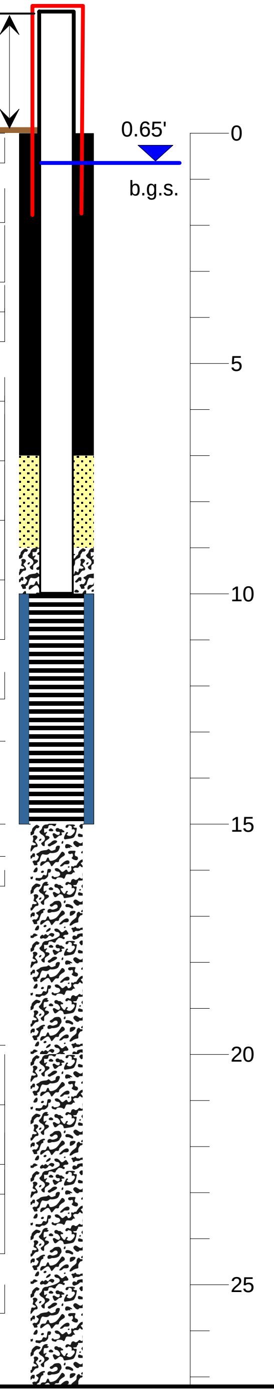
Top of PVC Casing: M.P. 5440.44 ft (NAVD 88)
Ground Elevation: 5437.8 ft (NAVD 88)



Ground Level

USCS Class	Lithology Log
N/A	No sample-root mass
OH	Soft, moist, gray, medium plasticity, fines-SILT/clay with some organics
OL	Soft, moist, black, low plasticity, fines-clay/SILT with thin layer of silt, organics
SP	Hard, dry, tan with pockets of brown/gray, fine-SAND
SP	Hard, dry, gray with pockets of black ,fine-SAND
OH	Soft, moist to wet, black, high plasticity, fines-silty/CLAY, organics, micaceous
CH	Very soft, wet(standing water), orange/brown, high plasticity, fines-silt/CLAY
SM	Soft, wet(standing water), red/brown/gray, medium grained SAND with silty red lamination layer at top
OH	Soft, moist, brown/gray/light brown, medium plasticity, fines-CLAY/silt, organics
OH	Soft, moist, dark gray, medium plasticity, fines-clay/SILT with fine sand, organics at top, micaceous
CH	Soft, moist to wet, black, high plasticity, fines-silt/CLAY with occasional fine sand, micaceous
SM	Loose, moist, black/purple/orange, medium-SAND, organics in top 4"
SP	Loose, moist, brown/orange, course-SAND with small gravel
SW	Loose, wet, red-brown, coarse-SAND with trace of small gravel
SW	Loose, moist, red/black, medium-SAND with small gravel
SM	Loose, wet, black/orange, fine to medium-SAND with varied layers of silt
SW	Loose, wet, orange/brown/black, coarse-SAND, layer of black sand at top1/4 "
SW	Loose, moist, red, coarse-SAND with trace of coarse gravel, micaceous
CL	Soft, wet, brown, silty-CLAY, micaceous, rock at bottom
SW	Loose, moist, black/brown/orange, medium-SAND with trace of silty coarse gravel
CL	Medium stiff, brown with orange staining, medium plasticity, fines-silt/CLAY
SP	Medium dense, moist, brown/black with trace of orange, fine-SAND with coarse gravel mixed

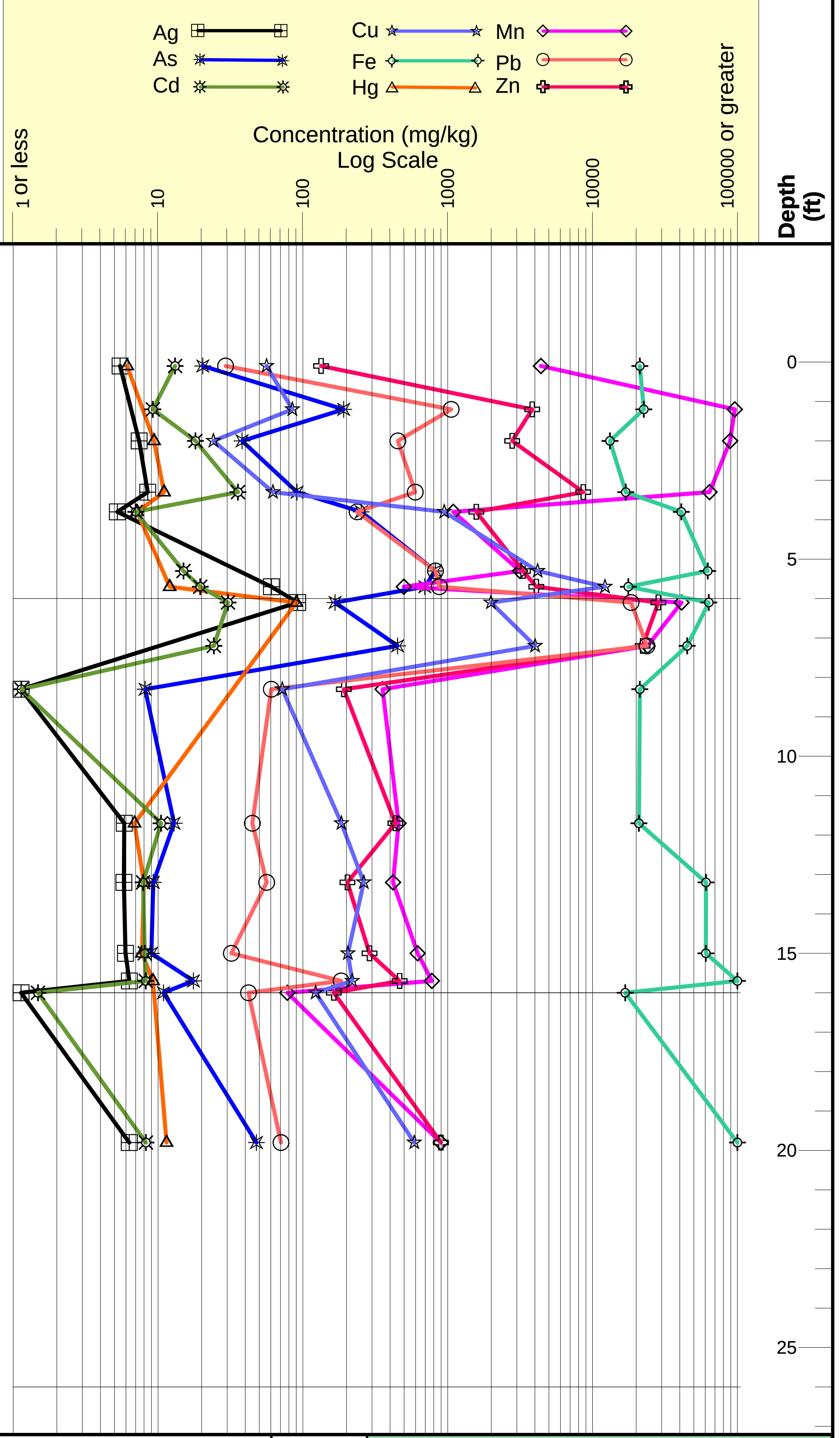
Well Construction



Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
ND	ND	NS

XRF or ICP Data from Collected Core



Driller: K. Manchester
Monitoring Well License # 518

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:7.0-9.0 ft
Screen Interval:10.0-15.0 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Well Construction

☰	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
☐	PVC Casing	■	Prepack
		⊓	Steel Protective Casing

Latitude: 45.9949233176(NAD 83) Decimal Degrees
Longitude:-112.545363154 (NAD 83) Decimal Degrees
Northing:651239.59 IF
Easting:1195014.45 IF
Ground Elevation:5437.8 ft (NAVD 88)
Measuring Point Elevation:5440.44 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

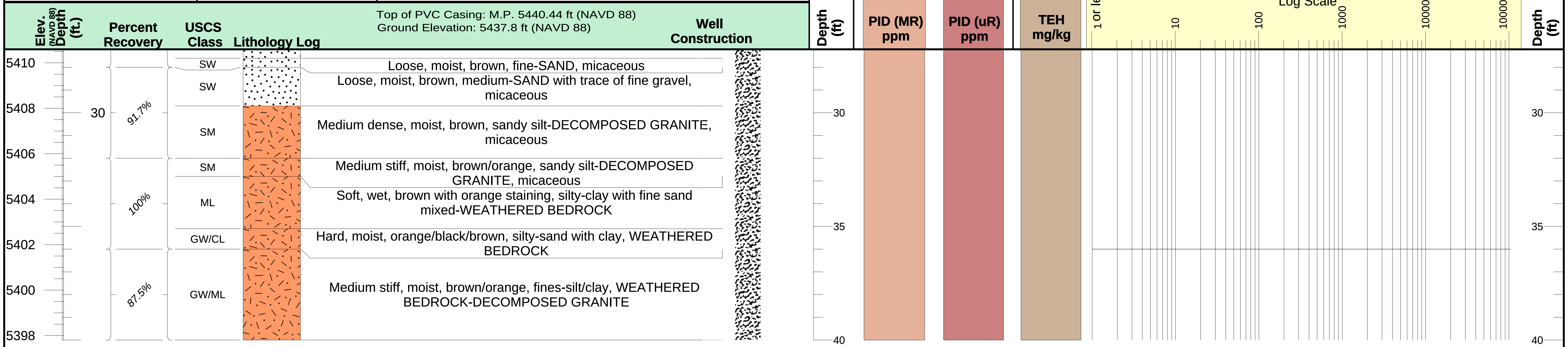
Piezometer Log

Piezometer Name: BRW18-PZ02

Project: BRW Phase I Site Investigation	Location: Butte, MT
Well Owner: Atlantic Richfield Co.	Depth to Water (bgs): 0.65 ft Water Level from MP: 3.31 ft Date:12/5/2018 Time:12:30

Logged By: K. Jackson, J. Flammang	Date Drilled: 9/20/2018	Casing Type/Dia: PVC/1.5"	Borehole Diameter: 3.25"/2.25"
Drilling Company: Pioneer	Drilling Method: Direct Push	Screen Type/Length:PVC/5' With 10/20 Sand Filter Prepack	

Top of PVC Casing: M.P. 5440.44 ft (NAVD 88)
Ground Elevation: 5437.8 ft (NAVD 88)



USCS Class	Lithology Log
SW	Loose, moist, brown, fine-SAND, micaceous
SW	Loose, moist, brown, medium-SAND with trace of fine gravel, micaceous
SM	Medium dense, moist, brown, sandy silt-DECOMPOSED GRANITE, micaceous
SM	Medium stiff, moist, brown/orange, sandy silt-DECOMPOSED GRANITE, micaceous
ML	Soft, wet, brown with orange staining, silty-clay with fine sand mixed-WEATHERED BEDROCK
GW/CL	Hard, moist, orange/black/brown, silty-sand with clay, WEATHERED BEDROCK
GW/ML	Medium stiff, moist, brown/orange, fines-silt/clay, WEATHERED BEDROCK-DECOMPOSED GRANITE

Driller: K. Manchester
Monitoring Well License # 518

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:7.0-9.0 ft
Screen Interval:10.0-15.0 ft
below ground surface
(b.g.s.)
photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Well Construction

▤	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
☐	PVC Casing	■	Prepack
		⊓	Steel Protective Casing

Latitude: 45.9949233176(NAD 83) Decimal Degrees
Longitude:-112.545363154 (NAD 83) Decimal Degrees
Northing:651239.59 IF
Easting:1195014.45 IF
Ground Elevation:5437.8 ft (NAVD 88)
Measuring Point Elevation:5440.44 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

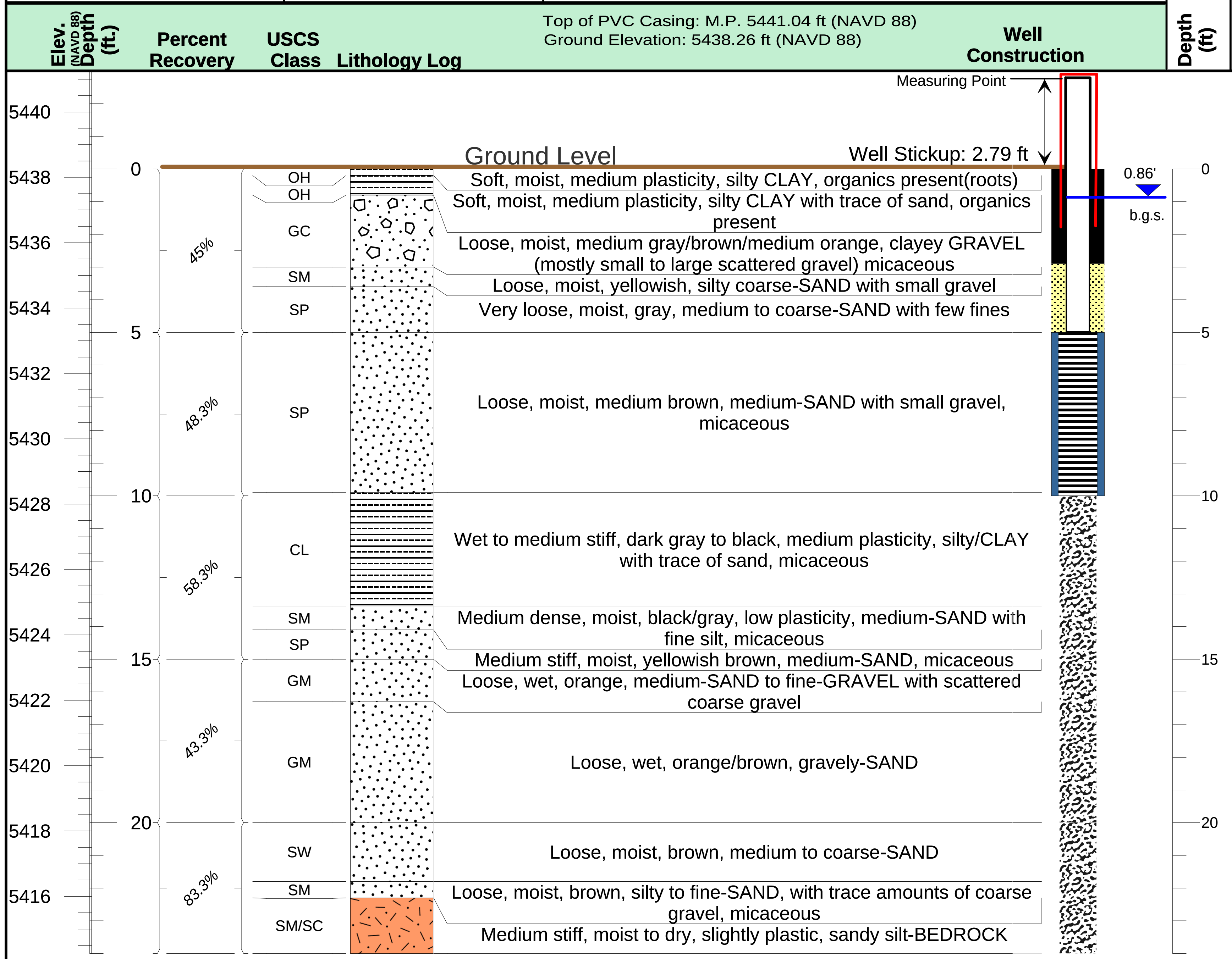
Piezometer Log

Piezometer Name: BRW18-PZ03

Project: BRW Phase I Site Investigation	Location: Butte, MT
Well Owner: Atlantic Richfield Co.	Depth to Water (bgs): 0.86 ft Water Level from MP: 3.52 ft Date:12/4/2018 Time:12:39

Logged By: K. Jackson, J. Flammang	Date Drilled: 9/19/2018	Casing Type/Dia: PVC/1.5"	Borehole Diameter: 3.25"/2.25"
Drilling Company: Pioneer	Drilling Method: Direct Push	Screen Type/Length:PVC/5' With 10/20 Sand Filter Prepack	

Top of PVC Casing: M.P. 5441.04 ft (NAVD 88)
Ground Elevation: 5438.26 ft (NAVD 88)

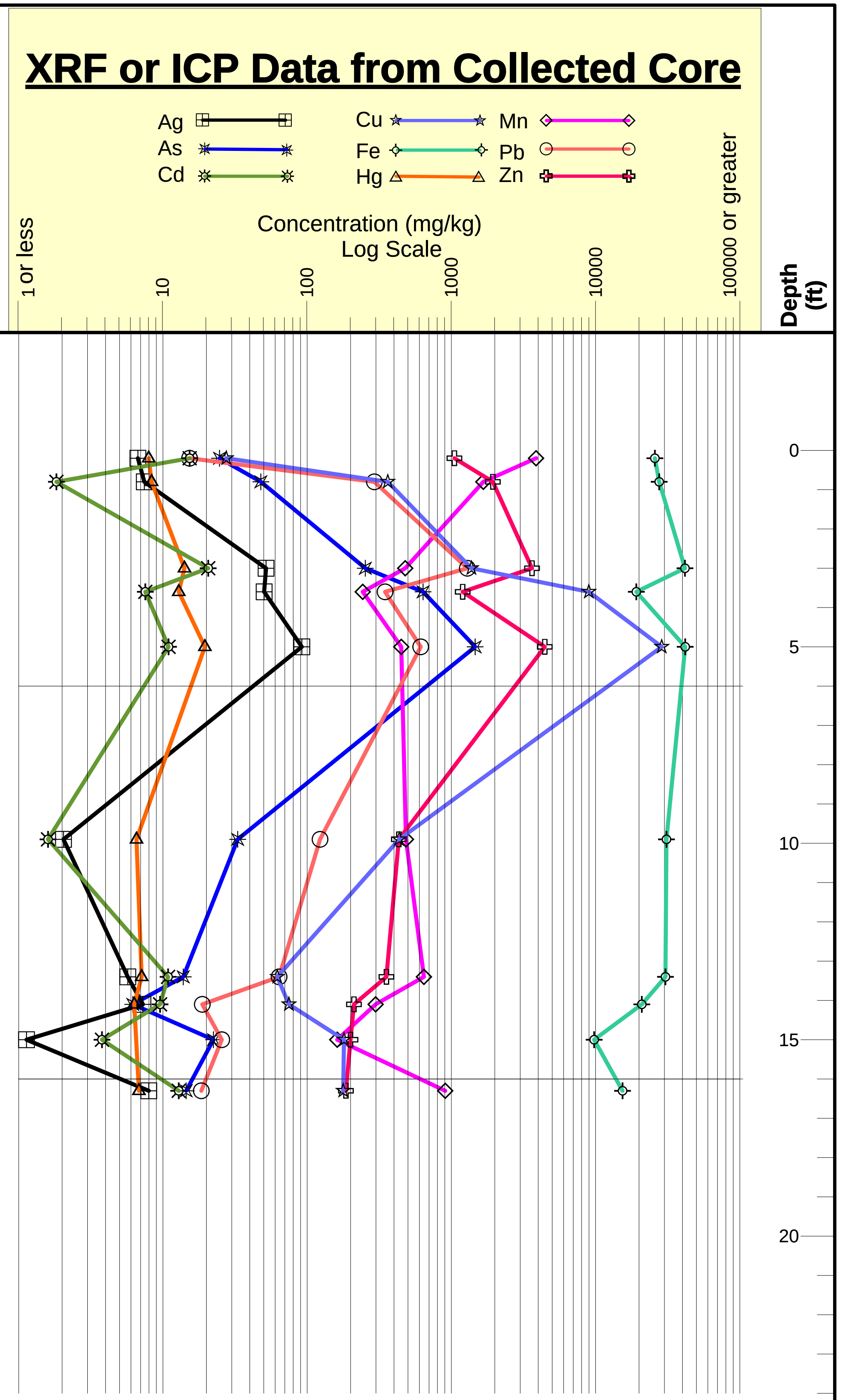


USCS Class	Lithology Log
OH	Soft, moist, medium plasticity, silty CLAY, organics present(roots)
OH	Soft, moist, medium plasticity, silty CLAY with trace of sand, organics present
GC	Loose, moist, medium gray/brown/medium orange, clayey GRAVEL (mostly small to large scattered gravel) micaceous
SM	Loose, moist, yellowish, silty coarse-SAND with small gravel
SP	Very loose, moist, gray, medium to coarse-SAND with few fines
SP	Loose, moist, medium brown, medium-SAND with small gravel, micaceous
CL	Wet to medium stiff, dark gray to black, medium plasticity, silty/CLAY with trace of sand, micaceous
SM	Medium dense, moist, black/gray, low plasticity, medium-SAND with fine silt, micaceous
SP	Medium stiff, moist, yellowish brown, medium-SAND, micaceous
GM	Loose, wet, orange, medium-SAND to fine-GRAVEL with scattered coarse gravel
GM	Loose, wet, orange/brown, gravely-SAND
SW	Loose, moist, brown, medium to coarse-SAND
SM	Loose, moist, brown, silty to fine-SAND, with trace amounts of coarse gravel, micaceous
SM/SC	Medium stiff, moist to dry, slightly plastic, sandy silt-BEDROCK

Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
ND	ND	NS

XRF or ICP Data from Collected Core



Driller: K. Manchester
Monitoring Well License # 518

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:2.9-3.2 ft
Screen Interval:5.0-10.0 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

- Bedrock
- Clay
- Clayey Sand
- Clayey Silt
- Gravel
- Sand
- Sandy Clay
- Sandy Gravel
- Sandy Silt
- Silt
- Silty Clay
- Silty Sand

Well Construction

- Screen
- Bentonite
- PVC Casing
- 10/20 Sand Filter Pack
- Natural Completion
- Prepack
- Steel Protective Casing

Latitude: 45.9952580256(NAD 83) Decimal Degrees
Longitude:-112.545003193 (NAD 83) Decimal Degrees
Northing:651357.94 IF
Easting:1195110.57 IF
Ground Elevation:5438.26 ft (NAVD 88)
Measuring Point Elevation:5441.04 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Piezometer Log

Piezometer Name: BRW18-PZ04

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 1.28 ft
Water Level from MP: 3.94 ft
Date:12/4/2018
Time:10:35

Logged By: K. Jackson, J. Flammang

Date Drilled: 9/19/2018

Casing Type/Dia: PVC/1.5"

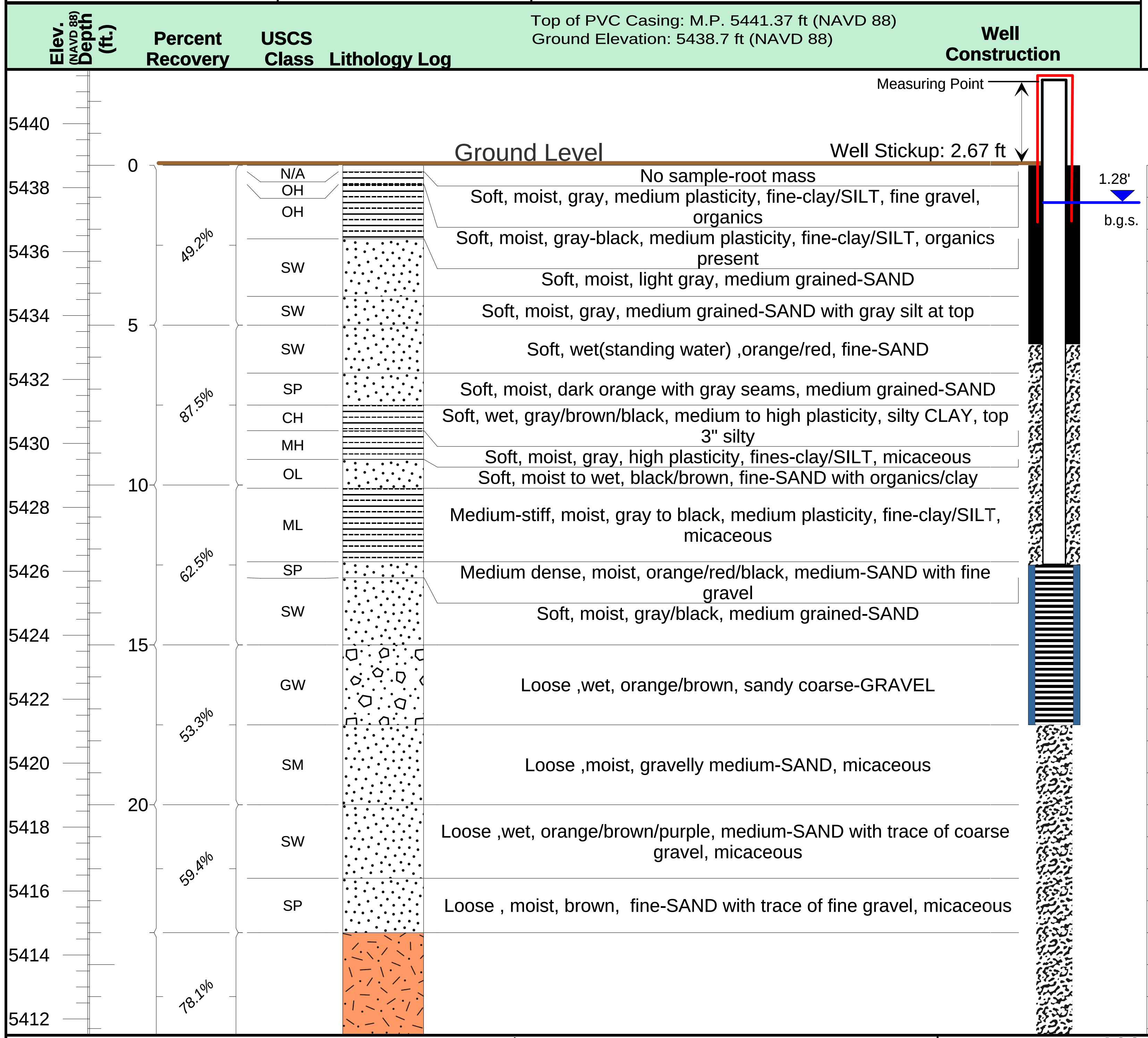
Borehole Diameter: 3.25"/2.25"

Drilling Company: Pioneer

Drilling Method: Direct Push

Screen Type/Length:PVC/5' With 10/20 Sand Filter Prepack

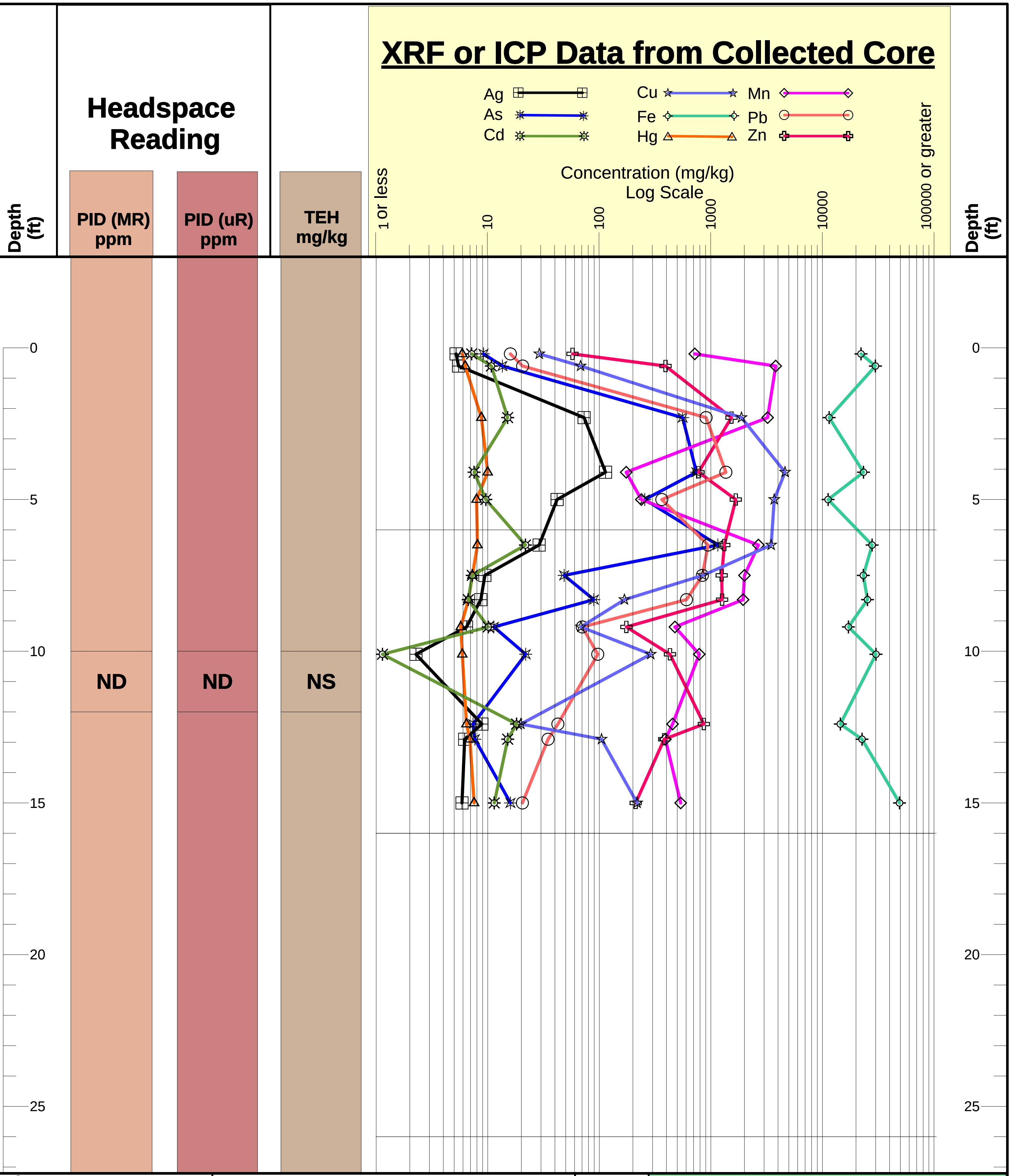
Top of PVC Casing: M.P. 5441.37 ft (NAVD 88)
Ground Elevation: 5438.7 ft (NAVD 88)



USCS Class	Lithology Log
N/A	No sample-root mass
OH	Soft, moist, gray, medium plasticity, fine-clay/SILT, fine gravel, organics
OH	Soft, moist, gray-black, medium plasticity, fine-clay/SILT, organics present
SW	Soft, moist, light gray, medium grained-SAND
SW	Soft, moist, gray, medium grained-SAND with gray silt at top
SW	Soft, wet(standing water) ,orange/red, fine-SAND
SP	Soft, moist, dark orange with gray seams, medium grained-SAND
CH	Soft, wet, gray/brown/black, medium to high plasticity, silty CLAY, top 3" silty
MH	Soft, moist, gray, high plasticity, fines-clay/SILT, micaceous
OL	Soft, moist to wet, black/brown, fine-SAND with organics/clay
ML	Medium-stiff, moist, gray to black, medium plasticity, fine-clay/SILT, micaceous
SP	Medium dense, moist, orange/red/black, medium-SAND with fine gravel
SW	Soft, moist, gray/black, medium grained-SAND
GW	Loose ,wet, orange/brown, sandy coarse-GRAVEL
SM	Loose ,moist, gravelly medium-SAND, micaceous
SW	Loose ,wet, orange/brown/purple, medium-SAND with trace of coarse gravel, micaceous
SP	Loose , moist, brown, fine-SAND with trace of fine gravel, micaceous

Headspace Reading

XRF or ICP Data from Collected Core



PID (MR) ppm	PID (uR) ppm	TEH mg/kg
ND	ND	NS

Driller: K. Manchester
Monitoring Well License # 518

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval: ft
Screen Interval:12.5-17.5 ft below ground surface (b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

- Bedrock
- Clay
- Clayey Sand
- Clayey Silt
- Gravel
- Sand
- Sandy Clay
- Sandy Gravel
- Sandy Silt
- Silt
- Silty Clay
- Silty Sand

Well Construction

- Screen
- Bentonite
- PVC Casing
- 10/20 Sand Filter Pack
- Natural Completion
- Prepack
- Steel Protective Casing

Latitude: 45.9953524399(NAD 83) Decimal Degrees
Longitude:-112.544851635 (NAD 83) Decimal Degrees
Northing:651390.83 IF
Easting:1195150.38 IF
Ground Elevation:5438.7 ft (NAVD 88)
Measuring Point Elevation:5441.37 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Piezometer Log

Piezometer Name: **BRW18-PZ04**

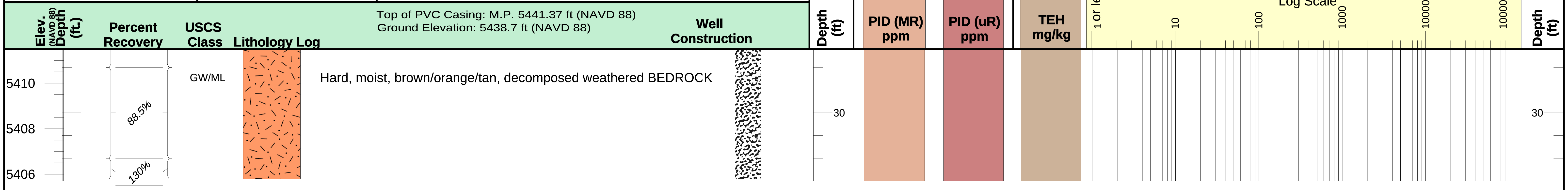
Project: BRW Phase I Site Investigation	Location: Butte, MT
Well Owner: Atlantic Richfield Co.	Depth to Water (bgs): 1.28 ft Water Level from MP: 3.94 ft Date:12/4/2018 Time:10:35

Logged By: K. Jackson, J. Flammang	Date Drilled: 9/19/2018	Casing Type/Dia: PVC/1.5"	Borehole Diameter: 3.25"/2.25"
Drilling Company: Pioneer	Drilling Method: Direct Push	Screen Type/Length:PVC/5' With 10/20 Sand Filter Prepack	

Top of PVC Casing: M.P. 5441.37 ft (NAVD 88)
Ground Elevation: 5438.7 ft (NAVD 88)

Headspace Reading

XRF or ICP Data from Collected Core



Hard, moist, brown/orange/tan, decomposed weathered BEDROCK

Driller: K. Manchester
Monitoring Well License # 518

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval: ft
Screen Interval:12.5-17.5 ft below ground surface (b.g.s.)
photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Well Construction

▤	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
☐	PVC Casing	■	Prepack
		⊓	Steel Protective Casing

Latitude: 45.9953524399(NAD 83) Decimal Degrees
Longitude:-112.544851635 (NAD 83) Decimal Degrees
Northing:651390.83 IF
Easting:1195150.38 IF
Ground Elevation:5438.7 ft (NAVD 88)
Measuring Point Elevation:5441.37 ft (NAVD 88)
T3N R8W S24

Piezometer Log

Piezometer Name: BRW18-PZ05

PIONEER TECHNICAL SERVICES, INC.

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 1.53 ft
Water Level from MP: 4.19 ft
Date:12/4/2018
Time:9:20

Logged By: K. Jackson, J. Flammang

Date Drilled: 9/17/2018

Casing Type/Dia: PVC/1.5"

Borehole Diameter: 3.25"/2.25"

Drilling Company: Pioneer

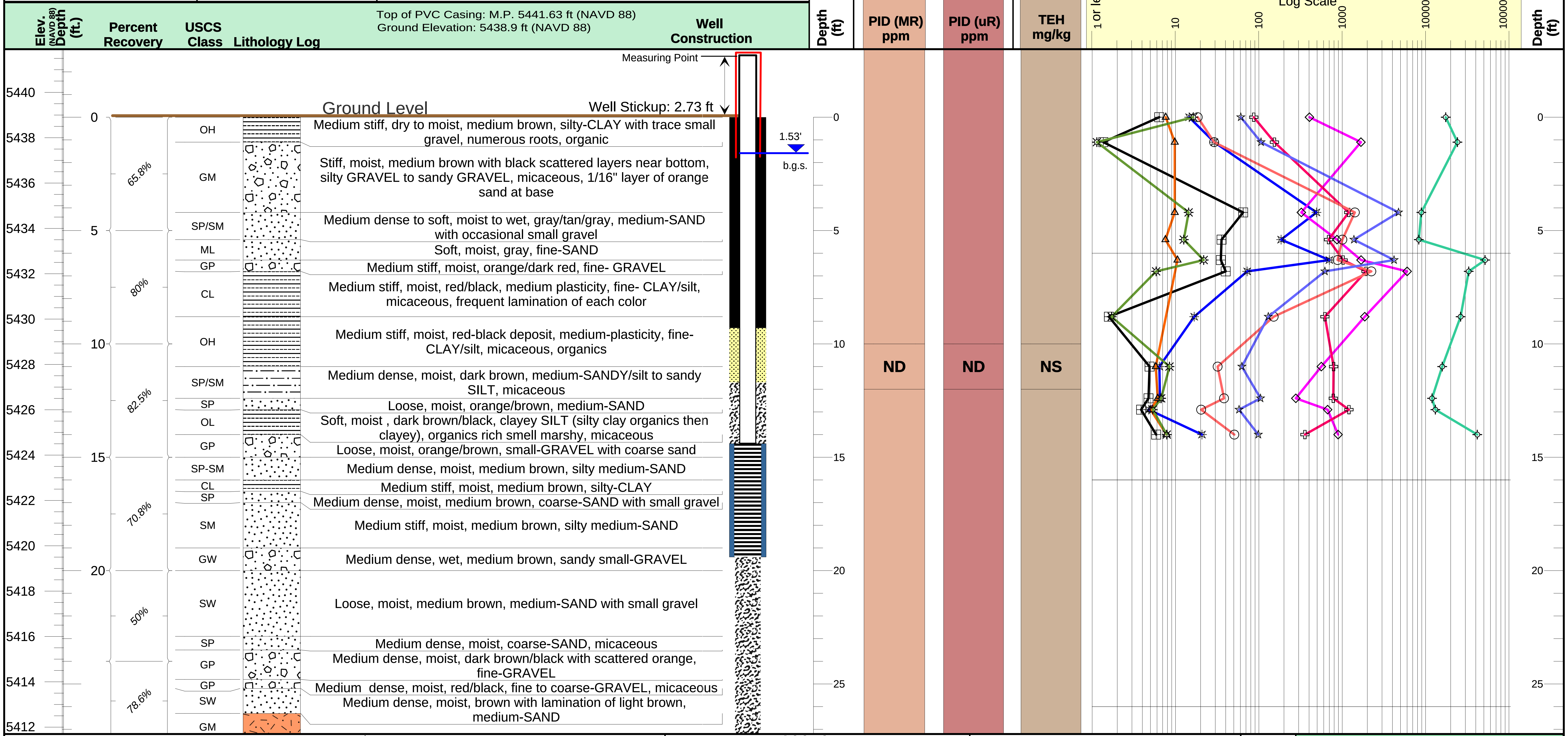
Drilling Method: Direct Push

Screen Type/Length:PVC/5' With 10/20 Sand Filter Prepack

Top of PVC Casing: M.P. 5441.63 ft (NAVD 88)
Ground Elevation: 5438.9 ft (NAVD 88)

Headspace Reading

XRF or ICP Data from Collected Core



USCS Class	Lithology Log
OH	Medium stiff, dry to moist, medium brown, silty-CLAY with trace small gravel, numerous roots, organic
GM	Stiff, moist, medium brown with black scattered layers near bottom, silty GRAVEL to sandy GRAVEL, micaceous, 1/16" layer of orange sand at base
SP/SM	Medium dense to soft, moist to wet, gray/tan/gray, medium-SAND with occasional small gravel
ML	Soft, moist, gray, fine-SAND
GP	Medium stiff, moist, orange/dark red, fine- GRAVEL
CL	Medium stiff, moist, red/black, medium plasticity, fine- CLAY/silt, micaceous, frequent lamination of each color
OH	Medium stiff, moist, red-black deposit, medium-plasticity, fine-CLAY/silt, micaceous, organics
SP/SM	Medium dense, moist, dark brown, medium-SANDY/silt to sandy SILT, micaceous
SP	Loose, moist, orange/brown, medium-SAND
OL	Soft, moist , dark brown/black, clayey SILT (silty clay organics then clayey), organics rich smell marshy, micaceous
GP	Loose, moist, orange/brown, small-GRAVEL with coarse sand
SP-SM	Medium dense, moist, medium brown, silty medium-SAND
CL	Medium stiff, moist, medium brown, silty-CLAY
SP	Medium dense, moist, medium brown, coarse-SAND with small gravel
SM	Medium stiff, moist, medium brown, silty medium-SAND
GW	Medium dense, wet, medium brown, sandy small-GRAVEL
SW	Loose, moist, medium brown, medium-SAND with small gravel
SP	Medium dense, moist, coarse-SAND, micaceous
GP	Medium dense, moist, dark brown/black with scattered orange, fine-GRAVEL
GP	Medium dense, moist, red/black, fine to coarse-GRAVEL, micaceous
SW	Medium dense, moist, brown with lamination of light brown, medium-SAND
GM	

Driller: K. Manchester
Monitoring Well License # 518

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:9.3-11.7 ft
Screen Interval:14.4-19.4 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

- Bedrock
- Clay
- Clayey Sand
- Clayey Silt
- Gravel
- Sand
- Sandy Clay
- Sandy Gravel
- Sandy Silt
- Silt
- Silty Clay
- Silty Sand

Well Construction

- Screen
- Bentonite
- PVC Casing
- 10/20 Sand Filter Pack
- Natural Completion
- Prepack
- Steel Protective Casing

Latitude: 45.9954642147(NAD 83) Decimal Degrees
Longitude:-112.544726075 (NAD 83) Decimal Degrees
Northing:651430.31 IF
Easting:1195183.84 IF
Ground Elevation:5438.9 ft (NAVD 88)
Measuring Point Elevation:5441.63 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Piezometer Log

Piezometer Name: BRW18-PZ05

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 1.53 ft
Water Level from MP: 4.19 ft
Date:12/4/2018
Time:9:20

Logged By: K. Jackson, J. Flammang

Date Drilled: 9/17/2018

Casing Type/Dia: PVC/1.5"

Borehole Diameter: 3.25"/2.25"

Drilling Company: Pioneer

Drilling Method: Direct Push

Screen Type/Length:PVC/5' With 10/20 Sand Filter Prepack

Top of PVC Casing: M.P. 5441.63 ft (NAVD 88)
Ground Elevation: 5438.9 ft (NAVD 88)

Elev. (NAVD 88) Depth (ft.)	Percent Recovery	USCS Class	Lithology Log		Well Construction	Depth (ft)	PID (MR) ppm	PID (uR) ppm	TEH mg/kg	XRF or ICP Data from Collected Core	Depth (ft)
				Stiff, moist, brown with scattered layers of light brown, DECOMPOSED GRANITE							

Headspace Reading

XRF or ICP Data from Collected Core

Ag ⊞ Cu ★ Mn ◇
As ✳ Fe ✧ Pb ○
Cd ⋇ Hg △ Zn ✚

Concentration (mg/kg)
Log Scale

1 or less 10 100 1000 10000 100000 or greater

Driller: K. Manchester
Monitoring Well License # 518

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:9.3-11.7 ft
Screen Interval:14.4-19.4 ft
below ground surface
(b.g.s.)
photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

🟧	Bedrock	▤	Sandy Clay
▤	Clay	▨	Sandy Gravel
▤	Clayey Sand	▤	Sandy Silt
▤	Clayey Silt	▤	Silt
▨	Gravel	▤	Silty Clay
▨	Sand	▤	Silty Sand

Well Construction

☰	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
☐	PVC Casing	🟦	Prepack
		🟥	Steel Protective Casing

Latitude: 45.9954642147(NAD 83) Decimal Degrees
Longitude:-112.544726075 (NAD 83) Decimal Degrees
Northing:651430.31 IF
Easting:1195183.84 IF
Ground Elevation:5438.9 ft (NAVD 88)
Measuring Point Elevation:5441.63 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Piezometer Log

Piezometer Name: BRW18-PZ06

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 1.76 ft
Water Level from MP: 4.42 ft
Date:12/3/2018
Time:1:50

Logged By: K. Jackson, J. Flammang

Date Drilled: 9/18/2018

Casing Type/Dia: PVC/1.5"

Borehole Diameter: 3.25"/2.25"

Drilling Company: Pioneer

Drilling Method: Direct Push

Screen Type/Length:PVC/5' With 10/20 Sand Filter Prepack

Top of PVC Casing: M.P. 5441.45 ft (NAVD 88)
Ground Elevation: 5438.7 ft (NAVD 88)

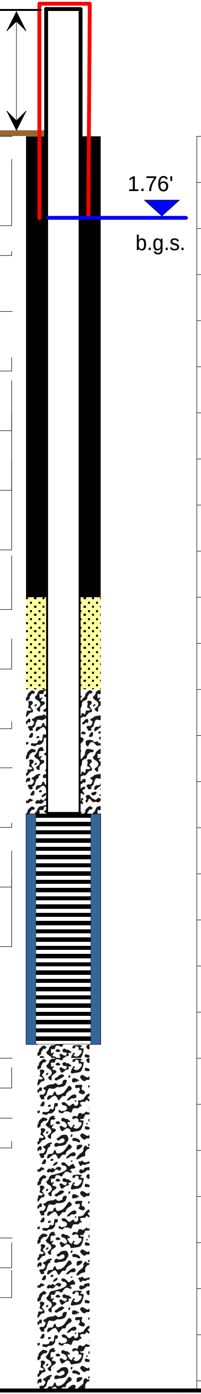
Elev. (NAVD 88): 5440, 5438, 5436, 5434, 5432, 5430, 5428, 5426, 5424, 5422, 5420, 5418, 5416, 5414, 5412

Depth (ft.): 0, 5, 10, 15, 20

Percent Recovery: 83.3%, 66.7%, 61.7%, 52.5%, 87.5%, 75%

USCS Class	Lithology Log
SC	Soft, moist, medium brown, clayey-SAND with some small gravel, organics present-occasional roots and one inch mass of root on surface
GM	Soft-medium stiff, dry, dark tan, gravelly-SILT with scattered roots
SC	Stiff, moist, medium brown, clayey/coarse-SAND
SP	Medium-stiff, moist, dark gray/black, medium-SAND with trace of clay and pockets of organic layer
OL	Soft, moist to wet, black, medium to fine-SAND with silt, organic, odor marshy
SW	Soft, moist, gray/black, medium-SAND with more coarse sand toward bottom, marshy odor
SW	Medium dense, moist, red/orange/gray with occasional black layer, coarse-SAND, organics
ML/MH	Very soft, moist, brown, fine-clay/SILT, thin layer of organics, micaceous (silty top 16-27"-clay rest)
CL	Soft, moist, medium plasticity, fines-silt/CLAY, micaceous, organic layer in top 2"
SP	Medium dense, moist, medium to dark brown, poorly graded medium to coarse-SAND
ML	Medium stiff, moist, black, slight plastic clayey-SILT, micaceous
SC-CL	Soft, moist, orange/medium brown/gray, medium sand to clayey-SILT, micaceous
GP	Medium dense to loose, moist to wet, medium brown-orange, sandy small-GRAVEL
GC	Medium dense, moist, medium brown, low plasticity, sandy-GRAVEL with clay
GP-SP	Dense, moist, orange to medium brown, sandy GRAVEL to medium grained SAND bottom and trace clay at very bottom
SM	Soft, wet, medium brown, medium-silty SAND
GP	Loose, wet , medium brown, small-GRAVEL with coarse sand mixed
SC	Soft, wet, medium brown, clayey SAND
GP	Medium dense, wet, sandy fine-GRAVEL
SW	Soft, wet, medium brown, medium grained- SAND
SC	Loose, wet , medium brown, clayey SAND, scattered micaceous
GC	Dense, wet to dry, orange/brown, sandy-GRAVEL, decompose granite, at 27" layer orange silty clay, micaceous

Well Construction

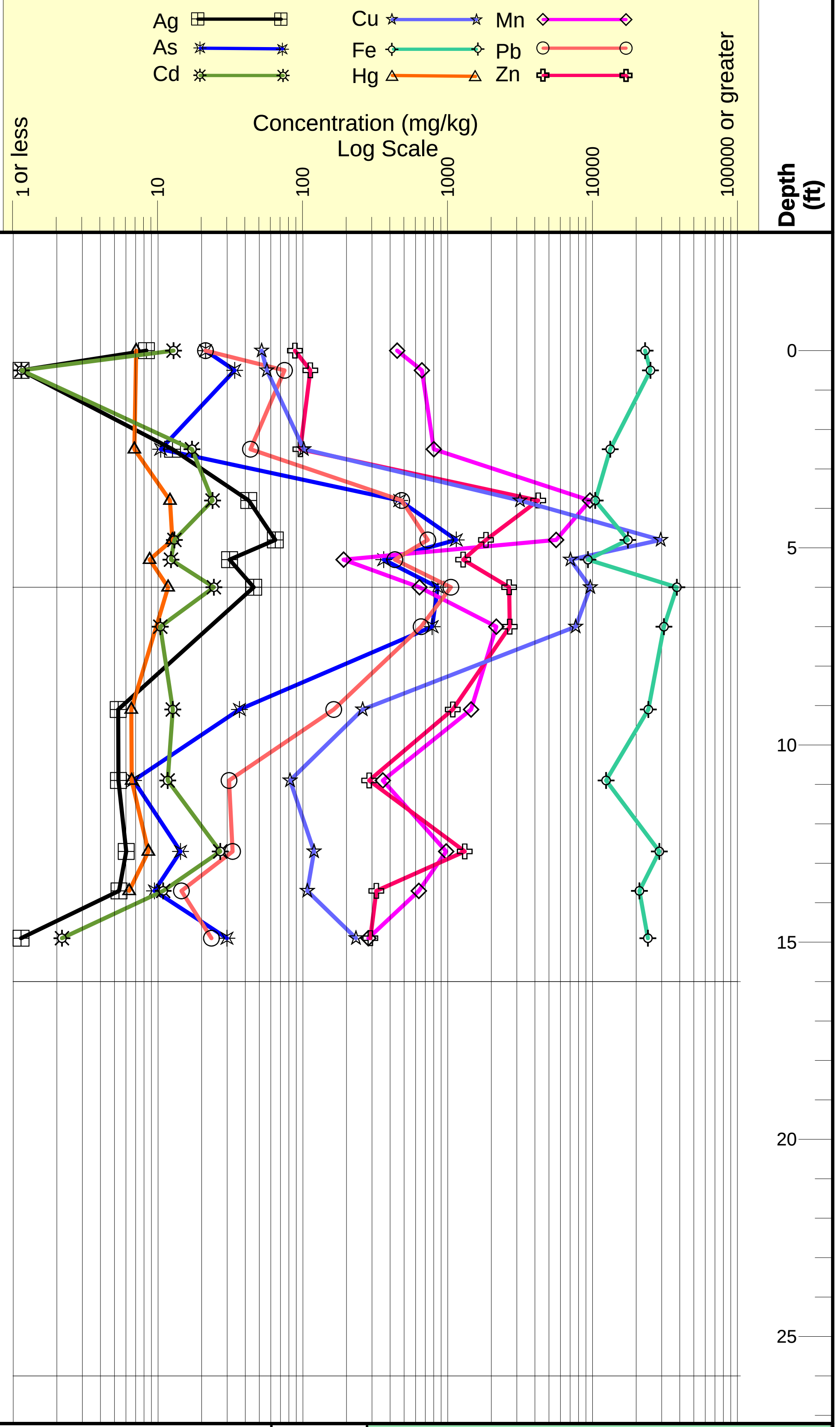


Depth (ft): 0, 5, 10, 15, 20, 25

Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
ND	ND	NS

XRF or ICP Data from Collected Core



Driller: K. Manchester
Monitoring Well License # 518

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:10.0-12.0 ft
Screen Interval:14.7-19.7 ft below ground surface (b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

▨	Bedrock	▤	Sandy Clay
▤	Clay	▨	Sandy Gravel
▤	Clayey Sand	▤	Sandy Silt
▤	Clayey Silt	▤	Silt
▨	Gravel	▤	Silty Clay
▨	Sand	▤	Silty Sand

Well Construction

▤	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
□	PVC Casing	■	Prepack
		⊓	Steel Protective Casing

Latitude: 45.995500323(NAD 83) Decimal Degrees
Longitude:-112.544921075 (NAD 83) Decimal Degrees
Northing:651445.38 IF
Easting:1195134.85 IF
Ground Elevation:5438.7 ft (NAVD 88)
Measuring Point Elevation:5441.45 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Piezometer Log

Piezometer Name: BRW18-PZ06

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 1.76 ft
Water Level from MP: 4.42 ft
Date:12/3/2018
Time:1:50

Logged By: K. Jackson, J. Flammang

Date Drilled: 9/18/2018

Casing Type/Dia: PVC/1.5"

Borehole Diameter: 3.25"/2.25"

Drilling Company: Pioneer

Drilling Method: Direct Push

Screen Type/Length: PVC/5' With 10/20 Sand Filter Prepack

Top of PVC Casing: M.P. 5441.45 ft (NAVD 88)
Ground Elevation: 5438.7 ft (NAVD 88)

Elev. (NAVD 88)	Depth (ft.)	Percent Recovery	USCS Class	Lithology Log	Well Construction	Depth (ft)	PID (MR) ppm	PID (uR) ppm	TEH mg/kg	XRF or ICP Data from Collected Core	Depth (ft)

Headspace Reading

XRF or ICP Data from Collected Core

Ag, As, Cd, Cu, Fe, Hg, Mn, Pb, Zn

Concentration (mg/kg)
Log Scale

1 or less, 10, 100, 1000, 10000, 100000 or greater

Driller: K. Manchester
Monitoring Well License # 518

Notes:
1. Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:10.0-12.0 ft
Screen Interval:14.7-19.7 ft
below ground surface
(b.g.s.)
photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

🟧	Bedrock	▤	Sandy Clay
▤	Clay	▨	Sandy Gravel
▨	Clayey Sand	▤	Sandy Silt
▤	Clayey Silt	▭	Silt
▨	Gravel	▤	Silty Clay
▨	Sand	▤	Silty Sand

Well Construction

▤	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
□	PVC Casing	🟦	Prepack
		🟥	Steel Protective Casing

Latitude: 45.995500323(NAD 83) Decimal Degrees
Longitude:-112.544921075 (NAD 83) Decimal Degrees
Northing:651445.38 IF
Easting:1195134.85 IF
Ground Elevation:5438.7 ft (NAVD 88)
Measuring Point Elevation:5441.45 ft (NAVD 88)
T3N R8W S24

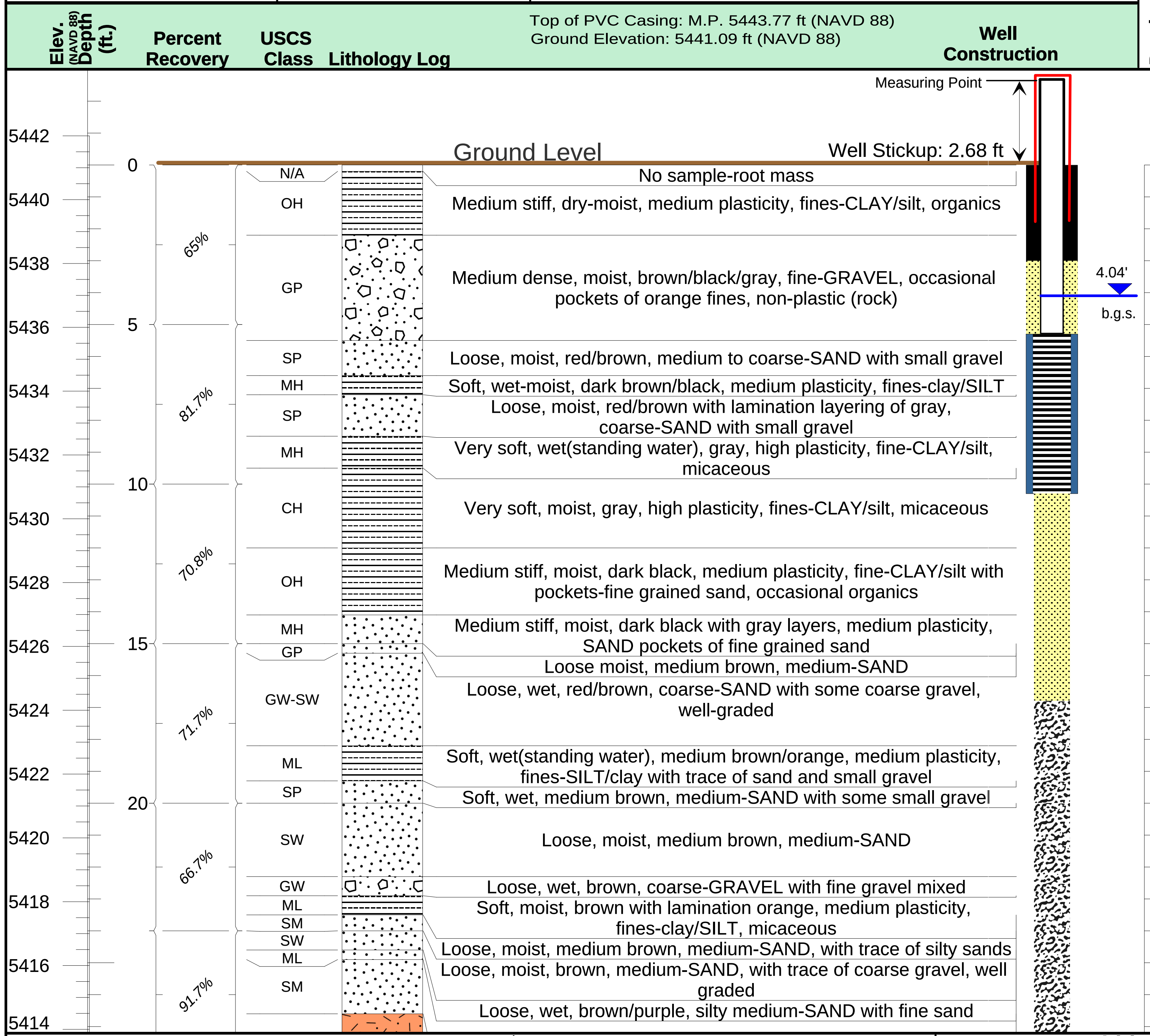
PIONEER TECHNICAL SERVICES, INC.

Piezometer Log

Piezometer Name: BRW18-PZ08

Project: BRW Phase I Site Investigation
Location: Butte, MT
Well Owner: Atlantic Richfield Co.
Depth to Water (bgs): 4.04 ft
Water Level from MP: 6.7 ft
Date:12/3/2018
Time:11:50
Logged By: K. Jackson, J. Flammang
Date Drilled: 9/18/2018
Casing Type/Dia: PVC/1.5"
Borehole Diameter: 3.25"/2.25"
Drilling Company: Pioneer
Drilling Method: Direct Push
Screen Type/Length: PVC/5' With 10/20 Sand Filter Prepack

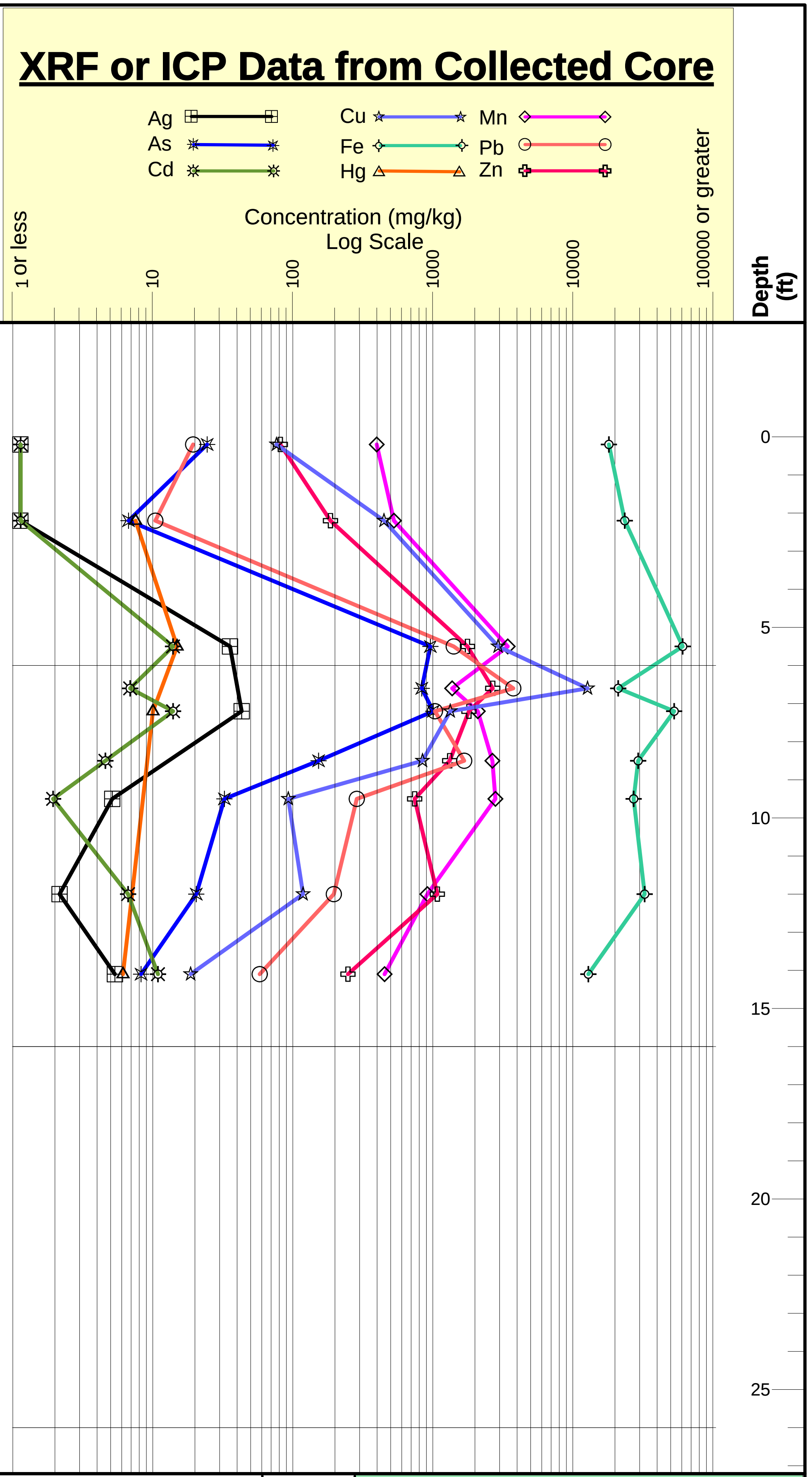
Top of PVC Casing: M.P. 5443.77 ft (NAVD 88)
Ground Elevation: 5441.09 ft (NAVD 88)



USCS Class	Lithology Log
N/A	No sample-root mass
OH	Medium stiff, dry-moist, medium plasticity, fines-CLAY/silt, organics
GP	Medium dense, moist, brown/black/gray, fine-GRAVEL, occasional pockets of orange fines, non-plastic (rock)
SP	Loose, moist, red/brown, medium to coarse-SAND with small gravel
MH	Soft, wet-moist, dark brown/black, medium plasticity, fines-clay/SILT
SP	Loose, moist, red/brown with lamination layering of gray, coarse-SAND with small gravel
MH	Very soft, wet(standing water), gray, high plasticity, fine-CLAY/silt, micaceous
CH	Very soft, moist, gray, high plasticity, fines-CLAY/silt, micaceous
OH	Medium stiff, moist, dark black, medium plasticity, fine-CLAY/silt with pockets-fine grained sand, occasional organics
MH	Medium stiff, moist, dark black with gray layers, medium plasticity, SAND pockets of fine grained sand
GP	Loose moist, medium brown, medium-SAND
GW-SW	Loose, wet, red/brown, coarse-SAND with some coarse gravel, well-graded
ML	Soft, wet(standing water), medium brown/orange, medium plasticity, fines-SILT/clay with trace of sand and small gravel
SP	Soft, wet, medium brown, medium-SAND with some small gravel
SW	Loose, moist, medium brown, medium-SAND
GW	Loose, wet, brown, coarse-GRAVEL with fine gravel mixed
ML	Soft, moist, brown with lamination orange, medium plasticity, fines-clay/SILT, micaceous
SM	
SW	Loose, moist, medium brown, medium-SAND, with trace of silty sands
ML	Loose, moist, brown, medium-SAND, with trace of coarse gravel, well graded
SM	Loose, wet, brown/purple, silty medium-SAND with fine sand

Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
ND	ND	NS


XRF or ICP Data from Collected Core

Driller: K. Manchester
Monitoring Well License # 518

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:13.0-21.0 ft
Screen Interval:5.3-10.3 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Well Construction

▤	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
□	PVC Casing	🟦	Prepack
		🟥	Steel Protective Casing

Latitude: 45.9956907052(NAD 83) Decimal Degrees
Longitude:-112.544541173 (NAD 83) Decimal Degrees
Northing:651510.97 IF
Easting:1195233.98 IF
Ground Elevation:5441.09 ft (NAVD 88)
Measuring Point Elevation:5443.77 ft (NAVD 88)
T3N R8W S24

Piezometer Log

Piezometer Name: BRW18-PZ08

PIONEER TECHNICAL SERVICES, INC.

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 4.04 ft
Water Level from MP: 6.7 ft
Date:12/3/2018
Time:11:50

Logged By: K. Jackson, J. Flammang

Date Drilled: 9/18/2018

Casing Type/Dia: PVC/1.5"

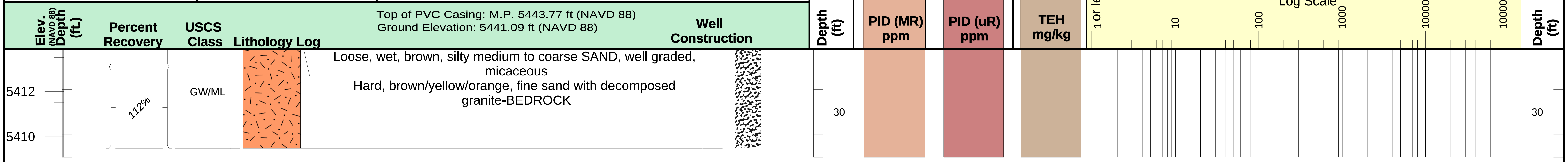
Borehole Diameter: 3.25"/2.25"

Drilling Company: Pioneer

Drilling Method: Direct Push

Screen Type/Length:PVC/5' With 10/20 Sand Filter Prepack

Top of PVC Casing: M.P. 5443.77 ft (NAVD 88)
Ground Elevation: 5441.09 ft (NAVD 88)



Loose, wet, brown, silty medium to coarse SAND, well graded, micaceous

Hard, brown/yellow/orange, fine sand with decomposed granite-BEDROCK

Driller: K. Manchester
Monitoring Well License # 518

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:13.0-21.0 ft
Screen Interval:5.3-10.3 ft below ground surface (b.g.s.)
photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

- Bedrock
- Clay
- Clayey Sand
- Clayey Silt
- Gravel
- Sand
- Sandy Clay
- Sandy Gravel
- Sandy Silt
- Silt
- Silty Clay
- Silty Sand

Well Construction

- Screen
- Bentonite
- PVC Casing
- 10/20 Sand Filter Pack
- Natural Completion
- Prepack
- Steel Protective Casing

Pg.2 of 2

Latitude: 45.9956907052(NAD 83) Decimal Degrees
Longitude:-112.544541173 (NAD 83) Decimal Degrees
Northing:651510.97 IF
Easting:1195233.98 IF
Ground Elevation:5441.09 ft (NAVD 88)
Measuring Point Elevation:5443.77 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Piezometer Log

Piezometer Name: BRW18-PZ09

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 2.26 ft
Water Level from MP: 4.92 ft
Date:12/3/2018
Time:10:20

Logged By: K. Jackson, J. Flammang

Date Drilled: 9/19/2018

Casing Type/Dia: PVC/1.5"

Borehole Diameter: 3.25"/2.25"

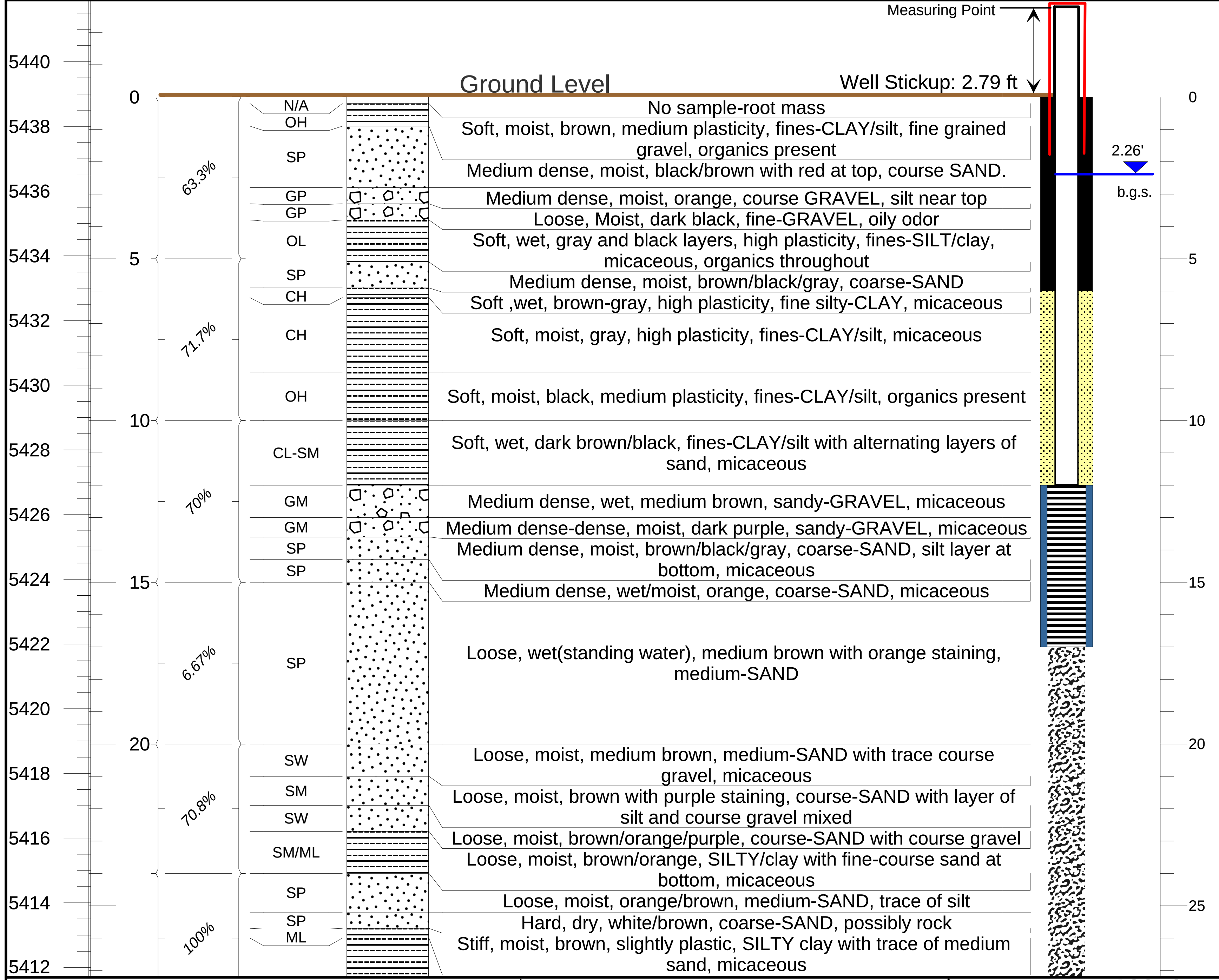
Drilling Company: Pioneer

Drilling Method: Direct Push

Screen Type/Length:PVC/5' With 10/20 Sand Filter Prepack

Top of PVC Casing: M.P. 5441.7 ft (NAVD 88)
Ground Elevation: 5438.91 ft (NAVD 88)

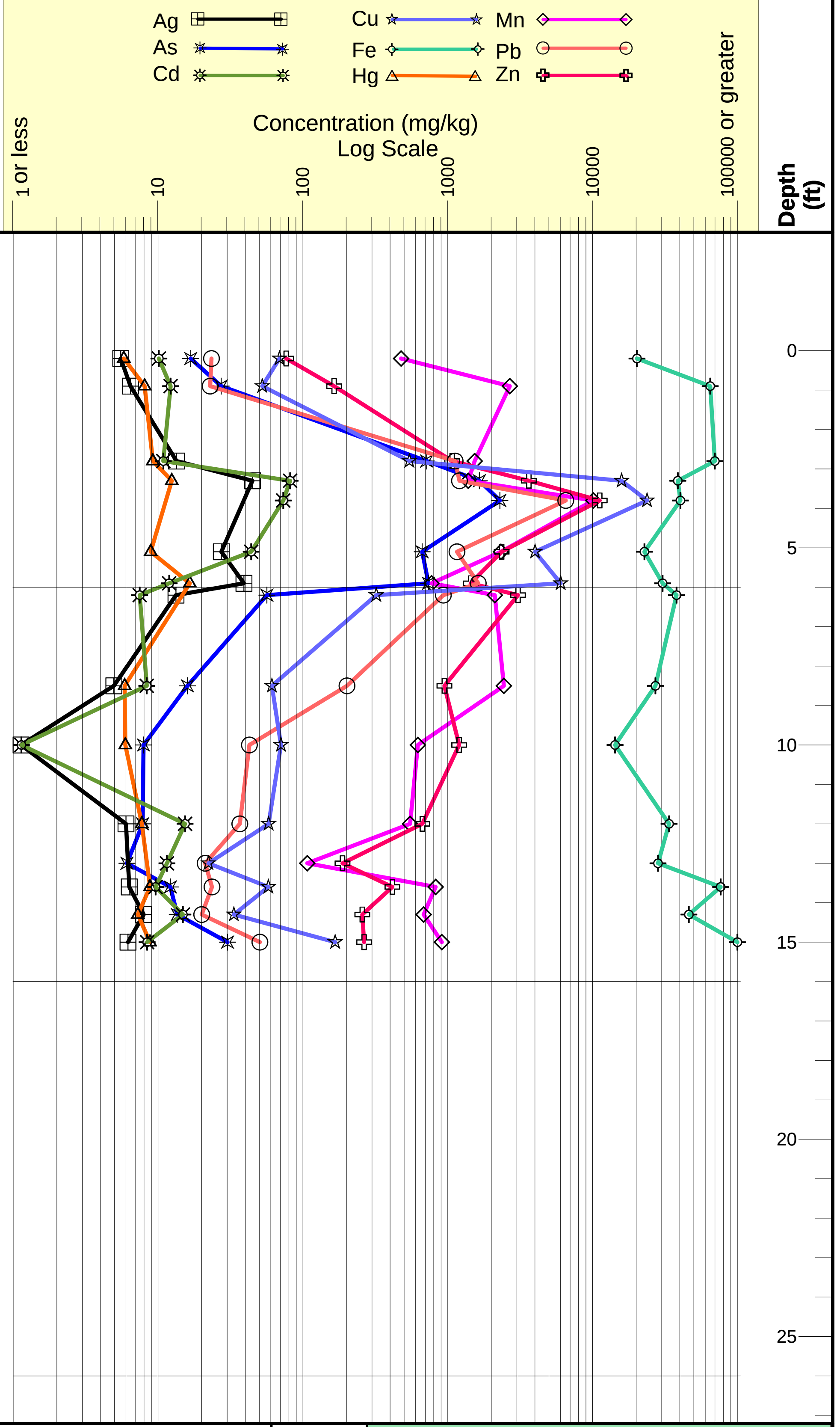
Percent Recovery	USCS Class	Lithology Log
	N/A	No sample-root mass
	OH	Soft, moist, brown, medium plasticity, fines-CLAY/silt, fine grained gravel, organics present
63.3%	SP	Medium dense, moist, black/brown with red at top, course SAND.
	GP	Medium dense, moist, orange, course GRAVEL, silt near top
	GP	Loose, Moist, dark black, fine-GRAVEL, oily odor
	OL	Soft, wet, gray and black layers, high plasticity, fines-SILT/clay, micaceous, organics throughout
	SP	Medium dense, moist, brown/black/gray, coarse-SAND
	CH	Soft ,wet, brown-gray, high plasticity, fine silty-CLAY, micaceous
71.7%	CH	Soft, moist, gray, high plasticity, fines-CLAY/silt, micaceous
	OH	Soft, moist, black, medium plasticity, fines-CLAY/silt, organics present
	CL-SM	Soft, wet, dark brown/black, fines-CLAY/silt with alternating layers of sand, micaceous
70%	GM	Medium dense, wet, medium brown, sandy-GRAVEL, micaceous
	GM	Medium dense-dense, moist, dark purple, sandy-GRAVEL, micaceous
	SP	Medium dense, moist, brown/black/gray, coarse-SAND, silt layer at bottom, micaceous
	SP	Medium dense, wet/moist, orange, coarse-SAND, micaceous
6.67%	SP	Loose, wet(standing water), medium brown with orange staining, medium-SAND
	SW	Loose, moist, medium brown, medium-SAND with trace course gravel, micaceous
70.8%	SM	Loose, moist, brown with purple staining, course-SAND with layer of silt and course gravel mixed
	SW	Loose, moist, brown/orange/purple, course-SAND with course gravel
	SM/ML	Loose, moist, brown/orange, SILTY/clay with fine-course sand at bottom, micaceous
	SP	Loose, moist, orange/brown, medium-SAND, trace of silt
100%	SP	Hard, dry, white/brown, coarse-SAND, possibly rock
	ML	Stiff, moist, brown, slightly plastic, SILTY clay with trace of medium sand, micaceous



Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
ND	ND	NS

XRF or ICP Data from Collected Core



Driller: K. Manchester
Monitoring Well License # 518

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:6.0-12.0 ft
Screen Interval:12.0-17.0 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Well Construction

▤	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
□	PVC Casing	■	Prepack
		⊓	Steel Protective Casing

Latitude: 45.9959513495(NAD 83) Decimal Degrees
Longitude:-112.544471346 (NAD 83) Decimal Degrees
Northing:651605.22 IF
Easting:1195255.4 IF
Ground Elevation:5438.91 ft (NAVD 88)
Measuring Point Elevation:5441.7 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Piezometer Log

Piezometer Name: BRW18-PZ09

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 2.26 ft
Water Level from MP: 4.92 ft
Date:12/3/2018
Time:10:20

Logged By: K. Jackson, J. Flammang

Date Drilled: 9/19/2018

Casing Type/Dia: PVC/1.5"

Borehole Diameter: 3.25"/2.25"

Drilling Company: Pioneer

Drilling Method: Direct Push

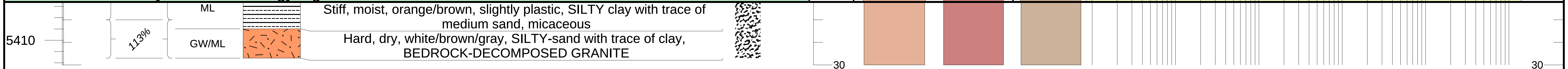
Screen Type/Length:PVC/5' With 10/20 Sand Filter Prepack

Top of PVC Casing: M.P. 5441.7 ft (NAVD 88)
Ground Elevation: 5438.91 ft (NAVD 88)

Headspace Reading

XRF or ICP Data from Collected Core

Elev. (NAVD 88)	Depth (ft.)	Percent Recovery	USCS Class	Lithology Log	Well Construction	Depth (ft)	PID (MR) ppm	PID (uR) ppm	TEH mg/kg	Concentration (mg/kg) Log Scale	Depth (ft)



Stiff, moist, orange/brown, slightly plastic, SILTY clay with trace of medium sand, micaceous

Hard, dry, white/brown/gray, SILTY-sand with trace of clay, BEDROCK-DECOMPOSED GRANITE

Driller: K. Manchester
Monitoring Well License # 518

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:6.0-12.0 ft
Screen Interval:12.0-17.0 ft
below ground surface
(b.g.s.)
photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Well Construction

▤	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
□	PVC Casing	■	Prepack
		⊓	Steel Protective Casing

Pg.2 of 2

Latitude: 45.9959513495(NAD 83) Decimal Degrees
Longitude:-112.544471346 (NAD 83) Decimal Degrees
Northing:651605.22 IF
Easting:1195255.4 IF
Ground Elevation:5438.91 ft (NAVD 88)
Measuring Point Elevation:5441.7 ft (NAVD 88)
T3N R8W S24

Piezometer Log

Piezometer Name: BRW18-PZ10

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 7.09 ft
Water Level from MP: 9.05 ft
Date:11/28/2018
Time:2:45

Logged By: K. Jackson, J. Flammang

Date Drilled: 10/1/2018

Casing Type/Dia: PVC/1.5"

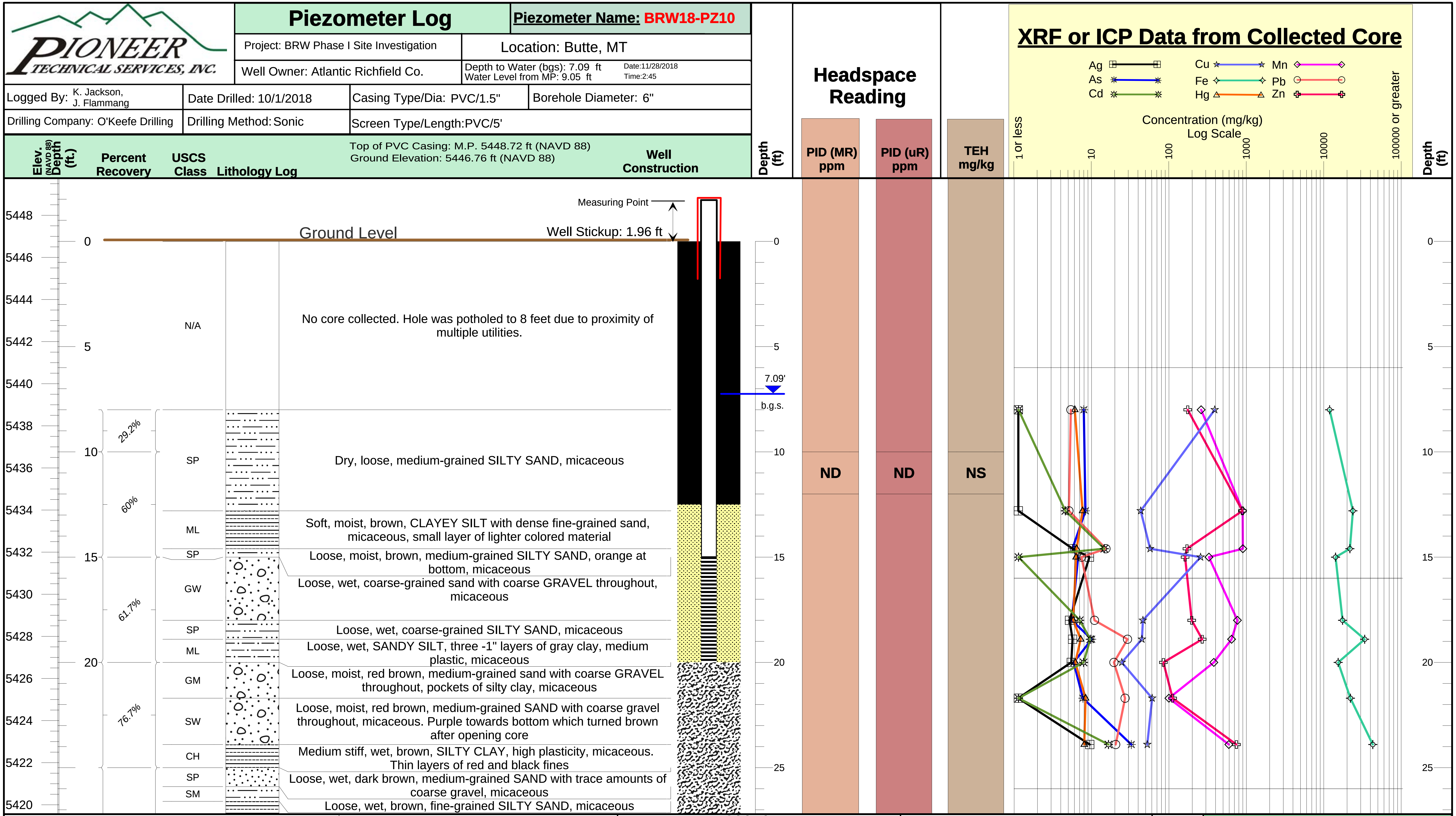
Borehole Diameter: 6"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length:PVC/5'

Top of PVC Casing: M.P. 5448.72 ft (NAVD 88)
Ground Elevation: 5446.76 ft (NAVD 88)



N/A	No core collected. Hole was potholed to 8 feet due to proximity of multiple utilities.
SP	Dry, loose, medium-grained SILTY SAND, micaceous
ML	Soft, moist, brown, CLAYEY SILT with dense fine-grained sand, micaceous, small layer of lighter colored material
SP	Loose, moist, brown, medium-grained SILTY SAND, orange at bottom, micaceous
GW	Loose, wet, coarse-grained sand with coarse GRAVEL throughout, micaceous
SP	Loose, wet, coarse-grained SILTY SAND, micaceous
ML	Loose, wet, SANDY SILT, three -1" layers of gray clay, medium plastic, micaceous
GM	Loose, moist, red brown, medium-grained sand with coarse GRAVEL throughout, pockets of silty clay, micaceous
SW	Loose, moist, red brown, medium-grained SAND with coarse gravel throughout, micaceous. Purple towards bottom which turned brown after opening core
CH	Medium stiff, wet, brown, SILTY CLAY, high plasticity, micaceous. Thin layers of red and black fines
SP	Loose, wet, dark brown, medium-grained SAND with trace amounts of coarse gravel, micaceous
SM	Loose, wet, brown, fine-grained SILTY SAND, micaceous

Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:12.5-22 ft
Screen Interval:15-20 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

Bedrock	Sandy Clay
Clay	Sandy Gravel
Clayey Sand	Sandy Silt
Clayey Silt	Silt
Gravel	Silty Clay
Sand	Silty Sand

Well Construction

Screen	10/20 Sand Filter Pack
Bentonite	Natural Completion
PVC Casing	Prepack
	Steel Protective Casing

Pg.1 of 2

Latitude: 45.9945784049(NAD 83) Decimal Degrees
Longitude:-112.543910331 (NAD 83) Decimal Degrees
Northing:651099.61 IF
Easting:1195378.38 IF
Ground Elevation:5446.76 ft (NAVD 88)
Measuring Point Elevation:5448.72 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Piezometer Log

Piezometer Name: BRW18-PZ10

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 7.09 ft
Water Level from MP: 9.05 ft
Date:11/28/2018
Time:2:45

Logged By: K. Jackson, J. Flammang

Date Drilled: 10/1/2018

Casing Type/Dia: PVC/1.5"

Borehole Diameter: 6"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length:PVC/5'

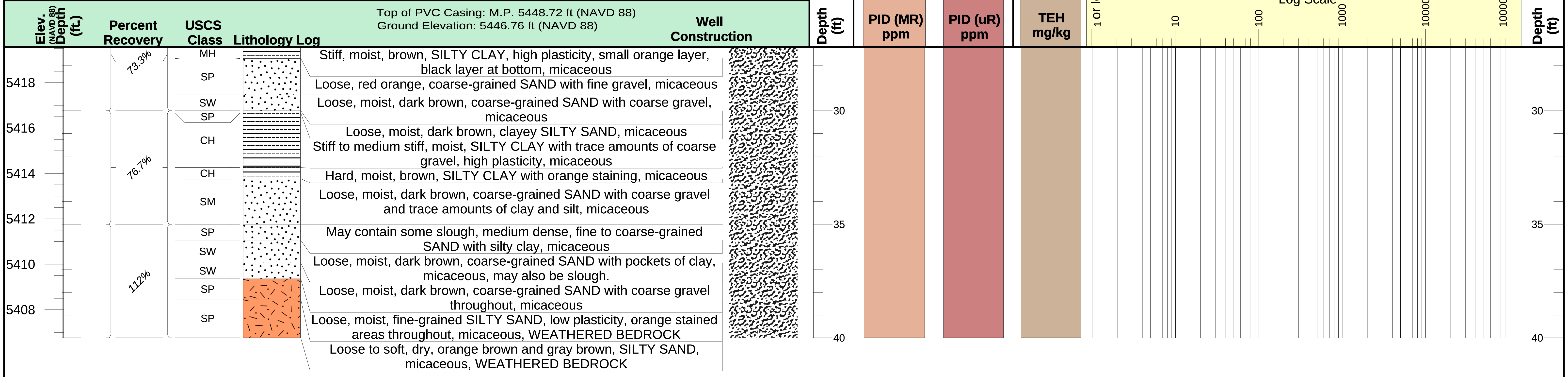
Top of PVC Casing: M.P. 5448.72 ft (NAVD 88)
Ground Elevation: 5446.76 ft (NAVD 88)

Headspace Reading

XRF or ICP Data from Collected Core

Ag ⊞ As ✳ Cd ✳ Cu ★ Fe ✧ Hg △ Mn ◇ Pb ○ Zn ✣

Concentration (mg/kg)
Log Scale



Stiff, moist, brown, SILTY CLAY, high plasticity, small orange layer, black layer at bottom, micaceous

Loose, red orange, coarse-grained SAND with fine gravel, micaceous

Loose, moist, dark brown, coarse-grained SAND with coarse gravel, micaceous

Loose, moist, dark brown, clayey SILTY SAND, micaceous

Stiff to medium stiff, moist, SILTY CLAY with trace amounts of coarse gravel, high plasticity, micaceous

Hard, moist, brown, SILTY CLAY with orange staining, micaceous

Loose, moist, dark brown, coarse-grained SAND with coarse gravel and trace amounts of clay and silt, micaceous

May contain some slough, medium dense, fine to coarse-grained SAND with silty clay, micaceous

Loose, moist, dark brown, coarse-grained SAND with pockets of clay, micaceous, may also be slough.

Loose, moist, dark brown, coarse-grained SAND with coarse gravel throughout, micaceous

Loose, moist, fine-grained SILTY SAND, low plasticity, orange stained areas throughout, micaceous, WEATHERED BEDROCK

Loose to soft, dry, orange brown and gray brown, SILTY SAND, micaceous, WEATHERED BEDROCK

Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:12.5-22 ft
Screen Interval:15-20 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

🟧	Bedrock	▤	Sandy Clay
▤	Clay	▨	Sandy Gravel
▨	Clayey Sand	▤	Sandy Silt
▤	Clayey Silt	▭	Silt
▨	Gravel	▤	Silty Clay
▨	Sand	▤	Silty Sand

Well Construction

▤	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
□	PVC Casing	🟦	Prepack
		⊓	Steel Protective Casing

Latitude: 45.9945784049(NAD 83) Decimal Degrees
Longitude:-112.543910331 (NAD 83) Decimal Degrees
Northing:651099.61 IF
Easting:1195378.38 IF
Ground Elevation:5446.76 ft (NAVD 88)
Measuring Point Elevation:5448.72 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Piezometer Log

Piezometer Name: BRW18-PZ11

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 6.01 ft
Water Level from MP: 7.75 ft
Date:11/29/2018
Time:3:15

Logged By: K. Jackson, J. Flammang

Date Drilled: 10/8/2018

Casing Type/Dia: PVC/1.5"

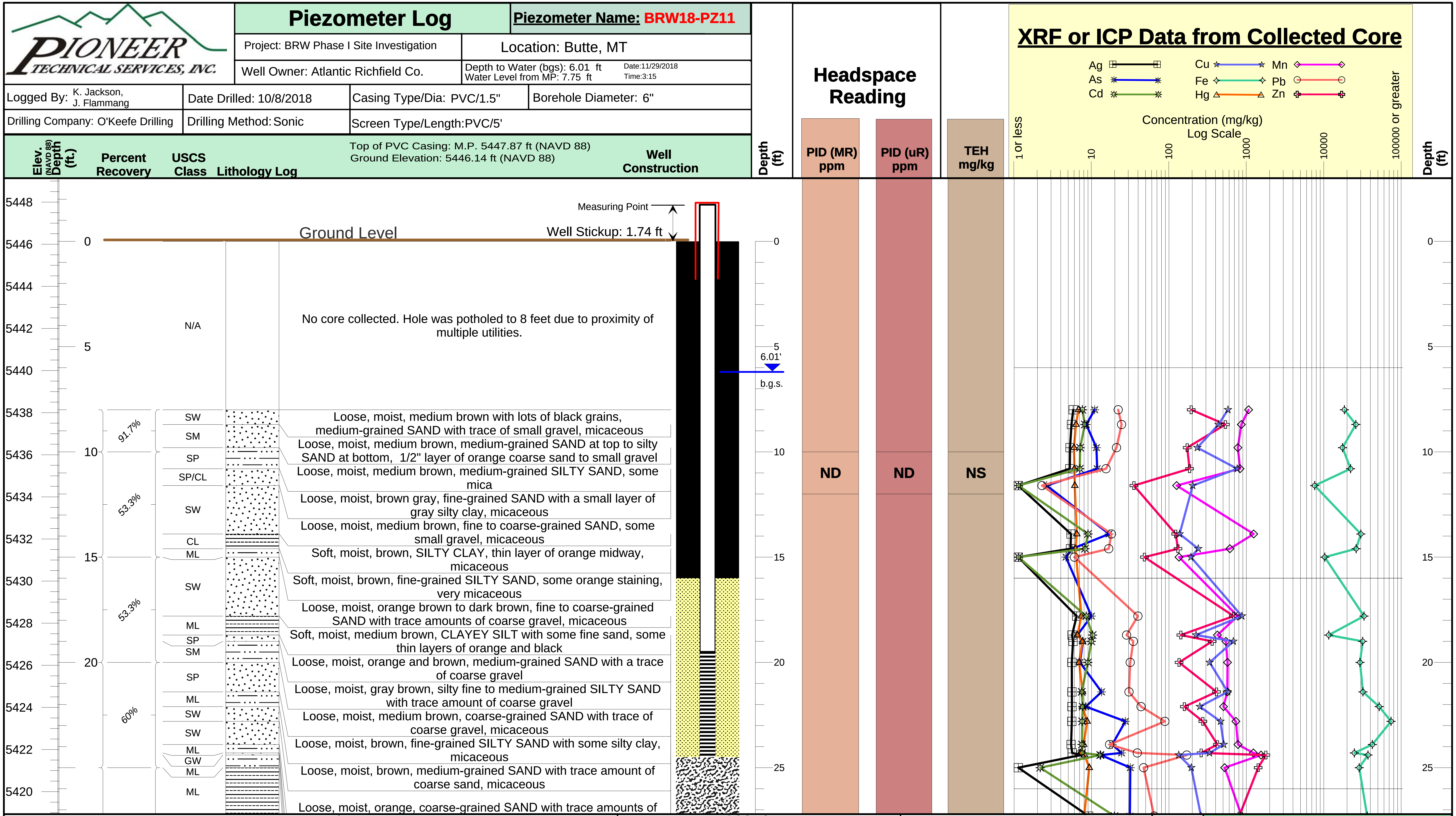
Borehole Diameter: 6"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length:PVC/5'

Top of PVC Casing: M.P. 5447.87 ft (NAVD 88)
Ground Elevation: 5446.14 ft (NAVD 88)



No core collected. Hole was potholed to 8 feet due to proximity of multiple utilities.

Loose, moist, medium brown with lots of black grains, medium-grained SAND with trace of small gravel, micaceous

Loose, moist, medium brown, medium-grained SAND at top to silty SAND at bottom, 1/2" layer of orange coarse sand to small gravel

Loose, moist, medium brown, medium-grained SILTY SAND, some mica

Loose, moist, brown gray, fine-grained SAND with a small layer of gray silty clay, micaceous

Loose, moist, medium brown, fine to coarse-grained SAND, some small gravel, micaceous

Soft, moist, brown, SILTY CLAY, thin layer of orange midway, micaceous

Soft, moist, brown, fine-grained SILTY SAND, some orange staining, very micaceous

Loose, moist, orange brown to dark brown, fine to coarse-grained SAND with trace amounts of coarse gravel, micaceous

Soft, moist, medium brown, CLAYEY SILT with some fine sand, some thin layers of orange and black

Loose, moist, orange and brown, medium-grained SAND with a trace of coarse gravel

Loose, moist, gray brown, silty fine to medium-grained SILTY SAND with trace amount of coarse gravel

Loose, moist, medium brown, coarse-grained SAND with trace of coarse gravel, micaceous

Loose, moist, brown, fine-grained SILTY SAND with some silty clay, micaceous

Loose, moist, brown, medium-grained SAND with trace amount of coarse sand, micaceous

Loose, moist, orange, coarse-grained SAND with trace amounts of

Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:16-26 ft
Screen Interval:19.5-24.5 ft below ground surface (b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

🟧	Bedrock	▨	Sandy Clay
▤	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▤	Clayey Silt	▭	Silt
▨	Gravel	▤	Silty Clay
▨	Sand	▨	Silty Sand

Well Construction

▤	Screen	🟨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
□	PVC Casing	🟦	Prepack
		🟥	Steel Protective Casing

Pg.1 of 2

Latitude: 45.9946190272(NAD 83) Decimal Degrees
Longitude:-112.543220952 (NAD 83) Decimal Degrees
Northing:651107.61 IF
Easting:1195553.96 IF
Ground Elevation:5446.14 ft (NAVD 88)
Measuring Point Elevation:5447.87 ft (NAVD 88)
T3N R8W S24

Piezometer Log

Piezometer Name: BRW18-PZ11

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 6.01 ft
Water Level from MP: 7.75 ft
Date:11/29/2018
Time:3:15

Logged By: K. Jackson, J. Flammang

Date Drilled: 10/8/2018

Casing Type/Dia: PVC/1.5"

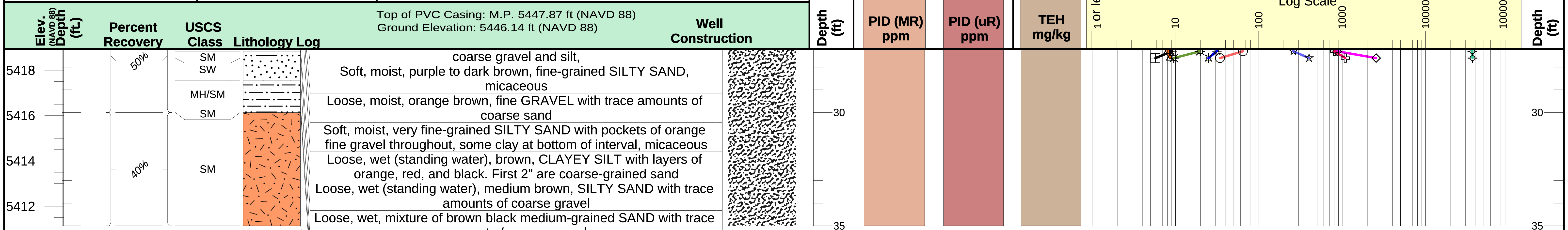
Borehole Diameter: 6"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length:PVC/5'

Top of PVC Casing: M.P. 5447.87 ft (NAVD 88)
Ground Elevation: 5446.14 ft (NAVD 88)



coarse gravel and silt,

Soft, moist, purple to dark brown, fine-grained SILTY SAND, micaceous

Loose, moist, orange brown, fine GRAVEL with trace amounts of coarse sand

Soft, moist, very fine-grained SILTY SAND with pockets of orange fine gravel throughout, some clay at bottom of interval, micaceous

Loose, wet (standing water), brown, CLAYEY SILT with layers of orange, red, and black. First 2" are coarse-grained sand

Loose, wet (standing water), medium brown, SILTY SAND with trace amounts of coarse gravel

Loose, wet, mixture of brown black medium-grained SAND with trace amount of coarse gravel

Soft, moist, brown, orange, gray SANDY SILT, micaceous

Loose, wet, dark brown, fine-grained SILTY SAND

Hard, moist to dry, orange white black, SANDY SILT. WEATHERED TO HARD BEDROCK.

Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:16-26 ft
Screen Interval:19.5-24.5 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

- Bedrock
- Clay
- Clayey Sand
- Clayey Silt
- Gravel
- Sand
- Sandy Clay
- Sandy Gravel
- Sandy Silt
- Silt
- Silty Clay
- Silty Sand

Well Construction

- Screen
- Bentonite
- PVC Casing
- 10/20 Sand Filter Pack
- Natural Completion
- Prepack
- Steel Protective Casing

Latitude: 45.9946190272(NAD 83) Decimal Degrees
Longitude:-112.543220952 (NAD 83) Decimal Degrees
Northing:651107.61 IF
Easting:1195553.96 IF
Ground Elevation:5446.14 ft (NAVD 88)
Measuring Point Elevation:5447.87 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Piezometer Log

Piezometer Name: BRW18-PZ12

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 6.63 ft
Water Level from MP: 8.3 ft
Date:11/28/2018
Time:12:00

Logged By: K. Jackson, J. Flammang

Date Drilled: 10/5/2018

Casing Type/Dia: PVC/1.5"

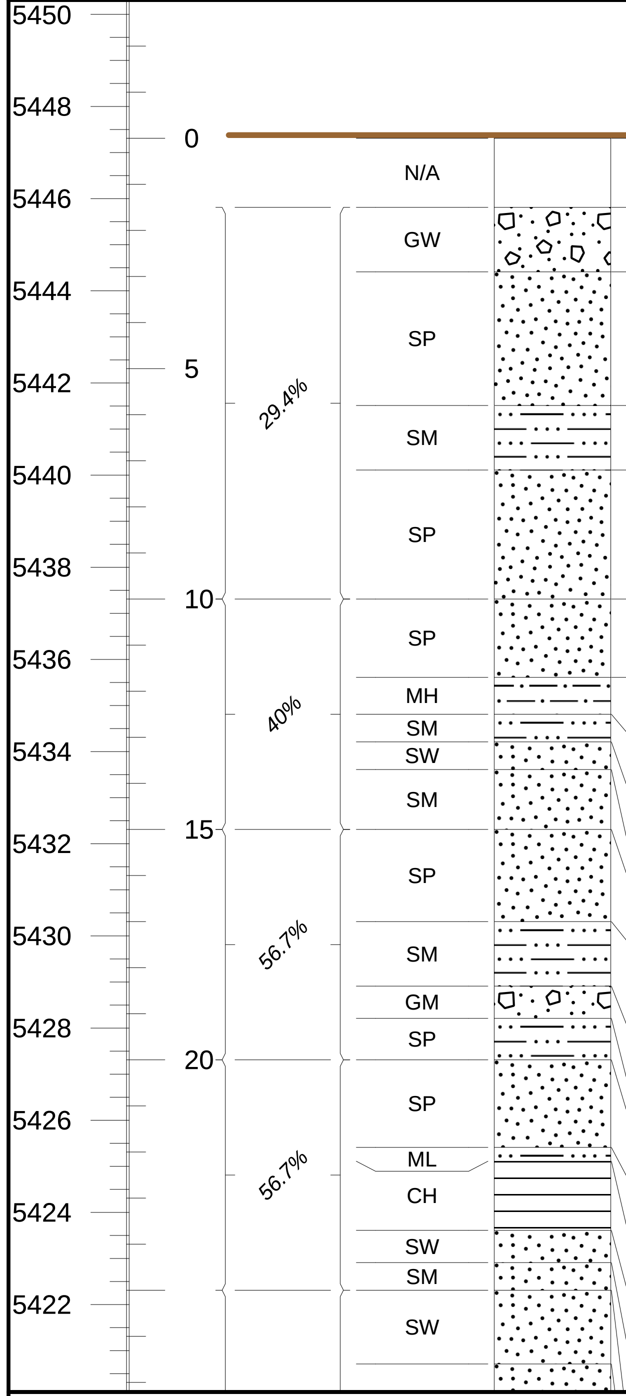
Borehole Diameter: 6"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length:PVC/5'

Top of PVC Casing: M.P. 5448.99 ft (NAVD 88)
Ground Elevation: 5447.31 ft (NAVD 88)



Ground Level

No core collected. Hole was potholed to 1.5 feet due to proximity of multiple utilities. Encountered slag at 1.5'.

Loose, moist, black, angular chunks of slag, coarse GRAVEL to cobble size

Loose, moist, medium brown, medium-grained SAND with trace amounts of coarse gravel, micaceous. 1" layer of dark brown silty sand in middle

Dense, moist, light brown, medium-grained SILTY SAND

Loose, wet, medium brown, fine to coarse-grained SAND, black mica throughout

Loose, wet, brown, fine to medium-grained SAND, micaceous

Soft, wet (standing water), brown with orange staining, SANDY SILT with nodules of silty clay, micaceous

Loose, wet (standing water), bright orange, fine to coarse-grained SILTY SAND, micaceous

Loose, wet (standing water), brown, coarse-grained SAND with small amounts of silt, micaceous

Loose, moist, brown, fine-grained SAND, small amounts of silt

Loose, moist, brown, coarse-grained SAND with trace amounts of coarse gravel, micaceous

Loose, moist, brown, fine-grained SILTY SAND with trace amounts of coarse gravel and some orange staining, small laminations of orange and black towards bottom, micaceous

Loose, moist, orange, coarse GRAVEL, brown towards top, some layers of brown silty sand

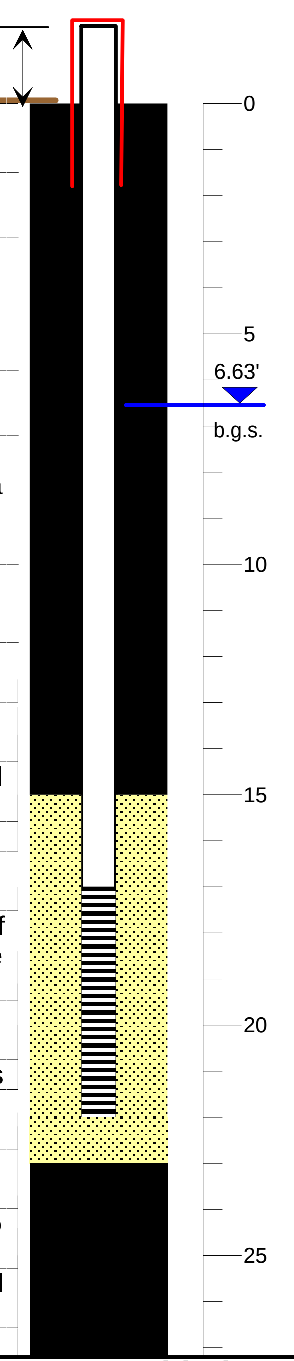
Loose, wet, brown, SILTY SAND, orange stains in top 1", micaceous

Loose, moist, light brown to orange, coarse-grained SAND with trace amount of coarse gravel, micaceous

Soft, moist, brown and gray, fine-grained SILTY SAND, trace amounts of coarse gravel, orange and black layering of silt

Soft, moist, brown, CLAY with black and orange laminations near top of interval, high plasticity

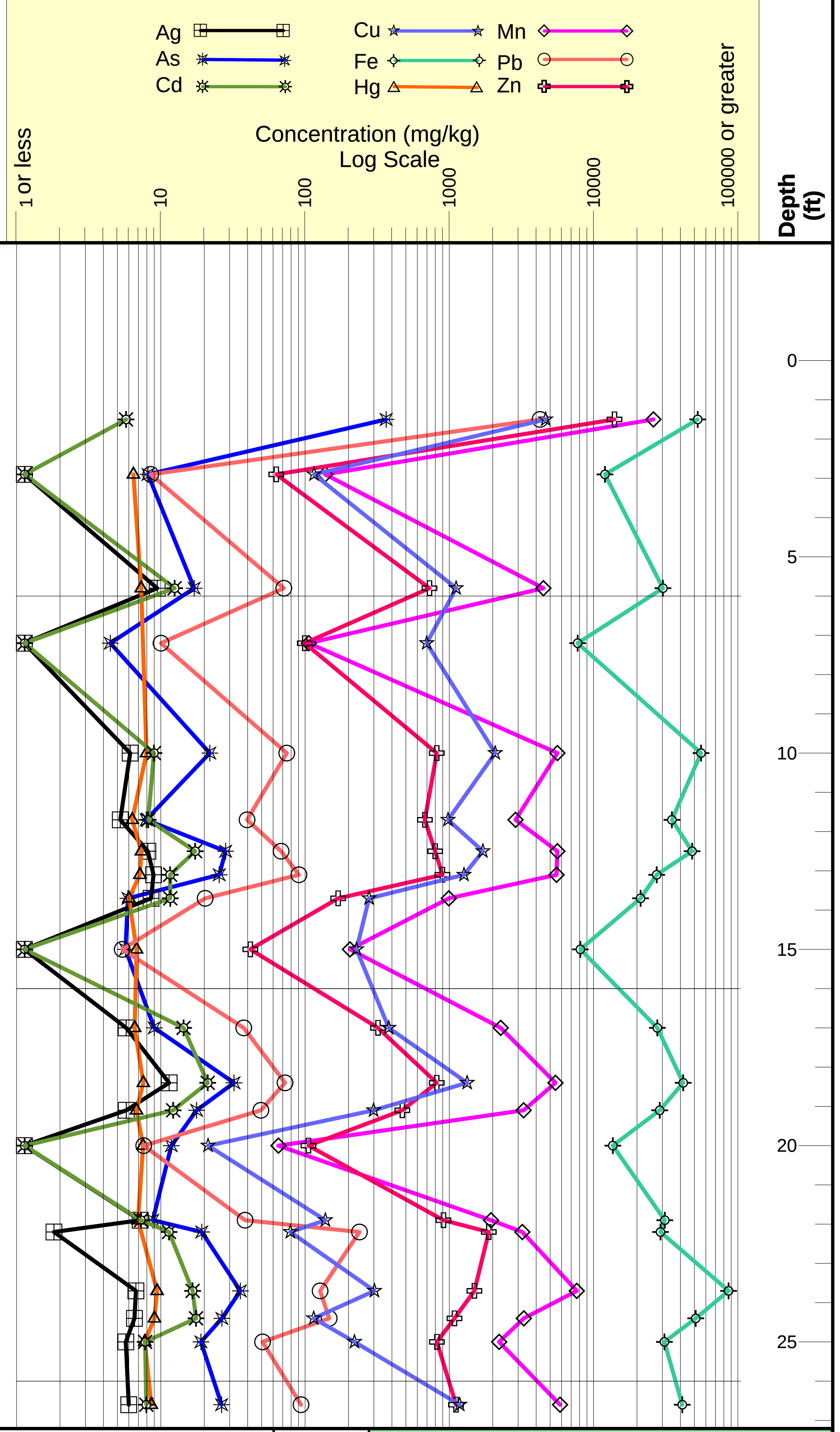
Loose, moist, brown purple, coarse-grained SAND with coarse gravel throughout



Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
3.2	0.125	ND

XRF or ICP Data from Collected Core



Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:17-22 ft
Screen Interval:17-22 ft
below ground surface
(b.g.s.)
photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

🟧	Bedrock	▭	Sandy Clay
▭	Clay	▭	Sandy Gravel
▭	Clayey Sand	▭	Sandy Silt
▤	Clayey Silt	▭	Silt
▭	Gravel	▤	Silty Clay
▭	Sand	▭	Silty Sand

Well Construction

▤	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
□	PVC Casing	🟦	Prepack
		🟥	Steel Protective Casing

Pg.1 of 2

Latitude: 45.9948160083(NAD 83) Decimal Degrees
Longitude:-112.542192094 (NAD 83) Decimal Degrees
Northing:651169.2 IF
Easting:1195817.94 IF
Ground Elevation:5447.31 ft (NAVD 88)
Measuring Point Elevation:5448.99 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Piezometer Log

Piezometer Name: BRW18-PZ12

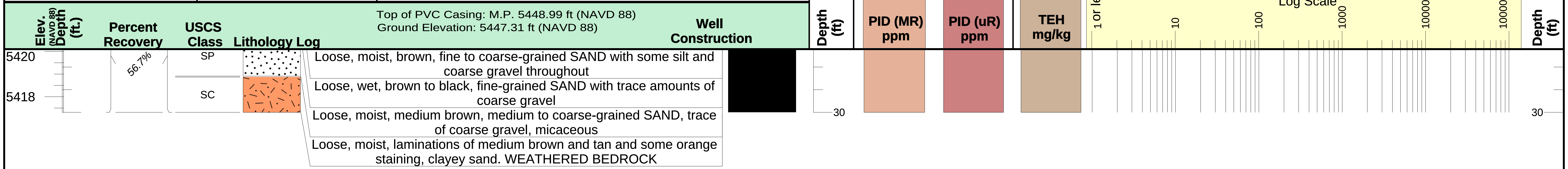
Project: BRW Phase I Site Investigation	Location: Butte, MT
Well Owner: Atlantic Richfield Co.	Depth to Water (bgs): 6.63 ft Water Level from MP: 8.3 ft Date:11/28/2018 Time:12:00

Logged By: K. Jackson, J. Flammang	Date Drilled: 10/5/2018	Casing Type/Dia: PVC/1.5"	Borehole Diameter: 6"
Drilling Company: O'Keefe Drilling	Drilling Method: Sonic	Screen Type/Length:PVC/5'	

Top of PVC Casing: M.P. 5448.99 ft (NAVD 88)
Ground Elevation: 5447.31 ft (NAVD 88)

Headspace Reading

XRF or ICP Data from Collected Core



Loose, moist, brown, fine to coarse-grained SAND with some silt and coarse gravel throughout

Loose, wet, brown to black, fine-grained SAND with trace amounts of coarse gravel

Loose, moist, medium brown, medium to coarse-grained SAND, trace of coarse gravel, micaceous

Loose, moist, laminations of medium brown and tan and some orange staining, clayey sand. WEATHERED BEDROCK

Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:17-22 ft
Screen Interval:17-22 ft
below ground surface
(b.g.s.)
photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

🟧	Bedrock	▭	Sandy Clay
▭	Clay	▭	Sandy Gravel
▭	Clayey Sand	▭	Sandy Silt
▤	Clayey Silt	▭	Silt
▭	Gravel	▤	Silty Clay
▭	Sand	▭	Silty Sand

Well Construction

▤	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
□	PVC Casing	🟦	Prepack
		⊓	Steel Protective Casing

Latitude: 45.9948160083(NAD 83) Decimal Degrees
Longitude:-112.542192094 (NAD 83) Decimal Degrees
Northing:651169.2 IF
Easting:1195817.94 IF
Ground Elevation:5447.31 ft (NAVD 88)
Measuring Point Elevation:5448.99 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

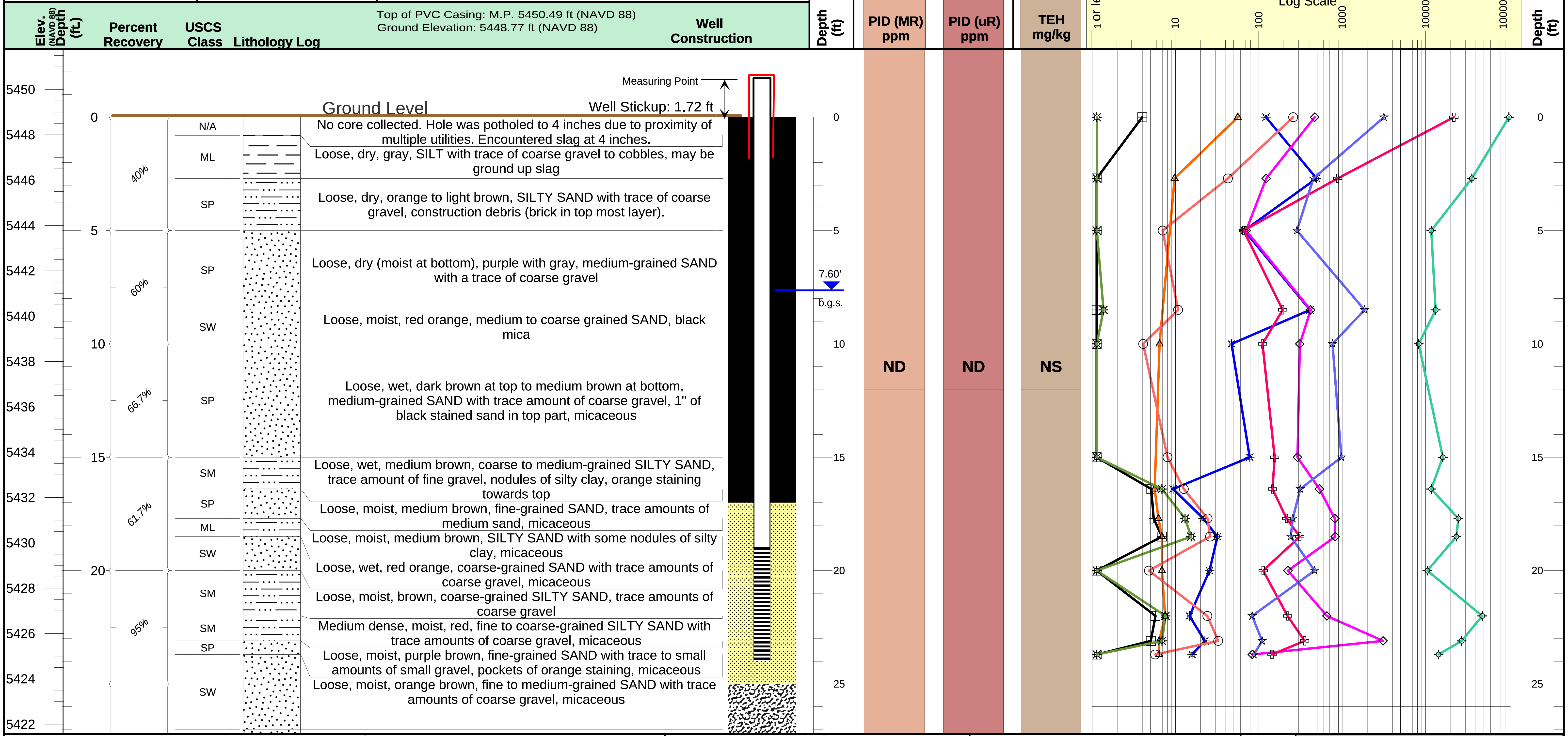
Piezometer Log

Piezometer Name: BRW18-PZ13

Project: BRW Phase I Site Investigation	Location: Butte, MT
Well Owner: Atlantic Richfield Co.	Depth to Water (bgs): 7.60 ft Water Level from MP: 9.32 ft Date:11/28/2018 Time:1:25

Logged By: K. Jackson, J. Flammang	Date Drilled: 10/11/2018	Casing Type/Dia: PVC/1.5"	Borehole Diameter: 6"
Drilling Company: O'Keefe Drilling	Drilling Method: Sonic	Screen Type/Length:PVC/5'	

Top of PVC Casing: M.P. 5450.49 ft (NAVD 88)
Ground Elevation: 5448.77 ft (NAVD 88)



USCS Class	Lithology Log
N/A	No core collected. Hole was potholed to 4 inches due to proximity of multiple utilities. Encountered slag at 4 inches.
ML	Loose, dry, gray, SILT with trace of coarse gravel to cobbles, may be ground up slag
SP	Loose, dry, orange to light brown, SILTY SAND with trace of coarse gravel, construction debris (brick in top most layer).
SP	Loose, dry (moist at bottom), purple with gray, medium-grained SAND with a trace of coarse gravel
SW	Loose, moist, red orange, medium to coarse grained SAND, black mica
SP	Loose, wet, dark brown at top to medium brown at bottom, medium-grained SAND with trace amount of coarse gravel, 1" of black stained sand in top part, micaceous
SM	Loose, wet, medium brown, coarse to medium-grained SILTY SAND, trace amount of fine gravel, nodules of silty clay, orange staining towards top
SP	Loose, moist, medium brown, fine-grained SAND, trace amounts of medium sand, micaceous
ML	Loose, moist, medium brown, SILTY SAND with some nodules of silty clay, micaceous
SW	Loose, wet, red orange, coarse-grained SAND with trace amounts of coarse gravel, micaceous
SM	Loose, moist, brown, coarse-grained SILTY SAND, trace amounts of coarse gravel
SM	Medium dense, moist, red, fine to coarse-grained SILTY SAND with trace amounts of coarse gravel, micaceous
SP	Loose, moist, purple brown, fine-grained SAND with trace to small amounts of small gravel, pockets of orange staining, micaceous
SW	Loose, moist, orange brown, fine to medium-grained SAND with trace amounts of coarse gravel, micaceous

Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:17-25 ft
Screen Interval:19-24 ft
below ground surface
(b.g.s.)
photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▤	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▤	Clayey Silt	▨	Silt
▨	Gravel	▤	Silty Clay
▨	Sand	▨	Silty Sand

Well Construction

▤	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
□	PVC Casing	🟦	Prepack
		🟥	Steel Protective Casing

Latitude: 45.9949527016(NAD 83) Decimal Degrees
Longitude:-112.541133745 (NAD 83) Decimal Degrees
Northing:651208.55 IF
Easting:1196088.54 IF
Ground Elevation:5448.77 ft (NAVD 88)
Measuring Point Elevation:5450.49 ft (NAVD 88)
T3N R8W S24

Piezometer Log

Piezometer Name: BRW18-PZ13

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 7.60 ft
Water Level from MP: 9.32 ft
Date:11/28/2018
Time:1:25

Logged By: K. Jackson, J. Flammang

Date Drilled: 10/11/2018

Casing Type/Dia: PVC/1.5"

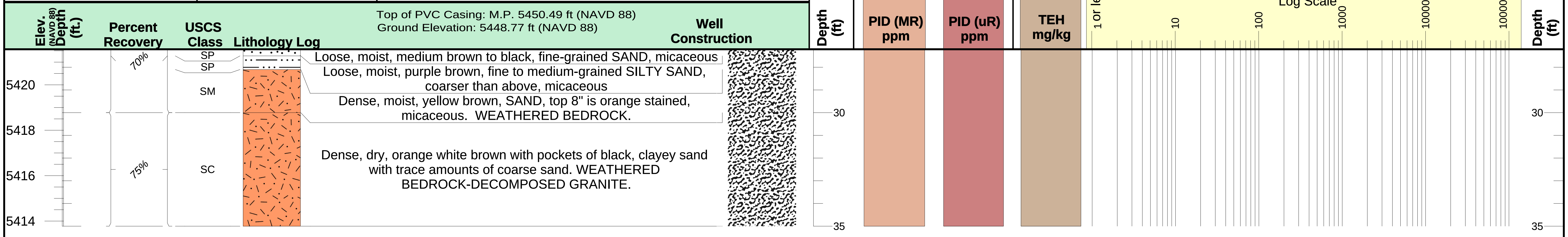
Borehole Diameter: 6"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length:PVC/5'

Top of PVC Casing: M.P. 5450.49 ft (NAVD 88)
Ground Elevation: 5448.77 ft (NAVD 88)



Loose, moist, medium brown to black, fine-grained SAND, micaceous

Loose, moist, purple brown, fine to medium-grained SILTY SAND, coarser than above, micaceous

Dense, moist, yellow brown, SAND, top 8" is orange stained, micaceous. WEATHERED BEDROCK.

Dense, dry, orange white brown with pockets of black, clayey sand with trace amounts of coarse sand. WEATHERED BEDROCK-DECOMPOSED GRANITE.

Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:17-25 ft
Screen Interval:19-24 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

🟧	Bedrock	▨	Sandy Clay
▤	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▤	Clayey Silt	▨	Silt
▨	Gravel	▤	Silty Clay
▨	Sand	▨	Silty Sand

Well Construction

▤	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
□	PVC Casing	🟦	Prepack
		🟥	Steel Protective Casing

Latitude: 45.9949527016(NAD 83) Decimal Degrees
Longitude:-112.541133745 (NAD 83) Decimal Degrees
Northing:651208.55 IF
Easting:1196088.54 IF
Ground Elevation:5448.77 ft (NAVD 88)
Measuring Point Elevation:5450.49 ft (NAVD 88)

T3N R8W S24

PIONEER
TECHNICAL SERVICES, INC.

Piezometer Log

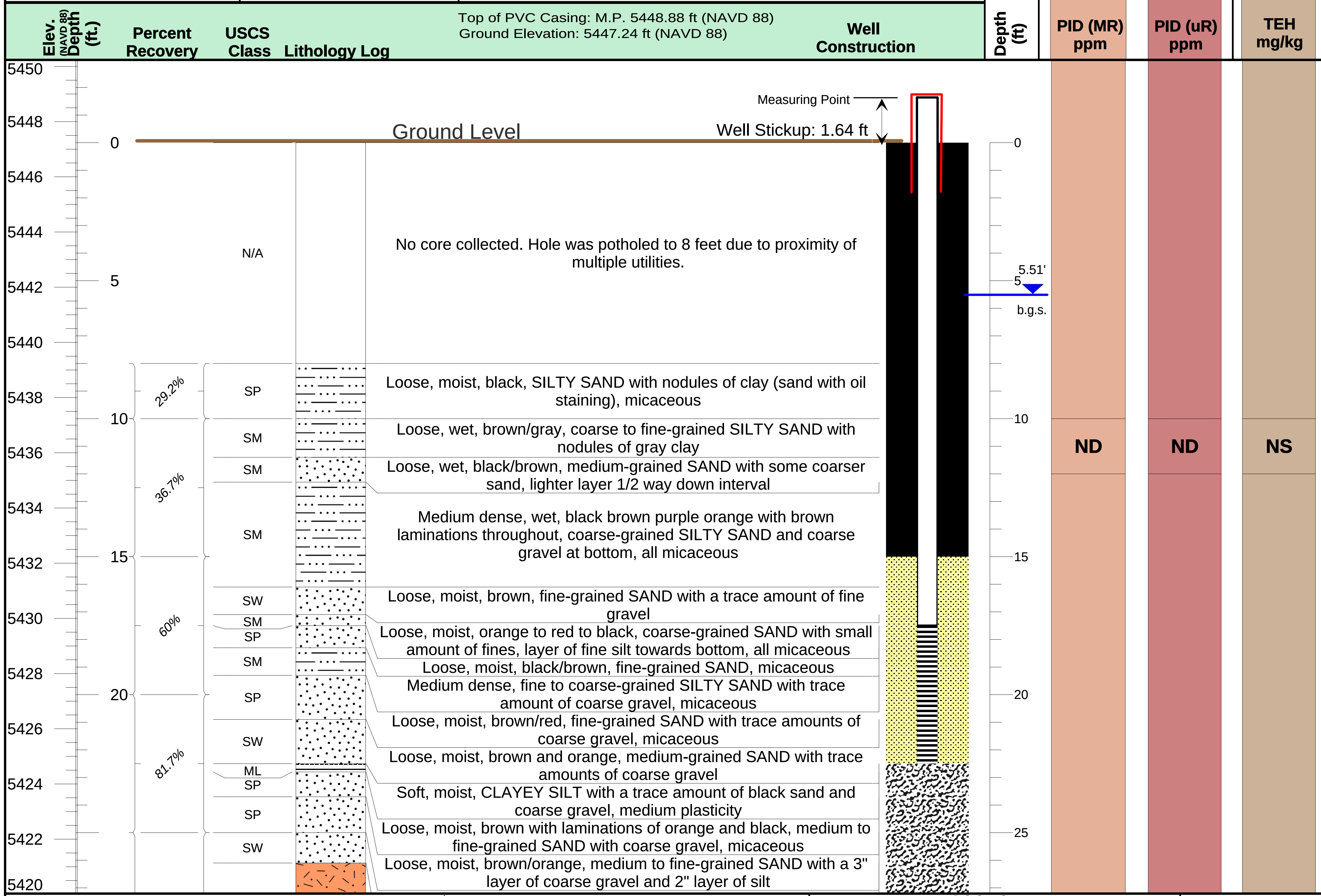
Piezometer Name: BRW18-PZ14

Project: BRW Phase I Site Investigation
Location: Butte, MT
Well Owner: Atlantic Richfield Co.
Depth to Water (bgs): 5.51 ft
Water Level from MP: 7.15 ft
Date:11/29/2018
Time:12:15
Logged By: K. Jackson, J. Flammang
Date Drilled: 10/8/2018
Casing Type/Dia: PVC/1.5"
Borehole Diameter: 6"
Drilling Company: O'Keefe Drilling
Drilling Method: Sonic
Screen Type/Length: PVC/5'

Top of PVC Casing: M.P. 5448.88 ft (NAVD 88)
Ground Elevation: 5447.24 ft (NAVD 88)

Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
ND	ND	NS



No core collected. Hole was potholed to 8 feet due to proximity of multiple utilities.

Loose, moist, black, SILTY SAND with nodules of clay (sand with oil staining), micaceous

Loose, wet, brown/gray, coarse to fine-grained SILTY SAND with nodules of gray clay

Loose, wet, black/brown, medium-grained SAND with some coarser sand, lighter layer 1/2 way down interval

Medium dense, wet, black brown purple orange with brown laminations throughout, coarse-grained SILTY SAND and coarse gravel at bottom, all micaceous

Loose, moist, brown, fine-grained SAND with a trace amount of fine gravel

Loose, moist, orange to red to black, coarse-grained SAND with small amount of fines, layer of fine silt towards bottom, all micaceous

Loose, moist, black/brown, fine-grained SAND, micaceous

Medium dense, fine to coarse-grained SILTY SAND with trace amount of coarse gravel, micaceous

Loose, moist, brown/red, fine-grained SAND with trace amounts of coarse gravel, micaceous

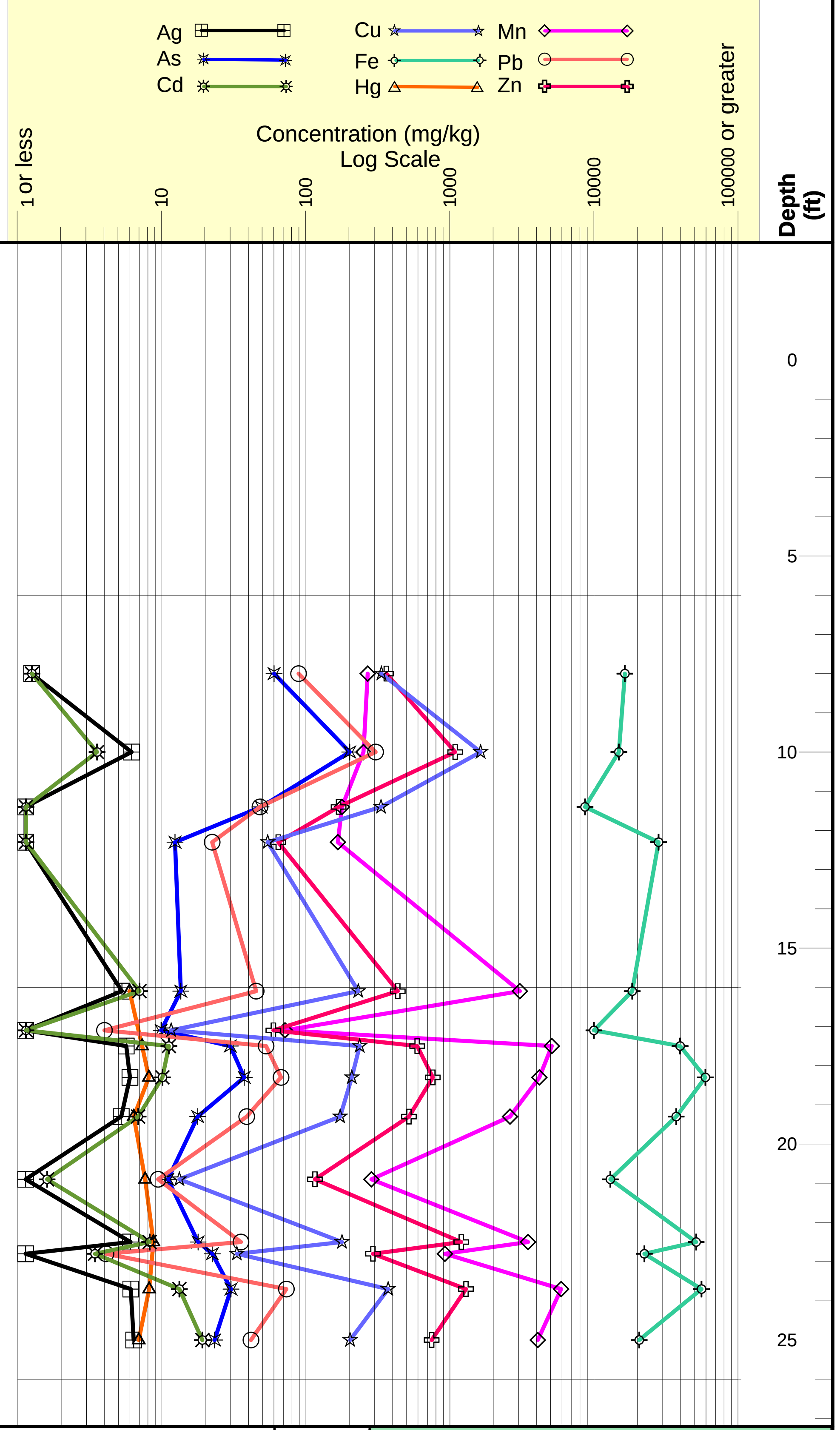
Loose, moist, brown and orange, medium-grained SAND with trace amounts of coarse gravel

Soft, moist, CLAYEY SILT with a trace amount of black sand and coarse gravel, medium plasticity

Loose, moist, brown with laminations of orange and black, medium to fine-grained SAND with coarse gravel, micaceous

Loose, moist, brown/orange, medium to fine-grained SAND with a 3" layer of coarse gravel and 2" layer of silt

XRF or ICP Data from Collected Core



Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:15-22.5 ft
Screen Interval:17.5-22.5 ft
below ground surface
(b.g.s.)
photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Well Construction

▤	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
□	PVC Casing	■	Prepack
		⊓	Steel Protective Casing

Latitude: 45.9953697786(NAD 83) Decimal Degrees
Longitude:-112.539298883 (NAD 83) Decimal Degrees
Northing:651342.37 IF
Easting:1196560.24 IF
Ground Elevation:5447.24 ft (NAVD 88)
Measuring Point Elevation:5448.88 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Piezometer Log

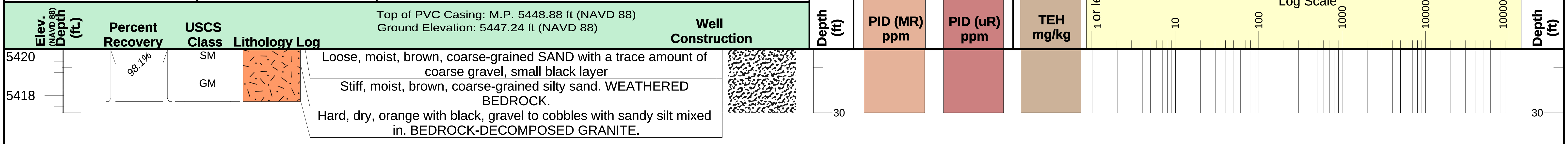
Piezometer Name: BRW18-PZ14

Project: BRW Phase I Site Investigation
Location: Butte, MT
Well Owner: Atlantic Richfield Co.
Depth to Water (bgs): 5.51 ft
Water Level from MP: 7.15 ft
Date:11/29/2018
Time:12:15
Logged By: K. Jackson, J. Flammang
Date Drilled: 10/8/2018
Casing Type/Dia: PVC/1.5"
Borehole Diameter: 6"
Drilling Company: O'Keefe Drilling
Drilling Method: Sonic
Screen Type/Length:PVC/5'

Top of PVC Casing: M.P. 5448.88 ft (NAVD 88)
Ground Elevation: 5447.24 ft (NAVD 88)

Headspace Reading

XRF or ICP Data from Collected Core



Elev. (NAVD 88)	USCS Class	Description
5420	SM	Loose, moist, brown, coarse-grained SAND with a trace amount of coarse gravel, small black layer
	GM	Stiff, moist, brown, coarse-grained silty sand. WEATHERED BEDROCK.
5418		Hard, dry, orange with black, gravel to cobbles with sandy silt mixed in. BEDROCK-DECOMPOSED GRANITE.

Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:15-22.5 ft
Screen Interval:17.5-22.5 ft
below ground surface
(b.g.s.)
photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

- Bedrock
- Clay
- Clayey Sand
- Clayey Silt
- Gravel
- Sand
- Sandy Clay
- Sandy Gravel
- Sandy Silt
- Silt
- Silty Clay
- Silty Sand

Well Construction

- Screen
- Bentonite
- PVC Casing
- 10/20 Sand Filter Pack
- Natural Completion
- Prepack
- Steel Protective Casing

Latitude: 45.9953697786(NAD 83) Decimal Degrees
Longitude:-112.539298883 (NAD 83) Decimal Degrees
Northing:651342.37 IF
Easting:1196560.24 IF
Ground Elevation:5447.24 ft (NAVD 88)
Measuring Point Elevation:5448.88 ft (NAVD 88)
T3N R8W S24

Piezometer Log

Piezometer Name: BRW18-PZ15

PIONEER TECHNICAL SERVICES, INC.

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 4.90 ft
Water Level from MP: 6.67 ft
Date:11/29/2018
Time:2:00

Logged By: K. Jackson, J. Flammang

Date Drilled: 10/5/2018

Casing Type/Dia: PVC/1.5"

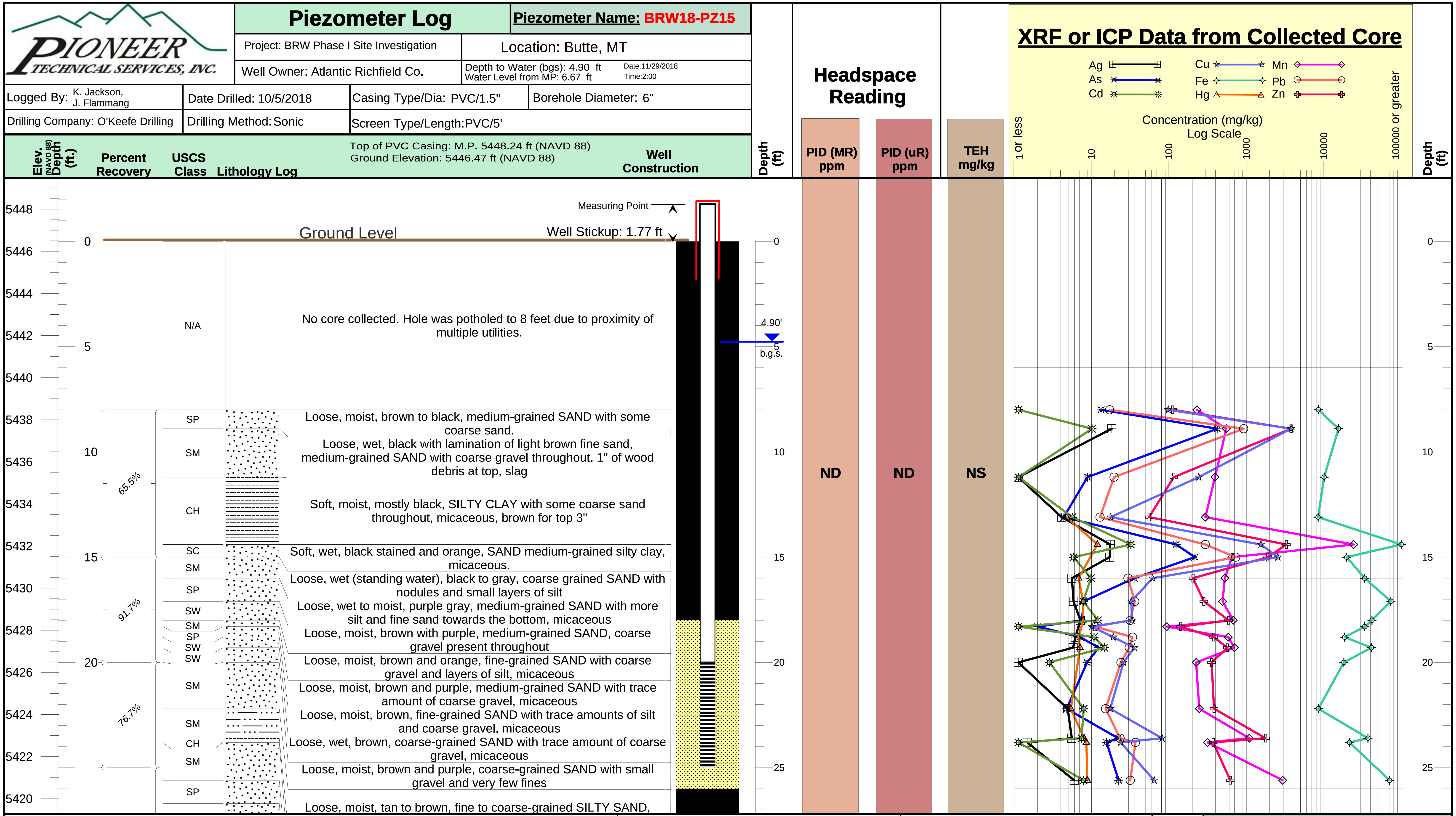
Borehole Diameter: 6"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length:PVC/5'

Top of PVC Casing: M.P. 5448.24 ft (NAVD 88)
Ground Elevation: 5446.47 ft (NAVD 88)



No core collected. Hole was potholed to 8 feet due to proximity of multiple utilities.

Loose, moist, brown to black, medium-grained SAND with some coarse sand.

Loose, wet, black with lamination of light brown fine sand, medium-grained SAND with coarse gravel throughout. 1" of wood debris at top, slag

Soft, moist, mostly black, SILTY CLAY with some coarse sand throughout, micaceous, brown for top 3"

Soft, wet, black stained and orange, SAND medium-grained silty clay, micaceous.

Loose, wet (standing water), black to gray, coarse grained SAND with nodules and small layers of silt

Loose, wet to moist, purple gray, medium-grained SAND with more silt and fine sand towards the bottom, micaceous

Loose, moist, brown with purple, medium-grained SAND, coarse gravel present throughout

Loose, moist, brown and orange, fine-grained SAND with coarse gravel and layers of silt, micaceous

Loose, moist, brown and purple, medium-grained SAND with trace amount of coarse gravel, micaceous

Loose, moist, brown, fine-grained SAND with trace amounts of silt and coarse gravel, micaceous

Loose, wet, brown, coarse-grained SAND with trace amount of coarse gravel, micaceous

Loose, moist, brown and purple, coarse-grained SAND with small gravel and very few fines

Loose, moist, tan to brown, fine to coarse-grained SILTY SAND,

Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:17-26 ft
Screen Interval:20-25 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Well Construction

▤	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
□	PVC Casing	■	Prepack
		⊓	Steel Protective Casing

Latitude: 45.9956314435(NAD 83) Decimal Degrees
Longitude:-112.539291241 (NAD 83) Decimal Degrees
Northing:651437.6 IF
Easting:1196565.88 IF
Ground Elevation:5446.47 ft (NAVD 88)
Measuring Point Elevation:5448.24 ft (NAVD 88)
T3N R8W S24

Piezometer Log

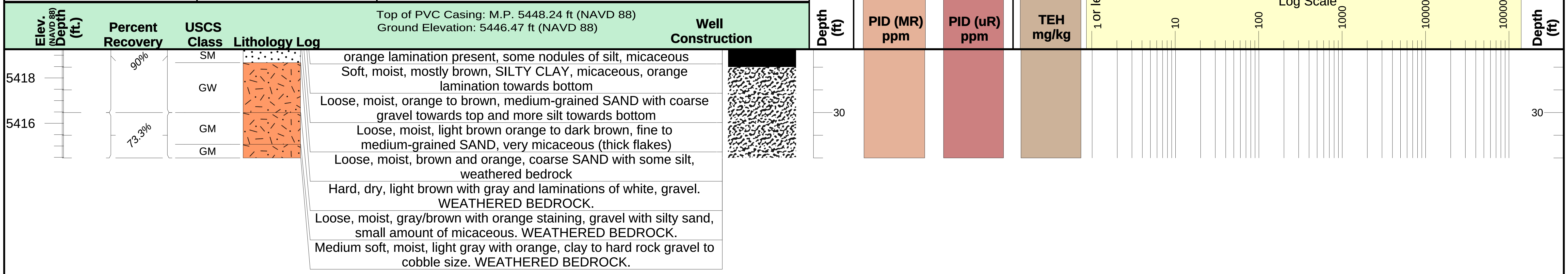
Piezometer Name: BRW18-PZ15

Project: BRW Phase I Site Investigation
Location: Butte, MT
Well Owner: Atlantic Richfield Co.
Depth to Water (bgs): 4.90 ft
Water Level from MP: 6.67 ft
Date:11/29/2018
Time:2:00
Logged By: K. Jackson, J. Flammang
Date Drilled: 10/5/2018
Casing Type/Dia: PVC/1.5"
Borehole Diameter: 6"
Drilling Company: O'Keefe Drilling
Drilling Method: Sonic
Screen Type/Length:PVC/5'

Top of PVC Casing: M.P. 5448.24 ft (NAVD 88)
Ground Elevation: 5446.47 ft (NAVD 88)

Headspace Reading

XRF or ICP Data from Collected Core



orange lamination present, some nodules of silt, micaceous

Soft, moist, mostly brown, SILTY CLAY, micaceous, orange lamination towards bottom

Loose, moist, orange to brown, medium-grained SAND with coarse gravel towards top and more silt towards bottom

Loose, moist, light brown orange to dark brown, fine to medium-grained SAND, very micaceous (thick flakes)

Loose, moist, brown and orange, coarse SAND with some silt, weathered bedrock

Hard, dry, light brown with gray and laminations of white, gravel. WEATHERED BEDROCK.

Loose, moist, gray/brown with orange staining, gravel with silty sand, small amount of micaceous. WEATHERED BEDROCK.

Medium soft, moist, light gray with orange, clay to hard rock gravel to cobble size. WEATHERED BEDROCK.

Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:17-26 ft
Screen Interval:20-25 ft
below ground surface
(b.g.s.)
photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

- 🟧 Bedrock
- ▤ Clay
- ▨ Clayey Sand
- ▤ Clayey Silt
- ▨ Gravel
- ▨ Sand
- ▨ Sandy Clay
- ▨ Sandy Gravel
- ▨ Sandy Silt
- ▤ Silt
- ▤ Silty Clay
- ▨ Silty Sand

Well Construction

- ▤ Screen
- ■ Bentonite
- □ PVC Casing
- ▨ 10/20 Sand Filter Pack
- ▨ Natural Completion
- 🟦 Prepack
- ⊓ Steel Protective Casing

Latitude: 45.9956314435(NAD 83) Decimal Degrees
Longitude:-112.539291241 (NAD 83) Decimal Degrees
Northing:651437.6 IF
Easting:1196565.88 IF
Ground Elevation:5446.47 ft (NAVD 88)
Measuring Point Elevation:5448.24 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Piezometer Log

Piezometer Name: BRW18-PZ16

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 19.19 ft
Water Level from MP: 20.91 ft
Date:11/29/2018
Time:9:20

Logged By: K. Jackson, J. Flammang

Date Drilled: 10/10/2018

Casing Type/Dia: PVC/1.5"

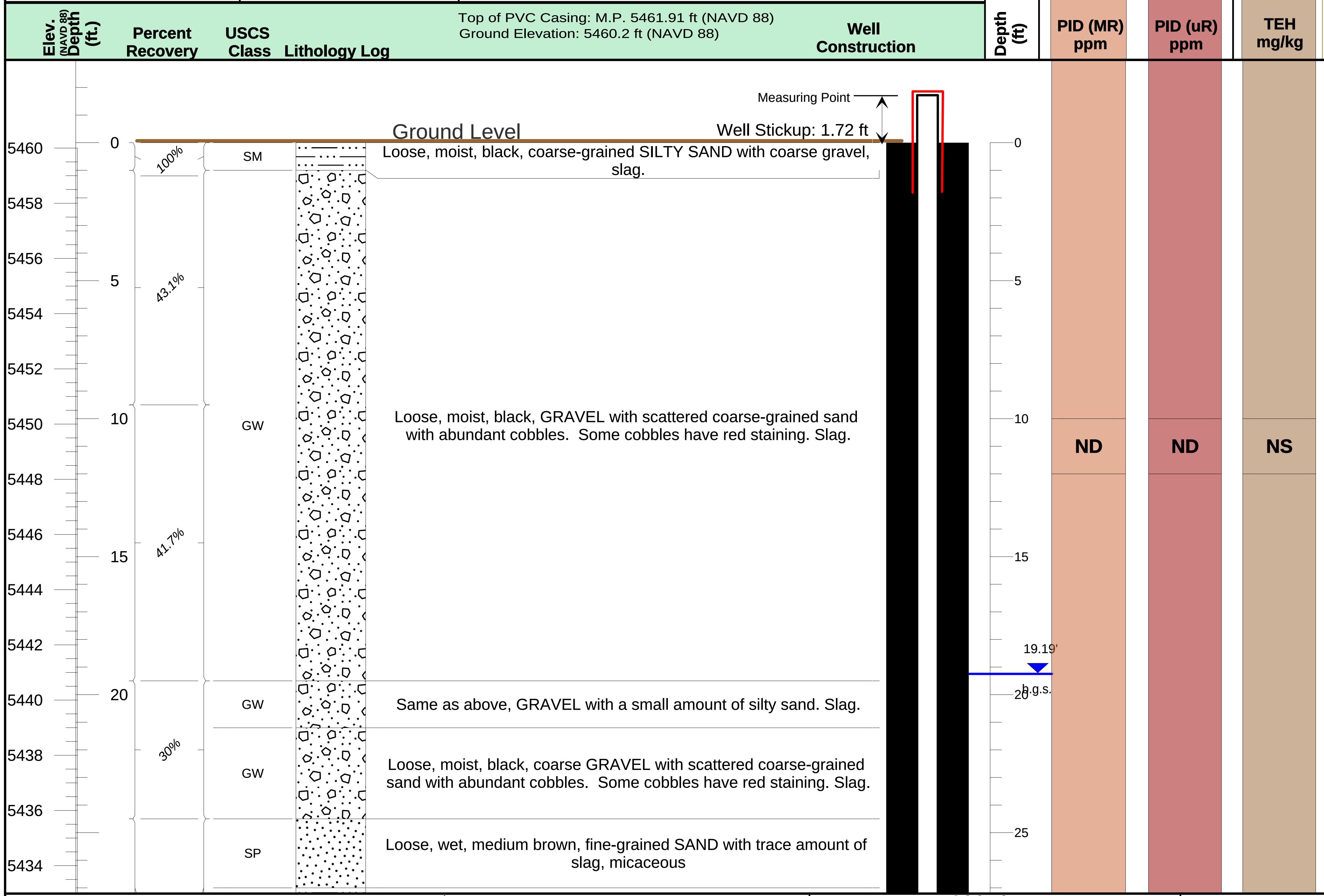
Borehole Diameter: 6"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length:PVC/5'

Top of PVC Casing: M.P. 5461.91 ft (NAVD 88)
Ground Elevation: 5460.2 ft (NAVD 88)



Loose, moist, black, coarse-grained SILTY SAND with coarse gravel, slag.

Loose, moist, black, GRAVEL with scattered coarse-grained sand with abundant cobbles. Some cobbles have red staining. Slag.

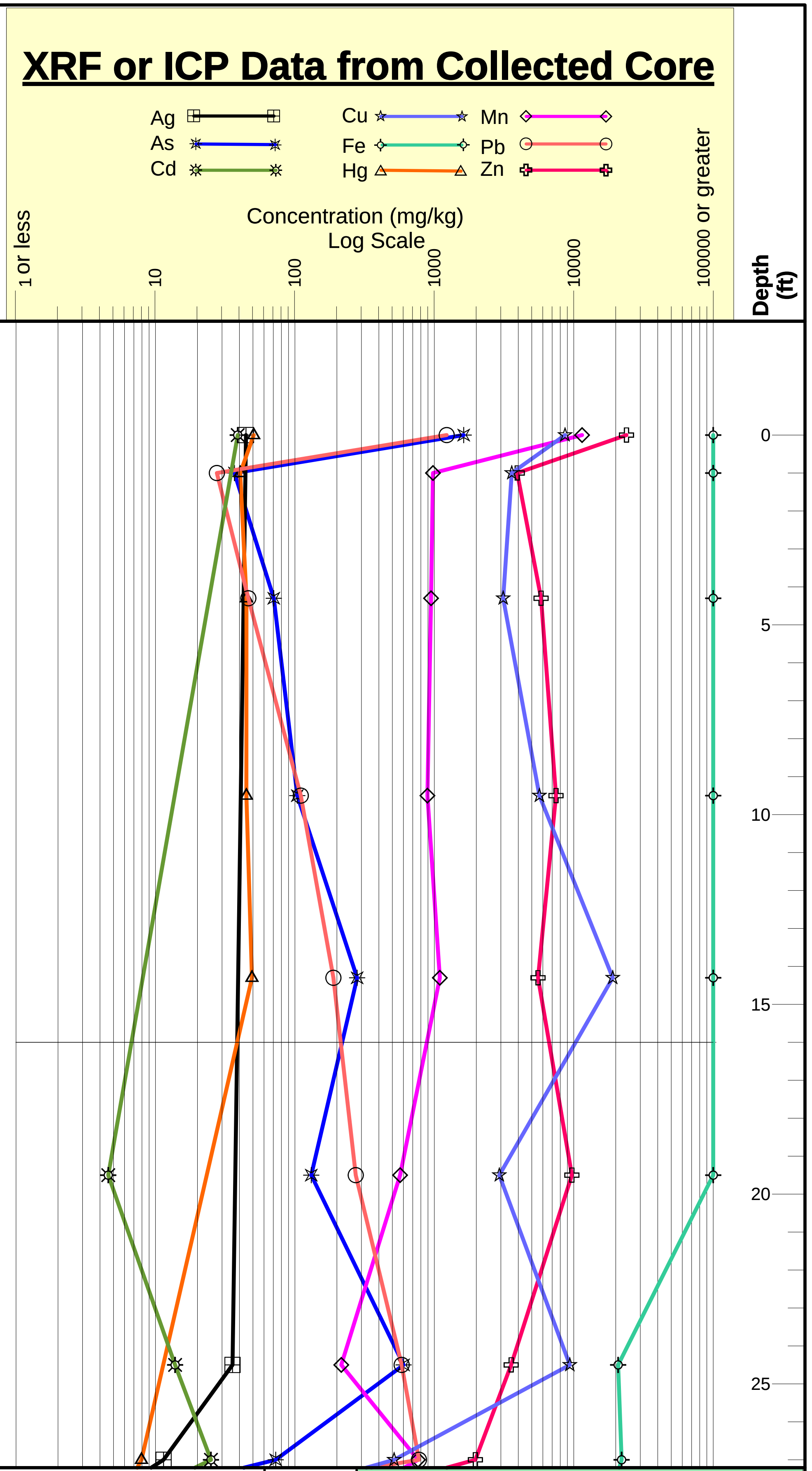
Same as above, GRAVEL with a small amount of silty sand. Slag.

Loose, moist, black, coarse GRAVEL with scattered coarse-grained sand with abundant cobbles. Some cobbles have red staining. Slag.

Loose, wet, medium brown, fine-grained SAND with trace amount of slag, micaceous

Headspace Reading

XRF or ICP Data from Collected Core



Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:32-37.5 ft
Screen Interval:32.5-37.5 ft
below ground surface
(b.g.s.)
photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Well Construction

☰	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
☐	PVC Casing	■	Prepack
		⊓	Steel Protective Casing

Latitude: 45.9959122745(NAD 83) Decimal Degrees
Longitude:-112.540037826 (NAD 83) Decimal Degrees
Northing:651547.25 IF
Easting:1196380.33 IF
Ground Elevation:5460.2 ft (NAVD 88)
Measuring Point Elevation:5461.91 ft (NAVD 88)
T3N R8W S24

Piezometer Log

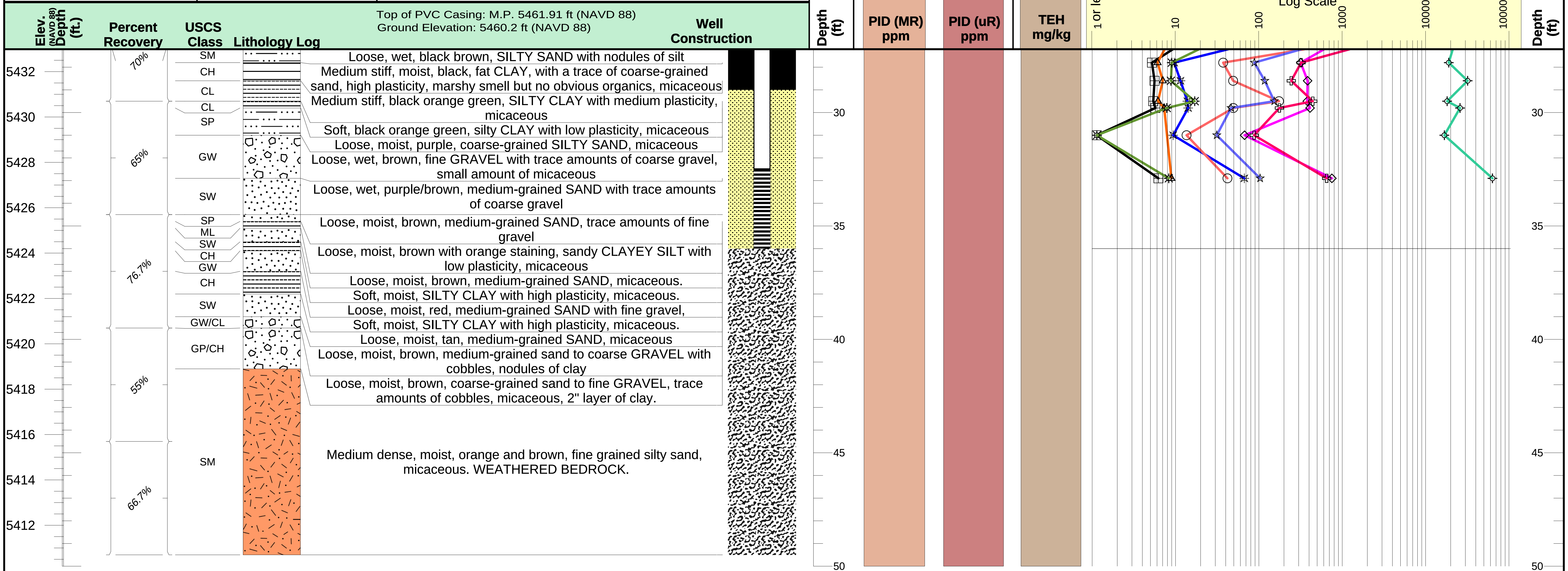
Piezometer Name: BRW18-PZ16

PIONEER TECHNICAL SERVICES, INC.

Project: BRW Phase I Site Investigation	Location: Butte, MT
Well Owner: Atlantic Richfield Co.	Depth to Water (bgs): 19.19 ft Water Level from MP: 20.91 ft Date:11/29/2018 Time:9:20

Logged By: K. Jackson, J. Flammang	Date Drilled: 10/10/2018	Casing Type/Dia: PVC/1.5"	Borehole Diameter: 6"
Drilling Company: O'Keefe Drilling	Drilling Method: Sonic	Screen Type/Length:PVC/5'	

Top of PVC Casing: M.P. 5461.91 ft (NAVD 88)
Ground Elevation: 5460.2 ft (NAVD 88)



Loose, wet, black brown, SILTY SAND with nodules of silt

Medium stiff, moist, black, fat CLAY, with a trace of coarse-grained sand, high plasticity, marshy smell but no obvious organics, micaceous

Medium stiff, black orange green, SILTY CLAY with medium plasticity, micaceous

Soft, black orange green, silty CLAY with low plasticity, micaceous

Loose, moist, purple, coarse-grained SILTY SAND, micaceous

Loose, wet, brown, fine GRAVEL with trace amounts of coarse gravel, small amount of micaceous

Loose, wet, purple/brown, medium-grained SAND with trace amounts of coarse gravel

Loose, moist, brown, medium-grained SAND, trace amounts of fine gravel

Loose, moist, brown with orange staining, sandy CLAYEY SILT with low plasticity, micaceous

Loose, moist, brown, medium-grained SAND, micaceous.

Soft, moist, SILTY CLAY with high plasticity, micaceous.

Loose, moist, red, medium-grained SAND with fine gravel,

Soft, moist, SILTY CLAY with high plasticity, micaceous.

Loose, moist, tan, medium-grained SAND, micaceous

Loose, moist, brown, medium-grained sand to coarse GRAVEL with cobbles, nodules of clay

Loose, moist, brown, coarse-grained sand to fine GRAVEL, trace amounts of cobbles, micaceous, 2" layer of clay.

Medium dense, moist, orange and brown, fine grained silty sand, micaceous. WEATHERED BEDROCK.

Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:32-37.5 ft
Screen Interval:32.5-37.5 ft
below ground surface
(b.g.s.)
photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

- ▨ Bedrock
- ☰ Clay
- ▨ Clayey Sand
- ☰ Clayey Silt
- ▨ Gravel
- ▨ Sand
- ▨ Sandy Clay
- ▨ Sandy Gravel
- ▨ Sandy Silt
- ☰ Silt
- ☰ Silty Clay
- ▨ Silty Sand

Well Construction

- ☰ Screen
- ■ Bentonite
- ☐ PVC Casing
- ▨ 10/20 Sand Filter Pack
- ▨ Natural Completion
- 🟦 Prepack
- ⊓ Steel Protective Casing

Latitude: 45.9959122745(NAD 83) Decimal Degrees
Longitude:-112.540037826 (NAD 83) Decimal Degrees
Northing:651547.25 IF
Easting:1196380.33 IF
Ground Elevation:5460.2 ft (NAVD 88)
Measuring Point Elevation:5461.91 ft (NAVD 88)
T3N R8W S24

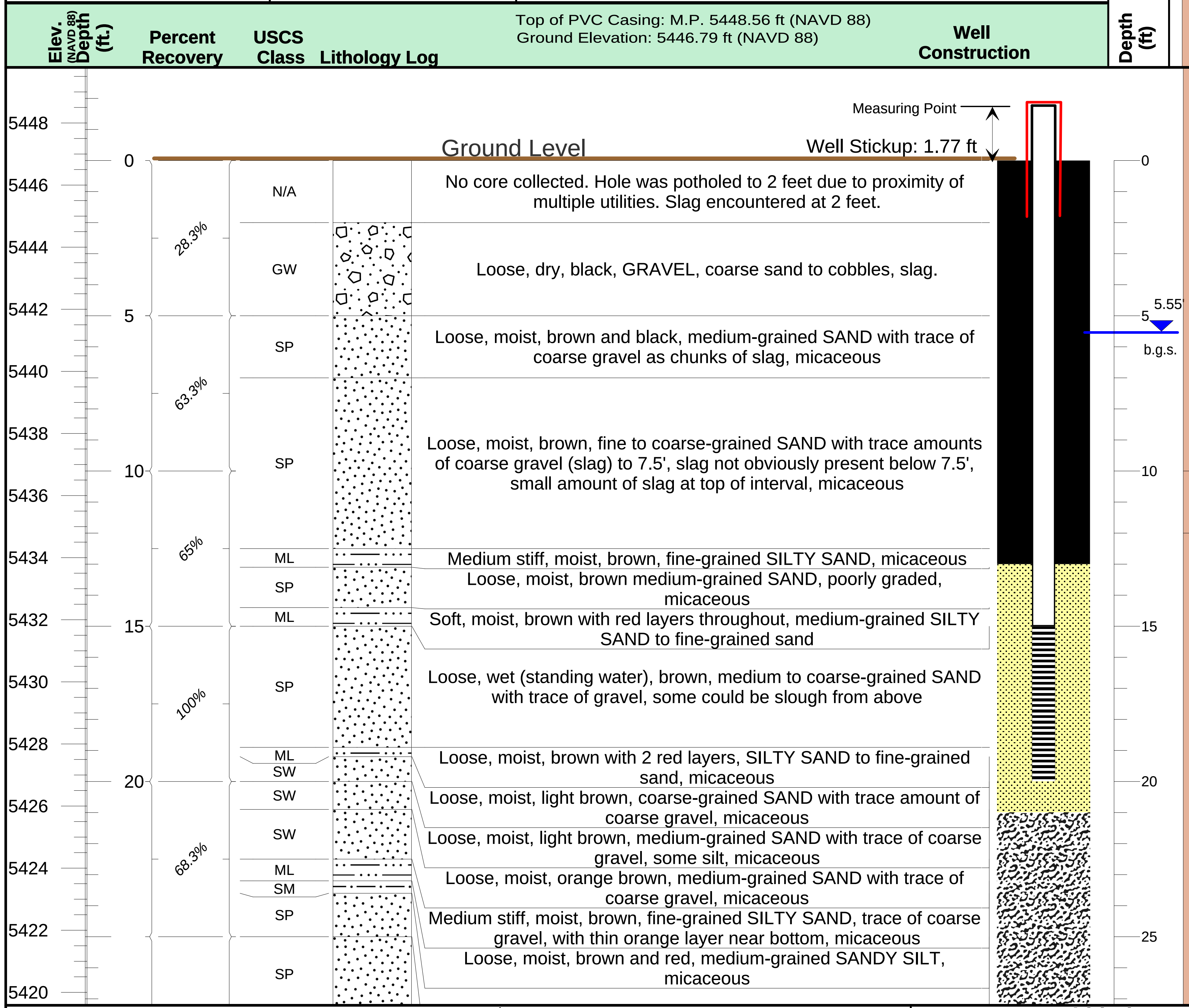
Piezometer Log

Piezometer Name: BRW18-PZ17

Project: BRW Phase I Site Investigation	Location: Butte, MT
Well Owner: Atlantic Richfield Co.	Depth to Water (bgs): 5.55 ft Water Level from MP: 7.32 ft Date:11/29/2018 Time:10:45

Logged By: K. Jackson, J. Flammang	Date Drilled: 10/15/2018	Casing Type/Dia: PVC/1.5"	Borehole Diameter: 6"
Drilling Company: O'Keefe Drilling	Drilling Method: Sonic	Screen Type/Length:PVC/5'	

Top of PVC Casing: M.P. 5448.56 ft (NAVD 88)
Ground Elevation: 5446.79 ft (NAVD 88)



No core collected. Hole was potholed to 2 feet due to proximity of multiple utilities. Slag encountered at 2 feet.

Loose, dry, black, GRAVEL, coarse sand to cobbles, slag.

Loose, moist, brown and black, medium-grained SAND with trace of coarse gravel as chunks of slag, micaceous

Loose, moist, brown, fine to coarse-grained SAND with trace amounts of coarse gravel (slag) to 7.5', slag not obviously present below 7.5', small amount of slag at top of interval, micaceous

Medium stiff, moist, brown, fine-grained SILTY SAND, micaceous

Loose, moist, brown medium-grained SAND, poorly graded, micaceous

Soft, moist, brown with red layers throughout, medium-grained SILTY SAND to fine-grained sand

Loose, wet (standing water), brown, medium to coarse-grained SAND with trace of gravel, some could be slough from above

Loose, moist, brown with 2 red layers, SILTY SAND to fine-grained sand, micaceous

Loose, moist, light brown, coarse-grained SAND with trace amount of coarse gravel, micaceous

Loose, moist, light brown, medium-grained SAND with trace of coarse gravel, some silt, micaceous

Loose, moist, orange brown, medium-grained SAND with trace of coarse gravel, micaceous

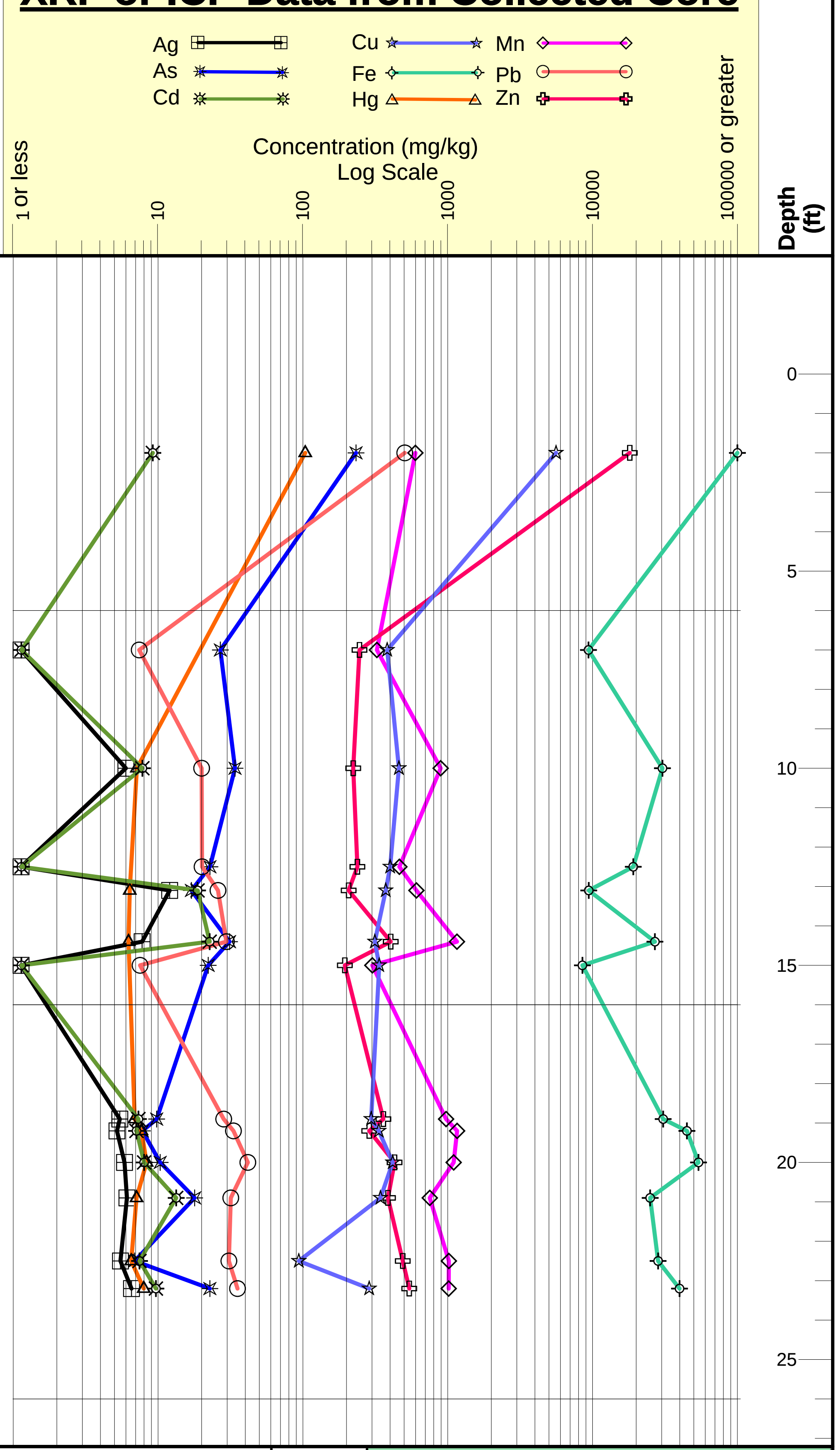
Medium stiff, moist, brown, fine-grained SILTY SAND, trace of coarse gravel, with thin orange layer near bottom, micaceous

Loose, moist, brown and red, medium-grained SANDY SILT, micaceous

Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
ND	ND	NS

XRF or ICP Data from Collected Core



Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:13-21 ft
Screen Interval:15-20 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Well Construction

▤	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
□	PVC Casing	🟦	Prepack
		⊓	Steel Protective Casing

Latitude: 45.9955416699(NAD 83) Decimal Degrees
Longitude:-112.540368955 (NAD 83) Decimal Degrees
Northing:651415.53 IF
Easting:1196291.03 IF
Ground Elevation:5446.79 ft (NAVD 88)
Measuring Point Elevation:5448.56 ft (NAVD 88)
T3N R8W S24

Piezometer Log

Piezometer Name: BRW18-PZ17

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 5.55 ft
Water Level from MP: 7.32 ft
Date:11/29/2018
Time:10:45

Logged By: K. Jackson, J. Flammang

Date Drilled: 10/15/2018

Casing Type/Dia: PVC/1.5"

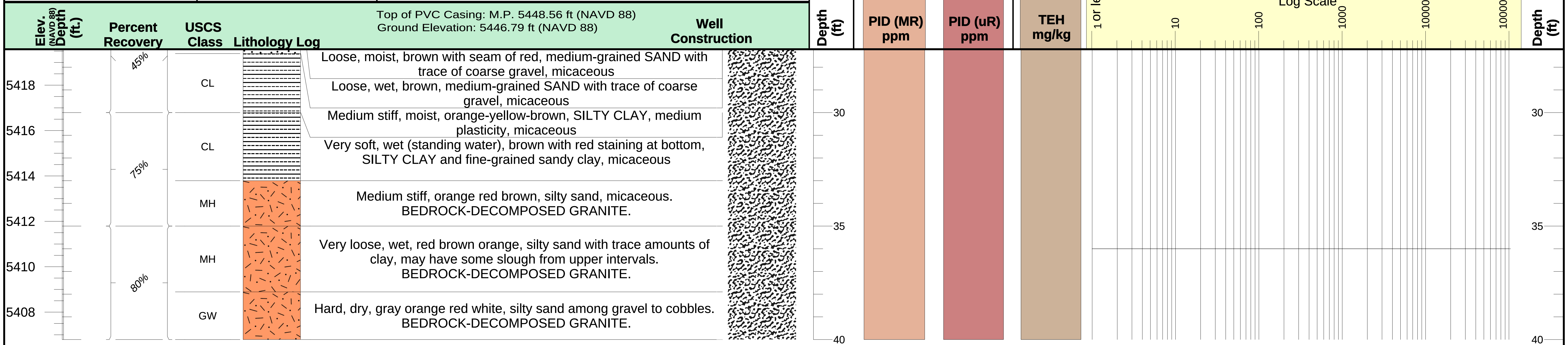
Borehole Diameter: 6"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length:PVC/5'

Top of PVC Casing: M.P. 5448.56 ft (NAVD 88)
Ground Elevation: 5446.79 ft (NAVD 88)



Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:13-21 ft
Screen Interval:15-20 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

🟧	Bedrock	▭	Sandy Clay
☰	Clay	▭	Sandy Gravel
▭	Clayey Sand	▭	Sandy Silt
☰	Clayey Silt	▭	Silt
▭	Gravel	☰	Silty Clay
▭	Sand	▭	Silty Sand

Well Construction

☰	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
□	PVC Casing	🟦	Prepack
		⊓	Steel Protective Casing

Latitude: 45.9955416699(NAD 83) Decimal Degrees
Longitude:-112.540368955 (NAD 83) Decimal Degrees
Northing:651415.53 IF
Easting:1196291.03 IF
Ground Elevation:5446.79 ft (NAVD 88)
Measuring Point Elevation:5448.56 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Piezometer Log

Piezometer Name: BRW18-PZ18

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 7.76 ft
Water Level from MP: 9.44 ft
Date:11/27/2018
Time:3:00

Logged By: K. Jackson, J. Flammang

Date Drilled: 10/2/2018

Casing Type/Dia: PVC/1.5"

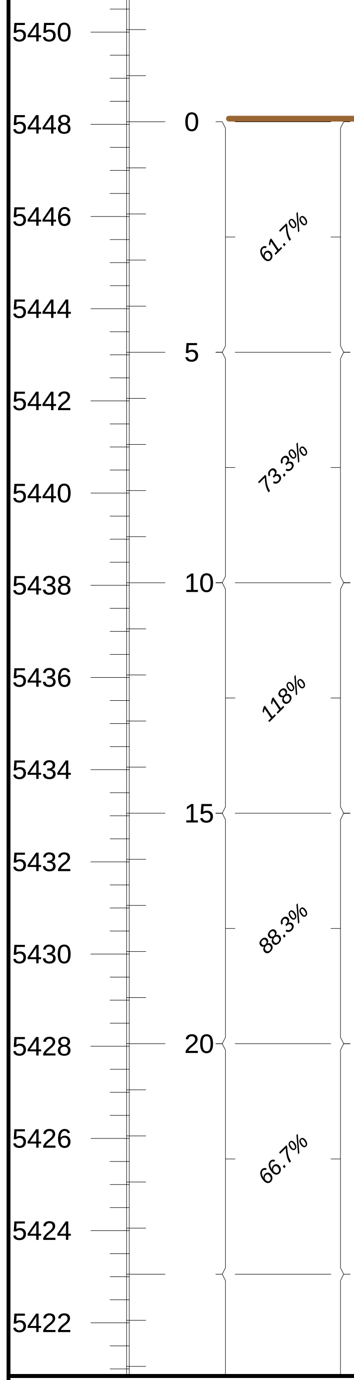
Borehole Diameter: 6"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length:PVC/5'

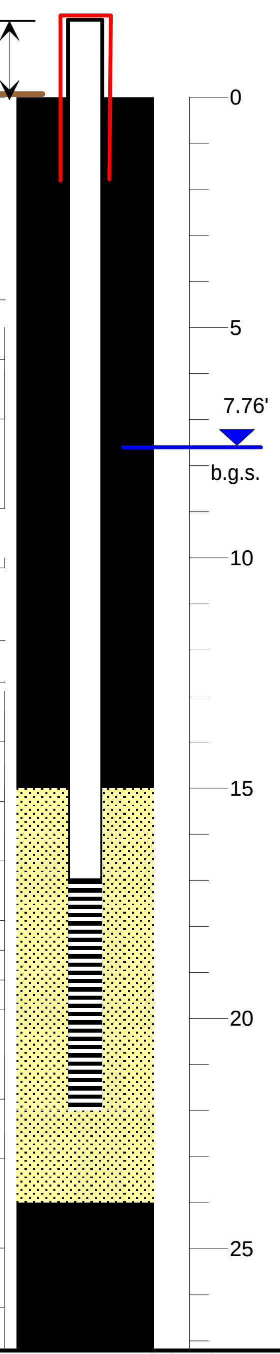
Top of PVC Casing: M.P. 5449.74 ft (NAVD 88)
Ground Elevation: 5448.06 ft (NAVD 88)



Ground Level

USCS Class	Lithology Log
SM	Loose, dry, dark brown to black, SANDY SILT with coarse gravel, construction debris with layers of soil (asphalt, brick, concrete, wood).
SM	Loose, dry, brown, SANDY SILT with coarse gravel to fine SAND with nodules of silty clay, micaceous
ML	Loose, moist, black brown tan, SILTY SAND with nodules of clay, low to medium plasticity, pronounced hydrocarbon odor
ML	Loose, moist, dark brown, medium-grained SANDY SILT with trace amounts of coarse gravel, micaceous, low plasticity, pronounced hydrocarbon odor
SP	Loose, moist, brown red orange, medium-grained SAND, poorly graded, micaceous
SM	Loose, wet (standing water), brown, SILTY SAND with trace amounts of coarse gravel and clayey nodules, micaceous, hydrocarbon odor
SM	Loose, moist, black to brown, SILTY SAND, low plasticity, micaceous
SW	Loose, moist, orange to red, fine-grained SAND with some silt, trace amounts of coarse sand, well graded, micaceous
ML	Medium stiff, moist, brown with laminations of red near top, fine-grained SAND to silty sand, low plasticity, micaceous
SP	Loose, moist, brown, fine to coarse-grained SAND with small amount of silt, micaceous
ML	Medium stiff, brown, SILTY SAND to fine-grained sand, low plasticity, micaceous
SM	Loose, moist, brown, coarse-grained SILTY SAND, micaceous
SM	Loose, wet (standing water), brown, SILTY SAND, micaceous
SM	Loose, moist, brown, medium-grained SILTY SAND, micaceous
SW	Loose, moist, brown with thin layer of red staining at top, coarse-grained SAND with trace amounts of coarse gravel, well graded, micaceous
SM	Loose, wet, brown, SILTY SAND with nodules of clayey silt throughout, poorly graded, micaceous
SP, CL	Loose, moist, orange and brown, coarse-grained SAND with nodules of black or purple sandy clay, brown appeared to get greenish tint during logging
CH	Dense, wet, brown with orange, SILTY CLAY with coarse-grained sand throughout, high plasticity, micaceous
SW	Loose, moist, brown with pockets of orange staining, coarse-grained
GW	

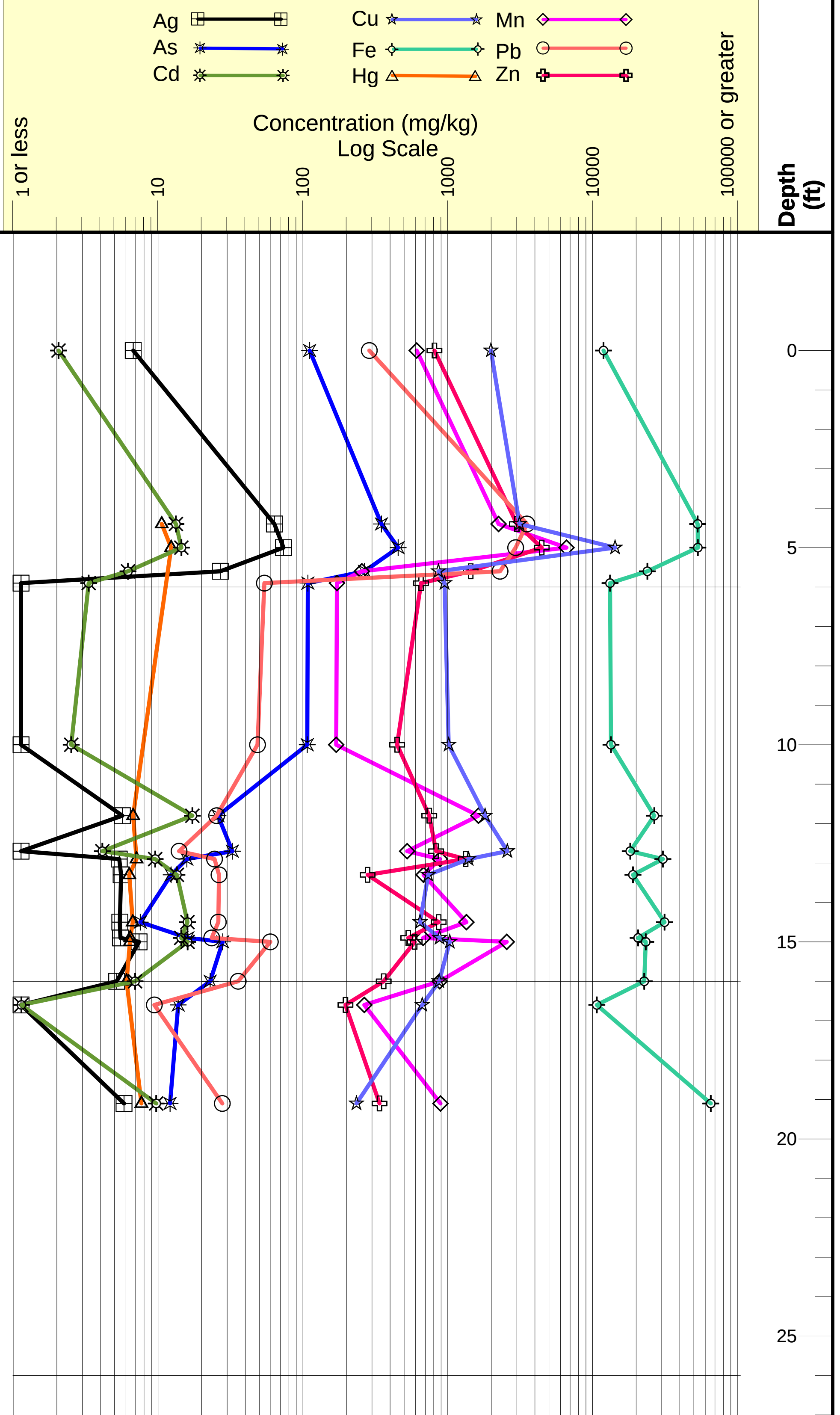
Well Construction



Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
61.2	12.65	367
560	204	2320
162.2	26.3	199
10	1.1	ND

XRF or ICP Data from Collected Core



Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:15-24 ft
Screen Interval:17-22 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

Bedrock
Clay
Clayey Sand
Clayey Silt
Gravel
Sand
Sandy Clay
Sandy Gravel
Sandy Silt
Silt
Silty Clay
Silty Sand

Well Construction

Screen
Bentonite
PVC Casing
10/20 Sand Filter Pack
Natural Completion
Prepack
Steel Protective Casing

Latitude: 45.9953856693(NAD 83) Decimal Degrees
Longitude:-112.542579446 (NAD 83) Decimal Degrees
Northing:651380.51 IF
Easting:1195727.67 IF
Ground Elevation:5448.06 ft (NAVD 88)
Measuring Point Elevation:5449.74 ft (NAVD 88)
T3N R8W S24

Piezometer Log

Piezometer Name: BRW18-PZ18

PIONEER TECHNICAL SERVICES, INC.

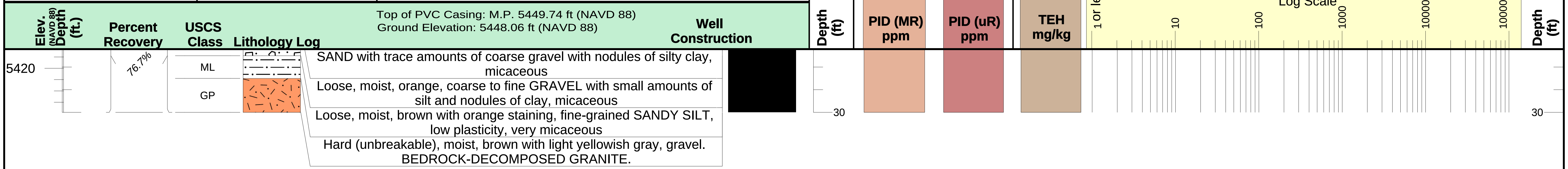
Project: BRW Phase I Site Investigation	Location: Butte, MT
Well Owner: Atlantic Richfield Co.	Depth to Water (bgs): 7.76 ft Water Level from MP: 9.44 ft Date:11/27/2018 Time:3:00

Logged By: K. Jackson, J. Flammang	Date Drilled: 10/2/2018	Casing Type/Dia: PVC/1.5"	Borehole Diameter: 6"
Drilling Company: O'Keefe Drilling	Drilling Method: Sonic	Screen Type/Length:PVC/5'	

Top of PVC Casing: M.P. 5449.74 ft (NAVD 88)
Ground Elevation: 5448.06 ft (NAVD 88)

Headspace Reading

XRF or ICP Data from Collected Core



SAND with trace amounts of coarse gravel with nodules of silty clay, micaceous

Loose, moist, orange, coarse to fine GRAVEL with small amounts of silt and nodules of clay, micaceous

Loose, moist, brown with orange staining, fine-grained SANDY SILT, low plasticity, very micaceous

Hard (unbreakable), moist, brown with light yellowish gray, gravel. BEDROCK-DECOMPOSED GRANITE.

Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:15-24 ft
Screen Interval:17-22 ft
below ground surface
(b.g.s.)
photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

🟧	Bedrock	▤	Sandy Clay
☐	Clay	▤	Sandy Gravel
▤	Clayey Sand	▤	Sandy Silt
▤	Clayey Silt	☐	Silt
▤	Gravel	▤	Silty Clay
▤	Sand	▤	Silty Sand

Well Construction

☰	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
☐	PVC Casing	🟦	Prepack
		🟥	Steel Protective Casing

Latitude: 45.9953856693(NAD 83) Decimal Degrees
Longitude:-112.542579446 (NAD 83) Decimal Degrees
Northing:651380.51 IF
Easting:1195727.67 IF
Ground Elevation:5448.06 ft (NAVD 88)
Measuring Point Elevation:5449.74 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Piezometer Log

Piezometer Name: BRW18-PZ19

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 13.20 ft
Water Level from MP: 14.89 ft
Date:11/27/2018
Time:12:10

Logged By: K. Jackson, J. Flammang

Date Drilled: 9/27/2018

Casing Type/Dia: PVC/1.5"

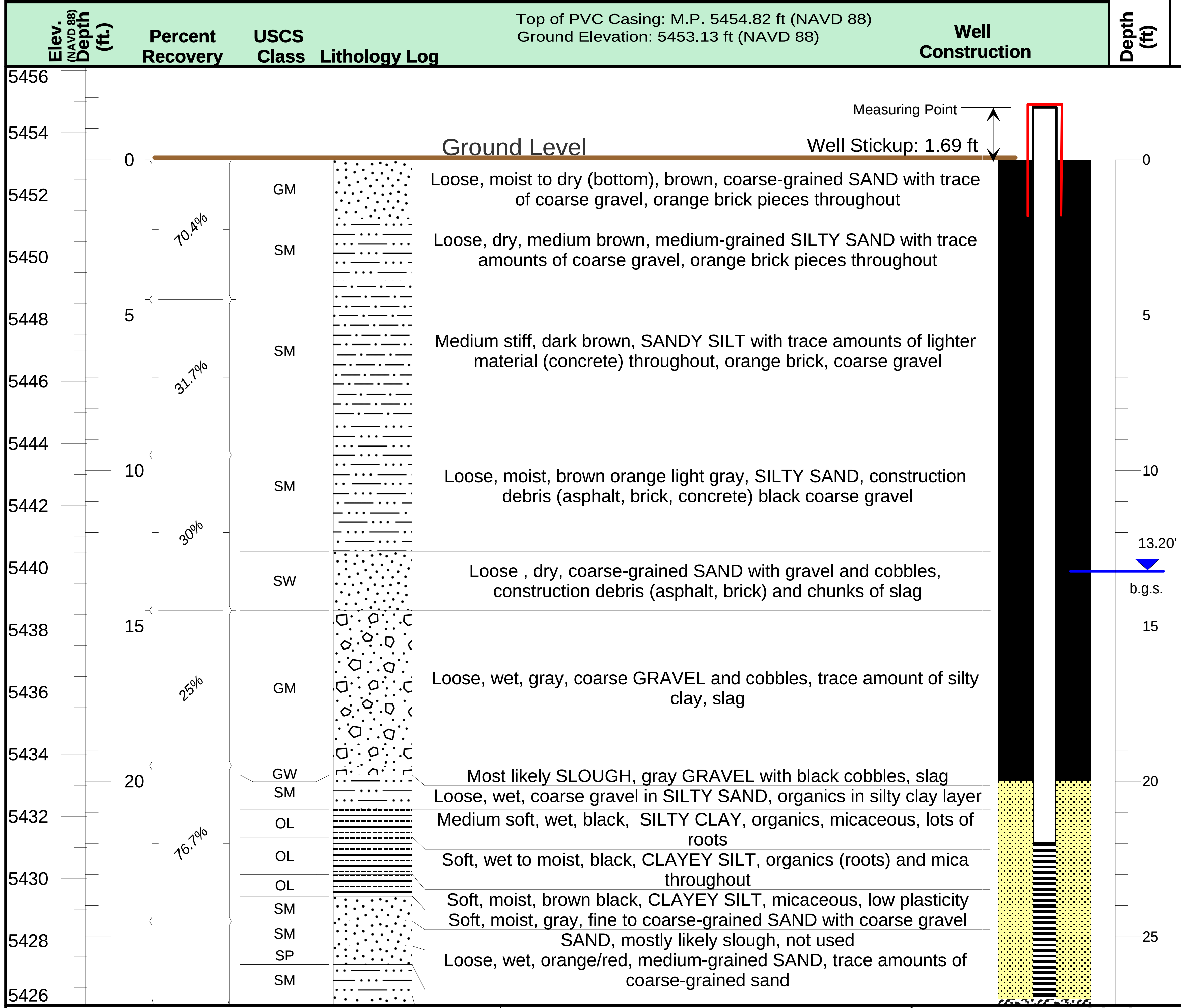
Borehole Diameter: 6"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length:PVC/5'

Top of PVC Casing: M.P. 5454.82 ft (NAVD 88)
Ground Elevation: 5453.13 ft (NAVD 88)

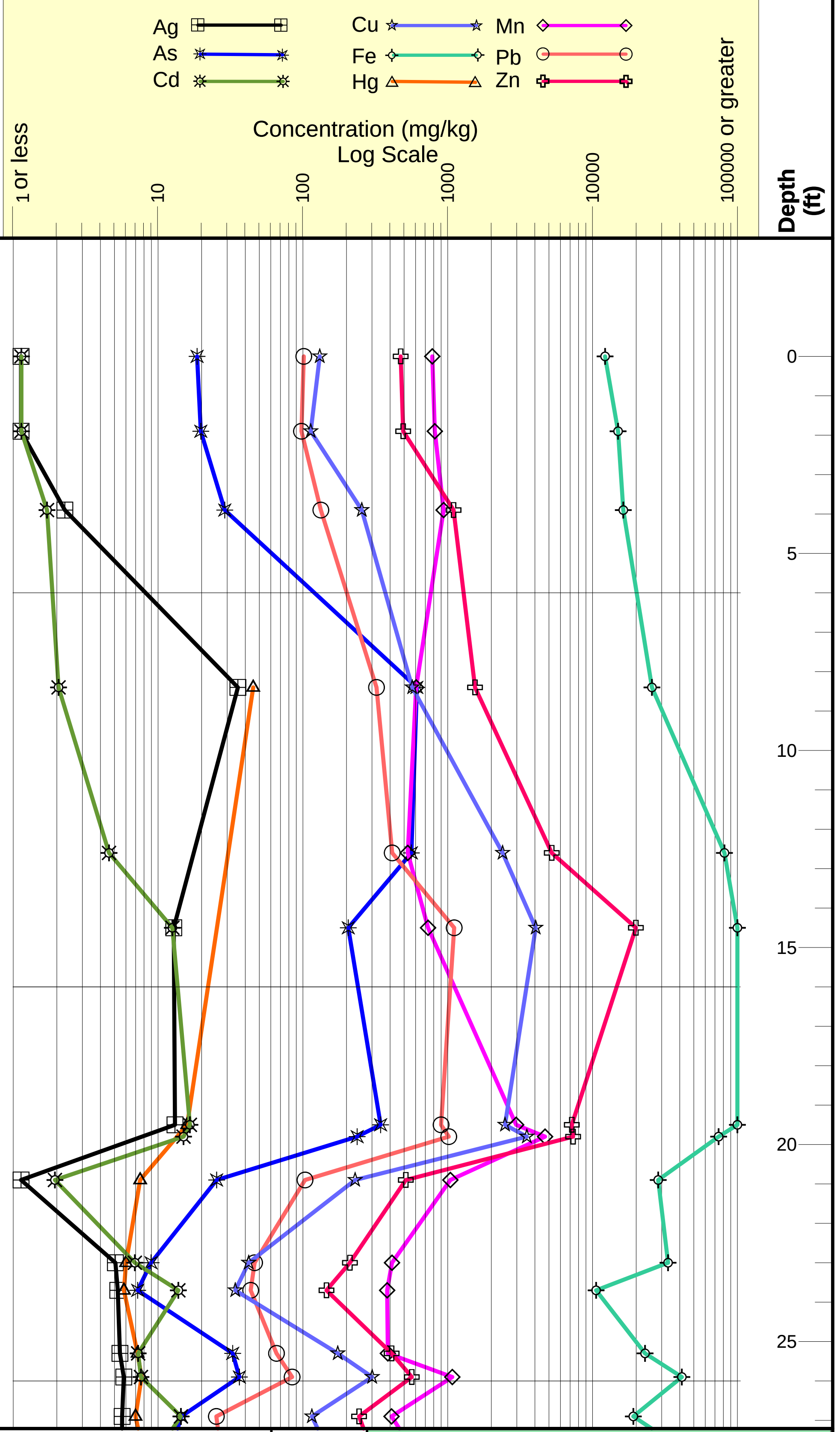


USCS Class	Lithology Log
GM	Loose, moist to dry (bottom), brown, coarse-grained SAND with trace of coarse gravel, orange brick pieces throughout
SM	Loose, dry, medium brown, medium-grained SILTY SAND with trace amounts of coarse gravel, orange brick pieces throughout
SM	Medium stiff, dark brown, SANDY SILT with trace amounts of lighter material (concrete) throughout, orange brick, coarse gravel
SM	Loose, moist, brown orange light gray, SILTY SAND, construction debris (asphalt, brick, concrete) black coarse gravel
SW	Loose , dry, coarse-grained SAND with gravel and cobbles, construction debris (asphalt, brick) and chunks of slag
GM	Loose, wet, gray, coarse GRAVEL and cobbles, trace amount of silty clay, slag
GW	Most likely SLOUGH, gray GRAVEL with black cobbles, slag
SM	Loose, wet, coarse gravel in SILTY SAND, organics in silty clay layer
OL	Medium soft, wet, black, SILTY CLAY, organics, micaceous, lots of roots
OL	Soft, wet to moist, black, CLAYEY SILT, organics (roots) and mica throughout
OL	Soft, moist, brown black, CLAYEY SILT, micaceous, low plasticity
SM	Soft, moist, gray, fine to coarse-grained SAND with coarse gravel
SM	SAND, mostly likely slough, not used
SP	Loose, wet, orange/red, medium-grained SAND, trace amounts of coarse-grained sand
SM	

Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
176.2	1.475	144
150.7	0.625	39
34.2	0.575	ND

XRF or ICP Data from Collected Core



Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:20-27 ft
Screen Interval:22-27 ft
below ground surface
(b.g.s.)
photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Well Construction

▤	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
□	PVC Casing	■	Prepack
		⊓	Steel Protective Casing

Latitude: 45.9957761255(NAD 83) Decimal Degrees
Longitude:-112.542417596 (NAD 83) Decimal Degrees
Northing:651521.13 IF
Easting:1195774.28 IF
Ground Elevation:5453.13 ft (NAVD 88)
Measuring Point Elevation:5454.82 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

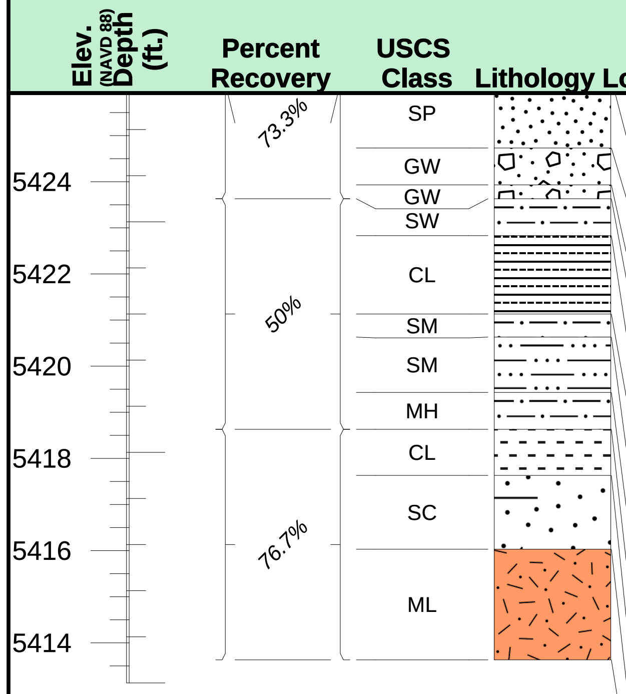
Piezometer Log

Piezometer Name: BRW18-PZ19

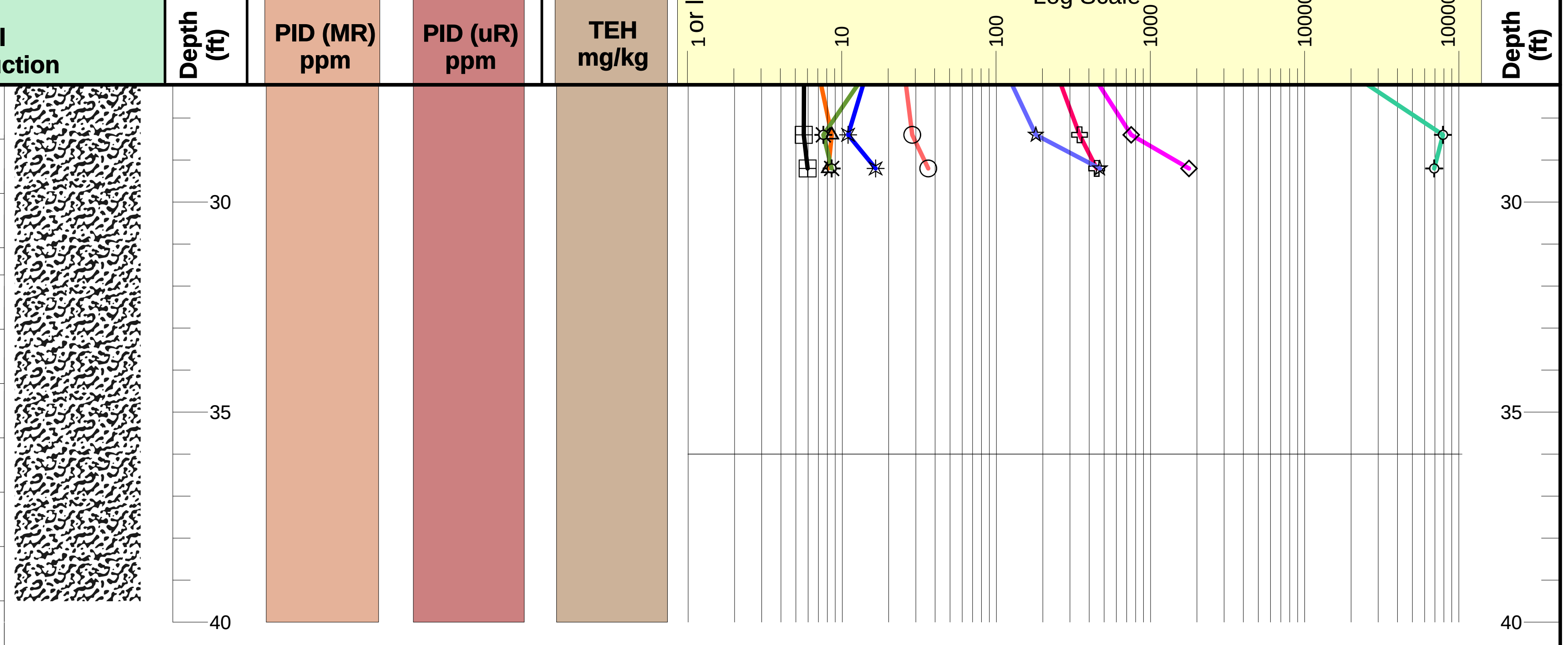
Project: BRW Phase I Site Investigation	Location: Butte, MT
Well Owner: Atlantic Richfield Co.	Depth to Water (bgs): 13.20 ft Water Level from MP: 14.89 ft Date:11/27/2018 Time:12:10

Logged By: K. Jackson, J. Flammang	Date Drilled: 9/27/2018	Casing Type/Dia: PVC/1.5"	Borehole Diameter: 6"
Drilling Company: O'Keefe Drilling	Drilling Method: Sonic	Screen Type/Length:PVC/5'	

Top of PVC Casing: M.P. 5454.82 ft (NAVD 88)
Ground Elevation: 5453.13 ft (NAVD 88)



USCS Class	Description
SP	Loose, wet, gray, SILTY SAND with coarse gravel with some lighter colored sand
GW	Loose, wet, red/orange, coarse-grained SAND with trace amounts of silt, micaceous
GW	Loose, wet, brown, coarse-grained sand to coarse GRAVEL with trace of silt
SW	Loose, wet, brown, fine GRAVEL and trace of cobbles
CL	Loose, moist, brown with pockets of red, SANDY SILT and trace amount of coarse gravel, micaceous
SM	Soft, moist, brown with red/orange staining , SILTY CLAY, low plasticity, micaceous
SM	Stiff, moist, orange brown with pockets of red staining, SANDY SILT with coarse gravel mixed in, micaceous
MH	Loose, moist, brown with orange staining, medium-grained SILTY SAND and trace amounts of fine sand, micaceous
CL	Loose, moist, red brown, SANDY SILT with pockets of red material, micaceous
SC	Loose, dry, orange brown, SANDY CLAY. Looks like weathered bedrock.
ML	Loose, moist, brown, CLAYEY SAND with nodules of clay, low plasticity, micaceous
	Loose, dry, gray brown, silty sand with some clay, medium plasticity. WEATHERED BEDROCK.



Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:20-27 ft
Screen Interval:22-27 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

🟧	Bedrock	▨	Sandy Clay
▤	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▤	Clayey Silt	▤	Silt
▨	Gravel	▤	Silty Clay
▨	Sand	▨	Silty Sand

Well Construction

▤	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
☐	PVC Casing	🟦	Prepack
		🟥	Steel Protective Casing

Latitude: 45.9957761255(NAD 83) Decimal Degrees
Longitude:-112.542417596 (NAD 83) Decimal Degrees
Northing:651521.13 IF
Easting:1195774.28 IF
Ground Elevation:5453.13 ft (NAVD 88)
Measuring Point Elevation:5454.82 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Piezometer Log

Piezometer Name: BRW18-PZ20

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 9.94 ft
Water Level from MP: 11.6 ft

Date:11/30/2018
Time:9:30

Logged By: K. Jackson, J. Flammang

Date Drilled: 10/3/2018

Casing Type/Dia: PVC/1.5"

Borehole Diameter: 6"

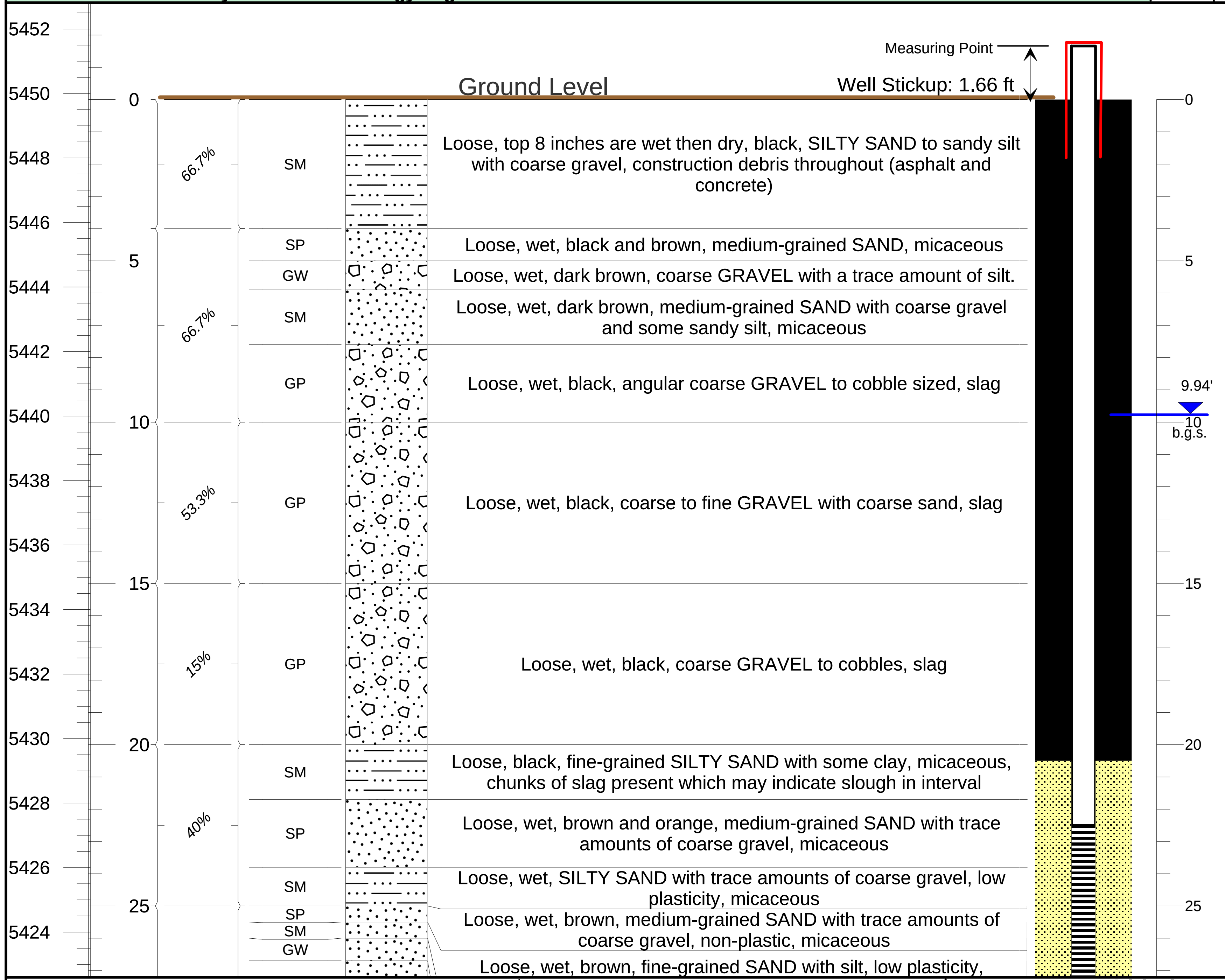
Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length:PVC/5'

Top of PVC Casing: M.P. 5451.47 ft (NAVD 88)
Ground Elevation: 5449.81 ft (NAVD 88)

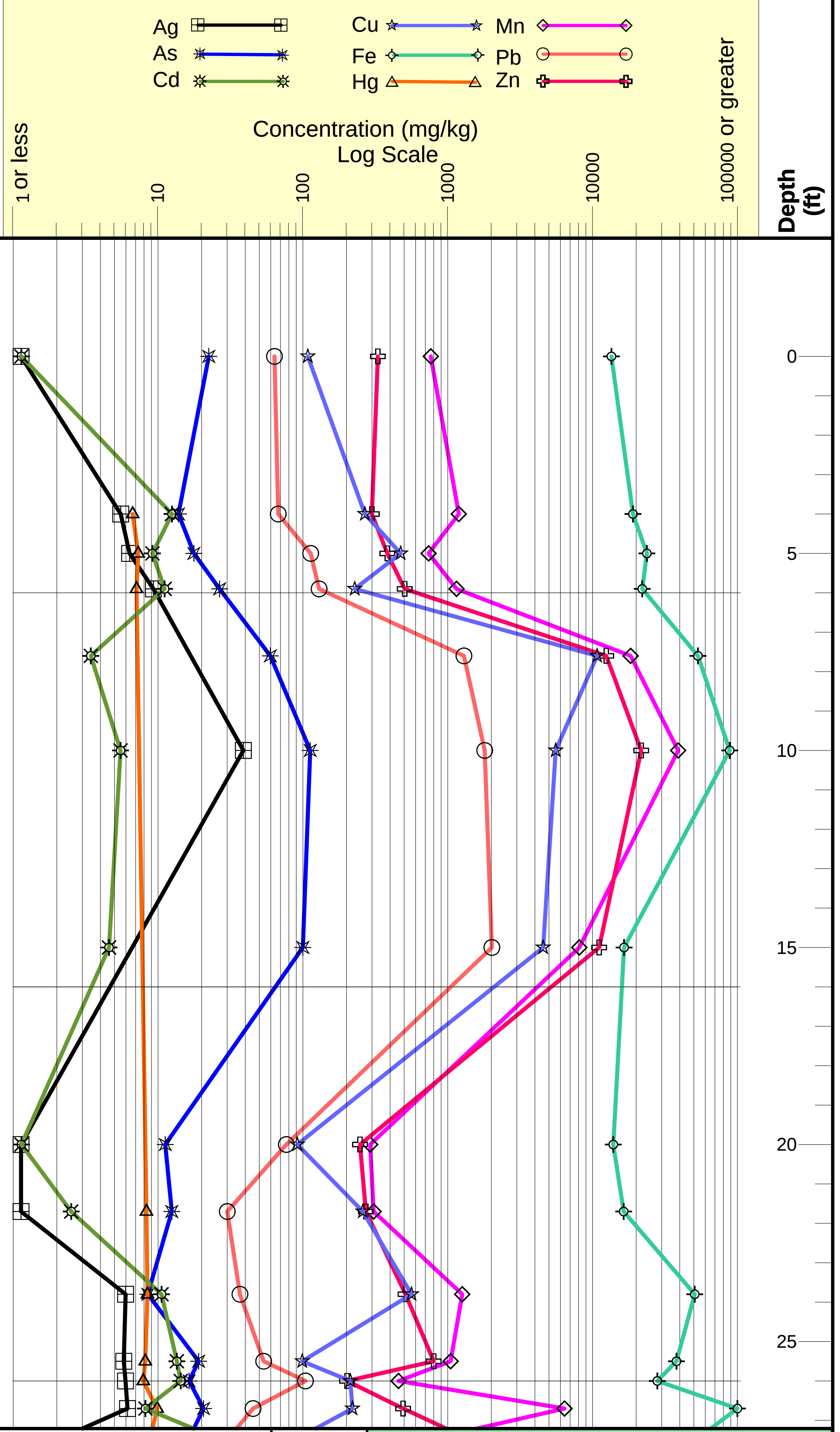
Percent Recovery	USCS Class	Lithology Log
66.7%	SM	Loose, top 8 inches are wet then dry, black, SILTY SAND to sandy silt with coarse gravel, construction debris throughout (asphalt and concrete)
	SP	Loose, wet, black and brown, medium-grained SAND, micaceous
	GW	Loose, wet, dark brown, coarse GRAVEL with a trace amount of silt.
66.7%	SM	Loose, wet, dark brown, medium-grained SAND with coarse gravel and some sandy silt, micaceous
	GP	Loose, wet, black, angular coarse GRAVEL to cobble sized, slag
53.3%	GP	Loose, wet, black, coarse to fine GRAVEL with coarse sand, slag
15%	GP	Loose, wet, black, coarse GRAVEL to cobbles, slag
40%	SM	Loose, black, fine-grained SILTY SAND with some clay, micaceous, chunks of slag present which may indicate slough in interval
	SP	Loose, wet, brown and orange, medium-grained SAND with trace amounts of coarse gravel, micaceous
	SM	Loose, wet, SILTY SAND with trace amounts of coarse gravel, low plasticity, micaceous
	SP	Loose, wet, brown, medium-grained SAND with trace amounts of coarse gravel, non-plastic, micaceous
	SM	Loose, wet, brown, fine-grained SAND with silt, low plasticity,
	GW	



Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
83.3	2	1280
17.7	5.775	ND

XRF or ICP Data from Collected Core



Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:20-27.5 ft
Screen Interval:22.5-27.5 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

🟧	Bedrock	▤	Sandy Clay
☰	Clay	▨	Sandy Gravel
▤	Clayey Sand	▤	Sandy Silt
▤	Clayey Silt	☐	Silt
▨	Gravel	☰	Silty Clay
▨	Sand	▤	Silty Sand

Well Construction

☰	Screen	🟨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
☐	PVC Casing	🟦	Prepack
		🟥	Steel Protective Casing

Latitude: 45.9952048072(NAD 83) Decimal Degrees
Longitude:-112.543272681 (NAD 83) Decimal Degrees
Northing:651321.48 IF
Easting:1195549.12 IF
Ground Elevation:5449.81 ft (NAVD 88)
Measuring Point Elevation:5451.47 ft (NAVD 88)
T3N R8W S24

Piezometer Log

Piezometer Name: BRW18-PZ20

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 9.94 ft
Water Level from MP: 11.6 ft
Date:11/30/2018
Time:9:30

Logged By: K. Jackson, J. Flammang

Date Drilled: 10/3/2018

Casing Type/Dia: PVC/1.5"

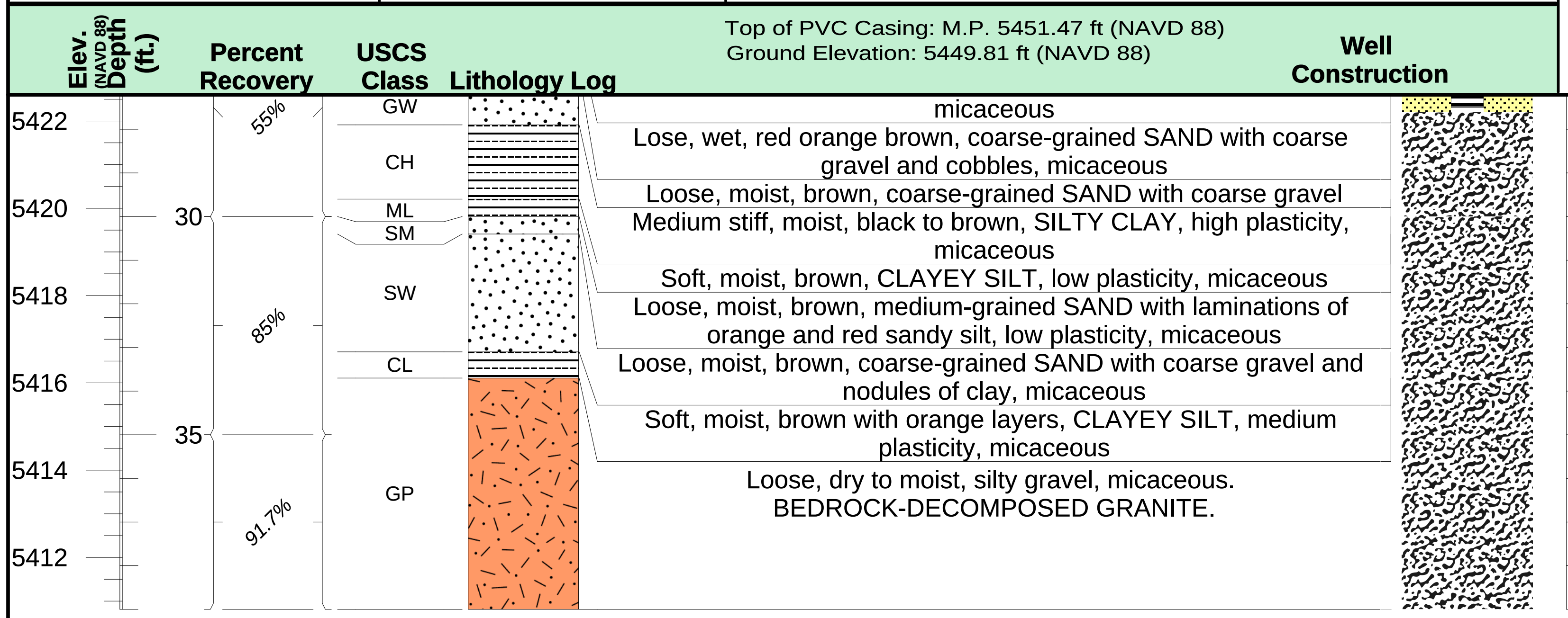
Borehole Diameter: 6"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length:PVC/5'

Top of PVC Casing: M.P. 5451.47 ft (NAVD 88)
Ground Elevation: 5449.81 ft (NAVD 88)



micaceous

Lose, wet, red orange brown, coarse-grained SAND with coarse gravel and cobbles, micaceous

Loose, moist, brown, coarse-grained SAND with coarse gravel

Medium stiff, moist, black to brown, SILTY CLAY, high plasticity, micaceous

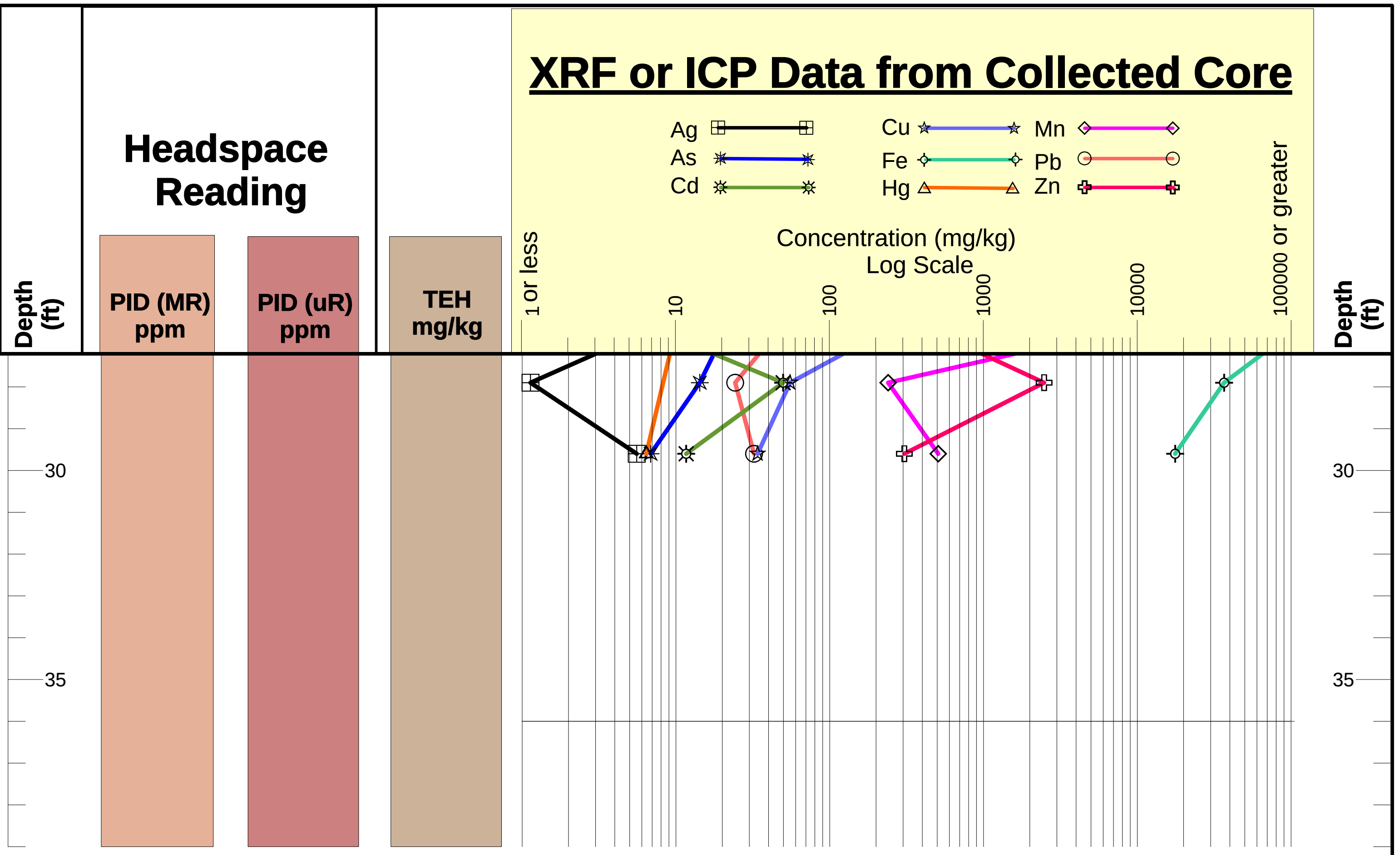
Soft, moist, brown, CLAYEY SILT, low plasticity, micaceous

Loose, moist, brown, medium-grained SAND with laminations of orange and red sandy silt, low plasticity, micaceous

Loose, moist, brown, coarse-grained SAND with coarse gravel and nodules of clay, micaceous

Soft, moist, brown with orange layers, CLAYEY SILT, medium plasticity, micaceous

Loose, dry to moist, silty gravel, micaceous.
BEDROCK-DECOMPOSED GRANITE.



Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:20-27.5 ft
Screen Interval:22.5-27.5 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Well Construction

▤	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
□	PVC Casing	■	Prepack
		⊓	Steel Protective Casing

Latitude: 45.9952048072(NAD 83) Decimal Degrees
Longitude:-112.543272681 (NAD 83) Decimal Degrees
Northing:651321.48 IF
Easting:1195549.12 IF
Ground Elevation:5449.81 ft (NAVD 88)
Measuring Point Elevation:5451.47 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Piezometer Log

Piezometer Name: BRW18-PZ21

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 13.57 ft
Water Level from MP: 15.18 ft
Date:11/26/2018
Time:1:30

Logged By: K. Jackson, J. Flammang

Date Drilled: 10/4/2018

Casing Type/Dia: PVC/1.5"

Borehole Diameter: 6"

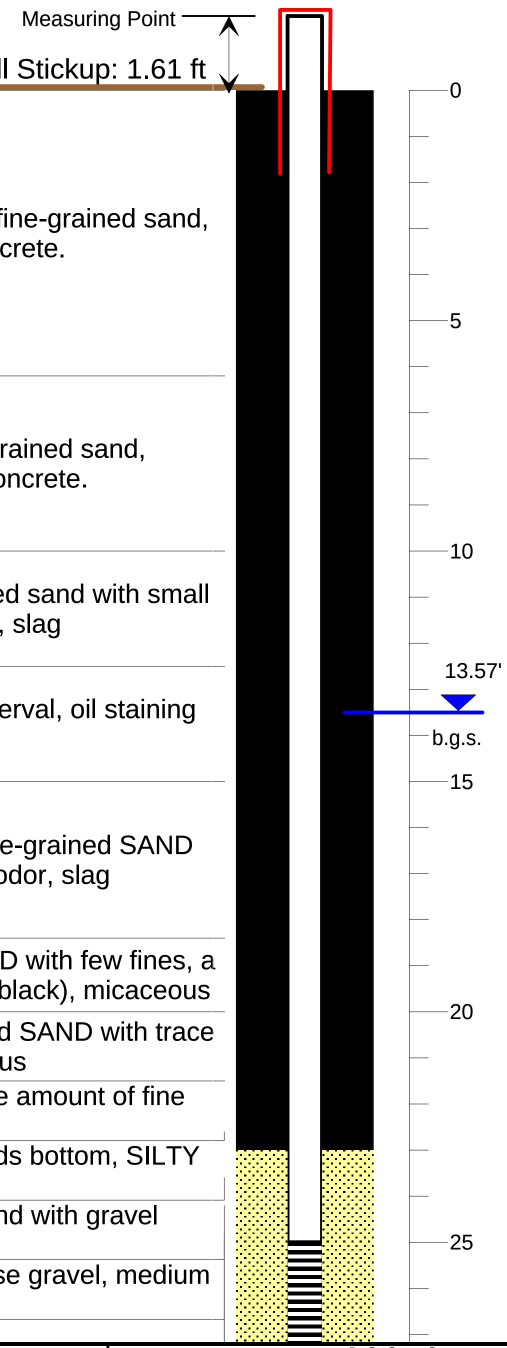
Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length:PVC/5'

Top of PVC Casing: M.P. 5455.08 ft (NAVD 88)
Ground Elevation: 5453.47 ft (NAVD 88)

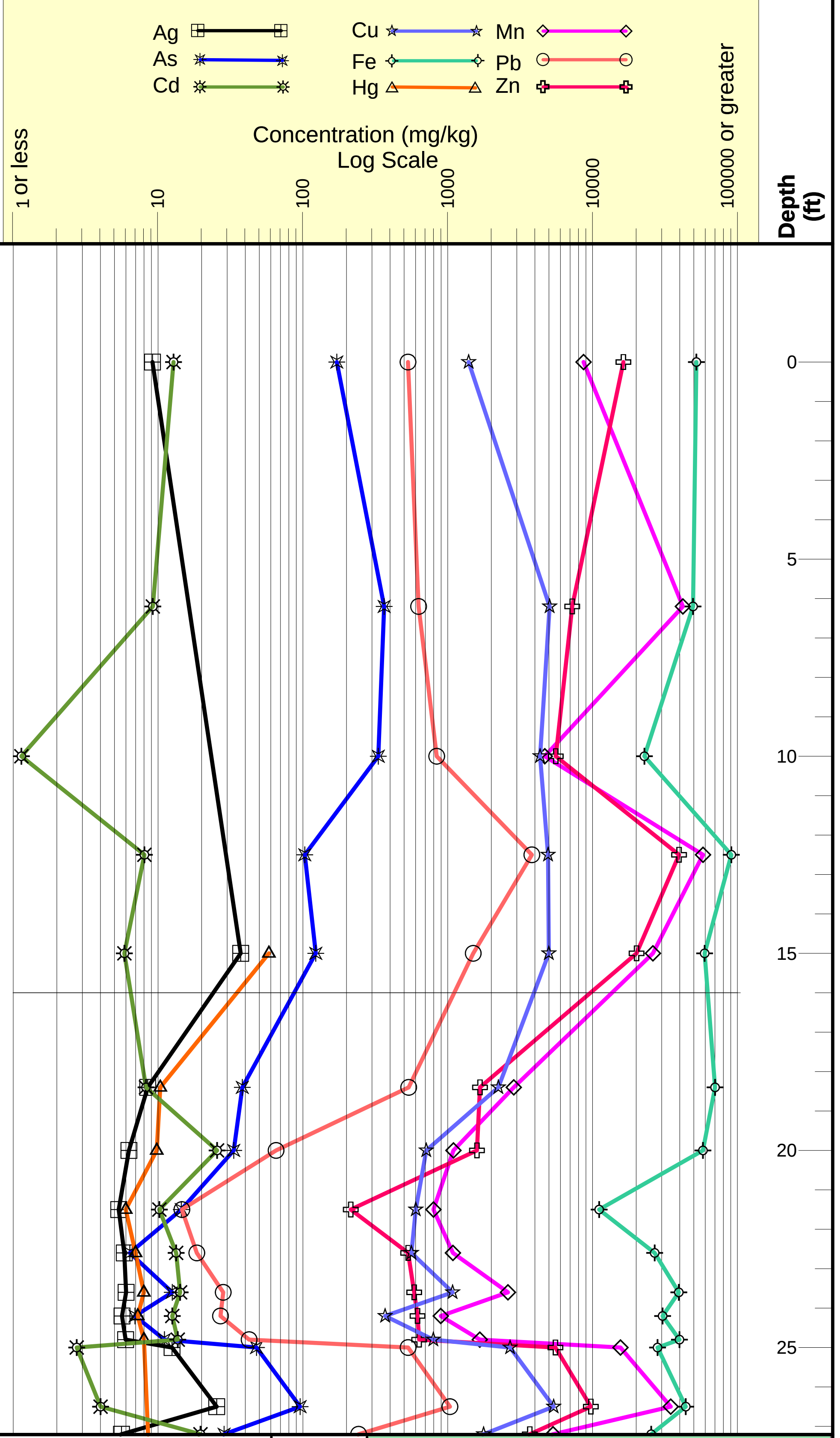
Percent Recovery	USCS Class	Lithology Log
16.7%	GP	Loose, dry, black brown red, coarse GRAVEL with fine-grained sand, construction debris, asphalt, brick, concrete.
41.7%	GP	Loose, dry, black, coarse GRAVEL with fine-grained sand, construction debris, asphalt, brick and concrete.
76.7%	SM	Soft, dry, dark gray, SILTY SAND to medium-grained sand with small gravel to cobbles, woody debris at top, slag
	SM	Same as above, woody debris at bottom of this interval, oil staining throughout, slag
63.3%	SW	Loose, moist, dark gray to black, medium to coarse-grained SAND with coarse gravel mixed in, hydrocarbon odor, slag
	SP-SM	Loose, moist, medium brown, medium-grained SAND with few fines, a 4" layer of silty sand near top (layered orange and black), micaceous
60%	SP	Loose, moist, dark brown, medium to coarse-grained SAND with trace amounts of coarse gravel, micaceous
	SM	Loose, moist, dark brown, SANDY SILT with trace amount of fine gravel, micaceous
	CL	Soft, moist, gray brown with orange staining towards bottom, SILTY CLAY, micaceous
	SM	Loose, moist, brown, SILT with fine-grained sand with gravel throughout, micaceous
	CL	Soft, moist, SILTY CLAY with trace amount of coarse gravel, medium plastic, micaceous
	GM	
	SP	
	SP	



Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
509.2	243.7	1870
411.7	143.3	1080
347	31.9	36
5.7	1.07	ND

XRF or ICP Data from Collected Core



Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:23-32 ft
Screen Interval:25-30 ft
below ground surface
(b.g.s.)
photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

Bedrock	Sandy Clay
Clay	Sandy Gravel
Clayey Sand	Sandy Silt
Clayey Silt	Silt
Gravel	Silty Clay
Sand	Silty Sand

Well Construction

Screen	10/20 Sand Filter Pack
Bentonite	Natural Completion
PVC Casing	Prepack
	Steel Protective Casing

Latitude: 45.9950231778(NAD 83) Decimal Degrees
Longitude:-112.543308639 (NAD 83) Decimal Degrees
Northing:651255.68 IF
Easting:1195537.42 IF
Ground Elevation:5453.47 ft (NAVD 88)
Measuring Point Elevation:5455.08 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Piezometer Log

Piezometer Name: BRW18-PZ21

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 13.57 ft
Water Level from MP: 15.18 ft
Date:11/26/2018
Time:1:30

Logged By: K. Jackson, J. Flammang

Date Drilled: 10/4/2018

Casing Type/Dia: PVC/1.5"

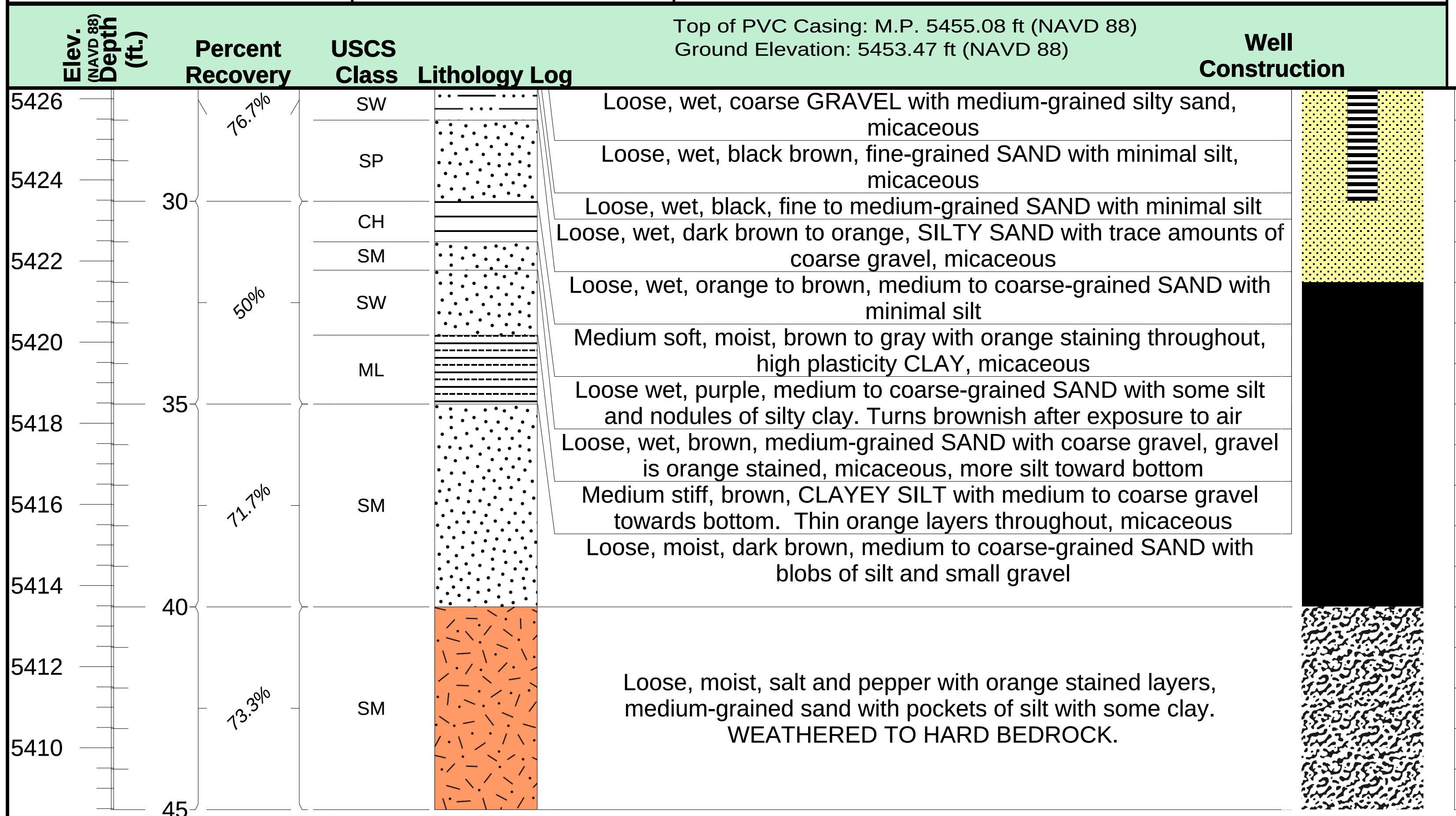
Borehole Diameter: 6"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length:PVC/5'

Top of PVC Casing: M.P. 5455.08 ft (NAVD 88)
Ground Elevation: 5453.47 ft (NAVD 88)



Loose, wet, coarse GRAVEL with medium-grained silty sand, micaceous

Loose, wet, black brown, fine-grained SAND with minimal silt, micaceous

Loose, wet, black, fine to medium-grained SAND with minimal silt

Loose, wet, dark brown to orange, SILTY SAND with trace amounts of coarse gravel, micaceous

Loose, wet, orange to brown, medium to coarse-grained SAND with minimal silt

Medium soft, moist, brown to gray with orange staining throughout, high plasticity CLAY, micaceous

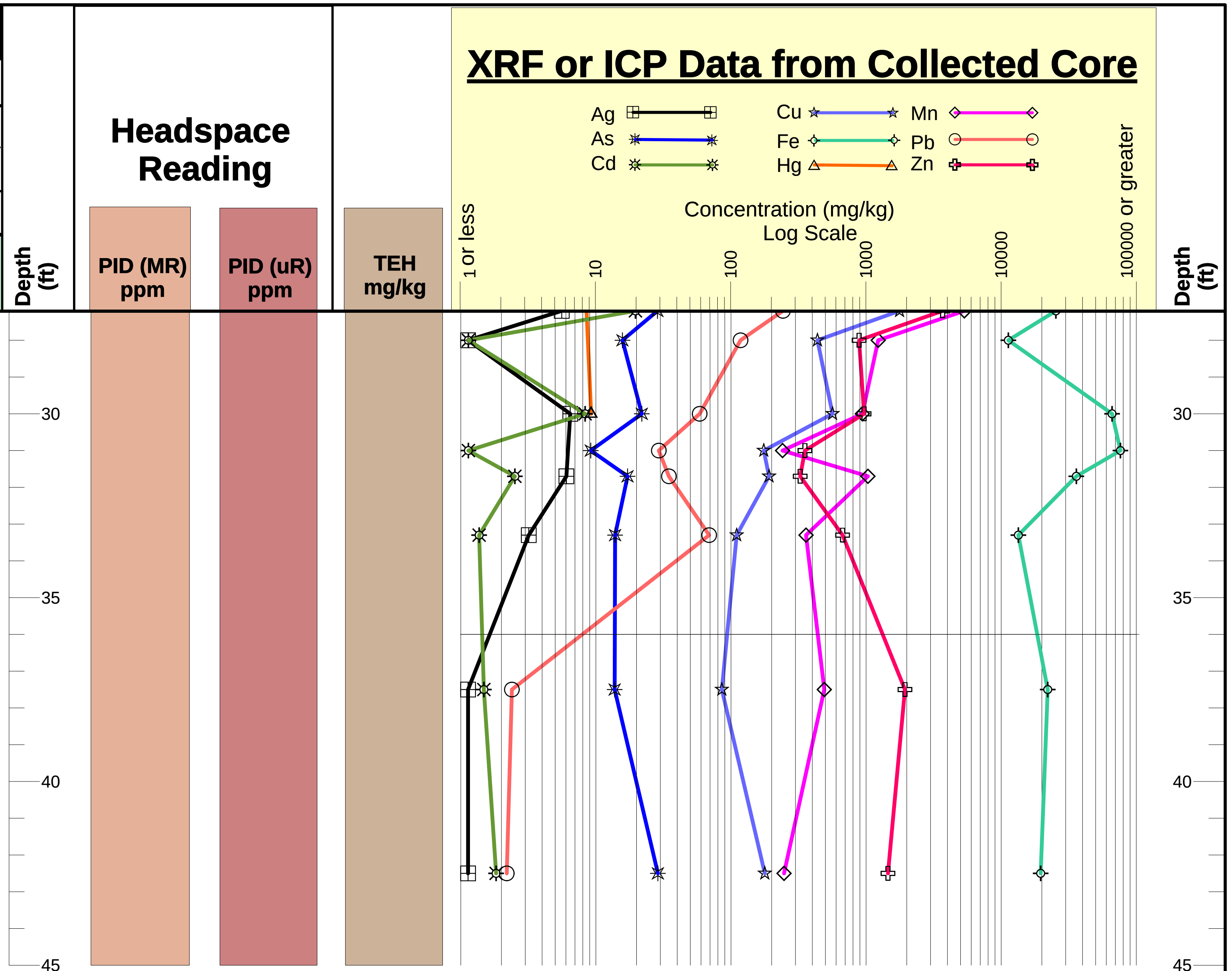
Loose wet, purple, medium to coarse-grained SAND with some silt and nodules of silty clay. Turns brownish after exposure to air

Loose, wet, brown, medium-grained SAND with coarse gravel, gravel is orange stained, micaceous, more silt toward bottom

Medium stiff, brown, CLAYEY SILT with medium to coarse gravel towards bottom. Thin orange layers throughout, micaceous

Loose, moist, dark brown, medium to coarse-grained SAND with blobs of silt and small gravel

Loose, moist, salt and pepper with orange stained layers, medium-grained sand with pockets of silt with some clay. WEATHERED TO HARD BEDROCK.



Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:23-32 ft
Screen Interval:25-30 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Well Construction

▤	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
☐	PVC Casing	🟦	Prepack
		⊓	Steel Protective Casing

Latitude: 45.9950231778(NAD 83) Decimal Degrees
Longitude:-112.543308639 (NAD 83) Decimal Degrees
Northing:651255.68 IF
Easting:1195537.42 IF
Ground Elevation:5453.47 ft (NAVD 88)
Measuring Point Elevation:5455.08 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Piezometer Log

Piezometer Name: **BRW18-PZ22**

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 13.70 ft
Water Level from MP: 15.41 ft
Date:11/30/2018
Time:11:45

Logged By: K. Jackson, J. Flammang

Date Drilled: 9/26/2018

Casing Type/Dia: PVC/1.5"

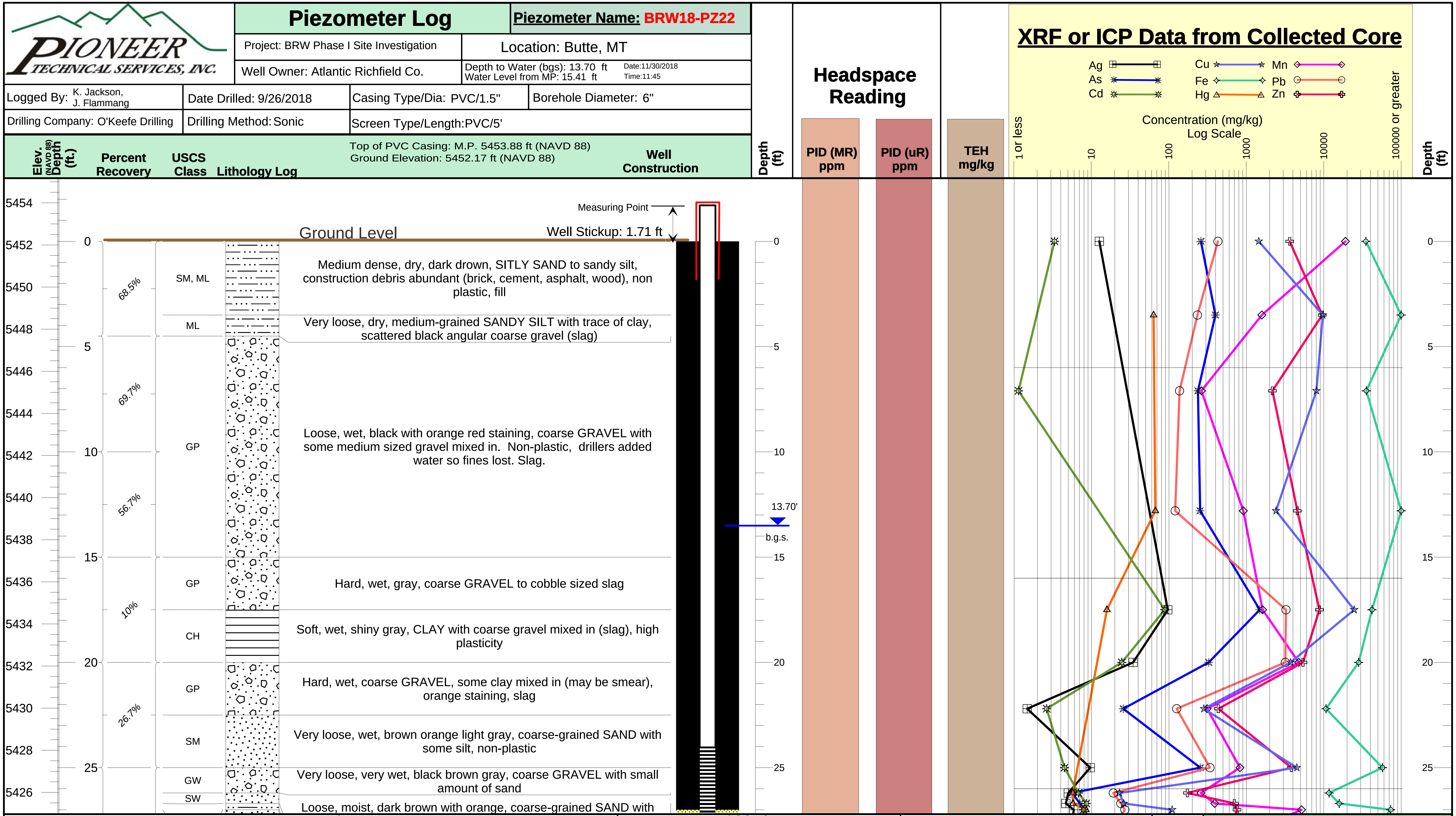
Borehole Diameter: 6"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length:PVC/5'

Top of PVC Casing: M.P. 5453.88 ft (NAVD 88)
Ground Elevation: 5452.17 ft (NAVD 88)



SM, ML — Medium dense, dry, dark drown, SITLY SAND to sandy silt, construction debris abundant (brick, cement, asphalt, wood), non plastic, fill

ML — Very loose, dry, medium-grained SANDY SILT with trace of clay, scattered black angular coarse gravel (slag)

GP — Loose, wet, black with orange red staining, coarse GRAVEL with some medium sized gravel mixed in. Non-plastic, drillers added water so fines lost. Slag.

GP — Hard, wet, gray, coarse GRAVEL to cobble sized slag

CH — Soft, wet, shiny gray, CLAY with coarse gravel mixed in (slag), high plasticity

GP — Hard, wet, coarse GRAVEL, some clay mixed in (may be smear), orange staining, slag

SM — Very loose, wet, brown orange light gray, coarse-grained SAND with some silt, non-plastic

GW — Very loose, very wet, black brown gray, coarse GRAVEL with small amount of sand

SW — Loose, moist, dark brown with orange, coarse-grained SAND with

Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:27-34 ft
Screen Interval:29-34 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Well Construction

▤	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
□	PVC Casing	■	Prepack
		⊓	Steel Protective Casing

Latitude: 45.9955496674(NAD 83) Decimal Degrees
Longitude:-112.543960122 (NAD 83) Decimal Degrees
Northing:651453.87 IF
Easting:1195379.49 IF
Ground Elevation:5452.17 ft (NAVD 88)
Measuring Point Elevation:5453.88 ft (NAVD 88)
T3N R8W S24

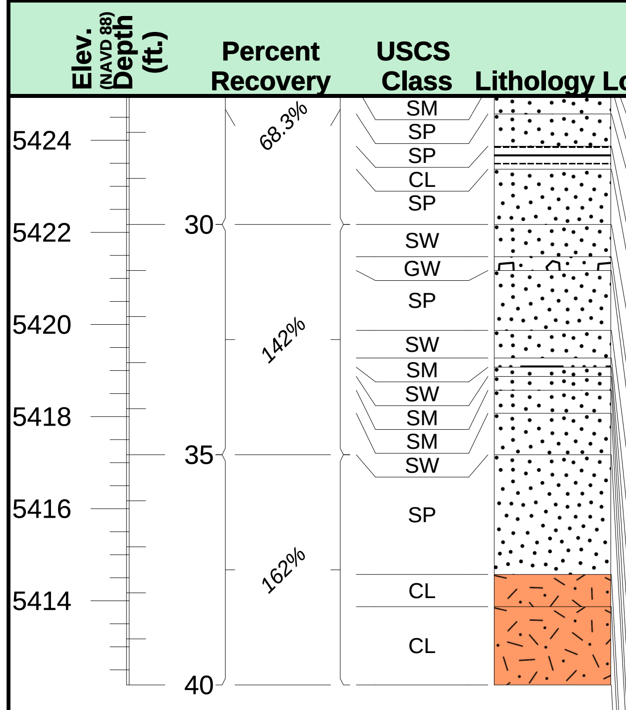
PIONEER TECHNICAL SERVICES, INC.

Piezometer Log

Piezometer Name: BRW18-PZ22

Project: BRW Phase I Site Investigation
Location: Butte, MT
Well Owner: Atlantic Richfield Co.
Depth to Water (bgs): 13.70 ft
Water Level from MP: 15.41 ft
Date:11/30/2018
Time:11:45
Logged By: K. Jackson, J. Flammang
Date Drilled: 9/26/2018
Casing Type/Dia: PVC/1.5"
Borehole Diameter: 6"
Drilling Company: O'Keefe Drilling
Drilling Method: Sonic
Screen Type/Length:PVC/5'

Top of PVC Casing: M.P. 5453.88 ft (NAVD 88)
Ground Elevation: 5452.17 ft (NAVD 88)



some gravel, micaceous

Soft, moist, brown, SILTY SAND, very micaceous, some plasticity

Loose, moist, orange brown, coarse-grained SAND

Loose, wet, dark red to brown black, coarse-grained SAND, micaceous

Soft, wet, brown black, SILTY CLAY, micaceous

Loose, wet to very wet, black and orange laminations, coarse-grained SAND with coarse gravel towards bottom

Loose, wet, black with orange staining, coarse-grained SAND with cobbles, maybe slough

Loose, wet, orange, coarse GRAVEL with some fine sand

Loose, moist, coarse-grained SAND with trace amounts of coarse gravel, micaceous

Loose, moist, brown and orange, coarse-grained SAND with coarse gravel throughout, micaceous

Soft, moist, brown with small layer of black at top, fine-grained SILTY SAND, micaceous

Loose, moist, coarse-grained brown SAND with trace amounts of gravel, micaceous

Soft, moist, brown gray with lamination of black material, fine-grained SAND with silt, micaceous

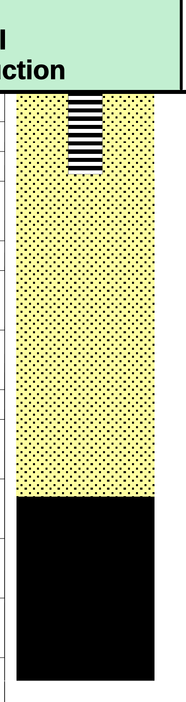
Soft, moist, brown gray, fine-grained SAND with some silt and nodules of clay, mica present, low plasticity

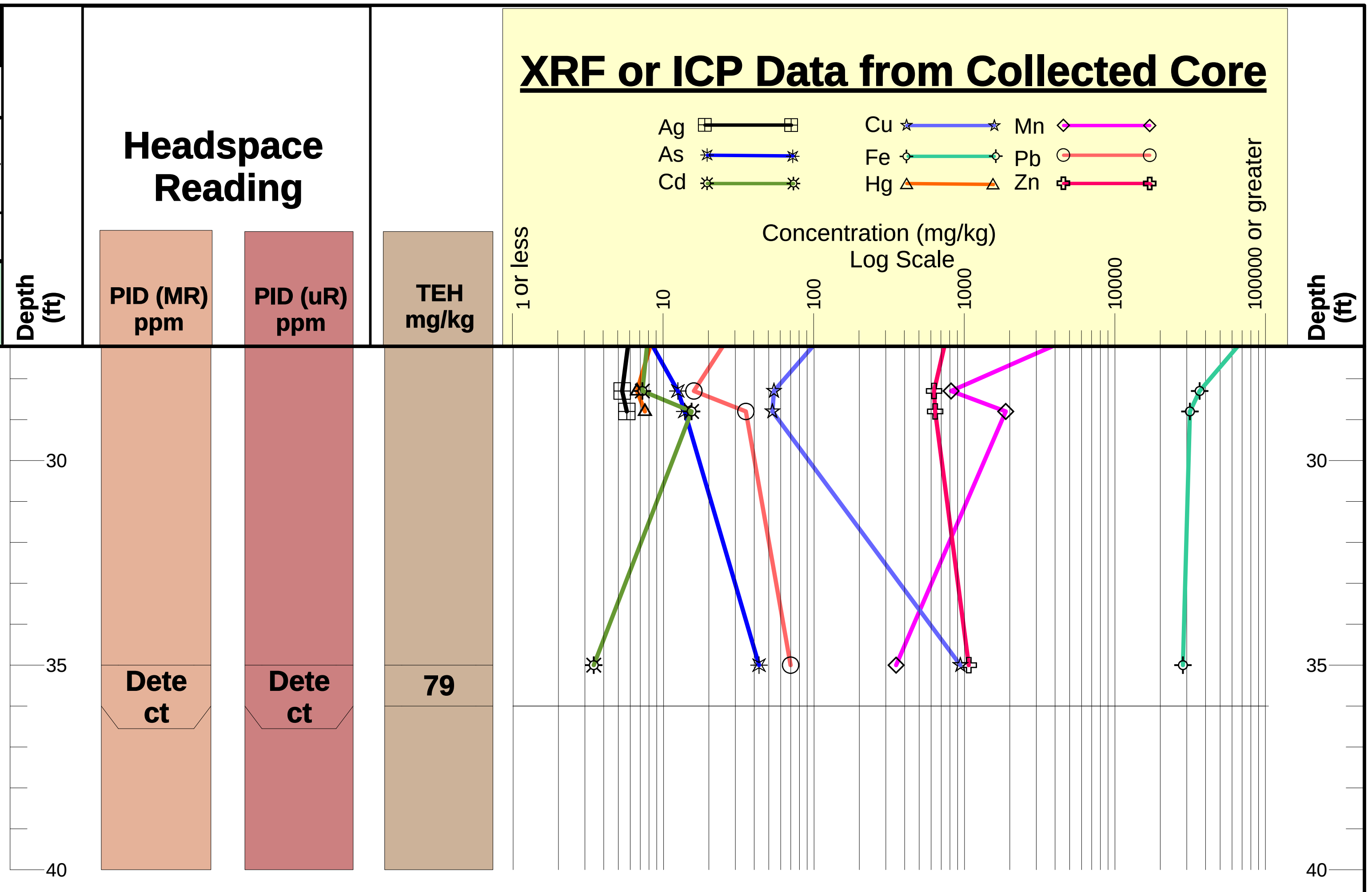
Loose, moist, SAND with coarse gravel, small layer of black at top

Loose, moist, top portion is black the rest is brown orange, coarse-grained SAND with coarse gravel and chunks of slag, minimal fines, micaceous. Strong hydrocarbon odor at top of core, maybe slough

Hard, dry, brown with orange black layering, silty clay. WEATHERED BEDROCK.

Hard, dry, brown orange black, silty clay layers around hard material in middle of core, low plasticity. BEDROCK-DECOMPOSED GRANITE.





Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:27-34 ft
Screen Interval:29-34 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

- 🟧 Bedrock
- ▭ Clay
- ▭ Clayey Sand
- ▤ Clayey Silt
- ▭ Gravel
- ▭ Sand
- ▭ Sandy Clay
- ▭ Sandy Gravel
- ▭ Sandy Silt
- ▭ Silt
- ▤ Silty Clay
- ▭ Silty Sand

Well Construction

- ☰ Screen
- ■ Bentonite
- □ PVC Casing
- ▒ 10/20 Sand Filter Pack
- ▒ Natural Completion
- 🟦 Prepack
- ⊓ Steel Protective Casing

Latitude: 45.9955496674(NAD 83) Decimal Degrees
Longitude:-112.543960122 (NAD 83) Decimal Degrees
Northing:651453.87 IF
Easting:1195379.49 IF
Ground Elevation:5452.17 ft (NAVD 88)
Measuring Point Elevation:5453.88 ft (NAVD 88)
T3N R8W S24

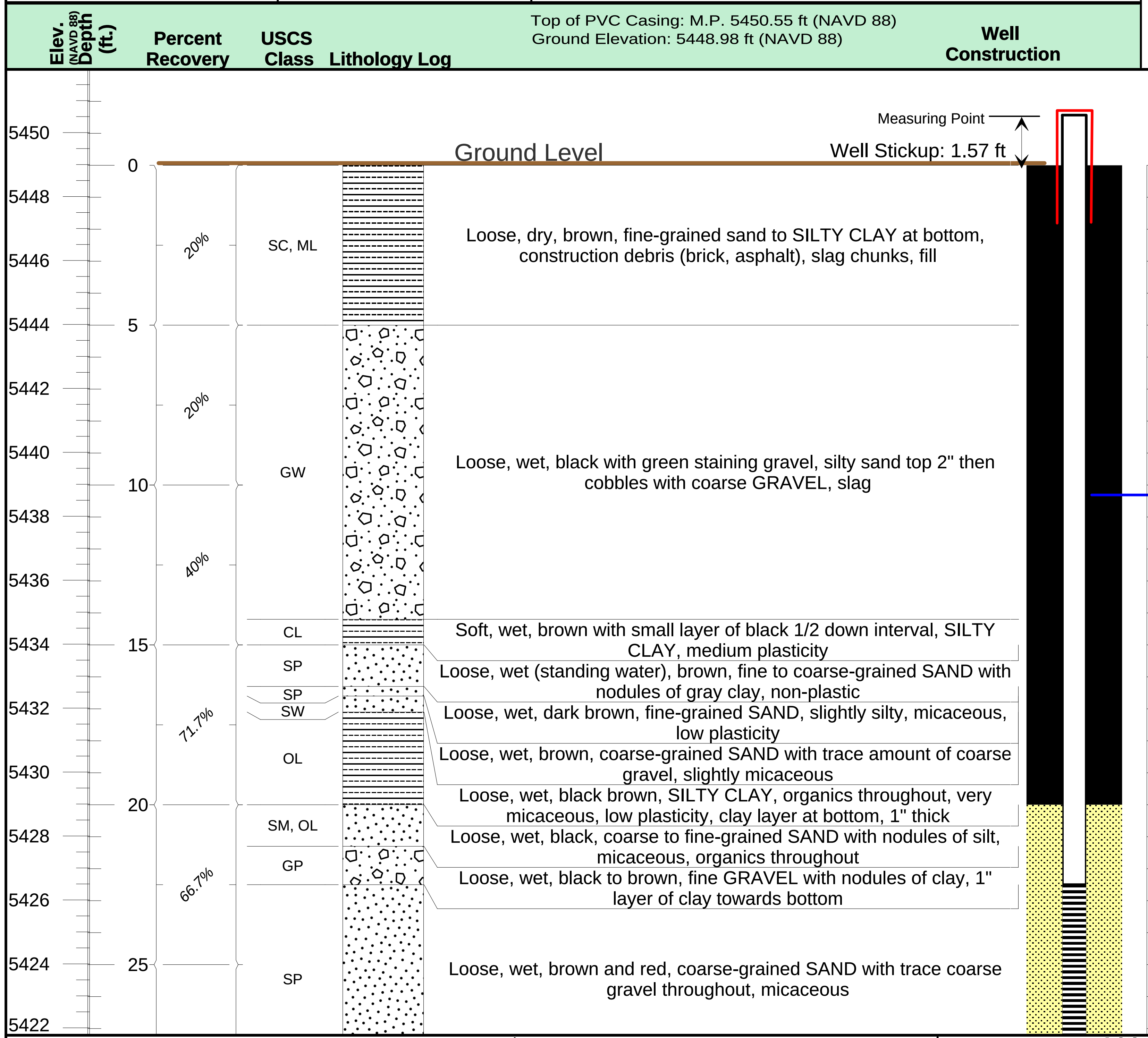
Piezometer Log

Piezometer Name: BRW18-PZ23

PIONEER TECHNICAL SERVICES, INC.

Project: BRW Phase I Site Investigation
Location: Butte, MT
Well Owner: Atlantic Richfield Co.
Depth to Water (bgs): 10.21 ft
Water Level from MP: 11.78 ft
Date:11/27/2018
Time:9:45
Logged By: K. Jackson, J. Flammang
Date Drilled: 10/9/2018
Casing Type/Dia: PVC/1.5"
Borehole Diameter: 6"
Drilling Company: O'Keefe Drilling
Drilling Method: Sonic
Screen Type/Length:PVC/5'

Top of PVC Casing: M.P. 5450.55 ft (NAVD 88)
Ground Elevation: 5448.98 ft (NAVD 88)



Loose, dry, brown, fine-grained sand to SILTY CLAY at bottom, construction debris (brick, asphalt), slag chunks, fill

Loose, wet, black with green staining gravel, silty sand top 2" then cobbles with coarse GRAVEL, slag

Soft, wet, brown with small layer of black 1/2 down interval, SILTY CLAY, medium plasticity

Loose, wet (standing water), brown, fine to coarse-grained SAND with nodules of gray clay, non-plastic

Loose, wet, dark brown, fine-grained SAND, slightly silty, micaceous, low plasticity

Loose, wet, brown, coarse-grained SAND with trace amount of coarse gravel, slightly micaceous

Loose, wet, black brown, SILTY CLAY, organics throughout, very micaceous, low plasticity, clay layer at bottom, 1" thick

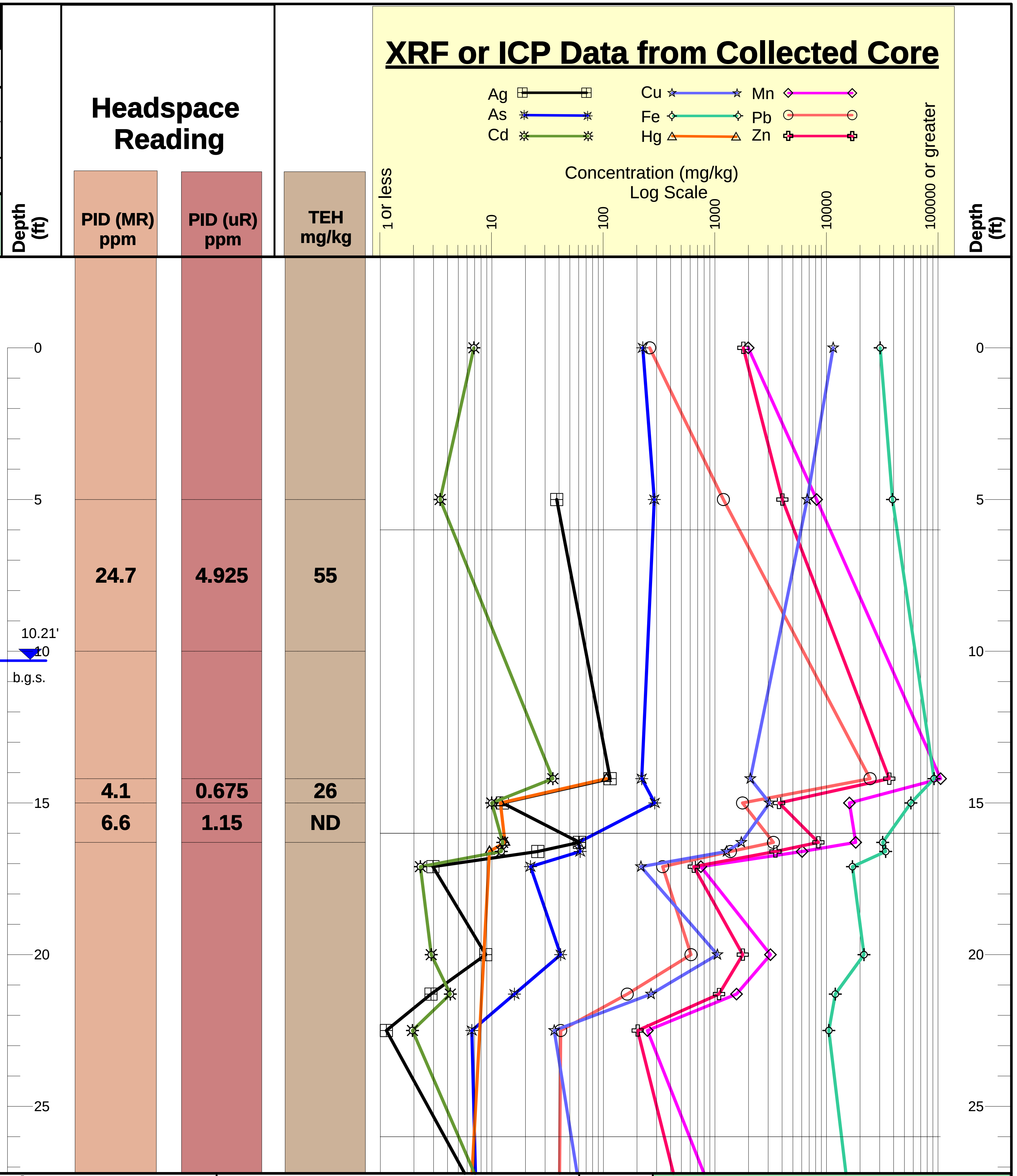
Loose, wet, black, coarse to fine-grained SAND with nodules of silt, micaceous, organics throughout

Loose, wet, black to brown, fine GRAVEL with nodules of clay, 1" layer of clay towards bottom

Loose, wet, brown and red, coarse-grained SAND with trace coarse gravel throughout, micaceous

Headspace Reading

XRF or ICP Data from Collected Core



PID (MR) ppm	PID (uR) ppm	TEH mg/kg
24.7	4.925	55
4.1	0.675	26
6.6	1.15	ND

Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:20-27.5 ft
Screen Interval:22.5-27.5 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▤	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▤	Clayey Silt	▭	Silt
▨	Gravel	▤	Silty Clay
▨	Sand	▨	Silty Sand

Well Construction

▤	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
□	PVC Casing	■	Prepack
		⊓	Steel Protective Casing

Latitude: 45.9959229837(NAD 83) Decimal Degrees
Longitude:-112.543413716 (NAD 83) Decimal Degrees
Northing:651584.45 IF
Easting:1195523.49 IF
Ground Elevation:5448.98 ft (NAVD 88)
Measuring Point Elevation:5450.55 ft (NAVD 88)
T3N R8W S24

Piezometer Log

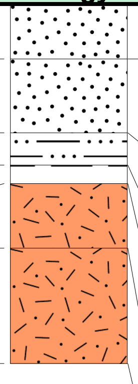
Piezometer Name: BRW18-PZ23

Project: BRW Phase I Site Investigation	Location: Butte, MT
Well Owner: Atlantic Richfield Co.	Depth to Water (bgs): 10.21 ft Water Level from MP: 11.78 ft Date:11/27/2018 Time:9:45

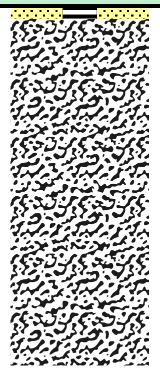
Logged By: K. Jackson, J. Flammang	Date Drilled: 10/9/2018	Casing Type/Dia: PVC/1.5"	Borehole Diameter: 6"
Drilling Company: O'Keefe Drilling	Drilling Method: Sonic	Screen Type/Length:PVC/5'	

Top of PVC Casing: M.P. 5450.55 ft (NAVD 88)
Ground Elevation: 5448.98 ft (NAVD 88)

Elev. (NAVD 88)	Depth (ft.)	Percent Recovery	USCS Class	Lithology Log
		70%		
5420			SP	Loose, moist, black to medium brown, medium-grained SAND with fine gravel and nodule of fat clay at top of interval, black coarse sand at top of clay, micaceous
	30		SM	Loose, moist, brown, medium-grained SILTY SAND with trace amounts of coarse gravel and cobbles
5418			ML	Soft, moist, purple, fine-grained SILT with a trace of medium-grained sand, clay nodules at top, micaceous
		70%	ML	Medium dense, moist to dry, dark brown, sandy silt with trace amounts of fine gravel, very micaceous. WEATHERED TO HARD BEDROCK.
5416			ML	Medium dense, moist to dry, brown orange gray, sandy silt with trace amounts of fine gravel, very micaceous. BEDROCK-DECOMPOSED GRANITE.
5414	35			



Well Construction

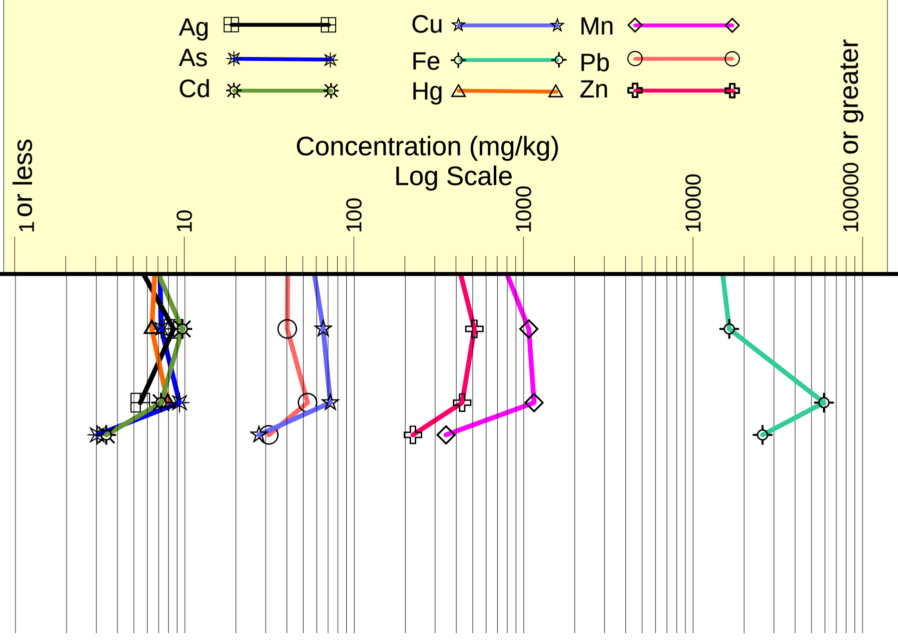


Depth (ft)
30
35

Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg

XRF or ICP Data from Collected Core



Depth (ft)
30
35

Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:20-27.5 ft
Screen Interval:22.5-27.5 ft
below ground surface
(b.g.s.)
photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

- Bedrock
- Clay
- Clayey Sand
- Clayey Silt
- Gravel
- Sand
- Sandy Clay
- Sandy Gravel
- Sandy Silt
- Silt
- Silty Clay
- Silty Sand

Well Construction

- Screen
- Bentonite
- PVC Casing
- 10/20 Sand Filter Pack
- Natural Completion
- Prepack
- Steel Protective Casing

Latitude: 45.9959229837(NAD 83) Decimal Degrees
Longitude:-112.543413716 (NAD 83) Decimal Degrees
Northing:651584.45 IF
Easting:1195523.49 IF
Ground Elevation:5448.98 ft (NAVD 88)
Measuring Point Elevation:5450.55 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Piezometer Log

Piezometer Name: BRW18-PZ24

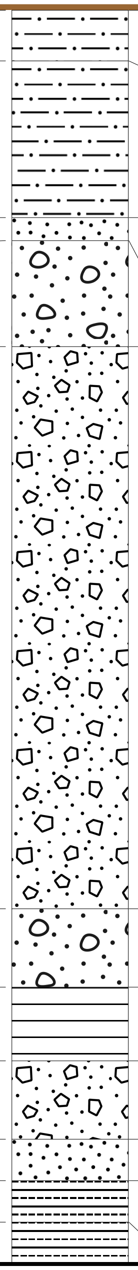
Project: BRW Phase I Site Investigation	Location: Butte, MT
Well Owner: Atlantic Richfield Co.	Depth to Water (bgs): 20.0 ft Water Level from MP: 21.61 ft Date:11/28/2018 Time:10:00

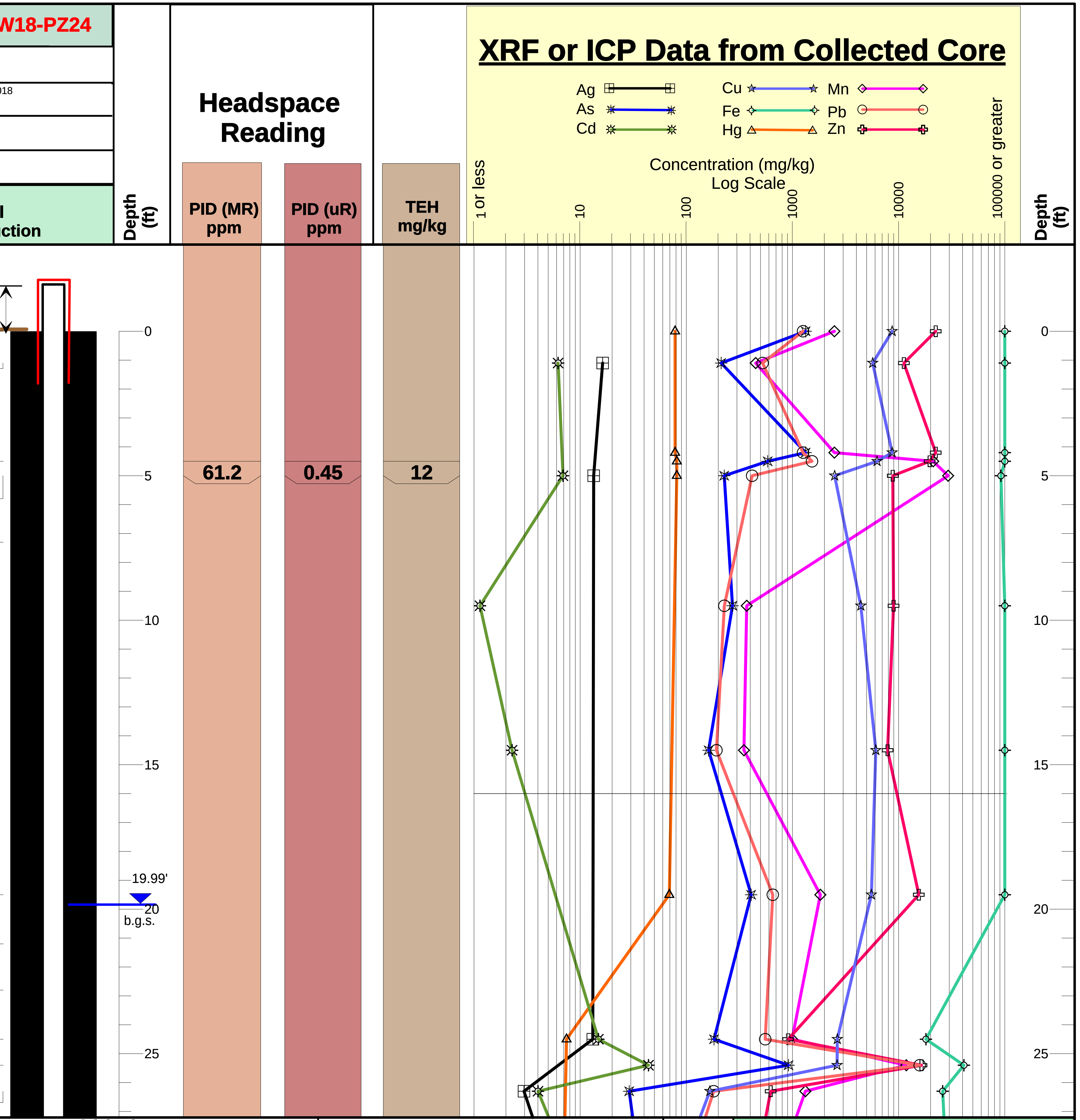
Logged By: K. Jackson, J. Flammang	Date Drilled: 10/9/2018	Casing Type/Dia: PVC/1.5"	Borehole Diameter: 6"
Drilling Company: O'Keefe Drilling	Drilling Method: Sonic	Screen Type/Length:PVC/5'	

Top of PVC Casing: M.P. 5460.15 ft (NAVD 88)
Ground Elevation: 5458.53 ft (NAVD 88)

Measuring Point
Ground Level
Well Stickup: 1.62 ft

Percent Recovery	USCS Class	Lithology Log
77.8%	SM	Loose, dry, orange brown to tan, fine grained sand to SANDY SILT, construction debris (asphalt, brick/slag) with chunks of slag, fill
	SM	Loose, dry, black, coarse gravel with cobbles with SANDY SILT and silty sand towards bottom, slag
	SM	Loose, wet, black, SAND with some silt, organics throughout, particles of red coarse grained sand throughout, slight plasticity, some slag
66.7%	GW	Loose, wet, black, coarse sand to coarse GRAVEL with a trace of cobbles, slag
40% 28.3%	GW	Loose, wet, black, coarse GRAVEL to cobbles, red staining on some slag
40%	GW	Loose, wet, black, coarse sand to coarse GRAVEL to cobbles, slag
	CH	Soft, wet, gray to black, fat CLAY, highly plastic, micaceous. Metal and construction debris towards bottom
	GW	Loose, wet, black, coarse GRAVEL, slag
	SP	Loose, wet, medium brown, SAND, micaceous, small chunks of slag
	CH	Soft, moist, brown gray, SILTY CLAY with laminations of black coarse sand in the middle 1".





Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:32-39 ft
Screen Interval:34-39 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Well Construction

▤	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
□	PVC Casing	■	Prepack
		⊓	Steel Protective Casing

Latitude: 45.99653497(NAD 83) Decimal Degrees
Longitude:-112.542957128 (NAD 83) Decimal Degrees
Northing:651802.85 IF
Easting:1195648.06 IF
Ground Elevation:5458.53 ft (NAVD 88)
Measuring Point Elevation:5460.15 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Piezometer Log

Piezometer Name: BRW18-PZ24

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 20.0 ft
Water Level from MP: 21.61 ft
Date:11/28/2018
Time:10:00

Logged By: K. Jackson, J. Flammang

Date Drilled: 10/9/2018

Casing Type/Dia: PVC/1.5"

Borehole Diameter: 6"

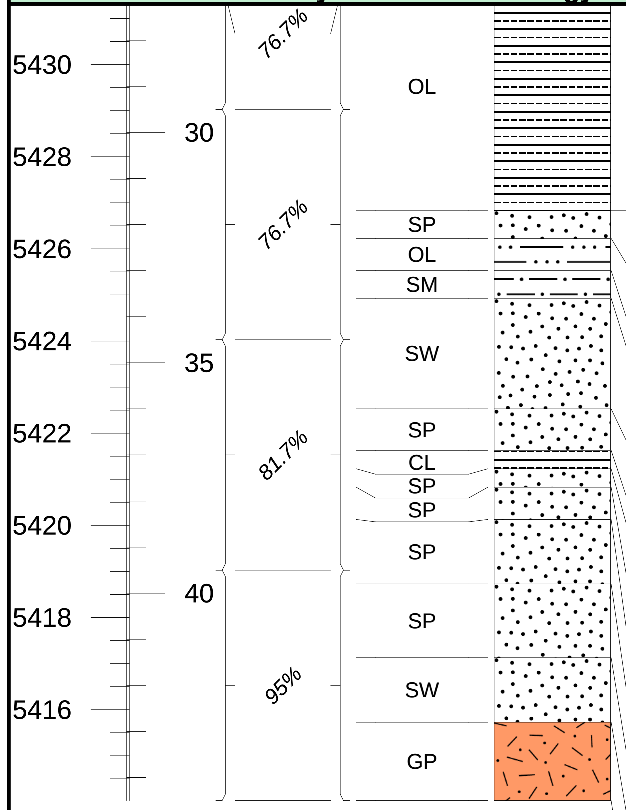
Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length: PVC/5'

Top of PVC Casing: M.P. 5460.15 ft (NAVD 88)
Ground Elevation: 5458.53 ft (NAVD 88)

Elev. (NAVD 88) Depth (ft.) | **Percent Recovery** | **USCS Class** | **Lithology Log** | **Well Construction** | **Depth (ft)**



Medium stiff, moist, black, SILTY CLAY with more silt towards the bottom, organics, micaceous, woody pieces in bottom

Loose, wet, black gray, coarse SAND, micaceous. Diesel/hydrocarbon odor

Soft, wet, black, SILTY SAND with small amount of clay, organics, micaceous

Loose, wet, black, SANDY SILT with a trace of coarse-grained sand

Loose, wet, orange medium brown with purple to orange toward the bottom of the interval, coarse-grained SAND with trace amount of coarse gravel

Loose, moist, dark brown, fine-grained SAND with nodules of clay at bottom, micaceous

Soft, moist, gray, SILTY CLAY

Loose, moist, gray, fine-grained SAND, micaceous. Top 1/4" is dark red fine-grained sand

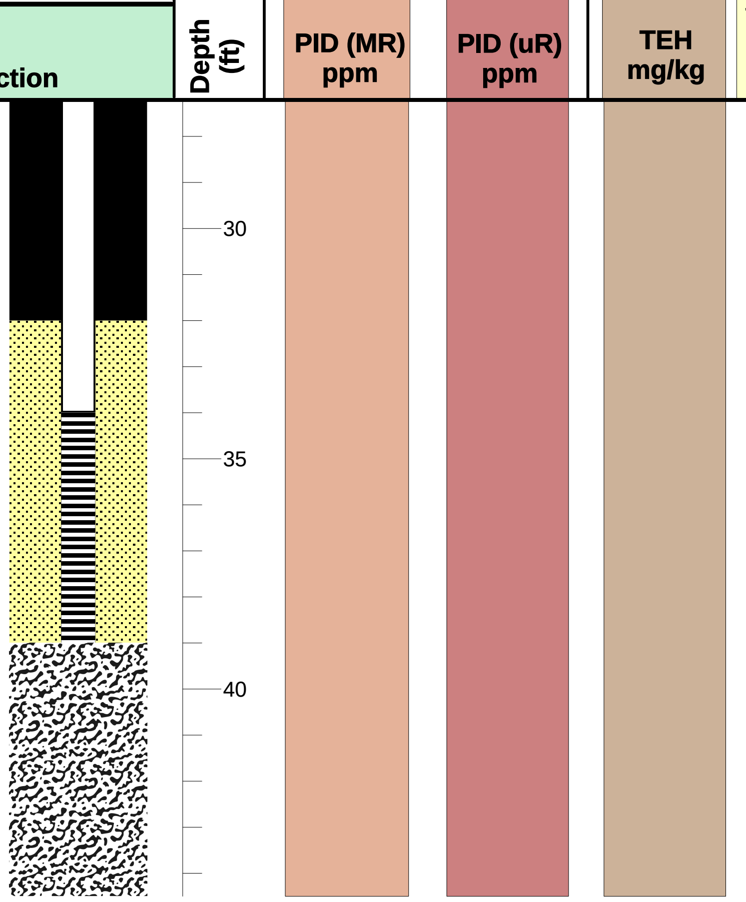
Loose, moist, dark orange to black with purple at the bottom of the interval, coarse-grained SAND with trace amounts of coarse gravel

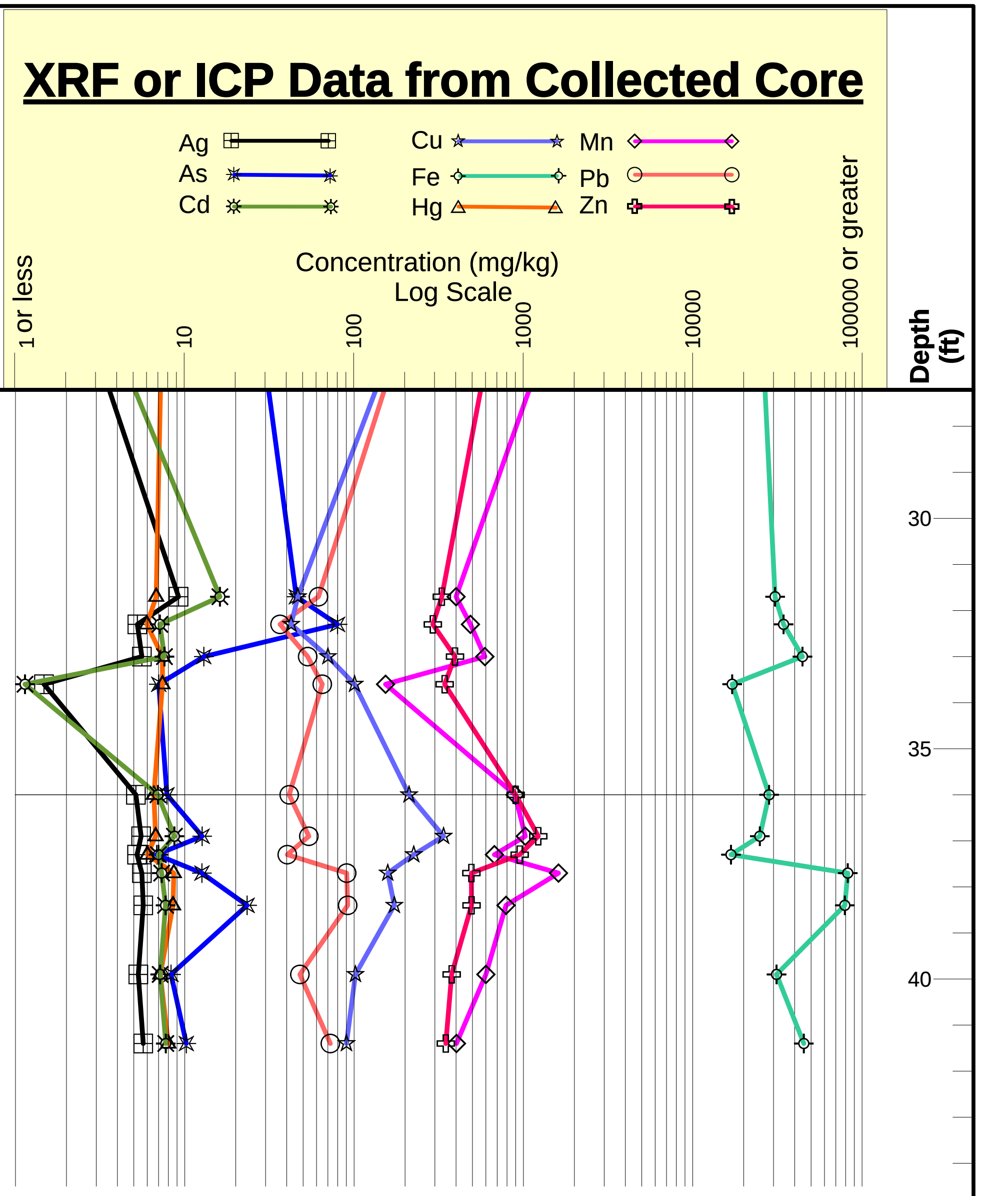
Loose, moist, medium brown to purple, coarse-grained SAND with trace amounts of coarse gravel, micaceous

Loose, moist, brown, medium to fine-grained SAND with trace amounts of coarse gravel, micaceous

Loose, wet, brown with purple layer at bottom, coarse SAND with fine gravel, micaceous

Medium stiff, moist, red orange light tan to brown yellow at the bottom, silty sandy gravel. Highly WEATHERED BEDROCK TO DECOMPOSED GRANITE.





Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:32-39 ft
Screen Interval:34-39 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

- Bedrock
- Clay
- Clayey Sand
- Clayey Silt
- Gravel
- Sand
- Sandy Clay
- Sandy Gravel
- Sandy Silt
- Silt
- Silty Clay
- Silty Sand

Well Construction

- Screen
- Bentonite
- PVC Casing
- 10/20 Sand Filter Pack
- Natural Completion
- Prepack
- Steel Protective Casing

Latitude: 45.99653497(NAD 83) Decimal Degrees
Longitude:-112.542957128 (NAD 83) Decimal Degrees
Northing:651802.85 IF
Easting:1195648.06 IF
Ground Elevation:5458.53 ft (NAVD 88)
Measuring Point Elevation:5460.15 ft (NAVD 88)
T3N R8W S24

PIONEER
TECHNICAL SERVICES, INC.

Piezometer Log

Piezometer Name: BRW18-PZ25

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 2.15 ft
Water Level from MP: 4.81 ft
Date:12/5/2018
Time:10:20

Logged By: K. Jackson, J. Flammang

Date Drilled: 10/10/2018

Casing Type/Dia: PVC/1.5"

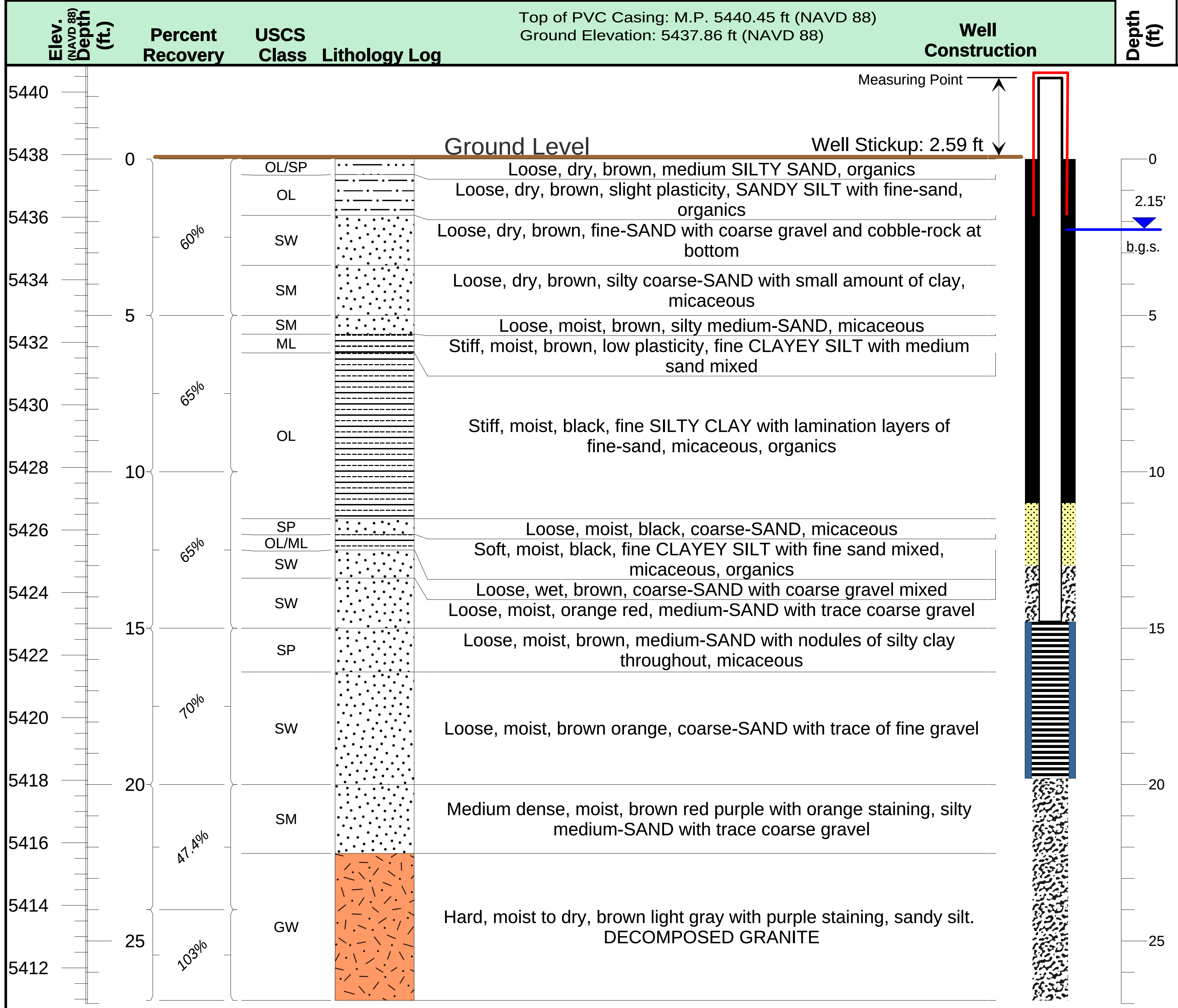
Borehole Diameter: 3.25"/2.25"

Drilling Company: Pioneer

Drilling Method: Direct Push

Screen Type/Length:PVC/5' With 10/20 Sand Filter Prepack

Top of PVC Casing: M.P. 5440.45 ft (NAVD 88)
Ground Elevation: 5437.86 ft (NAVD 88)

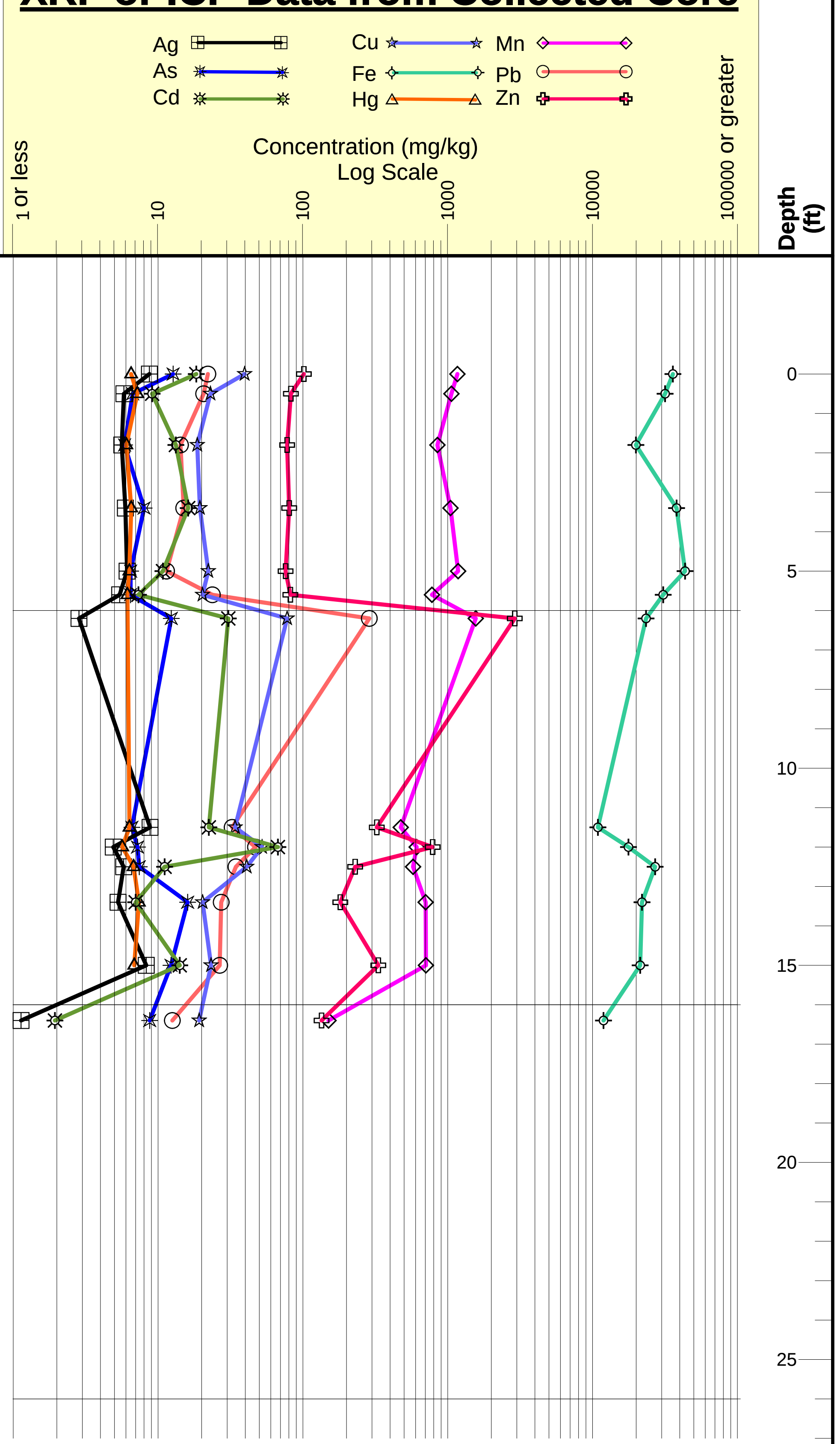


USCS Class	Lithology Log
OL/SP	Loose, dry, brown, medium SILTY SAND, organics
OL	Loose, dry, brown, slight plasticity, SANDY SILT with fine-sand, organics
SW	Loose, dry, brown, fine-SAND with coarse gravel and cobble-rock at bottom
SM	Loose, dry, brown, silty coarse-SAND with small amount of clay, micaceous
SM	Loose, moist, brown, silty medium-SAND, micaceous
ML	Stiff, moist, brown, low plasticity, fine CLAYEY SILT with medium sand mixed
OL	Stiff, moist, black, fine SILTY CLAY with lamination layers of fine-sand, micaceous, organics
SP	Loose, moist, black, coarse-SAND, micaceous
OL/ML	Soft, moist, black, fine CLAYEY SILT with fine sand mixed, micaceous, organics
SW	Loose, wet, brown, coarse-SAND with coarse gravel mixed
SW	Loose, moist, orange red, medium-SAND with trace coarse gravel
SP	Loose, moist, brown, medium-SAND with nodules of silty clay throughout, micaceous
SW	Loose, moist, brown orange, coarse-SAND with trace of fine gravel
SM	Medium dense, moist, brown red purple with orange staining, silty medium-SAND with trace coarse gravel
GW	Hard, moist to dry, brown light gray with purple staining, sandy silt. DECOMPOSED GRANITE

Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
ND	ND	NS

XRF or ICP Data from Collected Core



Driller: K. Manchester
Monitoring Well License # 518

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:11.0-13.0 ft
Screen Interval:14.8-19.8 ft
below ground surface
(b.g.s.)
photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

- Bedrock
- Clay
- Clayey Sand
- Clayey Silt
- Gravel
- Sand
- Sandy Clay
- Sandy Gravel
- Sandy Silt
- Silt
- Silty Clay
- Silty Sand

Well Construction

- Screen
- Bentonite
- PVC Casing
- 10/20 Sand Filter Pack
- Natural Completion
- Prepack
- Steel Protective Casing

Latitude: 45.9956512661(NAD 83) Decimal Degrees
Longitude:-112.5456952654 (NAD 83) Decimal Degrees
Northing:651508.01 IF
Easting:1194940.45 IF
Ground Elevation:5437.86 ft (NAVD 88)
Measuring Point Elevation:5440.45 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Test Pit Log

Test Pit Name: **BRW18-TP01**

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): NA ft
Water Level from MP: NA ft
Date:NA
Time:NA

Logged By: K. Jackson, J. Flammang

Date: 10/26/2018

Casing Type/Dia: None

Borehole Diameter: NA

Company: Hunter Brothers

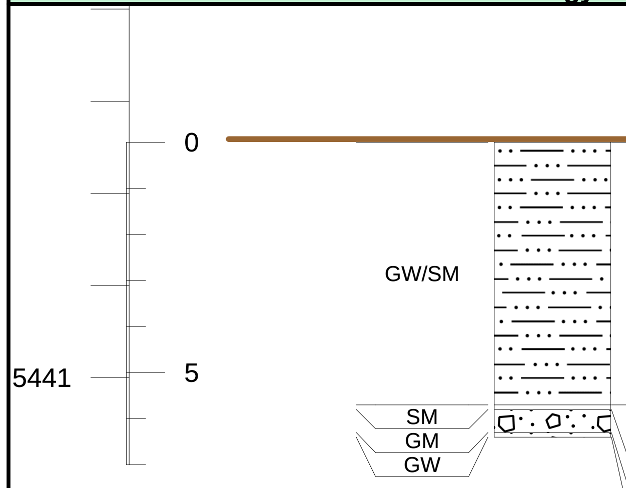
Equipment: 312C Excavator

Screen Type/Length: None

Elev. (NAVD 88) | **Depth (ft.)** | **USCS Class** | **Lithology Log**

Ground Elevation: 5446.11 ft (NAVD 88)

Ground Level



Loose/medium dense, dark brown, SILTY SAND with coarse to cobble (round to subangular) gravel mixed with more coarse sand towards bottom of interval, fill (brick/asphalt)

Loose, moist, orange and dark brown, SILTY SAND with trace fine gravel

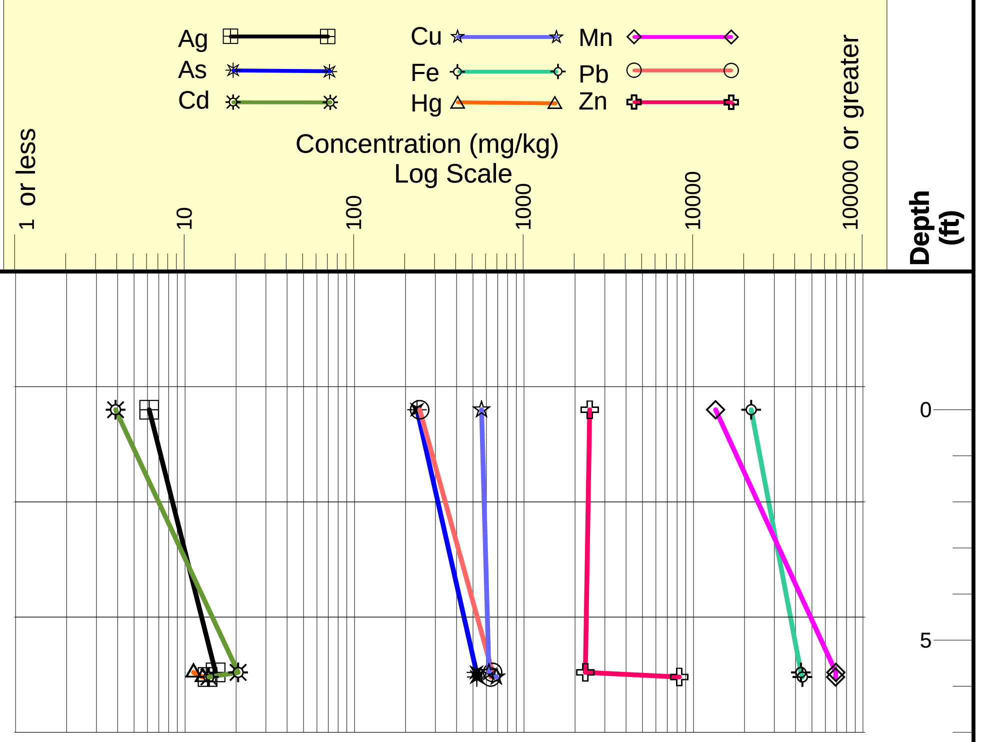
Hard, red orange, silty fine coarse-GRAVEL with brick

Hard, black, coarse to cobble-GRAVEL, slag. (Refusal @6.4').

Headspace Reading

Depth (ft)	PID (MR) ppm	PID (uR) ppm	TEH mg/kg
5	14.1	28.75	185

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS= Not Sampled

Lithology

- Bedrock
- Clay
- Clayey Sand
- Clayey Silt
- Gravel
- Sand
- Sandy Clay
- Sandy Gravel
- Sandy Silt
- Silt
- Silty Clay
- Silty Sand

Latitude: 45.994904(NAD 83) Decimal Degrees
Longitude:-112.5433828 (NAD 83) Decimal Degrees
Northing:651213.02 IF
Easting:1195516.91 IF
Ground Elevation:5446.11 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

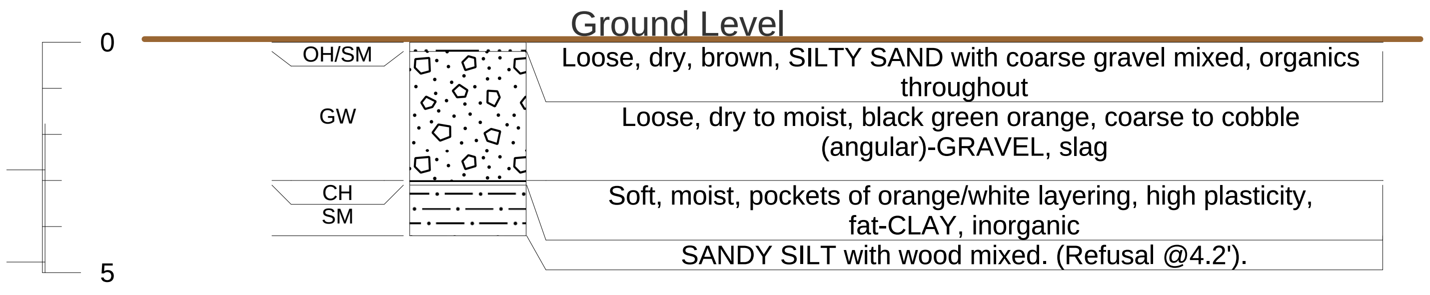
Test Pit Log

Test Pit Name: **BRW18-TP02**

Project: BRW Phase I Site Investigation	Location: Butte, MT
Well Owner: Atlantic Richfield Co.	Depth to Water (bgs): NA ft Date:NA Water Level from MP: NA ft Time:NA

Logged By: K. Jackson, J. Flammang	Date: 10/25/2018	Casing Type/Dia: None	Borehole Diameter: NA
Company: Hunter Brothers	Equipment: 312C Excavator	Screen Type/Length: None	

Elev. (NAVD 88) **Depth (ft.)** **USCS Class** **Lithology Log** Ground Elevation: 5451.77 ft (NAVD 88)



Loose, dry, brown, SILTY SAND with coarse gravel mixed, organics throughout

Loose, dry to moist, black green orange, coarse to cobble (angular)-GRAVEL, slag

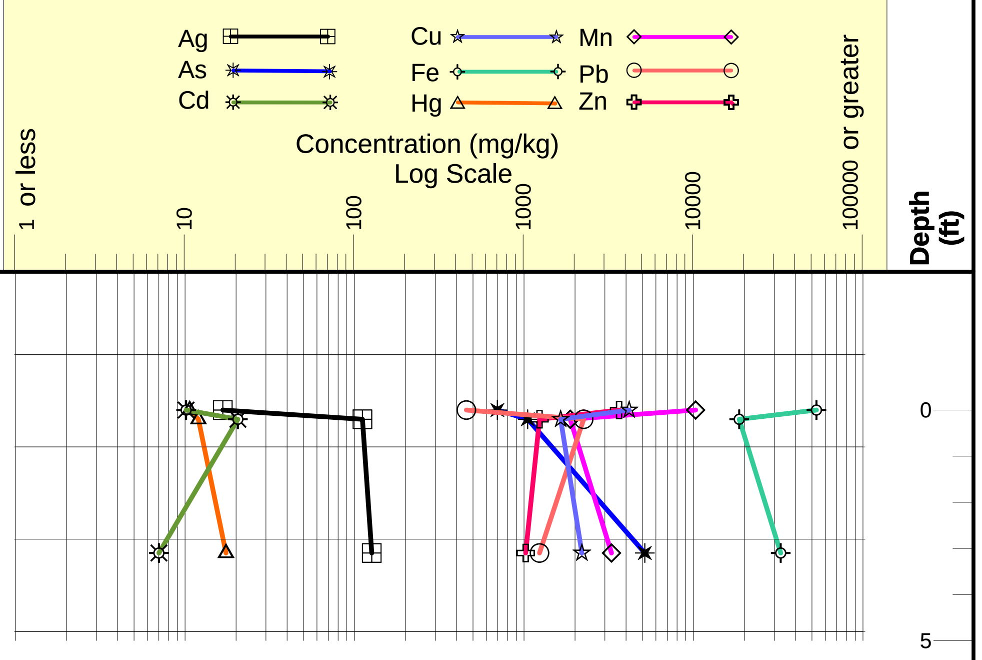
Soft, moist, pockets of orange/white layering, high plasticity, fat-CLAY, inorganic

SANDY SILT with wood mixed. (Refusal @4.2').

Headspace Reading

Depth (ft)	PID (MR) ppm	PID (uR) ppm	TEH mg/kg
0			
	2.7	0	62
5			

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS= Not Sampled

Lithology

Bedrock	Sandy Clay
Clay	Sandy Gravel
Clayey Sand	Sandy Silt
Clayey Silt	Silt
Gravel	Silty Clay
Sand	Silty Sand

Latitude: 45.9960766(NAD 83) Decimal Degrees
Longitude:-112.5435801 (NAD 83) Decimal Degrees
Northing:651642.05 IF
Easting:1195483.43 IF
Ground Elevation:5451.77 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Test Pit Log

Test Pit Name: **BRW18-TP03**

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): NA ft
Water Level from MP: NA ft
Date:NA
Time:NA

Logged By: K. Jackson, J. Flammang

Date: 10/25/2018

Casing Type/Dia: None

Borehole Diameter: NA

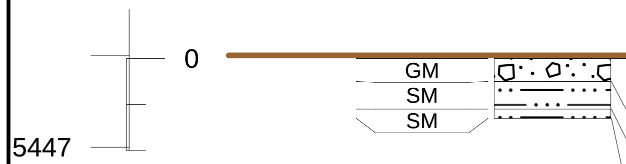
Company: Hunter Brothers

Equipment: 312C Excavator

Screen Type/Length: None

Elev. (NAVD 88) | **Depth (ft.)** | **USCS Class** | **Lithology Log** | Ground Elevation: 5448.93 ft (NAVD 88) | **Depth (ft)**

Ground Level



Hard, dry, black, coarse-GRAVEL with trace amounts of silt, asphalt crushed up, yellow paint throughout

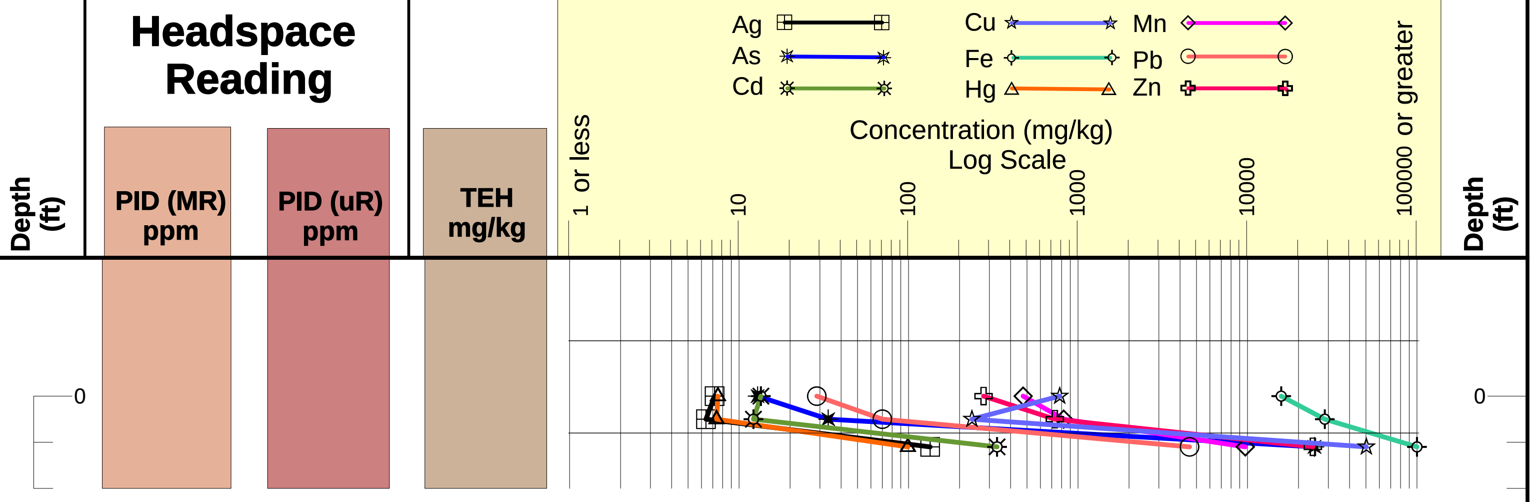
Medium dense, moist, dark brown, coarse SILTY SAND, fill

Soft, wet, orange/green/red, fine SILTY SAND with trace amounts of clay with fill underneath it, inorganic. (Refusal @1.3').

Headspace Reading

PID (MR) ppm | **PID (uR) ppm** | **TEH mg/kg**

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS= Not Sampled

Lithology

▨ Bedrock
▭ Clay
▨ Clayey Sand
▨ Clayey Silt
▨ Gravel
▨ Sand
▨ Sandy Clay
▨ Sandy Gravel
▨ Sandy Silt
▭ Silt
▨ Silty Clay
▨ Silty Sand

Latitude: 45.9957419(NAD 83) Decimal Degrees
Longitude:-112.5426441 (NAD 83) Decimal Degrees
Northing:651510.91 IF
Easting:1195716.3 IF
Ground Elevation:5448.93 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Test Pit Log

Test Pit Name: **BRW18-TP04**

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): NA ft
Water Level from MP: NA ft
Date:NA
Time:NA

Logged By: K. Jackson, J. Flammang

Date: 10/25/2018

Casing Type/Dia: None

Borehole Diameter: NA

Company: Hunter Brothers

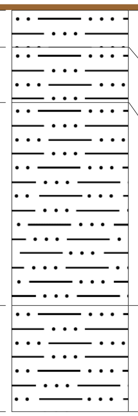
Equipment: 312C Excavator

Screen Type/Length: None

Ground Elevation: 5456.42 ft (NAVD 88)

Ground Level

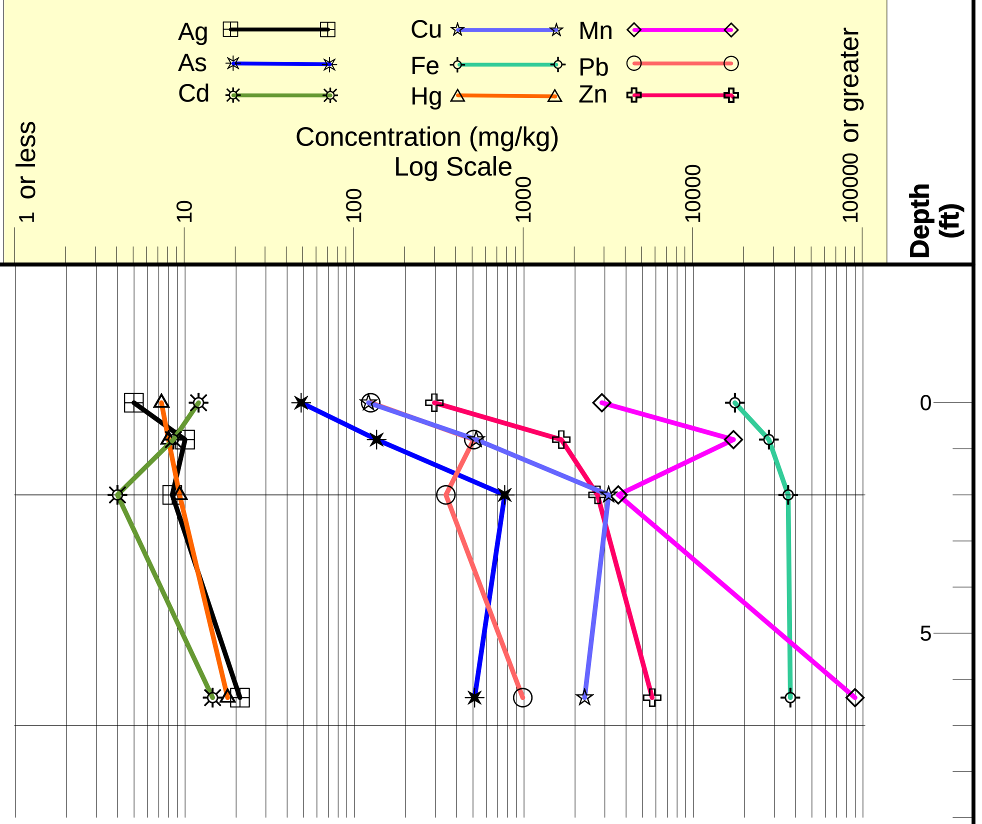
Elev. (NAVD 88)	Depth (ft.)	USCS Class	Lithology Log
	0	SW/OL	Loose, dry/moist, gray brown, SILTY SAND with fine to coarse gravel mixed, organic
		SM	Loose, moist, dark brown, silty coarse-SAND with coarse gravel mixed, micaceous
	5	SM/SP	Medium stiff, moist, red/dark brown, coarse silty-SAND with fine gravel mixed, chunks of slag, brick, and metal throughout
5449		SM/GW	Loose, moist, black, silty coarse-SAND with cobbles throughout, walls are more stable. (Refusal @8.7').



Headspace Reading

Depth (ft)	PID (MR) ppm	PID (uR) ppm	TEH mg/kg
0–5	ND	ND	NS

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS= Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Latitude: 45.9962226(NAD 83) Decimal Degrees
Longitude:-112.5417623 (NAD 83) Decimal Degrees
Northing:651677.3 IF
Easting:1195946.96 IF
Ground Elevation:5456.42 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Test Pit Log

Test Pit Name: BRW18-TP05

Project: BRW Phase I Site Investigation
Location: Butte, MT
Well Owner: Atlantic Richfield Co.
Depth to Water (bgs): NA ft
Water Level from MP: NA ft
Date:NA
Time:NA
Logged By: K. Jackson, J. Flammang
Date: 10/25/2018
Casing Type/Dia: None
Borehole Diameter: NA
Company: Hunter Brothers
Equipment: 312C Excavator
Screen Type/Length: None

Ground Elevation: 5448.1 ft (NAVD 88)

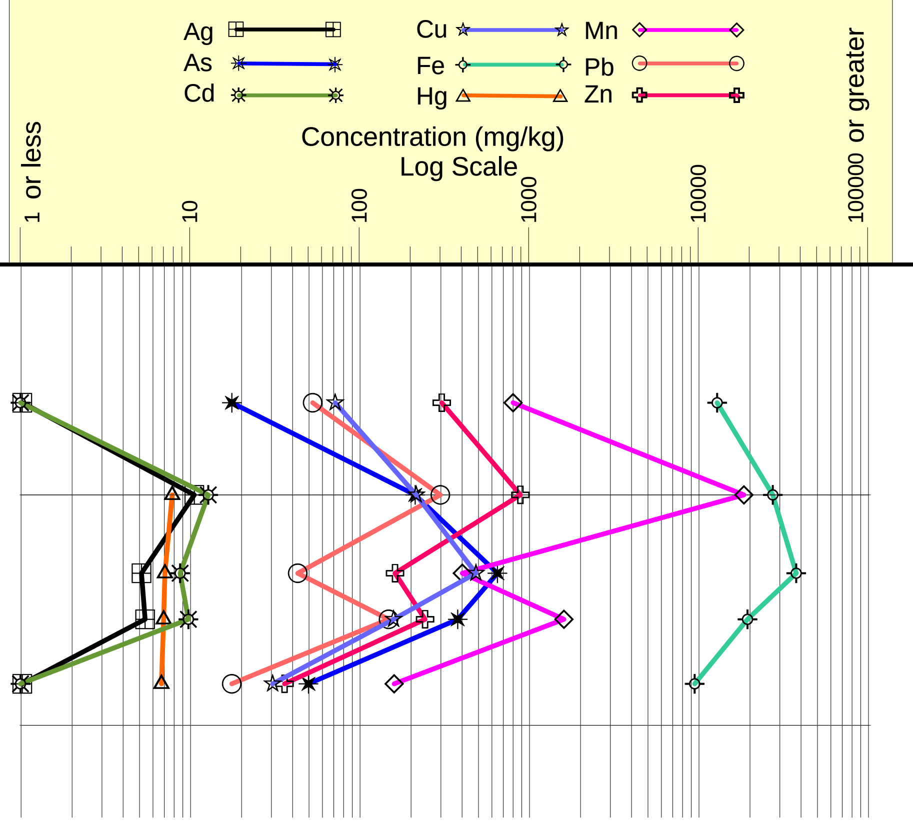
Ground Level

Elev. (NAVD 88)	Depth (ft.)	USCS Class	Lithology Log
	0	SW	Loose, moist/dry, medium brown, medium SILTY SAND with small gravel, micaceous, crusher fill
		GW/SW	Medium stiff, moist, black gray laminated layer, coarse SILTY SAND with coarse gravel mixed, brick/slag
		SM	Medium stiff/soft, moist, pink (first 1/4 ")/tan, fine SILTY SAND with trace fine gravel
	5	SW	Loose, moist, medium brown, coarse SILTY SAND with coarse gravel
5441		SP	Loose, moist/wet, light gray tan, medium to coarse SAND, crunchy beach sand. [Capillary Zone from bucket: (8.0-8.3)]
		SP	Loose, moist, white, medium to coarse SAND, crunchy beach sand, capillary zone. (Groundwater @8.3').

Headspace Reading

Depth (ft)	PID (MR) ppm	PID (uR) ppm	TEH mg/kg
0			
	ND	ND	NS
5			

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS= Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Latitude: 45.9949571(NAD 83) Decimal Degrees
Longitude:-112.5414379 (NAD 83) Decimal Degrees
Northing:651213.14 IF
Easting:1196011.39 IF
Ground Elevation:5448.1 ft (NAVD 88)

T3N R8W S24

Test Pit Log

Test Pit Name: BRW18-TP08

PIONEER TECHNICAL SERVICES, INC.

Project: BRW Phase I Site Investigation	Location: Butte, MT
Well Owner: Atlantic Richfield Co.	Depth to Water (bgs): NA ft Water Level from MP: NA ft Date:NA Time:NA
Logged By: K. Jackson, J. Flammang	Date: 10/24/2018
Casing Type/Dia: None	Borehole Diameter: NA
Company: Hunter Brothers	Equipment: 312C Excavator
Screen Type/Length: None	

Ground Elevation: 5448.38 ft (NAVD 88)

Elev. (NAVD 88) | Depth (ft.) | USCS Class | Lithology Log

Ground Level

Depth (ft.): 0, 5

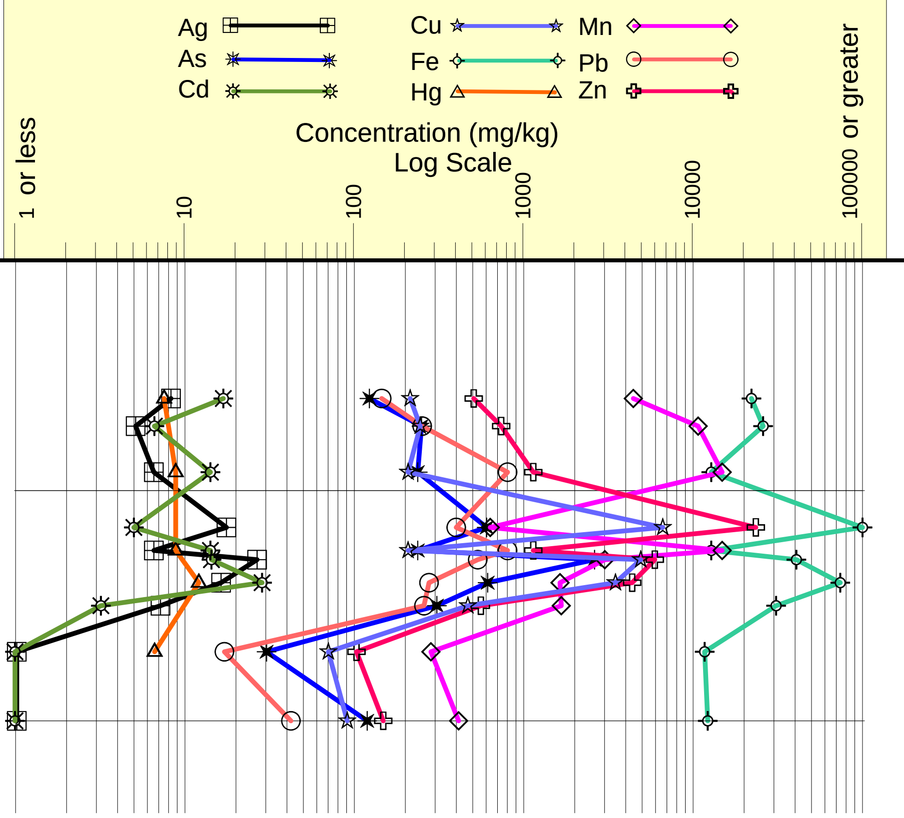
Elev.: 5441

USCS Class	Lithology Log
GW	Loose, dry, gray/brown, fine GRAVEL with silty sand, trace of asphalt
SM	Hard, dry to moist, medium brown/black, coarse SILTY SAND with trace of coarse gravel, construction debris (asphalt chunks, concrete)
SW	Hard, dry to moist, black/brown/red/orange, fine to coarse SAND with pocket of fine sand (3" in diameter), construction debris (wire, asphalt, concrete, brick)
GP	Loose, dry, black, fine angular GRAVEL with trace amount of silt (East side of test pit)
SC	Stiff, moist, white red gray black green (lamination all layers), clayey-SILT with fine sand mixed
SM	Loose, moist, white brown black, fine SILTY SAND, fill with white sand (crystal powder) mixed
SM	Loose, moist, red, medium SILTY SAND with trace of clay, chunks break apart very easily
SP	Loose , moist, brown/red/yellow, coarse SAND with trace of small gravel. [Capillary Zone from bucket: (7.0-7.8)]. (Groundwater @7.8').

Headspace Reading

Depth (ft)	PID (MR) ppm	PID (uR) ppm	TEH mg/kg
0–5	ND	ND	NS

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS= Not Sampled

Lithology

Bedrock	Sandy Clay
Clay	Sandy Gravel
Clayey Sand	Sandy Silt
Clayey Silt	Silt
Gravel	Silty Clay
Sand	Silty Sand

Latitude: 45.9953912(NAD 83) Decimal Degrees
Longitude:-112.5408733 (NAD 83) Decimal Degrees
Northing:651365.69 IF
Easting:1196160.86 IF
Ground Elevation:5448.38 ft (NAVD 88)

T3N R8W S24

PIONEER
TECHNICAL SERVICES, INC.

Test Pit Log

Test Pit Name: BRW18-TP09

Project: BRW Phase I Site Investigation

Location: Butte, MT

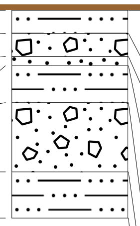
Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): NA ft Date:NA
Water Level from MP: NA ft Time:NA

Logged By: K. Jackson, J. Flammang
Date: 10/24/2018
Casing Type/Dia: None
Borehole Diameter: NA
Company: Hunter Brothers
Equipment: 312C Excavator
Screen Type/Length: None

Ground Elevation: 5449.99 ft (NAVD 88)

Ground Level

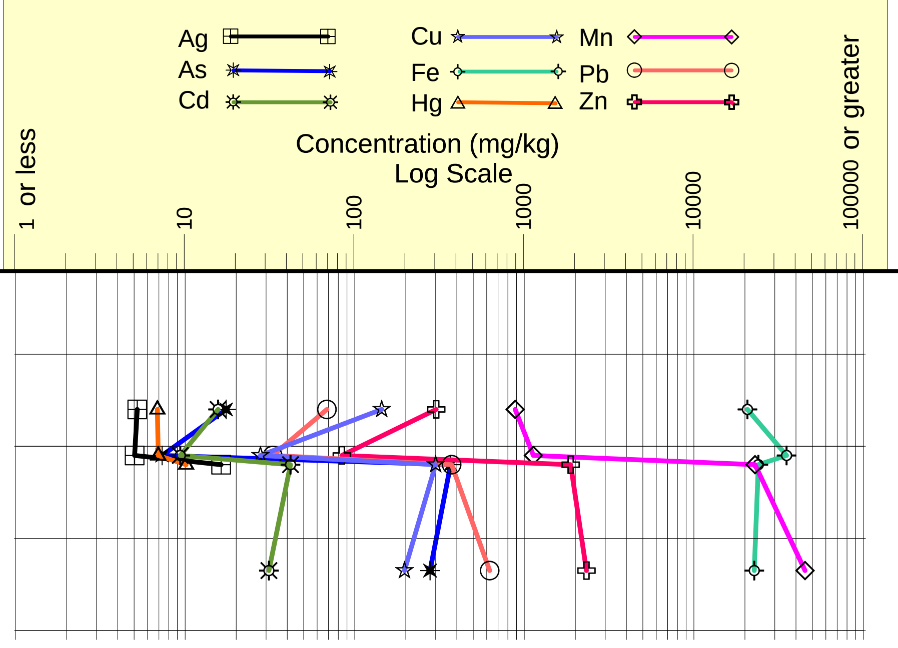


Elev. (NAVD 88)	Depth (ft.)	USCS Class	Lithology Log
	0	SW	Loose/hard, dry, brown black, fine SILTY SAND with mixture of coarse gravel and asphalt, degraded asphalt, micaceous
		GW	Hard, dry, black, asphalt, GRAVEL
		SW	Loose, moist, brown, coarse to fine SAND with fine gravel mixed, micaceous
		SM	Hard, dry/moist, dark brown, coarse SILTY SAND with coarse to cobble sized gravel mixed, fibers in this layer (rebar, metal pipe, railroad ties)
		GW	Hard, dry, gray/white, concrete chunks (hard slabs of concrete), GRAVEL, fibers in this layer, no fines
5445	5	SM	Loose, moist, light brown, coarse SILTY SAND with some fines, construction debris (brick, asphalt, rebar). [Concrete infrastructure, concrete wall with a metal/steel lid @4.5'].

Headspace Reading

Depth (ft)	PID (MR) ppm	PID (uR) ppm	TEH mg/kg
0–5	ND	ND	NS

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS= Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Latitude: 45.995496(NAD 83) Decimal Degrees
Longitude:-112.5408927 (NAD 83) Decimal Degrees
Northing:651404.07 IF
Easting:1196157.42 IF
Ground Elevation:5449.99 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Test Pit Log

Test Pit Name: BRW18-TP10

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): NA ft Date:NA
Water Level from MP: NA ft Time:NA

Logged By: K. Jackson, J. Flammang

Date: 10/24/2018

Casing Type/Dia: None

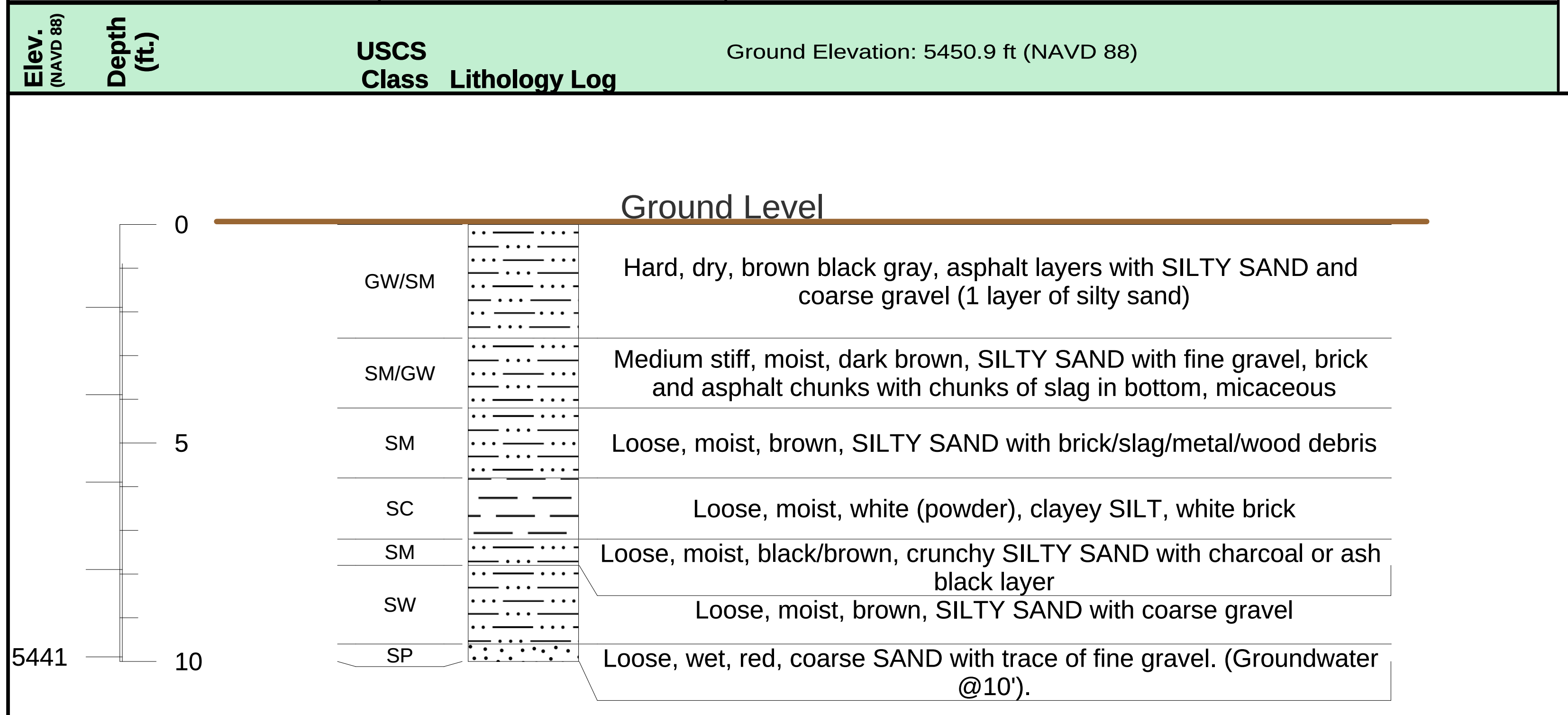
Borehole Diameter: NA

Company: Hunter Brothers

Equipment: 312C Excavator

Screen Type/Length: None

Ground Elevation: 5450.9 ft (NAVD 88)

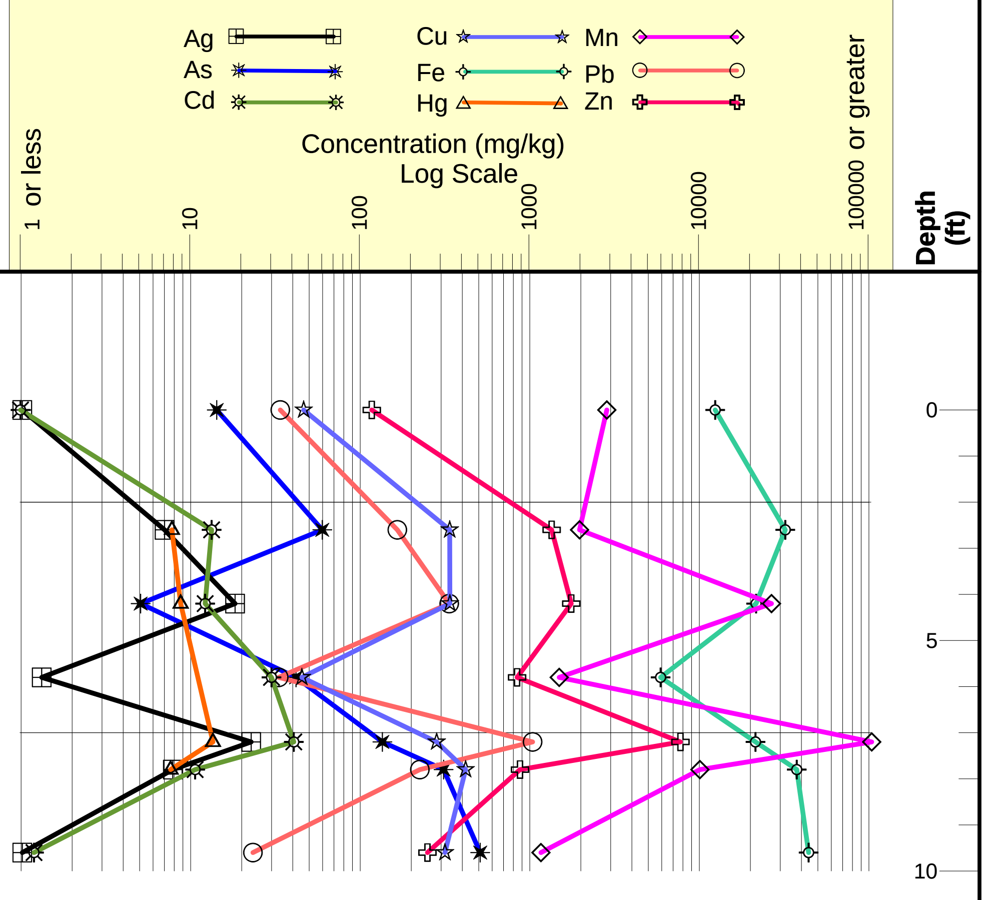


USCS Class	Lithology Log
GW/SM	Hard, dry, brown black gray, asphalt layers with SILTY SAND and coarse gravel (1 layer of silty sand)
SM/GW	Medium stiff, moist, dark brown, SILTY SAND with fine gravel, brick and asphalt chunks with chunks of slag in bottom, micaceous
SM	Loose, moist, brown, SILTY SAND with brick/slag/metal/wood debris
SC	Loose, moist, white (powder), clayey SILT, white brick
SM	Loose, moist, black/brown, crunchy SILTY SAND with charcoal or ash black layer
SW	Loose, moist, brown, SILTY SAND with coarse gravel
SP	Loose, wet, red, coarse SAND with trace of fine gravel. (Groundwater @10').

Headspace Reading

Depth (ft)	PID (MR) ppm	PID (uR) ppm	TEH mg/kg
	ND	ND	NS

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS= Not Sampled

Lithology

- Bedrock
- Clay
- Clayey Sand
- Clayey Silt
- Gravel
- Sand
- Sandy Clay
- Sandy Gravel
- Sandy Silt
- Silt
- Silty Clay
- Silty Sand

Latitude: 45.995682(NAD 83) Decimal Degrees
Longitude:-112.5407934 (NAD 83) Decimal Degrees
Northing:651470.84 IF
Easting:1196185.26 IF
Ground Elevation:5450.9 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Test Pit Log

Test Pit Name: BRW18-TP14

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): NA ft Date:NA
Water Level from MP: NA ft Time:NA

Logged By: K. Jackson, J. Flammang

Date: 10/23/2018

Casing Type/Dia: None

Borehole Diameter: NA

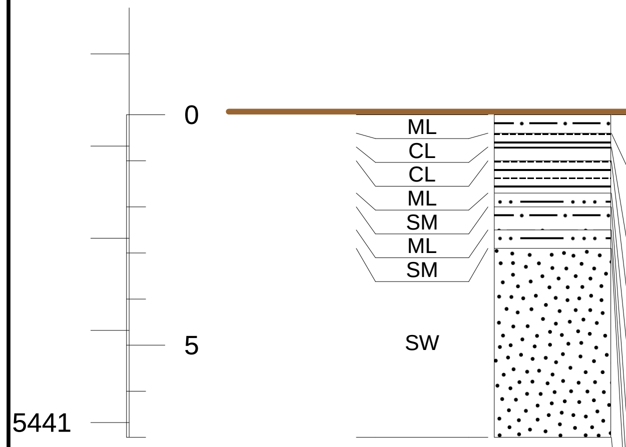
Company: Hunter Brothers

Equipment: 312C Excavator

Screen Type/Length: None

Elev. (NAVD 88) | Depth (ft.) | USCS Class | Lithology Log

Ground Elevation: 5447.68 ft (NAVD 88)



Ground Level

Loose, dry, medium brown, SANDY SILT with trace of small gravel, organics (some roots)

Medium stiff, dry, medium brown with orange staining, silty CLAY with small to coarse gravel in areas of orange staining, organics (some roots)

Medium stiff, dry, brown/black, sandy CLAY with small to large gravel, organics (some roots)

Stiff, moist, medium gray, clayey SILT with some small gravel, metal pieces, layer of wood mid way

Stiff, moist, medium gray to black with orange layering throughout, SILTY SAND with chunks of coarse to cobble gravel, micaceous, wood frame with concrete on inside

Stiff, moist, black with orange pockets, SANDY SILT with trace amounts of coarse gravel, with green rocks throughout

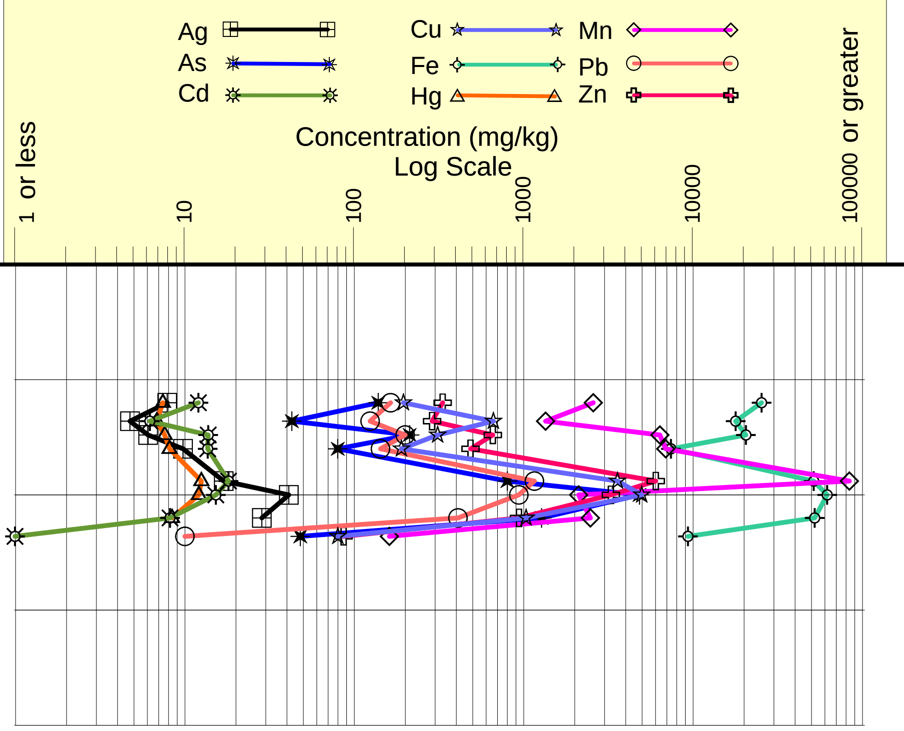
Medium stiff, moist, dark red, SILTY SAND with trace of fine gravel, micaceous

Medium stiff, moist, brown with red staining throughout, coarse SAND with trace of coarse gravel. (Groundwater @7.0').

Headspace Reading

Depth (ft)	PID (MR) ppm	PID (uR) ppm	TEH mg/kg
0			
	ND	ND	NS
5			

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS= Not Sampled

Lithology

Bedrock
Clay
Clayey Sand
Clayey Silt
Gravel
Sand
Sandy Clay
Sandy Gravel
Sandy Silt
Silt
Silty Clay
Silty Sand

Latitude: 45.9952264(NAD 83) Decimal Degrees
Longitude:-112.54023 (NAD 83) Decimal Degrees
Northing:651299.33 IF
Easting:1196321.83 IF
Ground Elevation:5447.68 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Test Pit Log

Test Pit Name: BRW18-TP15

Project: BRW Phase I Site Investigation
Location: Butte, MT
Well Owner: Atlantic Richfield Co.
Depth to Water (bgs): NA ft Date:NA
Water Level from MP: NA ft Time:NA
Logged By: K. Jackson, J. Flammang
Date: 10/24/2018
Casing Type/Dia: None
Borehole Diameter: NA
Company: Hunter Brothers
Equipment: 312C Excavator
Screen Type/Length: None

Ground Elevation: 5447.88 ft (NAVD 88)

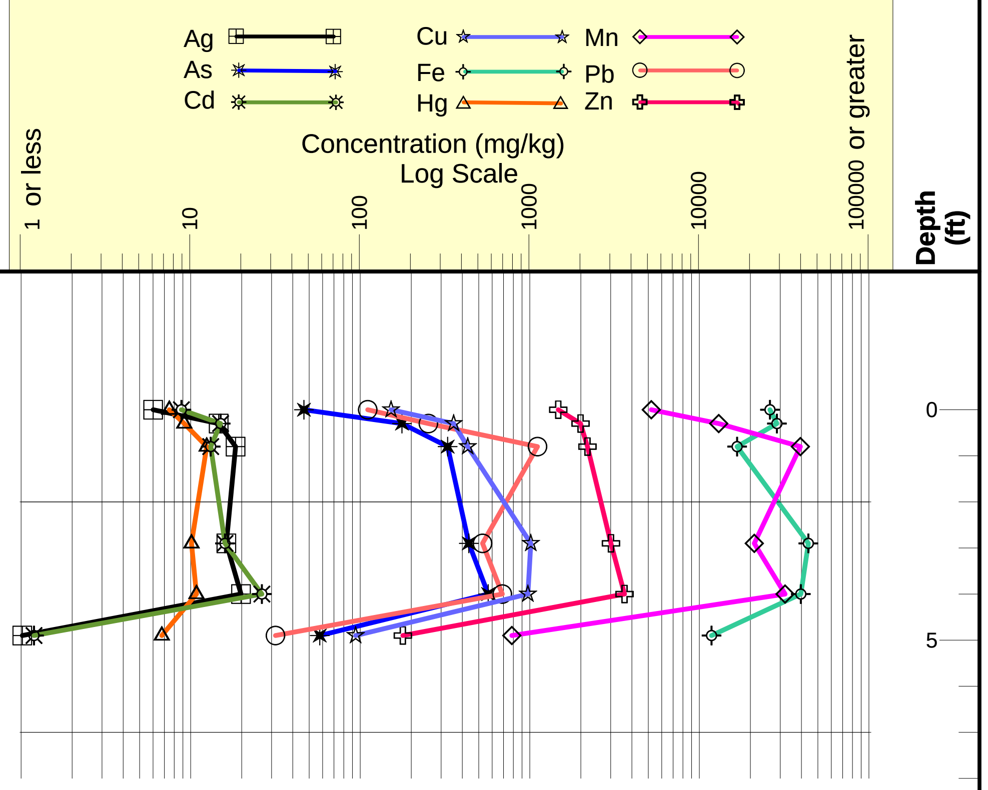
Ground Level

Elev. (NAVD 88)	Depth (ft.)	USCS Class	Lithology Log
	0	GP	Loose, dry, light brown, fine GRAVEL with trace amounts of silty sand, fill
		SM	Stiff, dry to moist, black brown red, SILTY SAND with coarse gravel, construction debris (brick, asphalt, concrete)
		SM/ML	Medium stiff, moist, SILTY SAND with trace of coarse gravel, extended layer of gray/black fine sandy clay with trace of wood, micaceous
	5	SM	Loose, moist, black with orange staining and pockets of lighter color, SILTY SAND with trace of fine gravel
5441		SP	Loose, moist to wet, black/brown with orange staining, fine to coarse SAND with trace small gravel, micaceous. (Groundwater @7.4').

Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
ND	ND	NS

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS= Not Sampled

Lithology

Bedrock	Sandy Clay
Clay	Sandy Gravel
Clayey Sand	Sandy Silt
Clayey Silt	Silt
Gravel	Silty Clay
Sand	Silty Sand

Latitude: 45.9952479(NAD 83) Decimal Degrees
Longitude:-112.5406101 (NAD 83) Decimal Degrees
Northing:651310.93 IF
Easting:1196225.65 IF
Ground Elevation:5447.88 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Test Pit Log

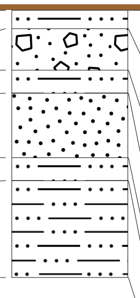
Test Pit Name: **BRW18-TP16**

Project: BRW Phase I Site Investigation	Location: Butte, MT
Well Owner: Atlantic Richfield Co.	Depth to Water (bgs): NA ft Water Level from MP: NA ft Date:NA Time:NA
Logged By: K. Jackson, J. Flammang	Date: 10/24/2018
Casing Type/Dia: None	Borehole Diameter: NA
Company: Hunter Brothers	Equipment: 312C Excavator
Screen Type/Length: None	

Elev. (NAVD 88) **Depth (ft.)** **USCS Class** **Lithology Log**

Ground Elevation: 5449 ft (NAVD 88)

Ground Level



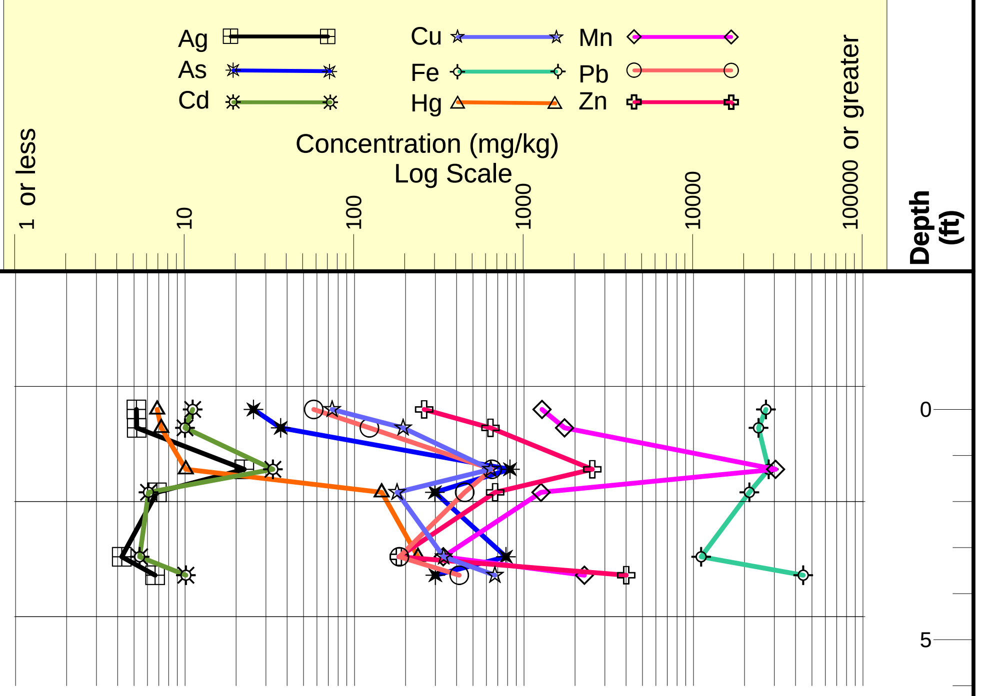
Depth (ft.)	USCS Class	Description
0	SW	Loose, dry, light brown, coarse SILTY SAND with coarse gravel, asphalt chunks
	GW	Hard, dry, brown/black, coarse GRAVEL with small amount of fines, construction debris(asphalt/concrete)
	SW	Medium stiff, moist, dark brown, fine SILTY SAND, chunks of slag, woody debris, brick, and wire throughout
	GM	Stiff, dry to moist, black white red brown, SAND, woody debris on top, construction debris(decomposed brick with ash)
	ML	Loose, dry to moist, black (powder), fine SILTY SAND, ash
5	GW/SM	Loose, dry to moist, green yellow orange, fine SILTY SAND with coarse to cobble sized slag. (Refusal @5.8').

Elev. 5443

Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
ND	ND	NS

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS= Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Latitude: 45.9955111(NAD 83) Decimal Degrees
Longitude:-112.5410008 (NAD 83) Decimal Degrees
Northing:651410.64 IF
Easting:1196130.2 IF
Ground Elevation:5449 ft (NAVD 88)

T3N R8W S24

Test Pit Log

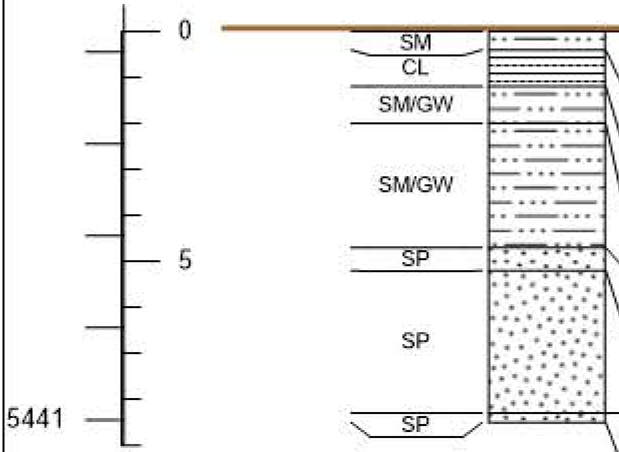
Test Pit Name: BRW18-TP17

PIONEER TECHNICAL SERVICES, INC.

Project: BRW Phase I Site Investigation
Location: Butte, MT
Well Owner: Atlantic Richfield Co.
Depth to Water (bgs): NA ft
Water Level from MP: NA ft
Date:NA
Time:NA
Logged By: K. Jackson, J. Flammang
Date: 10/25/2018
Casing Type/Dia: None
Borehole Diameter: NA
Company: Hunter Brothers
Equipment: 312C Excavator
Screen Type/Length: None

Elev. (NAVD 88) | Depth (ft.) | USCS Class | Lithology Log | Ground Elevation: 5449.45 ft (NAVD 88)

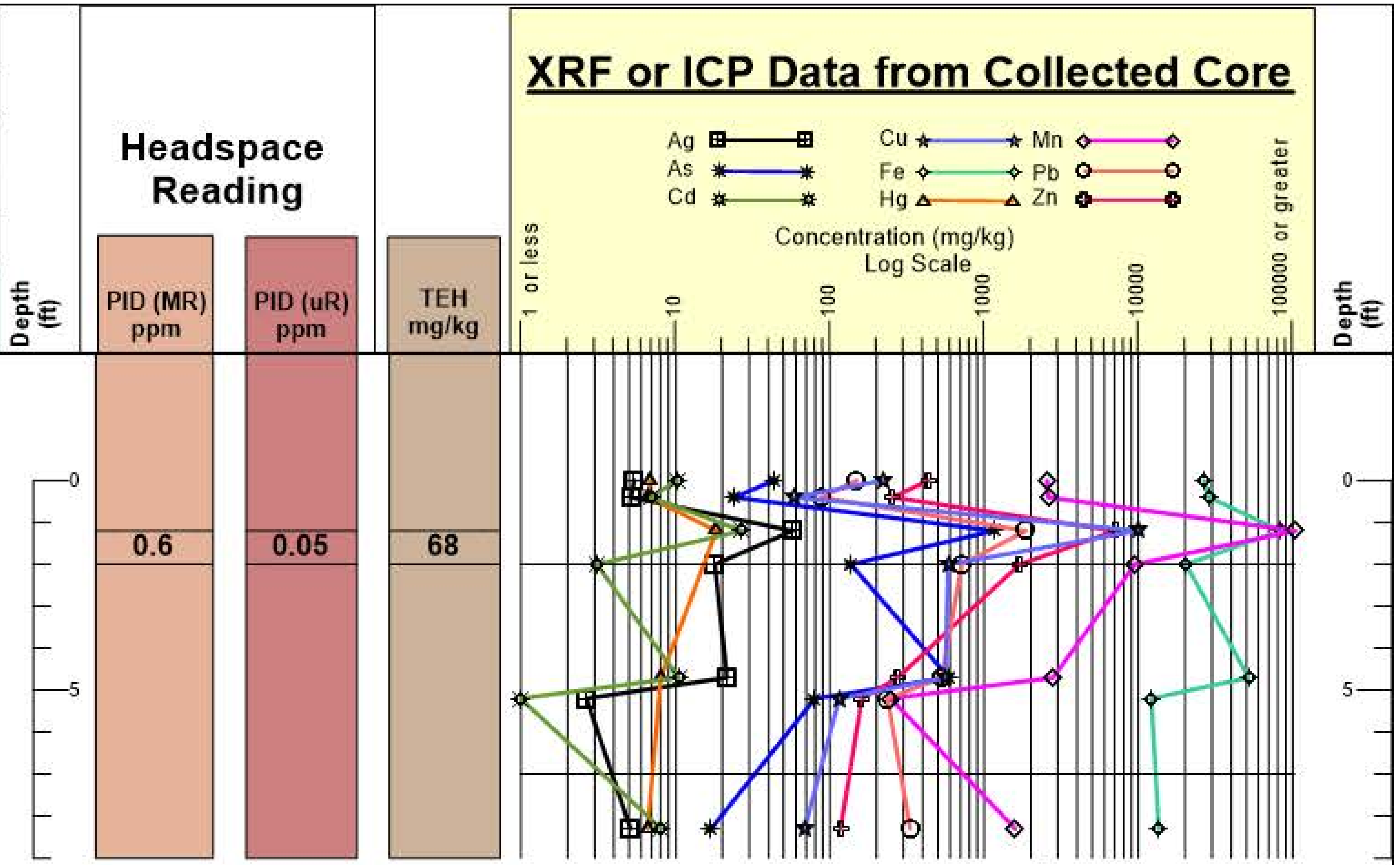
Ground Level



SM	Loose, dry, light brown, SILTY SAND with fine gravel mixed, fill from BSB
CL	Stiff, dry, medium to light brown, SILTY CLAY mixed with fine sand and trace of coarse gravel
SM/GW	Loose, dry to moist, brown black, SILTY SAND with coarse gravel, brick/metal fence posts/slag stained black with green
SM/GW	Loose, dry to moist, dark brown, coarse SILTY SAND with trace of cobble sized gravel
SP	Loose, moist, black, coarse SAND with silt, black layer two inches above silt layer
SP	Loose, moist, brown, coarse SAND with coarse gravel
SP	Loose, moist, orange red, coarse SAND with coarse gravel, capillary zone. (Groundwater @8.5').

Headspace Reading

XRF or ICP Data from Collected Core



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS= Not Sampled

Lithology

Bedrock	Sandy Clay
Clay	Sandy Gravel
Clayey Sand	Sandy Silt
Clayey Silt	Silt
Gravel	Silty Clay
Sand	Silty Sand

Latitude: 45.9954076(NAD 83) Decimal Degrees
Longitude:-112.5413658 (NAD 83) Decimal Degrees
Northing:651376.51 IF
Easting:1196036.06 IF
Ground Elevation:5449.45 ft (NAVD 88)

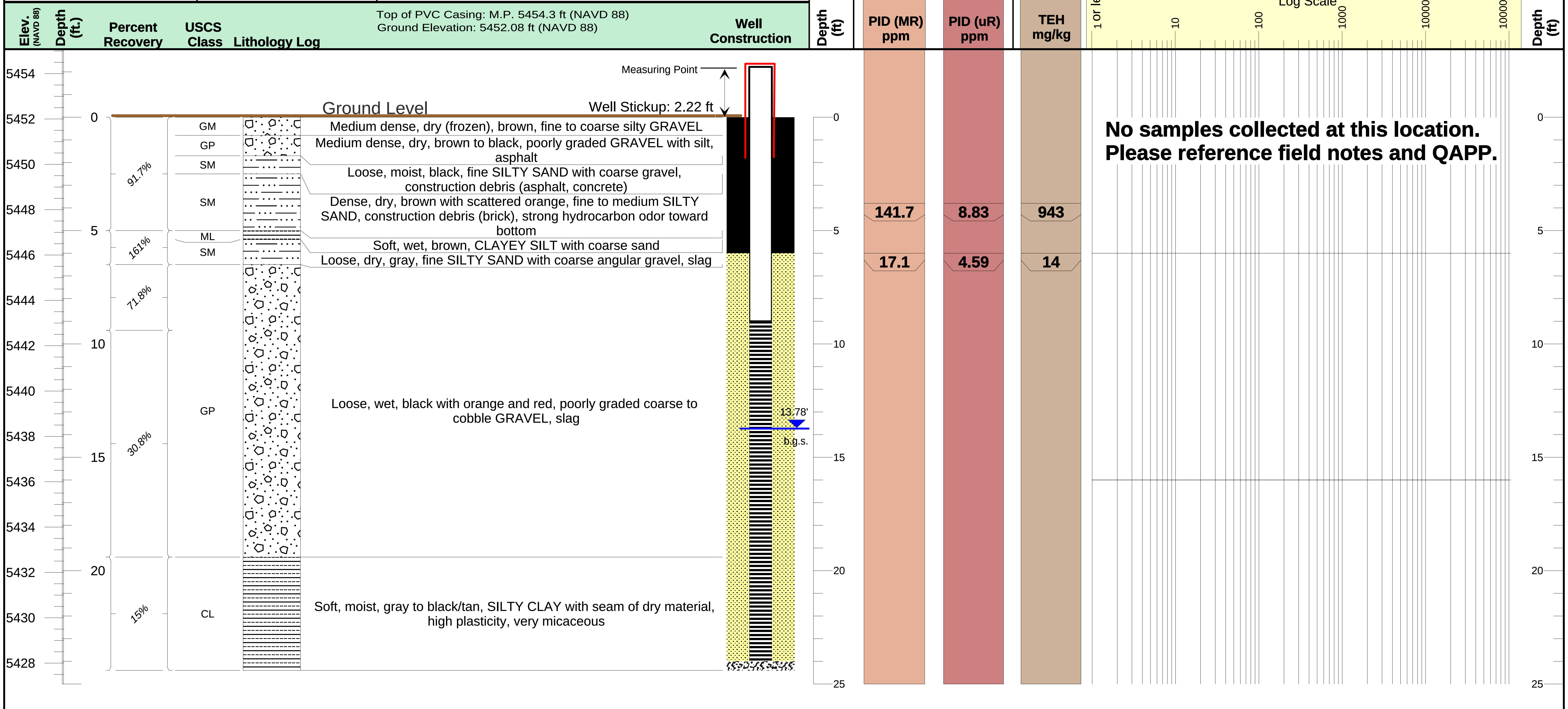
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Hydrocarbon Monitoring Well Log

Well Name: BRW19-HCW30

Project: BRW Phase I Site Investigation
Location: Butte, MT
Well Owner: Atlantic Richfield Co.
Depth to Water (bgs): 13.78 ft
Water Level from MP: 16 ft
Date:1/20/2020
Time:10:16
Logged By: K.Jackson, M. Pomeroy
Date Drilled: 12/18/2019
Casing Type/Dia: PVC/2"
Borehole Diameter: 6"
Drilling Company: O'Keefe Drilling
Drilling Method: Sonic
Screen Type/Length:PVC/15'
Top of PVC Casing: M.P. 5454.3 ft (NAVD 88)
Ground Elevation: 5452.08 ft (NAVD 88)



USCS Class	Lithology Log
GM	Medium dense, dry (frozen), brown, fine to coarse silty GRAVEL
GP	Medium dense, dry, brown to black, poorly graded GRAVEL with silt, asphalt
SM	Loose, moist, black, fine SILTY SAND with coarse gravel, construction debris (asphalt, concrete)
SM	Dense, dry, brown with scattered orange, fine to medium SILTY SAND, construction debris (brick), strong hydrocarbon odor toward bottom
ML	Soft, wet, brown, CLAYEY SILT with coarse sand
SM	Loose, dry, gray, fine SILTY SAND with coarse angular gravel, slag
GP	Loose, wet, black with orange and red, poorly graded coarse to cobble GRAVEL, slag
CL	Soft, moist, gray to black/tan, SILTY CLAY with seam of dry material, high plasticity, very micaceous

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
141.7	8.83	943
17.1	4.59	14

No samples collected at this location. Please reference field notes and QAPP.

Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:6-24 ft
Screen Interval:9-24 ft
below ground surface (b.g.s.)
photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

- Bedrock
- Clay
- Clayey Sand
- Clayey Silt
- Gravel
- Sand
- Sandy Clay
- Sandy Gravel
- Sandy Silt
- Silt
- Silty Clay
- Silty Sand

Well Construction

- Screen
- ■ Bentonite
- ☐ PVC Casing
- 10/20 Sand Filter Pack
- Natural Completion
- Prepack
- Steel Protective Casing

Pg.1 of 1

Latitude: (NAD 83) Decimal Degrees
Longitude: (NAD 83) Decimal Degrees
Northing:651450.51 IF
Easting:1195374.59 IF
Ground Elevation:5452.08 ft (NAVD 88)
Measuring Point Elevation:5454.3 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Hydrocarbon Monitoring Well Log

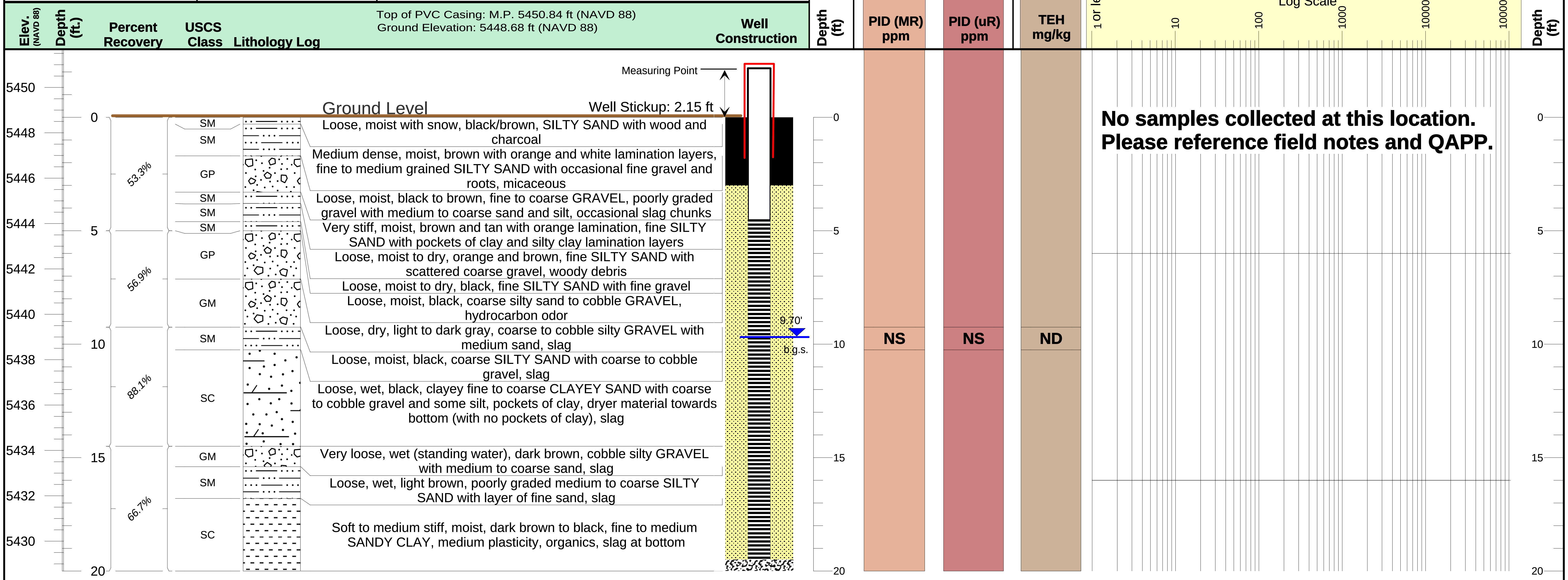
Well Name: BRW19-HCW31

Project: BRW Phase I Site Investigation
Location: Butte, MT
Well Owner: Atlantic Richfield Co.
Depth to Water (bgs): 9.70 ft
Water Level from MP: 11.86 ft
Date:1/27/2020
Time:11:07
Logged By: K.Jackson, M. Pomeroy
Date Drilled: 12/16/2019
Casing Type/Dia: PVC/2"
Borehole Diameter: 6"
Drilling Company: O'Keefe Drilling
Drilling Method: Sonic
Screen Type/Length:PVC/15'

Top of PVC Casing: M.P. 5450.84 ft (NAVD 88)
Ground Elevation: 5448.68 ft (NAVD 88)

Headspace Reading

XRF or ICP Data from Collected Core



Loose, moist with snow, black/brown, SILTY SAND with wood and charcoal

Medium dense, moist, brown with orange and white lamination layers, fine to medium grained SILTY SAND with occasional fine gravel and roots, micaceous

Loose, moist, black to brown, fine to coarse GRAVEL, poorly graded gravel with medium to coarse sand and silt, occasional slag chunks

Very stiff, moist, brown and tan with orange lamination, fine SILTY SAND with pockets of clay and silty clay lamination layers

Loose, moist to dry, orange and brown, fine SILTY SAND with scattered coarse gravel, woody debris

Loose, moist to dry, black, fine SILTY SAND with fine gravel

Loose, moist, black, coarse silty sand to cobble GRAVEL, hydrocarbon odor

Loose, dry, light to dark gray, coarse to cobble silty GRAVEL with medium sand, slag

Loose, moist, black, coarse SILTY SAND with coarse to cobble gravel, slag

Loose, wet, black, clayey fine to coarse CLAYEY SAND with coarse to cobble gravel and some silt, pockets of clay, dryer material towards bottom (with no pockets of clay), slag

Very loose, wet (standing water), dark brown, cobble silty GRAVEL with medium to coarse sand, slag

Loose, wet, light brown, poorly graded medium to coarse SILTY SAND with layer of fine sand, slag

Soft to medium stiff, moist, dark brown to black, fine to medium SANDY CLAY, medium plasticity, organics, slag at bottom

No samples collected at this location. Please reference field notes and QAPP.

Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:3-19.4 ft
Screen Interval:4.5-19.5 ft
below ground surface
(b.g.s.)
photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

🟧	Bedrock	▨	Sandy Clay
▤	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▤	Clayey Silt	▭	Silt
▨	Gravel	▤	Silty Clay
▨	Sand	▨	Silty Sand

Well Construction

▤	Screen	🟨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
□	PVC Casing	🟦	Prepack
		🟥	Steel Protective Casing

Latitude: (NAD 83) Decimal Degrees
Longitude: (NAD 83) Decimal Degrees
Northing:651587.17 IF
Easting:1195529.21 IF
Ground Elevation:5448.68 ft (NAVD 88)
Measuring Point Elevation:5450.84 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Hydrocarbon Monitoring Well Log

Well Name: BRW19-HCW32

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 12.80 ft
Water Level from MP: 15.02 ft
Date:1/27/2020
Time:11:10

Logged By: K.Jackson, M. Pomeroy

Date Drilled: 12/19/2019

Casing Type/Dia: PVC/2"

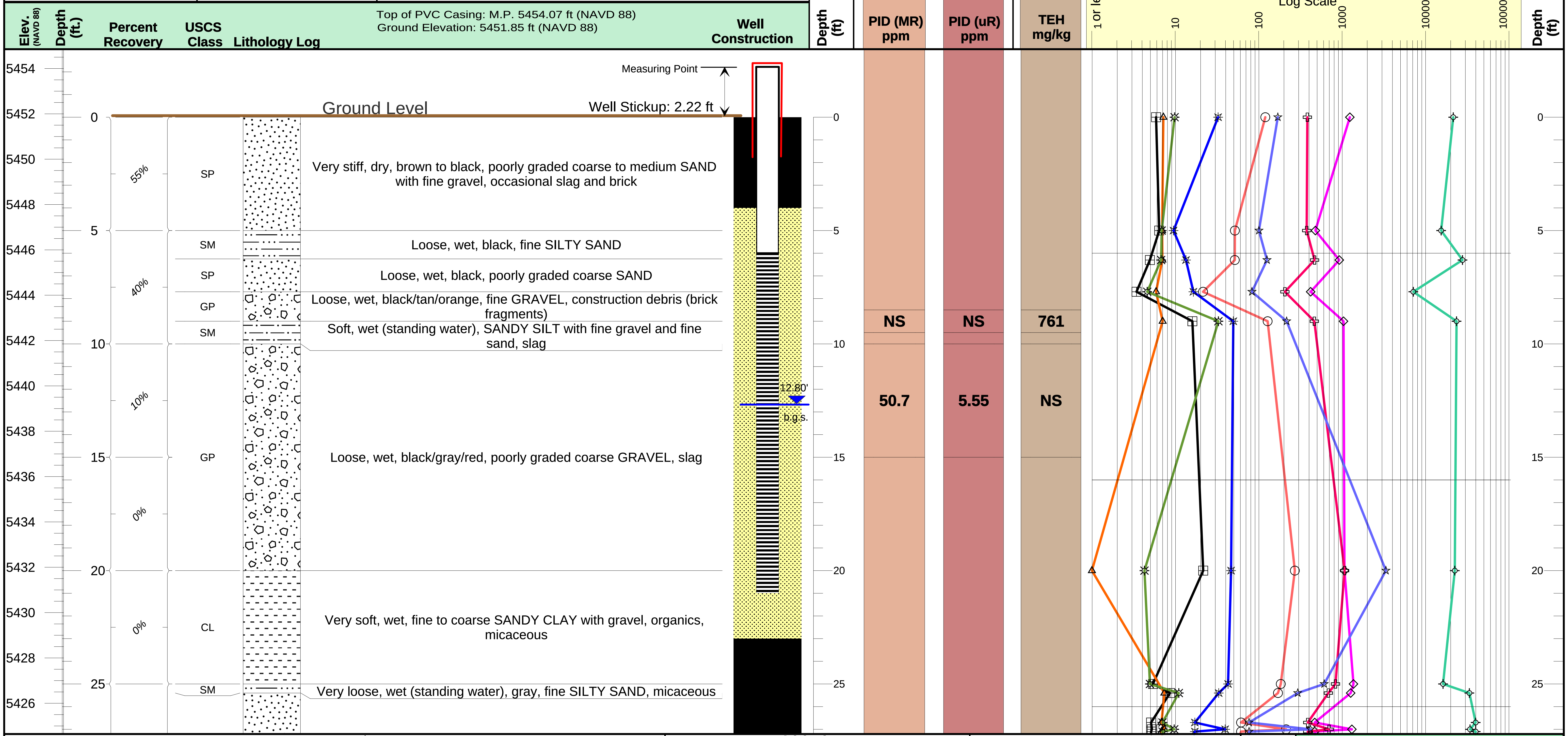
Borehole Diameter: 6"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length:PVC/15'

Top of PVC Casing: M.P. 5454.07 ft (NAVD 88)
Ground Elevation: 5451.85 ft (NAVD 88)



Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:4-23 ft
Screen Interval:6-21 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

Bedrock	Sandy Clay
Clay	Sandy Gravel
Clayey Sand	Sandy Silt
Clayey Silt	Silt
Gravel	Silty Clay
Sand	Silty Sand

Well Construction

Screen	10/20 Sand Filter Pack
Bentonite	Natural Completion
PVC Casing	Prepack
	Steel Protective Casing

Latitude: (NAD 83) Decimal Degrees
Longitude: (NAD 83) Decimal Degrees
Northing:651556.2 IF
Easting:1195703.74 IF
Ground Elevation:5451.85 ft (NAVD 88)
Measuring Point Elevation:5454.07 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Hydrocarbon Monitoring Well Log

Well Name: BRW19-HCW32

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 12.80 ft
Water Level from MP: 15.02 ft
Date:1/27/2020
Time:11:10

Logged By: K.Jackson, M. Pomeroy

Date Drilled: 12/19/2019

Casing Type/Dia: PVC/2"

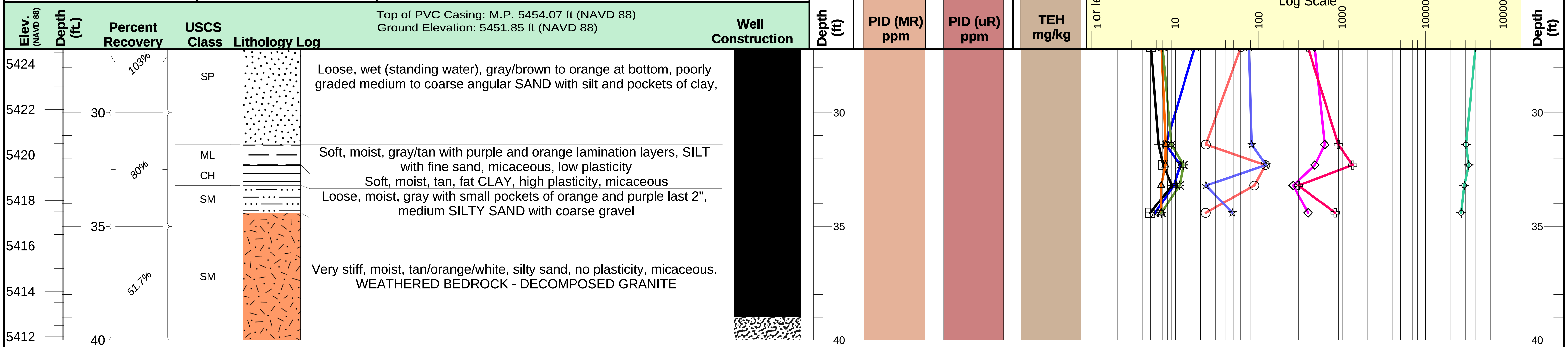
Borehole Diameter: 6"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length:PVC/15'

Top of PVC Casing: M.P. 5454.07 ft (NAVD 88)
Ground Elevation: 5451.85 ft (NAVD 88)



Loose, wet (standing water), gray/brown to orange at bottom, poorly graded medium to coarse angular SAND with silt and pockets of clay,

Soft, moist, gray/tan with purple and orange lamination layers, SILT with fine sand, micaceous, low plasticity

Soft, moist, tan, fat CLAY, high plasticity, micaceous

Loose, moist, gray with small pockets of orange and purple last 2", medium SILTY SAND with coarse gravel

Very stiff, moist, tan/orange/white, silty sand, no plasticity, micaceous. WEATHERED BEDROCK - DECOMPOSED GRANITE

Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

Filter Pack Interval:4-23 ft
Screen Interval:6-21 ft
below ground surface
(b.g.s.)
photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

- ▨ Bedrock
- ▨ Clay
- ▨ Clayey Sand
- ▨ Clayey Silt
- ▨ Gravel
- ▨ Sand
- ▨ Sandy Clay
- ▨ Sandy Gravel
- ▨ Sandy Silt
- ▨ Silt
- ▨ Silty Clay
- ▨ Silty Sand

Well Construction

- ▤ Screen
- ■ Bentonite
- □ PVC Casing
- ▨ 10/20 Sand Filter Pack
- ▨ Natural Completion
- ■ Prepack
- ⊓ Steel Protective Casing

Latitude: (NAD 83) Decimal Degrees
Longitude: (NAD 83) Decimal Degrees
Northing:651556.2 IF
Easting:1195703.74 IF
Ground Elevation:5451.85 ft (NAVD 88)
Measuring Point Elevation:5454.07 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Hydrocarbon Monitoring Well Log

Well Name: BRW19-HCW33R

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 10.36 ft
Water Level from MP: 12.3 ft

Date:1/27/2020
Time:11:12

Logged By: K.Jackson, N. Farley

Date Drilled: 1/13/2020

Casing Type/Dia: PVC/2"

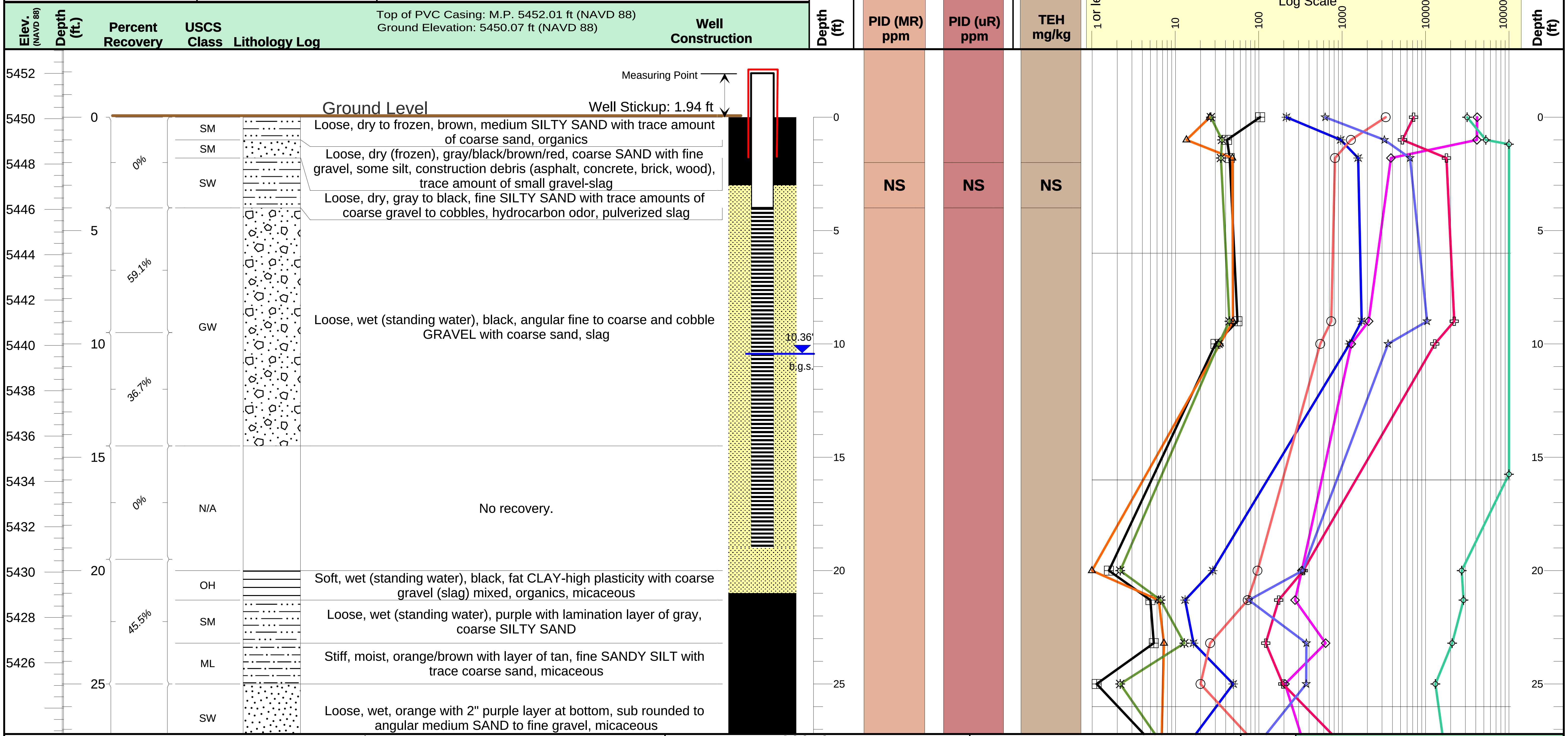
Borehole Diameter: 6"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length:PVC/15'

Top of PVC Casing: M.P. 5452.01 ft (NAVD 88)
Ground Elevation: 5450.07 ft (NAVD 88)



USCS Class	Lithology Log
SM	Loose, dry to frozen, brown, medium SILTY SAND with trace amount of coarse sand, organics
SM	Loose, dry (frozen), gray/black/brown/red, coarse SAND with fine gravel, some silt, construction debris (asphalt, concrete, brick, wood), trace amount of small gravel-slag
SW	Loose, dry, gray to black, fine SILTY SAND with trace amounts of coarse gravel to cobbles, hydrocarbon odor, pulverized slag
GW	Loose, wet (standing water), black, angular fine to coarse and cobble GRAVEL with coarse sand, slag
N/A	No recovery.
OH	Soft, wet (standing water), black, fat CLAY-high plasticity with coarse gravel (slag) mixed, organics, micaceous
SM	Loose, wet (standing water), purple with lamination layer of gray, coarse SILTY SAND
ML	Stiff, moist, orange/brown with layer of tan, fine SANDY SILT with trace coarse sand, micaceous
SW	Loose, wet, orange with 2" purple layer at bottom, sub rounded to angular medium SAND to fine gravel, micaceous

Driller: L. Phillips
Monitoring Well License # 704
Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).
3. XRF or ICP data from 0" to 10' bgs is from BRW19-HCW33.
Please reference field notes for further explanation.

Filter Pack Interval:3-21 ft
Screen Interval:4-19 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▤	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▤	Clayey Silt	▭	Silt
▨	Gravel	▤	Silty Clay
▨	Sand	▨	Silty Sand

Well Construction

▤	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
☐	PVC Casing	🟦	Prepack
		🟥	Steel Protective Casing

Latitude: (NAD 83) Decimal Degrees
Longitude: (NAD 83) Decimal Degrees
Northing:651518.73 IF
Easting:1195856.52 IF
Ground Elevation:5450.07 ft (NAVD 88)
Measuring Point Elevation:5452.01 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Hydrocarbon Monitoring Well Log

Well Name: BRW19-HCW33R

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 10.36 ft
Water Level from MP: 12.3 ft
Date:1/27/2020
Time:11:12

Logged By: K.Jackson, N. Farley

Date Drilled: 1/13/2020

Casing Type/Dia: PVC/2"

Borehole Diameter: 6"

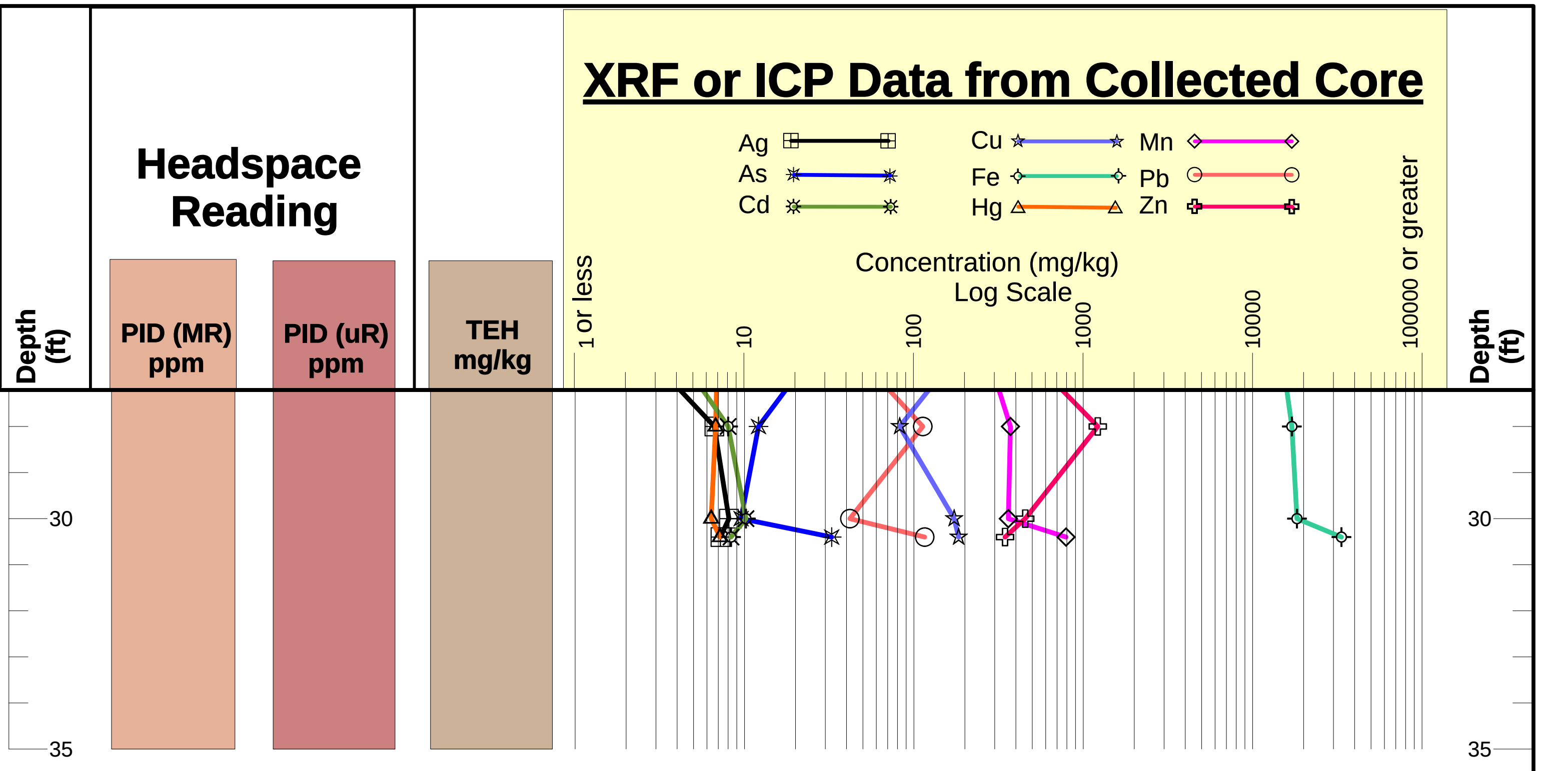
Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length:PVC/15'

Top of PVC Casing: M.P. 5452.01 ft (NAVD 88)
Ground Elevation: 5450.07 ft (NAVD 88)

Elev. (NAVD 88)	Depth (ft.)	Percent Recovery	USCS Class	Lithology Log		Well Construction
		63.3%				
			MH		Dense, moist, gray, fine SANDY SILT with 1.5" clay layer at top, micaceous	
	30	60%	SM		Loose, moist, brown, medium SILTY SAND with trace coarse gravel, micaceous	
			SW		Loose, moist, purple/brown, well graded coarse SAND with coarse gravel, small amount of silt	
			SM		Hard, dry, white/orange/brown, fine silty sand, micaceous. WEATHERED BEDROCK to BEDROCK- DECOMPOSED GRANITE	
	35					



Driller: L. Phillips
Monitoring Well License # 704
Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).
3. XRF or ICP data from 0" to 10' bgs is from BRW19-HCW33.
Please reference field notes for further explanation.

Filter Pack Interval:3-21 ft
Screen Interval:4-19 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Well Construction

▤	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
□	PVC Casing	■	Prepack
		⊓	Steel Protective Casing

Latitude: (NAD 83) Decimal Degrees
Longitude: (NAD 83) Decimal Degrees
Northing:651518.73 IF
Easting:1195856.52 IF
Ground Elevation:5450.07 ft (NAVD 88)
Measuring Point Elevation:5452.01 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Hydrocarbon Monitoring Well Log

Well Name: BRW19-HCW34

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 9.41 ft
Water Level from MP: 11.45 ft
Date:1/27/2020
Time:11:16

Logged By: K.Jackson, N. Farley

Date Drilled: 1/10/2020

Casing Type/Dia: PVC/2"

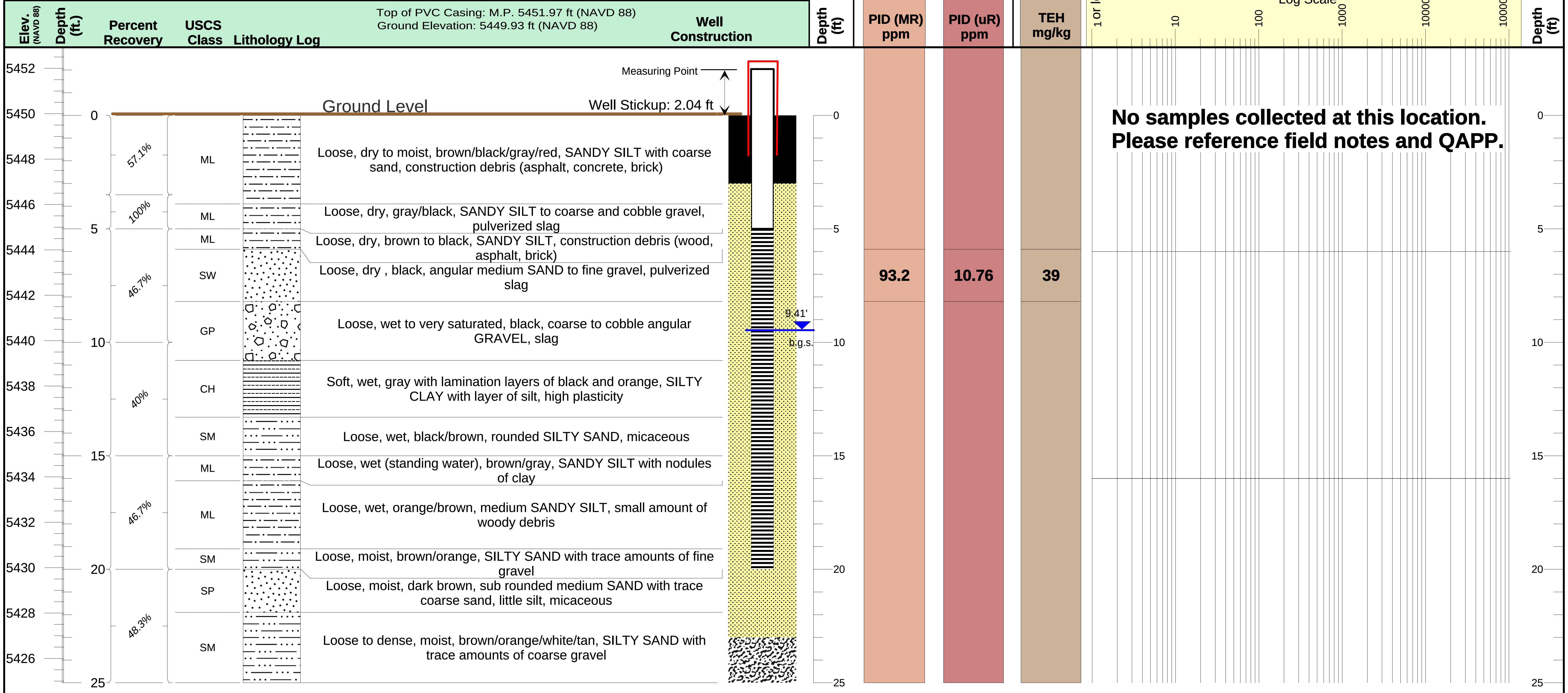
Borehole Diameter: 6"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length:PVC/15'

Top of PVC Casing: M.P. 5451.97 ft (NAVD 88)
Ground Elevation: 5449.93 ft (NAVD 88)



USCS Class	Lithology Log
ML	Loose, dry to moist, brown/black/gray/red, SANDY SILT with coarse sand, construction debris (asphalt, concrete, brick)
ML	Loose, dry, gray/black, SANDY SILT to coarse and cobble gravel, pulverized slag
ML	Loose, dry, brown to black, SANDY SILT, construction debris (wood, asphalt, brick)
SW	Loose, dry , black, angular medium SAND to fine gravel, pulverized slag
GP	Loose, wet to very saturated, black, coarse to cobble angular GRAVEL, slag
CH	Soft, wet, gray with lamination layers of black and orange, SILTY CLAY with layer of silt, high plasticity
SM	Loose, wet, black/brown, rounded SILTY SAND, micaceous
ML	Loose, wet (standing water), brown/gray, SANDY SILT with nodules of clay
ML	Loose, wet, orange/brown, medium SANDY SILT, small amount of woody debris
SM	Loose, moist, brown/orange, SILTY SAND with trace amounts of fine gravel
SP	Loose, moist, dark brown, sub rounded medium SAND with trace coarse sand, little silt, micaceous
SM	Loose to dense, moist, brown/orange/white/tan, SILTY SAND with trace amounts of coarse gravel

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
93.2	10.76	39

No samples collected at this location. Please reference field notes and QAPP.

Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Criteria.

Filter Pack Interval:3-23 ft
Screen Interval:5-20 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Well Construction

☰	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
□	PVC Casing	■	Prepack
		⊓	Steel Protective Casing

Latitude: (NAD 83) Decimal Degrees
Longitude: (NAD 83) Decimal Degrees
Northing:651484.16 IF
Easting:1195915.52 IF
Ground Elevation:5449.93 ft (NAVD 88)
Measuring Point Elevation:5451.97 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Hydrocarbon Monitoring Well Log

Well Name: BRW19-HCW35

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 10.19 ft
Water Level from MP: 11.87 ft
Date:1/27/2020
Time:11:17

Logged By: K.Jackson, N. Farley

Date Drilled: 1/9/2020

Casing Type/Dia: PVC/2"

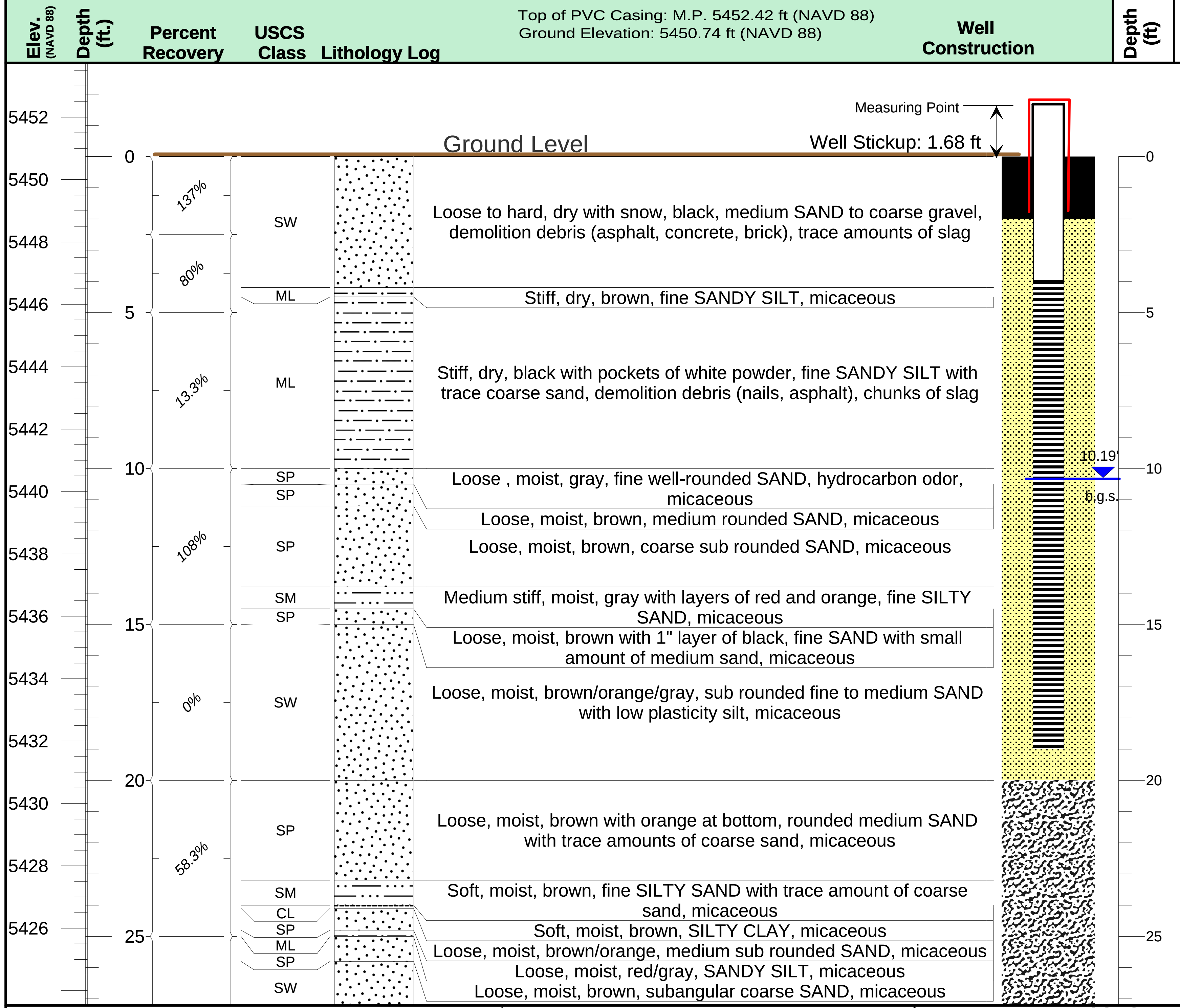
Borehole Diameter: 6"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length:PVC/15'

Top of PVC Casing: M.P. 5452.42 ft (NAVD 88)
Ground Elevation: 5450.74 ft (NAVD 88)



Loose to hard, dry with snow, black, medium SAND to coarse gravel, demolition debris (asphalt, concrete, brick), trace amounts of slag

Stiff, dry, brown, fine SANDY SILT, micaceous

Stiff, dry, black with pockets of white powder, fine SANDY SILT with trace coarse sand, demolition debris (nails, asphalt), chunks of slag

Loose , moist, gray, fine well-rounded SAND, hydrocarbon odor, micaceous

Loose, moist, brown, medium rounded SAND, micaceous

Loose, moist, brown, coarse sub rounded SAND, micaceous

Medium stiff, moist, gray with layers of red and orange, fine SILTY SAND, micaceous

Loose, moist, brown with 1" layer of black, fine SAND with small amount of medium sand, micaceous

Loose, moist, brown/orange/gray, sub rounded fine to medium SAND with low plasticity silt, micaceous

Loose, moist, brown with orange at bottom, rounded medium SAND with trace amounts of coarse sand, micaceous

Soft, moist, brown, fine SILTY SAND with trace amount of coarse sand, micaceous

Soft, moist, brown, SILTY CLAY, micaceous

Loose, moist, brown/orange, medium sub rounded SAND, micaceous

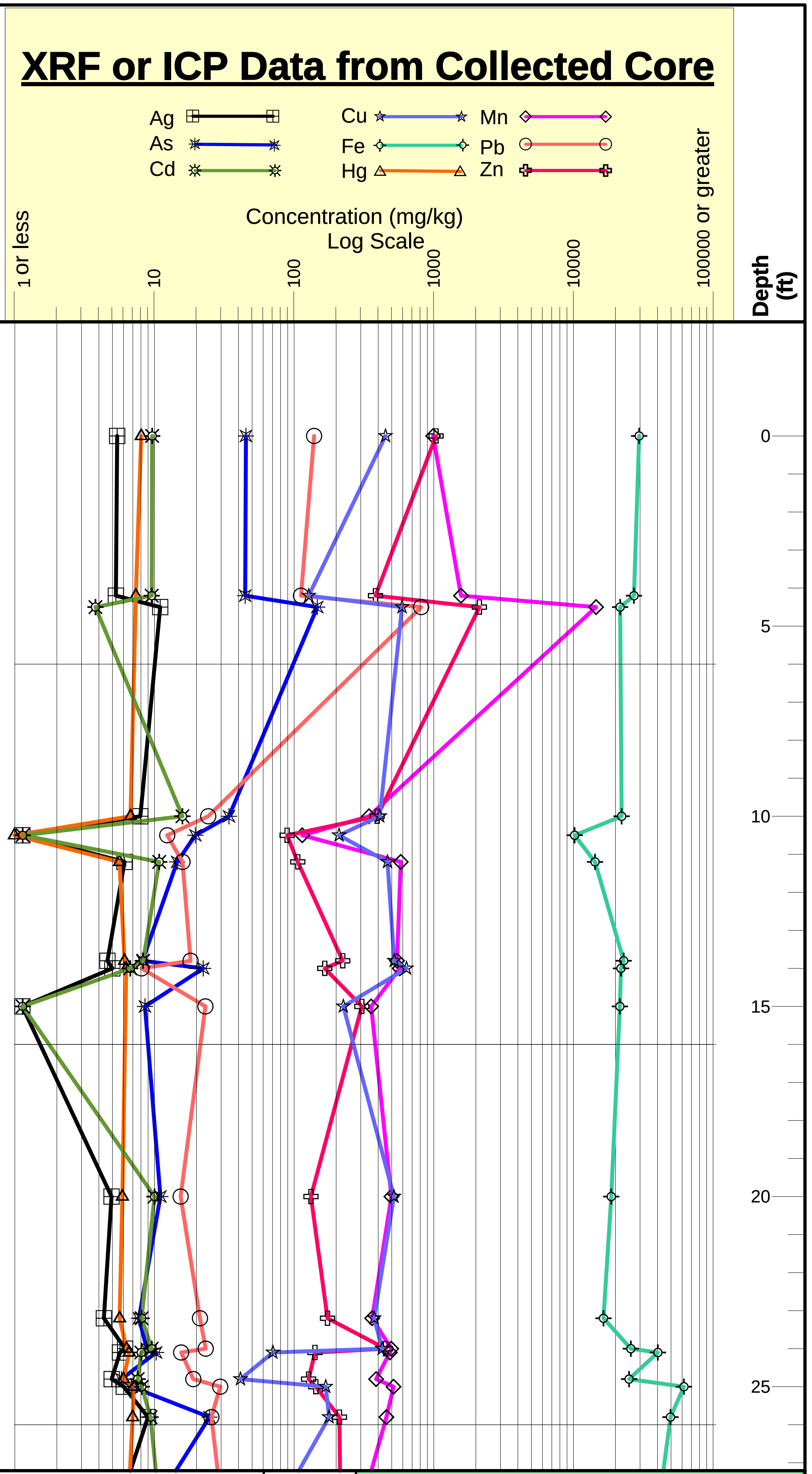
Loose, moist, red/gray, SANDY SILT, micaceous

Loose, moist, brown, subangular coarse SAND, micaceous

Headspace Reading

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
23.9	4.75	684
376.5	75.15	799
14.4	2.85	384

XRF or ICP Data from Collected Core



Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Criteria.

Filter Pack Interval:2-20 ft
Screen Interval:4-19 ft
below ground surface
(b.g.s.)
photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Well Construction

▤	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
□	PVC Casing	■	Prepack
		🟥	Steel Protective Casing

Latitude: (NAD 83) Decimal Degrees
Longitude: (NAD 83) Decimal Degrees
Northing:651388.39 IF
Easting:1195992.91 IF
Ground Elevation:5450.74 ft (NAVD 88)
Measuring Point Elevation:5452.42 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Hydrocarbon Monitoring Well Log

Well Name: **BRW19-HCW35**

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 10.19 ft
Water Level from MP: 11.87 ft
Date:1/27/2020
Time:11:17

Logged By: K.Jackson, N. Farley

Date Drilled: 1/9/2020

Casing Type/Dia: PVC/2"

Borehole Diameter: 6"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length:PVC/15'

Top of PVC Casing: M.P. 5452.42 ft (NAVD 88)
Ground Elevation: 5450.74 ft (NAVD 88)

Elev. (NAVD 88) | **Depth (ft.)** | **Percent Recovery** | **USCS Class** | **Lithology Log** | **Well Construction** | **Depth (ft)**

Depth (ft.): 30, 35

Percent Recovery: 55%, 93.3%

USCS Class: SW, SW, SM, SM, SP, SW, SM

Loose, moist, brown with orange at bottom, coarse SAND with coarse gravel, micaceous

Loose, moist, brown/black, coarse SAND with pockets of silt, micaceous

Loose, moist, brown, medium SAND with trace amounts of fine gravel, micaceous

Loose, moist, brown, fine SILTY SAND, micaceous

Loose, moist, brown with purple lamination of fine sand, coarse SILTY SAND with trace of fine gravel,

Loose, moist, brown, medium SAND with coarse sand, micaceous

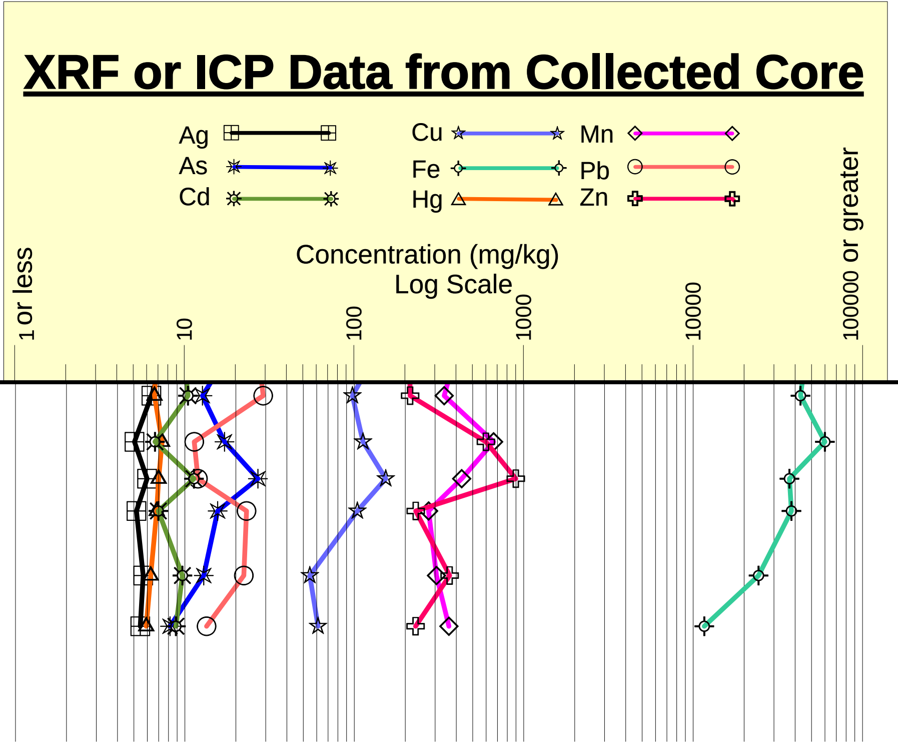
Loose, moist, brown, subangular coarse SAND with trace fine gravel, micaceous

Stiff, moist, orange/brown/tan, fine sand. WEATHERED BEDROCK-DECOMPOSED GRANITE

Depth (ft): 30, 35

Headspace Reading

PID (MR) ppm | **PID (uR) ppm** | **TEH mg/kg**


XRF or ICP Data from Collected Core

Depth (ft): 30, 35

Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Criteria.

Filter Pack Interval:2-20 ft
Screen Interval:4-19 ft
below ground surface
(b.g.s.)
photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

Bedrock	Sandy Clay
Clay	Sandy Gravel
Clayey Sand	Sandy Silt
Clayey Silt	Silt
Gravel	Silty Clay
Sand	Silty Sand

Well Construction

Screen	10/20 Sand Filter Pack
Bentonite	Natural Completion
PVC Casing	Prepack
	Steel Protective Casing

Latitude: (NAD 83) Decimal Degrees
Longitude: (NAD 83) Decimal Degrees
Northing:651388.39 IF
Easting:1195992.91 IF
Ground Elevation:5450.74 ft (NAVD 88)
Measuring Point Elevation:5452.42 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Hydrocarbon Monitoring Well Log

Well Name: BRW19-HCW36

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 8.09 ft
Water Level from MP: 9.65 ft

Date:1/27/2020
Time:10:56

Logged By: K.Jackson, N. Farley

Date Drilled: 1/8/2020

Casing Type/Dia: PVC/2"

Borehole Diameter: 6"

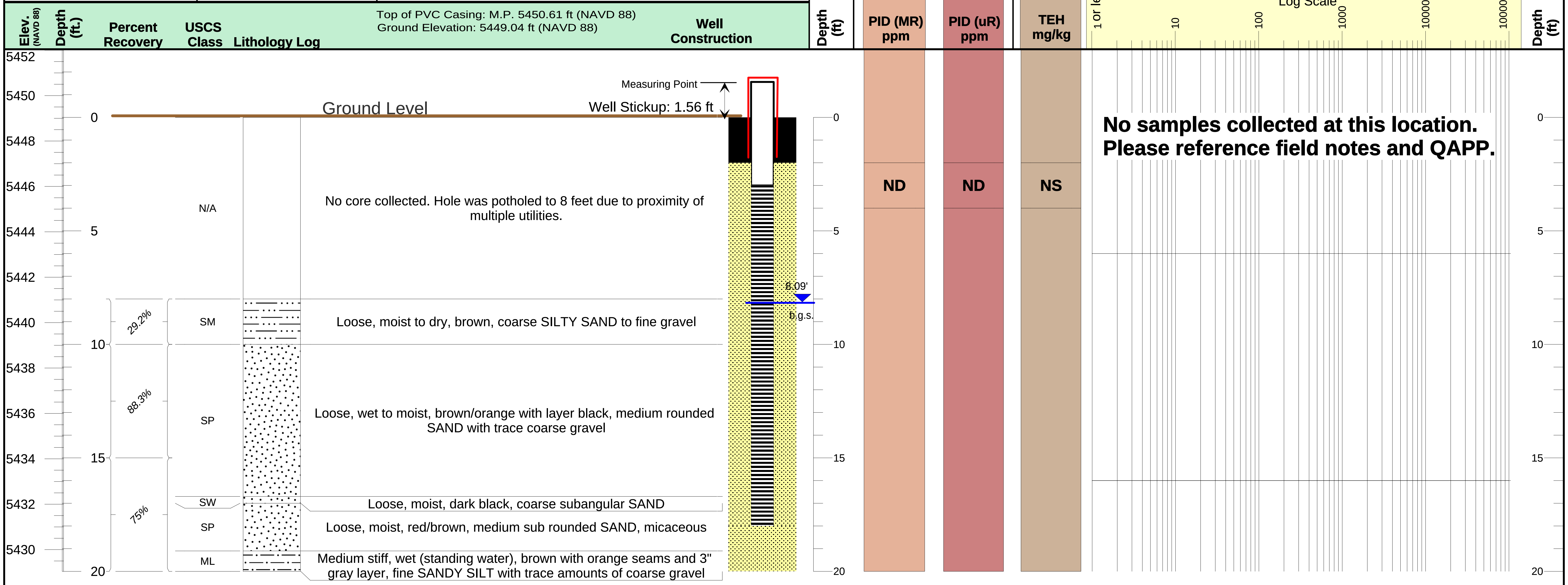
Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length:PVC/15'

Headspace Reading

XRF or ICP Data from Collected Core



Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Criteria.

Filter Pack Interval:2-20 ft
Screen Interval:3-18 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

🟧	Bedrock	▨	Sandy Clay
▤	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▤	Clayey Silt	▨	Silt
▨	Gravel	▤	Silty Clay
▨	Sand	▨	Silty Sand

Well Construction

▤	Screen	🟨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
□	PVC Casing	🟦	Prepack
		🟥	Steel Protective Casing

Pg.1 of 1

Latitude: (NAD 83) Decimal Degrees
Longitude: (NAD 83) Decimal Degrees
Northing:651213.42 IF
Easting:1196092.76 IF
Ground Elevation:5449.04 ft (NAVD 88)
Measuring Point Elevation:5450.61 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Hydrocarbon Monitoring Well Log

Well Name: BRW19-HCW37

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 12.80 ft
Water Level from MP: 14.95 ft
Date:1/20/2020
Time:10:19

Logged By: K.Jackson, N. Farley

Date Drilled: 1/6/2020

Casing Type/Dia: PVC/2"

Borehole Diameter: 6"

Drilling Company: O'Keefe Drilling

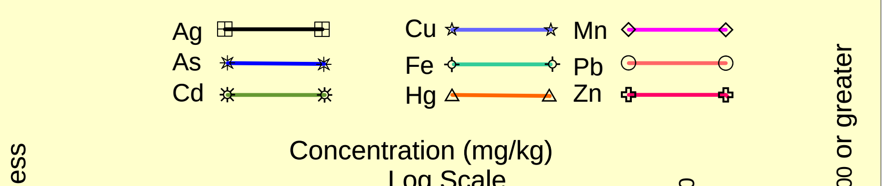
Drilling Method: Sonic

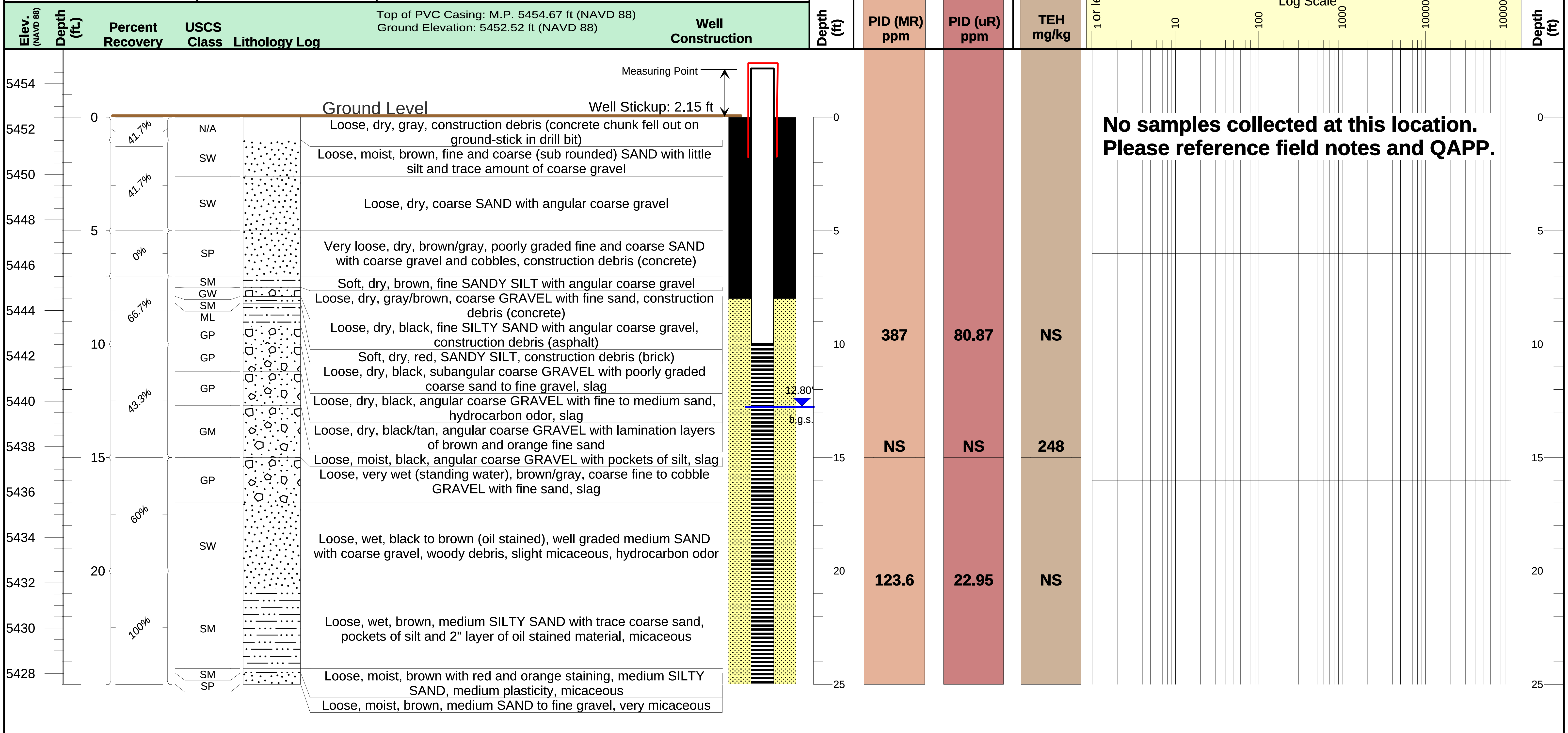
Screen Type/Length:PVC/15'

Top of PVC Casing: M.P. 5454.67 ft (NAVD 88)
Ground Elevation: 5452.52 ft (NAVD 88)

Headspace Reading

XRF or ICP Data from Collected Core





Loose, dry, gray, construction debris (concrete chunk fell out on ground-stick in drill bit)

Loose, moist, brown, fine and coarse (sub rounded) SAND with little silt and trace amount of coarse gravel

Loose, dry, coarse SAND with angular coarse gravel

Very loose, dry, brown/gray, poorly graded fine and coarse SAND with coarse gravel and cobbles, construction debris (concrete)

Soft, dry, brown, fine SANDY SILT with angular coarse gravel

Loose, dry, gray/brown, coarse GRAVEL with fine sand, construction debris (concrete)

Loose, dry, black, fine SILTY SAND with angular coarse gravel, construction debris (asphalt)

Soft, dry, red, SANDY SILT, construction debris (brick)

Loose, dry, black, subangular coarse GRAVEL with poorly graded coarse sand to fine gravel, slag

Loose, dry, black, angular coarse GRAVEL with fine to medium sand, hydrocarbon odor, slag

Loose, dry, black/tan, angular coarse GRAVEL with lamination layers of brown and orange fine sand

Loose, moist, black, angular coarse GRAVEL with pockets of silt, slag

Loose, very wet (standing water), brown/gray, coarse fine to cobble GRAVEL with fine sand, slag

Loose, wet, black to brown (oil stained), well graded medium SAND with coarse gravel, woody debris, slight micaceous, hydrocarbon odor

Loose, wet, brown, medium SILTY SAND with trace coarse sand, pockets of silt and 2" layer of oil stained material, micaceous

Loose, moist, brown with red and orange staining, medium SILTY SAND, medium plasticity, micaceous

Loose, moist, brown, medium SAND to fine gravel, very micaceous

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
387	80.87	NS
NS	NS	248
123.6	22.95	NS

No samples collected at this location. Please reference field notes and QAPP.

Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Criteria.

Filter Pack Interval:8-25 ft
Screen Interval:10-25 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

🟧	Bedrock	▤	Sandy Clay
▤	Clay	▨	Sandy Gravel
▨	Clayey Sand	▤	Sandy Silt
▤	Clayey Silt	▤	Silt
▨	Gravel	▤	Silty Clay
▨	Sand	▤	Silty Sand

Well Construction

▤	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
□	PVC Casing	🟦	Prepack
		🟥	Steel Protective Casing

Latitude: (NAD 83) Decimal Degrees
Longitude: (NAD 83) Decimal Degrees
Northing:651247.07 IF
Easting:1195537.85 IF
Ground Elevation:5452.52 ft (NAVD 88)
Measuring Point Elevation:5454.67 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Hydrocarbon Monitoring Well Log

Well Name: BRW19-HCW38

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 8.51 ft
Water Level from MP: 10.98 ft
Date:1/20/2020
Time:10:47

Logged By: K.Jackson, N. Farley

Date Drilled: 1/7/2020

Casing Type/Dia: PVC/2"

Borehole Diameter: 6"

Drilling Company: O'Keefe Drilling

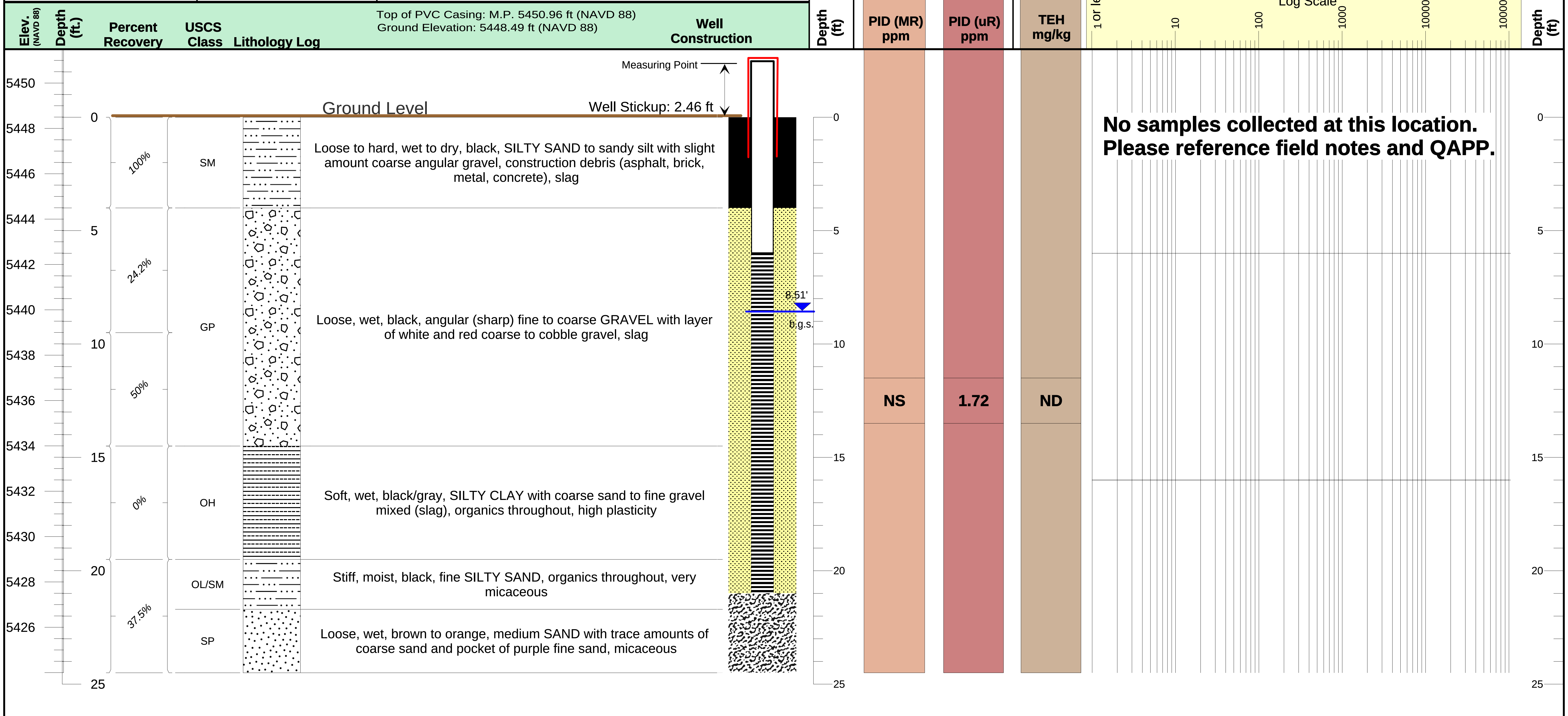
Drilling Method: Sonic

Screen Type/Length:PVC/15'

Top of PVC Casing: M.P. 5450.96 ft (NAVD 88)
Ground Elevation: 5448.49 ft (NAVD 88)

Headspace Reading

XRF or ICP Data from Collected Core



Loose to hard, wet to dry, black, SILTY SAND to sandy silt with slight amount coarse angular gravel, construction debris (asphalt, brick, metal, concrete), slag

Loose, wet, black, angular (sharp) fine to coarse GRAVEL with layer of white and red coarse to cobble gravel, slag

Soft, wet, black/gray, SILTY CLAY with coarse sand to fine gravel mixed (slag), organics throughout, high plasticity

Stiff, moist, black, fine SILTY SAND, organics throughout, very micaceous

Loose, wet, brown to orange, medium SAND with trace amounts of coarse sand and pocket of purple fine sand, micaceous

PID (MR) ppm	PID (uR) ppm	TEH mg/kg
NS	1.72	ND

No samples collected at this location. Please reference field notes and QAPP.

Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Criteria.

Filter Pack Interval:4-21 ft
Screen Interval:6-21 ft
below ground surface
(b.g.s.)
photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

Bedrock
Clay
Clayey Sand
Clayey Silt
Gravel
Sand
Sandy Clay
Sandy Gravel
Sandy Silt
Silt
Silty Clay
Silty Sand

Well Construction

Screen
Bentonite
PVC Casing
10/20 Sand Filter Pack
Natural Completion
Prepack
Steel Protective Casing

Latitude: (NAD 83) Decimal Degrees
Longitude: (NAD 83) Decimal Degrees
Northing:651319.59 IF
Easting:1195542.24 IF
Ground Elevation:5448.49 ft (NAVD 88)
Measuring Point Elevation:5450.96 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Hydrocarbon Monitoring Well Log

Well Name: BRW19-HCW39

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 13.29 ft
Water Level from MP: 14.94 ft
Date:2/5/2020
Time:3:05

Logged By: K.Jackson, N. Farley

Date Drilled: 1/9/2020

Casing Type/Dia: PVC/2"

Borehole Diameter: 6"

Drilling Company: O'Keefe Drilling

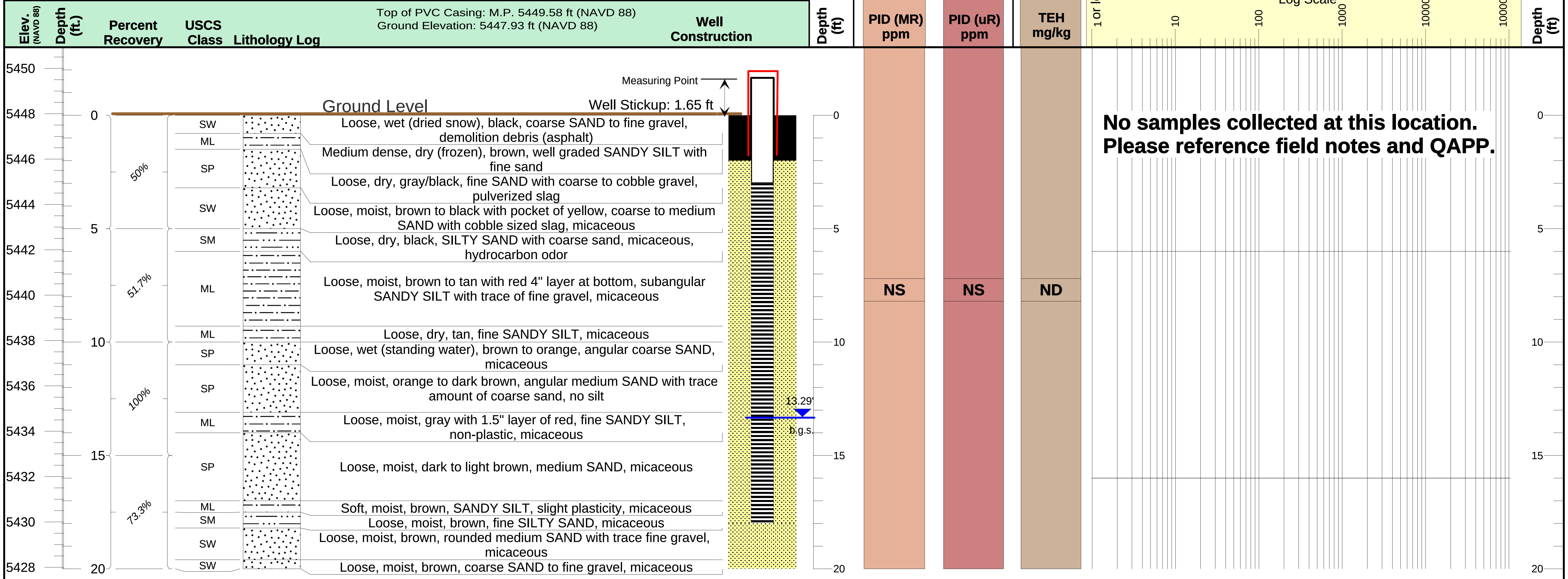
Drilling Method: Sonic

Screen Type/Length:PVC/15'

Top of PVC Casing: M.P. 5449.58 ft (NAVD 88)
Ground Elevation: 5447.93 ft (NAVD 88)

Headspace Reading

XRF or ICP Data from Collected Core



No samples collected at this location. Please reference field notes and QAPP.

USCS Class	Lithology Log
SW	Loose, wet (dried snow), black, coarse SAND to fine gravel, demolition debris (asphalt)
ML	Medium dense, dry (frozen), brown, well graded SANDY SILT with fine sand
SP	Loose, dry, gray/black, fine SAND with coarse to cobble gravel, pulverized slag
SW	Loose, moist, brown to black with pocket of yellow, coarse to medium SAND with cobble sized slag, micaceous
SM	Loose, dry, black, SILTY SAND with coarse sand, micaceous, hydrocarbon odor
ML	Loose, moist, brown to tan with red 4" layer at bottom, subangular SANDY SILT with trace of fine gravel, micaceous
ML	Loose, dry, tan, fine SANDY SILT, micaceous
SP	Loose, wet (standing water), brown to orange, angular coarse SAND, micaceous
SP	Loose, moist, orange to dark brown, angular medium SAND with trace amount of coarse sand, no silt
ML	Loose, moist, gray with 1.5" layer of red, fine SANDY SILT, non-plastic, micaceous
SP	Loose, moist, dark to light brown, medium SAND, micaceous
ML	Soft, moist, brown, SANDY SILT, slight plasticity, micaceous
SM	Loose, moist, brown, fine SILTY SAND, micaceous
SW	Loose, moist, brown, rounded medium SAND with trace fine gravel, micaceous
SW	Loose, moist, brown, coarse SAND to fine gravel, micaceous

Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Criteria.

Filter Pack Interval:2-20 ft
Screen Interval:3-18 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Well Construction

▤	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
□	PVC Casing	🟦	Prepack
		⊓	Steel Protective Casing

Pg.1 of 1

Latitude: (NAD 83) Decimal Degrees
Longitude: (NAD 83) Decimal Degrees
Northing:651381.32 IF
Easting:1195720.77 IF
Ground Elevation:5447.93 ft (NAVD 88)
Measuring Point Elevation:5449.58 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Hydrocarbon Monitoring Well Log

Well Name: BRW19-HCW40

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 6.58 ft
Water Level from MP: 8.88 ft

Date:1/27/2020
Time:10:58

Logged By: K.Jackson, M. Pomeroy

Date Drilled: 12/17/2019

Casing Type/Dia: PVC/2"

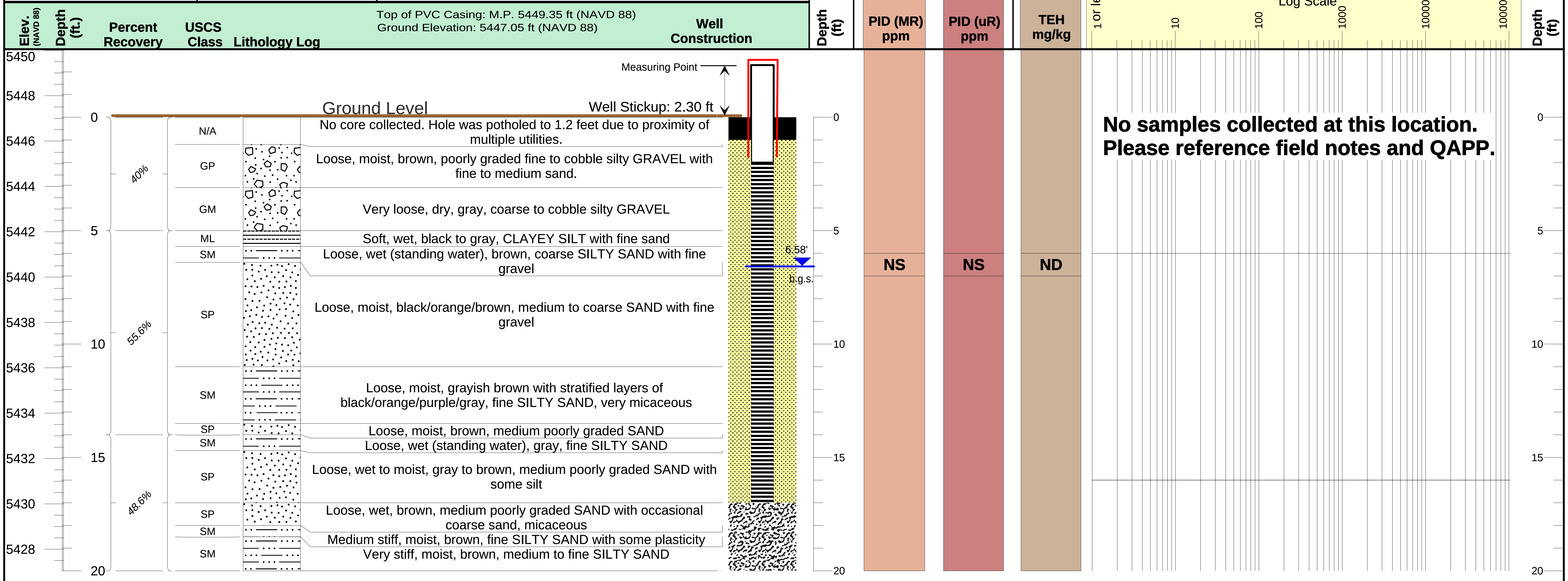
Borehole Diameter: 6"

Drilling Company: O'Keefe Drilling

Drilling Method: Sonic

Screen Type/Length:PVC/15'

Top of PVC Casing: M.P. 5449.35 ft (NAVD 88)
Ground Elevation: 5447.05 ft (NAVD 88)



USCS Class	Lithology Log
N/A	No core collected. Hole was potholed to 1.2 feet due to proximity of multiple utilities.
GP	Loose, moist, brown, poorly graded fine to cobble silty GRAVEL with fine to medium sand.
GM	Very loose, dry, gray, coarse to cobble silty GRAVEL
ML	Soft, wet, black to gray, CLAYEY SILT with fine sand
SM	Loose, wet (standing water), brown, coarse SILTY SAND with fine gravel
SP	Loose, moist, black/orange/brown, medium to coarse SAND with fine gravel
SM	Loose, moist, grayish brown with stratified layers of black/orange/purple/gray, fine SILTY SAND, very micaceous
SP	Loose, moist, brown, medium poorly graded SAND
SM	Loose, wet (standing water), gray, fine SILTY SAND
SP	Loose, wet to moist, gray to brown, medium poorly graded SAND with some silt
SP	Loose, wet, brown, medium poorly graded SAND with occasional coarse sand, micaceous
SM	Medium stiff, moist, brown, fine SILTY SAND with some plasticity
SM	Very stiff, moist, brown, medium to fine SILTY SAND

No samples collected at this location. Please reference field notes and QAPP.

Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Criteria.

Filter Pack Interval:1-17 ft
Screen Interval:2-17 ft
below ground surface
(b.g.s.)
photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▨	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▨	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Well Construction

▤	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
□	PVC Casing	🟦	Prepack
		⊓	Steel Protective Casing

Latitude: (NAD 83) Decimal Degrees
Longitude: (NAD 83) Decimal Degrees
Northing:651172.99 IF
Easting:1195824.47 IF
Ground Elevation:5447.05 ft (NAVD 88)
Measuring Point Elevation:5449.35 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Hydrocarbon Monitoring Well Log

Well Name: BRW19-HCW41

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 6.70 ft
Water Level from MP: 8.48 ft
Date:1/27/2020
Time:10:54

Logged By: K.Jackson, N. Farley

Date Drilled: 1/8/2020

Casing Type/Dia: PVC/2"

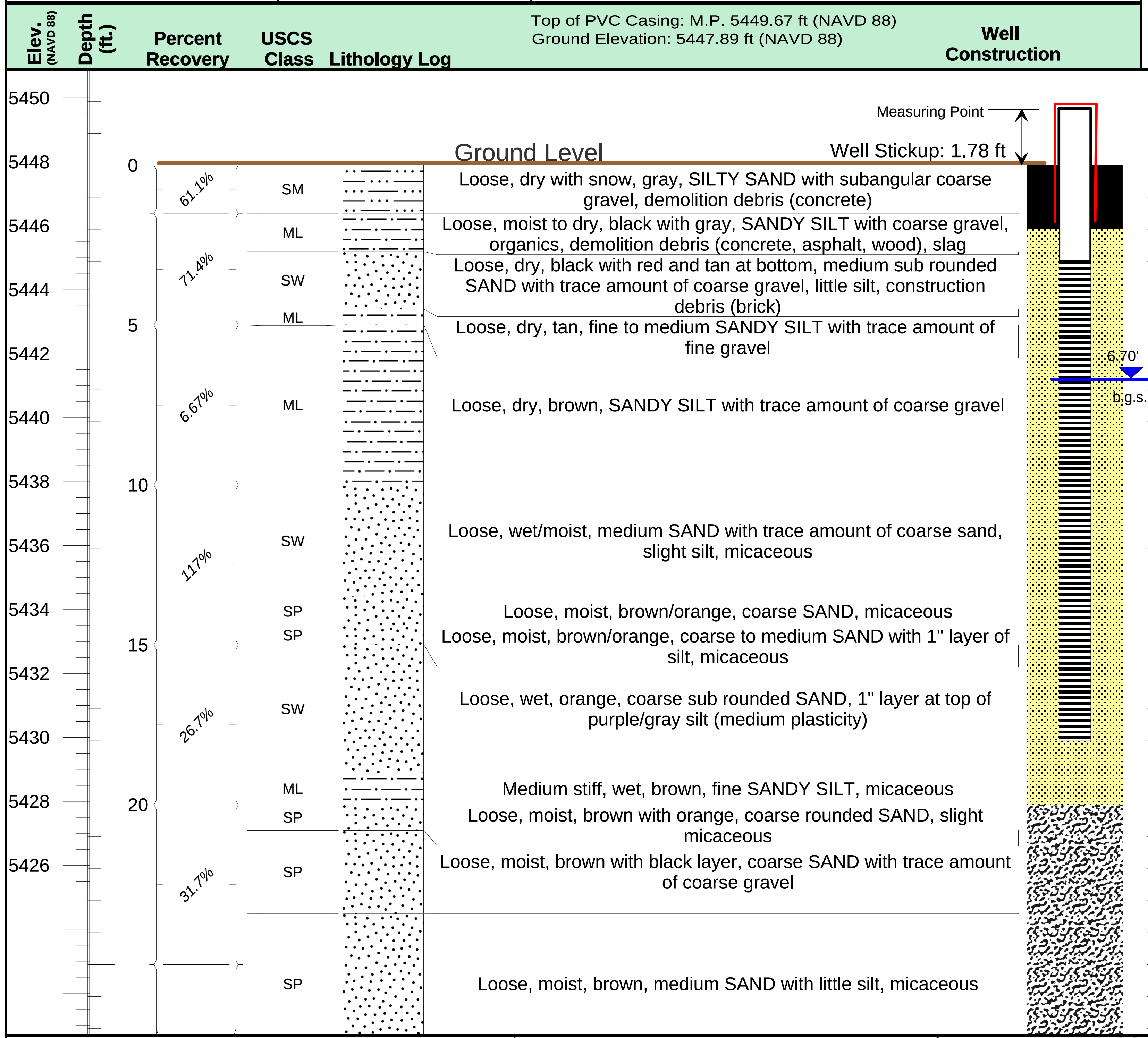
Borehole Diameter: 6"

Drilling Company: O'Keefe Drilling

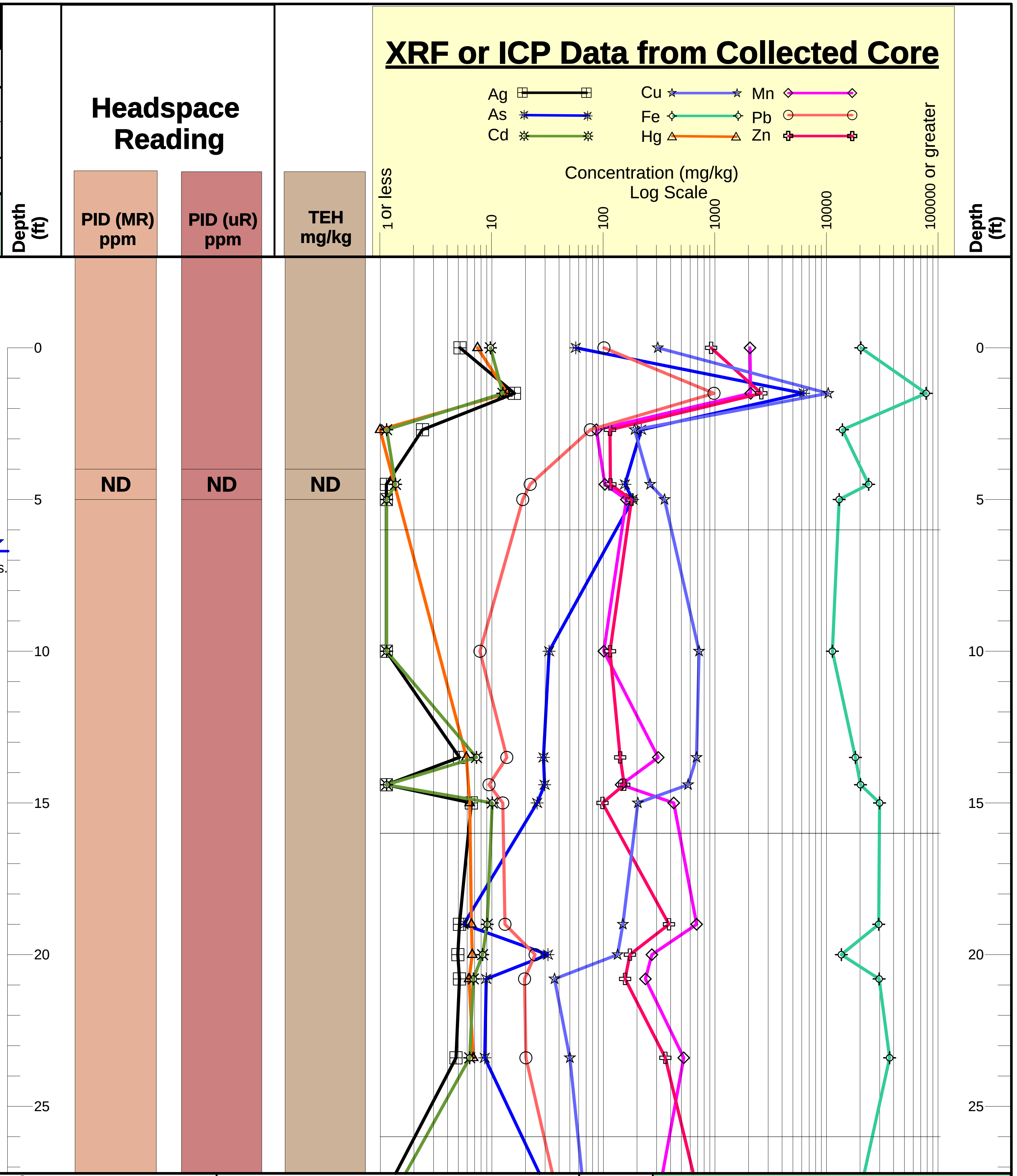
Drilling Method: Sonic

Screen Type/Length:PVC/15'

Top of PVC Casing: M.P. 5449.67 ft (NAVD 88)
Ground Elevation: 5447.89 ft (NAVD 88)



USCS Class	Lithology Log
SM	Loose, dry with snow, gray, SILTY SAND with subangular coarse gravel, demolition debris (concrete)
ML	Loose, moist to dry, black with gray, SANDY SILT with coarse gravel, organics, demolition debris (concrete, asphalt, wood), slag
SW	Loose, dry, black with red and tan at bottom, medium sub rounded SAND with trace amount of coarse gravel, little silt, construction debris (brick)
ML	Loose, dry, tan, fine to medium SANDY SILT with trace amount of fine gravel
ML	Loose, dry, brown, SANDY SILT with trace amount of coarse gravel
SW	Loose, wet/moist, medium SAND with trace amount of coarse sand, slight silt, micaceous
SP	Loose, moist, brown/orange, coarse SAND, micaceous
SP	Loose, moist, brown/orange, coarse to medium SAND with 1" layer of silt, micaceous
SW	Loose, wet, orange, coarse sub rounded SAND, 1" layer at top of purple/gray silt (medium plasticity)
ML	Medium stiff, wet, brown, fine SANDY SILT, micaceous
SP	Loose, moist, brown with orange, coarse rounded SAND, slight micaceous
SP	Loose, moist, brown with black layer, coarse SAND with trace amount of coarse gravel
SP	Loose, moist, brown, medium SAND with little silt, micaceous



Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Criteria.

Filter Pack Interval:2-20 ft
Screen Interval:3-18 ft
below ground surface
(b.g.s.)

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

- Bedrock
- Clay
- Clayey Sand
- Clayey Silt
- Gravel
- Sand
- Sandy Clay
- Sandy Gravel
- Sandy Silt
- Silt
- Silty Clay
- Silty Sand

Well Construction

- Screen
- Bentonite
- PVC Casing
- 10/20 Sand Filter Pack
- Natural Completion
- Prepack
- Steel Protective Casing

Latitude: (NAD 83) Decimal Degrees
Longitude: (NAD 83) Decimal Degrees
Northing:651297.44 IF
Easting:1196317.74 IF
Ground Elevation:5447.89 ft (NAVD 88)
Measuring Point Elevation:5449.67 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Hydrocarbon Monitoring Well Log

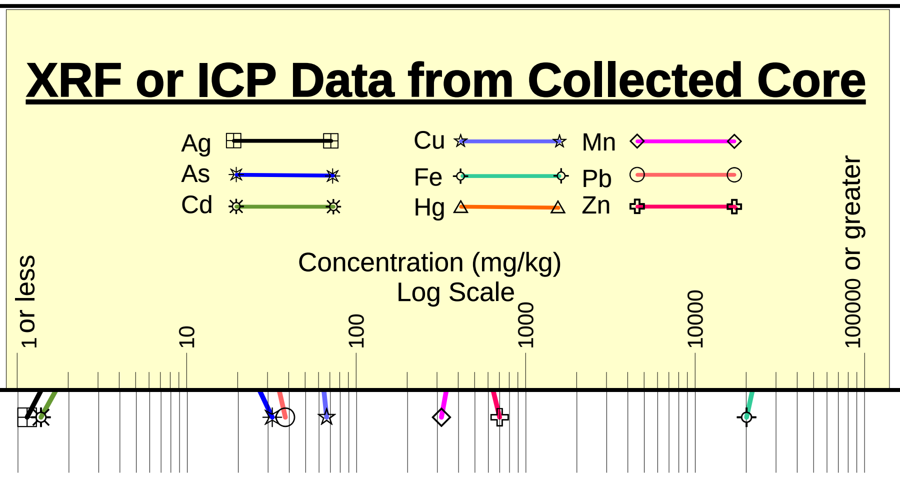
Well Name: BRW19-HCW41

Project: BRW Phase I Site Investigation	Location: Butte, MT
Well Owner: Atlantic Richfield Co.	Depth to Water (bgs): 6.70 ft Water Level from MP: 8.48 ft Date:1/27/2020 Time:10:54

Logged By: K.Jackson, N. Farley	Date Drilled: 1/8/2020	Casing Type/Dia: PVC/2"	Borehole Diameter: 6"
Drilling Company: O'Keefe Drilling	Drilling Method: Sonic	Screen Type/Length:PVC/15'	

Top of PVC Casing: M.P. 5449.67 ft (NAVD 88)
Ground Elevation: 5447.89 ft (NAVD 88)

Elev. (NAVD 88)	Depth (ft.)	Percent Recovery	USCS Class	Lithology Log		Well Construction	Depth (ft)	Headspace Reading PID (MR) ppm	PID (uR) ppm	TEH mg/kg
		85%	SP		Loose, moist, gray with bright orange, fine SAND to coarse gravel					
			SM		Hard, moist to dry, brown/orange/white, silty sand. WEATHERED BEDROCK -DECOMPOSED GRANITE					



Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Criteria.

Filter Pack Interval:2-20 ft
Screen Interval:3-18 ft
below ground surface
(b.g.s.)
photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

🟧	Bedrock		Sandy Clay
	Clay		Sandy Gravel
	Clayey Sand		Sandy Silt
	Clayey Silt		Silt
	Gravel		Silty Clay
	Sand		Silty Sand

Well Construction

☰	Screen	▨	10/20 Sand Filter Pack
■	Bentonite	▨	Natural Completion
☐	PVC Casing	🟦	Prepack
		🟥	Steel Protective Casing

Pg.2 of 2

Latitude: (NAD 83) Decimal Degrees
Longitude: (NAD 83) Decimal Degrees
Northing:651297.44 IF
Easting:1196317.74 IF
Ground Elevation:5447.89 ft (NAVD 88)
Measuring Point Elevation:5449.67 ft (NAVD 88)
T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Hydrocarbon Monitoring Well Log

Well Name: BRW19-HCW42

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): 6.32 ft
Water Level from MP: 8.1 ft
Date:1/27/2020
Time:11:00

Logged By: K.Jackson, N. Farley

Date Drilled: 1/6/2020

Casing Type/Dia: PVC/2"

Borehole Diameter: 6"

Drilling Company: O'Keefe Drilling

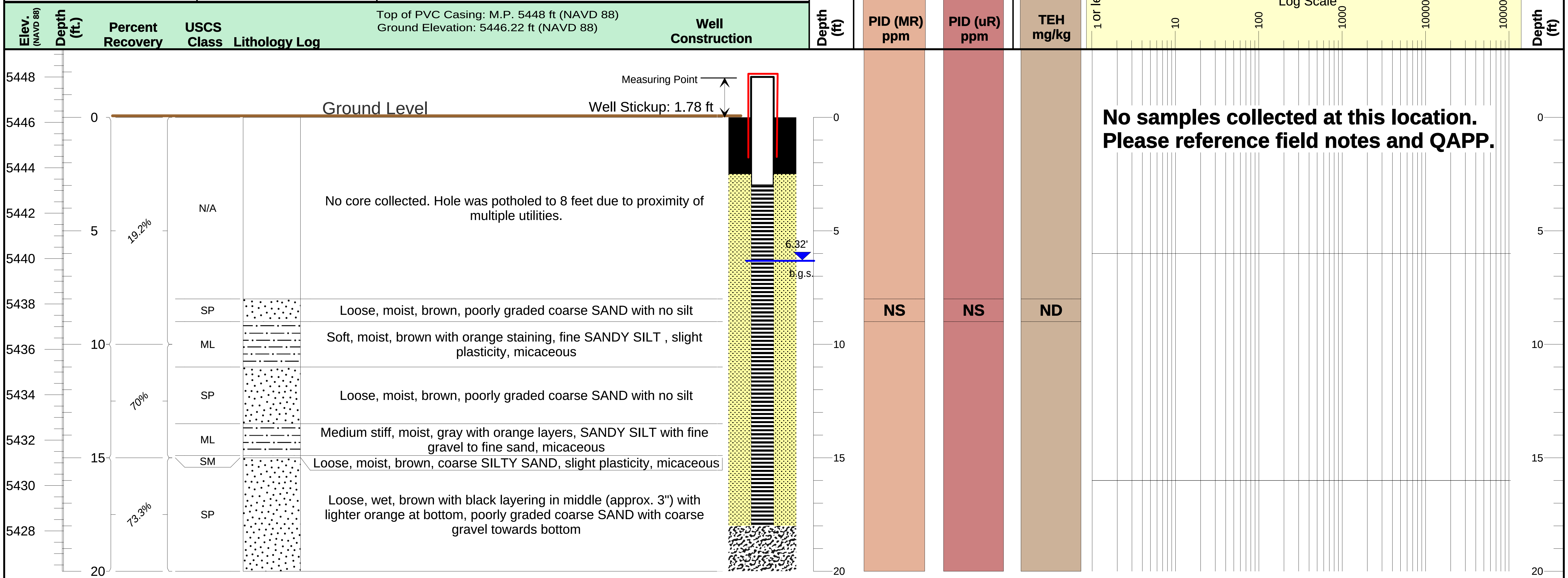
Drilling Method: Sonic

Screen Type/Length:PVC/15'

Top of PVC Casing: M.P. 5448 ft (NAVD 88)
Ground Elevation: 5446.22 ft (NAVD 88)

Headspace Reading

XRF or ICP Data from Collected Core



No core collected. Hole was potholed to 8 feet due to proximity of multiple utilities.

Loose, moist, brown, poorly graded coarse SAND with no silt

Soft, moist, brown with orange staining, fine SANDY SILT , slight plasticity, micaceous

Loose, moist, brown, poorly graded coarse SAND with no silt

Medium stiff, moist, gray with orange layers, SANDY SILT with fine gravel to fine sand, micaceous

Loose, moist, brown, coarse SILTY SAND, slight plasticity, micaceous

Loose, wet, brown with black layering in middle (approx. 3") with lighter orange at bottom, poorly graded coarse SAND with coarse gravel towards bottom

No samples collected at this location. Please reference field notes and QAPP.

Driller: L. Phillips
Monitoring Well License # 704

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Criteria.

Filter Pack Interval:2.5-20 ft
Screen Interval:3-18 ft
below ground surface
(b.g.s.)
photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND = Non Detected
NS = Not Sampled

Lithology

- Bedrock
- Clay
- Clayey Sand
- Clayey Silt
- Gravel
- Sand
- Sandy Clay
- Sandy Gravel
- Sandy Silt
- Silt
- Silty Clay
- Silty Sand

Well Construction

- Screen
- Bentonite
- PVC Casing
- 10/20 Sand Filter Pack
- Natural Completion
- Prepack
- Steel Protective Casing

Latitude: (NAD 83) Decimal Degrees
Longitude: (NAD 83) Decimal Degrees
Northing:651111.54 IF
Easting:1195564.83 IF
Ground Elevation:5446.22 ft (NAVD 88)
Measuring Point Elevation:5448 ft (NAVD 88)
T3N R8W S24

PIONEER
TECHNICAL SERVICES, INC.

Hydrocarbon Test Pit Log

Test Pit Name: BRW19-HCTP30

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): NA ft
Water Level from MP: NA ft
Date:NA
Time:NA

Logged By: K. Jackson, N. Farley

Date: 1/16/2020

Casing Type/Dia: None

Borehole Diameter: NA

Company: Hunter Brothers

Equipment: 312C Excavator

Screen Type/Length: None

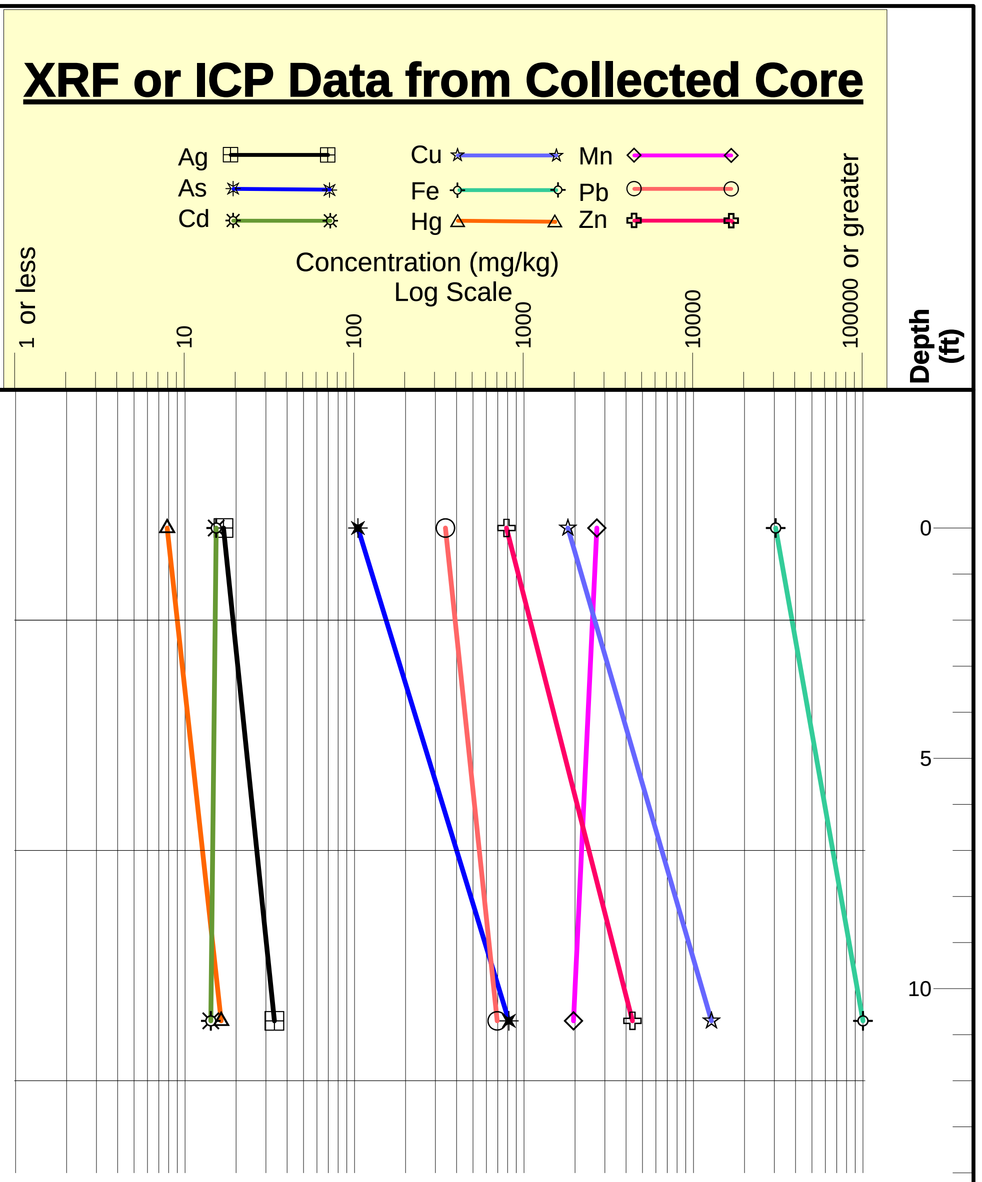
Ground Elevation: 5448.61 ft (NAVD 88)

Ground Level

Elev. (NAVD 88)	Depth (ft.)	USCS Class	Lithology Log
5449	0	SW	Loose, dry, gray/brown, SILTY SANDS, coarse sand to coarse gravel
	5	GP	Loose, black with blue sheen (from paring it), coarse to cobble angular sharp- no fines, no sample, SLAG with brick top on south wall, woody debris throughout.
5439	10		

Headspace Reading

Depth (ft)	PID (MR) ppm	PID (uR) ppm	TEH mg/kg
10	NS	NS	23
	59.9	4.81	21



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS= Not Sampled

Lithology

▨	Bedrock	▨	Sandy Clay
▭	Clay	▨	Sandy Gravel
▨	Clayey Sand	▨	Sandy Silt
▨	Clayey Silt	▭	Silt
▨	Gravel	▨	Silty Clay
▨	Sand	▨	Silty Sand

Latitude: (NAD 83) Decimal Degrees
Longitude: (NAD 83) Decimal Degrees
Northing:651534.86 IF
Easting:1195839.94 IF
Ground Elevation:5448.61 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Hydrocarbon Test Pit Log

Test Pit Name: BRW19-HCTP31

Project: BRW Phase I Site Investigation	Location: Butte, MT
Well Owner: Atlantic Richfield Co.	Depth to Water (bgs): NA ft Water Level from MP: NA ft Date:NA Time:NA

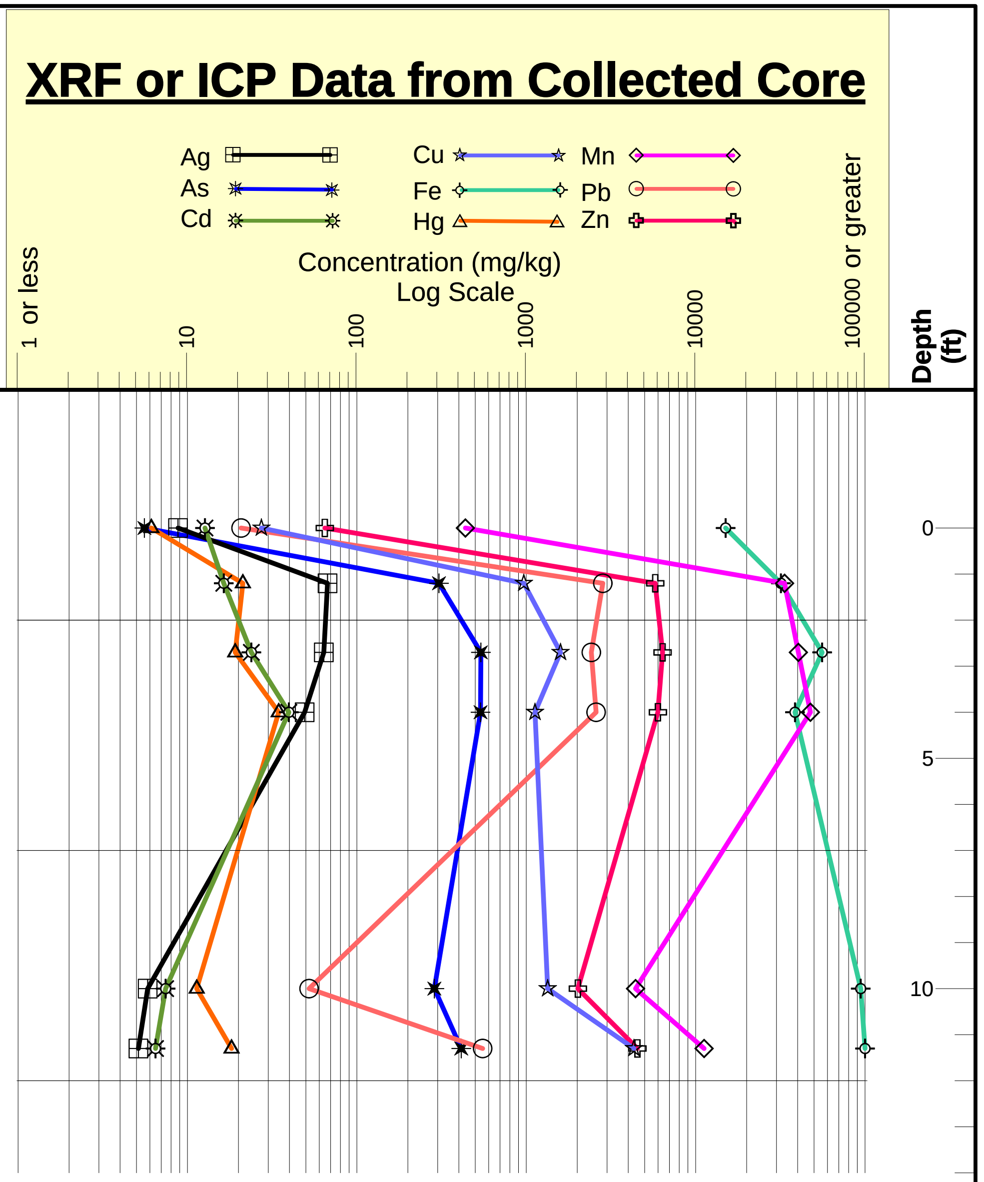
Logged By: K. Jackson, N. Farley	Date: 1/16/2020	Casing Type/Dia: None	Borehole Diameter: NA
Company: Hunter Brothers	Equipment: 312C Excavator	Screen Type/Length: None	

Ground Elevation: 5448.63 ft (NAVD 88)

Ground Level

Elev. (NAVD 88)	Depth (ft.)	USCS Class	Lithology Log	PID (MR) ppm	PID (uR) ppm	TEH mg/kg
5449	0	SW	Loose, gray, SILTY SAND, medium sand, well graded- screened rock			
		SP	Loose and frozen, brown, medium to coarse SAND, mica			
		SW	Loose, dark brown, SILTY SAND, mica, coarse sand, brick/slag/cables/woody debris/metal			
	5	SW	Loose, dark brown/black, SILTY SAND, coarse sand with coarse to cobble gravel, concrete, brick (yellow/red), woody debris, metal, slag			
5439	10	GW	Loose, moist, orange/brown/red, angular- sharp coarse GRAVEL, silty gravel, slag/brick	94.8	6.13	88
		GW	Loose, wet, saturated, black, sharp angular coarse GRAVEL with no fines	484.9	184.4	NS

Headspace Reading



Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS= Not Sampled

Lithology

Bedrock	Sandy Clay
Clay	Sandy Gravel
Clayey Sand	Sandy Silt
Clayey Silt	Silt
Gravel	Silty Clay
Sand	Silty Sand

Latitude: (NAD 83) Decimal Degrees
Longitude: (NAD 83) Decimal Degrees
Northing:651528.67 IF
Easting:1195985.68 IF
Ground Elevation:5448.63 ft (NAVD 88)

T3N R8W S24

PIONEER TECHNICAL SERVICES, INC.

Hydrocarbon Test Pit Log

Test Pit Name: BRW19-HCTP32

Project: BRW Phase I Site Investigation

Location: Butte, MT

Well Owner: Atlantic Richfield Co.

Depth to Water (bgs): NA ft
Water Level from MP: NA ft
Date:NA
Time:NA

Logged By: K. Jackson, N. Farley

Date: 1/16/2020

Casing Type/Dia: None

Borehole Diameter: NA

Company: Hunter Brothers

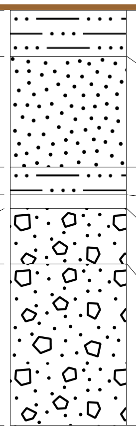
Equipment: 312C Excavator

Screen Type/Length: None

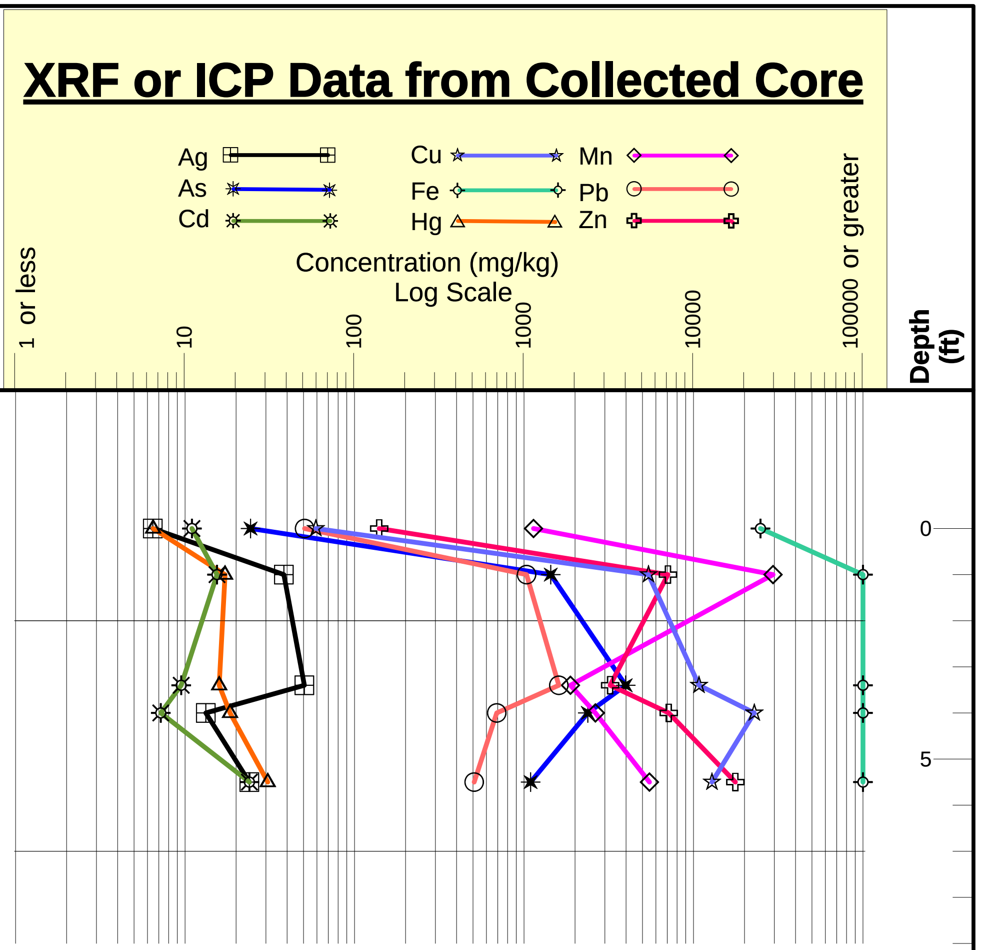
Ground Elevation: 5447.88 ft (NAVD 88)

Ground Level

Elev. (NAVD 88)	Depth (ft.)	USCS Class	Lithology Log	PID (MR) ppm	PID (uR) ppm	TEH mg/kg
5449	0	SW	Loose/froze, dry, SILTY SAND, coarse sand with fine gravel, well grinded			
		SP	Loose, dry, brown/red/gray/black, coarse SAND with silty sands, cobble sized slag			
		SP	Loose, moist, SILTY SAND, medium sand with coarse sand, brick/slag	78.2	7.23	39
		ML	Loose, black, SANDY SILT, medium sand, slag chunks mixed	440	35.61	1010
	5	GP	Loose, moist, black with orange staining and yellow slag chunks, cobble GRAVEL			
5439		GW	Loose, moist with sheen on rock, coarse to cobble GRAVEL	511.1	97.34	1740



Headspace Reading



XRF or ICP Data from Collected Core

Notes:
1.Marker for XRF or ICP data marks concentration at top of hydrogeological lithological layer.
2. Generally XRF and Lab samples were only collected until a depth where material passed the Waste Identification Criteria (BPSOU CD 2020).

photoionization detector (PID)
total extractable hydrocarbons (TEH)
ND= Not Detected
NS= Not Sampled

Lithology

- Bedrock
- Clay
- Clayey Sand
- Clayey Silt
- Gravel
- Sand
- Sandy Clay
- Sandy Gravel
- Sandy Silt
- Silt
- Silty Clay
- Silty Sand

Latitude: (NAD 83) Decimal Degrees
Longitude: (NAD 83) Decimal Degrees
Northing:651447.18 IF
Easting:1195967.89 IF
Ground Elevation:5447.88 ft (NAVD 88)

T3N R8W S24

Appendix C
Leapfrog Model

TECHNICAL MEMORANDUM

Butte Reduction Works Phase I Site Investigation XRF to ICP Correlation and Regression Analysis

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Date:	05/13/2021	**Rev or Mod #:**	04
To:	Atlantic Richfield Company		
From:	Pioneer Technical Services, Inc.		

Table of Contents

1 INTRODUCTION

Waste located within the Butte Reduction Works (BRW) Smelter Area Mine Waste Remediation and Contaminated Groundwater Hydraulic Control Site (Site) removal corridor will need to be excavated during remedial action construction activities defined in the Butte Priority Soils Operable Unit (BPSOU) Consent Decree (CD) (EPA, 2020). To determine the volume and extent of this waste, Pioneer Technical Services, Inc. (Pioneer) collected soil samples from 51 boreholes and 15 test pits during 2018 and 2020. Pioneer analyzed the samples for contaminants of concern (COCs) using an X-ray fluorescent (XRF) analyzer and/or laboratory analysis via inductively coupled plasma-optical emission spectrometry (ICP). Details on the samples selected for XRF and/or ICP analysis are included in Section 2.1 of the Site Pre-Design Investigation (PDI) Evaluation Report (main BRW PDI Report) to which this Technical Memorandum (Tech Memo) is part of (included in Appendix C of the main BRW PDI Report).

Pioneer input the XRF and ICP concentration data into a 3-dimensional modeling program called Leapfrog Works (Leapfrog) to estimate the extent of material that does not meet the waste identification criteria (EPA, 2020) and define the excavation surface. Details on how the data were used in the Leapfrog model are included in the BRW Phase I Investigation Leapfrog Model Inputs Tech Memo (Model Inputs memo), which is also included in Appendix C of the main BRW PDI Report). Because XRF concentrations are not as accurate as ICP concentrations, the XRF concentrations must be adjusted prior to their import into Leapfrog. The objective of this Tech Memo is to identify a regression relationship between the XRF and ICP concentrations for each COC so the resulting regression coefficients can be used to adjust the XRF concentrations to meet the accuracy of the ICP concentrations for input into the Leapfrog model.

2 METHODS AND DATA

The BRW Phase I Site Investigation began in August 2018 and concluded in February 2020. During the investigation activities in 2018, Pioneer collected composite soil samples from 47 boreholes and 12 test pits. The soil samples were analyzed with the XRF unit in the Pioneer field office at 244 Anaconda Road in Butte, Montana (results referenced herein as "XRF data") and/or sent for laboratory analysis via ICP. The samples analyzed with the XRF were dried, screened, and placed in a small plastic cup with a mylar film cover prior to analysis. Only XRF samples prepared/analyzed in the Pioneer field office were used for this analysis; samples analyzed in the field were excluded since those samples were meant as field screening information and the samples were not prepped (i.e., dried, screened, and placed in small plastic cups with a mylar film cover) prior to analysis. Also, any data points rejected during the data validation process were excluded from being used to determine the regression relationship (refer to Appendix A of the main BRW PDI Report for more details).

The 2018 soil cores were archived and additional samples were taken from the archived cores in 2019 and analyzed with the XRF and/or sent for laboratory ICP analysis. In February 2020, Pioneer collected additional composite samples from 4 new boreholes and 3 new test pits. The procedures for the sample collection and analysis are outlined in the *BRW Phase I Quality Assurance Project Plan* (Atlantic Richfield, 2021).

To facilitate the XRF to ICP correlation, a subset of the data collected during the Phase I Site Investigation included a "paired" dataset, where composite samples from the same location and depth interval were analyzed with the XRF and also submitted for laboratory ICP analysis. An additional 55 samples were taken from the archived soil cores collected during the 2018 investigation and sent for laboratory ICP analysis in May 2020. These samples included those requested by U.S. Environmental Protection Agency (EPA) and Montana Department of Environmental Quality (DEQ) on March 25, 2020, in an email to Atlantic Richfield Company titled Update on Leap Frog and Suggested ICP Analysis. Of the 55 samples, 45 had corresponding XRF results and were used in the XRF to ICP analysis for the alluvium, tailings, and organic soil (ATO) materials. The XRF to ICP correlation and regression analyses for arsenic, cadmium, copper, lead, and zinc were performed on the paired dataset, including the additional samples analyzed in May 2020.

An initial analysis was conducted on the 2018 and 2019 results to compare the XRF to ICP correlations and regressions in the 4 main material categories identified in the "Sample Purpose Code" field of the database. The 4 material categories are Slag, Demolition Debris, ATO, and Other. The initial findings revealed that the correlations for the Slag, Demolition Debris, and Other materials were either very poor or there was an insufficient number of samples from the material to create adequate regression models. The ATO were combined into a single category for several reasons. First, combining these materials into 1 material category provided over 130 samples to use in creating the correlation and regression analysis. There was an insufficient number of samples to create a correlation analysis for tailings and organics. Second, a review of the lithology logs (included with the main BRW PDI Report) revealed that the ATO materials were intermixed in such a way that modeling those materials separately would prove difficult. Third, the XRF to ICP correlation analysis for the ATO materials provided strong linear relationships across 4 of the 5 COCs and a moderate relationship for the fifth. Furthermore, the data discussed in this Tech Memo will be used to refine the excavation surface, which is located entirely within ATO materials. Therefore, this Tech Memo focuses only on the ATO materials. The results of the initial regression are summarized in a February 25, 2020, letter to EPA and DEQ (Atlantic Richfield, 2020).

2.1 Correlation Analysis

The paired COC (arsenic, cadmium, copper, lead, and zinc) datasets from the XRF and ICP analyses were compared to determine the strength of the relationship between the XRF and ICP concentration results. The analyses produced correlation coefficients (R) which ranged from -1 (a strong negative linear relationship) to +1 (a strong positive linear relationship). A value of zero indicates that the relationship is not linear, and a regression analysis would not be recommended for this dataset (Montgomery and Runger, 2007). Generally, an R value of 0.7 and above or -0.7 and below would indicate an acceptable correlation, and R values greater than 0.83 and less than -0.83 would be preferred. However, additional analysis of the correlation is imperative to determining the strength of the linear relationship.

The correlation coefficients are listed in Table 1 and the data used in the analysis are listed in Table 2. The correlation analysis was performed on the entire paired dataset for each COC and then again after outliers were removed from the regression analysis to ensure that the modified data still had a linear relationship between the XRF and ICP concentration results. Both correlation coefficients are shown in Table 1.

There were two items of note. First, that the correlations were set so the independent value (x-value) was the XRF concentration result and the dependent value (y-value) was the ICP result, as per the method described in *Field Portable XRF Analysis of Environmental Samples* (Kalnicky and Singhvi, 2001). Second, the data in Table 2 and on the plots on Figures 1 through 5 were segregated to indicate which points were part of the 2020 sampling and analysis activities; the 2020 data had not previously been submitted to EPA or DEQ.

2.2 Regression Analysis

Once it was determined that the XRF and ICP concentration results had an acceptable linear relationship, a regression analysis was conducted to produce a linear regression, a regression for the upper 95% confidence interval (referred to as the upper 95% regression and discussed in more detail in Section 2.2.2), and a coefficient of determination (R^2). The regressions are defined by a slope (m) and a y-intercept (b). Again, the correlations were set so the independent value (x-value) was the XRF concentration result and the dependent value (y-value) was the ICP result. This produced a formula that readily transforms the XRF concentration result for import into Leapfrog. The R^2 ranges from 0 to 1, is used to determine the adequacy of the regression model, and can be used loosely to describe how well the regression model accounts for the variability in the data. An R^2 model of 1 indicates a perfect model that accounts for 100% of the variability in the data (Montgomery and Runger, 2007). Generally, an R^2 value of 0.5 is considered acceptable while an R^2 value of 0.7 and above is preferred. However, as for the correlation analysis, additional analysis is imperative to determining the adequacy of the regression.

A summary of the regression results are shown in Table 1, and the data used in the analysis are shown in Table 2. The regression results in Table 1 were produced with the dataset where the outliers had been removed. The outlier analysis is discussed in the following section.

2.2.1 Outlier Analysis

An outlier analysis was performed to remove any pairs of data that were not representative of the population for each COC. As with the correlation and regression analyses, the outlier analysis was performed with the XRF concentrations set as the independent value (x-value) and the ICP concentrations set as the dependent value (y-value). The analysis followed the methods recommended in "*Field portable XRF analysis of environmental samples*" in the *Journal of Hazardous Materials* (Kalnicky & Singhvi, 2001). The article was coauthored by Dennis J. Kalnicky from Lockheed Martin Technology Services Group and Raj Singhvi of EPA, Environmental Response Team Center. The article describes the methods for conducting an XRF analysis of soils and other materials and includes recommendations on conducting an XRF to laboratory regression analysis. They recommend that the linear regression model between XRF and laboratory data is "*most meaningful, i.e. the one that omits outliers and retains data bracketing action level concentrations, should be used for final evaluation of the XRF data.*"

Kalnicky and Singhvi recommend plotting the residuals, the differences between the predicted and actual laboratory values, against the XRF concentration values to select outliers. On this plot the residuals should appear as a random scattering of points around the zero-residual line. Points that lie far outside of the group should be removed as outliers. To remove the subjectivity of this method, Pioneer took a slightly different approach and standardized the residuals by dividing each residual by the standard deviation of the residuals. Literature suggests that standardized residuals with values greater than 2 (outside of 95% of the population) or 3 (outside of 99.7% of the population) and less than negative 2 or 3 can be considered outliers (Montgomery and Runger, 2007; PennState, 2018). Based on a review of the outlier summary plots (Figure 1 through Figure 5), using standardized residual threshold boundaries of positive and negative 2 were appropriate for all 5 COCs. Points outside these boundaries were scattered beyond the main clumping of data around the zero-standardized-residual line and have been removed from the regression analysis.

For each regression analysis, Pioneer used the Excel Data Analysis ToolPak to calculate the standardized residuals. Any point with a standardized residual value greater than 2 or less than negative 2 was deemed an outlier and removed from the dataset. The points removed from the dataset are indicated in Table 2. The outlier analysis removed 10 samples from the arsenic regression, 6 from the cadmium regression, 7 from the copper regression, 4 from the lead regression, and 6 from the zinc regression.

2.2.2 Upper 95% Regression

Two sets of data were imported into the Leapfrog model. The first adjusted the XRF concentration results using the regression variables shown in Table 1. The second adjusted the XRF concentration results using the upper 95% regression variables shown in Table 1. The upper 95% regression provides a more conservative estimate of the COC concentrations by adjusting the XRF results to higher values than the regression. The upper 95% regression was generated using the Excel Data Analysis ToolPak and represents the upper 95% confidence in the linear regression model. Additional details on how the XRF concentrations were adjusted and imported into the Leapfrog model are in the Model Inputs memo (included in Appendix C of the main BRW PDI Report).

3 RESULTS AND DISCUSSION

The correlation analysis indicates that the XRF and ICP concentration values for arsenic, copper, lead, and zinc have moderately strong linear relationships before the outliers are removed (R values range between 0.74 and 0.80) and the strength of that relationship increases after the outliers are removed from the dataset (R values increase to between 0.93 and 0.96). The correlation analysis for cadmium indicates that the relationship is not as strong (R value equals 0.48 with all data and R value equals 0.61 after the outliers are removed), but the relationship is not so poor (i.e., R value is approximately 0) as to indicate a non-linear relationship (Table 1).

The regression analyses indicate that the linear models for arsenic, copper, lead, and zinc adequately explain the variability in the data because the coefficients of determination for these 4 COCs were greater than 0.7 (Table 1). Even after removal of the outliers, the coefficient of determination for cadmium was only 0.37; therefore, the linear model for this analysis is only able to explain approximately one-third of the variability in the data. The significance of the cadmium model is further discussed in the Regression Summary sections below.

3.1 Arsenic

Regression Summary

The regression analysis for arsenic indicates that the XRF analysis overestimates the arsenic concentrations (m = 0.86). There is a small initial offset to the data indicated by the y-intercept, which is equal to 13.7 milligrams per kilogram (mg/kg) (Table 1). The coefficient of determination can be interpreted to indicate that the model accounts for approximately 92% of the variability in the data (Table 1).

Figure 1 shows the 3 plots used to assess the regression analysis. The first plot (upper left hand corner), Arsenic XRF to ICP Correlation: Entire Data Set with Outliers, shows the entire dataset, the outliers removed to calculate the regression, and the linear regression model flanked by the upper and lower 95% regressions. The data points are grouped primarily near the origin, with points scattered above and below the regression line.

The second plot (upper right hand corner), Arsenic XRF to ICP Regression: View Near Waste Criteria, shows a zoomed-in view of the first plot and shows the points around the waste criteria 200 mg/kg (EPA, 2020). The points are generally grouped below the regression line for XRF concentrations ranging from 0 mg/kg to 100 mg/kg and then are scattered above and below the regression line at higher XRF concentrations (Figure 1). Overall, the regression line provides a good balance between the points scattered above and those scattered below. This is reflected in the high correlation coefficient (R = 0.96).

Outlier Summary

The third plot, Outlier Summary: Arsenic Standardized Residual Plot, shows the standardized residuals of the entire dataset with respect to the XRF concentration values and the standardized residual threshold boundaries of positive and negative 2. Points that fall outside the positive and negative 2 standardized residual threshold boundary lines have been determined to be outliers. (Figure 1).

Conclusion

Overall, the regression model for arsenic fits the data well and provides adequate coverage for the variability in the dataset. Therefore, the regression and upper 95% regression will be used to adjust the XRF concentration values for import into Leapfrog. Details of how the regression and upper 95% regression were used in the Leapfrog model are in the Model Inputs memo (included in Appendix C of the main BRW PDI Report).

3.2 Cadmium

Regression Summary

The regression model for cadmium was not as strong as the regression models for the other 4 COCs. The correlation analysis indicates that the linear relationship between the XRF and ICP concentration results is not as strong as the relationships for the other 4 COCs (R value equals 0.61 as compared to R values ranging from 0.93 to 0.96). Additionally, the coefficient of determination is 0.37, indicating that the regression model can only account for 37% of the variability in the data (Table 1).

Figure 2 shows the 2 plots used to assess the regression analysis. The first, Cadmium XRF to ICP Correlation: Entire Data Set with Outliers, shows the entire dataset, the outliers removed to calculate the regression, and the linear regression model flanked by the upper and lower 95% regressions. The data points show a generally linear relationship, but there is far too much scattering in the points. The scattering supports the lower strength of the linear relationship and the lower coefficient of determination.

Outlier Summary

The second plot on Figure 2, Outlier Summary: Cadmium Standardized Residual Plot, identifies outliers above the standardized residual threshold boundary value of 2. The location of the outliers on the first plot reinforces their designation of outliers: they sit well above the other points in the dataset (Figure 2).

Conclusion

The slope (m = 0.45) indicates that the regression model found the XRF concentration results to be overestimated by a factor of almost 2. There is a small initial negative offset to the data indicated by the y-intercept, which is equal to -1.60 mg/kg. When examining the plot of XRF to ICP results (Figure 2), the regression appears to capture the midpoint of the scattered data. The centroid of the data, where the XRF value is equal to the average XRF values in the regression dataset (12.3 mg/kg) and the ICP value is equal to the average ICP values (3.9 mg/kg), resides almost directly on the regression line. The predicted ICP value where the XRF value equals 12.3 mg/kg is 3.92 mg/kg. Additionally, the more conservative upper 95% regression line, which has a steeper slope and a y-intercept of nearly 0 (-0.15 mg/kg), will provide a more conservative estimate of cadmium concentrations, and the changes between the 2 models will be accounted for in the Leapfrog model. Therefore, the regression and upper 95% regression models will still be used to adjust the XRF concentration results in the Leapfrog model. Details of how the regression and upper 95% regression were used in the Leapfrog model are in the Model Inputs memo (included in Appendix C of the main BRW PDI Report).

3.3 Copper

Regression Summary

The slope of the regression analysis (m) for copper is 1.11, indicating that XRF analysis slightly underestimates the copper concentrations. There is a small initial negative offset to the data indicated by the y-intercept, b = -34 (Table 1). The coefficient of determination can be interpreted to indicate that the model accounts for approximately 88% of the variability in the data (Table 1).

Figure 3 shows the 4 plots used to assess the regression analysis. The first plot, Copper XRF to ICP Correlation: Entire Data Set with Removed Outliers, shows the entire dataset, the outliers removed to calculate the regression, and the linear regression model flanked by the upper and lower 95% regressions. The data points generally follow the regression lines with a few points scattered above and below the linear regression model.

The second plot, Copper XRF to ICP Regression: View Near Maximum Waste Criteria, shows a zoomed-in view of the first plot and shows the points around the waste criteria (1,000 mg/kg) and the maximum waste criteria (5,000 mg/kg) lines (EPA, 2020). There are a number of points that fall outside of the upper and lower 95% regression lines, but the regression balances that variability. The third plot, Copper XRF to ICP Regression: View near Waste Criteria also shows a range of points falling above and below the upper and lower 95% regression lines. From the two plots, it appears that the regression line generally overestimates the XRF concentration values near the waste criteria (1,000 mg/kg), which will provide a more conservative model (Figure 3).

Outlier Summary

The fourth plot, Outlier Summary: Copper Standardized Residual Plot, shows the standardized residuals of the entire dataset plotted against the XRF concentration values. The outlier points fall outside the positive and negative standardized residual threshold boundary lines and are scattered beyond the greater grouping around the zero line. The location of the outliers on the first plot reinforces their designation of outliers: they generally sit well above and well below the other points in the dataset (Figure 3).

Conclusion

When viewing the plots on Figure 3, the copper regression provides a balanced regression that straddles the scattering of points on the plots. Therefore, the regression and upper 95% regression will be used to adjust the XRF concentration values for import into Leapfrog. Details of how the regression and upper 95% regression were used in the Leapfrog model are in the Model Inputs memo (included in Appendix C of the main BRW PDI Report).

3.4 Lead

Regression Summary

The regression analysis for lead indicates that the XRF analysis underestimated the lead concentrations in the samples (m = 1.56). There is a small initial negative offset to the data indicated by the y-intercept, b = -144. The coefficient of determination can be interpreted to indicate that the model accounts for approximately 91% of the variability in the data (Table 1).

Figure 4 shows the 4 plots used to assess the regression analysis. The first plot, Lead XRF to ICP Correlation: Entire Data Set with Removed Outliers, shows the entire dataset, the outliers removed to calculate the regression, and the linear regression model flanked by the upper and lower 95% regressions. The data points generally follow the regression lines and the regression lines appear well balanced in relation to the points that fall well above and below.

The second plot, Lead XRF to ICP Regression: View Near Maximum Waste Criteria, shows a zoomed-in view of the first plot and shows the points near both the waste criteria (1,000 mg/kg) and the maximum waste criteria (5,000 mg/kg) lines (EPA, 2020). There are a number of points that fall outside of the upper and lower 95% regression lines, but most appear to fall below the regression lines. The third plot, Lead XRF to ICP Regression: View Near Waste Criteria, illustrates how the upper points may be pulling the regression line up, making the adjustment more conservative at higher concentrations, while the lower points pull the y-intercept into negative values, making the adjustment less conservative at lower concentrations (Figure 4).

Outlier Summary

The fourth plot, Outlier Summary: Lead Standardized Residual Plot, shows the standardized residuals of the entire dataset plotted against the XRF concentration values. The outlier points are scattered above and below other values, which generally fall well within the positive and negative standardized residual threshold boundary lines. The location of the outliers on the first plot reinforces their designation as outliers: they sit well above and below the other points in the dataset (Figure 4).

Conclusion

The low XRF concentration to high ICP concentration ratio of 2 non-outlier points in the dataset appears to have shifted the linear regression upwards, making the slope steeper and more conservative at higher XRF concentrations. The smaller XRF to ICP ratio at lower XRF concentrations appears to have shifted the y-intercept down to negative values, which makes the model less conservative at lower XRF concentrations. However, the shifts are not dramatic enough to warrant performing another outlier analysis. Therefore, the regression and upper 95% regression will be used to adjust the XRF values for import into Leapfrog. Details of how the regression and upper regression were used in the Leapfrog model are in the Model Inputs memo (included in Appendix C of the main BRW PDI Report).

3.5 Zinc

Regression Analysis

The slope of the regression analysis for zinc indicates that the XRF analysis overestimates the zinc concentrations in the samples (m = 0.87). The y-intercept (b = 195) suggests that some of the points are pulling the regression line upward. The coefficient of determination can be interpreted to indicate that the model accounts for approximately 86% of the variability in the data (Table 1).

Figure 5 shows the 4 plots used to assess the regression analysis. The first plot, Zinc XRF to ICP Correlation: Entire Data Set with Removed Outliers, shows the entire dataset, the outliers removed to calculate the regression, and the linear regression model flanked by the upper and lower 95% regressions. The data points show a concentrated mass near the XRF and ICP concentrations ranging from 5,000 mg/kg, the maximum waste criteria, to 10,000 mg/kg with many points lying outside the upper 95% and lower 95% regression lines. As the XRF values increase, there are far fewer points, with 1 higher concentration near the regression line where the XRF concentration value is near 30,000 mg/kg (6 times greater than the maximum waste criteria of 5,000 mg/kg). The cluster near the lower concentrations is shown further in the second and third plots.

The second plot, Zinc XRF to ICP Regression: View Near Maximum Waste Criteria, shows a zoomed-in view of the first plot and shows the points near the maximum waste criteria, 5,000 mg/kg (EPA, 2020). Here, the regression line tends to overestimate concentrations near the waste criteria (1,000 mg/kg), but the scatter increases dramatically as the XRF concentration values increase to the maximum waste criteria (Figure 5). The third plot, Zinc XRF to ICP Regression: View Near Waste Criteria, further illustrates the overestimation of the linear regression near the waste criteria (Figure 5).

Outlier Analysis

The fourth plot, Outlier Summary: Zinc Standardized Residual Plot, shows the standardized residuals of the entire dataset plotted against the XRF concentration values. Six outlier points fall above and below the standardized residual threshold boundary line and are generally scattered beyond the greater grouping around the zero line. The location of the outlier points on the first plot, far above and to the left of the majority of the dataset, demonstrates the legitimacy in removing them as outliers (Figure 5).

Conclusion

The scattering of points at the higher XRF concentration values appears to shift the entire regression upward, resulting in a relatively larger y-intercept (i.e., 433 for the upper 95% regression, Table 1). This shift likely results in a potential overestimation of values at the lower concentrations, which produces a more conservative model. At concentrations greater than the waste criteria (1,000 mg/kg) and maximum waste criteria (5,000 mg/kg), the regression balances the scattering of points. This balancing act is reflected in the high correlation coefficient (R = 0.93) (Table 1). Therefore, the regression and upper 95% regression model will be used to adjust the XRF concentration data for import into Leapfrog. Details of how the regression and upper regression were used in the Leapfrog model are in the Model Inputs memo (included in Appendix C of the main BRW PDI Report).

4 CONCLUSION

The XRF concentration data will be used within the Leapfrog model to determine the extent of waste that will need to be excavated from the removal corridor within the Site (details are also included in the Model Inputs memo included in Appendix C of the main BRW PDI Report). Prior to being used in Leapfrog, the XRF concentration data must be adjusted to better match the accuracy of the ICP data. The objective of this memorandum was to analyze the regression relationship between the XRF and ICP concentrations and provide the resulting regression coefficients to adjust the XRF concentration data. Table 1 provides the results of the regression and correlation analyses, including the coefficients to adjust the XRF concentration data for each of the 5 COCs (arsenic, cadmium, copper, lead, and zinc).

The regression models generated by the Excel Data Analysis ToolPak were all evaluated to ensure that the models fit the data appropriately and that outliers within the data were identified and removed. The model for cadmium was limited by the weaker relationship between the XRF and ICP concentrations, however the model does provide an acceptable correlation and regression. As a result, the regression and upper 95% regression models provide a good adjustment factor for the XRF results and will be used to adjust the XRF data for import into Leapfrog.

5 REFERENCES

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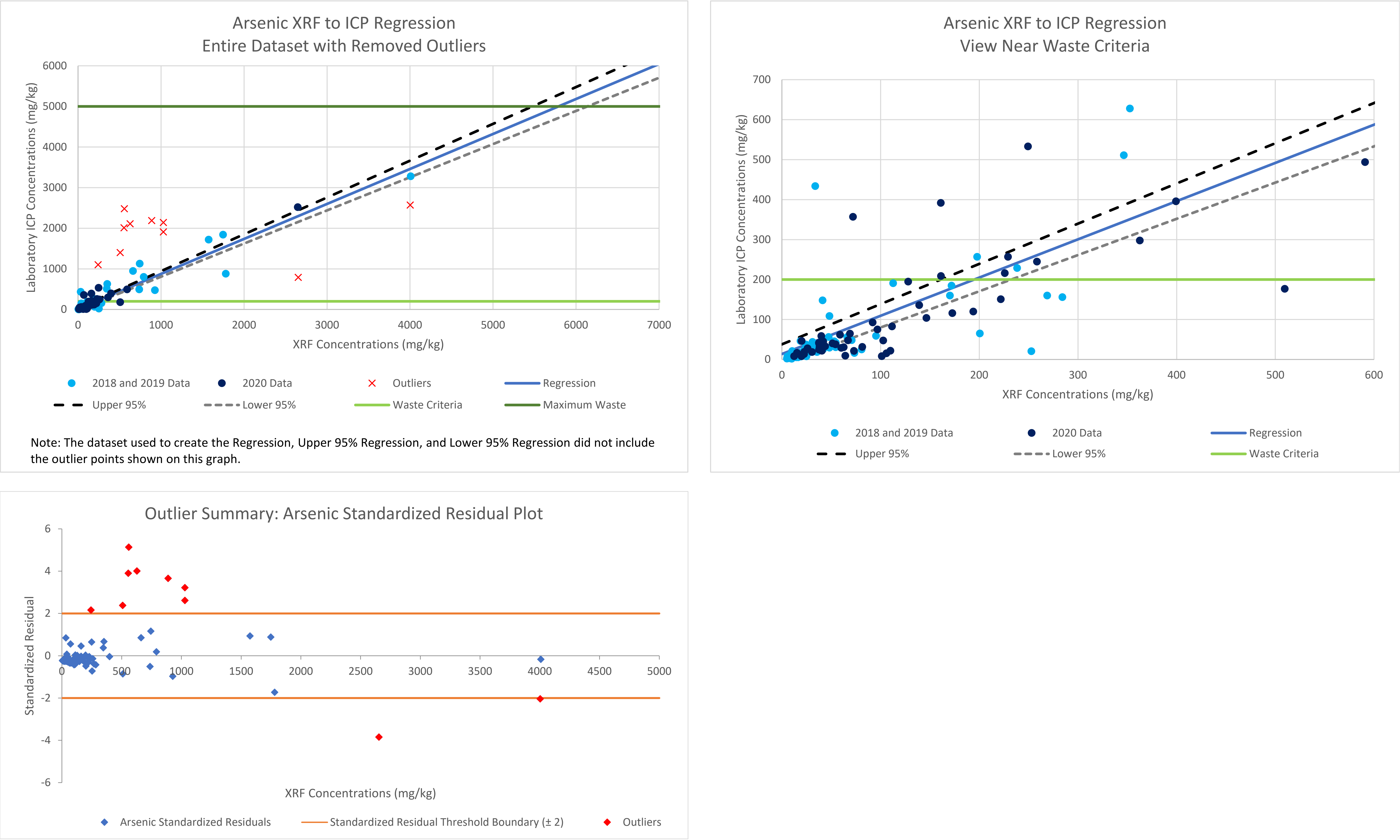
FIGURES

Figure 1. Arsenic Regression Analysis



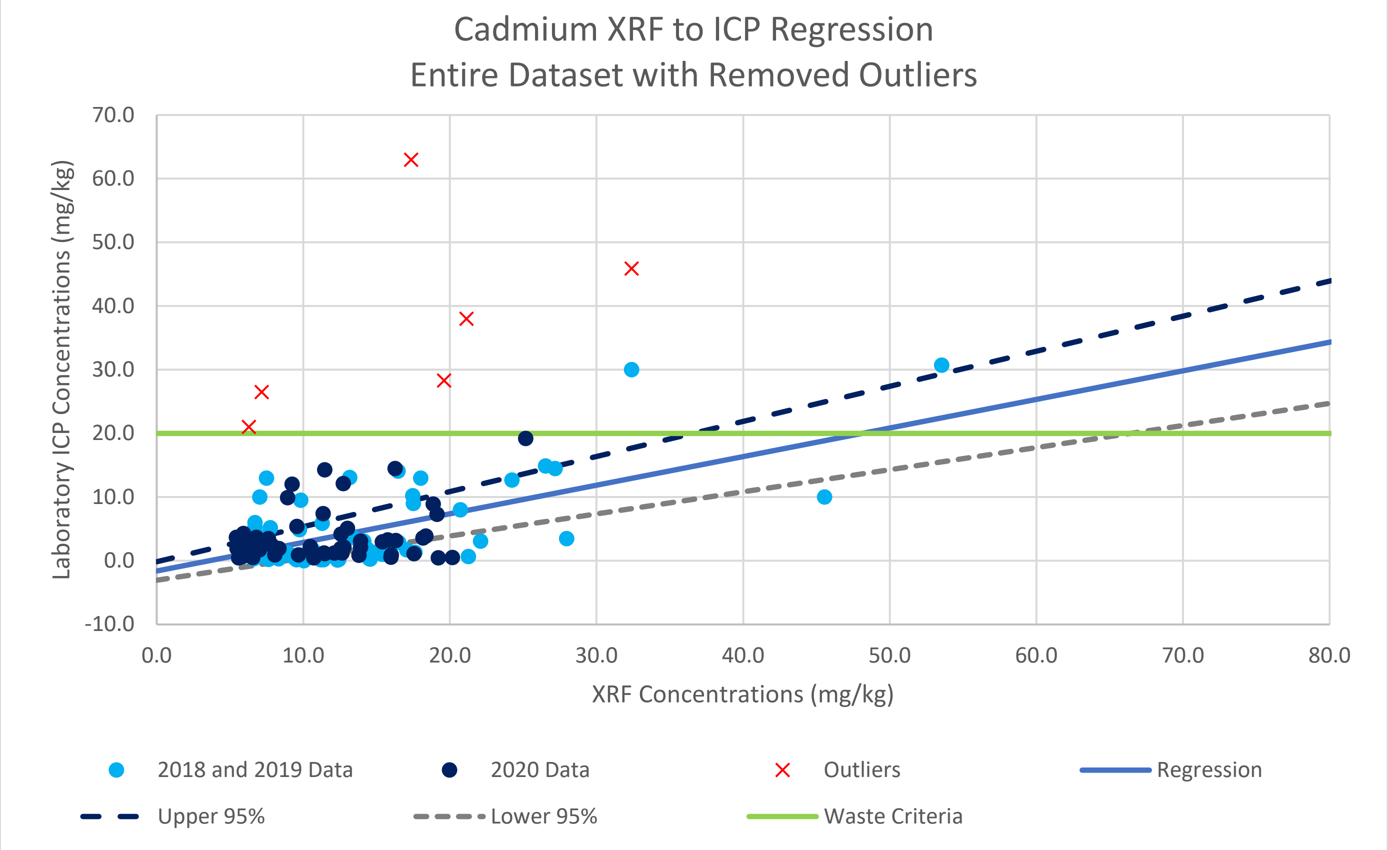
Arsenic XRF to ICP Regression
Entire Dataset with Removed Outliers

Note: The dataset used to create the Regression, Upper 95% Regression, and Lower 95% Regression did not include the outlier points shown on this graph.

Arsenic XRF to ICP Regression
View Near Waste Criteria

Outlier Summary: Arsenic Standardized Residual Plot

Figure 2. Cadmium Regression Analysis



Note: The dataset used to create the Regression, Upper 95% Regression, and Lower 95% Regression did not include the outlier points shown on this graph.

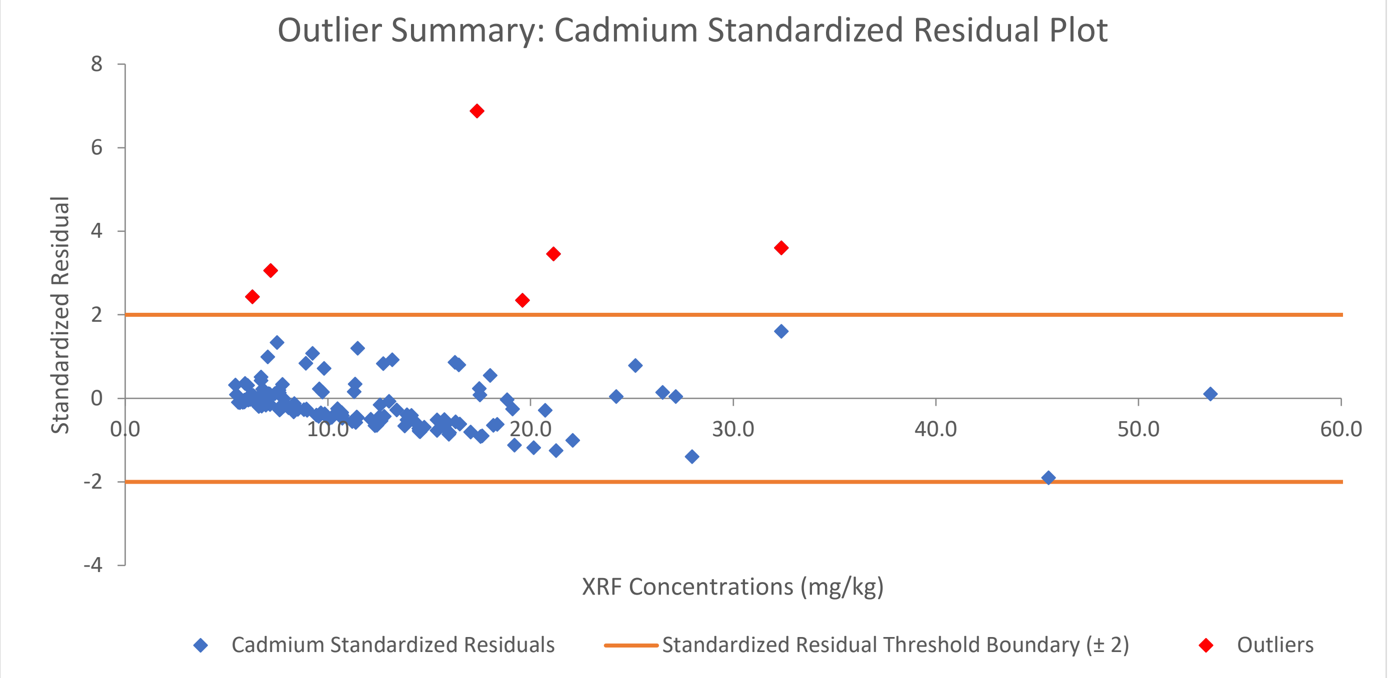


Figure 3. Copper Regression Analysis

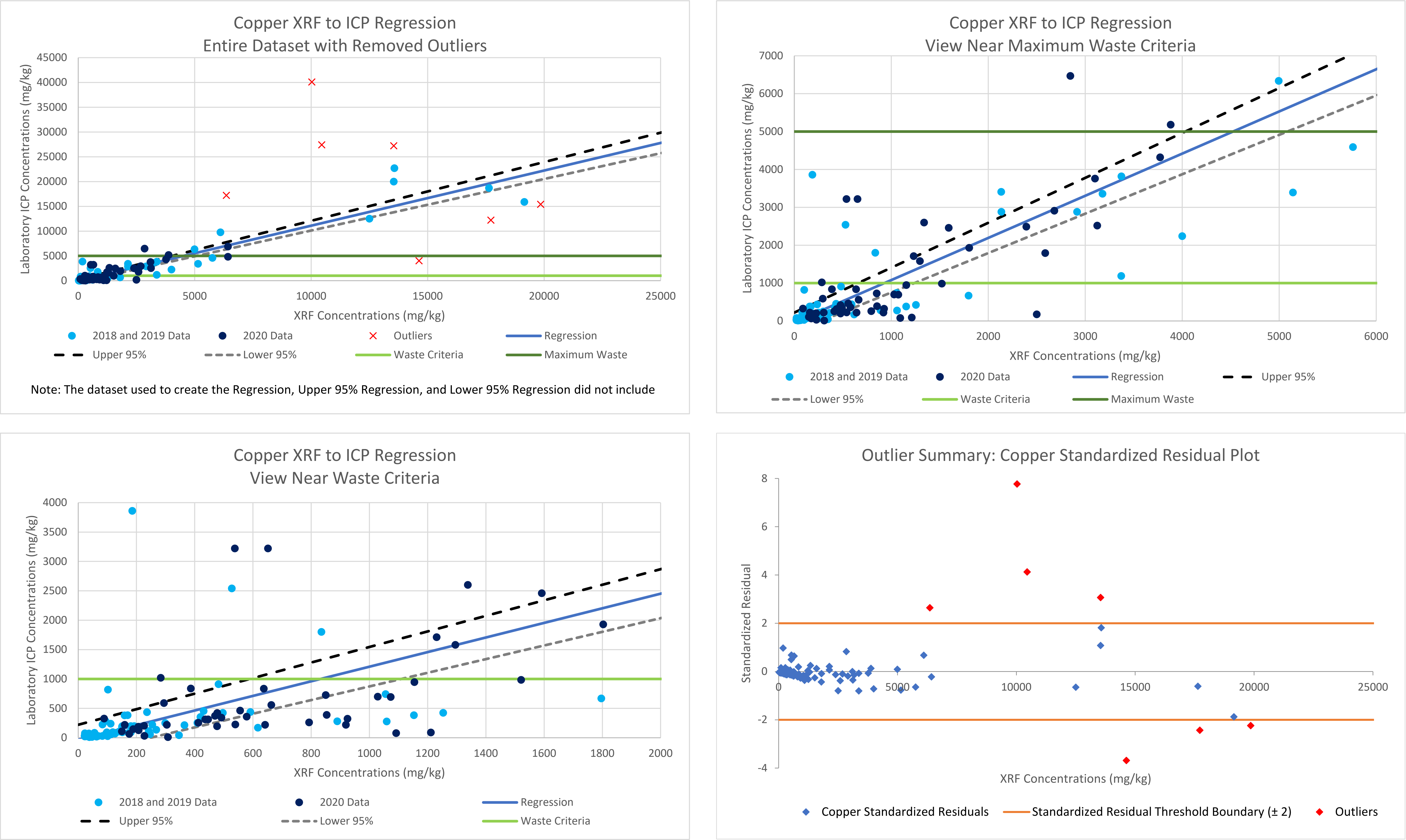
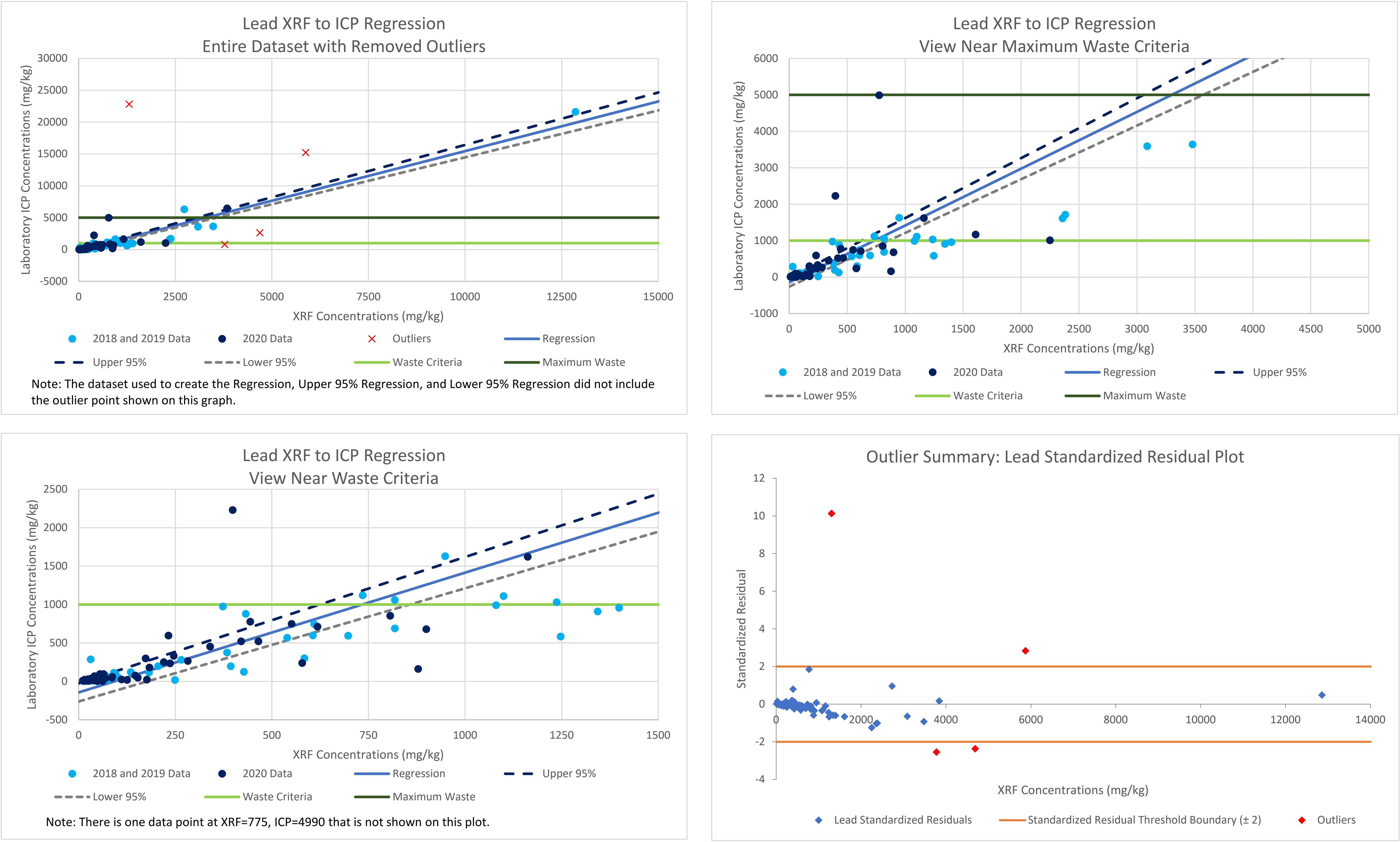


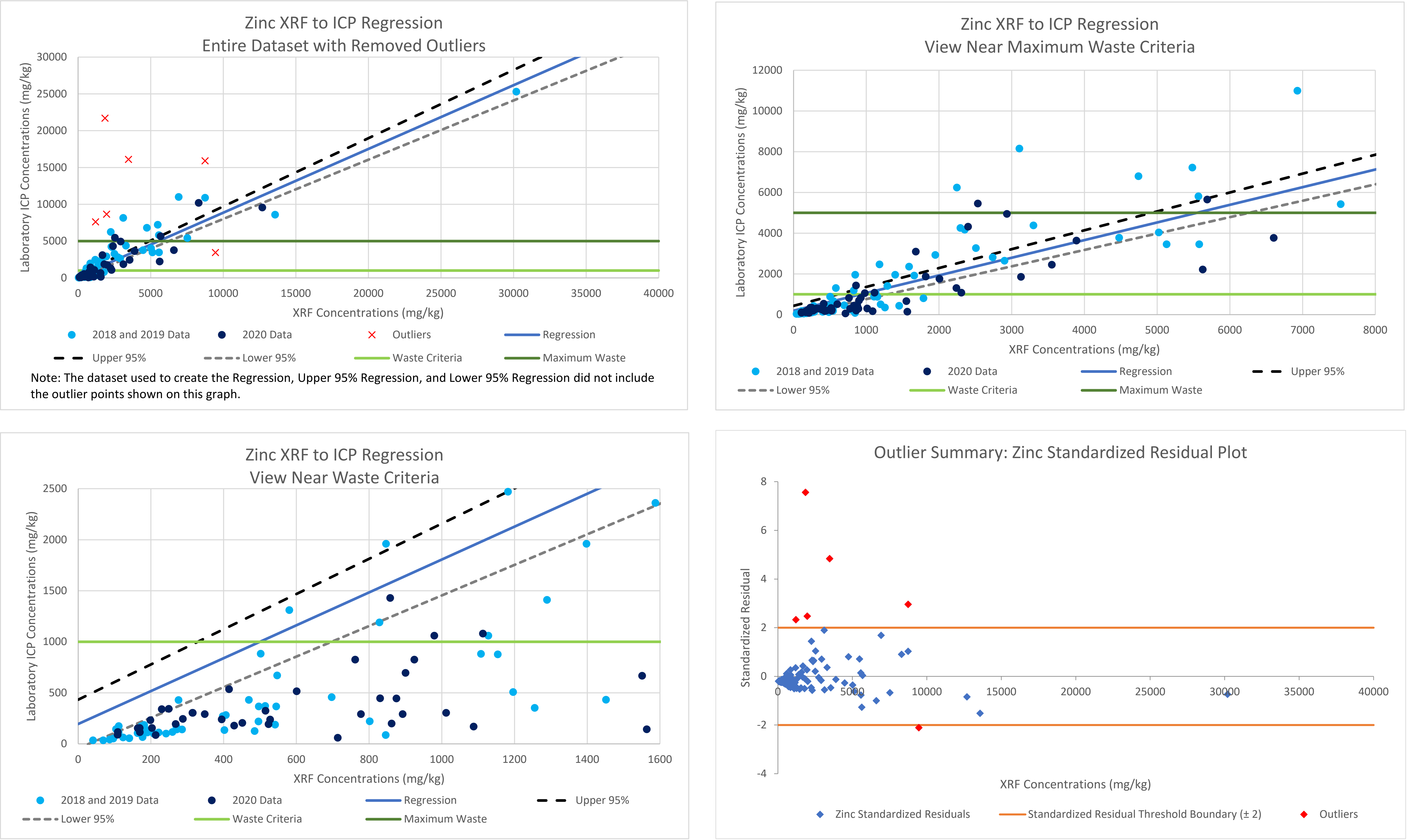
Figure 4. Lead Regression Analysis



Note: The dataset used to create the Regression, Upper 95% Regression, and Lower 95% Regression did not include the outlier point shown on this graph.

Note: There is one data point at XRF=775, ICP=4990 that is not shown on this plot.

Figure 5. Zinc Regression Analysis



Note: The dataset used to create the Regression, Upper 95% Regression, and Lower 95% Regression did not include the outlier points shown on this graph.

TABLES

Table 1: Summary of XRF and ICP Correlation and Regression Analyses

	Number of Samples[*]	Correlation Coefficient		Coefficient of Determination[**]	Regression[**]		Upper 95% Regression[**]	
		All Data	Outliers Removed		Slope	y-Intercept	Slope	y-Intercept
		R		R^2	m	b	m	b
Arsenic	127	0.80	0.96	0.92	0.86	13.7	0.91	38.0
Cadmium	130	0.48	0.61	0.37	0.45	-1.6	0.55	-0.15
Copper	130	0.80	0.94	0.88	1.11	-34	1.19	221
Lead	133	0.74	0.95	0.91	1.56	-144	1.64	-26.1
Zinc	131	0.76	0.93	0.86	0.87	195	0.93	433

[*] There are 137 total samples for arsenic, copper, lead and zinc, and 136 samples for cadmium. The number of samples presented here is equal to the number of samples used in the regression analysis after the outliers were removed. The data used in the regression analyses are shown in Table 2, which also indicates which samples were removed during the outlier analysis.

[**] The Coefficient of Determination, Regression, and Upper 95% Regression were all generated using the dataset with the outliers removed. The number of samples to the left indicates the number of samples used to generate the linear models with these values. Table 2 indicates which samples were used for these analyses.

Table 2. Sample Results Used in the Correlation and Regression Analyses

2018 and 2019 Samples													
Station Name	**Field Sample ID (XRF)***	**Field Sample ID (ICP)**	**Lab (ICP)**	**Arsenic (XRF)**	**Arsenic (ICP)**	**Cadmium (XRF)**	**Cadmium (ICP)**	**Copper (XRF)**	**Copper (ICP)**	**Lead (XRF)**	**Lead (ICP)**	**Zinc (XRF)**	**Zinc (ICP)**
BH01	BRW18-BH01(25.8-27.5)-03052019	BRW18-BH01(25.8-27.5)-10122018	PACE_MPLS	73.4	16.3	21.3	0.7	1153	384	1247	584	1196	507
BH02	BRW18-BH02(18.3-23.4)-03052019	BRW18-BH02(18.3-23.4)-10172018	PACE_MPLS	353	628	13.2	13.1	5761	4590	384	376	2354	4170
BH02	BRW18-BH02(28.2-32.5)-03052019	BRW18-BH02(28.2-32.5)-10172018	PACE_MPLS	7.4	3.2	6.6	0.3	268	136	25.0	11.0	242	101
BH03	BRW18-BH03(15.0-20.0)-02152019	BRW18-BH03(15-20)-09252018	PACE_MPLS	269	160		0.9	2915	2880	393	196	5579	3460
BH03	BRW18-BH03(15.0-20.0)-09252018	BRW18-BH03(15-20)-09252018	PACE_MPLS	170	160	8.5	0.9	2135	2880	205	196	5129	3460
BH03	BRW18-BH03(25.7-27.3)-09252018	BRW18-BH03(25.7-27.3)-09252018	PACE_MPLS	37.1	32.6	7.8	5.2	83.1	227	265	280	1182	2470
BH05	BRW18-BH05(21.9-23.4)-03052019	BRW18-BH05(21.9-23.4)-09252018	PACE_MPLS	24.3	37.8	13.4	3.7	170	384	540	567	1588	2360
BH08	BRW18-BH08(24.5-26.3)-03052019	BRW18-BH08(24.5-26.3)-09282018	PACE_MPLS	8.2	11.8	17.6	1.3	36.4	73.1	48.9	16.4	406	283
BH09	BRW18-BH09(31.4-32.6)-03052019	BRW18-BH09(31.4-32.6)-09242018	PACE_MPLS	284	156	14.1	3.1	3371	1190	584	301	1787	802
BH09	BRW18-BH09(36.8-37.4)-09242018	BRW18-BH09(36.8-37.4)-03062019	ENRHSPLP	41.8	26.0	7.7	1.0	173	85.0	102	48.0	496	219
BH09	BRW18-BH09(38.0-40.0)-03052019	BRW18-BH09(38-40)-09242018	PACE_MPLS	28.4	19.0	9.8	0.9	152	93.4	73.8	33.8	497	367
BH09	BRW18-BH09(38.0-40.0)-09242018	BRW18-BH09(38-40)-09242018	PACE_MPLS	35.5	19.0	6.5	0.9	181	93.4	52.4	33.8	545	367
BH16	BRW18-BH16(7.5-12.2)-03052019	BRW18-BH16(7.5-12.2)-10122018	PACE_MPLS	95.4	59.3	7.7	0.5	365	214	28.1	6.4	271	141
BH18	BRW18-BH18(10.1-13.1)-03052019	BRW18-BH18(10.1-13.1)-09182018	PACE_MPLS	18.7	17.2	16.5	2.9	58.8	58.1	91.0	111	547	670
BH18	BRW18-BH18(4.1-6.1)-03052019	BRW18-BH18(4.1-6.1)-09182018	PACE_MPLS	4003	2570	28.0	3.5	4994	6340	4686	2620	2739	2810
BH20	BRW18-BH20(1.3-3.3)-03052019	BRW18-BH20(1.3-3.3)-09172018	PACE_MPLS	7.3	9.6	12.4	0.2	21.9	32.4	16.8	7.6	96.7	51.6
BH20	BRW18-BH20(5.8-7.7)-03052019	BRW18-BH20(5.8-7.7)-09172018	PACE_MPLS	198	257	22.1	3.1	3177	3360	735	1120	1950	2930
BH21	BRW18-BH21(5.0-7.5)-03052019	BRW18-BH21(5-7.5)-09132018	PACE_MPLS	744	1130	11.3	5.9	2133	3410	697	595	1398	1960
BH22	BRW18-BH22(3.5-6.8)-03052019	BRW18-BH22(3.5-6.8)-09132018	PACE_MPLS	4008	3280	19.6	28.3	12499	12500	2381	1710	3106	8160
BH23	BRW18-BH23(2.7-4.8)-03052019	BRW18-BH23(2.7-4.8)-09132018	PACE_MPLS	48.2	109	26.5	14.9	112	57.1	610	745	4743	6800
BH25	BRW18-BH25(8.3-10.8)-03052019	BRW18-BH25(8.3-10.8)-09142018	PACE_MPLS	113	191	17.5	10.2	835	1800	3088	3590	5568	5810
BH26	BRW18-BH26(12.7-14.7)-03052019	BRW18-BH26(12.7-14.7)-09142018	PACE_MPLS	7.5	7.4	9.7	4.9	68.7	29.2	39.2	35.5	697	457
BH26	BRW18-BH26(4.5-6.5)-03052019	BRW18-BH26(4.5-6.5)-09142018	PACE_MPLS	662	946	16.5	14.1	6101	9770	1100	1110	2246	6240
BH26	BRW18-BH26(6.5-6.8)-09142018	BRW18-BH26(6.5-6.8)-03062019	ENRHSPLP	346	511	17.5	9.0	3373	3820	12859	21600	30188	25300
BH26	BRW18-BH26(7.2-9.7)-09142018	BRW18-BH26(7.2-9.7)-09142018	PACE_MPLS	31.0	44.0	6.7	5.3	112	238	432	878	847	1960
BH27	BRW18-BH27(10.0-12.3)-03052019	BRW18-BH27(10-12.3)-09142018	PACE_MPLS	16.5	5.6	14.5	0.8	1796	668	47.9	16.3	485	126
BH28	BRW18-BH28(0.0-1.5)-09142018	BRW18-BH28(0.0-1.5)-03042019	ENRHSPLP	253	21.0	15.4	1.0	23.1	76.0	249	18.0	846	86.0
BH28	BRW18-BH28(5.9-8.6)-03052019	BRW18-BH28(5.9-8.6)-09142018	PACE_MPLS	1030	2140	32.4	45.9	13544	20000	818	1060	8745	15900
BH28	BRW18-BH28(5.9-8.6)-03052019	BRW18-BH28(5.9-8.6)-03062019	ENRHSPLP	1030	1910	32.4	30.0	13544	27200	818	689	8745	10900
BH29	BRW18-BH29(5.8-8.1)-03052019	BRW18-BH29(5.8-8.1)-09172018	PACE_MPLS	1574	1720	24.2	12.7	19854	15400	1343	909	5023	4040
BH29	BRW18-BH29(8.1-11.1)-03052019	BRW18-BH29(8.1-11.1)-09172018	PACE_MPLS	1748	1840	53.5	30.7	19148	15900	2358	1610	13575	8590
PZ01	BRW18-PZ01(15.0-19.2)-03052019	BRW18-PZ01(15-19.2)-09202018	PACE_MPLS	7.0	8.2	7.8	1.1	181	199	27.7	11.6	184	144
PZ01	BRW18-PZ01(15.0-19.2)-09202018	BRW18-PZ01(15-19.2)-09202018	PACE_MPLS	5.6	8.2	5.9	1.1	152	199	18.6	11.6	104	144
PZ01	BRW18-PZ01(4.4-6.7)-03052019	BRW18-PZ01(4.4-6.7)-09202018	PACE_MPLS	6.8	5.9	12.3	0.1	141	106	16.2	5.8	141	55.8
PZ02	BRW18-PZ02(1.2-2.0)-09202018	BRW18-PZ02(1.2-2.0)-03042019	ENRHSPLP	172	185	20.7	8.0	55.6	83.0	1237	1030	4478	3780
PZ02	BRW18-PZ02(5.3-5.7)-09202018	BRW18-PZ02(5.3)-03042019	ENRHSPLP	2653	790	7.5	13.0	14630	4020	3778	803	2507	3270
PZ02	BRW18-PZ02(7.2-8.3)-09202018	BRW18-PZ02(7.2-8.3)-03042019	ENRHSPLP	33.7	434	6.3	21.0	186	3860	1306	22800	1854	21700

* In the database there are 2 XRF sample results, those labeled as "Field" and those labeled as "Pioneer". Only Pioneer results are being used in the regression analyses.

Color Coding in the Station Name Column

🟦 There are two Pioneer XRF results for the sample interval that correspond to one ICP result. The ICP result was duplicated for this analysis

🟧 There are two ICP results that correspond to the same sample interval as one Pioneer XRF result. The Pioneer XRF result was duplicated for this analysis

Color Coding in the Analyte Result Columns

🟨 There was no Cadmium XRF result for this sample. Therefore this point was not used in the Cadmium regression.

⬛ These points were identified as outliers and were not used in the final regression analyses.

2018 and 2019 Samples

Station Name	Field Sample ID (XRF)*	Field Sample ID (ICP)	Lab (ICP)	Arsenic (XRF)	Arsenic (ICP)	Cadmium (XRF)	Cadmium (ICP)	Copper (XRF)	Copper (ICP)	Lead (XRF)	Lead (ICP)	Zinc (XRF)	Zinc (ICP)
PZ03	BRW18-PZ03(0.8-3.0)-03052019	BRW18-PZ03(0.8-3)-09192018	PACE_MPLS	18.8	46.5	10.7	1.6	420	353	31.0	287	1659	1920
PZ03	BRW18-PZ03(5.0-9.9)-03052019	BRW18-PZ03(5.0-9.9)-03062019	ENRHSPLP	555	2010	7.0	10.0	17635	18700	373	974	2295	4260
PZ03	BRW18-PZ03(5.0-9.9)-09192018	BRW18-PZ03(5-9.9)-09192018	PACE_MPLS	509	1400	9.8	9.5	10451	27400	606	599	3298	4380
PZ03	BRW18-PZ03(9.9-13.4)-09192018	BRW18-PZ03(9.9-13.4)-09192018	PACE_MPLS	31.6	32.2	6.2	1.4	497	423	135	121	469	431
PZ04	BRW18-PZ04(10.1-12.4)-09192018	BRW18-PZ04(10.1-12.4)-09192018	PACE_MPLS	10.4	21.4	8.8	1.0	94.0	282	95.9	95.5	276	429
PZ08	BRW18-PZ08(2.2-5.0)-03052019	BRW18-PZ08(2.2-5.5)-09192018	PACE_MPLS	7.1	6.6	11.2	0.2	236	436	21.7	10.4	181	186
PZ08	BRW18-PZ08(6.6-7.2)-09182018	BRW18-PZ08(6.6-7.2)-03042019	ENRHSPLP	792	801	6.7	6.0	17714	12200	3480	3640	2902	2650
PZ08	BRW18-PZ08(8.5-9.5)-09182018	BRW18-PZ08(8.5-9.5)-03042019	ENRHSPLP	41.1	148	6.0	4.0	102	819	948	1630	581	1310
PZ09	BRW18-PZ09(10.0-12.0)-09192018	BRW18-PZ09(10-12)-09192018	PACE_MPLS	12.3	7.8	5.7	0.5	95.4	69.3	62.4	42.3	828	1190
PZ09	BRW18-PZ09(13.0-13.6)-09192018	BRW18-PZ09(13.0-13.6)-03042019	ENRHSPLP	13.9	6.0	45.6	10.0	35.3	22.0	42.0	21.0	542	188
PZ09	BRW18-PZ09(3.8-5.1)-09192018	BRW18-PZ09(3.8-5.1)-03042019	ENRHSPLP	888	2190	17.4	63.0	13571	22700	2732.4	6310.0	6929	11000
PZ10	BRW18-PZ10(12.8-14.6)-03052019	BRW18-PZ10(12.8-14.6)-09282018	PACE_MPLS	9.0	8.2	7.6	4.0	346	43	17.1	5.1	502	884
PZ10	BRW18-PZ10(15.0-18.0)-03052019	BRW18-PZ10-(15-18)-09282018	PACE_MPLS	5.9	6.6	14.6	0.3	299	250	19.8	7.4	182	162
PZ10	BRW18-PZ10(21.7-23.9)-03052019	BRW18-PZ10(21.7-23.9)-09282018	PACE_MPLS	19.3	7.6	6.9	0.8	247	60	76.8	26.9	221	112
PZ10	BRW18-PZ10(8.0-12.8)-03052019	BRW18-PZ10(8-12.8)-09282018	PACE_MPLS	6.3	7.8	8.3	0.3	159	380	27.2	5.4	112	175
PZ11	BRW18-PZ11(11.6-13.9)-03052019	BRW18-PZ11(11.6-13.9)-10082018	PACE_MPLS	5.0	2.6	9.5	0.2	192	198	11.8	2.3	40.7	35.6
PZ11	BRW18-PZ11(25.0-27.3)-03052019	BRW18-PZ11(25-27.3)-10082018	PACE_MPLS	54.5	30.9	14.3	1.9	151	190	69.5	46.5	1289	1410
PZ12	BRW18-PZ12(15.0-17.0)-03052019	BRW18-PZ12(15-17)-10052018	PACE_MPLS	14.5	5.6	6.6	0.3	254	222	12.8	5.4	86.3	42.1
PZ12	BRW18-PZ12(2.9-5.8)-03052019	BRW18-PZ12(2.9-5.8)-10052018	PACE_MPLS	24.8	8.0	7.6	0.2	242	113	33.4	8.5	123	63.6
PZ12	BRW18-PZ12(20.0-21.9)-03052019	BRW18-PZ12(20-21.9)-10052018	PACE_MPLS	10.2	11.6	6.7	0.5	22.6	21.0	22.0	7.6	163	106
PZ13	BRW18-PZ13(10.0-15.0)-03052019	BRW18-PZ13(10-15)-10112018	PACE_MPLS	53.0	45.8	14.5	0.4	1056	742	15.1	4.1	190	111
PZ13	BRW18-PZ13(2.7-5.0)-03052019	BRW18-PZ13(2.7-5)-10112018	PACE_MPLS	927	473	10.1	0.0	591	439	71.5	42.1	1154	877
PZ13	BRW18-PZ13(20.0-22.0)-03052019	BRW18-PZ13(20-22)-10112018	PACE_MPLS	22.8	25.0	10.2	0.4	431	453	29.2	4.8	184	113
PZ13	BRW18-PZ13(5.0-8.5)-03052019	BRW18-PZ13(5-8.5)-10112018	PACE_MPLS	201	65.1	14.5	0.3	889	279	19.9	7.0	177	66.1
PZ14	BRW18-PZ14(20.9-22.5)-03052019	BRW18-PZ14(20.9-22.5)-10082018	PACE_MPLS	18.0	10.8	8.3	1.4	47.0	13.1	28.0	9.4	259	116
PZ15	BRW18-PZ15(18.3-18.8)-10052018	BRW18-PZ15(18.3-18.8)-03062019	ENRHSPLP	9.9	2.0	7.2	1.0	38.0	10.0	46.9	11.0	286	142
PZ15	BRW18-PZ15(23.8-25.6)-03052019	BRW18-PZ15(23.8-25.6)-10052018	PACE_MPLS	12.3	15.3	6.5	1.0	29.4	23.5	63.5	36.6	514	372
PZ15	BRW18-PZ15(8.0-8.9)-10052018	BRW18-PZ15(8.0-8.9)-03062019	ENRHSPLP	10.7	13.0	9.0	1.0	118	96.0	29.5	17.0	111	112
PZ19	BRW18-PZ19(19.8-20.9)-09272018	BRW18-PZ19(19.8-20.9)-03042019	ENRHSPLP	238	229	18.0	13.0	5141	3390	1080	991	5485	7220
PZ20	BRW18-PZ20(21.7-23.8)-10032018	BRW18-PZ20(21.7-23.8)-10032018	PACE_MPLS	16.1	12.2	6.6	2.2	409	253	44.4	29.8	398	272
PZ21	BRW18-PZ21(28.0-30.0)-03052019	BRW18-PZ21(28-30)10042018	PACE_MPLS	14.6	15.4	6.7	1.0	1254	425	182	116	1108	882
PZ21	BRW18-PZ21(31.0-31.7)-10042018	BRW18-PZ21(31.0-31.7)-03062019	ENRHSPLP	24.6	9.0	8.1	1.0	617	171	68.0	29.0	1256	352
PZ22	BRW18-PZ22(22.2-25.0)-03052019	BRW18-PZ22(22.2-25)-09262018	PACE_MPLS	80.7	25.1	15.8	2.3	1059	276	427	124	1452	433
PZ22	BRW18-PZ22(35.0-37.6)-02192019	BRW18-PZ22(35.0-37.6)-03042019	ENRHSPLP	54.6	42.0	7.1	3.0	482	910	71.4	69.0	1128	1060
PZ23	BRW18-PZ23(30.7-31.1)-10092018	BRW18-PZ23(30.7-31.1)-03042019	ENRHSPLP	9.9	3.0	7.1	3.0	101	27.0	56.2	31.0	802	222
PZ24	BRW18-PZ24(25.4-26.3)-10092018	BRW18-PZ24(25.4-26.3)-03042019	ENRHSPLP	1781	881	21.1	38.0	527	2540	5874	15200	3475	16100
PZ25	BRW18-PZ25(16.4-20.0)-10102018	BRW18-PZ25(16.4-20)-10172018	PACE_MPLS	11.5	8.6	17.0	1.7	62.9	19.0	33.8	12.5	402	135
TP04	BRW18-TP04(6.4-8.7)-03052019	BRW18-TP04(6.4-8.7)-102252018	PACE_MPLS	738	495	27.2	14.5	4000	2240	1399	957	7524	5430
TP05	BRW18-TP05(6.1-8.3)-03052019	BRW18-TP05(6.1-8.3)-10252018	PACE_MPLS	70.7	48.5	11.4	0.1	83.0	30.5	28.9	17.3	68.8	34.8
TP08	BRW18-TP08(5.5-7.8)-10242018	BRW18-TP08(5.5-7.8)-10242018	PACE_MPLS	48.2	29.7	9.4	0.4	126	70.0	46.8	16.9	208	100
TP15	BRW18-TP15(4.9-7.4)-03052019	BRW18-TP15(4.9-7.4)-10242018	PACE_MPLS	47.3	56.4	14.8	1.2	98.1	93.5	28.3	31.2	173	172
TP15	BRW18-TP15(4.9-7.4)-10242018	BRW18-TP15(4.9-7.4)-10242018	PACE_MPLS	66.1	56.4	8.9	1.2	180	93.5	25.1	31.2	270	172

* In the database there are 2 XRF sample results, those labeled as "Field" and those labeled as "Pioneer". Only Pioneer results are being used in the regression analyses.

Color Coding in the Station Name Column

🟦 There are two Pioneer XRF results for the sample interval that correspond to one ICP result. The ICP result was duplicated for this analysis
🟩 There are two Pioneer XRF results and two ICP results for the same interval. The XRF sample is paired with the ICP sample taken near the same date.

Color Coding in the Analyte Result Columns

▨ These points were identified as outliers and were not used in the final regression analyses.

2020 Samples													
Station Name	Field Sample ID (XRF)*	Field Sample ID (ICP)	Lab (ICP)	Arsenic (XRF)	Arsenic (ICP)	Cadmium (XRF)	Cadmium (ICP)	Copper (XRF)	Copper (ICP)	Lead (XRF)	Lead (ICP)	Zinc (XRF)	Zinc (ICP)
BH01	BRW18-BH01(22.6-23.8)-10122018	BRW18-BH01(22.6-23.8)-05122020	PACE_MPLS	559	2480	9.2	12.0	10030	40100	806	854	2401	4320
BH01	BRW18-BH01(23.8-25.0)-10122018	BRW18-BH01(23.8-25.0)-05122020	PACE_MPLS	161	392	11.4	7.4	2846	6470	1162	1620	2934	4950
BH03	BRW18-BH03(30.0-35.0)-2-09252018	BRW18-BH03(30.0-35.0)-05122020	PACE_MPLS	72.9	21.7	19.1	7.3	446	313	146	75.6	2239	1310
BH08	BRW18-BH08(14.5-16.0)-09282018	BRW18-BH08(14.5-16.0)-05122020	PACE_MPLS	194	120	16.3	3.2	3124	2520	1608	1170	9463	3440
BH08	BRW18-BH08(19.5-19.9)-09282018	BRW18-BH08(19.5-19.9)-05122020	PACE_MPLS	112	82.8	13.9	2.1	1803	1930	900	680	5626	2220
BH09	BRW18-BH09(35.7-36.8)-09242018	BRW18-BH09(35.7-36.8)-05122020	PACE_MPLS	40.7	31.1	17.5	1.1	208	129	64.6	94.4	288	244
BH09	BRW18-BH09(37.4-38.0)-09242018	BRW18-BH09(37.4-38.0)-05122020	PACE_MPLS	43.8	33.4	6.6	1.3	189	147	49.0	29.2	601	515
BH10	BRW18-BH10(27.0-28.4)-09272018	BRW18-BH10(27.0-28.4)-05122020	PACE_MPLS	68.9	64.8	12.6	4.2	470	373	20.7	14.2	348	292
BH11	BRW18-BH11(15.0-16.3)-10112018	BRW18-BH11(15.0-16.3)-05122020	PACE_MPLS	243	1100	12.7	12.1	3100	3760	340	453	1681	3100
BH11	BRW18-BH11(16.3-17.1)-10112018	BRW18-BH11(16.3-17.1)-05122020	PACE_MPLS	249	533	18.9	8.9	2682	2910	444	776	3552	2450
BH16	BRW18-BH16(6.2-7.5)-10122018	BRW18-BH16(6.2-7.5)-05122020	PACE_MPLS	139	136	16.0	0.6	304	220	24.1	26.7	199	232
BH16	BRW18-BH16(16.5-16.9)-10122018	BRW18-BH16(16.5-16.9)-05122020	PACE_MPLS	39.9	58.7	6.4	1.2	637	836	15.3	8.5	249	343
BH16	BRW18-BH16(16.9-17.5)-10122018	BRW18-BH16(16.9-17.5)-05122020	PACE_MPLS	58.9	62.2	11.4	1.1	850	726	19.9	8.6	169	155
BH16	BRW18-BH16(17.5-18.0)-10122018	BRW18-BH16(17.5-18.0)-05122020	PACE_MPLS	37.7	39.2	6.2	1.7	477	421	19.2	9.0	451	205
BH16	BRW18-BH16(18.0-19.3)-10122018	BRW18-BH16(18.0-19.3)-05122020	PACE_MPLS	37.7	24.8	13.8	0.9	477	197	24.9	5.1	213	87.4
BH22	BRW18-BH22(6.8 -8.6)-09132018	BRW18-BH22(6.8-8.6)-05122020	PACE_MPLS	226	216	25.2	19.2	6425	6900	3842	6470	8304	10200
BH24	BRW18-BH24(5.3-6.7)-09132018	BRW18-BH24(5.3-6.7)-05122020	PACE_MPLS	628	2110	7.2	26.5	6358	17200	551	748	1206	7610
BH24	BRW18-BH24(7.3-7.9)-02192019	BRW18-BH24(7.3-7.9)-05122020	PACE_MPLS	72.0	357	16.3	14.5	538	3220	775	4990	1970	8660
BH29	BRW18-BH29(14.1-15.0)-09172018	BRW18-BH29(14.1-15.0)-05122020	PACE_MPLS	54.4	38.0	12.8	2.1	1073	693	86.7	59.6	875	445
HCW32	BRW19-HCW32(20.0-25.0)-12192019	BRW19-HCW32(20.0-25.0)-1219201	PACE_MPLS	41.8	45.2	5.4	3.7	651	3220	282	265	979	1060
HCW32	BRW19-HCW32(25.0-25.4)-12192019	BRW19-HCW32(25.0-25.4)-0512202	PACE_MPLS	37.5	41.6	5.9	4.3	294	590	183	180	762	825
HCW33R	BRW19-HCW33R(20.0-21.3)-01132020	BRW19-HCW33R(20.0-21.3)-011420	PACE_MPLS	26.0	27.3	5.5	1.9	88.9	326	54.8	94.9	230	340
HCW33R	BRW19-HCW33R(25.0-28.0)-01132020	BRW19-HCW33R(25.0-28.0)-051220	PACE_MPLS	67.0	47.9	8.3	1.9	579	360	31.3	19.8	268	194
HCW35	BRW19-HCW35(10.5-11.2)-01092020	BRW19-HCW35 (10.5-11.2)-011020	PACE_MPLS	22.7	19.2	5.8	0.6	226	205	16.8	12.3	108	89.5
HCW35	BRW19-HCW35(15.0-20.0)HS-01092020	BRW19-HCW35(15.0-20.0)-0512202	PACE_MPLS	101	8.4	16.0	0.9	642	220	177	23.0	1012	305
HCW35	BRW19-HCW35(15.0-20.0)SAND-01092020	BRW19-HCW35(15.0-20.0)-0512202	PACE_MPLS	19.8	8.4	9.7	0.9	919	220	27.1	23.0	315	305
HCW35	BRW19-HCW35(15.0-20.0)SILT-01092020	BRW19-HCW35(15.0-20.0)-0512202	PACE_MPLS	12.3	8.4	8.1	0.9	160	220	15.3	23.0	314	305
HCW41	BRW19-HCW41(4.5-5.0)-01082020	BRW19-HCW41(4.5-5.0)-05132020	PACE_MPLS	222	151	6.1	1.2	412	256	29.2	21.9	109	116
HCW41	BRW19-HCW41(5.0-10.0)-01082020	BRW19-HCW41(5.0-10.0)-05132020	PACE_MPLS	510	177	5.9	0.8	492	344	125	18.8	429	179
HCW41	BRW19-HCW41(10.0-13.5)-01082020	BRW19-HCW41(10.0-13.5)-0513202	PACE_MPLS	38.1	31.8	5.6	0.5	1029	700	14.1	7.8	169	115
HCW41	BRW19-HCW41(14.4-15.0)-01082020	BRW19-HCW41(14.4-15.0)-0513202	PACE_MPLS	40.1	29.0	5.8	0.7	663	558	10.6	9.4	164	154
HCW41	BRW19-HCW41(27.8-28.7)-01082020	BRW19-HCW41(27.8-28.7)-0513202	PACE_MPLS	62.5	31.0	12.1	1.2	175	65.4	63.1	37.6	900	696
PZ03	BRW18-PZ03(15.0-16.3)-02192019	BRW18-PZ03(15.0-16.3)-05122020	PACE_MPLS	110	21.9	15.8	3.3	2500	176	111	25.4	862	200
PZ06	BRW18-PZ06(14.9-15.5)-09182018	BRW18-PZ06(14.9-15.5)-05122020	PACE_MPLS	60.2	29.2	12.5	1.9	540	227	57.7	23.2	778	292
PZ12	BRW18-PZ12(22.2-23.7)-10052018	BRW18-PZ12(22.2-23.7)-05122020	PACE_MPLS	30.5	18.8	8.9	9.9	1092	77.6	237	234	3127	1860
PZ13	BRW18-PZ13(8.5-10.0)-10112018	BRW18-PZ13(8.5-10.0)-05122020	PACE_MPLS	399	396	12.6	1.2	2587	1790	40.4	10.7	523	193
PZ13	BRW18-PZ13(15.0-16.4)-10112018	BRW18-PZ13(15.0-16.4)-05122020	PACE_MPLS	96.7	75.4	6.6	0.5	1154	947	22.9	8.0	203	155
PZ14	BRW18-PZ14(10.0-11.4)-10082018	BRW18-PZ14(10.0-11.4)-05122020	PACE_MPLS	128	195	13.9	3.1	1295	1580	173	299	1113	1080
PZ14	BRW18-PZ14(11.4-12.3)-10082018	BRW18-PZ14(11.4-12.3)-05122020	PACE_MPLS	103	47.6	10.7	0.5	925	324	153	47.5	1088	169

* In the database there are 2 XRF sample results, those labeled as "Field" and those labeled as "Pioneer". Only Pioneer results are being used in the regression analyses.

Color Coding in the Station Name Column

🟦 There are three Pioneer XRF results for the sample interval that correspond to one ICP result. The ICP result was duplicated for this analysis

Color Coding in the Analyte Result Columns

▨ These points were identified as outliers and were not used in the final regression analyses.

2020 Samples

Station Name	**Field Sample ID (XRF)***	**Field Sample ID (ICP)**	**Lab (ICP)**	**Arsenic (XRF)**	**Arsenic (ICP)**	**Cadmium (XRF)**	**Cadmium (ICP)**	**Copper (XRF)**	**Copper (ICP)**	**Lead (XRF)**	**Lead (ICP)**	**Zinc (XRF)**	**Zinc (ICP)**
PZ14	BRW18-PZ14(17.1-17.5)-10082018	BRW18-PZ14(17.1-17.5)-05122020	PACE_MPLS	64.3	9.7	20.2	0.5	308	11.5	61.7	4.0	714	59.9
PZ14	BRW18-PZ14(22.8-23.7)-10082018	BRW18-PZ14(22.8-23.7)-05122020	PACE_MPLS	40.5	21.9	15.4	3.0	227	32.7	48.0	4.1	892	292
PZ15	BRW18-PZ15(15.0-16.0)-10052018	BRW18-PZ15(15.0-16.0)-05122020	PACE_MPLS	161	209	13.0	5.1	1592	2460	618	712	1816	1870
PZ17	BRW18-PZ17(12.5-13.1)-10152018	BRW18-PZ17(12.5-13.1)-05132020	PACE_MPLS	39.8	22.3	10.7	1.0	853	390	34.4	20.0	528	238
PZ18	BRW18-PZ18(5.6-5.9)-10032018	BRW18-PZ18(5.6-5.9)-05132020	PACE_MPLS	229	257	9.6	5.4	387	837	399	2230	858	1430
PZ18	BRW18-PZ18(10.0-11.8)-10032018	BRW18-PZ18(10.0-11.8)-05132020	PACE_MPLS	146	104	10.5	2.2	1521	984	85.9	48.1	830	446
PZ18	BRW18-PZ18(12.7-12.9)-10032018	BRW18-PZ18(12.7-12.9)-05132020	PACE_MPLS	81.4	31.8	18.2	3.6	2393	2490	56.0	13.9	925	826
PZ21	BRW18-PZ21(25.0-26.5)-10042018	BRW18-PZ21(25.0-26.5)-05122020	PACE_MPLS	19.9	46.6	6.2	2.4	1338	2600	421	521	2534	5460
PZ21	BRW18-PZ21(26.5-27.2)-10042018	BRW18-PZ21(26.5-27.2)-05122020	PACE_MPLS	91.9	92.9	7.6	3.5	3880	5180	2249	1010	12691	9560
PZ21	BRW18-PZ21(27.2-28.0)-10042018	BRW18-PZ21(27.2-28.0)-05122020	PACE_MPLS	25.9	27.9	7.0	1.7	1231	1710	579	238	3891	3640
PZ21	BRW18-PZ21(31.7-33.3)-10042018	BRW18-PZ21(31.7-33.3)-05122020	PACE_MPLS	15.2	16.8	6.3	2.2	206	187	31.1	34.4	515	325
PZ21	BRW18-PZ21(33.3-35.0)-10042018	BRW18-PZ21(33.3-35.0)-05122020	PACE_MPLS	22.4	13.6	11.4	1.2	150	108	41.0	68.1	1551	667
PZ22	BRW18-PZ22(25.0-26.2)-09262018	BRW18-PZ22(25.0-26.2)-05122020	PACE_MPLS	258	245	18.4	3.9	3771	4320	246	332	6603	3770
PZ23	BRW18-PZ23(20.0-21.3)-10092018	BRW18-PZ23(20.0-21.3)-05132020	PACE_MPLS	51.2	40.3	7.8	2.5	283	1020	232	596	2007	1760
PZ23	BRW18-PZ23(21.3-22.5)-10092018	BRW18-PZ23(21.3-22.5)-05132020	PACE_MPLS	106	15.6	6.8	3.7	793	261	879	161	2307	1080
TP08	BRW18-TP08(3.5-4.0)-10242018	BRW18-TP08(3.5-4.0)-05122020	PACE_MPLS	2649	2520	11.5	14.3	6427	4810	465	522	5689	5650
TP08	BRW18-TP08(4.5-5.5)-10242018	BRW18-TP08(4.5-5.5)-05122020	PACE_MPLS	363	298	7.4	3.2	556	463	220	252	415	536
TP08	BRW18-TP08(7.0-7.8)-10242018	BRW18-TP08(7.0-7.8)-05122020	PACE_MPLS	173	116	19.2	0.5	1211	90.4	69.4	41.6	1564	143
TP10	BRW18-TP10(9.6-10.0)-10242018	BRW18-TP10(9.6-10.0)-05122020	PACE_MPLS	591	494	10.7	1.2	436	313	39.6	23.0	395	240

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PIONEER
TECHNICAL SERVICES, INC.

TECHNICAL MEMORANDUM

Butte Reduction Works (BRW) Phase I Investigation Leapfrog Model Inputs

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Date: 5/13/2021
To: Atlantic Richfield Company
From: Pioneer Technical Services, Inc.

Rev or Mod #: 04

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1 INTRODUCTION

The Butte Reduction Works (BRW) Smelter Area Mine Waste Remediation and Contaminated Groundwater Hydraulic Control Site (Site) is one of 9 remedial elements addressed in the *Butte Priority Soils Operable Unit Consent Decree* (BPSOU CD) (EPA, 2020). The BPSOU CD requires the removal of waste within a 275-foot average width corridor along the southern portion of the Site. The BPSOU CD also specifies that "*An excavation surface (subject to EPA approval, in consultation with DEQ) shall be developed during design and will consider the results of the predesign investigation. The excavation surface will define the vertical extent of removal within the removal corridor.*" Pioneer Technical Services, Inc. (Pioneer), in consultation with U.S. Environmental Protection Agency (EPA) and the Montana Department of Environmental Quality (DEQ), has developed a 3-dimensional statistical model to estimate the waste extents within the removal corridor at BRW to inform the design of the excavation surface. The intent is to define the excavation surface during design so that no field confirmation sampling is needed during the remedial action construction. This Technical Memorandum (Tech Memo) defines and justifies the model inputs used to create the statistical model and identifies the data gaps related to finalizing the waste volume and excavation surface under design. This Tech Memo is part of the BRW Site Pre-Design Investigation (PDI) Evaluation Report (referred to herein as main BRW PDI Report).

After removing the waste material at the Site, Silver Bow Creek will be rerouted from its current path through the Slag canyon on the northern portion of the Site through the excavated area (Figure 1).

To begin determining the extent of materials that do not meet the waste identification criteria (waste criteria) (EPA, 2020) within the removal corridor, Pioneer collected soil samples from 51 boreholes and 15 test pits during the BRW Phase I Site Investigation (Phase I Site Investigation). The soil samples were analyzed for contaminants of concern (COCs) and the concentrations were input into a 3-dimensional modeling program called Leapfrog Works (Leapfrog). Leapfrog was used to estimate the distribution of 5 COCs throughout the Site and assist in determining the extent of waste removal required. The 5 COCs analyzed in the model (arsenic, cadmium, copper, lead, and zinc) are 5 of the 6 waste criteria elements defined in the BPSOU CD (EPA, 2020). Note that there is currently insufficient information to analyze the mercury concentrations. Additionally, this model does not estimate the extents of organic pollutants impacting the soils at BRW. The model will be updated with the Phase II and Phase III data, gathered during the BRW Phase II and Phase III Site Investigations, and may include models for the organic pollutant impact to the soil. This Tech Memo outlines and evaluates the model parameters used to create the Leapfrog model for BRW (BRW Model) in a manner that another individual can recreate the model, discusses the model limitations, and identifies data gaps that can be resolved in future investigations.

2 CREATING THE LEAPFROG WASTE EXTENTS MODEL

The Total Waste Volume created in the BRW Model is the last product in a long, iterative series of models generated in Leapfrog. Figure 2 lays out a diagram of the models, outputs, and their interactions and provides a roadmap for all the components in the BRW Model. This section describes the purpose of each model and its outputs, the inputs used to create the models, and how those inputs were evaluated.

Pioneer had a series of meetings with EPA representatives to discuss EPA’s Leapfrog model and the BRW Model. Many of the model inputs were selected to match those used in EPA’s Leapfrog model.

To better understand how the Leapfrog program works and how to create the series of models and output volumes, this introduction section provides a brief description of the Leapfrog Project Tree and a brief summary of the order in which the data were input into the BRW Model. The Project Tree is made up of a series of folders with additional subfolders. Within these folders are the commands used to import data and generate the individual models. Below is an overview of the folders in the Project Tree (refer to the actual Leapfrog guidance and help system for specific information):

- **Topography**: This folder houses the surface used to define the top of the models. Also, 2-dimensional objects can be draped across this surface. These objects can include polygons or polylines.

- **GIS Data, Maps and Photos**: Geographic Information System (GIS) objects such as shapefiles can be imported into this folder as well as maps and images. When these objects are imported, the user has the option to set the elevation to a particular value, use the elevation that came with the object, or drape the object over a surface.

- **Borehole Data**: This folder contains borehole and test pit data. The data and observations collected from the Phase I Site Investigation, observations from previous investigations, and observations from the installation of monitoring wells were input into

Leapfrog in a spreadsheet format. The location information for the boreholes and test pits were entered in as northing, easting, and elevation coordinates. Each investigation location was divided into depth intervals from the ground surface. Each depth interval can have information related to the type of material for that interval, including lithology, concentration information, and other notes, such as whether the interval passes or fails the waste criteria. Additional proposed or planned borehole data can be added in a subfolder and displayed in the BRW Model to show how future investigations will meet data gaps. Note that references to borehole data in the following text also refers to test pit data.

- **Points**: Additional point information can be imported as points into this folder. Much like the borehole data, the location information for each point is entered in as northing, easting, and elevation coordinates. The points can be used to create surfaces and Geological or Contaminant Models. Points can also be extracted from surfaces or models and saved in the Points folder. In the BRW Model, points were used in the Geological Models to assist in creating the bedrock surface.

- **Meshes**: The Meshes folder houses the 3-dimensional, no-volume surfaces (surfaces) and 3-dimensional volumes (volumes) that play an important role in the BRW Model. Surfaces and volumes can be imported from AutoCAD or GIS files. The tools in the Meshes folder can be used to create 3-dimensional surfaces from borehole or point data using Leapfrog's form of kriging as well as merging or cutting volumes. The Boolean Volume tool in the Meshes folder allows the user to create a new volume from the intersection of up to 4 other volumes or to create a union of multiple volumes. The Meshes tool is used to combine the waste volumes from each COC into the Total Waste Volume (see Figure 2).

- **Geological Models**: Leapfrog uses the borehole data to create a 3-dimensional model of the Site's material type or lithology, which is housed in this Geologic Model folder. The models are created by selecting the intersection between material types to generate 3-dimensional contact surfaces. These surfaces define the boundaries between the material types or lithologies. Geological Models can also be created using surfaces from the Meshes folder to define material types besides those in the Borehole Data folder. For example, the excavation surface can be used to define material that will be excavated and material that will be remaining or a groundwater surface can be used to define material that is dry or saturated. In the BRW Model, two primary Geological Models were created: the *Excavation Model* to evaluate the preliminary waste excavation surface, and the *Material Types Model* to create the volumes of different material types at BRW (see Figure 2).

  One feature unique to the Geological Models is that the model domain (the volume within which the program models the specified information) can be capped by the topography on top, lateral extents to the sides, and a base surface on the bottom. One feature in the Geological Model tool creates a vertical wall from a polyline that can be used to cut vertical walls down the sides of the model. This vertical wall can also be applied to the surfaces and volumes stored in the Meshes folder. For example, a secondary Geological Model, *inside the removal corridor model*, was created for the sole purpose of creating the vertical wall boundary from the removal corridor polyline so that the Total Waste Volume could be cut to determine the waste within the removal corridor.

- **Contaminant Models**: The Contaminant Models folder is subdivided into the Estimation Model folder and the Block Models folder. These folders contain the tools needed to estimate the COC concentration distribution and perform complex calculations to further evaluate the data used in the models. The Estimation Models can evaluate only one COC at a time and are defined by a domain volume that can come from the volumes produced by the Geological Models or the volumes stored in the Meshes folder. The Block Models use formulas to evaluate individual or multiple models and can be used to examine the data and kriging evaluations used to generate the estimation models.

The BRW Model was generally set up in the following order:

- Input the data (Section 2.1). Select data from each borehole and test pit were filtered and imported into the Borehole Data folder of the Project Tree. Leapfrog identified any errors, such as overlapping intervals, and the data were reviewed and updated to eliminate those errors.

- The topography, boundaries, images, and surfaces were added to the Topography folder; GIS Data, Maps, and Photos folder; and the Meshes folder to define the topography, the Site boundary, the removal corridor, background image for reference, and a preliminary waste excavation[1] surface respectively (Section 2.2).

- Geological Models were set up to define the volumes of material types within the Site (Material Types Model on Figure 2), define which material would be excavated and which material would remain based on a preliminary waste excavation surface (Excavation Model on Figure 2), and provide a boundary to determine the quantity of material within the removal corridor (Section 2.3).

- In the Contaminant Models folder, Estimation Models were set up to estimate the concentration distribution of each COC within the Site and Block Models were created to evaluate the Estimation Models and help refine the model parameters (Section 2.4).

- Once the models in the Contaminant Models folder were created, the Meshes tools were used to combine the volumes of material exceeding the waste criteria with the volumes of waste modeled in the Material Types Model (Figure 2). The waste criteria Meshes were

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[1] The preliminary waste excavation surface evaluated in the BRW Model captures the waste material in the removal corridor only. It does not include the material that will need to be removed to accommodate the stream design or end land use features. The preliminary waste excavation surface will be incorporated into the final excavation surface during the remedial design.

then cut along the removal corridor with the vertical wall tool to determine the Total Waste Volume within the removal corridor and inform and evaluate the design of the excavation surface (Section 2.5).

- Finally, the BRW Model was evaluated to determine where additional information would be beneficial (Section 3) and to discuss the limitations of the model (Section 4).

Figure 1 shows the Site, Site boundary, removal corridor, and conceptual future alignment of Silver Bow Creek. The boundaries shown are the ones used to define the BRW Model's extents.

The following sections detail how the data were selected for import, which model boundaries were used to define the model volumes, and which model parameters were selected in creating the Geologic, Estimation, and Block Models.

2.1 Inputting the Data

Concentration data from the Phase I Site Investigation were adjusted, filtered, and imported into the Borehole Data folder in the BRW Model. Any results rejected during the data validation process were excluded. For additional details, refer to the BRW Site Phase I Data Summary Report, which is an Appendix to the main BRW PDI Report. Concentration data from previous investigations were not used in the BRW Model due to the use of different methods to collect that concentration data. Observations of Slag and Demolition Debris from previous investigations and from the installation of older monitoring wells were used to supplement the information found during the Phase I Site Investigation when creating the Material Types Model (Figure 2). Figure 1 shows the locations of all the investigation points used in the BRW Model.

During the Phase I Site Investigation, field x-ray fluorescence (XRF), Pioneer laboratory XRF, and laboratory inductively coupled plasma – optical emission spectroscopy (ICP) concentration data were collected. In some instances, both XRF and ICP concentration results were available for the same sample interval and in other instances, sample intervals overlapped. To input the data properly, it was necessary to develop a hierarchy to filter the data. Additionally, the XRF concentration results were not as accurate as the ICP concentration results and were therefore adjusted before being imported into Leapfrog. The BRW *Phase I Site Investigation XRF to ICP Correlation and Regression Analysis Technical Memorandum* (XRF to ICP Tech Memo), included in Appendix C of the main BRW PDI Report, provides the details on the correlation and regression analysis used to produce the regression coefficients that were used to adjust the XRF concentration data.

2.1.1 Hierarchy to Filter the Data

The hierarchy to filter the data ensures that one (and only one) dataset was associated with one (and only one) lithology interval within each borehole or test pit. A hierarchy of rules were developed to filter out the duplicate sample results and address overlapping sample intervals. The rules are included with this document as Exhibit B-1. The rules give the following general priority to samples in the following order:

1. ICP concentration results will be retained over Pioneer laboratory XRF concentration results (Exhibit B-1). Note that no field XRF concentration data were used. Refer to the XRF to ICP Tech Memo for details on the methods used during the Phase I Investigation to gather the XRF concentration data.
2. Higher concentrations and those failing the waste criteria will be retained over lower concentrations and those passing the waste criteria.

When sample results overlapped, and the overlap could not be eliminated using the priority listed above, the sample interval depths were adjusted rather than mixing concentrations between multiple samples. To determine how to adjust the sample interval, the same priorities listed above were used. The reason for removing a result or changing the sample intervals was noted as described in Exhibit B-1.

2.1.2 Adjusting the XRF Concentration Results

Where XRF concentration results were to be retained in the dataset, those results were adjusted to better match the accuracy of the ICP concentration results. Correlation and regression analyses were performed to find a linear model that would allow the XRF concentration results to be adjusted to better match the ICP concentration results. That correlation and regression analysis is detailed in the XRF to ICP Tech Memo. The regression coefficients are listed in Table 1. To adjust the XRF concentration data, the y-intercept coefficient (b) was added to the product of the XRF result and the slope coefficient (m). Where the regression coefficients adjusted the XRF concentrations to negative values, the adjusted XRF concentration was manually changed to 0.

Two regression models were used to adjust the XRF concentration data. The first regression model, referred to as the linear regression, is the one that best fits all the data used in the regression analysis. The second regression model, referred to as the upper 95% regression, is a more conservative model that adjusts the XRF concentration results to match the upper 95% confidence of the regression analysis (refer to the XRF to ICP Tech Memo for details). Each COC was modeled twice, once with the XRF concentration results adjusted with the regression coefficients and once with the XRF concentration results adjusted with the upper 95% regression coefficients. The ways these regressions impact the Total Waste Volume Model are discussed in further detail below.

2.1.3 Using the Borehole Data to Evaluate the Model Inputs

Once the Phase I Site Investigation data had been filtered and the XRF concentration results adjusted, the lithology and COC data were imported into the Borehole Data folder of the BRW Model. When selecting the model parameters to use for generating these models, the borehole data were viewed in the same scene as the model to help verify that the model parameters were generating models that fit the imported data.

The boreholes can be displayed as cylinders with concentration or other category information displayed as different colors. The borehole colors can be set to emulate the model colors to visually determine whether the model parameters have been set properly and whether it may be prudent to adjust the category information. The model can also be sliced in a nearly infinite number of ways to see the interior of the model and whether it matches the borehole data. Figure 3 shows a sliced image of the Total Waste Volume (Figure 2) inside the removal corridor.

This Total Waste Volume uses the upper 95% regression coefficients to adjust the XRF concentration data (upper 95% regression Total Waste Volume) (displayed with red shading). The slice occurred vertically along the A-A' slicer line shown in the plan view on Figure 3. The columns represent the borehole data, specifically whether the material in the intervals passed (blue shading) or failed (red shading) the waste criteria. (Note that materials designated as Slag, Demolition Debris, or Other are considered waste regardless of their concentration. This is further discussed in Section 2.3.1). This figure shows how overlaying the borehole data on the model was used to evaluate the individual models. The slice can be moved incrementally forward and backward to display different sections of the model. The slice can be cut in any orientation in the 3-dimensional plane. Comparing the borehole data to the model was used extensively to select the model parameters for the Material Types Model and the Contaminant Models (Figure 2), which are discussed in further detail below.

2.2 Setting the Model Boundaries

When setting up a model, one of the first inputs is to set the model domain. The domain is the volume within which the program models the specified information. The simplest settings create a domain in the shape of a 3-dimensional box that contains the extents of the borehole data. Using the Geological Model tools, this box can be further refined by applying a topography surface to the top of the model, using a polyline to cut a vertical wall to define the sides of the model, and/or using a bedrock surface to define the bottom of the model. This feature does have a drawback, however, when models with complex boundaries are combined, the output volumes can be flawed to the point where Leapfrog cannot designate a volume to the material. To avoid this possibility, the topography surface, which is a very complex surface, was applied only to the Material Types Model since its output volumes are the only volumes used to define the Total Waste Volume (Figure 2).

The Geological Models in the BRW Model were set using the following surfaces and boundaries:

- A topography surface based on the Light Detection and Ranging (LiDAR) data for the Site was used to define the top of the Material Types Model (Figure 2). The LiDAR data were modified to estimate the ground surface after Butte-Silver Bow removes their material stockpiles from the Site. Some of the boreholes appear to stick up out of the ground because they were drilled in areas where some overburden material stockpile removal is expected.

- A bedrock surface based on observations of bedrock during drilling was used to define the bottom of the Material Types Model (Figure 2). The bedrock surface was created in Leapfrog using the bedrock observations imported into Leapfrog as points.

- A preliminary removal corridor was used to define the waste material within the preliminary excavation area in the secondary Geological Model (*inside removal corridor model*). The removal corridor is a polyline that outlines the top of the excavation area at the topography surface. Leapfrog uses the polyline to cut a vertical wall down through the model. The model can be set to encompass the material inside or outside of the vertical wall.

- The Site boundary was used to define the extents of materials within the Site and define the lateral extents of the BRW Model domain. The Site boundary is a polyline that follows the outlines for the engineered cap and tailings, waste, and contaminated soil removal area shown on Figure BRW-1 in Appendix D of the BPSOU CD (EPA, 2020). This polyline was used to cut a vertical wall down through the model to define the material within the Site.

- The Excavation Model retained the simple 3-dimensional box domain so that when it was combined with the Total Waste Volume, the boundaries used to define the Material Types Model volumes would not interfere and produce invalid volumes.

2.3 Geological Models

Two primary Geological Models were developed for the Site. The first, the Material Types Model, defines the volumes of material types within the Site (Figure 2). This model defines the Slag, Demolition Debris, and Other waste volumes and defines the domain for the Contaminant Models (Figure 2). The second, the Excavation Model, defines the extent and volumes of excavated and remaining materials based on the preliminary waste excavation surface (Figure 2). This model is used to evaluate the preliminary waste excavation surface to ensure it adequately captures the Total Waste Volume and identify those areas where construction constraints limit removal (Figure 2). The model inputs are discussed in further detail in the next sections.

One secondary Geological Model was created to define the material inside the removal corridor (*inside removal corridor model*). This model was not included on Figure 2 because it only serves to separate the material inside the removal corridor from the rest of the Site.

2.3.1 Setting Up the Models

As mentioned previously, the Geological Models are defined by a series of boundaries and surfaces. Surfaces in Leapfrog are created with a series of points and triangles. The lengths of the sides of the triangles are defined by the surface resolutions; the two primary Geological Models were set up with surface resolutions of 20 feet. When the topography or excavation surfaces are used, the points and lengths of the triangles are set to match the topography or excavation surface. All other model parameters vary from model to model and are discussed in further detail in the next sections.

Material Types Model

There were 6 material types identified during the Phase I Site Investigation: Slag; Demolition Debris; alluvium, tailing, and organic soil (ATO); and Other. The ATO soils were combined into one material category during the XRF to ICP regression analysis, as discussed in the XRF to ICP Tech Memo. For the purpose of determining waste within the Site, the Slag, Demolition Debris, and Other materials were automatically considered waste, regardless of the concentration of COCs, and therefore will be removed to the extent practical within the removal corridor. With these wastes removed, the removal surface will be defined primarily through the ATO group, and therefore, the concentration distribution analysis was performed only in the ATO materials. This decision was made for the following reasons:

- The Other material category was used primarily to catalog the Butte-Silver Bow stockpiles located on the surface of the Site and to catalog topsoil. These materials will have to be removed to excavate the waste beneath.

- The Demolition Debris and Slag material types are often located just beneath the Other material category and would need to be removed to make way for the installation of the creek within the removal corridor.

- The bottom of waste is located primarily within the ATO materials. Therefore, it is important to model the concentration distribution within this material type to determine the waste extents.

- Finally, there was a lack of samples and/or poor correlation between the XRF and ICP concentrations for the Slag, Demolition Debris, and Other material types (refer to the XRF to ICP Tech Memo). This made it difficult to determine if the XRF concentration results would indicate that the material was clean. To provide a more conservative Total Waste Volume, these material types were automatically assumed to be waste.

These material types were entered into the Sample Purpose Code field of the database and were entered into Leapfrog as a category field. As described previously, the material type volumes in the model are created by selecting the contact points between material types to generate 3-dimensional contact surfaces that define the boundaries between the material types. The contact surfaces are created using Leapfrog's kriging functions to generate surfaces connecting the specified contact points. It is important that the selection of contact points to define materials does not overlap. For example, the ATO material was defined with the contact points between ATO, Slag, Demolition Debris, and Other. When the Slag material is set up, the contact points cannot include those between ATO and Slag, because they were already used to define the ATO. Using duplicate points can cause errors in the model.

The Material Types Model was built from the bottom up using the deposit feature in Leapfrog. The deposit feature creates layers of material added one on top of the other in much the same way sediments are deposited in a marine environment. This layering effect was selected to match the general material lithology order observed in the boreholes. The ATO material was defined first by the contact points between ATO and Slag, Demolition Debris, and Other material types. The Slag material was defined next by the contact points between the Slag and Demolition Debris and Other material types. Next, the Demolition Debris was defined by the contact points between the Demolition Debris and Other material types. Finally, all remaining material was defined as the Other category.

Figure 4 shows the Material Types Model with the final Slag, Demolition Debris, Other, and ATO volumes. The model has been sliced vertically along the A-A' slicer line (shown in plan view on Figure 4) to display the interior of the model near the future conceptual flow path of Silver Bow Creek. The borehole data are displayed as columns showing the material type designations for each soil interval.

When selecting the model inputs, the contact surfaces between the material contact points are set to snap to the borehole data with a maximum snap distance of 10 feet (50% of the 20-foot resolution). This helps the model better represent the borehole data. The contact surfaces are set to a 1:1:1 (northing:easting:elevation) ellipsoid ratio, with a 0-degree (°) dip, 0° dip azimuth, and 90° pitch. The ellipsoid ratio, dip, dip azimuth, and pitch define the extents to which the borehole data influence the model. It was determined after some experimentation that the ratio used in the model provides a smoother transition surface between the contact points. Higher northing:elevation and easting:elevation ratios produced pockets in the surface that did not seem to reflect real-world conditions and extended the Slag and Demolition Debris volumes into areas where there was no data. Once the Material Types Model was set up, it was evaluated, and adjustments were made to the data as noted in Section 2.3.2.

One limitation to this model was that there were pockets of borehole data that were located in a different material volume. For example, in the borehole data for BRW18-PZ20 there was an interval of ATO material from 4 feet to 7.6 feet below ground surface (bgs) that was modeled as Slag. Below this interval of ATO was an interval of Slag from 7.6 feet to 21.7 feet bgs (Figure 4). Because the deposit tool was used to model the material types, it did not model pockets of ATO above the Slag. If the borehole data (i.e., more than 1 borehole in an area) indicate that there should be a pocket of ATO within the Slag, this can be modeled using one of the other modeling tools, the intrusion tool. However, upon reviewing the model and the data, there were no indications that applying the intrusion tool was necessary. The pockets were few and sporadically spaced. Also, having pockets of ATO borehole data within the Slag, Demolition Debris, or Other material volumes provided a more conservative estimate of the Total Waste Volume because all these materials will be categorized as waste. It is important to note that the model was evaluated to ensure that no pockets of Slag, Demolition Debris, or Other borehole data were located within the ATO volume. Because the concentration data were not modeled for the Slag, Demolition Debris, or Other material types, there was no guarantee the model would classify them as waste.

Excavation Model

The Excavation Model was constructed to ensure the excavation surface was capturing the Total Waste Volume in the removal corridor and identify areas where removal is infeasible due to slope constraints and other construction related constraints. The preliminary waste excavation surface was used to define the excavated and remaining material volumes (Figure 2). This model will be used to evaluate the excavation surface as it is updated during the design phase and with information from future investigations. Using the same deposit feature as for the Material Types Model, the model was cut with the preliminary waste excavation surface so that materials above the excavation surface were designated as excavated and materials below were designated as remaining. In order to cut through the entire Site, the preliminary waste excavation surface was merged with the topography surface outside the removal corridor.

Inside Removal Corridor Model

This secondary Geological Model was set with the simplest of parameters. The lateral extents of the model were set so that the removal corridor cut a vertical wall through the model to create the volume of material inside the removal corridor. The vertical wall was then applied using the clip volume tool to the Total Waste Volume to define the waste material within the removal corridor.

2.3.2 Evaluating and Adjusting the Geological Models

The Material Types Model required a thorough review to ensure it matched the observations made during the Phase I Site Investigation. The Excavation Model was updated periodically to reflect the most up-to-date version of the preliminary waste excavation surface.

The Material Types Model was sliced vertically and horizontally and compared to the borehole data using the method described in Section 2.1.3. After the initial review, some adjustments were made to the sample purpose code to create more conservative (i.e., more) volumes of Slag and Demolition Debris. The majority of the changes involved changing an Other materials designation to a Slag or Demolition Debris materials designation. However, there were two instances where an Other materials designation was changed to ATO and an ATO designation was changed to Slag, as follows:

- In two boreholes, BRW18-BH08 and BRW19-HCW32, decomposed bedrock at the bottom of the borehole was classified as Other. This designation was changed to ATO and the concentration results for these intervals were modeled with the ATO data.

- In BRW18-TP04, additional data were added to extend the Slag interval down to the same elevation observed in BPS07-15A. When excavating BRW18-TP04, the excavator encountered Slag at 6.4 feet bgs and hit refusal at 8.7 feet bgs. In the soil lithology log for BPS07-15A, which is located immediately adjacent to BRW18-TP04, Slag was observed to a depth of 20 feet bgs. With the original model, the ATO to Slag contact surface came up to a point at this location in a manner that did not seem to reflect real-world conditions. Therefore, an interval was added to BRW18-TP04 to extend the Slag data down to the bottom elevation of observed Slag in BPS07-15A.

The changes to the sample purpose code were noted in the Leapfrog Filter field in the database.

Once these changes were made, the model was further reviewed to ensure that the ellipsoid ratios were set so the contact surfaces produced reasonable material types volumes.

2.4 Contaminant Models

The Contaminant Models estimate the concentration distribution of the five COCs across the Site. As described in Section 2.3.1, concentration data imported into Leapfrog were limited to the data in the ATO materials category. The concentration information for materials designated as Slag, Demolition Debris, and Other was not imported into the program.

The concentration distribution for each COC was modeled using estimation and interpolation algorithms called Radial Based Functions (RBFs), which were developed by the developers of Leapfrog. The RBFs approximate a type of global kriging that uses the global neighborhood (i.e., a greater range of points from the dataset than those immediately adjacent) of inputted numeric data to estimate unknown points.

As discussed previously, the Contaminant Models were broken into Estimation and Block Models. The Block Models derive their information from the Estimation Models, and the Block

Models provide statistics that were used to refine the model inputs in the Estimation Models. Therefore, there were several iterations where information from the Block Models was used to update the Estimation Models, which then updated the Block Models, etc.

2.4.1 Setting Up the Contaminant Models

Estimation Models
Ten Estimation Models were set up to estimate the concentration distribution of the 5 COCs within the Site. The first set of 5 modeled the concentration distribution of the 5 COCs using the regression coefficients for the XRF concentration results. The second set modeled the concentration distribution of the 5 COCs using the upper 95% regression coefficients for the XRF concentration results. In the figures and Leapfrog viewer, the model names for the models using the regression are followed by "_R." The model names for the models using the upper 95% regression are followed by "_UR."

Each Estimation Model was set with the following initial parameters:

- The domain was set to the ATO volume created in the Material Types Model (Figure 2 and Section 2.3). This restricted the concentration distribution to the ATO material.

- The domain was set with a soft boundary with a range of 20 feet, which allowed the model to incorporate concentration data 20 feet outside of the domain. As discussed in Section 2.3.1, a few pockets of ATO borehole data were not classified as ATO in the Material Types Model, but rather as Slag, Demolition Debris, or Other. This occurred where ATO materials were located above Slag, Demolition Debris, or Other materials and was to be expected given the methods used to create the Material Types Model. Selecting the soft boundary allowed the concentration information from those pockets to influence the data. Figure 5 shows the sample count inside and outside the ATO domain.

- The borehole data were composited to 1-foot lengths with a minimum coverage of 50%. Compositing the data divided the borehole into equal lengths and the concentration values for each interval were equal to the length-weighted average of all data in that interval. The data points used in the Estimation Model fall at the center of each composite interval.

Once the 10 Estimation Models were set up, 3 estimators, the Waste Estimator (RBF), the Interval Estimator (RBF), and the Kriging Estimator were set up within each Estimation Model (Figure 2). The Waste and Interval Estimators show the concentration distribution within the Site for each COC while the Kriging Estimator provided information to the Block Model that was later used to set the model inputs for the Estimation Model. The Waste Estimator generated the volume of material greater than the waste criteria for each COC (*Volume Above Waste Criteria*) and greater than the maximum waste criteria (*Volume Above Maximum Waste Criteria* [i.e., 5,000 milligrams per kilogram (mg/kg)] (Figure 2 and EPA, 2020). These volumes were then combined, as discussed in Section 2.5, to create the Total Waste Volume. The Interval Estimator modeled the volume of material within specified concentration intervals, and this Estimator was used to compare the Estimator Model outputs to the borehole data (as indicated in Section 2.1.3) and to compare how changing model inputs changed the concentration distribution. The details for the Waste and Interval Estimators are discussed further in Section 2.4.5.

Block Models

Ten Block Models were set up to evaluate each of the 10 Estimation Models and determine the model inputs that were used to refine the Estimation Models. Block Models allow the user to evaluate the different types of estimators that are available in the Estimation Models. For this Site, the Block Models were used to define the model inputs discussed in Sections 2.4.2 and 2.4.5, and were used in the sensitivity analysis described in Section 2.4.4.

The Block Models are made of blocks, as the name indicates. Each Block Model was set up with blocks 30 feet long (x), 30 feet wide (y), and 1 foot deep (z). The Block Model's boundaries enclose the ATO domain used in the Estimation Model. Each Block Model evaluates the three Estimators created in the Estimation Models (Figure 2). The Block Models provide statistics on the data entered into the model and the kriging and RBF results. Additionally, the Block Models were set up with 2 calculations to evaluate where the data were influencing the model and where the algorithms were taking over. These calculations are discussed further in Section 3.

2.4.2 The Variogram

The primary Estimation Model input parameters were entered into each model's variogram. Figure 6 shows the variogram for the Arsenic_R Estimation Model. The variogram shows a visualization of the variability of the data in the 3-dimensional model space, which allows the user to set (1) the type of model used to estimate the variance in the data, (2) the range each data point has on the model, and (3) the maximum allowable variance the model can use when estimating unknown points (referred to as the sill). It is important to note that only 1 sill can be used for all 3 dimensions and a spherical model was used in all 10 variograms. Additionally, it was determined that a nugget was not required (i.e., an initial variance offset when the distance is equal to 0) to account for the variance in the data.

Ellipsoid

An ellipsoid is used to define the range each data point has over the model. Figure 7 shows the ellipsoid for the Arsenic_R Estimation Model settled in among the borehole data for the Arsenic_R Estimation Model. The user sets a maximum major axis, semi-major axis, and minor axis distance of the ellipsoid that sets the limits that each data point has on the model, as discussed in Section 2.4.3. Beyond these limits, the estimation algorithms take over and the variance in the model is set to the sill, which is the maximum allowable variance. The model defaults to using the x (easting), y (northing), and z (elevation) axes for the major, semi-major, and minor axis, respectively, for the ellipsoids that will determine the allowable range of data. These directions can be adjusted so that the axis of the ellipsoid follows the variance in the data.

Individual Axes Variograms

The variogram displays the variance of the data in a scatter plot that plots the variance in the data (y-axis) against the distance between points (x-axis). Figure 6 shows the variograms for each axis for the Arsenic_R Estimation Model. There are 3 scatter plots, 1 each for the major, semi-major, and minor axes of the ellipsoid. The user sets a search parameter to define how the composited borehole data points will be grouped together by setting the distance between points (lag distance) and the number of search blocks (number of lags) the computer will analyze. For example, if the lag distance is set to 30, the model finds the variance between all composited borehole data points 30 feet apart and then again at 60 feet, 90 feet, and out to encompass the number of lags. The search parameters must be set for each axis of the variogram. The resulting scatter plots scale the plotted points to represent the number of composited borehole concentration values located within each lag distance.

Radial Plot (two-dimensional Variogram)
The variance is further displayed on a radial plot (represented by the two-dimensional variogram on Figure 6) that shows how the variance changes as the distance between points increases and how the variance changes in a radial direction. Like the individual axes variograms, the radial plot can also be set with a lag distance and a number of lags, which determines the distance between points and the number of search blocks, respectively. This plot helps the user set the direction of the major and semi-major axes. The major axis (represented by the red arrow on Figure 6) should fall in the area with the lowest variability, while the semi-major axis (represented by the green arrows on Figure 6), should fall in the area with the greatest variability. The major and semi-major axes always maintain a 90° angle between themselves. The green circle in the radial plot (Figure 6) represents the range (discussed in section 2.4.3) set for the major and semi-major axis. Figure 6 shows the radial plot for the Arsenic_R Estimation Model.

2.4.3 Setting the Variogram Inputs

Each variogram for the 10 Estimation Models was analyzed and set up to view a reasonable number of visible points on the variograms for the individual axes, the range was set to the mean average distance between points, and a sill was set according to the distribution of points on the axes variograms.

The lag distance for the individual axes variograms and the radial plot was set to 30 feet and the number of lags was set to 30 for the major and semi-major axes on both the individual axes plots and the radial plot. The lag distance for the minor axis was set to 1 foot and the number of lags was set to 30, which would cover the distance down to the bottom of most of the boreholes. The lag distance for the major and semi-major axes is approximately one-tenth of the average distance between points and the number of lags shows points out to approximately 3 times the average distance.

For each Estimation Model, the range for the major and semi-major axes was set to the mean average distance between points, rounded to the nearest 5 feet. The average distance between points was determined using the Block Models set up to correspond with the individual Estimation Models. The significance of using the average distance between points as the range is discussed in Section 2.4.4 and Section 2.4.5. The range for the minor axis was selected after the sill was determined and was set visually. The range selected for the minor axis was the point that allowed the spherical model line to follow as many of the initial data points as possible.

The sill was set visually by comparing the distribution of points on the individual axes variograms to the spherical model line. The spherical model line, shown on Figure 6, on each individual axis's variance plot was set to account for the majority of the variance in the major and semi-major axes. Once the sill was set (refer to the Total Sill lines as shown on the Figure 6 scatter plots), the range for the minor axis was set to allow the spherical model line to follow the points shown on the minor axis variogram plot.

The model inputs for the 10 Estimation Models are listed in Table 2.

2.4.4 Variogram and Model Inputs Sensitivity Analysis

A sensitivity analysis was conducted to determine which model inputs had the greatest impact on the Estimation Models.

Sill Analysis

The analysis to determine how changing the sill impacted the model revealed that it has little to no direct impact on the Estimation Model. The analysis was completed on the Arsenic_R Estimation Model and the Interval Estimator (Figure 2) was used to evaluate the sill's impact. In the Interval Estimator, the ATO domain was divided into volumes encompassing the specified concentration interval. For this sensitivity analysis, the volume of ATO material with arsenic concentrations between 200 mg/kg and 500 mg/kg was compared when the normal sill (the maximum sill divided by the mean variance in the borehole data) was changed from 0.5, to 1, to 2, and to 10, with all other model inputs remaining constant. The sensitivity analysis revealed that the volume of ATO material with concentrations between 200 mg/kg and 500 mg/kg did not change at all when the sill was adjusted (Figure 8).

Using the data points shown on the variograms, the sill was set to best match the data in the major and semi-major axes. The selected sill played an important role in determining the range for the z-axis.

Range Analysis

Of the variogram model inputs, the range had the greatest influence on the models. As stated previously, the range defines how far out into the model each point has influence. It is important to set a range that allows nearby points to influence each other, but not set the range too far out as to cause points with no possible relationship to influence each other.

The sensitivity analysis for range was conducted on the Lead_R Estimation Model. The x (major axis) and y (semi-major axis) ranges were set to values of 200 feet, 400 feet, 600 feet, 800 feet, and 1,000 feet (note that x was set to equal y). The z (minor axis) range was set to 10 feet for all models and the normal sill was set to 2.5. The Interval Estimator for lead was used for the evaluation, specifically the volume of material with concentrations between 1,000 mg/kg and 3,000 mg/kg. Figure 9 shows the positive relationship between the range and the volume of material in the 1,000 mg/kg and 3,000 mg/kg interval. Note that the volumes have been offset vertically from their usual elevation in order to view all 5 in one image. Also note that these volumes were not cut with the Site boundary, but instead extend in a square block with similar dimensions as the image shown beneath the volumes. The Site boundary was not used to cut the model in order to see how setting the range influenced the volumes outside of the collected data.

As the range increases past 400 feet (yellow), the volume of material begins to expand out past those areas where data had been collected, specifically out into the area west and north of Silver

Bow Creek. As a result, a range greater than 400 feet does not appear to provide an accurate assessment of the concentration distribution within the Site.

The Block Models were used to further evaluate the range and determine the best value to use for the models. Figure 10 shows a plan view of the Block Model for the Lead_R Estimation Model set to show the average distance between points. Overlaid on the model are the investigation points used to create the concentration distribution. The Block Model is only showing the top layer of material and has not been sliced to show the interior. As the points become more dispersed near the northeastern portions of the model, the average distance increases.

The average distance between points for the 10 Contaminant Models ranges from between approximately 135 feet and 140 feet to between 550 feet and 560 feet. The mean value ranges from approximately 310 feet to 320 feet. It was determined that setting the x and y range to be equal to the mean average distance between points would allow the points to influence each other without extending that influence too far into the model. Setting the value to the mean average distance was further supported during the analysis of the model drift and the data gaps, discussed in Section 2.4.5 and Section 3.

2.4.5 Interval and Waste Estimator Inputs

The Interval and Waste Estimator inputs were limited to setting the output concentration interval and setting the drift. The Waste Estimators were set so the output volumes encompassed the waste criteria concentrations and any greater values. The Interval Estimators were set so the concentration volumes encompassed specific intervals. The intervals were set on an individual model basis to capture a reasonable percentage of the input data within each interval.

When the estimators estimate the concentrations in areas past the range of the data (set in the variogram), the drift is the default value the model uses for those concentrations. Looking back at the variogram for the Arsenic_R Estimation Model (Figure 6), the drift takes over when the sill takes over. Setting the drift too high can result in waste material being modeled at the bottom of the model, where the distance between points is greater than the range set in the variogram, even though the borehole data indicate the material is clean. It was therefore important to determine where the drift was taking over the model so it could be set to a reasonable value.

Drift Analysis

The drift analysis was conducted on the Arsenic_R Estimation Model using a copy of the Interval Estimator (*drift analysis estimator*). The drift was set to the average concentration of material sitting just above bedrock in the original Interval and Waste Estimator, the reasoning for which is discussed below. The drift analysis was conducted using the same variogram inputs as indicated in Table 2.

In the *drift analysis estimator*, the drift was set to twice the maximum arsenic concentration observed in the borehole data. An additional interval was added to model the concentrations greater than the maximum observed arsenic concentration. Setting the drift to this value increased the average modeled concentration from 116 mg/kg of arsenic to 1,985 mg/kg. The mean concentration in the borehole data is 206 mg/kg. Figure 11 shows the volume of material modeled in the *drift analysis estimator* as being greater than the maximum observed arsenic concentration. This volume represents the approximate area of the model where the drift has the most influence. The area of concern for the excavation is located near the bottom of the model, or near the bedrock. It was determined that setting the drift to be equal to the average concentration in the interval just above the bedrock would prevent the drift from modeling waste material near bedrock where the borehole data indicated that the material was clean. The drift values for the 10 models are listed in Table 3 along with the samples used to determine those average values.

2.5 Waste Meshes

Once all the parameters were set, the Waste Estimators were used to determine the Total Waste Volume. The Boolean Volume tool under the Meshes folder was used to find where any 3 COCs failed the waste criteria (EPA, 2020), where any 1 COC failed the maximum waste criteria, and where the model showed Slag, Demolition Debris, and Other material. To find where any 3 COCs failed the waste criteria, the following 10 Meshes were created to find the intersection where all 3 elements exceeded the waste criteria:

1. Arsenic – Cadmium – Copper
2. Arsenic – Cadmium – Lead
3. Arsenic – Cadmium – Zinc
4. Arsenic – Copper – Lead
5. Arsenic – Copper – Zinc
6. Arsenic – Lead – Zinc
7. Cadmium – Copper – Lead
8. Cadmium – Copper – Zinc
9. Cadmium – Lead – Zinc
10. Copper – Lead – Zinc

The resulting 10 volumes were then combined using the union tool with the volumes of material that exceeded the 5,000 mg/kg waste criteria and with the volumes of Slag, Demolition Debris, and Other material from the Geological Model. Two Total Waste Volumes were created: 1 where the XRF concentration data were adjusted using the regression coefficients and 1 where the XRF concentration data were adjusted using the upper 95% regression coefficients. Figure 12 shows the Total Waste Volume modeled using the regression coefficients and the upper 95% regression coefficients within the removal corridor as well as volume of material that the upper 95% regression coefficients added to the Total Waste Volume when compared to the regression coefficients. This figure demonstrates how the adjustments to the XRF data influence the Total Waste Volume.

2.6 Excavation

The upper 95% regression Total Waste Volume was used to update the preliminary waste excavation surface, so it extends down to capture the waste modeled using the upper 95% regression coefficients. The Total Waste Volume was exported and integrated into the excavation surface in AutoCAD. Figure 13 shows the waste material that will remain in place if the preliminary waste excavation surface were to be used to remove the waste. The preliminary waste excavation surface will be further refined during design and with the data from the Phase II and III Investigations. At the time of this report, no substantial effort was made to incorporate the remaining material at the bottom of the excavation. The remaining waste material on the slopes of the excavation will be refined as the design progresses. Currently, it is assumed that excavation side slopes will be 2:1 horizontal:vertical (H:V). On the southern portion of the Site, the railroad bed cannot be disturbed, and any excavation surface must maintain adequate slopes to prevent movement. All other borders will also require the excavation to maintain adequate slopes for safety reasons. Additionally, there were some small waste volumes near the borders of the Site where it was not feasible to capture the material while maintaining safe slopes. These volumes will have to be accounted for during the design of the hydraulic control.

3 DATA GAPS

In the final evaluation of the model inputs and model accuracy, the Block Models were used to determine where the model took over the evaluation and where additional data may be needed to refine the Total Waste Volume. This comparison was used to further evaluate where to place additional boreholes for the Phase III Site Investigation. Figure 14 and Figure 15 show the two Block Models for the Arsenic_R Estimation Model. The area marked as "1. Measured" (green) indicates that that portion of the model is pulling directly from the data. The other three categories (yellow, orange, and red) indicate that the model is taking over and relying less and less on the inputted data to the point where at "4. Unclassified" the model has full control and the data are not playing much of a role.

These colors were differentiated using 2 equations provided by Leapfrog. The first equation compared the kriging efficiency and slope of regression and the second compared the average distance to the slope of regression. The kriging efficiency measures the effectiveness of the model to reproduce the data and ranges from 0 to 1. The slope of regression is based on the regression of the estimated value and the theoretical true value and ranges from 0 to 1. The average distance was discussed in Section 2.4.4. The Block Model formulas are shown below:

Confidence Category Kriging (KE) and Slope of Regression (SoR)

1. $Measured = KE < 0.95 \; and \; SoR > 0.95$
2. $Indicated = KE < 0.85 \; and \; SoR > 0.85$
3. $Inferred = KE < 0.7 \; and \; SoR > 0.7$
4. $Unclassified = All \; other \; Areas$

Confidence Category Average Distance (AvgD) and SoR

For arsenic, cadmium, copper, and lead (Range in X and Y = 310):

1. $Measured = AvgD < 310 \; and \; SoR > 0.95$
2. $Indicated = [AvgD < 326 \; and \; SoR > 0.85] \; or \; [AvgD < 357 \; and \; SoR > 0.85]$
3. $Inferred = AvgD < 403 \; and \; SoR > 0.7$
4. $Unclassified = All \; other \; Areas$

For zinc (Range in X and Y = 315):

1. $Measured = AvgD < 315\ and\ SoR > 0.95$
2. $Indicated = [AvgD < 331\ and\ SoR > 0.85]\ or\ [AvgD < 362\ and\ SoR > 0.85]$
3. $Inferred = AvgD < 410\ and\ SoR > 0.7$
4. $Unclassified = All\ other\ Areas$

The Block Model formulas were altered from the originals sent by the developers of Leapfrog to better match what had been observed during the drift analysis. With the new formulas, the Block Models could show where Leapfrog had identified limits in the distribution of data. On Figure 16 and Figure 17, the two Block Models (Figure 14 and Figure 15) were overlaid on the volume of material from the drift analysis (the volume where the drift value takes over the interpolation from the imported data [Figure 11 and Section 2.4.4]). Figure 16 shows how the volume from Figure 11 matches the areas in the Kriging Efficiency and Slope of Regression Block Model. In this overlapping area the algorithms are taking over, and the data has less sway over the final modeled volumes. The Kriging Efficiency and Slope of Regression Block Model therefore provides a representation of how the distribution of data correlates with where the drift influences the model. In comparison, the Average Distance and Slope of Regression Block Model (Figure 17) shows how the distribution of data and the limits set by the range influence where the algorithms determine the outputs of the model. As shown on Figure 17, using the Average Distance and Slope of Regression Block Model to find the limits in the data distribution provides a much more conservative estimate of where the model is taking over.

Figure 18 shows the locations of the investigation points from the Phase II Site Investigation and the proposed Phase III Site Investigation boreholes overlaid on top of the Average Distance and Slope of Regression Block Model. The Phase III boreholes were selected to add data to those remaining areas within or near the Block Model areas shaded in yellow, tan, or red (i.e., where the drift and algorithms are providing the major source of the concentration distribution).

4 MODEL LIMITATIONS

It is important to keep in mind that the models created by Leapfrog are statistical models that use real-world data to estimate the concentration and material distributions within the Site. The model resolution, 20 feet, and the ranges set in the variogram also limit the accuracy. Additionally, there are numerous instances where an extremely high concentration interval is bounded by much lower concentration intervals both above and below. Leapfrog will smooth out the concentration interval and will not be able to model the extremely high concentration at that point. In other instances, a series of higher concentration values will infiltrate areas where the borehole data have lower concentrations. Therefore, this tool should be viewed as a guide to assist in design and not as a real-world view of the concentrations within the Site.

With those limitations in mind, the model parameters have been set to provide an excellent conservative estimate of the Total Waste Volume within the Site. With the additional data gathered during the future Phase II and Phase III Site Investigations, the updated model will provide designers with a conservative estimate of where to remove waste from the Site.

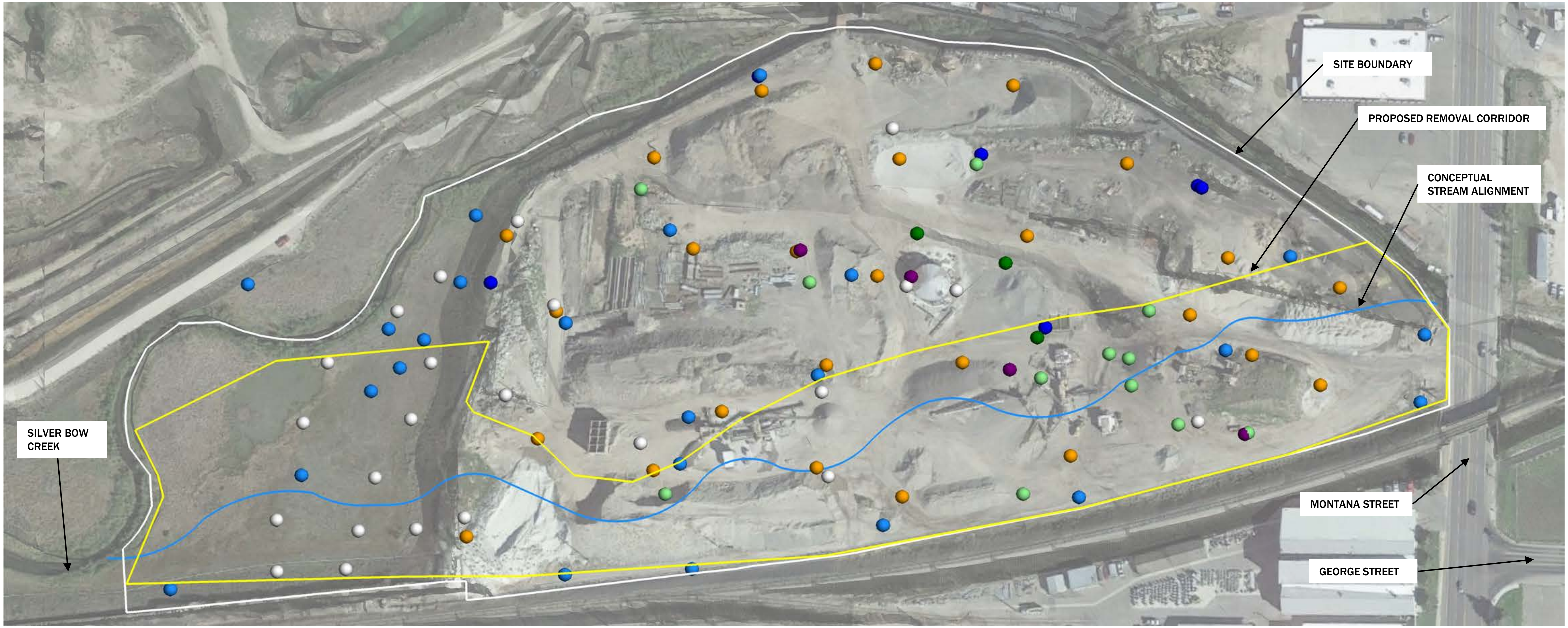
5 CONCLUSION

This Tech Memo achieves its objective by providing the model inputs used to create the BRW Model and the justification for those inputs as well as defining the information inputs needed to finalize the BRW Model and excavation surface. Each model input was evaluated to determine its impact on the model and each of the models were evaluated to ensure they reflected the conditions observed during the Phase I Site Investigation. The Total Waste Volume produced by the BRW Model using these model inputs provides the first steps in defining the volume and extents of waste within the removal corridor and will be used to inform the design of the excavation surface. As the design progresses, the BRW Model can be used to evaluate the excavation design to ensure it adequately captures the Total Waste Volume in the removal corridor.

6 REFERENCES

EPA, 2020. Consent Decree for the Butte Priority Soils Operable Unit. Partial Remedial Design/Remedial Action and Operation and Maintenance. U.S. Environmental Protection Agency. February 13, 2020. Released to the public in 2020 for public comment and Butte-Silver Bow approval. Available at https://www.co.silverbow.mt.us/2161/Butte-Priority-Soils-Operable-Unit-Conse.

FIGURES



LEGEND

PREVIOUSLY INSTALLED
- ● EXISTING MONITORING WELL
- ● TEST PIT (NATIONAL RESOURCE DAMAGE PROGRAM, 2016)

INSTALLED IN 2018
- ● BOREHOLE
- ● PIEZOMETER
- ● TEST PIT

INSTALLED IN 2020
- ● HYDROCARBON PIEZOMETER
- ● HYDROCARBON TEST PIT

NOTE:
THE PROPOSED REMOVAL CORRIDOR SHOWN IS PRELIMINARY AND ONLY SHOWN AS A REFERENCE AT THIS POINT. THE REMOVAL CORRIDOR AND EXCAVATION SURFACE WILL BE REFINED FURTHER DURING THE REMEDIAL DESIGN AND WILL BE SUBMITTED FOR AGENCIES' REVIEW AND APPROVAL.

N

DISPLAYED AS:
COORD SYS/ZONE: NA
DATUM: NA
UNITS: NA
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 N.T.S.

FIGURE 1

BRW SITE AND PROPOSED REMOVAL CORRIDOR

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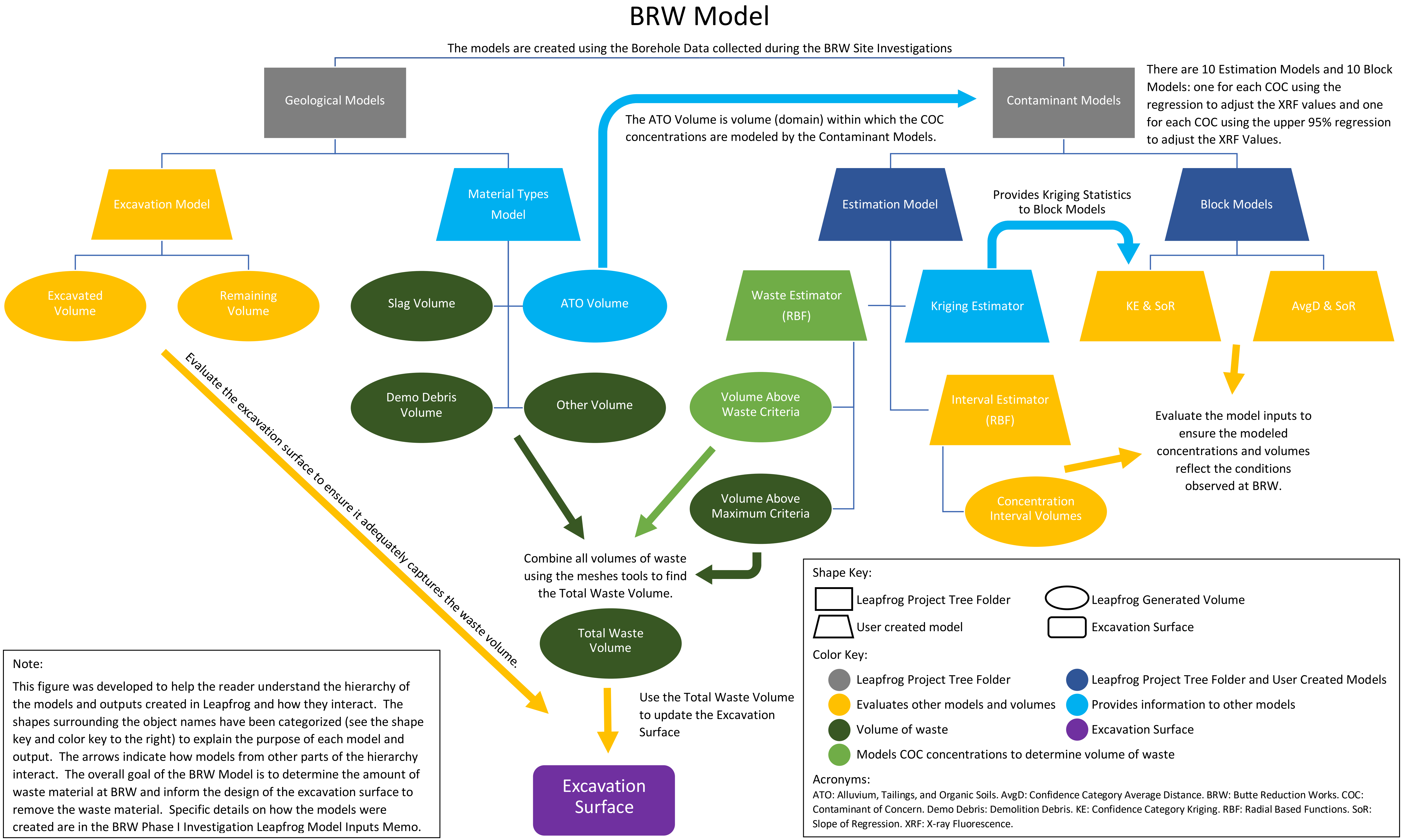
Figure 2. Diagram of the Supporting Models and Output Volumes in the BRW Model



The models are created using the Borehole Data collected during the BRW Site Investigations

There are 10 Estimation Models and 10 Block Models: one for each COC using the regression to adjust the XRF values and one for each COC using the upper 95% regression to adjust the XRF Values.

The ATO Volume is volume (domain) within which the COC concentrations are modeled by the Contaminant Models.

Provides Kriging Statistics to Block Models

Evaluate the model inputs to ensure the modeled concentrations and volumes reflect the conditions observed at BRW.

Evaluate the excavation surface to ensure it adequately captures the waste volume.

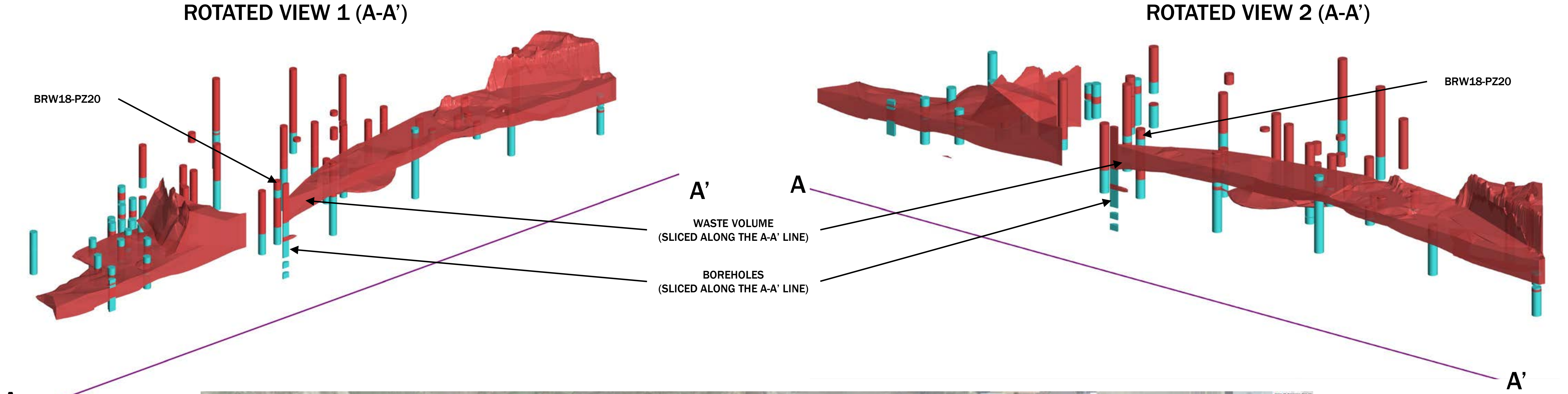
Combine all volumes of waste using the meshes tools to find the Total Waste Volume.

Use the Total Waste Volume to update the Excavation Surface

Acronyms:
ATO: Alluvium, Tailings, and Organic Soils. AvgD: Confidence Category Average Distance. BRW: Butte Reduction Works. COC: Contaminant of Concern. Demo Debris: Demolition Debris. KE: Confidence Category Kriging. RBF: Radial Based Functions. SoR: Slope of Regression. XRF: X-ray Fluorescence.

Note:

This figure was developed to help the reader understand the hierarchy of the models and outputs created in Leapfrog and how they interact. The shapes surrounding the object names have been categorized (see the shape key and color key to the right) to explain the purpose of each model and output. The arrows indicate how models from other parts of the hierarchy interact. The overall goal of the BRW Model is to determine the amount of waste material at BRW and inform the design of the excavation surface to remove the waste material. Specific details on how the models were created are in the BRW Phase I Investigation Leapfrog Model Inputs Memo.



ROTATED VIEW 1 (A-A')

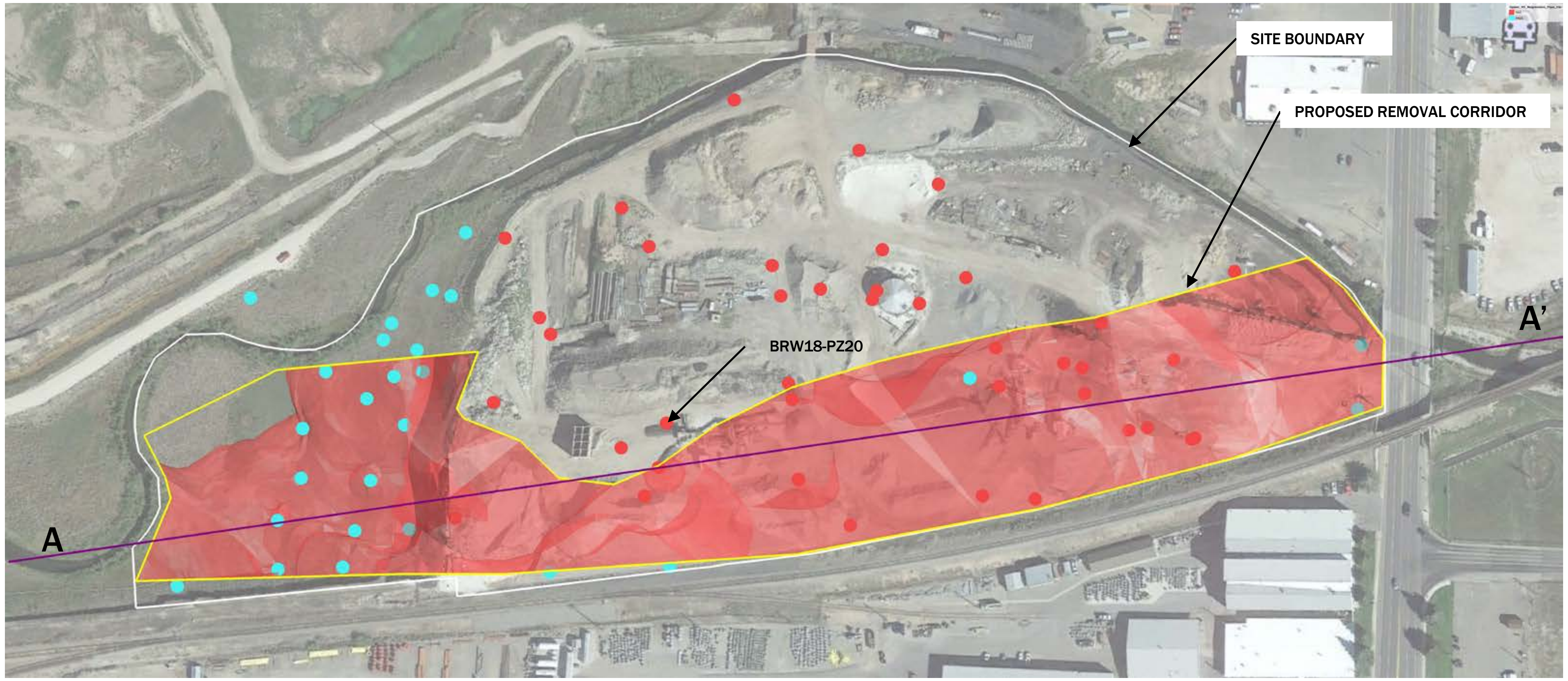
ROTATED VIEW 2 (A-A')

NOTES:

THIS FIGURE AND MODELED VOLUMES WERE GENERATED USING LEAPFROG WORKS. THE VOLUME IS A MODELED APPROXIMATION BASED ON THE BOREHOLE AND TEST PIT DATA COLLECTED DURING THE BRW PHASE I SITE INVESTIGATION AS WELL AS OBSERVATIONS FROM PREVIOUS INVESTIGATIONS AND THE INSTALLATION OF OLDER MONITORING WELLS.

THE INVESTIGATION LOCATIONS/BOREHOLES SHOWN IN THE PLAN VIEW SHOW THE DATA FOR THE TOP INTERVAL.

THE ROTATED VIEWS HAVE BEEN SCALED SO THE ELEVATION (Z) AXIS IS 5 TIMES GREATER THAN THE NORTHING (Y) AND EASTING (X) AXES.



THE PROPOSED REMOVAL CORRIDOR SHOWN IS PRELIMINARY AND ONLY SHOWN AS A REFERENCE AT THIS POINT. THE REMOVAL CORRIDOR AND EXCAVATION SURFACE WILL BE REFINED FURTHER DURING THE REMEDIAL DESIGN AND WILL BE SUBMITTED FOR AGENCIES' REVIEW AND APPROVAL.

LEGEND

🟦 MATERIAL PASSES WASTE IDENTIFICATION CRITERIA

🟥 MATERIAL FAILS WASTE IDENTIFICATION CRITERIA*

*THE WASTE IDENTIFICATION CRITERIA DEFINED IN THE BPSOU CD (EPA, 2020). MATERIAL FAILING THE WASTE CRITERIA INCLUDES MATERIAL CATEGORIZED AS SLAG, DEMOLITION DEBRIS, AND OTHER, WHICH IS ASSUMED TO BE WASTE REGARDLESS OF COC CONCENTRATIONS.

N

DISPLAYED AS:
COORD SYS/ZONE: NA
DATUM: NA
UNITS: NA
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 N.T.S.

FIGURE 3

EVALUATING A MODEL

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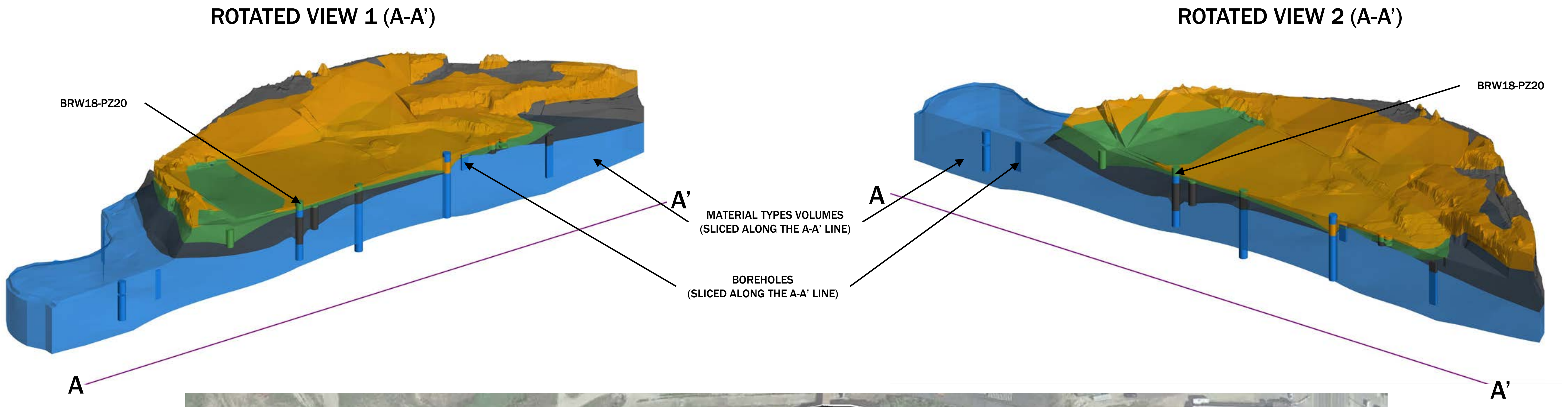

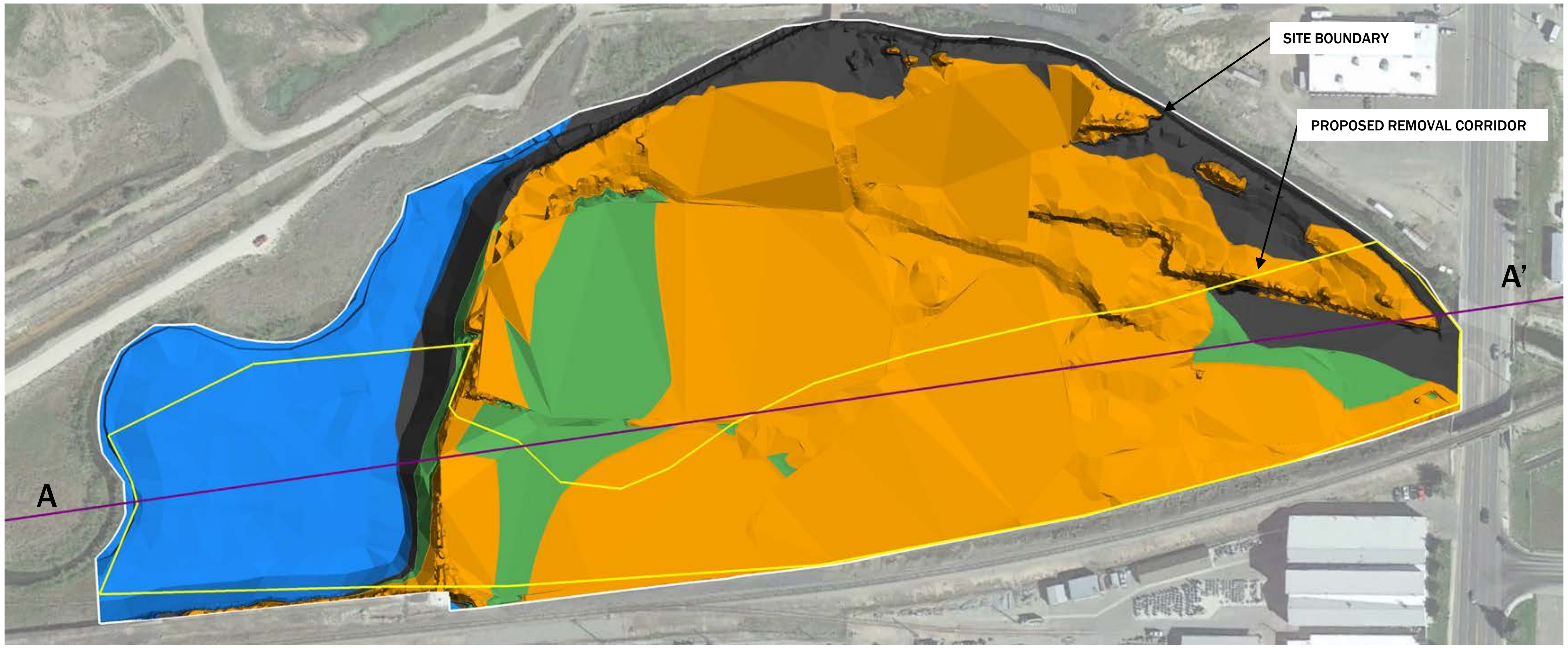

THE PROPOSED REMOVAL CORRIDOR SHOWN IS PRELIMINARY AND ONLY SHOWN AS A REFERENCE AT THIS POINT. THE REMOVAL CORRIDOR AND EXCAVATION SURFACE WILL BE REFINED FURTHER DURING THE REMEDIAL DESIGN AND WILL BE SUBMITTED FOR AGENCIES' REVIEW AND APPROVAL.

LEGEND

- ⬛ SLAG
- 🟩 DEMOLITION DEBRIS
- 🟧 OTHER
- 🟦 ATO (ALLUVIUM, TAILINGS, AND ORGANIC SOILS)

NOTES:

THIS FIGURE AND MODELED VOLUMES WERE GENERATED USING LEAPFROG WORKS. THE VOLUME IS A MODELED APPROXIMATION BASED ON THE BOREHOLE AND TEST PIT DATA COLLECTED DURING THE BRW PHASE I SITE INVESTIGATION AS WELL AS OBSERVATIONS FROM PREVIOUS INVESTIGATIONS AND THE INSTALLATION OF OLDER MONITORING WELLS.

THE ROTATED VIEWS HAVE BEEN SCALED SO THE ELEVATION (Z) AXIS IS 5 TIMES GREATER THAN THE NORTHING (Y) AND EASTING (X) AXES.

N

DISPLAYED AS:

COORD SYS/ZONE:	NA
DATUM:	NA
UNITS:	NA
SOURCE:	PIONEER/GOOGLE

SCALE IN FEET
0 N.T.S.

FIGURE 4

MATERIAL TYPES MODEL

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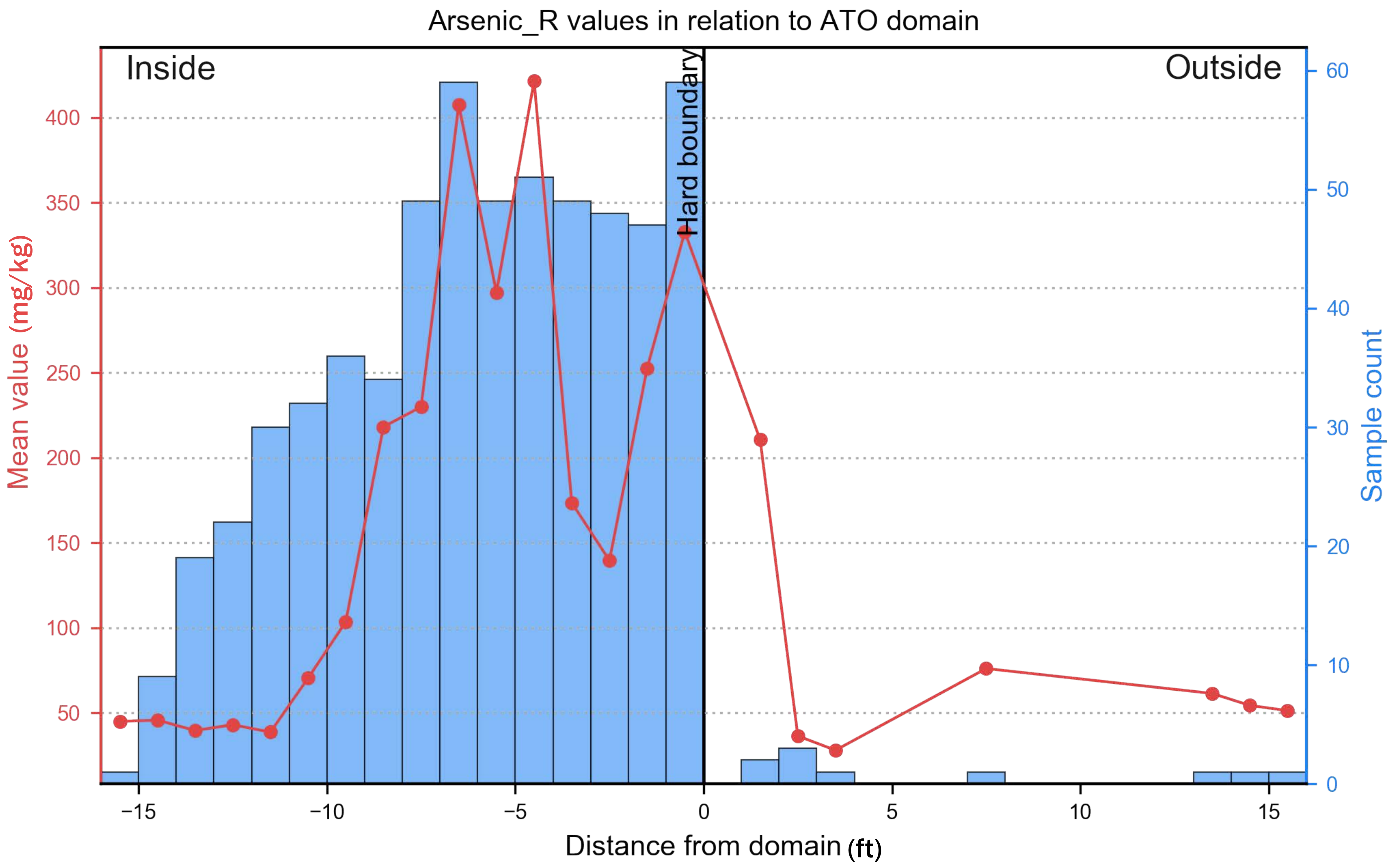

NOTE:

THIS IMAGE WAS GENERATED BY LEAPFROG WORKS AND SHOWS THE NUMBER OF BOREHOLE DATA POINTS AND THE MEAN CONCENTRATION [AFTER THE VALUES HAVE BEEN COMPOSITED] IN RELATION TO THE DISTANCE INSIDE AND OUTSIDE THE ATO (ALLUVIUM, TAILINGS, AND ORGANIC SOILS) DOMAIN.

DISPLAYED AS:
COORD SYS/ZONE: NA
DATUM: NA
UNITS: NA
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 N.T.S.

FIGURE 5

CONTAMINANT
MODEL BOUNDARY
ANALYSIS

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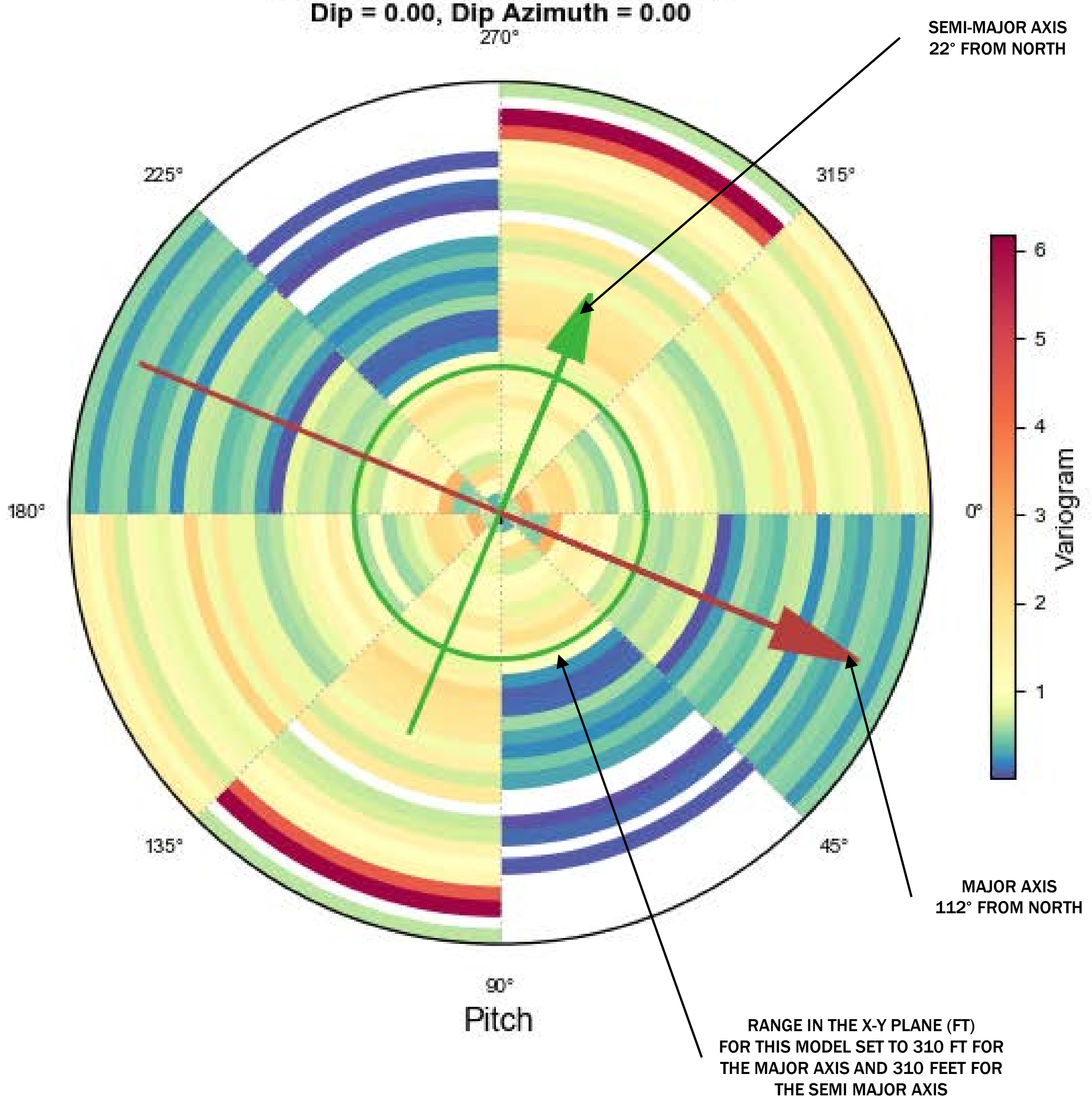
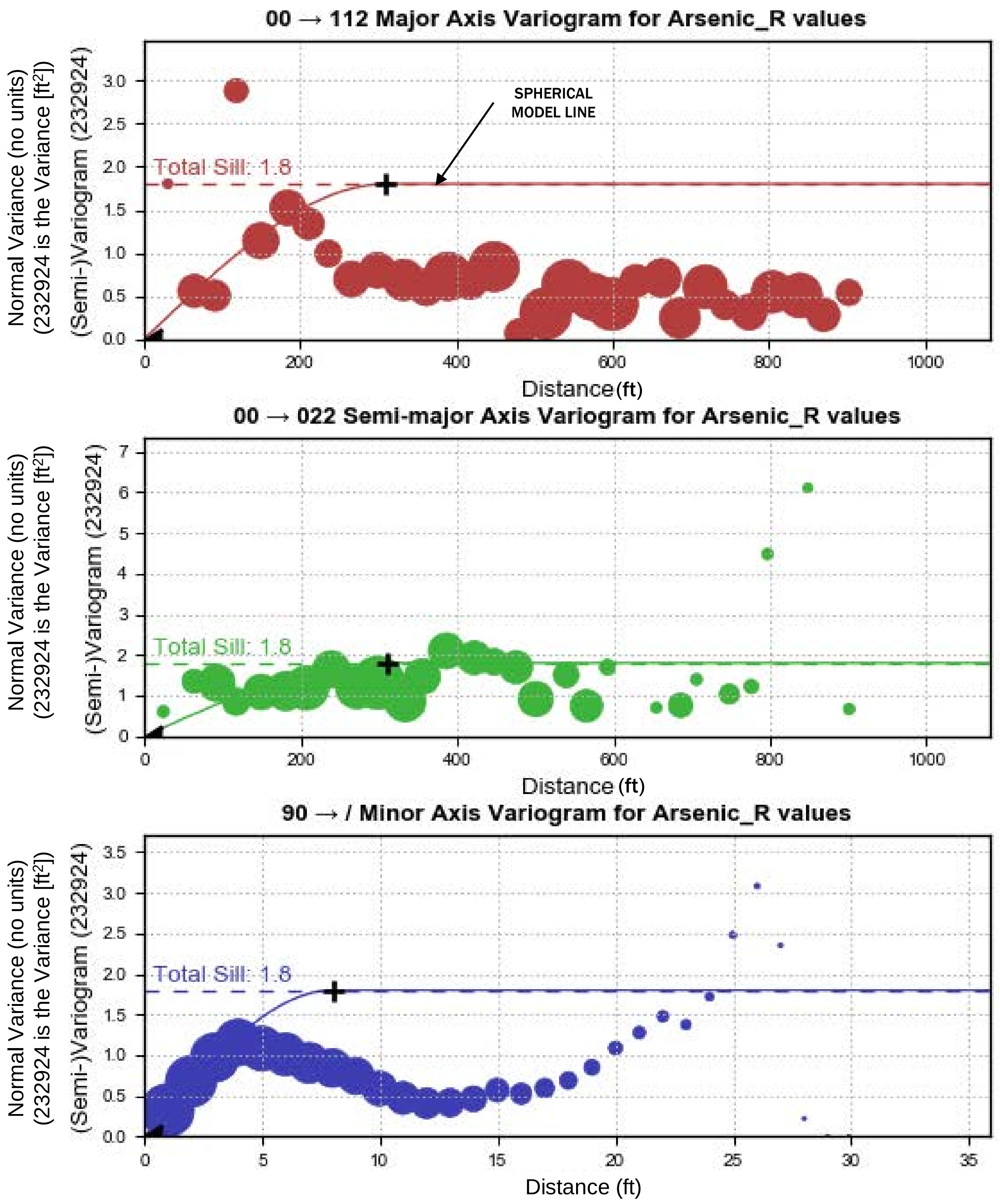
Variogram Radial Plot

2D Variogram for Arsenic_R values

Dip = 0.00, Dip Azimuth = 0.00



Variogram Scatter Plots



NOTE:

THIS FIGURE WAS GENERATED BY LEAPFROG WORKS AND SHOWS THE VARIOGRAM PLOTS USED TO SET THE RANGE AND SILL FOR THE ARSENIC_R ESTIMATION MODEL.

THE NUMBERS IN THE VARIOGRAM SCATTER PLOT TITLES (I.E. 00 – 112 MAJOR AXIS VARIOGRAM FOR ARSENIC_R VALUES) CORRESPOND TO THE ANGLE BETWEEN THE Y-AXIS (NORTH) AND THE SELECTED DIRECTION FOR EACH AXIS.

N

DISPLAYED AS:
COORD SYS/ZONE: NA
DATUM: NA
UNITS: NA
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 N.T.S.

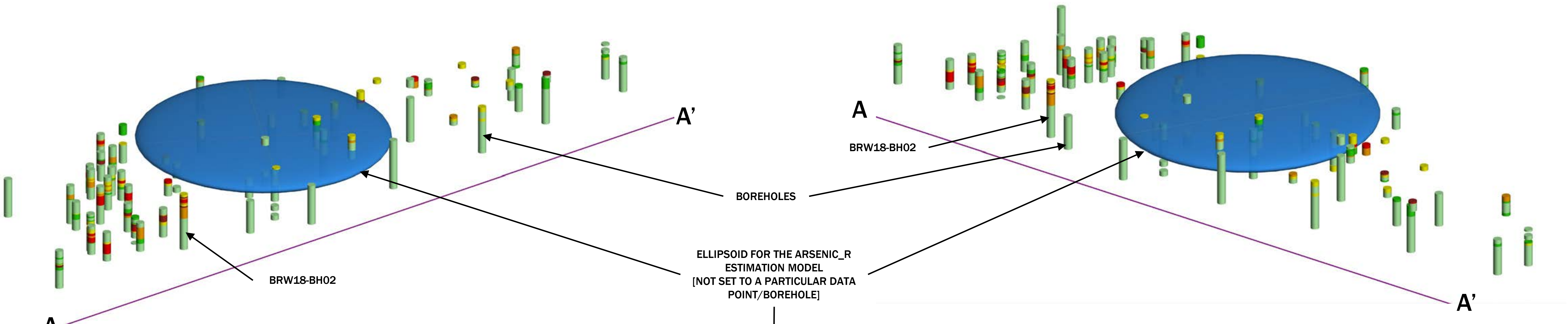
FIGURE 6 VARIOGRAM

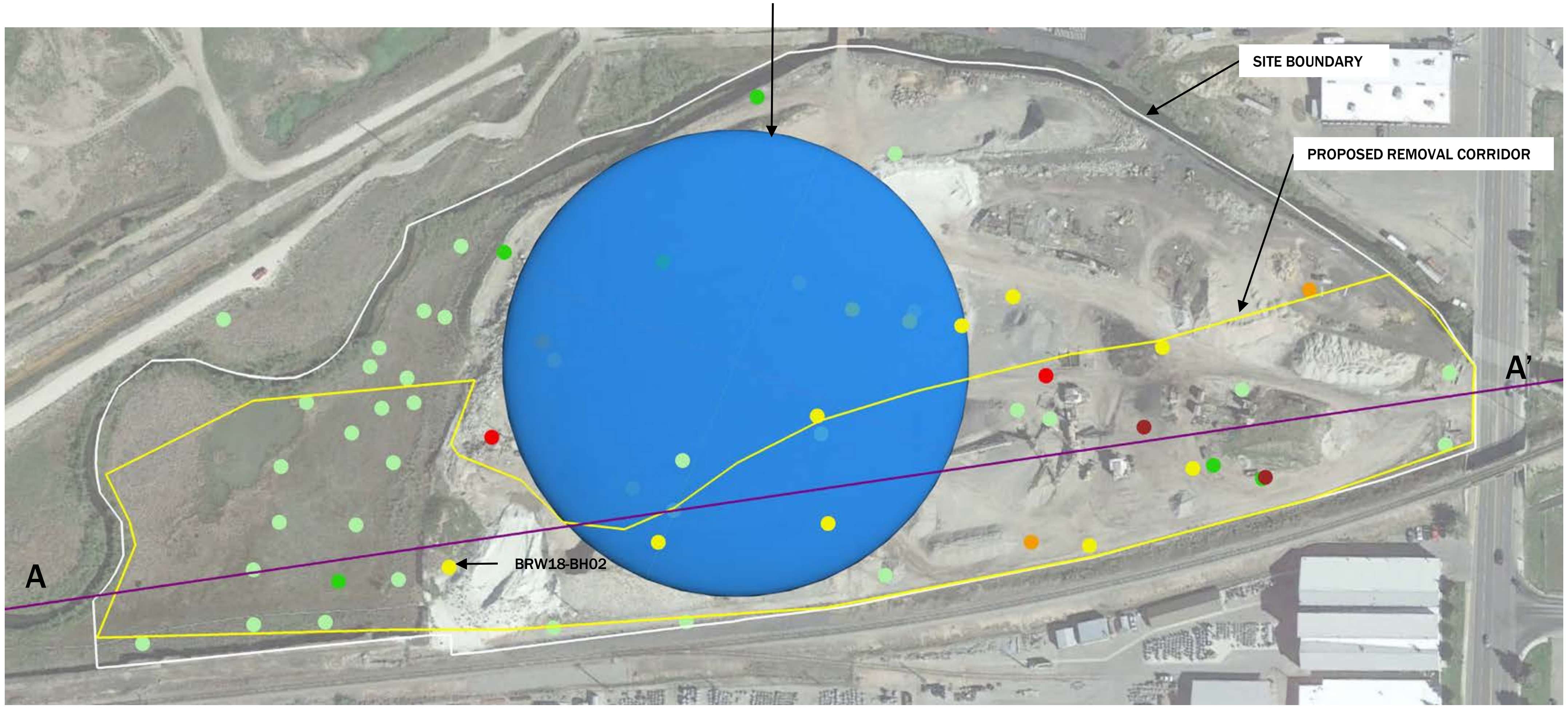
PIONEER
TECHNICAL SERVICES, INC.
1101 SOUTH MONTANA
BUTTE, MONTANA 59701
(406) 782-5177

DATE: 5/10/2021

ROTATED VIEW 1 (A-A')

ROTATED VIEW 2 (A-A')





NOTES:

THIS FIGURE AND ELLIPSOID FOR THE ARSENIC_R MODEL WERE GENERATED USING LEAPFROG WORKS. ALSO SHOWN ARE THE ARSENIC CONCENTRATIONS, USING THE REGRESSION TO ADJUST THE XRF DATA, FROM THE BOREHOLE AND TEST PIT DATA COLLECTED DURING THE BRW PHASE I SITE INVESTIGATION.

THE INVESTIGATION LOCATIONS/BOREHOLES SHOWN IN THE PLAN VIEW SHOW THE DATA FOR THE TOP INTERVAL.

THE ROTATED VIEWS HAVE BEEN SCALED SO THE ELEVATION (Z) AXIS IS 5 TIMES GREATER THAN THE NORTHING (Y) AND EASTING (X) AXES.

THE PROPOSED REMOVAL CORRIDOR SHOWN IS PRELIMINARY AND ONLY SHOWN AS A REFERENCE AT THIS POINT. THE REMOVAL CORRIDOR AND EXCAVATION SURFACE WILL BE REFINED FURTHER DURING THE REMEDIAL DESIGN AND WILL BE SUBMITTED FOR AGENCIES' REVIEW AND APPROVAL.

LEGEND

ARSENIC CONCENTRATIONS IN THE BOREHOLES (mg/kg)

🟩 0 – 90
🟩 90 – 200
🟨 200 – 500
🟧 500 – 1,000
🟥 1,000 – 2,500
🟫 > 2,500

N

DISPLAYED AS:
COORD SYS/ZONE: NA
DATUM: NA
UNITS: NA
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 N.T.S.

FIGURE 7 ELLIPSOID

PIONEER TECHNICAL SERVICES, INC.
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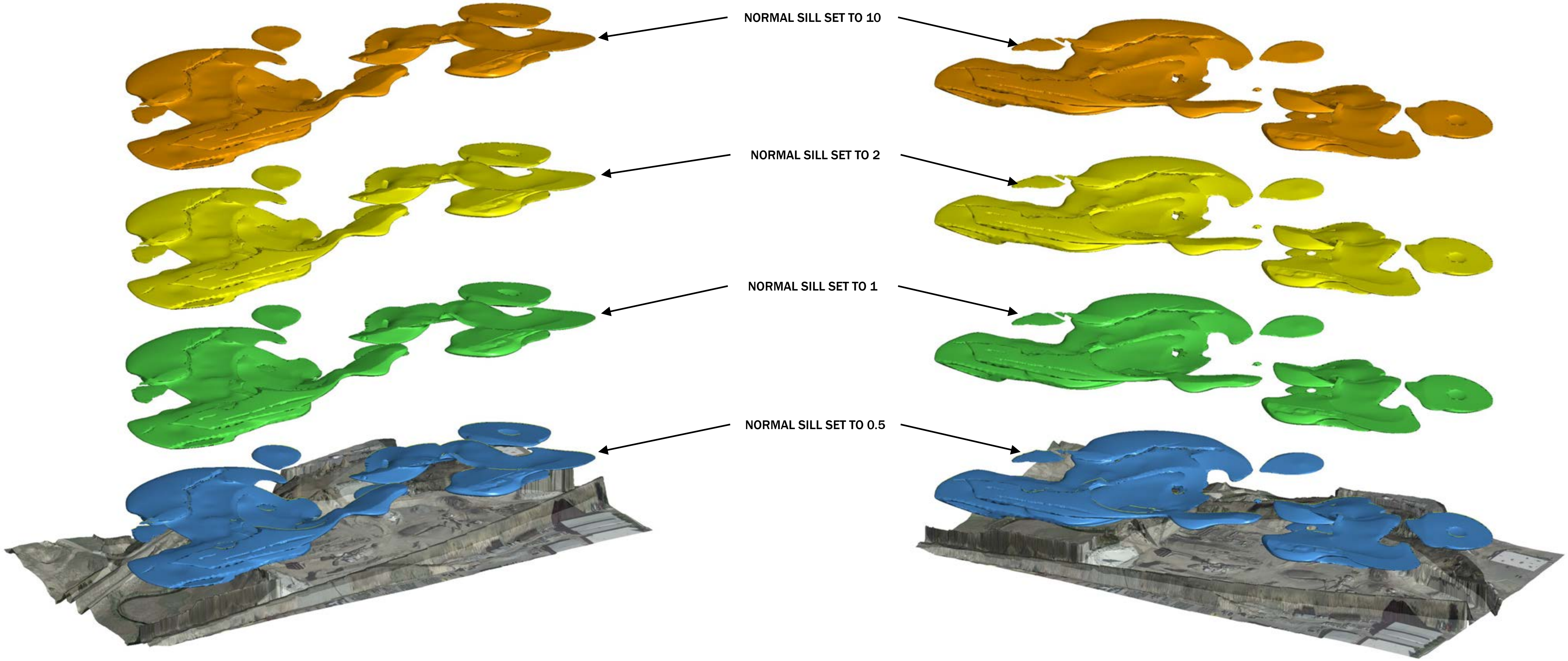
BUTTE, MONTANA 59701
(406) 782-5177

DATE: 5/10/2021

5/10/2021 10:14 AM Z:\Shared\Active Projects\ARCO\BPSOU\BRW\Leapfrog\Figures



NOTES:

THIS FIGURE DEMONSTRATES THE INFLUENCE THE SILL, OR NORMAL SILL, HAS OVER THE MODELED CONCENTRATION VOLUMES. THE VOLUMES WERE CREATED IN THE ARSENIC_R INTERVAL ESTIMATOR. EACH VOLUME SHOWS THE MATERIALS WITH ARSENIC CONCENTRATIONS BETWEEN 250 AND 500 mg/kg. THE VOLUMES HAVE BEEN OFFSET VERTICALLY FROM THEIR ORIGINAL POSITION SO ALL 4 MAY BE VIEWED IN ONE SCENE.

THE MODELED VOLUMES WERE GENERATED USING LEAPFROG WORKS. THE VOLUMES ARE A MODELED APPROXIMATION BASED ON THE BOREHOLE AND TEST PIT DATA COLLECTED DURING THE BRW PHASE I SITE INVESTIGATION.

THE ROTATED VIEWS HAVE BEEN SCALED SO THE ELEVATION (Z) AXIS IS 5 TIMES GREATER THAN THE NORTHING (Y) AND EASTING (X) AXES.

CONCLUSION:

THE MODELED CONCENTRATION VOLUMES ARE NOT SENSITIVE TO THE SILL VALUE.

LEGEND

- 🟦 ATO MATERIAL WITH ARSENIC CONCENTRATIONS BETWEEN 200 AND 500 mg/kg NORMAL SILL SET TO 0.5
- 🟩 ATO MATERIAL WITH ARSENIC CONCENTRATIONS BETWEEN 200 AND 500 mg/kg NORMAL SILL SET TO 1
- 🟨 ATO MATERIAL WITH ARSENIC CONCENTRATIONS BETWEEN 200 AND 500 mg/kg NORMAL SILL SET TO 2
- 🟧 ATO MATERIAL WITH ARSENIC CONCENTRATIONS BETWEEN 200 AND 500 mg/kg NORMAL SILL SET TO 10

ATO MATERIAL = ALLUVIUM, TAILINGS, AND ORGANIC SOILS

N

DISPLAYED AS:
COORD SYS/ZONE: NA
DATUM: NA
UNITS: NA
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 N.T.S.

FIGURE 8

SENSITIVITY ANALYSIS - SILL

PIONEER TECHNICAL SERVICES, INC.
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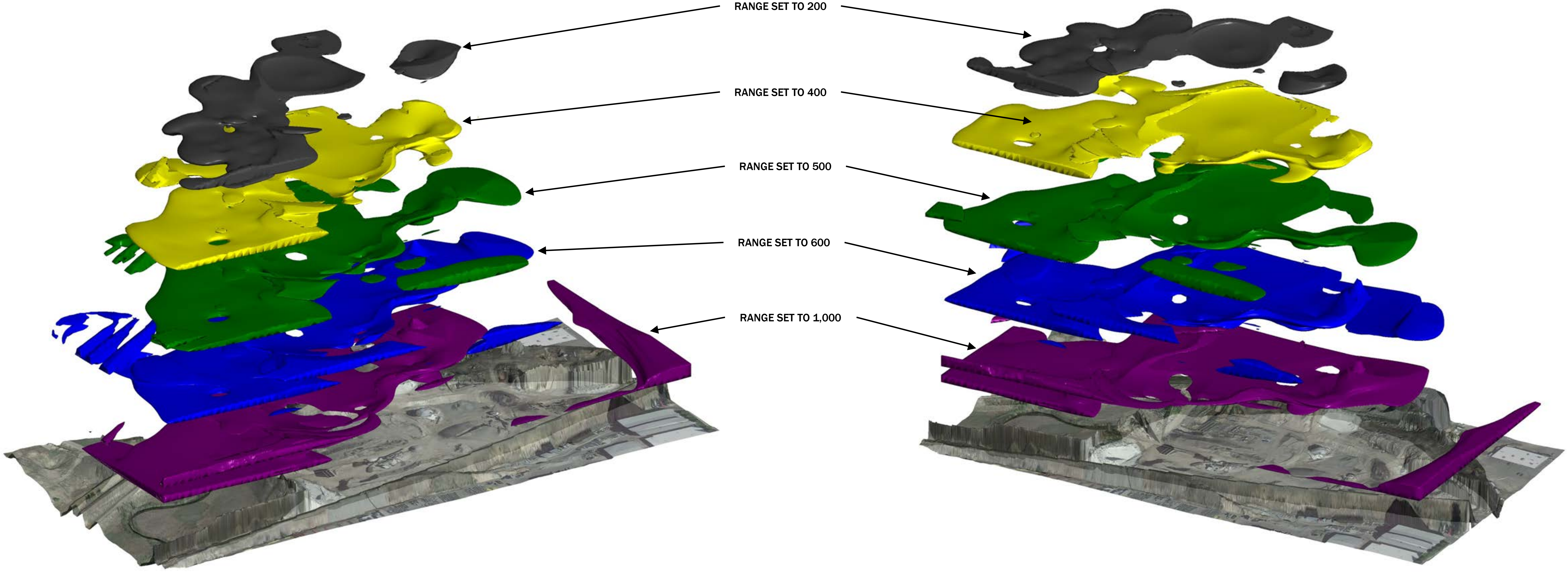
BUTTE, MONTANA 59701
(406) 782-5177

DATE: 4/12/2021

4/12/2021 11:35 AM Z:\Shared\Active Projects\ARCO\BPSOU\BRW\Leapfrog\Figures



NOTES:

THIS FIGURE DEMONSTRATES THE INFLUENCE THE RANGE HAS OVER THE MODELED CONCENTRATION VOLUMES. THE VOLUMES WERE CREATED IN THE LEAD_R INTERVAL ESTIMATOR. EACH VOLUME SHOWS THE MATERIALS WITH LEAD CONCENTRATIONS BETWEEN 1,000 AND 3,000 mg/kg. THE VOLUMES HAVE BEEN OFFSET VERTICALLY FROM THEIR ORIGINAL POSITION SO ALL 5 MAY BE VIEWED IN ONE SCENE.

THE MODELED VOLUMES WERE GENERATED USING LEAPFROG WORKS. THE VOLUMES ARE A MODELED APPROXIMATION BASED ON THE BOREHOLE AND TEST PIT DATA COLLECTED DURING THE BRW PHASE I SITE INVESTIGATION.

THE ROTATED VIEWS HAVE BEEN SCALED SO THE ELEVATION (Z) AXIS IS 5 TIMES GREATER THAN THE NORTHING (Y) AND EASTING (X) AXES.

CONCLUSION:

THE MODELED CONCENTRATION VOLUMES ARE VERY SENSITIVE TO THE RANGE VALUE.

LEGEND

- ⬛ ATO MATERIAL WITH LEAD CONCENTRATIONS BETWEEN 1,000 AND 3,000 mg/kg RANGE SET TO 200
- 🟨 ATO MATERIAL WITH LEAD CONCENTRATIONS BETWEEN 1,000 AND 3,000 mg/kg RANGE SET TO 400
- 🟩 ATO MATERIAL WITH LEAD CONCENTRATIONS BETWEEN 1,000 AND 3,000 mg/kg RANGE SET TO 500
- 🟦 ATO MATERIAL WITH LEAD CONCENTRATIONS BETWEEN 1,000 AND 3,000 mg/kg RANGE SET TO 600
- 🟪 ATO MATERIAL WITH LEAD CONCENTRATIONS BETWEEN 1,000 AND 3,000 mg/kg RANGE SET TO 1,000

ATO MATERIAL = ALLUVIUM, TAILINGS, AND ORGANIC SOILS

N

DISPLAYED AS:
COORD SYS/ZONE: NA
DATUM: NA
UNITS: NA
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 N.T.S.

FIGURE 9

SENSITIVITY ANALYSIS - RANGE

PIONEER TECHNICAL SERVICES, INC.
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(406) 782-5177

DATE: 4/12/2021

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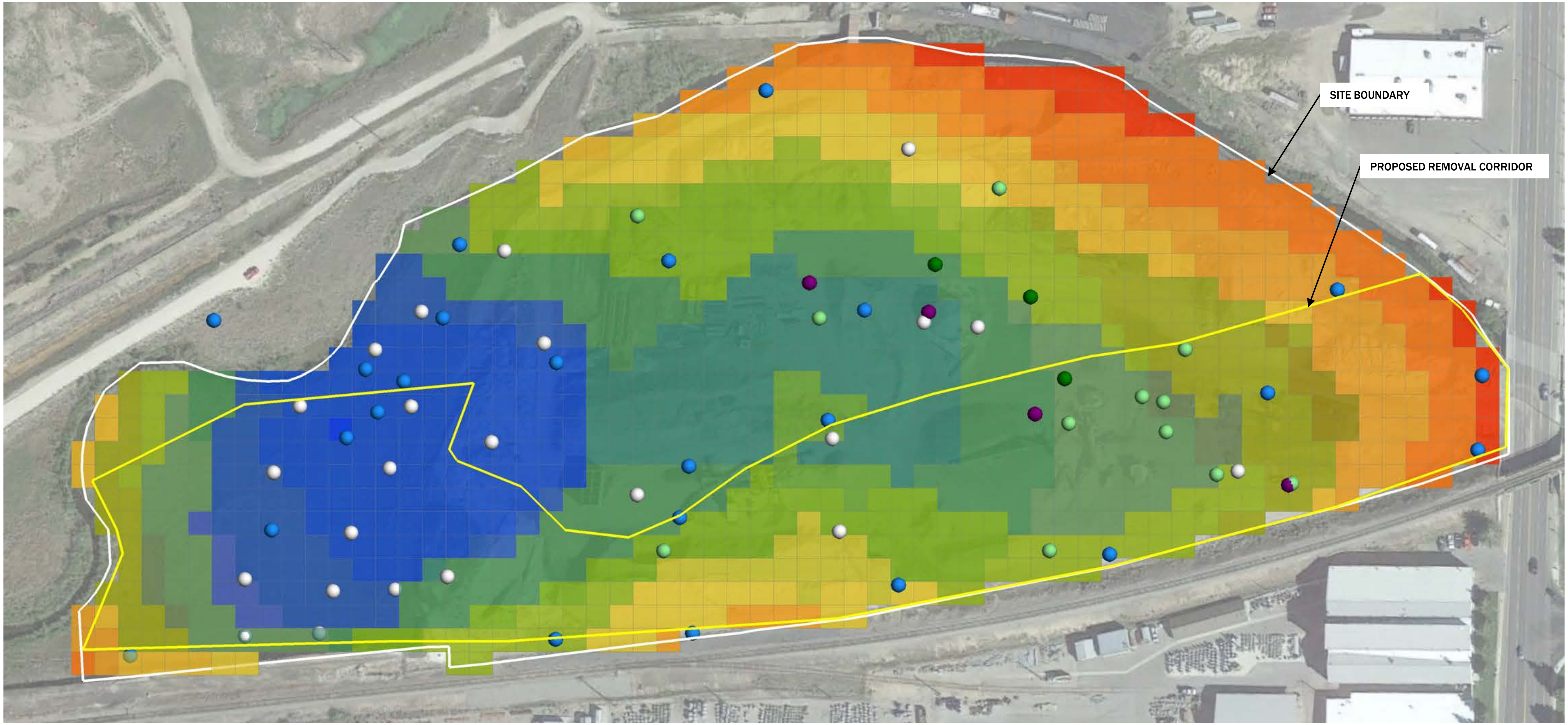

LEGEND

AVERAGE DISTANCE

- 🟦 0 – 250 FEET
- 🟩 250 - 300 FEET
- 🟩 300 – 350 FEET
- 🟨 350 – 400 FEET
- 🟧 400 – 450 FEET
- 🟥 450 – 550 FEET

INVESTIGATION LOCATIONS

INSTALLED IN 2018
- ● BOREHOLE
- ● PIEZOMETER
- ● TEST PIT

INSTALLED IN 2018
- ● HYDROCARBON PIEZOMETER
- ● HYDROCARBON TEST PIT

NOTES:

THIS IMAGE WAS GENERATED BY LEAPFROG WORKS AND SHOWS THE AVERAGE DISTANCE BETWEEN POINTS AS MODELED BY THE LEAD_R BLOCK MODEL.

THE PROPOSED REMOVAL CORRIDOR SHOWN IS PRELIMINARY AND ONLY SHOWN AS A REFERENCE AT THIS POINT. THE REMOVAL CORRIDOR AND EXCAVATION SURFACE WILL BE REFINED FURTHER DURING THE REMEDIAL DESIGN AND WILL BE SUBMITTED FOR AGENCIES' REVIEW AND APPROVAL.

N

DISPLAYED AS:
COORD SYS/ZONE: NA
DATUM: NA
UNITS: NA
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 N.T.S.

FIGURE 10

BLOCK MODEL – AVERAGE DISTANCE

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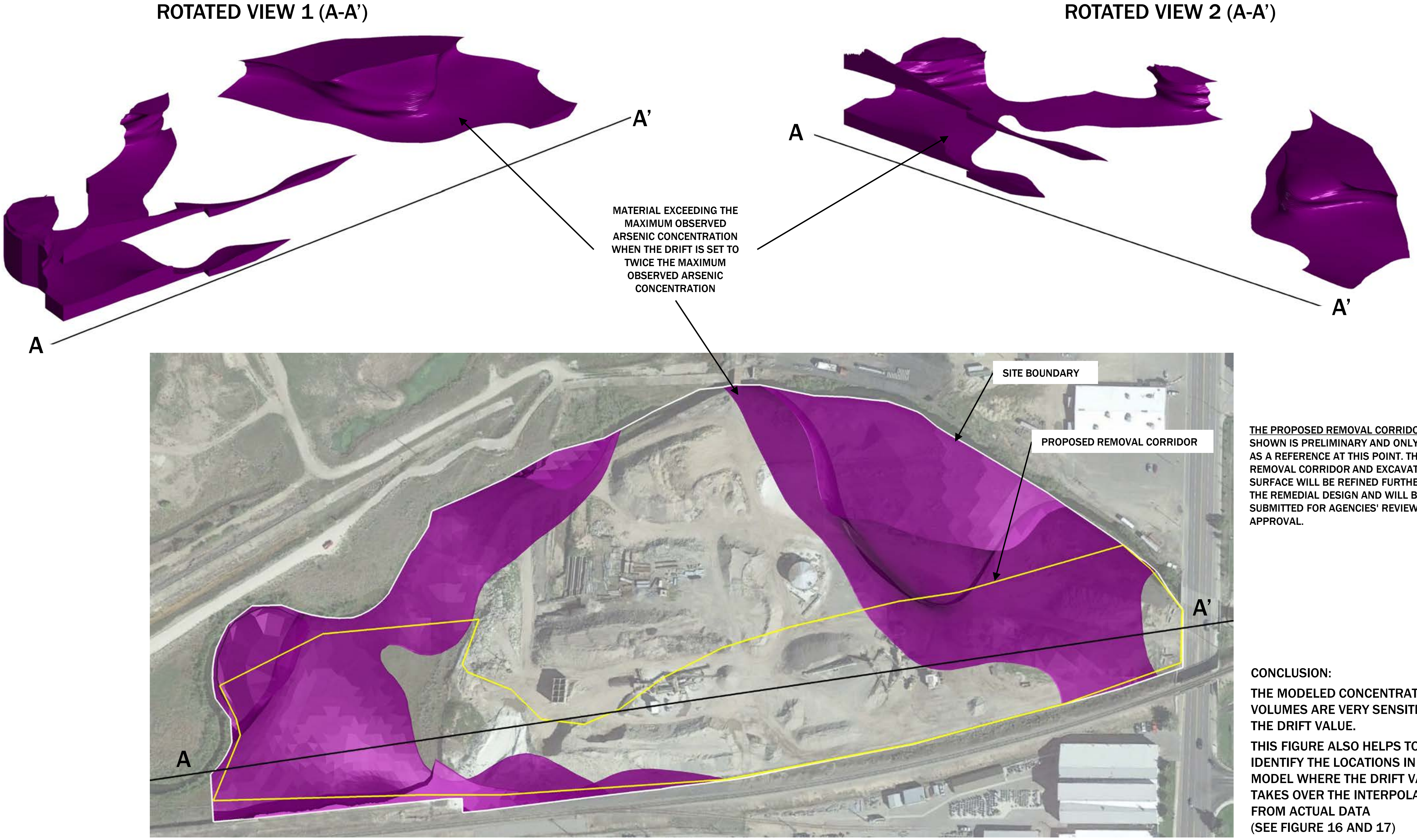

THE PROPOSED REMOVAL CORRIDOR SHOWN IS PRELIMINARY AND ONLY SHOWN AS A REFERENCE AT THIS POINT. THE REMOVAL CORRIDOR AND EXCAVATION SURFACE WILL BE REFINED FURTHER DURING THE REMEDIAL DESIGN AND WILL BE SUBMITTED FOR AGENCIES' REVIEW AND APPROVAL.

CONCLUSION:

THE MODELED CONCENTRATION VOLUMES ARE VERY SENSITIVE TO THE DRIFT VALUE.

THIS FIGURE ALSO HELPS TO IDENTIFY THE LOCATIONS IN THE MODEL WHERE THE DRIFT VALUE TAKES OVER THE INTERPOLATION FROM ACTUAL DATA (SEE FIGURE 16 AND 17)

NOTES:

THIS FIGURE DEMONSTRATES WHERE THE BOREHOLE DATA NO LONGER INFLUENCES THE MODEL (I.E., THE MODEL IS EXTRAPOLATING OUTSIDE THE LIMITS OF THE BOREHOLE DATA). THE VOLUME WAS GENERATED WITH THE ARSENIC_R INTERVAL ESTIMATOR BY SETTING THE DRIFT EQUAL TO APPROXIMATELY TWICE THE MAXIMUM OBSERVED ARSENIC CONCENTRATION. THE VOLUME SHOWN HERE IS THE VOLUME OF MATERIAL WITH CONCENTRATIONS GREATER THAN THE MAXIMUM OBSERVED ARSENIC CONCENTRATION.

THIS FIGURE AND MODELED VOLUMES WERE GENERATED USING LEAPFROG WORKS. THE VOLUME IS A MODELED APPROXIMATION BASED ON THE BOREHOLE AND TEST PIT DATA COLLECTED DURING THE BRW PHASE I SITE INVESTIGATION.

THE ROTATED VIEWS HAVE BEEN SCALED SO THE ELEVATION (Z) AXIS IS 5 TIMES GREATER THAN THE NORTHING (Y) AND EASTING (X) AXES.

N

DISPLAYED AS:
COORD SYS/ZONE: NA
DATUM: NA
UNITS: NA
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 N.T.S.

FIGURE 11

SENSITIVITY ANALYSIS - DRIFT

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BUTTE, MONTANA 59701
(406) 782-5177

DATE: 4/12/2021

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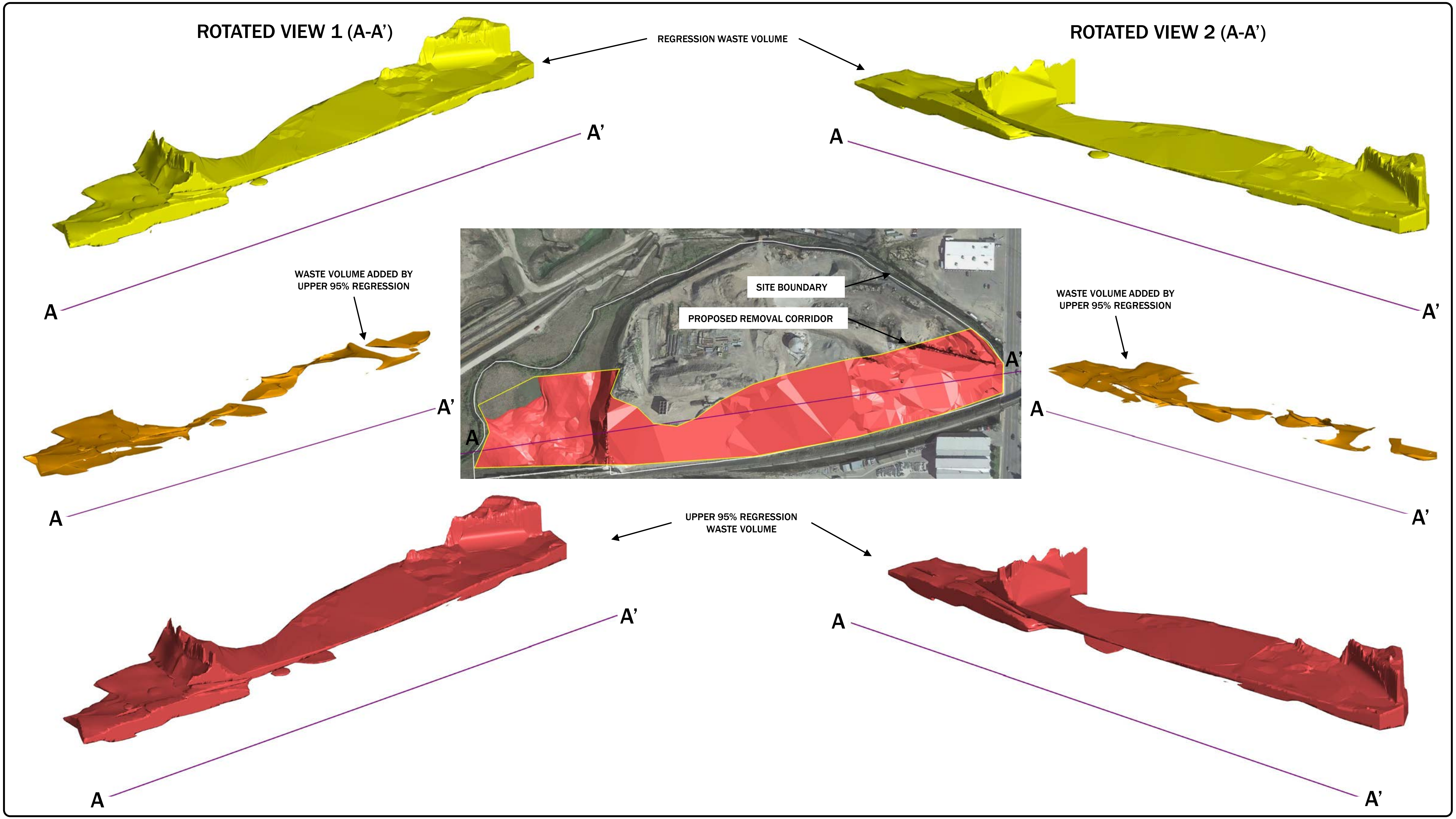

LEGEND

- 🟨 WASTE VOLUME USING THE REGRESSION TO ADJUST XRF RESULTS
- 🟧 WASTE VOLUME ADDED TO THE REGRESSION WASTE VOLUME USING THE UPPER 95% REGRESSION TO ADJUST THE XRF RESULTS
- 🟥 WASTE VOLUME USING THE UPPER 95% REGRESSION TO ADJUST THE XRF RESULTS

NOTES:

THIS FIGURE AND MODELED VOLUMES WERE GENERATED USING LEAPFROG WORKS. THE VOLUME IS A MODELED APPROXIMATION BASED ON THE BOREHOLE AND TEST PIT DATA COLLECTED DURING THE BRW PHASE I SITE INVESTIGATION AS WELL AS OBSERVATIONS FROM PREVIOUS INVESTIGATIONS AND THE INSTALLATION OF OLDER MONITORING WELLS.

THE ROTATED VIEWS HAVE BEEN SCALED SO THE ELEVATION (Z) AXIS IS 5 TIMES GREATER THAN THE NORTHING (Y) AND EASTING (X) AXES.

N

DISPLAYED AS:
COORD SYS/ZONE: NA
DATUM: NA
UNITS: NA
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 N.T.S.

FIGURE 12

PIONEER TECHNICAL SERVICES, INC.
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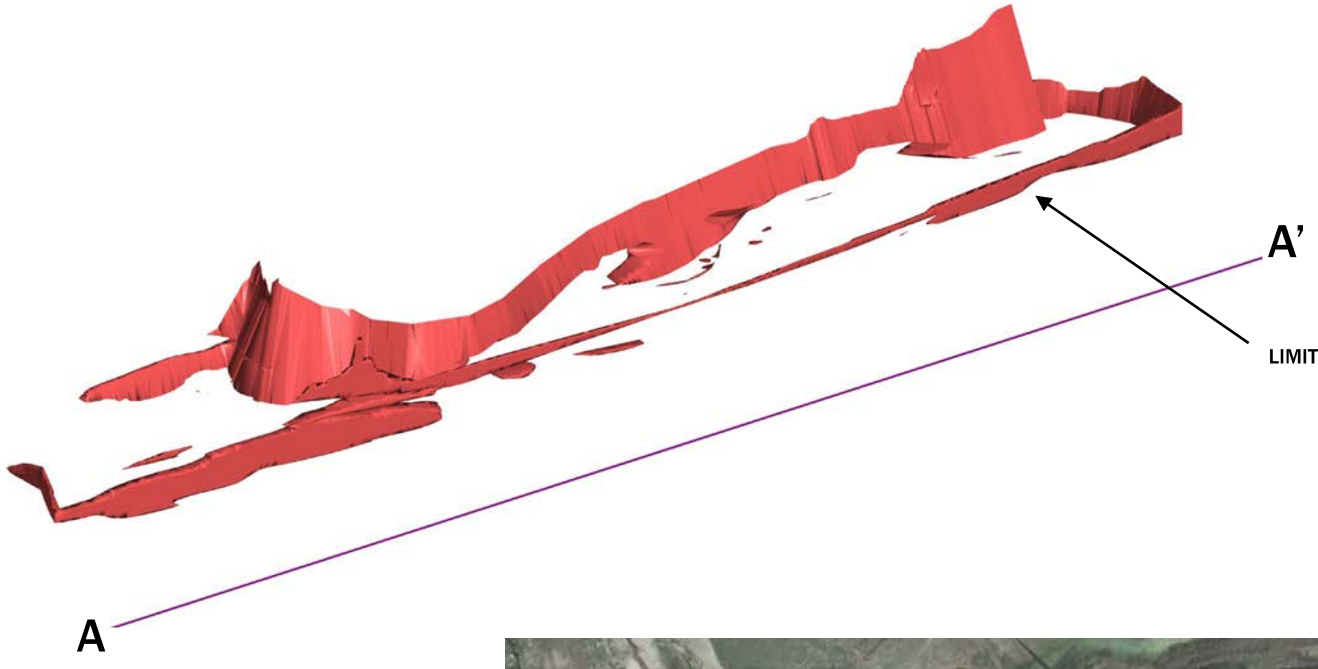
BUTTE, MONTANA 59701
(406) 782-5177

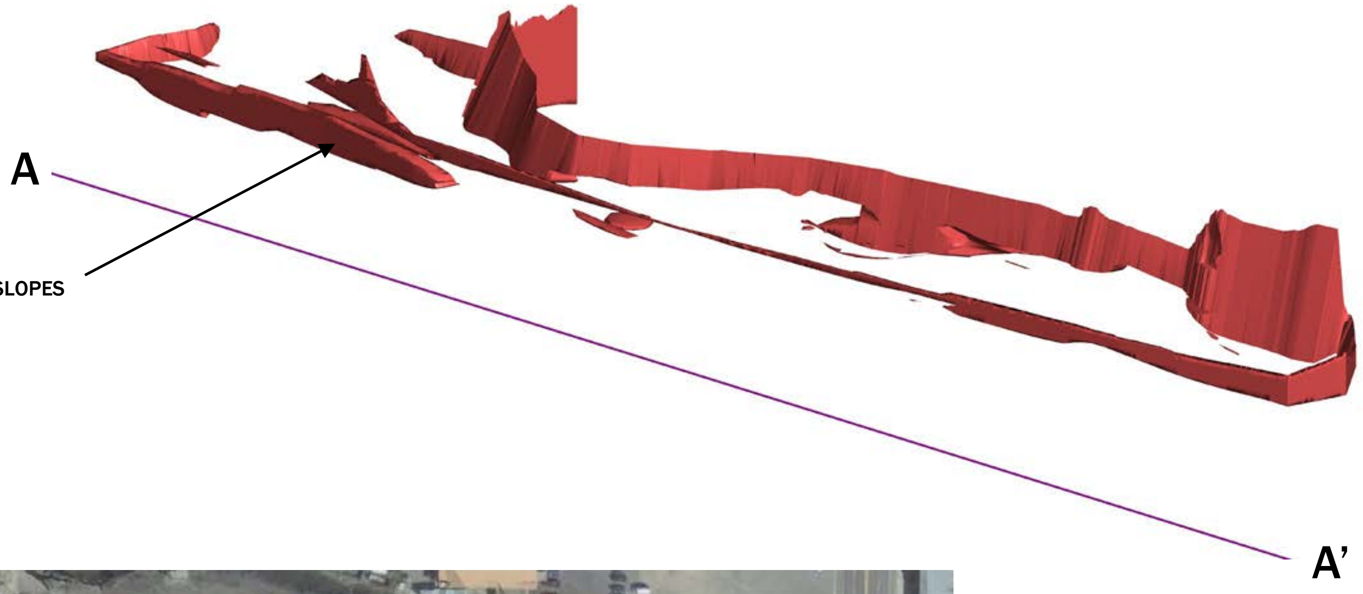
WASTE VOLUME WITHIN REMOVAL CORRIDOR

DATE: 5/10/2021

ROTATED VIEW 1 (A-A')



ROTATED VIEW 2 (A-A')



WASTE REMOVAL
LIMITED BY 2:1 EXCAVATION SLOPES

NOTES:

THE WASTE REMOVAL IS CONSTRAINED BY 2:1 EXCAVATION SLOPES, WHICH ARE SHOWN IN THE ROTATED VIEWS ABOVE AND IN THE PLAN VIEW TO THE RIGHT.

OTHER CONSTRAINTS MAY FURTHER RESTRICT THE REMOVAL OF THE WASTE VOLUME, SUCH AS PROPERTY OWNERSHIP, UTILITIES, CONSTRUCTION DEWATERING, ETC. THESE CONSTRAINTS WILL BE IDENTIFIED AND EVALUATED DURING THE DESIGN PHASE.

THIS FIGURE AND MODELED VOLUMES WERE GENERATED USING LEAPFROG WORKS. THE WASTE VOLUME WAS EXPORTED AND INTEGRATED INTO THE PRELIMINARY WASTE EXCAVATION SURFACE IN AUTOCAD. THE WASTE VOLUME IS A MODELED APPROXIMATION BASED ON THE BOREHOLE AND TEST PIT DATA COLLECTED DURING THE BRW PHASE I SITE INVESTIGATION AS WELL AS OBSERVATIONS FROM PREVIOUS INVESTIGATIONS AND THE INSTALLATION OF OLDER MONITORING WELLS.

THE ROTATED VIEWS HAVE BEEN SCALED SO THE ELEVATION (Z) AXIS IS 5 TIMES GREATER THAN THE NORTHING (Y) AND EASTING (X) AXES.

THE PROPOSED REMOVAL CORRIDOR SHOWN IS PRELIMINARY AND ONLY SHOWN AS A REFERENCE AT THIS POINT. THE REMOVAL CORRIDOR AND EXCAVATION SURFACE WILL BE REFINED FURTHER DURING THE REMEDIAL DESIGN AND WILL BE SUBMITTED FOR AGENCIES' REVIEW AND APPROVAL.

LEGEND

🟥 MATERIAL FAILS WASTE IDENTIFICATION CRITERIA*

*THE WASTE IDENTIFICATION CRITERIA DEFINED IN THE BPSOU CD (EPA, 2020). MATERIAL FAILING THE WASTE CRITERIA INCLUDES MATERIAL CATEGORIZED AS SLAG, DEMOLITION DEBRIS, AND OTHER.

N

DISPLAYED AS:

COORD SYS/ZONE: NA
DATUM: NA
UNITS: NA
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 N.T.S.

FIGURE 13

REMAINING WASTE
DUE TO SLOPE
CONSTRAINTS

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TECHNICAL SERVICES, INC.
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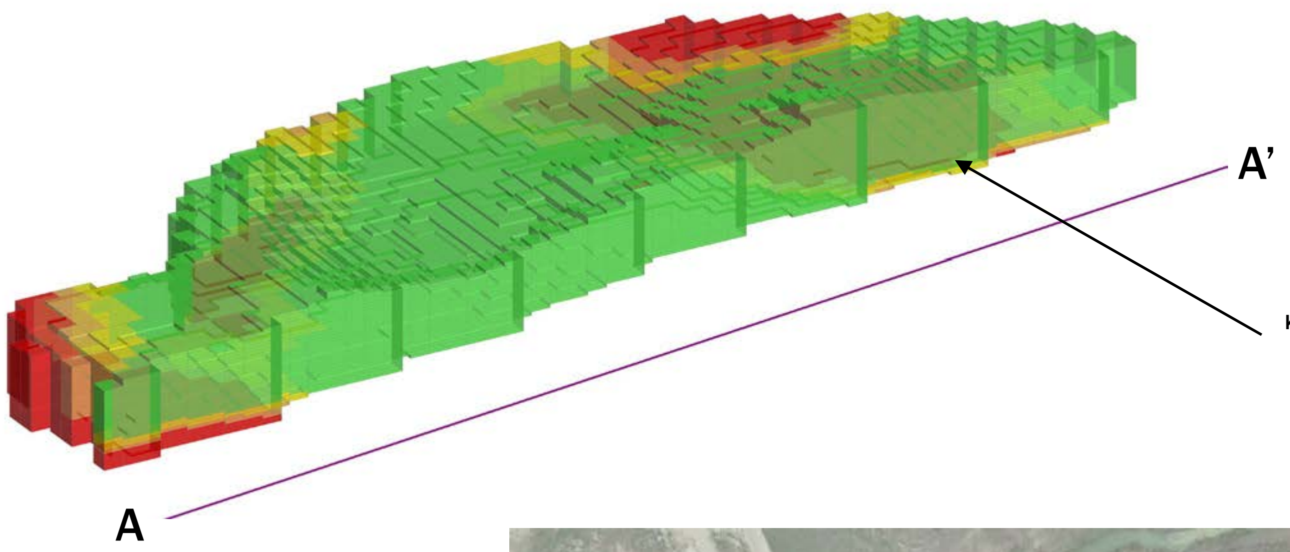
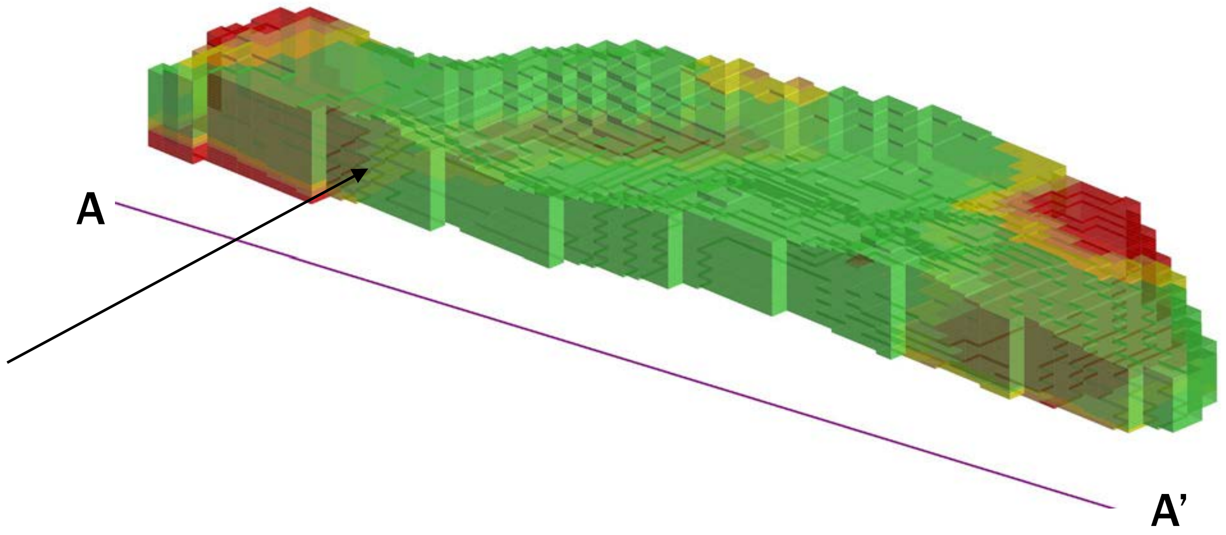
BUTTE, MONTANA 59701
(406) 782-5177

DATE: 5/10/2021

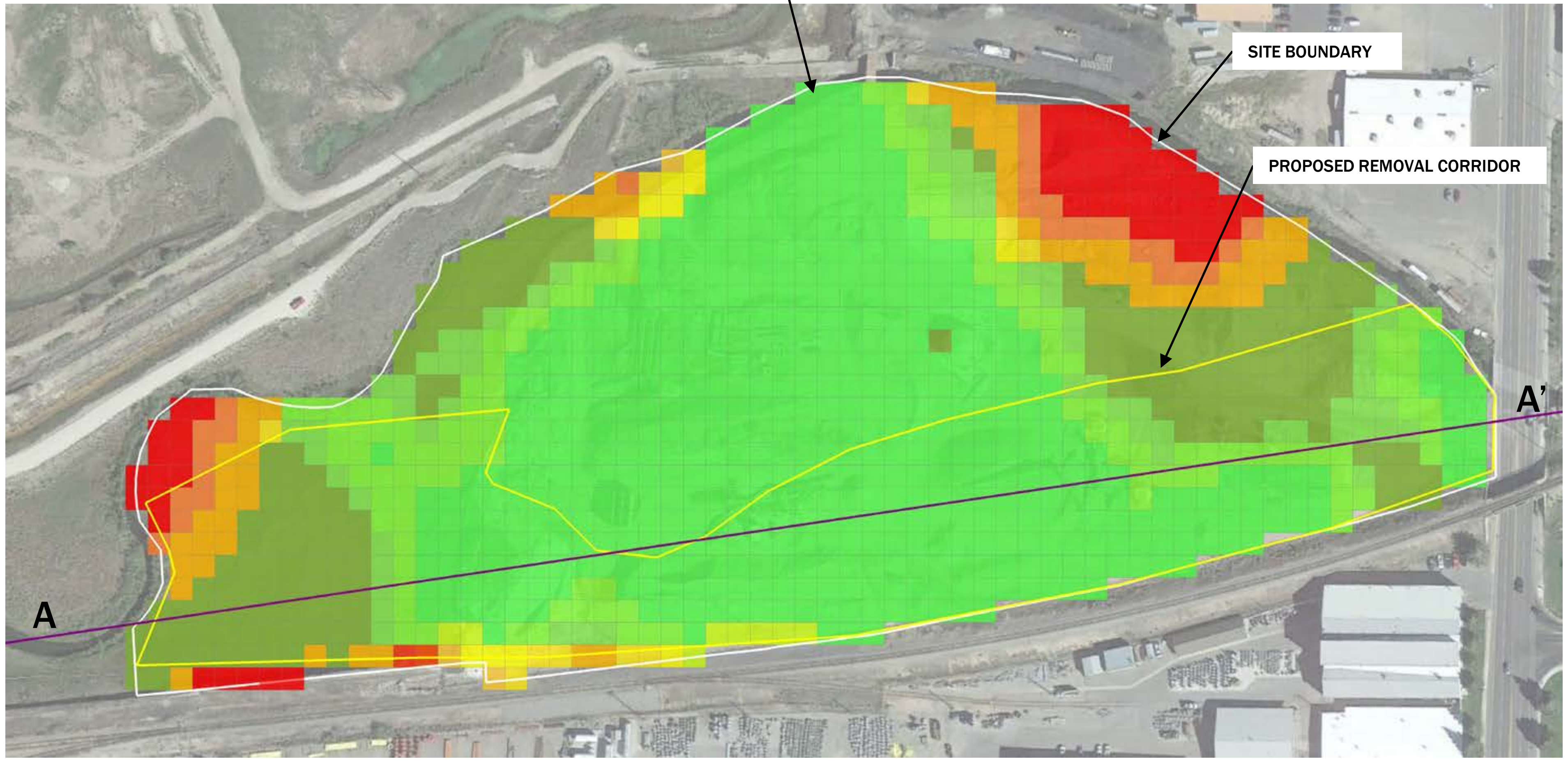
ROTATED VIEW 1 (A-A’)



ROTATED VIEW 2 (A-A’)



KRIGING EFFICIENCY AND SLOPE OF REGRESSION BLOCK MODEL



NOTES:

FIGURES 14 AND 15 USE TWO DIFFERENT EQUATIONS PROVIDED BY LEAPFROG. THE EQUATION USED IN FIGURE 15 PROVIDES A MORE CONSERVATIVE ESTIMATE OF WHERE THE MODEL IS TAKING OVER THE INTERPOLATION.

THE FORMULAS USED TO GENERATE THIS BLOCK MODEL (ARSENIC_R) USE THE KRIGING EFFICIENCY AND SLOPE OF REGRESSION TO INDICATE WHERE THE MODEL IS PULLING INFORMATION DIRECTLY FROM THE BOREHOLE DATA (1. MEASURED), WHERE THE MODEL HAS MORE INFLUENCE (2. INDICATED AND 3. INFERRED), AND WHERE THE MODEL TAKES OVER (4. UNCLASSIFIED).

THIS FIGURE AND BLOCK MODEL WERE GENERATED USING LEAPFROG WORKS. THE BLOCK MODEL IS BASED ON THE BOREHOLE AND TEST PIT DATA COLLECTED DURING THE BRW PHASE I SITE INVESTIGATION.

THE ROTATED VIEWS HAVE BEEN SCALED SO THE ELEVATION (Z) AXIS IS 5 TIMES GREATER THAN THE NORTHING (Y) AND EASTING (X) AXES.

THE PROPOSED REMOVAL CORRIDOR SHOWN IS PRELIMINARY AND ONLY SHOWN AS A REFERENCE AT THIS POINT. THE REMOVAL CORRIDOR AND EXCAVATION SURFACE WILL BE REFINED FURTHER DURING THE REMEDIAL DESIGN AND WILL BE SUBMITTED FOR AGENCIES' REVIEW AND APPROVAL.

LEGEND

- 🟩 1. MEASURED
- 🟨 2. INDICATED
- 🟧 3. INFERRED
- 🟥 4. UNCLASSIFIED

DISPLAYED AS:
COORD SYS/ZONE: NA
DATUM: NA
UNITS: NA
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 N.T.S.

FIGURE 14

PIONEER TECHNICAL SERVICES, INC.
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KRIGING EFFICIENCY AND SLOPE OF REGRESSION BLOCK MODEL

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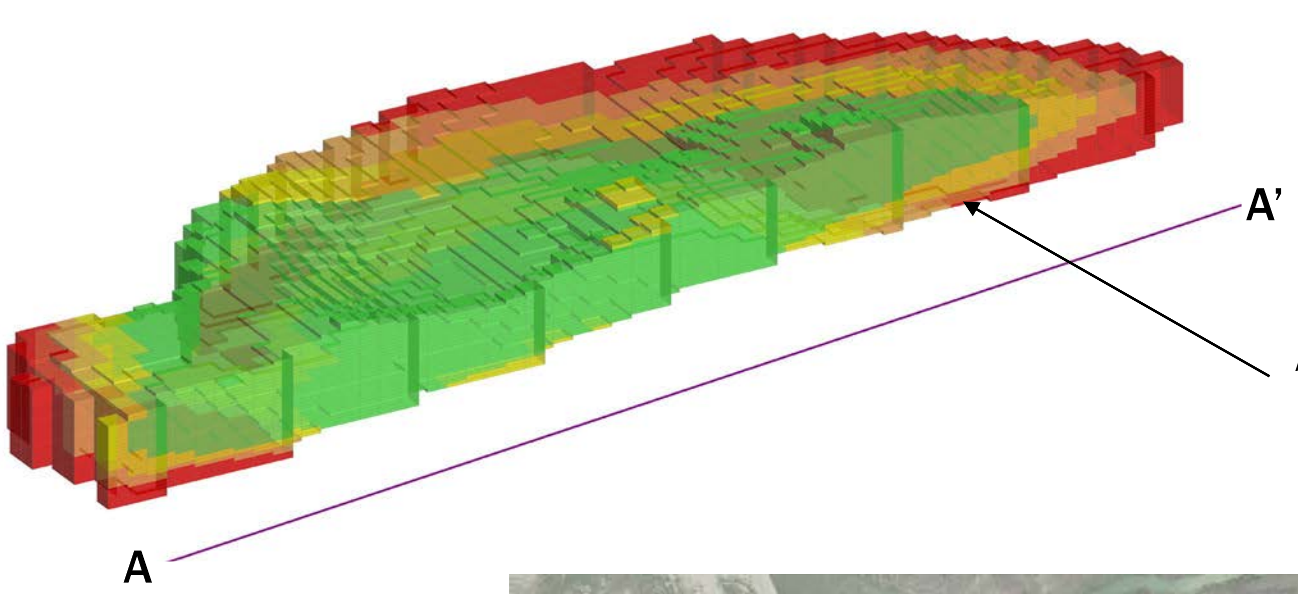
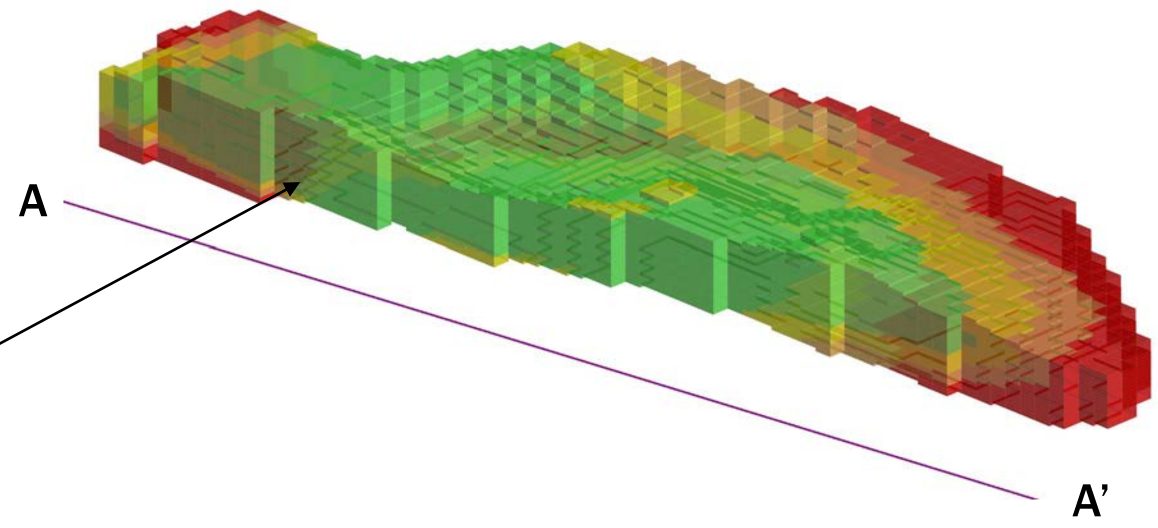
ROTATED VIEW 1 (A-A’)



ROTATED VIEW 2 (A-A’)



AVERAGE DISTANCE AND SLOPE OF REGRESSION BLOCK MODEL

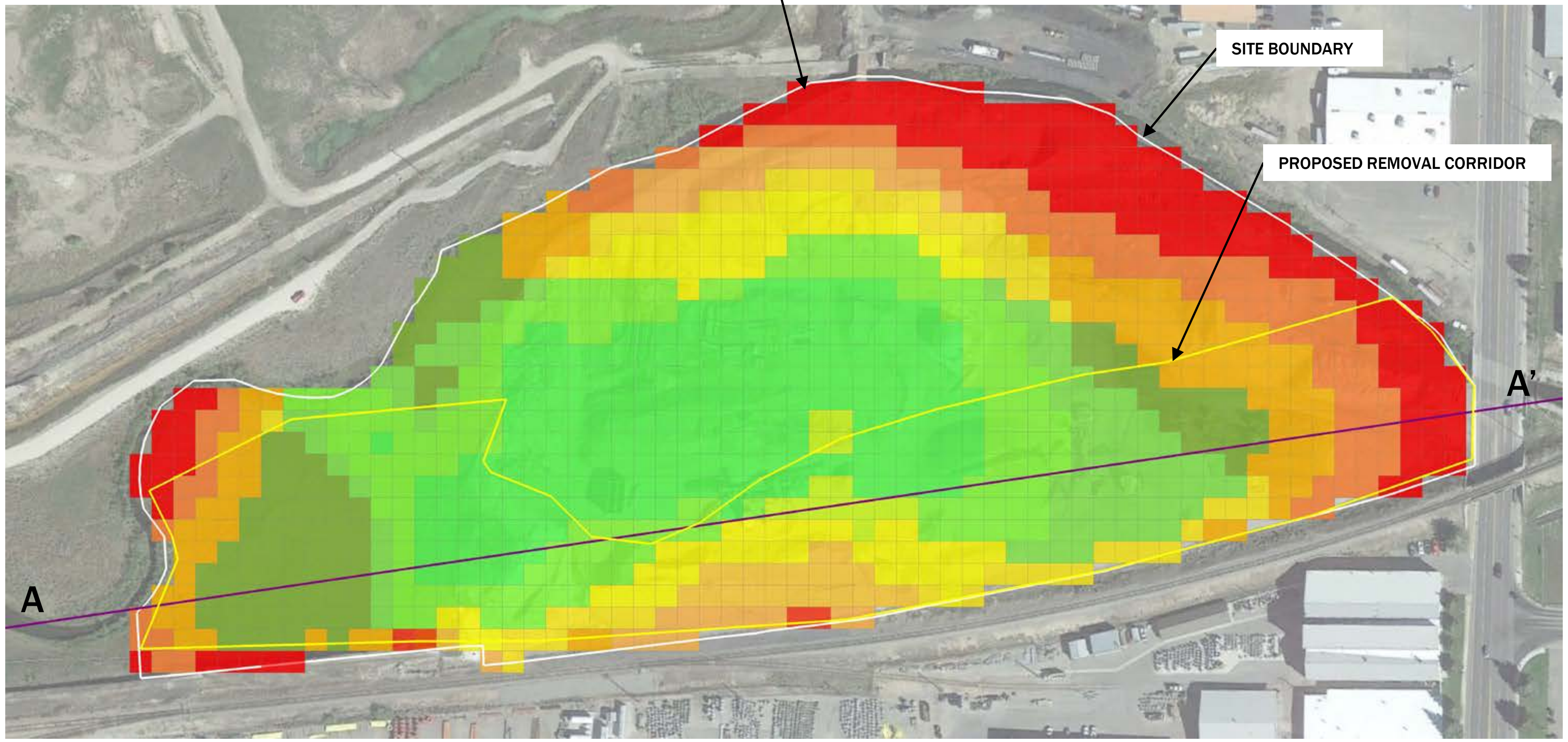
NOTES:

FIGURES 14 AND 15 USE TWO DIFFERENT EQUATIONS PROVIDED BY LEAPFROG. THE EQUATION USED IN FIGURE 15 PROVIDES A MORE CONSERVATIVE ESTIMATE OF WHERE THE MODEL IS TAKING OVER THE INTERPOLATION.

THE FORMULAS USED TO GENERATE THIS BLOCK MODEL (ARSENIC_R) USE THE AVERAGE DISTANCE BETWEEN POINTS AND SLOPE OF REGRESSION TO INDICATE WHERE THE MODEL IS PULLING INFORMATION DIRECTLY FROM THE BOREHOLE DATA (1. MEASURED), WHERE THE MODEL HAS MORE INFLUENCE (2. INDICATED AND 3. INFERRED), AND WHERE THE MODEL TAKES OVER (4. UNCLASSIFIED).

THIS FIGURE AND BLOCK MODEL WERE GENERATED USING LEAPFROG WORKS. THE BLOCK MODEL IS BASED ON THE BOREHOLE AND TEST PIT DATA COLLECTED DURING THE BRW PHASE I SITE INVESTIGATION.

THE ROTATED VIEWS HAVE BEEN SCALED SO THE ELEVATION (Z) AXIS IS 5 TIMES GREATER THAN THE NORTHING (Y) AND EASTING (X) AXES.



THE PROPOSED REMOVAL CORRIDOR SHOWN IS PRELIMINARY AND ONLY SHOWN AS A REFERENCE AT THIS POINT. THE REMOVAL CORRIDOR AND EXCAVATION SURFACE WILL BE REFINED FURTHER DURING THE REMEDIAL DESIGN AND WILL BE SUBMITTED FOR AGENCIES' REVIEW AND APPROVAL.

LEGEND

- 🟩 1. MEASURED
- 🟨 2. INDICATED
- 🟧 3. INFERRED
- 🟥 4. UNCLASSIFIED

N

DISPLAYED AS:

COORD SYS/ZONE: NA
DATUM: NA
UNITS: NA
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0
N.T.S.

FIGURE 15

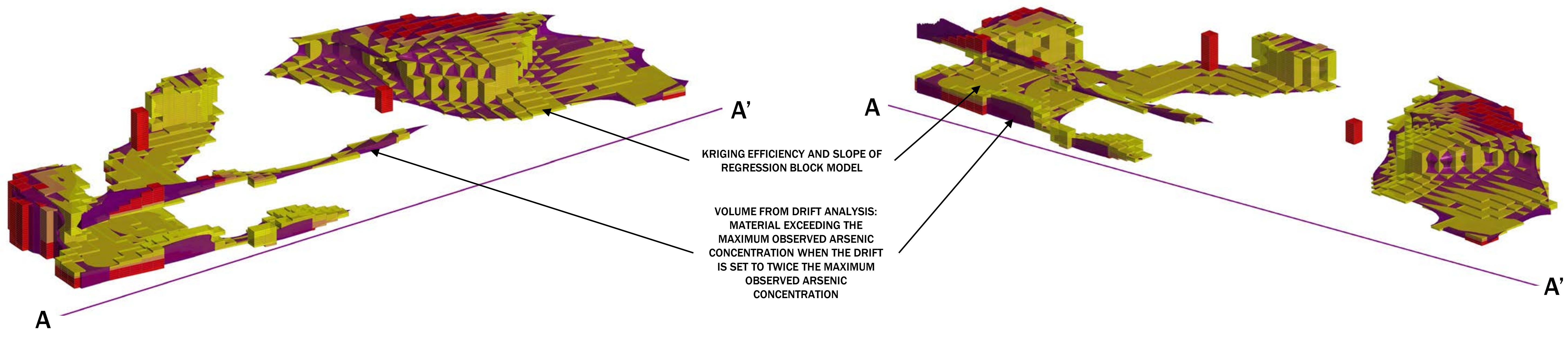
PIONEER TECHNICAL SERVICES, INC.
1101 SOUTH MONTANA
BUTTE, MONTANA 59701
(406) 782-5177

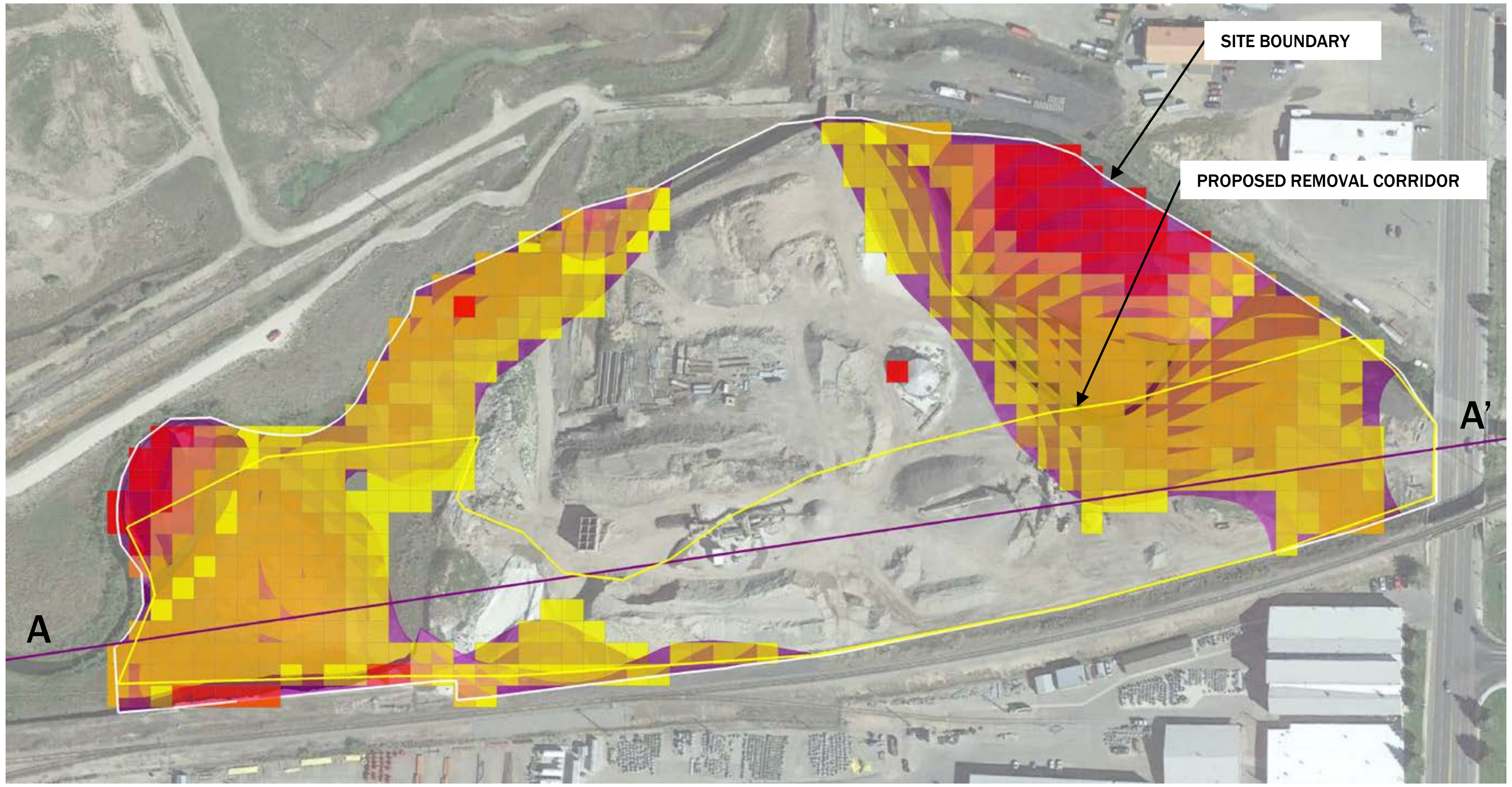
AVERAGE DISTANCE AND SLOPE OF REGRESSION BLOCK MODEL

DATE: 5/10/2021

ROTATED VIEW 1 (A-A’)

ROTATED VIEW 2 (A-A’)





THE PROPOSED REMOVAL CORRIDOR SHOWN IS PRELIMINARY AND ONLY SHOWN AS A REFERENCE AT THIS POINT. THE REMOVAL CORRIDOR AND EXCAVATION SURFACE WILL BE REFINED FURTHER DURING THE REMEDIAL DESIGN AND WILL BE SUBMITTED FOR AGENCIES' REVIEW AND APPROVAL.

CONCLUSION: THE KRIGING EFFICIENCY AND SLOPE OF REGRESSION BLOCK MODEL HELPS TO IDENTIFY THE LOCATIONS IN THE MODEL WHERE INTERPOLATION IS NOT BEING DRIVEN BY ACTUAL DATA. THE COMPARISON WITH THE DRIFT SENSITIVITY ANALYSIS VOLUME (SEE FIGURE 11) SUPPORTS THIS CONCLUSION.

LEGEND

- 🟪 DRIFT SENSITIVITY ANALYSIS VOLUME (FIGURE 11)
- 🟨 2. INDICATED
- 🟧 3. INFERRED
- 🟥 4. UNCLASSIFIED

NOTES:

THIS MODEL COMPARES HOW THE VOLUME GENERATED IN THE DRIFT SENSITIVITY ANALYSIS FITS WITH THE KRIGING EFFICIENCY AND SLOPE OF REGRESSION BLOCK MODEL.

THIS FIGURE, BLOCK MODEL, AND MODELED VOLUMES WERE GENERATED USING LEAPFROG WORKS. THE VOLUME AND BLOCK MODEL ARE BASED ON THE BOREHOLE AND TEST PIT DATA COLLECTED DURING THE BRW PHASE I SITE INVESTIGATION.

THE ROTATED VIEWS HAVE BEEN SCALED SO THE ELEVATION (Z) AXIS IS 5 TIMES GREATER THAN THE NORTHING (Y) AND EASTING (X) AXES.

N

DISPLAYED AS:
COORD SYS/ZONE: NA
DATUM: NA
UNITS: NA
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 N.T.S.

FIGURE 16

PIONEER TECHNICAL SERVICES, INC.
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COMPARING KRIGING EFFICIENCY AND SLOPE OF REGRESSION BLOCK MODEL TO DRIFT SENSITIVITY ANALYSIS

DATE: 5/10/2021

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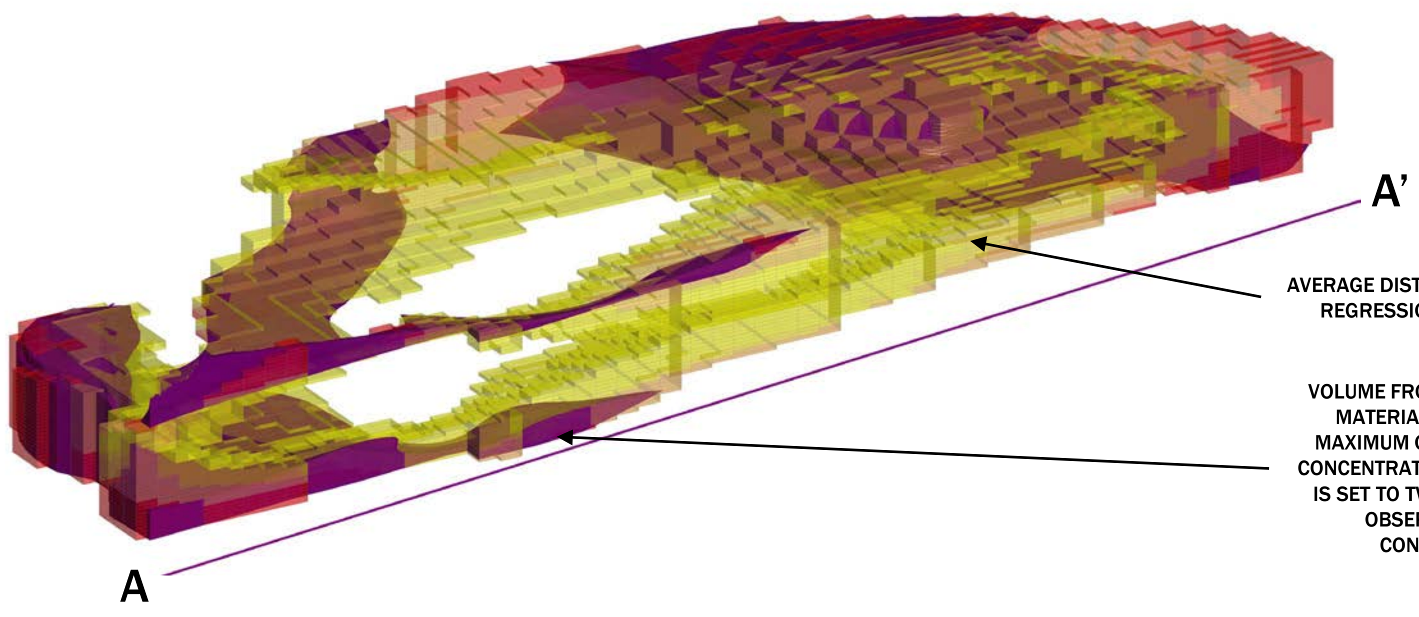
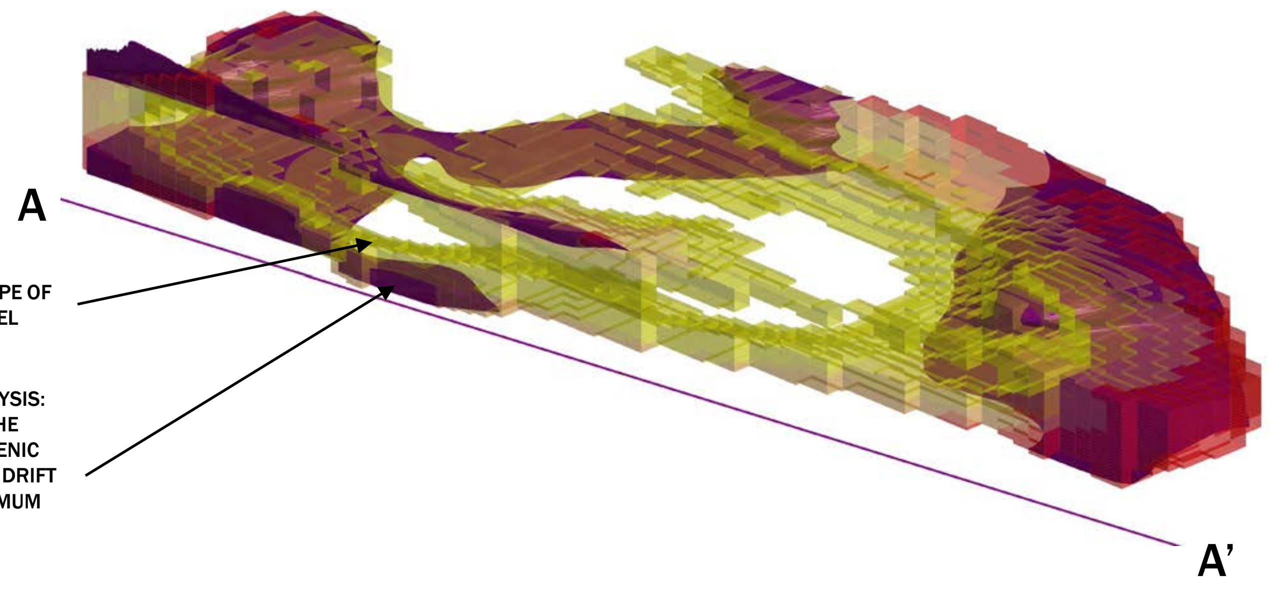
ROTATED VIEW 1 (A-A')

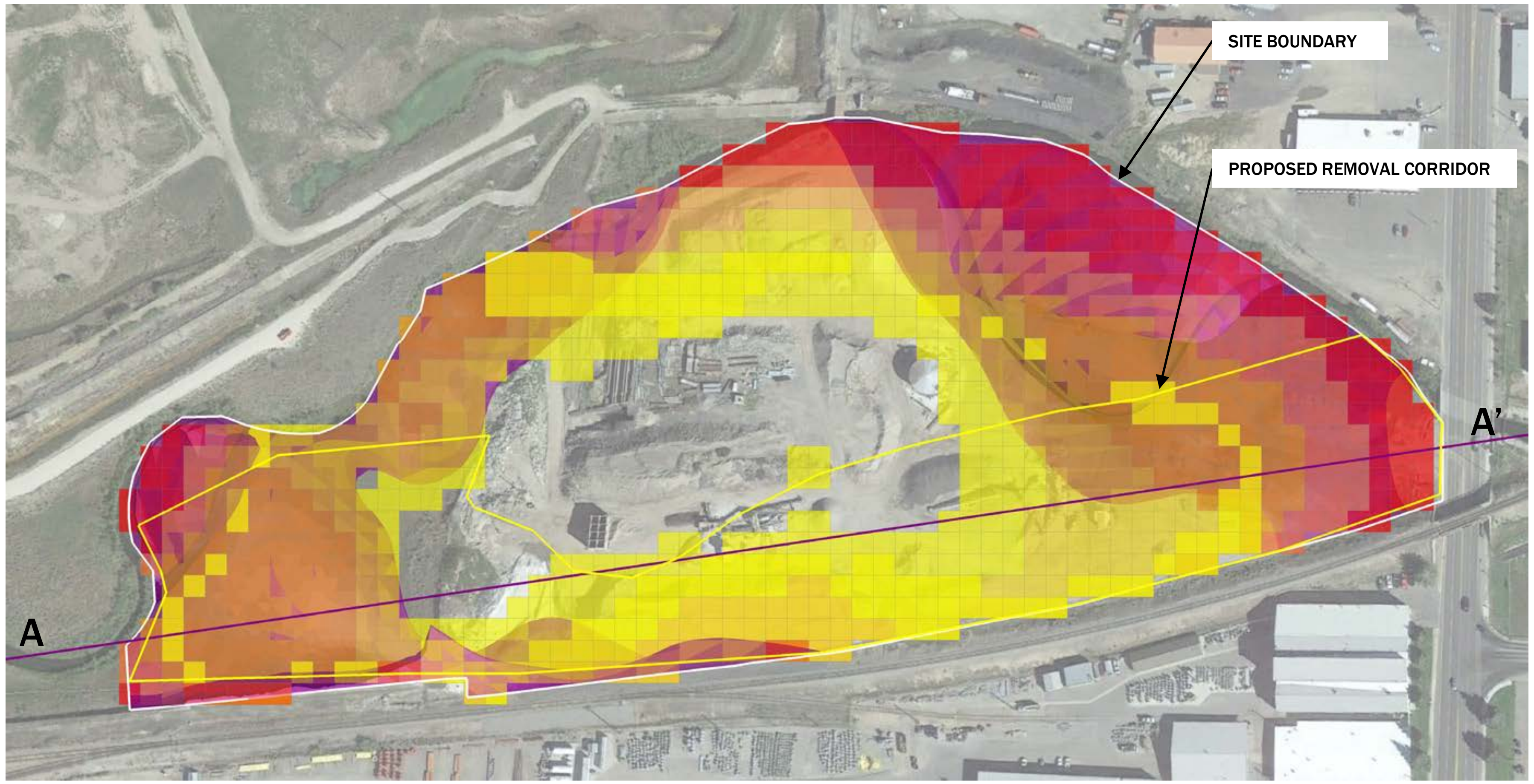


ROTATED VIEW 2 (A-A')



AVERAGE DISTANCE AND SLOPE OF REGRESSION BLOCK MODEL

VOLUME FROM DRIFT ANALYSIS: MATERIAL EXCEEDING THE MAXIMUM OBSERVED ARSENIC CONCENTRATION WHEN THE DRIFT IS SET TO TWICE THE MAXIMUM OBSERVED ARSENIC CONCENTRATION



<u>THE PROPOSED REMOVAL CORRIDOR</u> SHOWN IS PRELIMINARY AND ONLY SHOWN AS A REFERENCE AT THIS POINT. THE REMOVAL CORRIDOR AND EXCAVATION SURFACE WILL BE REFINED FURTHER DURING THE REMEDIAL DESIGN AND WILL BE SUBMITTED FOR AGENCIES' REVIEW AND APPROVAL.

CONCLUSION: THE AVERAGE DISTANCE AND SLOPE OF REGRESSION BLOCK MODEL IS A MORE CONSERVATIVE ESTIMATE TO IDENTIFY THE LOCATIONS IN THE MODEL WHERE INTERPOLATION IS NOT BEING DRIVEN BY ACTUAL DATA. THE COMPARISON WITH THE DRIFT SENSITIVITY ANALYSIS VOLUME (SEE FIGURE 11) SUPPORTS THIS CONCLUSION.

LEGEND

- 🟪 DRIFT SENSITIVITY ANALYSIS VOLUME (FIGURE 11)
- 🟨 2. INDICATED
- 🟧 3. INFERRED
- 🟥 4. UNCLASSIFIED

NOTES:

THIS MODEL COMPARES HOW THE VOLUME GENERATED IN THE DRIFT SENSITIVITY ANALYSIS FITS WITH THE AVERAGE DISTANCE AND SLOPE OF REGRESSION BLOCK MODEL.

THIS FIGURE, BLOCK MODEL, AND MODELED VOLUMES WERE GENERATED USING LEAPFROG WORKS. THE VOLUME AND BLOCK MODEL ARE BASED ON THE BOREHOLE AND TEST PIT DATA COLLECTED DURING THE BRW PHASE I SITE INVESTIGATION.

THE ROTATED VIEWS HAVE BEEN SCALED SO THE ELEVATION (Z) AXIS IS 5 TIMES GREATER THAN THE NORTHING (Y) AND EASTING (X) AXES.

N

DISPLAYED AS:
COORD SYS/ZONE: NA
DATUM: NA
UNITS: NA
SOURCE: PIONEER/GOOGLE

SCALE IN FEET
0 N.T.S.

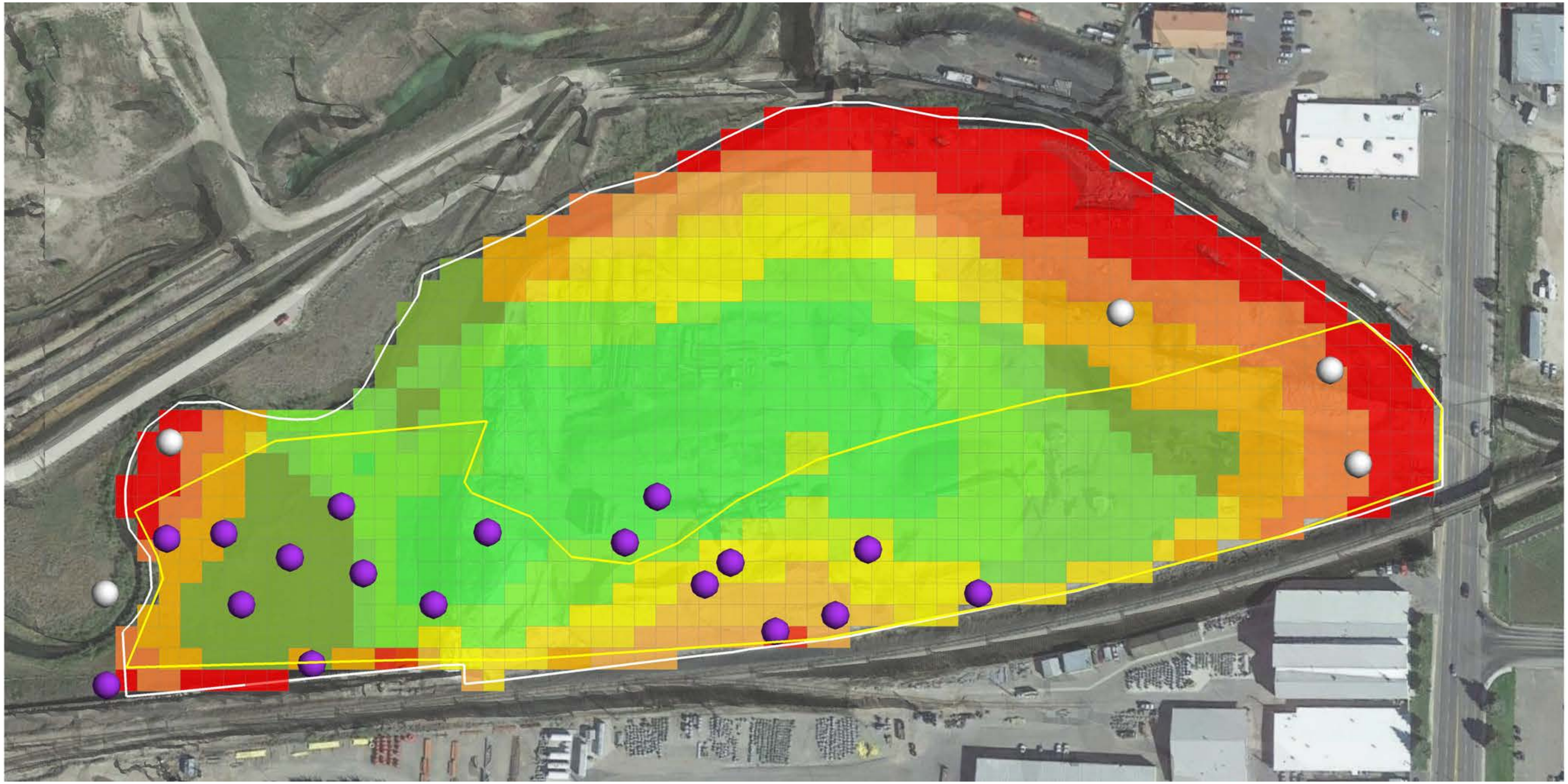
FIGURE 17

PIONEER TECHNICAL SERVICES, INC.
1101 SOUTH MONTANA
BUTTE, MONTANA 59701
(406) 782-5177

COMPARING AVERAGE DISTANCE AND SLOPE OF REGRESSION BLOCK MODEL TO DRIFT SENSITIVITY ANALYSIS

DATE: 5/10/2021

5/10/2021 10:19 AM Z:\Shared\Active Projects\ARCO\BPSOU\BRW\Leapfrog\Figures



LEGEND

- 🟩 1. MEASURED
- 🟨 2. INDICATED
- 🟧 3. INFERRED
- 🟥 4. UNCLASSIFIED
- ● PHASE II BOREHOLES
- ○ PROPOSED PHASE III BOREHOLES

NOTES:

THIS MODEL OVERLAYS THE PHASE ii BOREHOLES ON THE AVERAGE DISTANCE AND SLOPE OF REGRESSION BLOCK MODEL AND IDENTIFIES LOCATIONS FOR PROPOSED PHASE III BOREHOLES.

THIS FIGURE AND MODELED VOLUMES WERE GENERATED USING LEAPFROG WORKS. THE BLOCK MODEL IS BASED ON THE BOREHOLE AND TEST PIT DATA COLLECTED DURING THE BRW PHASE I SITE INVESTIGATION.

N

DISPLAYED AS:

COORD SYS/ZONE:	NA
DATUM:	NA
UNITS:	NA
SOURCE:	PIONEER/GOOGLE

SCALE IN FEET

0 N.T.S.

FIGURE 18

PROPOSED BOREHOLE LOCATIONS

PIONEER TECHNICAL SERVICES, INC.
1101 SOUTH MONTANA
BUTTE, MONTANA 59701
(406) 782-5177

DATE: 5/10/2021

5/10/2021 10:20 AM Z:\Shared\Active Projects\ARCO\BPSOU\BRW\Leapfrog\Figures

TABLES

Table 1: XRF to ICP Regression Coefficients

	Regression		Upper 95% Regression	
	Slope	y-Intercept	Slope	y-Intercept
	m	b	m	b
Arsenic	0.86	13.7	0.91	38.0
Cadmium	0.45	-1.6	0.55	-0.15
Copper	1.11	-34	1.19	221
Lead	1.56	-144	1.64	-26
Zinc	0.87	195	0.93	433

Table 2: Variogram Model Inputs

	Range			Normal Sill	Lag Distance				Number of Lags				Pitch*
	Major	Semi-Major	Minor	All Axes	Major	Semi-Major	Minor	Radial	Major	Semi-Major	Minor	Radial	-
	Feet			-	Feet				-				Degrees
Regression													
Arsenic_R	310	310	8	1.8	30	30	1	30	30	30	30	30	22.5
Cadmium_R	310	310	8	1.5	30	30	1	30	30	30	30	30	22.5
Copper_R	310	310	9	1.6	30	30	1	30	30	30	30	30	67.5
Lead_R	310	310	10	2.5	30	30	1	30	30	30	30	30	22.5
Zinc_R	310	310	10	2	30	30	1	30	30	30	30	30	67.5
Upper 95% Regression													
Arsenic_UR	310	310	8	1.7	30	30	1	30	30	30	30	30	22.5
Cadmium_UR	310	310	8	1.5	30	30	1	30	30	30	30	30	22.5
Copper_UR	310	310	9	1.6	30	30	1	30	30	30	30	30	67.5
Lead_UR	310	310	10	2.5	30	30	1	30	30	30	30	30	22.5
Zinc_UR	310	310	10	2	30	30	1	30	30	30	30	30	67.5

* In the radial plot in the variogram, pitch is a clockwise measurement of the angle between the major axis and the y = 0 and x approaches positive infinity line. In the real world plane, the pitch is a clockwise measurement of the angle counterclockwise from y (northing) =0 and x (easting) approaches negative infinity line.

Table 3. Drift Concentration Values

	Average Concentration Just Above Bedrock*
Regression	
Arsenic_R	27
Cadmium_R	2.1
Copper_R	251
Lead_R	15
Zinc_R	761
Upper 95% Regression	
Arsenic_UR	44
Cadmium_UR	3.7
Copper_UR	433
Lead_UR	65
Zinc_UR	941

* Data from 12 samples were used for these concentrations. The samples used were those whose sample bottom was at the observed bedrock depth. The samples used are listed below.

Samples used to determine average concentration just above bedrock

Location Name	Sample Top	Sample Bottom
BH02	38.5	40
BH08	28.6	29.5
PZ12	26.6	28.4
PZ14	25	26.1
PZ21	37.5	40
PZ22	35	37.6
PZ23	30.7	31.1
PZ24	41.4	42.8
HCW32	33.2	34.4
HCW33R	30.4	31.4
HCW35	32.5	33.2
HCW41	27.8	28.7

Exhibit B-1
Hierarchy to Filter Butte Reduction Works Sample Data

Pioneer’s Hierarchy to Filter Butte Reduction Works Sample Data

This hierarchy was developed to select a single data set that best represents the Butte Reduction Works (BRW) Site for import into the Leapfrog Modelling software. This hierarchy has been designed to function independently of any X-ray fluorescence (XRF) to Inductively Coupled Plasma (ICP) correlation. An XRF to ICP correction may be applied to the data set after it has been filtered through the hierarchy.

For overlapping intervals, the following steps will be applied in the following order. Where a sample is to be “removed” a note will be added in Pioneer’s database (to the column titled “Leapfrog Filter”). No sample(s) will be removed from the spreadsheet. When creating a comma separated value (csv) file format to import into the Leapfrog Model, the analytical results will be filtered to remove any sample(s) flagged for removal. The resulting data will be copied and pasted into a .csv file for import into the Leapfrog Model.

1. Where a Pioneer laboratory XRF sample interval is equal[1] to a PACE_MPLS or ENRHSPLP sample interval, the Pioneer laboratory XRF sample will be removed.
2. If two PACE_MPLS or ENRHSPLP sample intervals are equal[1]:
    a. If one sample passes and the other fails, the sample that passes will be removed.

    b. If both samples pass or fail, the sample with the lower metals concentrations will be removed.[2]

    c. If the samples have similar concentrations (i.e., within 20% of the lower value across all contaminants of concern [COCs]), the ENHRSPLP result will be removed.

   If a PACE_MPLS or ENRHSPLP sample interval resides within[3] a PACE_MPLS or ENRHSPLP sample interval:

    a. If the internal interval passes where the external interval fails, the internal interval will be removed.

    b. If the internal interval and external interval both pass or fail and if the internal interval has lower concentrations[2] than the external interval, the internal interval will be removed.

    c. If the internal interval is ENHRSPLP and the external interval is PACE and they have similar concentrations (i.e., within 20% of the lower value across all COCs), the ENHRSPLP result will be removed.

    d. If the sample does not meet any of these criteria, the sample will be flagged for further review.
3. If two Pioneer laboratory XRF sample intervals are equal[1]:
    a. If one sample passes and the other fails, the sample that passes will be removed.

    b. If both samples pass or fail, the sample with the lower metals concentrations will be removed.[2]

4. If a Pioneer laboratory XRF sample interval resides within[3] a PACE_MPLS or ENRHSPLP sample interval, the Pioneer laboratory XRF sample will be removed.
5. If a Pioneer laboratory XRF sample interval resides within[3] another Pioneer laboratory XRF sample interval:
    a. If the internal interval fails where the external interval passes, the sample will be flagged for further review.
    b. If the internal interval has higher concentrations (i.e., greater than 20% of the lower value for any individual COC) than the external interval, the sample will be flagged for further review.
    c. If the sample has not been flagged, the internal interval will be removed.
6. If a Pioneer laboratory XRF sample interval overlaps[4] one or more PACE_MPLS or ENRHSPLP sample intervals:
    a. Where a Pioneer laboratory XRF sample (the middle sample) overlaps both the interval above and the interval below and the intervals above and below are either PACE_MPLS or ENRHSPLP samples, the middle sample will be removed as long as it does not create a gap in the borehole or test pit data.
    b. For all other instances, the sample will be flagged for further review.
7. If a Pioneer laboratory XRF sample interval overlaps one or more Pioneer laboratory XRF sample intervals:
    a. Where a Pioneer laboratory XRF sample (the middle sample) overlaps both the interval above and the interval below, and all sample results have similar concentrations (i.e., within 20% across all COCs), the middle sample will be removed as long as it does not create a gap in the borehole or test pit data.
    b. For all other instances, the sample will be flagged for further review.
8. Samples flagged for further review:
    a. To account for overlaps in sample intervals, the sample intervals may be adjusted based on lithology (using the Sample Purpose Code in the database) to ensure that the sample intervals abut appropriately. Concentration results will not be modified (after completing this hierarchy review, a correction factor may be applied to the XRF data, but the results will be placed in a new field). All proceeding steps must be taken before the sample intervals are adjusted.
    b. No adjustments will be made to the sample top or sample bottom to cover intervals where no samples were taken, and no adjustments will be made to the sample top or sample bottom that create a gap in the borehole or test pit data.
    c. Adjustments to the sample top and sample bottom will be made in new columns titled “Modified Sample Top” and “Modified Sample Bottom.” No changes will be made to the original Sample Top and Sample Bottom fields.

   d. Any adjustments to the sample top or sample bottom will be made only when removing a conflicting sample would result in a gap in the borehole or test pit interval. These adjustments will be made using the following criteria:
      i. Where there are PACE_MPLS or ENRHSPLP results, those intervals will remain the same and must not be overlapped by Pioneer laboratory XRF samples. The Pioneer laboratory XRF sample top or sample bottom may be adjusted as long as it does not conflict with a PACE_MPLS or ENRHSPLP result. Any adjustments will be noted in the "Leapfrog Filter" column.
      ii. Where a Pioneer laboratory XRF sample interval overlaps with another (including internal samples), the failing result or higher concentration (i.e., greater than 20% of the lower value for any individual COC[2]) must remain the same and must not be overlapped. The Pioneer laboratory XRF sample top or sample bottom may be adjusted as long as it does not conflict with a failing XRF sample interval or with a sample with substantially higher concentrations (i.e., greater than 20% of the lower value for any individual COC[2]). Any adjustments will be noted in the "Leapfrog Filter" column.

The notes for the Leapfrog Filter will be formatted following the layout of this document. For example, when a sample is removed using the criteria listed under item 1, the note "Remove 1" will be added to the "Leapfrog Filter" column.

When adjusting Pioneer laboratory XRF intervals, any sample with an adjusted interval will have a note in the "Leapfrog Filter" column indicating how the sample top or sample bottom was adjusted. For example, "Changed Sample Top from 10 to 12.5."

Notes:

[1] Sample intervals are equal when two or more samples are taken from the same borehole or test pit and the sample tops and sample bottoms are equal.

[2] When determining which sample has lower metals concentrations, compare the concentrations of the individual COCs. If the difference between the individual COCs is less than 20% of the lower value, that concentration will not be used to determine which sample to remove. Once the samples with less than 20% difference have been removed from consideration, take the average of the remaining COCs and whichever has the lower value will be removed.

[3] A sample interval resides within another sample interval when the samples are taken from the same borehole or test pit and the internal sample has a sample top greater than or equal to the external interval and a sample bottom less than or equal to the external interval. An example would be:

Internal Sample: Sample Top = 12.5 feet; Sample Bottom = 15 feet.
External Sample: Sample Top = 10 feet; Sample Bottom = 15 feet.

[4] Sample intervals overlap when the samples are taken from the same borehole or test pit and some portion of one overlapping sample interval resides within the other sample interval. An example would be:

Overlapping Sample 1: Sample Top = 7 feet; Sample Bottom = 12.5 feet.
Overlapping Sample 2: Sample Top = 10 feet; Sample Bottom = 15 feet.

Appendix D

Butte Reduction Works Multichannel Analysis of Surface Waves Survey Final Report

RESTORING OUR ENVIRONMENT • DESIGNING OUR FUTURE

Butte Reduction Works Multichannel Analysis of Surface Waves (MASW) Survey Final Report

Butte, Montana

Prepared for:
Atlantic Richfield Company
Butte, MT

Prepared by:
Pioneer Technical Services, Inc.
1101 S. Montana Street
Butte, MT 59701

September 27, 2018

Butte Reduction Works Multichannel Analysis of Surface Waves (MASW) Survey Final Report

Butte, MT

Prepared for:
Atlantic Richfield Company
Butte, MT

Prepared by:
Pioneer Technical Services, Inc.
1101 S. Montana Street
Butte, MT 59701

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REVISION SUMMARY

Revision No.	Author	Version	Description	Date
01	Pioneer	Draft	Internal review	9/14/18
02	Pioneer	Final	Issued as Final	9/27/18

1 INTRODUCTION AND GOALS

The Butte Reduction Works (BRW) Investigation Site (Site) is in Butte, Montana, adjacent to Silver Bow Creek and west of Montana Street. Historic industrial infrastructure at the Site has the potential to impact future remediation efforts. Atlantic Richfield Company contracted Pioneer Technical Services, Inc. (Pioneer) to conduct a seismic, geophysical investigation of the Site to confirm the location of the Blacktail Creek Flume (flume), which was estimated to run east-west through the middle of the Site as shown on Figure 6 of the *BRW Phase I Quality Assurance Project Plan (QAPP)* (Atlantic Richfield, 2018). This report describes the methods used, data gathered, and results of the investigation.

2 BACKGROUND

At the Site, there is visible evidence of the location of the flume; near the west end of the Site the flume is completely exposed, revealing two tunnels formed from slag and brick, and in the center of the Site the roof of one of these tunnels is exposed. The flume is assumed to continue between these two points. Historic documents indicate the flume extends east and west of the two exposed points, as shown on Figure 6 of the QAPP (Atlantic Richfield, 2018).

3 SEISMIC SHEAR WAVE SURVEY

In September 2018, Pioneer completed Multichannel Analysis of Surface Waves (MASW) surveys along 3 separate transects at the Site. Pioneer positioned the east and west MASW survey transect lines to intersect the approximate location of the flume and to cross as much of the southern part of the Site as possible. Although data were collected along the entire transect, as anticipated, approximately 60 feet of the end of each transect did not produce a shear wave velocity (Vs) profile (and so were not part of the profile). These data at the end of the transect are used to determine boundary conditions for the Vs profiles. The middle transect was positioned between the east and west transects, just west of the exposed roof of the flume (see Figure 1).

Geophones were placed at constant intervals along each line, either 2 or 5 feet apart. The geophones detect and convert the mechanically induced seismic shocks into an analog electrical signal, which is recorded by the seismograph. The Pioneer team used a 20-pound sledge hammer to produce the seismic energy, or shot, using the hammer to strike a steel ground plate, imparting energy into the ground below. Shots were located at a specific offset from the end of the geophone line. The team recorded 5 hammer blows at each shot location, a process known as stacking. Stacking of shots allows the seismic energy recorded at the geophones to be amplified, while at the same time reducing unwanted noise in the signal. Each shot was recorded at each geophone, resulting in numerous shot records. After all shots were recorded, the entire setup was moved 1 interval. The team repeated this process numerous times to extend transects across the area of interest. Each individual move produced a 1-dimensional (1-D) Vs profile. The 1-D profiles were combined to create 2-dimensional (2-D) velocity profiles for each line.

The data were recorded on a 24-channel Seistronix seismograph using single 10 hertz (Hz) geophones. All shot records and line location data were entered into a computer program called SurfSeis®, which performs the calculations to model a profile of the subsurface Vs structure for each survey line (see Appendix A). The velocity is used to determine the relative stiffness of a material and, from that, estimate the density of the soil or rock. Low velocity indicates a less dense material and high velocity indicates an increase in density.

3.1 Seismic Shear Wave Survey Data

Using the procedure described above, Pioneer created Vs profiles along the 3 transects (referred to as the “west,” “east,” and “middle” transects) (see Appendix A). The relative difference in measured velocity between materials can be used to identify the flume and other void spaces. The color scale on the Vs profiles represents the measured Vs of the materials. Density and Vs are related and, typically, lower velocities imply lower densities. Voids are represented as very low velocity (dark blue) zones on the Vs profiles, with velocities lower than 400 feet per second.

3.1.1 West Transect

For this survey, the west transect line was positioned at the far west end of the Site, running north-south, as shown on Figure 1. The interval between geophones was 5 feet. Shots were located at offsets of 10 and 25 feet from the closest geophone. Data from the 2 shot offsets were combined and analyzed to produce a 2-D Vs profile. The Vs profile for the west transect is 205 feet long. There were no low velocity zones worth noting on this profile (see Appendix A).

3.1.2 Middle Transect

The middle transect was positioned between the east and west transects. The interval between geophones was 2 feet. Shots were located at offsets of 10 and 24 feet from the closest geophone. Data from the 2 shot offsets were combined and analyzed to produce a 2-D Vs profile. The Vs profile for this line was 134 feet long.

There were lower velocity zones in this profile, but only 1 had a velocity low enough to be considered a void. At the surface location of 300 feet, and at a depth of 7 feet below the ground surface, there was a low velocity zone that likely represents a void (see Appendix A). This surface location closely matched the estimated location of the flume.

3.1.3 East Transect

The east transect was near the east end of the Site. The interval between geophones was 5 feet. Shots were located at offsets of 10 and 25 feet from the closest geophone. Data from the 2 shot offsets were combined and analyzed to produce a 2-D Vs profile. The Vs profile for the east transect was 315 feet long.

In this profile, a low velocity zone approximately 5 feet thick was apparent below the surface location of 67 feet, and at a depth of 10 feet below the ground surface (see Appendix A). The size, shape, and depth of this low velocity anomaly strongly indicates it is a void, most likely the flume.

4 CONCLUSIONS AND RECOMMENDATIONS

Based on the analyses of Vs profiles from this MASW survey and background information, the historic flume can be traced from the exposed brick and slag tunnel near the west end of the Site and then through the void identified on Profile 2, Middle Transect, the exposed roof of the flume in the middle of the Site, and the void identified in Profile 3, East Transect (Appendix A).

To confirm these findings, a series of boreholes could be drilled or test pits dug to intersect the flume structure to assess the conditions within the flume. If necessary, other methods (such as downhole cameras) could be used to observe the flume conditions to assess the risk of future collapse or release of groundwater. Overall, the results from this MASW survey identified the location and alignment of the flume.

5 REFERENCES

Atlantic Richfield, 2018. Silver Bow Creek/Butte Area NPL Site, Bute Priority Soils Operable Unit, Final Butte Reduction Works (BRW) Phase I Quality Assurance Project Plan. Atlantic Richfield Company, August 28, 2018.

Figures

Figure 1. Seismograph Locations to Determine Existence of Durable Historic Infrastructure

N

DISPLAYED AS:
COORD SYS/ZONE: MSP83
DATUM: NAVD88
UNITS: IF
SOURCE: PIONEER/AES

SCALE IN FEET
0 50 100

FIGURE 1

SEISMOGRAPH LOCATIONS TO DETERMINE EXISTENCE OF DURABLE HISTORIC INFRASTRUCTURE

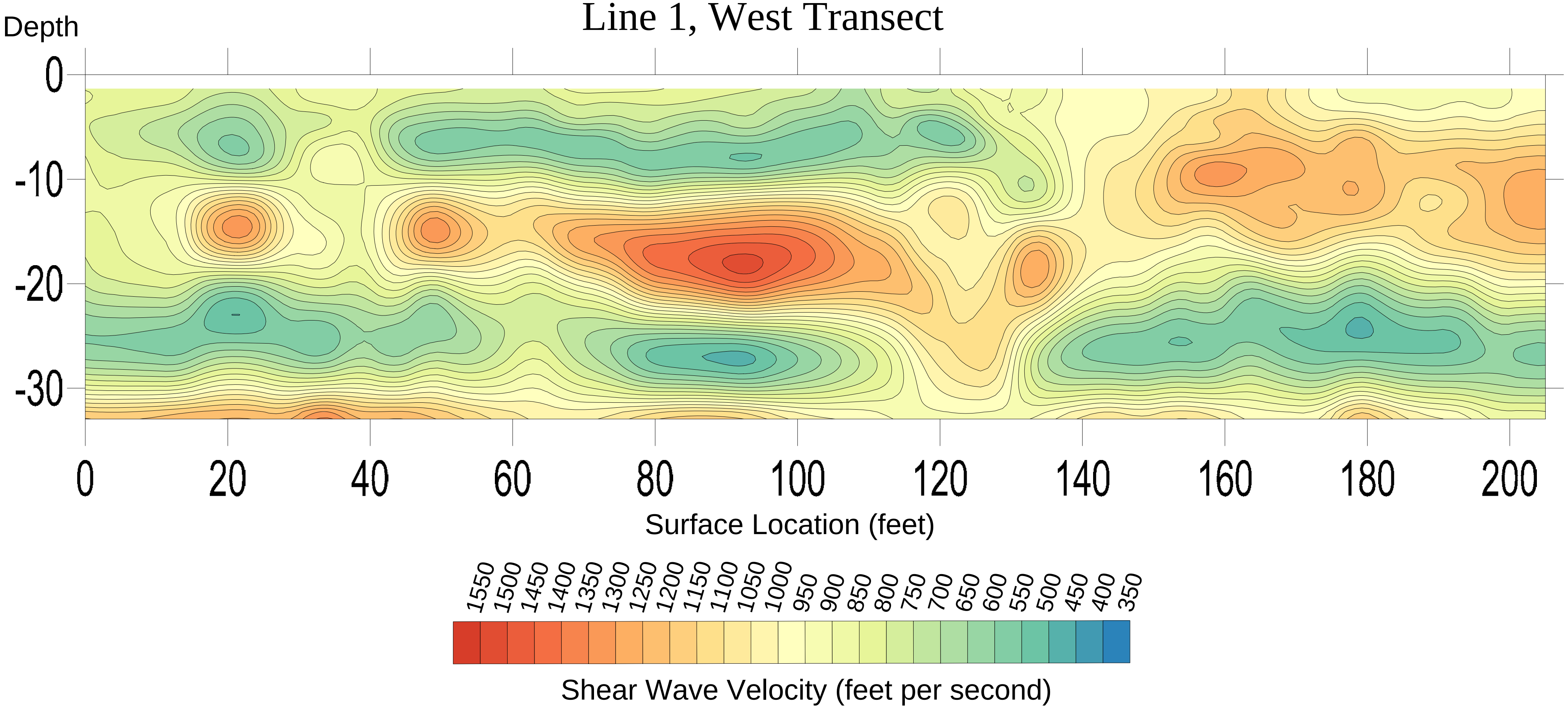
PIONEER
TECHNICAL SERVICES, INC.
1101 SOUTH MONTANA
BUTTE, MONTANA 59701
(406) 782-5177

DATE: 9/2018

Appendix A.
Shear Wave Velocity Profiles

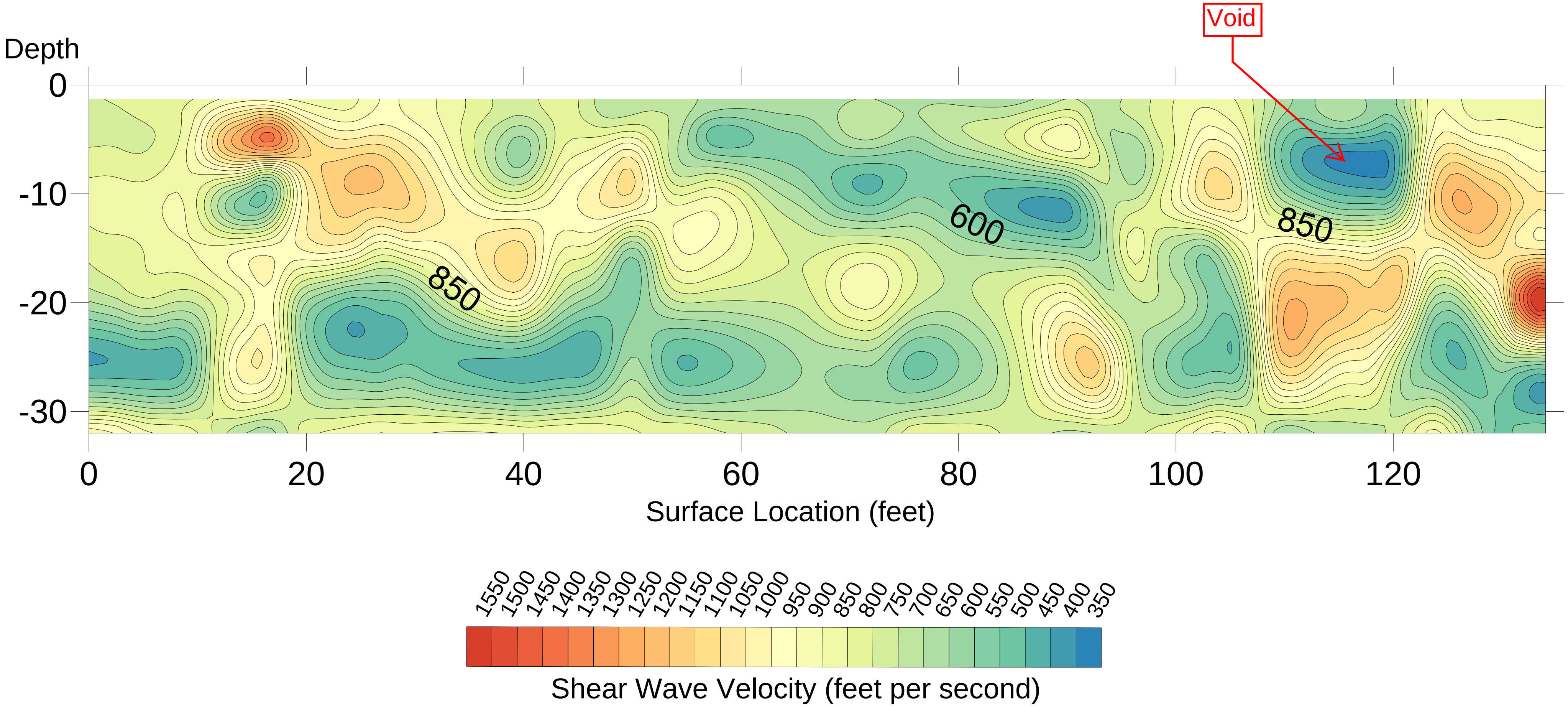
Profile 1

Line 1, West Transect



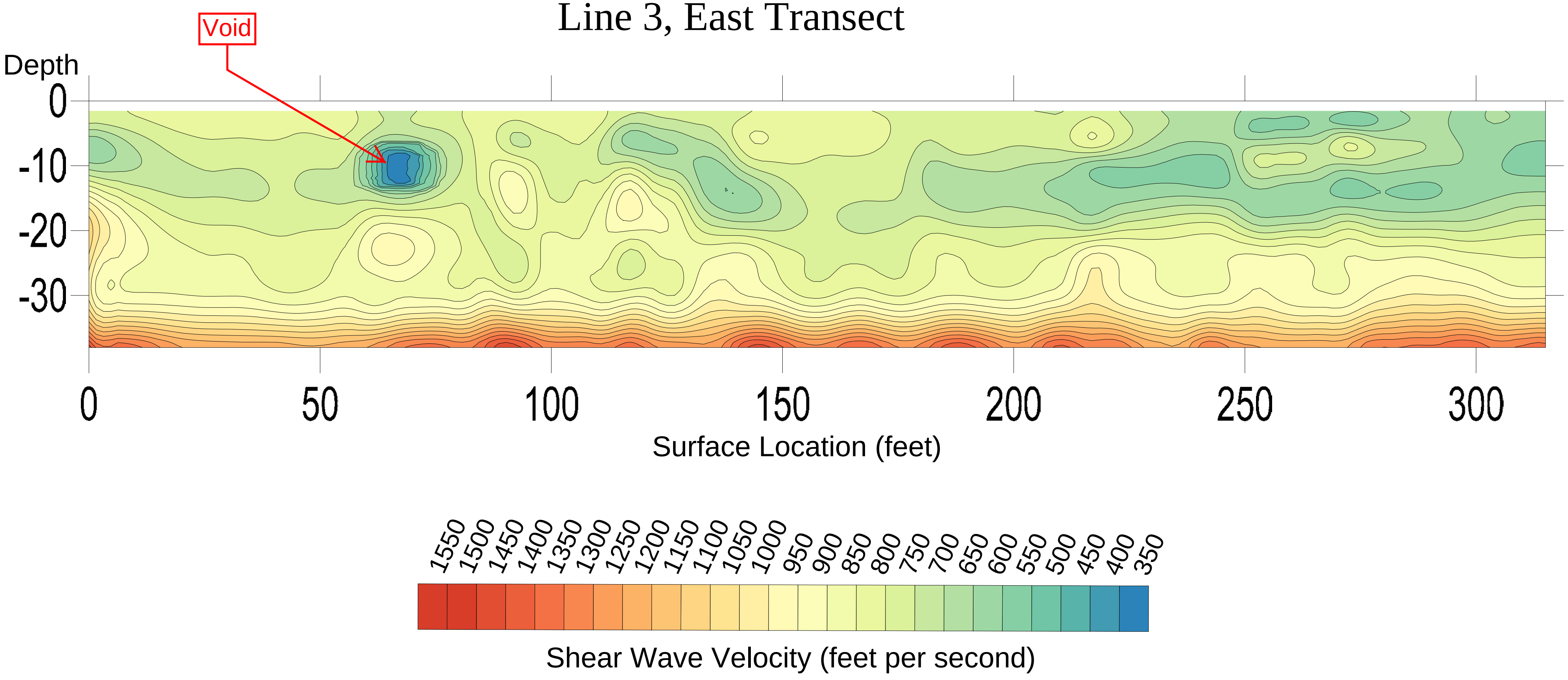
Profile 2

Line 2, Middle Transect



Profile 3

Line 3, East Transect



Appendix E

Waters of the U.S. Delineation Report

Appendix E

Waters of the U.S. Delineation Report

SILVER BOW CREEK/BUTTE AREA NPL SITE
BUTTE PRIORITY SOILS OPERABLE UNIT

Draft Final

2019 Butte Reduction Works
Waters of the U.S. Delineation Report

Atlantic Richfield Company

October 6, 2020

SILVER BOW CREEK/BUTTE AREA NPL SITE
BUTTE PRIORITY SOILS OPERABLE UNIT

Draft Final

2019 Butte Reduction Works Waters of the U.S. Delineation Report

Prepared for:

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Prepared by:

Pioneer Technical Services, Inc.
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October 6, 2020

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REVISION SUMMARY

Revision No.	Author	Version	Description	Date
Rev 0	Murray Strong	Draft	Issued for Internal Atlantic Richfield Company Review	08/21/2020
Rev 1	Murray Strong	Draft Final	Issued for Agency Review	10/06/2020

1.0 INTRODUCTION

This Waters of the U.S. Delineation Report presents the results of the field survey performed by Pioneer Technical Services, Inc. (Pioneer) within the Butte Reduction Works (BRW) Smelter Area Mine Waste Remediation and Contaminated Groundwater Hydraulic Control Site (Site) within the Butte Priority Soils Operable Unit (BPSOU), during the second week of June 2019. The results support the remedial design (RD) of the Site as required by the U.S. Environmental Protection Agency (EPA) and Montana Department of Environmental Quality (DEQ) in the *Draft Final for Public Review Remedial Elements Work Plan* (EPA, 2018). Work conducted as a basis for this report included the following:

- Wetland delineations and survey.
- Non-wetland waters of the U.S. determinations and survey.
- Functionally Effective Wetland Area (FEWA) determination.

2.0 BACKGROUND

2.1 Butte Reduction Works

The Site is 23.2 acres located within the city of Butte, Montana, and within the SW ¼ Section 24, T03N, R08W (Figure 1). The eastern boundary of the unit is Montana Street and the western boundary is a north-south line bisecting the Silver Bow Creek floodplain, approximately 1,800 feet west of Montana Street. The southern boundary is the Union Pacific Railroad right-of-way and the northern boundary includes slag walls and a Lower Area One (LAO) operational road. The unit includes 2 sub areas: 4.2 acres of reconstructed stream and floodplain (identified on Figure 1 as the “BRW-LAO” area); and 19.0 acres that includes slag and areas used by Butte-Silver Bow County for a hot mix operation with Silver Bow Creek flowing along the north side (identified on Figure 1 as the “BRW-BSB” area). The floodplain area was reconstructed as part of the LAO construction completed in 1998.

During the late 1800s and early 1900s, numerous smelters, mills, and concentrators were operated along Silver Bow Creek, including the BRW Smelter within the Site. These included surface impoundments for storage of mining wastes.

2.2 Waters of the U.S. Regulatory Environment

Recognizing the potential for continued degradation of its Nation’s waters, the U.S. Congress enacted the Clean Water Act (CWA) in 1972. The Act’s objective was to maintain and restore the chemical, physical, and biological integrity of waters of the U.S. Under Section 404 of the CWA, the U.S. Army Corps of Engineers (USACE) regulates discharges into the following jurisdictional waters (Environmental Laboratory, 1987):

- Territorial seas.
- Coastal and inland waters, lakes, rivers, and streams that are navigable, including adjacent wetlands.

- Tributaries to navigable waters, including adjacent wetlands.
- Interstate waters and tributaries, including wetlands.
- All other waters of the U.S. not identified above, such as isolated wetlands and lakes, intermittent streams, prairie potholes, and other waters.

Rivers, streams, and drainageways with a definable bed and bank are classified as waters of the U.S. under Section 404 CWA. In the absence of a wetland area, the USACE's jurisdiction ends where the ordinary highwater mark (OHWM) is no longer perceptible. Deep water aquatic habitats (greater than 6.6 feet deep) and ditches are not classified as wetlands under the FEWA evaluation methodology but may be regulated under additional statutes.

For the FEWA evaluation within the BPSOU, Pioneer used the methods set forth in the *Wetlands Delineation Manual* (Environmental Laboratory, 1987) and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region* (USACE, 2010). Per the Code of Federal Regulations (CFR) 33 CFR 328.3 and 40 CFR 230.3 wetlands are defined as:

> *"Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions."*

These unique areas generally develop over time through the interaction of hydrology, hydric soils, and hydrophytic vegetation. The term wetland hydrology is defined as follows (Environmental Laboratory, 1987):

> *"…wetland hydrology encompasses all hydrologic characteristics of areas that are periodically inundated or have soils saturated to the surface at some time during the growing season. Areas with evident characteristics of wetland hydrology are those where the presence of water has an overriding influence on characteristics of vegetation and soils due to anaerobic and reducing conditions, respectively. Such characteristics are usually present in areas that are inundated or have soils that are saturated to the surface for duration to develop hydric soils and support vegetation typically adapted for live in periodically anaerobic soil conditions."*

The term hydric soil is defined as *"a soil that formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part"* (NRCS, 2019a).

The term hydrophytic vegetation is defined as *"…the sum total of macrophytic plant life that occurs in areas where the frequency and duration of inundation or soil saturation produce permanently or periodically saturated soils of sufficient duration to exert a controlling influence on the plant species present"* (Environmental Laboratory, 1987).

The USACE requires documentation of one positive indicator in each one of the categories to classify the sampling location as within a jurisdictional wetland. The lack of positive hydrology, hydric soil, and/or hydrophytic vegetation indicators would place the sample location outside a jurisdictional wetland. However, the Site could still be within regulated waters of the U.S.

In recent decades, regulatory agencies, the public, and the U.S. judicial system have faced challenges in further defining jurisdictional waters and application of the CWA. While permits are not required for the Site under the 1980 Comprehensive Environmental Response, Compensation, and Liability Act (also known as the Superfund Program), Section 404 CWA, and the Montana Natural Streambed and Land Preservation Act (310), any actions are required to meet the intent of the permitting process.. The field survey and this report includes relevant information from the *Montana Wetland Boundary Verification Checklist* (USACE, 2013). Jurisdictional status opinions were made based on Site history, as well as connection to other waters of the U.S.

3.0 METHODS

3.1 Pre-Field Work Protocols

The following were obtained and/or reviewed prior to initiating field work:

- Ground Disturbance Permit providing checklist and qualifications to begin field work.
- Utility Locate, including a Utility Locate Ticket, to identify all underground utilities within and adjacent to the proposed work area.
- Management of Change (MoC) procedures or policies to identify and manage existing and potential risks associated with (but not limited to) changes in the organization, staffing levels, equipment, maintenance practices, materials, substances, procedures, and applicable legislation.
- The BRW Site-Specific Health and Safety Plan (SSHASP) and necessary Task Risk Assessment (TRA) to identify and ameliorate possible risks in the field.

3.2 Review of Existing Materials

Prior to initiating field work, the field team reviewed existing maps, studies, and related published information including the following:

- US Fish and Wildlife Service (USFWS) National Wetland Inventory (NWI) map (USFWS, 2019).
- Montana Natural Heritage Program (MNHP) Environment Summary (MNHP, 2019a).
- MNHP Map Viewer (MNHP, 2019b).
- Federal Emergency Management Agency mapping (FEMA, 2019).
- Natural Resource and Conservation Service (NRCS) Soil Survey of Silver Bow County (NRCS, 2019b).
- State Soil Data Access Hydric Soils List (NRCS, 2019c).
- Historic aerial imagery.

3.3 Field Methods

Field wetland delineations were made based on methods stated in the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory, 1987) and the western mountains, valleys, and coast regional supplement (USACE, 2010). Hydrology, soils, and vegetation were evaluated at selected sample points whose location was determined based on landscape position and visible hydrology and/or vegetation changes. The presence of all three criteria—hydrology, hydric soils, and hydrophytic vegetation—qualified the Site as being a jurisdictional wetland. Where applicable, paired sample plots including adjacent wetland and non-wetland samples were obtained to provide a mapped boundary. Sample points and boundaries were mapped using Global Positioning System (GPS) survey units. Pin flags were used to denote sample locations and wetland/upland boundary.

Wetland determination data forms (Appendix A) were filled out for each plot, and a photolog and logbook used to record information. Additional periodic sampling was made to verify wetland/upland boundary locations. This generally entailed digging a 16-inch pothole to determine any change in the water or soil type. All locations were photographed (Appendix B).

3.3.1 Vegetation

At each plot a determination was made as to whether the plant species were predominantly upland or wetland (hydrophytic). Vegetation was stratified into 2 strata: herb and sapling/shrub. A fixed radius circular sample plot was used for sampling: 5-foot radius for herbaceous materials and 15-foot radius for sapling/shrub. Field personnel individually identified species, estimated their absolute cover (Appendix A), and assigned each an indicator status based on their propensity to be found in a wetland: obligate (OBL), facultative wetland (FACW), facultative (FAC), facultative upland (FACU), and upland (UPL). To determine the presence of hydrophytic vegetation, field personnel used the Dominance Test and, in a few instances, the Prevalence and Rapid Tests. In accordance with methodology stated in the *Wetlands Delineation Manual* (Environmental Laboratory 1987), 50% of the dominant species are required to be OBL, FACW, and/or FAC to meet the hydrophytic vegetation criteria for the plot. The 2016 National Plant List (Lichvar et al., 2016) was used to determine the status of each species.

3.3.2 Soils

Soils at each paired sample point location were characterized, by horizon, to a depth of 18 inches, or restrictive layer, using procedures described in the western mountains, valleys, and coast regional supplement (USACE, 2010). All applicable hydric indicators were characterized based on the NRCS Field Indicators of Hydric Soils in the United States (NRCS, 2018) and noted on the wetland determination field form (Appendix A). Soil textures were determined using the NRCS *Guide to Texture by Feel* diagram (NRCS, 2019d). Moist samples were used to determine redox features including type and location. Soil color charts (Munsell, 2009) were used to determine color and percentage of matrix and redox features.

3.3.3 Hydrology

The USACE’s technical standard requires 14 or more consecutive days of flooding or ponding, or a water table 12 inches or less below the soil surface, during the growing season at a minimum frequency of 5 in 10 years (50 percentile). The growing season is defined by median dates of 29 degrees Fahrenheit (^{o}F) low air temperatures in spring and fall, based on long-term records gathered by the National Weather Service (USACE, 2010). The growing season recorded at the Butte Bert Mooney Airport meteorological station is May 26 to September 13 (WRCC, 2019).

To determine hydrology, observations were made as to the presence of surface water, groundwater (water table), and/or saturation to a depth of up to 12 inches below ground surface. There are an additional 16 less obvious primary wetland hydrology indicators and 9 secondary indicators that can be used, and these are shown on the wetland determination data form (Appendix A). These indicators reflect what is occurring on the surface. A minimum of 1 primary and 2 secondary indicators are required to verify wetland hydrology.

Field work was conducted in June. The nearest U.S. Geological Survey (USGS) stream gage is at the confluence of Blacktail and Silver Bow Creeks east of Montana Avenue in Butte. Stream flows noted during the time of the survey were 24 to 31 cubic feet per second (cfs) relative to a 30-year median average of 16 cfs to 19 cfs.

3.3.4 Non-Wetland Waters of the U.S.

Non-wetland waters of the U.S. include drainage features having a defined bed and bank that will not meet the criteria for wetlands (i.e., having hydrology, hydric soils, and hydrophytic vegetation). These waters were classified as non-wetland waters of the U.S. The banks were identified as the side-slopes of the stream, and the bed was identified as the area between the bottom of the opposite side-slopes. The OHWM was delineated according to 33 CFR 328.3, using a line on the shore established by fluctuating water and indicated by characteristics such as a clear, natural line impressed on the bank, shelving, destruction of terrestrial vegetation, the presence of litter and debris, etc.

3.4 Wetland Classification

Wetland areas were classified based on the USFWS classification system as described in *Classification of Wetlands and Deepwater Habitats of the United States* (USFWS, 1979). Classification is based on the uppermost strata with 30% or greater coverage. In all cases, the classification was the Palustrine System. The definition of the system is as follows:

“The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, persistent emergent, emergent mosses or lichens… It also includes wetlands lacking such vegetation, but with all of the following four characteristics: (1) area less than 8 ha (20 acres); (2) active wave-formed or bedrock shoreline features lacking; (3) water depth in the deepest part of the basin less than 2 m at low water; and (4) salinity due to ocean-derived salts less than $0.5^{0/00}$*.”*

Additional classes (modifiers) include Rock Bottom, Unconsolidated Bottom, Aquatic Bed, Unconsolidated Shore, Moss-Lichen Wetland, Emergent Wetland, Scrub-Shrub Wetland, and Forested Wetland. Water regimes include Temporarily Flooded, Seasonally Flooded, Semi-permanently Flooded, Intermittently Exposed, Permanently Flooded, and Saturated.

3.5 Functional Assessment

Results from the wetland survey were used in conducting a functional assessment as part of the Upper Clark Fork River wetlands mitigation process within the BPSOU. Assessments included not only the wetland areas but the characteristics of the individual operable unit and watersheds. The evaluation was used in FEWA determinations, a method of comparing pre- and post-remediation areas (not considered actual acres). Assessment and FEWA determinations were made using FEWA forms (Appendix C).

The assessment area is critical in determining the FEWA, since the overall rating for each evaluation applies to the entire assessment area evaluated. Consequently, because the area to be evaluated is made up of areas that have experienced very different levels of disturbance or negative impacts, they were evaluated desperately.

The Site was divided into 2 areas based on current conditions (Figure 1). The area immediately west of Montana Street consists of the “Slag Canyon” and BSB maintenance materials area. For assessment purposes, this 19.0-acre area is identified as BRW-BSB. The area just west of the BSB site and “Slag Canyon” is approximately 4.2 acres in size and is identified as BRW-LAO.

4.0 RESULTS AND DISCUSSION

This section describes results of this wetland survey. Wetland determination forms are in Appendix A, photographs are in Appendix B, FEWA evaluation forms are in Appendix C, and the MNHP environmental summary is in Appendix D.

4.1 Delineated Wetlands

Based on this survey, 3.2 acres of reconstructed wetland exists within the Site (Figure 2). The wetland is located along both banks of the stream channel (Photograph 1) and the terrace to the south (Photograph 2) and for all intents and purposes is a continuous feature. Wetland boundaries were not readily apparent based on vegetative and soil characteristics; therefore, depth to groundwater or soil saturation was used as the major determinant. The defined area also includes a confined area between slag walls (Photograph 3). The banks of the stream are jurisdictional wetland areas, but the stream channel itself is not. However, it is a non-wetland waters of the U.S.

The wetland continues downstream outside the study area boundary, supported hydrologically by the stream and groundwater discharges.

Photograph 1: Wetland along Silver Bow Creek showing both the palustrine emergent and shrub-scrub habitats.

Photograph 2: Broad wetland area on south side of Silver Bow Creek.

Photograph 3: Slag Canyon with limited wetland characteristics.

4.1.1 Vegetation

Common and field names as recorded in the 2016 National Wetland Plant List (Lichvar et al., 2016) are used in this narrative. Vegetation included sapling/shrub and herb strata. Narrow-leaf cottonwood (*Salix exigua*) was the dominant shrub, a FACW species. The herb layer was dominated by field meadow-foxtail (*Alopecurus pratensis*), a FAC neutral species, and smooth brome (*Bromus inermis*) in the drier more mesic areas and Northwest Territory sedge (*Carex utriculata*) and Baltic rush (*Juncus balticus*) in the wetter areas. The transitional boundaries were not distinct in terms of vegetational composition. Basin wildrye, also known as western bottlebrush grass (*Elymus elymoides*), was prevalent in the upland area. More than likely, the field meadow-foxtail, sedge, and wildrye were included in the original seed mixture. Species observed during the field delineation and their indicator status are shown in Table 1. The list is by no means exhaustive.

4.1.2 Soils

The Site is mapped as fill (mine and garbage dumps) by the NRCS (2019a) (Figure 3). During stream and floodplain reconstruction activities over the years, a portion of the mining wastes were removed and replaced with clean barrow material lacking distinct horizons and hydric features (Photograph 4). Soils used in recently developed wetlands qualify as hydric soils under jurisdictional requirements if, among other things, one or more of the following are present within the delineated area (USACE, 2010):

- Hydric vegetation predominates.
- Soil hydrology requirements are met.
- Landscape includes toe-of-slope and floodplain or low terrace.
- Soils have 2 centimeters of muck and/or very shallow dark surface layer.
- Stream gauge and/or monitoring well data indicate that the water table is within 12 inches of the surface for 14 or more consecutive days during the growing season for 5 years within a 10-year period.

Photograph 4: Borrow material without distinct soil horizon but exhibiting a dark surface layer and groundwater near the surface.

4.1.3 Hydrology

Silver Bow Creek is assumed to be a significant influence on wetland hydrology along its banks. Currently, the groundwater remedy in the area hydraulically controls groundwater to the north and underneath Silver Bow Creek, which minimizes groundwater gain to surface water along this reach of the creek. Stream flows noted during the survey were in the 24 to 31 cfs range relative to a 30-year median average of 16 to 19 cfs (USGS, 2019) possibly making the hydrology indicator somewhat conservative (i.e., soil saturation close to the surface). Shallow groundwater was observed in potholes at the base of the slope along the south side of the stream and extended floodplain (Photograph 2).

4.2 Classifications

4.2.1 Palustrine Emergent Wetland Community

The Palustrine Emergent wetland community (PEM) was the dominant plant community. These communities are characterized by erect, rooted, herbaceous hydrophytes for most of the growing season in most years and usually dominated by perennial plants (USFWS, 1979). The Hydromorphic (HGM) Classification is Riverine (Smith et al., 1995).

The width of the PEM on the north bank varied up to 50 feet from the edge of bank. The exception being where it extended up a constructed channel leading from the water treatment facility (Figure 2). The width of the PEM along the south side of Silver Bow Creek was limited by 450 feet of slag wall before broadening out onto a terrace roughly 250 feet by 250 feet (1.4 acres) and subject to toe-of-slope shallow groundwater. Dried previous years' plant matter was common and acts as ground cover.

Vegetation within the PEM community along the north bank includes a prevalence of Northwest Territory sedge, meadow foxtail, smooth brome, and Kentucky bluegrass (*Poa pratensis*). Additionally, commonly observed species include large leave avens (Geum macrophyllum), American wild mint (*Mentha arvense*), Canada thistle (*Cirsium arvense*), red-tinge bulrush (Scirpus microcarpus), broad-leaf cattail (*Typha latifolia*), and willow dock (Rumex salicifolius). The vegetation component of the broad terraced area on the south side of Silver Bow Creek is dominated by Baltic rush and meadow-foxtail.

4.2.2 Shrub-Scrub Wetland Community

The shrub-scrub (S/S) wetland community dominates the streambanks intermittently along Silver Bow Creek. The *Classification of Wetlands and Deepwater Habitats of the U.S.* (USFWS, 1979) defines the community as dominated by woody vegetation less than 20 feet tall. Narrow-leaf willow was the only willow species recorded and ranged up to 12 feet in height. The understory consisted principally of Northwest Territory sedge and meadow foxtail. The HGM classification (Smith et al., 1995) is Riverine and the principal source of hydrology is Silver Bow Creek.

4.2.3 Upland Areas

Thirteen upland sample points were recorded. These were paired with wetland sample points in determining the delineation boundary. Species composition was oftentimes similar to the PEM and S/S communities with more of a prevalence of brome or wildrye. Yarrow (*Achillea millefolium*), Wild blue flax (Linum lewisii), sweet vetch (Hedysarum sulphurescens), and yellow sweet-clover (Melilotus officinalis) were found along the upland boundaries bordering the southwest floodplain terrace.

4.2.4 Agency Classification

The USFWS NWI map indicates most of the unit to be non-wetland except the Silver Bow Creek channel which is mapped as Riverine (USFWS, 2019) (Figure 4). The MNHP map (2019b) did not record wetlands within the Site and did not record the stream channel as Riverine. The FEMA map (2019) shows the straightened Silver Bow Creek channel to have a 1% Annual Chance Flood Hazard (Figure 5).

4.3 Functional Assessment/Functionally Effective Wetland Area

4.3.1 FEWA – BRW-LAO

The overall FEWA rating for the BRW-LAO site is 1.68 out of 3.0 (Table 2). The full FEWA analysis is in Appendix C.1. The site scored high ratings for Hydrologic Support and Sediment Stabilization/Erosion Control. The site scored moderate for the following:

- Production Export/Food Chain Support.
- Wildlife Diversity/Abundance: Breeding.
- Wildlife Diversity/Abundance: Wintering.
- Threatened and Endangered Species Habitat.

The assessment area scored low for the following:

- Floodflow Alteration.
- Water Purification.
- Aquatic Diversity/Abundance.
- Wildlife Diversity/Abundance: Migration.

A total of 3.14 acres of wetland areas were mapped within the BRW-LAO site (Figure 2).

4.3.2 FEWA – BRW-BSB

The overall FEWA rating for the BRW-BSB site is 0.9 out of 3.0 (Table 3). The full FEWA analysis is in Appendix C.2. The rating was high for Sediment Stabilization and Erosion Control. The site was rated low for the following:

- Hydrologic Support.
- Floodflow Alteration.
- Water Purification.
- Production Export/Food Chain Support.
- Threatened and Endangered Species Habitat.

The site was rated very low for the following:

- Wildlife Diversity/Abundance: Breeding.
- Wildlife Diversity/Abundance: Migration.
- Wildlife Diversity/Abundance: Wintering.

A total of 0.06 acres of wetland areas were mapped within the BRW-BSB site (Figure 2).

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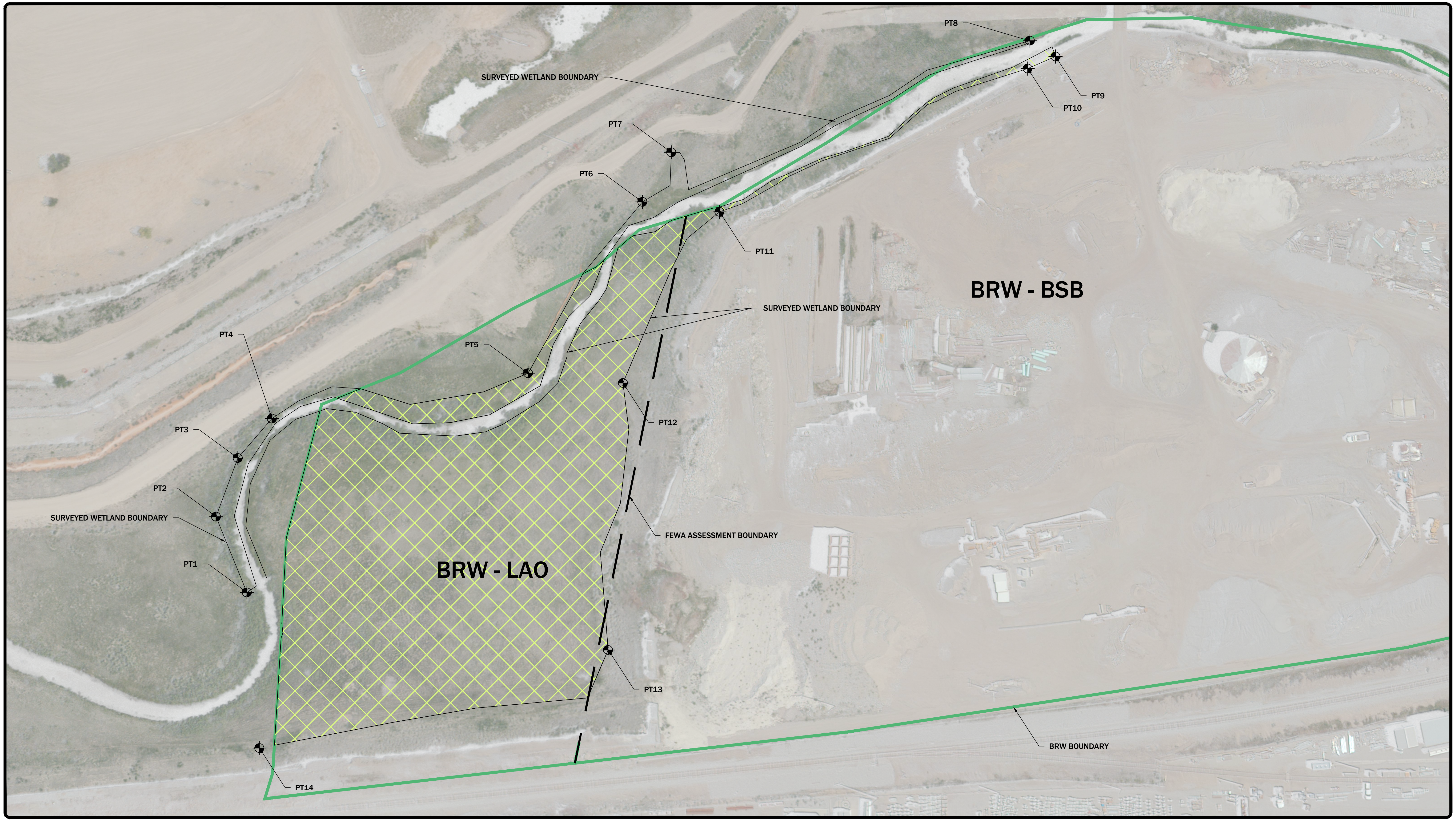
FIGURES

Path: P:\ARCO\BPSOU\DRAFTING\BRW\GIS\2018_QAPP\BRW-SAP-002-StMp_18 Murray.mxd

Figure 1. Location of Study Area



━━━	BRW BOUNDARY
— — —	FEWA ASSESSMENT BOUNDARY
───	SURVEYED WETLAND BOUNDARY
▨	FEWA WETLAND AREAS WITHIN BRW BOUNDARY
⊕	WETLAND DELINEATION POINT

N

DISPLAYED AS:
COORD SYS/ZONE: MSP
DATUM: NAD 83
UNITS: FEET
SOURCE: PIONEER

SCALE IN FEET
0 100 200

FIGURE 2

PIONEER
TECHNICAL SERVICES, INC.
1101 SOUTH MONTANA
BUTTE, MONTANA 59701
(406) 782-5177

BRW
WETLAND DELINEATION FEWA ASSESSMENT AREAS

DATE: 10/28/2019

10/28/2019 3:56:48 PM P:\ARCO\BPSOU\BRW\BRW_DESIGN\2019\WETLAND_FEWA\SURVEY_FIGURE 2\WETLAND SURVEY AREAS.DWG

Figure 3. NRCS Soil Mapping

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

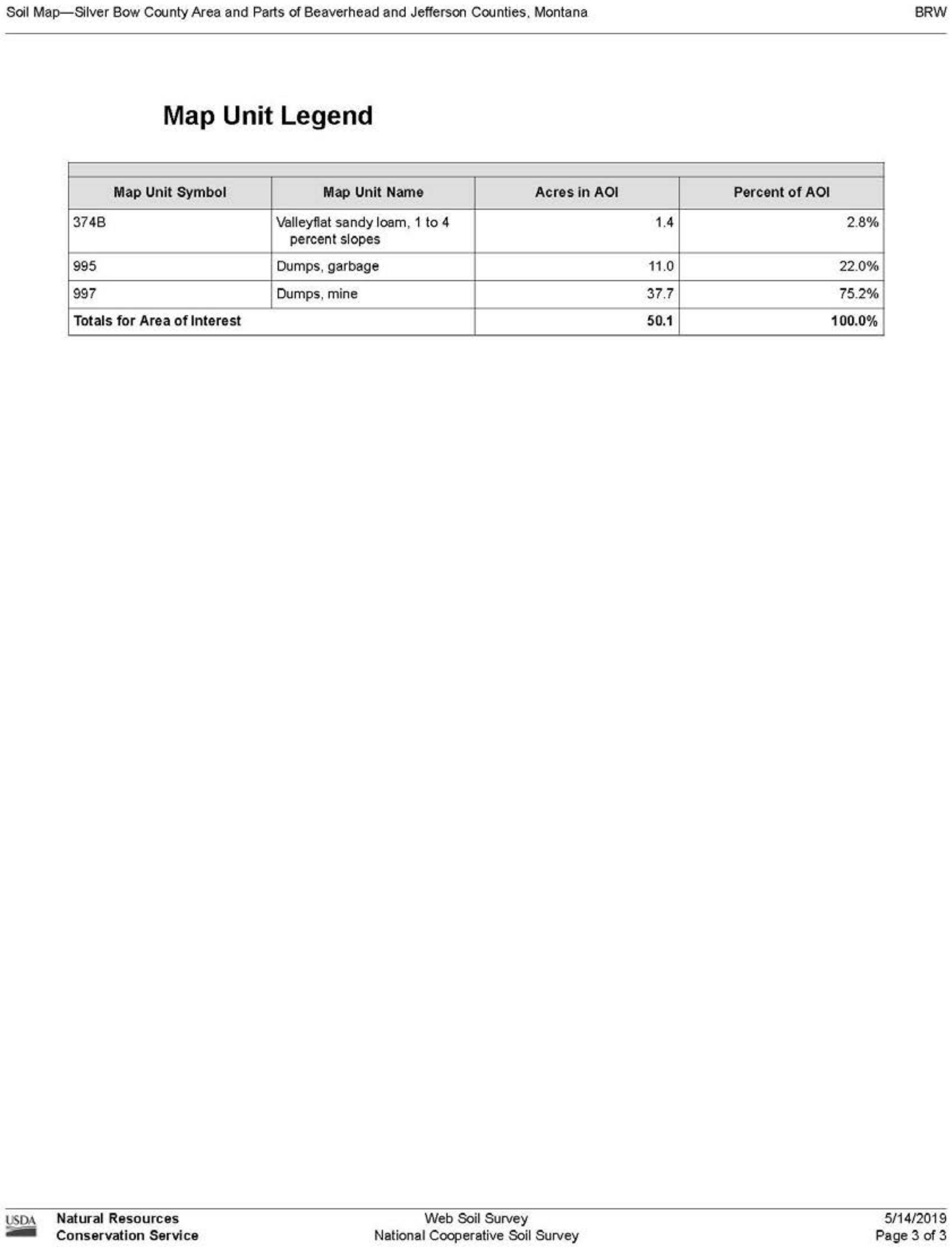
This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Silver Bow County Area and Parts of Beaverhead and Jefferson Counties, Montana
Survey Area Data: Version 19, Sep 10, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 24, 2013—Sep 25, 2016

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.



Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
374B	Valleyflat sandy loam, 1 to 4 percent slopes	1.4	2.8%
995	Dumps, garbage	11.0	22.0%
997	Dumps, mine	37.7	75.2%
Totals for Area of Interest		**50.1**	**100.0%**

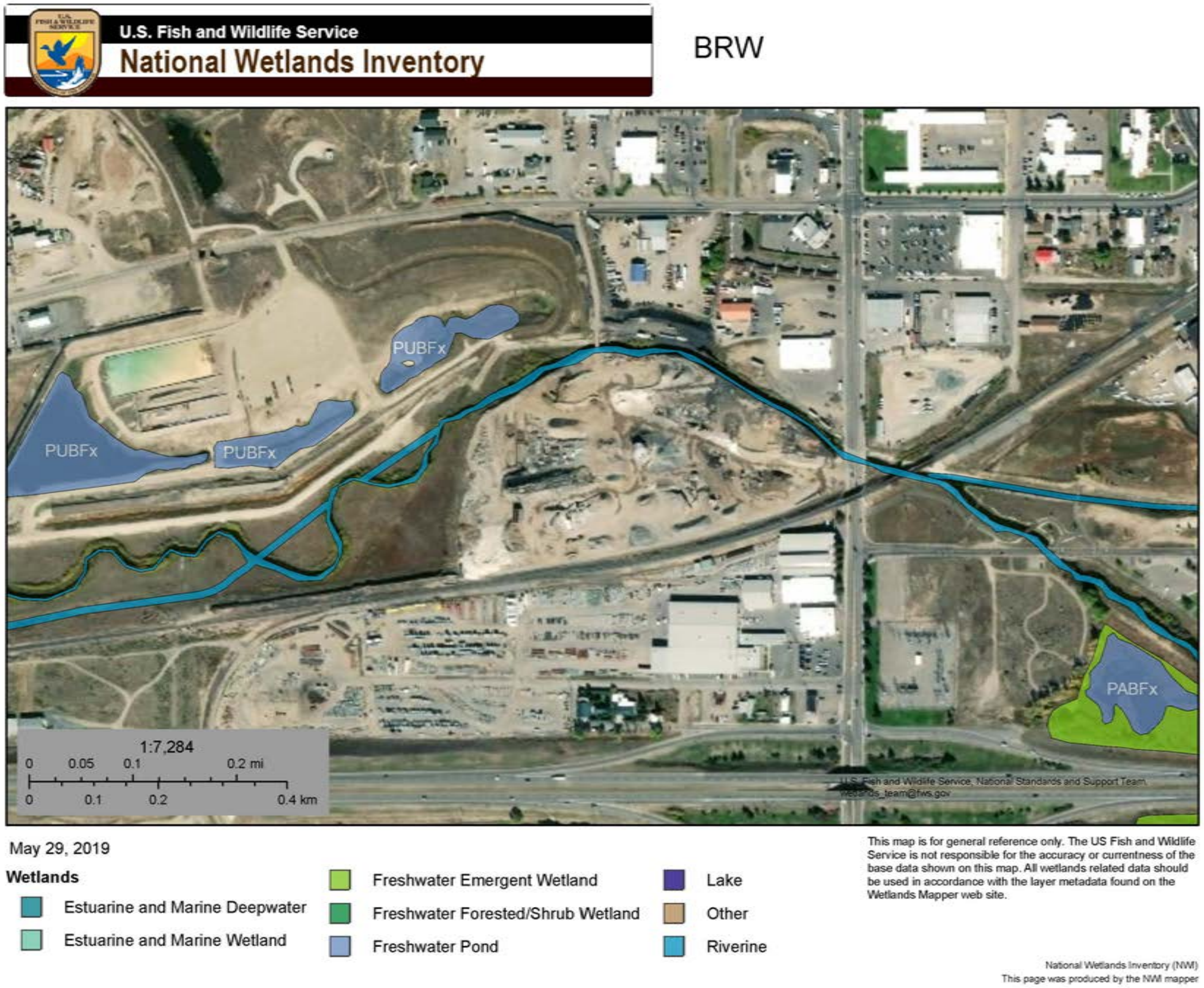


Figure 4. National Wetland Inventory Map (NWI)

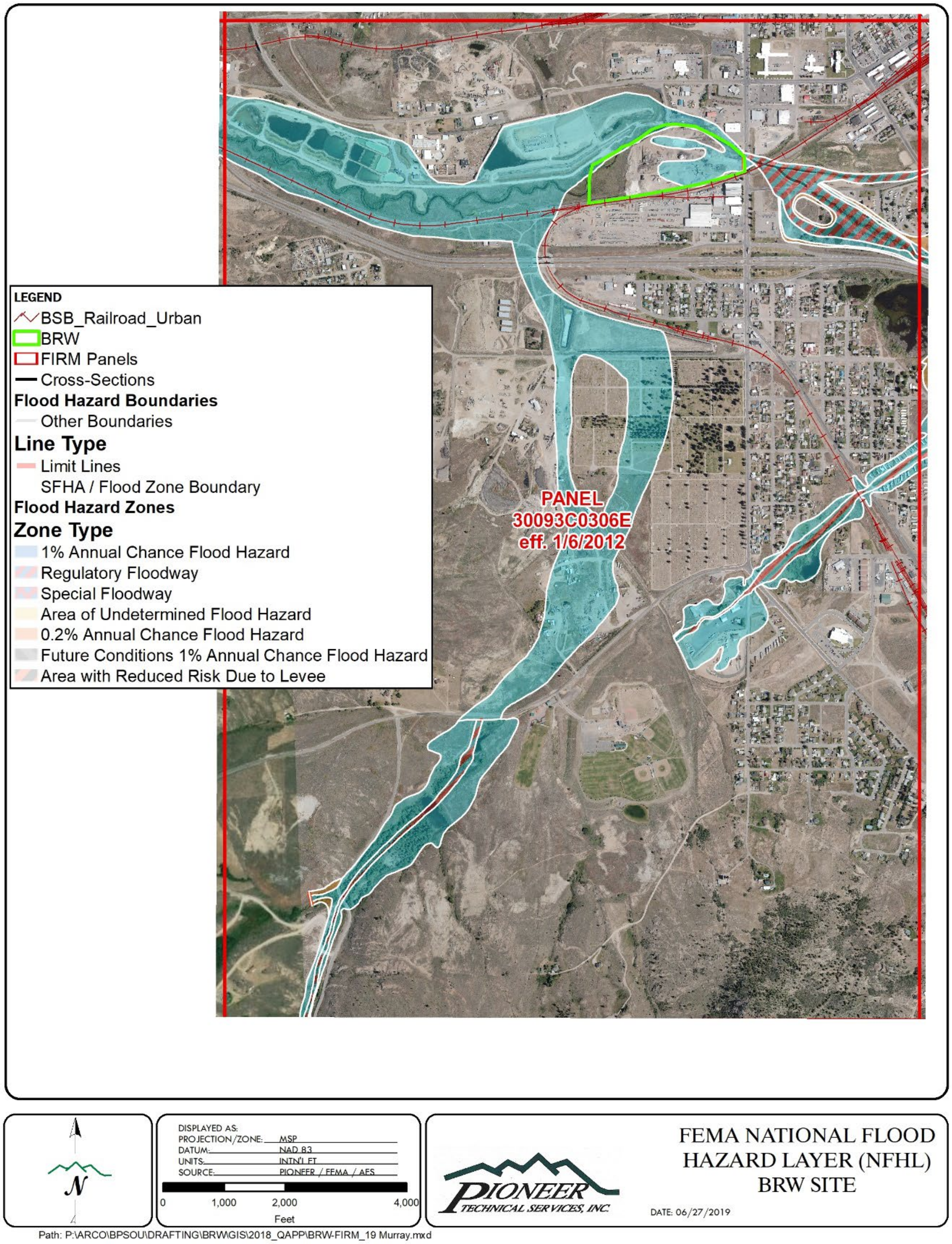


Figure 5 FEMA Map

TABLES

Table 1. List of Species Observed in the Project Area[1,2]

Scientific Name	Common Name	Indicator Status
Shrubs and Sub-shrubs (Scrub)		
Ribes aureum	Golden Currant	FAC
Rosa acicularis	Prickly Rose	FACU
Salix exigua	Narrow-Leaf Willow	FACW
Graminoides		
Alopecurus pratensis	Field Meadow Foxtail	FAC
Bromus inermis	Smooth Brome	UPA
Carex nebrascensis	Nebraska Sedge	OBL
Carex utriculata	Northwest Territory Sedge	OBL
Eleocharis palustris	Common Spike Rush	OBL
Elymus elymoides	Western Bottle-Brush Grass	UPL
Juncus balticus	Baltic Rush	FACW
Typha latifolia	Broad-Leaf Cattail	OBL
Poa palustris	Fowl Blue Grass	FAC
Poa pratensis	Kentucky Blue Grass	FAC
Forbes		
Achillea millefolium	Common Yarrow	FACU
Cyrtorhyncha cymbalaria	Alkali buttercup	OBL
Epilobium ciliatum	Fringed Willow herb	FACW
Geum macrophyllum	Large-Leafed Avens	FAC
Hedysarum sulphurescens	Sweet Vetch	NL
Linum lewisii	Wild Blue Flax	NL
Lomatium cusickii	Biscuitroot	NL
Medicago sativa	Alfalfa	UPL
Mentha arvensis	Field Mint	FACW
Potentilla anserina	Silverweed	OBL
Potentilla gracilis	Graceful Cinquefoil	FAC
Rumex salicifolius	Willow Dock	FACW
Scirpus microcarpus	Red Tinged Bulrush	OBL
Scutellaria galericulata	Hooded Skullcap	OBL
Sium suave	Hemlock Water-Parsnip	OBL
Undesirable Weedy Species		
Cirsium arvense	Canada Thistle	FAC
Cynoglossum officinale	Common Houndstongue	NL
Descurainia incana	Tansy Mustard	NL
Euphorbia esula	Leafy Spurge	NL

Scientific Name	Common Name	Indicator Status
Sonchus arvensis	Field Sow-Thistle	FACU
Tanacetum vulgare	Common Tansy	UPL
Taraxacum officinale	Common Dandelion	FACU
Thlaspi arvense	Pennycress	UPL
Verbascum thapsus	Mullein	FACU

[1] Lichvar et al., 2016.

[2] List is not exhaustive.

OBL: obligate. FACW: facultative wetland. FAC: facultative. FACU: facultative upland.
UPL: upland. NL: not listed.

Table 2. FEWA Summary Table – BRW-LAO

Functional Category	Rating	Numeric Rating	Weight	Score
Hydrologic Support	High	3	1.0	3
Floodflow Alteration	Low	1	0.5	0.5
Sediment Stabilization and Erosion Control	High	3	1.0	3
Water Purification	Low	1	1.0	1
Production Export/Food Chain Support	Moderate	2	1.0	2
Aquatic Diversity/Abundance	Low	1	1.5	1.5
Wildlife Diversity/Abundance: Breeding	Moderate	2	1.5	3
Wildlife Diversity/Abundance: Migration	Low	1	1.5	1.5
Wildlife Diversity/Abundance: Wintering	Moderate	2	1.0	2
TES Species Habitat	Low	1	1.0	1
Total (sum of column (d))				18.5
Maximum Total				33
Overall Rating for Assessment Area Wetland				**1.68**

Table 3 FEWA Summary Table – BRW-BSB

Functional Category	Rating	Numeric Rating	Weight	Score
Hydrologic Support	High	Low	1	1.0
Floodflow Alteration	Low	Low	1	0.5
Sediment Stabilization and Erosion Control	High	High	3	1.0
Water Purification	Low	Low	1	1.0
Production Export/Food Chain Support	Moderate	Low	1	1.0
Aquatic Diversity/Abundance	Low	Low	1	1.5
Wildlife Diversity/Abundance: Breeding	Moderate	V. Low	0.5	1.5
Wildlife Diversity/Abundance: Migration	Low	V. Low	0.5	1.5
Wildlife Diversity/Abundance: Wintering	Moderate	V. Low	0.5	1.0
TES Species Habitat	Moderate	Low	1.0	1.0
Total (sum of column (d))				10
Maximum Total				33
Overall Rating for Assessment Area Wetland				**0.90**

Appendix A
Wetland Data Forms

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: BPSOU BRW City/County: Butte-Silver Bow Sampling Date: June 10, 2019

Applicant/Owner: ARCO State: MT Sampling Point: 1A

Investigator(s): Strong Section, Township, Range: Section 24 T03N R08W

Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): none Slope (%): <1%

Subregion (LRR): LRR E Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: Dumps, mine NWI classification: Riverine

Are climatic / hydrologic conditions on the site typical for this time of year? [✓ Yes] No ______ (If no, explain in Remarks.)

Are Vegetation Yes, Soil Yes, or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes ______ [✓ No]

Are Vegetation No, Soil Yes, or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? [✓ Yes] No ______

Hydric Soil Present? [✓ Yes] No ______

Wetland Hydrology Present? [✓ Yes] No ______

Is the Sampled Area within a Wetland? **[✓ Yes] No ______**

Remarks:
The site is a reconstructed floodplain and stream channel developed over 20 years ago. Recent activities have included the removal of beaver and the mowing of vegetation. Soils were brought in from a barrow source and are non-native.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover	0		
Sapling/Shrub Stratum (Plot size: 15' radius)			
1. Salix exigua	20	Yes	FACW
2.			
3.			
4.			
5.			
= Total Cover	20		
Herb Stratum (Plot size: 5' radius)			
1. Salix exigua	40	Yes	FACW
2. Carex utriculata	50	Yes	OBL
3. Geum macrophyllum	T	No	FACW
4. Mentha arvense	1	No	FACW
5. Scirpus microcarpus	T	No	OBL
6.			
7.			
8.			
9.			
10.			
11.			
= Total Cover	91		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover	0		

% Bare Ground in Herb Stratum 5

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	50	x 1 =	50
FACW species	60	x 2 =	120
FAC species		x 3 =	0
FACU species		x 4 =	0
UPL species		x 5 =	0
Column Totals:	110 (A)		170 (B)

Prevalence Index = B/A = 0.45

Hydrophytic Vegetation Indicators:

- [✓] 1 - Rapid Test for Hydrophytic Vegetation
- [✓] 2 - Dominance Test is >50%
- [✓] 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **[✓ Yes] No ______**

Remarks:

SOIL

Sampling Point: 1A

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix		Redox Features				Texture	Remarks
	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]		
0-12	10YR 2/2	100					SCL-CL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

☐ Histosol (A1)
☒ Histic Epipedon (A2)
☐ Black Histic (A3)
☐ Hydrogen Sulfide (A4)
☐ Depleted Below Dark Surface (A11)
☐ Thick Dark Surface (A12)
☐ Sandy Mucky Mineral (S1)
☐ Sandy Gleyed Matrix (S4)
☐ Sandy Redox (S5)
☐ Stripped Matrix (S6)
☐ Loamy Mucky Mineral (F1) (**except MLRA 1**)
☐ Loamy Gleyed Matrix (F2)
☐ Depleted Matrix (F3)
☐ Redox Dark Surface (F6)
☐ Depleted Dark Surface (F7)
☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

☐ 2 cm Muck (A10)
☐ Red Parent Material (TF2)
☐ Very Shallow Dark Surface (TF12)
☒ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: Roots

Depth (inches): 8

Hydric Soil Present? Yes X **No** ______

Remarks:

Soil brought to site during construction. Lacks horizons.
Exhibits very shallow dark surface (F22).

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

☐ Surface Water (A1)
☒ High Water Table (A2)
☒ Saturation (A3)
☒ Water Marks (B1)
☐ Sediment Deposits (B2)
☐ Drift Deposits (B3)
☐ Algal Mat or Crust (B4)
☐ Iron Deposits (B5)
☐ Surface Soil Cracks (B6)
☐ Inundation Visible on Aerial Imagery (B7)
☐ Sparsely Vegetated Concave Surface (B8)
☐ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B)**
☐ Salt Crust (B11)
☐ Aquatic Invertebrates (B13)
☐ Hydrogen Sulfide Odor (C1)
☐ Oxidized Rhizospheres along Living Roots (C3)
☐ Presence of Reduced Iron (C4)
☐ Recent Iron Reduction in Tilled Soils (C6)
☐ Stunted or Stressed Plants (D1) (**LRR A**)
☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

☐ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B)**
☐ Drainage Patterns (B10)
☐ Dry-Season Water Table (C2)
☐ Saturation Visible on Aerial Imagery (C9)
☐ Geomorphic Position (D2)
☐ Shallow Aquitard (D3)
☐ FAC-Neutral Test (D5)
☐ Raised Ant Mounds (D6) (**LRR A**)
☐ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ______ No X Depth (inches): ______
Water Table Present? Yes X No ______ Depth (inches): 6
Saturation Present? (includes capillary fringe) Yes X No ______ Depth (inches): 4

Wetland Hydrology Present? Yes X **No** ______

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

USGS 12423240 - Blacktail Creek at Butte, MT registered 31 cfs and 30-year median is 20 cfs.

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: BPSOU BRW City/County: Butte-Silver Bow Sampling Date: June 10, 2019
Applicant/Owner: ARCO State: MT Sampling Point: 1B
Investigator(s): Strong Section, Township, Range: Section 24 T03N R08W
Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): none Slope (%): <2%
Subregion (LRR): LRR E Lat: ______ Long: ______ Datum: ______
Soil Map Unit Name: Dumps, mine NWI classification: None
Are climatic / hydrologic conditions on the site typical for this time of year? [✓ Yes] No ______ (If no, explain in Remarks.)
Are Vegetation Yes, Soil Yes, or Hydrology No significantly disturbed? Are “Normal Circumstances” present? Yes ______ [✓ No]
Are Vegetation No, Soil Yes, or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? [✓ Yes] No ______
Hydric Soil Present? Yes ______ [✓ No]
Wetland Hydrology Present? Yes ______ [✓ No]

Is the Sampled Area within a Wetland? **Yes** ______ **[✓ No]**

Remarks:
The site is a reconstructed floodplain and stream channel developed over 20 years ago. Recent activities have included the removal of beaver and the mowing of vegetation. Soils were brought in from a barrow source and are non-native.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover	0		
Sapling/Shrub Stratum (Plot size: 15' radius)			
1. Salix exigua	5	Yes	FACW
2.			
3.			
4.			
5.			
= Total Cover	5		
Herb Stratum (Plot size: 5' radius)			
1. Salix exigua	20	Yes	FACW
2. Carex utriculata	30	Yes	OBL
3. Bromus inermis	10	No	UPL
4. Mentha arvense	1	No	FACW
5. Alopercurus pratensis	10	No	FAC
6. Cirseum arvense	7	No	FAC
7.			
8.			
9.			
10.			
11.			
= Total Cover	78		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover	0		

% Bare Ground in Herb Stratum 20

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)
Total Number of Dominant Species Across All Strata: 3 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 = 0
FACW species		x 2 = 0
FAC species		x 3 = 0
FACU species		x 4 = 0
UPL species		x 5 = 0
Column Totals:	0 (A)	0 (B)

Prevalence Index = B/A = 0.45

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- [✓] 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **[✓ Yes]** **No** ______

Remarks:

SOIL

Sampling Point: 1B

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Redox Features Type[1]	Redox Features Loc[2]	Texture	Remarks
0-16	10YR 5/3	80	10YR 4/6	10			C-SC	\

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ☐ 2 cm Muck (A10)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes ☐ **No** ☒

Remarks:

Soil brought to site during construction. Lacks horizons.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B)**
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Stunted or Stressed Plants (D1) (**LRR A**)
- ☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ☐ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B)**
- ☐ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☒ FAC-Neutral Test (D5)
- ☐ Raised Ant Mounds (D6) (**LRR A**)
- ☐ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ☐ No ☒ Depth (inches): ______

Water Table Present? Yes ☐ No ☒ Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ☐ No ☒ Depth (inches): ______

Wetland Hydrology Present? Yes ☐ **No** ☒

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

USGS 12423240 - Blacktail Creek at Butte, MT registered 31 cfs and 30-year median is 20 cfs.

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: BPSOU BRW City/County: Butte-Silver Bow Sampling Date: June 10, 2019
Applicant/Owner: ARCO State: MT Sampling Point: 2A
Investigator(s): Strong Section, Township, Range: Section 24 T03N R08W
Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): none Slope (%): <1%
Subregion (LRR): LRR E Lat: ______ Long: ______ Datum: ______
Soil Map Unit Name: Dumps, mine NWI classification: Riverine
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ____ (If no, explain in Remarks.)
Are Vegetation Yes, Soil Yes, or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes ____ No X
Are Vegetation No, Soil Yes, or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes X No ____
Hydric Soil Present? Yes X No ____
Wetland Hydrology Present? Yes X No ____

Is the Sampled Area within a Wetland? **Yes X** **No ____**

Remarks:
The site is a reconstructed floodplain and stream channel developed over 20 years ago. Recent activities have included the removal of beaver and the mowing of vegetation. Soils were brought in from a barrow source and are non-native.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover	0		
Sapling/Shrub Stratum (Plot size: 15' radius)			
1. Salix exigua	50	Yes	FACW
2.			
3.			
4.			
5.			
= Total Cover	50		
Herb Stratum (Plot size: 5' radius)			
1. Salix exigua	10	Yes	FACW
2. Bromus inermis	30	Yes	UPL
3. Alopercurus pratensis	20	Yes	FAC
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
= Total Cover	60		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover	0		

% Bare Ground in Herb Stratum 35

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)
Total Number of Dominant Species Across All Strata: 4 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 75% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 = 0
FACW species		x 2 = 0
FAC species		x 3 = 0
FACU species		x 4 = 0
UPL species		x 5 = 0
Column Totals:	0 (A)	0 (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** X **No** ____

Remarks:

SOIL

Sampling Point: 2A

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix		Redox Features				Texture	Remarks
	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]		
0-2	10YR 2/2	100					SCL-SC	\
2	2.5YR 2/4	50	10YR 5/3	50	CS	M	S	Distinct sand layer
2+	10YR 5/3	90	10YR 4/5	10			SC	

[1] Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2] Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

☐ Histosol (A1)
☐ Histic Epipedon (A2)
☐ Black Histic (A3)
☐ Hydrogen Sulfide (A4)
☐ Depleted Below Dark Surface (A11)
☐ Thick Dark Surface (A12)
☐ Sandy Mucky Mineral (S1)
☐ Sandy Gleyed Matrix (S4)
☐ Sandy Redox (S5)
☐ Stripped Matrix (S6)
☐ Loamy Mucky Mineral (F1) (**except MLRA 1**)
☐ Loamy Gleyed Matrix (F2)
☐ Depleted Matrix (F3)
☐ Redox Dark Surface (F6)
☐ Depleted Dark Surface (F7)
☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

☐ 2 cm Muck (A10)
☐ Red Parent Material (TF2)
☐ Very Shallow Dark Surface (TF12)
☒ Other (Explain in Remarks)

[3] Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ____

Depth (inches): ____

Hydric Soil Present? Yes ☒ **No** ☐

Remarks:

Reconstructed soil. Early soil genesis. Determined to by hydric due to proximity to water table. Exhibits very shallow dark surface (F22).

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

☐ Surface Water (A1)
☒ High Water Table (A2)
☒ Saturation (A3)
☐ Water Marks (B1)
☐ Sediment Deposits (B2)
☐ Drift Deposits (B3)
☐ Algal Mat or Crust (B4)
☐ Iron Deposits (B5)
☐ Surface Soil Cracks (B6)
☐ Inundation Visible on Aerial Imagery (B7)
☐ Sparsely Vegetated Concave Surface (B8)
☐ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B)**
☐ Salt Crust (B11)
☐ Aquatic Invertebrates (B13)
☐ Hydrogen Sulfide Odor (C1)
☐ Oxidized Rhizospheres along Living Roots (C3)
☐ Presence of Reduced Iron (C4)
☐ Recent Iron Reduction in Tilled Soils (C6)
☐ Stunted or Stressed Plants (D1) (**LRR A**)
☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

☐ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B)**
☐ Drainage Patterns (B10)
☐ Dry-Season Water Table (C2)
☐ Saturation Visible on Aerial Imagery (C9)
☐ Geomorphic Position (D2)
☐ Shallow Aquitard (D3)
☐ FAC-Neutral Test (D5)
☐ Raised Ant Mounds (D6) (**LRR A**)
☐ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ☐ No ☒ Depth (inches): ____
Water Table Present? Yes ☒ No ☐ Depth (inches): 9
Saturation Present? (includes capillary fringe) Yes ☒ No ☐ Depth (inches): 9

Wetland Hydrology Present? Yes ☒ **No** ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

USGS 12423240 - Blacktail Creek at Butte, MT registered 31 cfs and 30-year median is 20 cfs.

Remarks:

Distinct water layer - saturation and/or water table 9 inches below surface.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: BPSOU BRW City/County: Butte-Silver Bow Sampling Date: June 10, 2019

Applicant/Owner: ARCO State: MT Sampling Point: 2B

Investigator(s): Strong Section, Township, Range: Section 24 T03N R08W

Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): none Slope (%): <1%

Subregion (LRR): LRR E Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: Dumps, mine NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? [✓ Yes] No ___ (If no, explain in Remarks.)

Are Vegetation Yes, Soil Yes, or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes ___ [✓ No]

Are Vegetation No, Soil Yes, or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? [✓ Yes] No ___

Hydric Soil Present? Yes ___ [✓ No]

Wetland Hydrology Present? Yes ___ [✓ No]

Is the Sampled Area within a Wetland? **Yes** ___ **[✓ No]**

Remarks:
The site is a reconstructed floodplain and stream channel developed over 20 years ago. Recent activities have included the removal of beaver and the mowing of vegetation. Soils were brought in from a barrow source and are non-native.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover	0		
Sapling/Shrub Stratum (Plot size: 15' radius)			
1. Salix exigua	10	Yes	FACW
2.			
3.			
4.			
5.			
= Total Cover	10		
Herb Stratum (Plot size: 5' radius)			
1. Alopercurus pratensis	20	Yes	FACW
2. Juncus balticus	30	Yes	FACW
3. Salix exigua	10	No	FACW
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
= Total Cover	60		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover	0		

% Bare Ground in Herb Stratum 35

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 75% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	0
FACW species		x 2 =	0
FAC species		x 3 =	0
FACU species		x 4 =	0
UPL species		x 5 =	0
Column Totals:	0	(A)	0 (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- [✓] 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **[✓ Yes]** **No** ___

Remarks:

SOIL

Sampling Point: 2B

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-2	10YR 2/2	100					SCL-SC	
2-16	10YR 5/3	90	10YR 4/6	10			SC	

[1] Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2] Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

☐ Histosol (A1)
☐ Histic Epipedon (A2)
☐ Black Histic (A3)
☐ Hydrogen Sulfide (A4)
☐ Depleted Below Dark Surface (A11)
☐ Thick Dark Surface (A12)
☐ Sandy Mucky Mineral (S1)
☐ Sandy Gleyed Matrix (S4)
☐ Sandy Redox (S5)
☐ Stripped Matrix (S6)
☐ Loamy Mucky Mineral (F1) (**except MLRA 1**)
☐ Loamy Gleyed Matrix (F2)
☐ Depleted Matrix (F3)
☐ Redox Dark Surface (F6)
☐ Depleted Dark Surface (F7)
☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

☐ 2 cm Muck (A10)
☐ Red Parent Material (TF2)
☒ Very Shallow Dark Surface (TF12)
☒ Other (Explain in Remarks)

[3] Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type:

Depth (inches):

Hydric Soil Present? **Yes** ☐ **No** ☒

Remarks:

Soil brought to site during construction. Has developed a dark surface layer.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

☐ Surface Water (A1)
☐ High Water Table (A2)
☐ Saturation (A3)
☐ Water Marks (B1)
☐ Sediment Deposits (B2)
☐ Drift Deposits (B3)
☐ Algal Mat or Crust (B4)
☐ Iron Deposits (B5)
☐ Surface Soil Cracks (B6)
☐ Inundation Visible on Aerial Imagery (B7)
☐ Sparsely Vegetated Concave Surface (B8)
☐ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B)**
☐ Salt Crust (B11)
☐ Aquatic Invertebrates (B13)
☐ Hydrogen Sulfide Odor (C1)
☐ Oxidized Rhizospheres along Living Roots (C3)
☐ Presence of Reduced Iron (C4)
☐ Recent Iron Reduction in Tilled Soils (C6)
☐ Stunted or Stressed Plants (D1) (**LRR A**)
☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

☐ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B)**
☐ Drainage Patterns (B10)
☐ Dry-Season Water Table (C2)
☐ Saturation Visible on Aerial Imagery (C9)
☐ Geomorphic Position (D2)
☐ Shallow Aquitard (D3)
☒ FAC-Neutral Test (D5)
☐ Raised Ant Mounds (D6) (**LRR A**)
☐ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ☐ No ☒ Depth (inches):
Water Table Present? Yes ☐ No ☒ Depth (inches):
Saturation Present? (includes capillary fringe) Yes ☐ No ☒ Depth (inches):

Wetland Hydrology Present? **Yes** ☐ **No** ☒

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

USGS 12423240 - Blacktail Creek at Butte, MT registered 31 cfs and 30-year median is 20 cfs.

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: BPSOU BRW City/County: Butte-Silver Bow Sampling Date: June 10, 2019

Applicant/Owner: ARCO State: MT Sampling Point: 3A

Investigator(s): Strong Section, Township, Range: Section 24 T03N R08W

Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): none Slope (%): <1%

Subregion (LRR): LRR E Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: Dumps, mine NWI classification: Riverine

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ____ (If no, explain in Remarks.)

Are Vegetation Yes, Soil Yes, or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes ____ No X

Are Vegetation No, Soil Yes, or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes X No ____

Hydric Soil Present? Yes X No ____

Wetland Hydrology Present? Yes X No ____

Is the Sampled Area within a Wetland? **Yes X No ____**

Remarks:

The site is a reconstructed floodplain and stream channel developed over 20 years ago. Recent activities have included the removal of beaver and the mowing of vegetation. Soils were brought in from a barrow source and are non-native.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover	0		
Sapling/Shrub Stratum (Plot size: 15' radius)			
1. Salix exigua	60	Yes	FACW
2.			
3.			
4.			
5.			
= Total Cover	60		
Herb Stratum (Plot size: 5' radius)			
1. Salix exigua	15	Yes	FACW
2. Bromus inermis	20	Yes	UPL
3. Alopercurus pratensis	15	Yes	FAC
4. Carex utriculata	5	No	OBL
5.			
6.			
7.			
8.			
9.			
10.			
11.			
= Total Cover	55		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover	0		

% Bare Ground in Herb Stratum 40

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 75% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	0
FACW species		x 2 =	0
FAC species		x 3 =	0
FACU species		x 4 =	0
UPL species		x 5 =	0
Column Totals:	0 (A)		0 (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** X **No** ____

Remarks:

SOIL

Sampling Point: 3A

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-2	10YR 2/2	100					SL	
2+	2.5YR 5/2	90	7.5YR 4/6	10			S	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)

___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
_X_ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______________________

Depth (inches): ______________________

Hydric Soil Present? Yes X **No** ______

Remarks:

Reconstructed soil. Early soil genesis. Determined to by hydric due to proximity to water table. Exhibits very shallow dark surface (F22).

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
_X_ High Water Table (A2)
_X_ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)

___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B)**
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B)**
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ______ No X Depth (inches): ____________
Water Table Present? Yes X No ______ Depth (inches): 8
Saturation Present? (includes capillary fringe) Yes X No ______ Depth (inches): 8

Wetland Hydrology Present? Yes X **No** ______

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

USGS 12423240 - Blacktail Creek at Butte, MT registered 31 cfs and 30-year median is 20 cfs.

Remarks:

Distinct water table at 8 inches below ground surface

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: BPSOU BRW City/County: Butte-Silver Bow Sampling Date: June 10, 2019
Applicant/Owner: ARCO State: MT Sampling Point: 3B
Investigator(s): Strong Section, Township, Range: Section 24 T03N R08W
Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): none Slope (%): <1%
Subregion (LRR): LRR E Lat: ______ Long: ______ Datum: ______
Soil Map Unit Name: Dumps, mine NWI classification: None
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ____ (If no, explain in Remarks.)
Are Vegetation Yes, Soil Yes, or Hydrology No significantly disturbed? Are “Normal Circumstances” present? Yes ____ No X
Are Vegetation No, Soil Yes, or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes ____ No X
Hydric Soil Present? Yes ____ No X
Wetland Hydrology Present? Yes ____ No X

Is the Sampled Area within a Wetland? **Yes** ____ **No** X

Remarks:
The site is a reconstructed floodplain and stream channel developed over 20 years ago. Recent activities have included the removal of beaver and the mowing of vegetation. Soils were brought in from a barrow source and are non-native.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
	0	= Total Cover	
Sapling/Shrub Stratum (Plot size: 15' radius)			
1. Salix exigua	T	No	FACW
2.			
3.			
4.			
5.			
	0	= Total Cover	
Herb Stratum (Plot size: 5' radius)			
1. Alopercurus pratensis	20	Yes	FACW
2. Bromus inermis	30	Yes	UPL
3. Salix exigua	30	Yes	UPL
4. Carex utiriculata	T	No	OBL
5. Rosa acicularis	T	No	UPL
6.			
7.			
8.			
9.			
10.			
11.			
	80	= Total Cover	
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
	0	= Total Cover	

% Bare Ground in Herb Stratum 20

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)
Total Number of Dominant Species Across All Strata: 3 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 33% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	0
FACW species		x 2 =	0
FAC species		x 3 =	0
FACU species		x 4 =	0
UPL species		x 5 =	0
Column Totals:	0 (A)		0 (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ___ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** ____ **No** X

Remarks:

SOIL

Sampling Point: 3B

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-2	10YR 2/2	100					SCL-SC	\
2-16	2.5YR 5/2	90	7.5 YR 4/6	10	RM	M	SC	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
_X_ Very Shallow Dark Surface (TF12)
_X_ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______________________

Depth (inches): ______________________

Hydric Soil Present? Yes ______ No __X__

Remarks:

Soil brought to site during construction. Has developed a dark surface layer.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B)**
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B)**
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
_X_ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes _____ No __X__ Depth (inches): ___________
Water Table Present? Yes _____ No __X__ Depth (inches): ___________
Saturation Present? (includes capillary fringe) Yes _____ No __X__ Depth (inches): ___________

Wetland Hydrology Present? Yes ______ No __X__

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

USGS 12423240 - Blacktail Creek at Butte, MT registered 31 cfs and 30-year median is 20 cfs.

Remarks:

No water found within 16 inches of surface.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: BPSOU BRW City/County: Butte-Silver Bow Sampling Date: June 10, 2019

Applicant/Owner: ARCO State: MT Sampling Point: 4A

Investigator(s): Strong Section, Township, Range: Section 24 T03N R08W

Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): none Slope (%): <1%

Subregion (LRR): LRR E Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: Dumps, mine NWI classification: Riverine

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ______ (If no, explain in Remarks.)

Are Vegetation Yes, Soil Yes, or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes ______ No X

Are Vegetation No, Soil Yes, or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes X No ______

Hydric Soil Present? Yes X No ______

Wetland Hydrology Present? Yes X No ______

Is the Sampled Area within a Wetland? **Yes X No ______**

Remarks:
The site is a reconstructed floodplain and stream channel developed over 20 years ago. Recent activities have included the removal of beaver and the mowing of vegetation. Soils were brought in from a barrow source and are non-native.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover	0		
Sapling/Shrub Stratum (Plot size: 15' radius)			
1. Salix exigua	60	Yes	FACW
2.			
3.			
4.			
5.			
= Total Cover	60		
Herb Stratum (Plot size: 5' radius)			
1. Salix exigua	15	Yes	FACW
2. Bromus inermis	20	Yes	UPL
3. Alopercurus pratensis	15	Yes	FAC
4. Carex utriculata	5	No	OBL
5.			
6.			
7.			
8.			
9.			
10.			
11.			
= Total Cover	55		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover	0		

% Bare Ground in Herb Stratum 40

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 75% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	0
FACW species		x 2 =	0
FAC species		x 3 =	0
FACU species		x 4 =	0
UPL species		x 5 =	0
Column Totals:	0 (A)		0 (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** X **No** ______

Remarks:

SOIL

Sampling Point: 4A

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-2	10YR 2/2	100					SL	
2+	2.5YR 5/2	90	7.5YR 4/6	10			S	

[1] Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2] Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
X Other (Explain in Remarks)

[3] Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes X **No** ______

Remarks:

Reconstructed soil. Early soil genesis. Determined to by hydric due to proximity to water table. Exhibits very shallow dark surface (F22).

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
X High Water Table (A2)
X Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B)**
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B)**
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ______ No X Depth (inches): ______
Water Table Present? Yes X No ______ Depth (inches): 3
Saturation Present? (includes capillary fringe) Yes X No ______ Depth (inches): 2

Wetland Hydrology Present? Yes X **No** ______

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

USGS 12423240 - Blacktail Creek at Butte, MT registered 31 cfs and 30-year median is 20 cfs.

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: BPSOU BRW City/County: Butte-Silver Bow Sampling Date: June 10, 2019

Applicant/Owner: ARCO State: MT Sampling Point: 4B

Investigator(s): Strong Section, Township, Range: Section 24 T03N R08W

Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): none Slope (%): <1%

Subregion (LRR): LRR E Lat: ____ Long: ____ Datum: ____

Soil Map Unit Name: Dumps, mine NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ____ (If no, explain in Remarks.)

Are Vegetation Yes, Soil Yes, or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes ____ No X

Are Vegetation No, Soil Yes, or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ____	No X
Hydric Soil Present?	Yes ____	No X
Wetland Hydrology Present?	Yes ____	No X

Is the Sampled Area within a Wetland? **Yes** ____ **No** X

Remarks:
The site is a reconstructed floodplain and stream channel developed over 20 years ago. Recent activities have included the removal of beaver and the mowing of vegetation. Soils were brought in from a barrow source and are non-native.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ____)			
1.			
2.			
3.			
4.			
	0	= Total Cover	
Sapling/Shrub Stratum (Plot size: 15' radius)			
1. Salix exigua	T	No	FACW
2.			
3.			
4.			
5.			
	0	= Total Cover	
Herb Stratum (Plot size: 5' radius)			
1. Alopercurus pratensis	20	Yes	FACW
2. Bromus inermis	30	Yes	UPL
3. Salix exigua	30	Yes	UPL
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	80	= Total Cover	
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
	0	= Total Cover	
% Bare Ground in Herb Stratum 20			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 33% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	0
FACW species		x 2 =	0
FAC species		x 3 =	0
FACU species		x 4 =	0
UPL species		x 5 =	0
Column Totals:	0	(A)	0 (B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ___ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** ____ **No** X

Remarks:

SOIL

Sampling Point: 4B

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-2	10YR 2/2	100					SCL-SC	\
2-16	2.5YR 5/2	90	7.5 YR 4/6	10	RM	M	SC	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

☐ Histosol (A1)
☐ Histic Epipedon (A2)
☐ Black Histic (A3)
☐ Hydrogen Sulfide (A4)
☐ Depleted Below Dark Surface (A11)
☐ Thick Dark Surface (A12)
☐ Sandy Mucky Mineral (S1)
☐ Sandy Gleyed Matrix (S4)
☐ Sandy Redox (S5)
☐ Stripped Matrix (S6)
☐ Loamy Mucky Mineral (F1) (**except MLRA 1**)
☐ Loamy Gleyed Matrix (F2)
☐ Depleted Matrix (F3)
☐ Redox Dark Surface (F6)
☐ Depleted Dark Surface (F7)
☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

☐ 2 cm Muck (A10)
☐ Red Parent Material (TF2)
☒ Very Shallow Dark Surface (TF12)
☒ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______

Depth (inches): ______

Hydric Soil Present? **Yes** ______ **No** X

Remarks:

Soil brought to site during construction. Has developed a dark surface layer.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

☐ Surface Water (A1)
☐ High Water Table (A2)
☐ Saturation (A3)
☐ Water Marks (B1)
☐ Sediment Deposits (B2)
☐ Drift Deposits (B3)
☐ Algal Mat or Crust (B4)
☐ Iron Deposits (B5)
☐ Surface Soil Cracks (B6)
☐ Inundation Visible on Aerial Imagery (B7)
☐ Sparsely Vegetated Concave Surface (B8)
☐ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B)**
☐ Salt Crust (B11)
☐ Aquatic Invertebrates (B13)
☐ Hydrogen Sulfide Odor (C1)
☐ Oxidized Rhizospheres along Living Roots (C3)
☐ Presence of Reduced Iron (C4)
☐ Recent Iron Reduction in Tilled Soils (C6)
☐ Stunted or Stressed Plants (D1) (**LRR A**)
☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

☐ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B)**
☐ Drainage Patterns (B10)
☐ Dry-Season Water Table (C2)
☐ Saturation Visible on Aerial Imagery (C9)
☐ Geomorphic Position (D2)
☐ Shallow Aquitard (D3)
☐ FAC-Neutral Test (D5)
☐ Raised Ant Mounds (D6) (**LRR A**)
☐ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ______ No X Depth (inches): ______
Water Table Present? Yes ______ No X Depth (inches): ______
Saturation Present? (includes capillary fringe) Yes ______ No X Depth (inches): ______

Wetland Hydrology Present? **Yes** ______ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

USGS 12423240 - Blacktail Creek at Butte, MT registered 31 cfs and 30-year median is 20 cfs.

Remarks:

No water found within 16 inches of surface.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: BPSOU BRW City/County: Butte-Silver Bow Sampling Date: June 10, 2019

Applicant/Owner: ARCO State: MT Sampling Point: 5A

Investigator(s): Strong Section, Township, Range: Section 24 T03N R08W

Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): none Slope (%): <1%

Subregion (LRR): LRR E Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: Dumps, mine NWI classification: Riverine

Are climatic / hydrologic conditions on the site typical for this time of year? [✓ Yes] No ______ (If no, explain in Remarks.)

Are Vegetation Yes, Soil Yes, or Hydrology No significantly disturbed? Are “Normal Circumstances” present? Yes ______ [✓ No]

Are Vegetation No, Soil Yes, or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? [✓ Yes] No ______

Hydric Soil Present? [✓ Yes] No ______

Wetland Hydrology Present? [✓ Yes] No ______

Is the Sampled Area within a Wetland? **[✓ Yes] No**

Remarks:
The site is a reconstructed floodplain and stream channel developed over 20 years ago. Recent activities have included the removal of beaver and the mowing of vegetation. Soils were brought in from a barrow source and are non-native.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	0 = Total Cover		
Sapling/Shrub Stratum (Plot size: 15' radius)			
1.			
2.			
3.			
4.			
5.			
	0 = Total Cover		
Herb Stratum (Plot size: 5' radius)			
1. Salix exigua	5	No	FACW
2. Carex utriculata	20	Yes	OBL
3. Alopercurus pratensis	40	Yes	FAC
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	65 = Total Cover		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
	0 = Total Cover		

% Bare Ground in Herb Stratum 30

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 = 0
FACW species		x 2 = 0
FAC species		x 3 = 0
FACU species		x 4 = 0
UPL species		x 5 = 0
Column Totals:	0 (A)	0 (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- [✓] 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **[✓ Yes] No ______**

Remarks:

SOIL

Sampling Point: 5A

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0 - 2	10YR 2/2	100					SL	
2 - 8	10YR 5/3	93	10YR 4/6	7	RM	M	SCL-SC	
8+	10 YR 2/2	50	10 YR 4/6	50	CS	M	S	

[1] Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2] Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

☐ Histosol (A1)
☐ Histic Epipedon (A2)
☐ Black Histic (A3)
☐ Hydrogen Sulfide (A4)
☐ Depleted Below Dark Surface (A11)
☐ Thick Dark Surface (A12)
☐ Sandy Mucky Mineral (S1)
☐ Sandy Gleyed Matrix (S4)
☐ Sandy Redox (S5)
☐ Stripped Matrix (S6)
☐ Loamy Mucky Mineral (F1) (**except MLRA 1**)
☐ Loamy Gleyed Matrix (F2)
☐ Depleted Matrix (F3)
☐ Redox Dark Surface (F6)
☐ Depleted Dark Surface (F7)
☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

☐ 2 cm Muck (A10)
☐ Red Parent Material (TF2)
☐ Very Shallow Dark Surface (TF12)
☒ Other (Explain in Remarks)

[3] Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______

Depth (inches): ______

Hydric Soil Present? **Yes** X **No** ______

Remarks:

Reconstructed soil. Early soil genesis. Determined to by hydric due to proximity to water table. Exhibits very shallow dark surface (F22).

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

☐ Surface Water (A1)
☐ High Water Table (A2)
☒ Saturation (A3)
☐ Water Marks (B1)
☐ Sediment Deposits (B2)
☐ Drift Deposits (B3)
☐ Algal Mat or Crust (B4)
☐ Iron Deposits (B5)
☐ Surface Soil Cracks (B6)
☐ Inundation Visible on Aerial Imagery (B7)
☐ Sparsely Vegetated Concave Surface (B8)
☐ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B)**
☐ Salt Crust (B11)
☐ Aquatic Invertebrates (B13)
☐ Hydrogen Sulfide Odor (C1)
☐ Oxidized Rhizospheres along Living Roots (C3)
☐ Presence of Reduced Iron (C4)
☐ Recent Iron Reduction in Tilled Soils (C6)
☐ Stunted or Stressed Plants (D1) (**LRR A**)
☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

☐ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B)**
☐ Drainage Patterns (B10)
☐ Dry-Season Water Table (C2)
☐ Saturation Visible on Aerial Imagery (C9)
☐ Geomorphic Position (D2)
☐ Shallow Aquitard (D3)
☐ FAC-Neutral Test (D5)
☐ Raised Ant Mounds (D6) (**LRR A**)
☐ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ______ No X Depth (inches): ______
Water Table Present? Yes ______ No X Depth (inches): ______
Saturation Present? (includes capillary fringe) Yes X No ______ Depth (inches): 8

Wetland Hydrology Present? **Yes** X **No** ______

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

USGS 12423240 - Blacktail Creek at Butte, MT registered 31 cfs and 30-year median is 20 cfs.

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: BPSOU BRW City/County: Butte-Silver Bow Sampling Date: June 10, 2019
Applicant/Owner: ARCO State: MT Sampling Point: 5B
Investigator(s): Strong Section, Township, Range: Section 24 T03N R08W
Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): none Slope (%): <1%
Subregion (LRR): LRR E Lat: ______ Long: ______ Datum: ______
Soil Map Unit Name: Dumps, mine NWI classification: None
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ______ (If no, explain in Remarks.)
Are Vegetation Yes, Soil Yes, or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes ______ No X
Are Vegetation No, Soil Yes, or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes ______ No X
Hydric Soil Present? Yes ______ No X
Wetland Hydrology Present? Yes ______ No X

Is the Sampled Area within a Wetland? Yes ______ No X

Remarks:
The site is a reconstructed floodplain and stream channel developed over 20 years ago. Recent activities have included the removal of beaver and the mowing of vegetation. Soils were brought in from a barrow source and are non-native.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover	0		
Sapling/Shrub Stratum (Plot size: 15' radius)			
1. Salix exigua	T	No	FACW
2.			
3.			
4.			
5.			
= Total Cover	0		
Herb Stratum (Plot size: 5' radius)			
1. Alopercurus pratensis	30	Yes	FACW
2. Bromus inermis	30	Yes	UPL
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
= Total Cover	60		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover	0		

% Bare Ground in Herb Stratum 35

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)
Total Number of Dominant Species Across All Strata: 3 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 33% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	0
FACW species		x 2 =	0
FAC species		x 3 =	0
FACU species		x 4 =	0
UPL species		x 5 =	0
Column Totals:	0 (A)		0 (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ___ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ______ No X

Remarks:

SOIL

Sampling Point: 5B

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Redox Features Type[1]	Redox Features Loc[2]	Texture	Remarks
0 - 5	10YR 2/2	100					SL	\
5+	10YR 5/3	100					SC	

[1] Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2] Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
_X_ Very Shallow Dark Surface (TF12)
_X_ Other (Explain in Remarks)

[3] Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes ______ **No** _X_

Remarks:

Soil brought to site during construction. Has developed a dark surface layer.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B)**
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B)**
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ______ No _X_ Depth (inches): ______
Water Table Present? Yes ______ No _X_ Depth (inches): ______
Saturation Present? (includes capillary fringe) Yes ______ No _X_ Depth (inches): ______

Wetland Hydrology Present? Yes ______ **No** _X_

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

USGS 12423240 - Blacktail Creek at Butte, MT registered 31 cfs and 30-year median is 20 cfs.

Remarks:

Water found at 16 inches below surface.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: BPSOU BRW City/County: Butte-Silver Bow Sampling Date: June 13, 2019

Applicant/Owner: ARCO State: MT Sampling Point: 6A

Investigator(s): Strong Section, Township, Range: Section 24 T03N R08W

Landform (hillslope, terrace, etc.): Drainage Local relief (concave, convex, none): none Slope (%): <1%

Subregion (LRR): LRR E Lat: ____ Long: ____ Datum: ____

Soil Map Unit Name: Dumps, mine NWI classification: Riverine

Are climatic / hydrologic conditions on the site typical for this time of year? [✓ Yes] No ____ (If no, explain in Remarks.)

Are Vegetation Yes, Soil Yes, or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes ____ [✓ No]

Are Vegetation No, Soil Yes, or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? [✓ Yes] No ____

Hydric Soil Present? [✓ Yes] No ____

Wetland Hydrology Present? [✓ Yes] No ____

Is the Sampled Area within a Wetland? **[✓ Yes] No**

Remarks:

The site is a reconstructed floodplain and stream channel developed over 20 years ago. Soils were brought in from a barrow source and are non-native.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ____)			
1.			
2.			
3.			
4.			
	0 = Total Cover		
Sapling/Shrub Stratum (Plot size: 15' radius)			
1. Salix exigua	3	No	FACW
2.			
3.			
4.			
5.			
	3 = Total Cover		
Herb Stratum (Plot size: 5' radius)			
1. Salix exigua	5	No	FACW
2. Carex utriculata	8	No	OBL
3. Alopercurus pratensis	60	Yes	FAC
4. Scirpus microcarpus	T	No	OBL
5. Rumex salicifolius	T	No	FACW
6. Geum macrophylum	T	No	FAC
7. Cirsium arvense	T	No	FAC
8. Potentilla anserina	T	No	OBL
9. Scutellaria galericulata	T	No	OBL
10.			
11.			
	73 = Total Cover		
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
	0 = Total Cover		

% Bare Ground in Herb Stratum 25

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 1 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 = 0
FACW species		x 2 = 0
FAC species		x 3 = 0
FACU species		x 4 = 0
UPL species		x 5 = 0
Column Totals:	0 (A)	0 (B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **[✓ Yes] No ____**

Remarks:

SOIL

Sampling Point: 6A

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix		Redox Features				Texture	Remarks
	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]		
0 - 6	10YR 2/1	100					SL	
6 - 8	10YR 5/3	95	10YR 3/6	4	RM	M	CL	
8 - 9	5 YR 4/6	50	5Y 2.5/1	50	CS	M	SL	
9+	5Y 2.5/1	50	10YR 3/2	50	CS	M	SL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
_X_ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ___

Depth (inches): ___

Hydric Soil Present? Yes _X_ **No** ___

Remarks:

Reconstructed soil. Early soil genesis. Determined to by hydric due to proximity to water table.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
_X_ High Water Table (A2)
_X_ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B)**
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B)**
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
_X_ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ___ No _X_ Depth (inches): ___
Water Table Present? Yes _X_ No ___ Depth (inches): 8
Saturation Present? (includes capillary fringe) Yes _X_ No ___ Depth (inches): 2

Wetland Hydrology Present? Yes _X_ **No** ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

USGS 12423240 - Blacktail Creek at Butte, MT registered 24 cfs and 30-year median is 18 cfs.

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: BPSOU BRW City/County: Butte-Silver Bow Sampling Date: June 13, 2019
Applicant/Owner: ARCO State: MT Sampling Point: 6B
Investigator(s): Strong Section, Township, Range: Section 24 T03N R08W
Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): none Slope (%): <1%
Subregion (LRR): LRR E Lat: Long: Datum:
Soil Map Unit Name: Dumps, mine NWI classification: Riverine
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks.)
Are Vegetation Yes, Soil Yes, or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes No X
Are Vegetation No, Soil Yes, or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes X No
Hydric Soil Present? Yes X No
Wetland Hydrology Present? Yes No X

Is the Sampled Area within a Wetland? **Yes** **No** X

Remarks:
The site is a reconstructed floodplain and stream channel developed over 20 years ago. Soils were brought in from a barrow source and are non-native.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size:)			
1.			
2.			
3.			
4.			
= Total Cover	0		
Sapling/Shrub Stratum (Plot size: 15' radius)			
1. Salix exigua	3	No	FACW
2.			
3.			
4.			
5.			
= Total Cover	3		
Herb Stratum (Plot size: 5' radius)			
1. Salix exigua	20	No	FACW
2. Elymus elymoides	5	No	UPL
3. Alopercurus pratensis	50	Yes	FAC
4. Juncus balticus	5	No	OBL
5.			
6.			
7.			
8.			
9.			
10.			
11.			
= Total Cover	80		
Woody Vine Stratum (Plot size:)			
1.			
2.			
= Total Cover	0		

% Bare Ground in Herb Stratum 20

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)
Total Number of Dominant Species Across All Strata: 2 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	0
FACW species		x 2 =	0
FAC species		x 3 =	0
FACU species		x 4 =	0
UPL species		x 5 =	0
Column Totals:	0	(A)	0 (B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ___ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** X **No**

Remarks:

SOIL

Sampling Point: 6B

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0 - 2	10YR 2/1	100					SCL	
2 - 18	10YR 5/3	95	10YR 3/6	4	RM	M	SC	

[1] Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2] Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
_X_ Very Shallow Dark Surface (TF12)
_X_ Other (Explain in Remarks)

[3] Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes _X_ No ___

Remarks:

Reconstructed soil. Early soil genesis. Determined to by hydric due to proximity to water table.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B)**
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B)**
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
_X_ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ___ No _X_ Depth (inches): ______
Water Table Present? Yes ___ No _X_ Depth (inches): ______
Saturation Present? (includes capillary fringe) Yes ___ No _X_ Depth (inches): ______

Wetland Hydrology Present? Yes ___ No _X_

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

USGS 12423240 - Blacktail Creek at Butte, MT registered 31 cfs and 30-year median is 20 cfs.

Remarks:

Saturation at 14 inches.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: BPSOU BRW City/County: Butte-Silver Bow Sampling Date: June 13, 2019

Applicant/Owner: ARCO State: MT Sampling Point: 7A

Investigator(s): Strong Section, Township, Range: Section 24 T03N R08W

Landform (hillslope, terrace, etc.): Streambank Local relief (concave, convex, none): none Slope (%): <1%

Subregion (LRR): LRR E Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: Dumps, mine NWI classification: Riverine

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ______ (If no, explain in Remarks.)

Are Vegetation Yes, Soil Yes, or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes ______ No X

Are Vegetation No, Soil Yes, or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No ______
Hydric Soil Present?	Yes X	No ______
Wetland Hydrology Present?	Yes X	No ______

Is the Sampled Area within a Wetland? **Yes X** **No ______**

Remarks:
The site is a reconstructed floodplain and stream channel developed over 20 years ago. Soils were brought in from a barrow source and are non-native.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
	0	= Total Cover	
Sapling/Shrub Stratum (Plot size: 15' radius)			
1.			
2.			
3.			
4.			
5.			
	0	= Total Cover	
Herb Stratum (Plot size: 5' radius)			
1. Salix exigua	5	No	FACW
2. Juncus balticus	60	Yes	FACW
3. Alopercurus pratensis	30	Yes	FAC
4. Eleocharis palustris	5	No	OBL
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	100	= Total Cover	
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
	0	= Total Cover	

% Bare Ground in Herb Stratum ______

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	0
FACW species		x 2 =	0
FAC species		x 3 =	0
FACU species		x 4 =	0
UPL species		x 5 =	0
Column Totals:	0 (A)		0 (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes X** **No ______**

Remarks:

SOIL

Sampling Point: 7A

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
1 - 0							OM	
0 - 4	10 YR 4/2	97	7.5 YR 4/4	3	RM	M	SC	
4 - 12+	10YR 5/2	95	7.5 YR 4/4	5	RM	M	SL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

☐ Histosol (A1)
☐ Histic Epipedon (A2)
☐ Black Histic (A3)
☐ Hydrogen Sulfide (A4)
☐ Depleted Below Dark Surface (A11)
☐ Thick Dark Surface (A12)
☐ Sandy Mucky Mineral (S1)
☐ Sandy Gleyed Matrix (S4)
☐ Sandy Redox (S5)
☐ Stripped Matrix (S6)
☐ Loamy Mucky Mineral (F1) (**except MLRA 1**)
☐ Loamy Gleyed Matrix (F2)
☐ Depleted Matrix (F3)
☐ Redox Dark Surface (F6)
☐ Depleted Dark Surface (F7)
☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

☐ 2 cm Muck (A10)
☐ Red Parent Material (TF2)
☐ Very Shallow Dark Surface (TF12)
☒ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes X **No** ______

Remarks:

Reconstructed soil. Early soil genesis. Determined to by hydric due to proximity to water table. Exhibits very shallow dark surface (F22).

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

☐ Surface Water (A1)
☐ High Water Table (A2)
☒ Saturation (A3)
☐ Water Marks (B1)
☐ Sediment Deposits (B2)
☐ Drift Deposits (B3)
☐ Algal Mat or Crust (B4)
☐ Iron Deposits (B5)
☐ Surface Soil Cracks (B6)
☐ Inundation Visible on Aerial Imagery (B7)
☐ Sparsely Vegetated Concave Surface (B8)
☐ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B)**
☐ Salt Crust (B11)
☐ Aquatic Invertebrates (B13)
☐ Hydrogen Sulfide Odor (C1)
☐ Oxidized Rhizospheres along Living Roots (C3)
☐ Presence of Reduced Iron (C4)
☐ Recent Iron Reduction in Tilled Soils (C6)
☐ Stunted or Stressed Plants (D1) (**LRR A**)
☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

☐ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B)**
☐ Drainage Patterns (B10)
☐ Dry-Season Water Table (C2)
☐ Saturation Visible on Aerial Imagery (C9)
☐ Geomorphic Position (D2)
☐ Shallow Aquitard (D3)
☐ FAC-Neutral Test (D5)
☐ Raised Ant Mounds (D6) (**LRR A**)
☐ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ______ No X Depth (inches): ______
Water Table Present? Yes ______ No X Depth (inches): ______
Saturation Present? (includes capillary fringe) Yes X No ______ Depth (inches): 12

Wetland Hydrology Present? Yes X **No** ______

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

USGS 12423240 - Blacktail Creek at Butte, MT registered 31 cfs and 30-year median is 20 cfs.

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: BPSOU BRW City/County: Butte-Silver Bow Sampling Date: June 13, 2019

Applicant/Owner: ARCO State: MT Sampling Point: 7B

Investigator(s): Strong Section, Township, Range: Section 24 T03N R08W

Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): none Slope (%): <1%

Subregion (LRR): LRR E Lat: ____ Long: ____ Datum: ____

Soil Map Unit Name: Dumps, mine NWI classification: Riverine

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ____ (If no, explain in Remarks.)

Are Vegetation Yes, Soil Yes, or Hydrology No significantly disturbed? Are “Normal Circumstances” present? Yes ____ No X

Are Vegetation No, Soil Yes, or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes X No ____

Hydric Soil Present? Yes X No ____

Wetland Hydrology Present? Yes ____ No X

Is the Sampled Area within a Wetland? **Yes** ____ **No** X

Remarks:

The site is a reconstructed floodplain and stream channel developed over 20 years ago. Soils were brought in from a barrow source and are non-native.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ____)			
1.			
2.			
3.			
4.			
	0	= Total Cover	
Sapling/Shrub Stratum (Plot size: 15' radius)			
1.			
2.			
3.			
4.			
5.			
	0	= Total Cover	
Herb Stratum (Plot size: 5' radius)			
1. Salix exigua	5	No	FACW
2. Juncus balticus	45	Yes	OBL
3. Alopercurus pratensis	25	Yes	FAC
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	75	= Total Cover	
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
	0	= Total Cover	

% Bare Ground in Herb Stratum 20

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 = 0
FACW species		x 2 = 0
FAC species		x 3 = 0
FACU species		x 4 = 0
UPL species		x 5 = 0
Column Totals:	0 (A)	0 (B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** X **No** ____

Remarks:

SOIL

Sampling Point: 7B

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0 - 4	10YR 3/2	100					SCL	
2 - 16	10YR 4/2	95	10YR 4/6	5	CS	M	Sand	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
_X_ Very Shallow Dark Surface (TF12)
_X_ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ___

Depth (inches): ___

Hydric Soil Present? **Yes** _X_ **No** ___

Remarks:

Reconstructed soil. Early soil genesis. Determined to by hydric due to proximity to water table.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B)**
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B)**
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ___ No _X_ Depth (inches): ___
Water Table Present? Yes ___ No _X_ Depth (inches): ___
Saturation Present? (includes capillary fringe) Yes ___ No _X_ Depth (inches): ___

Wetland Hydrology Present? Yes ___ **No** _X_

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

USGS 12423240 - Blacktail Creek at Butte, MT registered 31 cfs and 30-year median is 20 cfs.

Remarks:

No water found in the upper 14 inches.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: BPSOU BRW City/County: Butte-Silver Bow Sampling Date: June 13, 2019
Applicant/Owner: ARCO State: MT Sampling Point: 8A
Investigator(s): Strong Section, Township, Range: Section 24 T03N R08W
Landform (hillslope, terrace, etc.): Streambank Local relief (concave, convex, none): none Slope (%): 3%
Subregion (LRR): LRR E Lat: Long: Datum:
Soil Map Unit Name: Dumps, mine NWI classification: Riverine
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks.)
Are Vegetation Yes, Soil Yes, or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes No X
Are Vegetation No, Soil Yes, or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes X No
Hydric Soil Present? Yes X No
Wetland Hydrology Present? Yes X No

Is the Sampled Area within a Wetland? Yes X No

Remarks:
The site is a reconstructed floodplain and stream channel developed over 20 years ago. Soils were brought in from a barrow source and are non-native.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	0 = Total Cover		
Sapling/Shrub Stratum (Plot size: 15' radius)			
1.			
2.			
3.			
4.			
5.			
	0 = Total Cover		
Herb Stratum (Plot size: 5' radius)			
1. Carex utriculata	30	Yes	OBL
2. Cirsium arvense	T	No	FAC
3. Rumex salicifolius	30	Yes	FACW
4. Typha latifolia	T	No	OBL
5. Poa pratensis	20	Yes	FAC
6.			
7.			
8.			
9.			
10.			
11.			
	80 = Total Cover		
Woody Vine Stratum (Plot size:)			
1.			
2.			
	0 = Total Cover		

% Bare Ground in Herb Stratum 20

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)
Total Number of Dominant Species Across All Strata: 3 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 = 0
FACW species		x 2 = 0
FAC species		x 3 = 0
FACU species		x 4 = 0
UPL species		x 5 = 0
Column Totals:	0 (A)	0 (B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- 3 - Prevalence Index is ≤3.0[1]
- 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- 5 - Wetland Non-Vascular Plants[1]
- Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No

Remarks:

SOIL

Sampling Point: 8A

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0 - 13+	10 YR 2/2	95	5 YR 4/4	5	RM	M	SL-SCL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

☐ Histosol (A1)
☐ Histic Epipedon (A2)
☐ Black Histic (A3)
☐ Hydrogen Sulfide (A4)
☐ Depleted Below Dark Surface (A11)
☐ Thick Dark Surface (A12)
☐ Sandy Mucky Mineral (S1)
☐ Sandy Gleyed Matrix (S4)
☐ Sandy Redox (S5)
☐ Stripped Matrix (S6)
☐ Loamy Mucky Mineral (F1) (**except MLRA 1**)
☐ Loamy Gleyed Matrix (F2)
☐ Depleted Matrix (F3)
☐ Redox Dark Surface (F6)
☐ Depleted Dark Surface (F7)
☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

☐ 2 cm Muck (A10)
☐ Red Parent Material (TF2)
☐ Very Shallow Dark Surface (TF12)
☒ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes [✓ ×] No ______

Remarks:

Reconstructed soil. Early soil genesis. Determined to by hydric due to proximity to water table. Exhibits very shallow dark surface (F22).

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

☐ Surface Water (A1)
☒ High Water Table (A2)
☒ Saturation (A3)
☐ Water Marks (B1)
☐ Sediment Deposits (B2)
☐ Drift Deposits (B3)
☐ Algal Mat or Crust (B4)
☐ Iron Deposits (B5)
☐ Surface Soil Cracks (B6)
☐ Inundation Visible on Aerial Imagery (B7)
☐ Sparsely Vegetated Concave Surface (B8)
☐ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B)**
☐ Salt Crust (B11)
☐ Aquatic Invertebrates (B13)
☐ Hydrogen Sulfide Odor (C1)
☐ Oxidized Rhizospheres along Living Roots (C3)
☐ Presence of Reduced Iron (C4)
☐ Recent Iron Reduction in Tilled Soils (C6)
☐ Stunted or Stressed Plants (D1) (**LRR A**)
☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

☐ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B)**
☐ Drainage Patterns (B10)
☐ Dry-Season Water Table (C2)
☐ Saturation Visible on Aerial Imagery (C9)
☐ Geomorphic Position (D2)
☐ Shallow Aquitard (D3)
☐ FAC-Neutral Test (D5)
☐ Raised Ant Mounds (D6) (**LRR A**)
☐ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ______ No [✓ ×] Depth (inches): ______
Water Table Present? Yes [✓ ×] No ______ Depth (inches): 10
Saturation Present? (includes capillary fringe) Yes [✓ ×] No ______ Depth (inches): 12

Wetland Hydrology Present? Yes [✓ ×] No ______

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

USGS 12423240 - Blacktail Creek at Butte, MT registered 31 cfs and 30-year median is 20 cfs.

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: BPSOU BRW City/County: Butte-Silver Bow Sampling Date: June 13, 2019
Applicant/Owner: ARCO State: MT Sampling Point: 8B
Investigator(s): Strong Section, Township, Range: Section 24 T03N R08W
Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): none Slope (%): <1%
Subregion (LRR): LRR E Lat: Long: Datum:
Soil Map Unit Name: Dumps, mine NWI classification: Riverine
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks.)
Are Vegetation Yes, Soil Yes, or Hydrology No significantly disturbed? Are “Normal Circumstances” present? Yes No X
Are Vegetation No, Soil Yes, or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes X No Hydric Soil Present? Yes No X Wetland Hydrology Present? Yes No X	**Is the Sampled Area within a Wetland? Yes No X**

Remarks:
The site is a reconstructed floodplain and stream channel developed over 20 years ago. Soils were brought in from a barrow source and are non-native.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size:)			
1.			
2.			
3.			
4.			
	0	= Total Cover	
Sapling/Shrub Stratum (Plot size: 15' radius)			
1.			
2.			
3.			
4.			
5.			
	0	= Total Cover	
Herb Stratum (Plot size: 5' radius)			
1. Poa pratensis	30	Yes	FAC
2. Juncus balticus	15	Yes	OBL
3. Carex utriculata	15	Yes	OBL
4. Rumex salicifoius	10	No	FACW
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	70	= Total Cover	
Woody Vine Stratum (Plot size:)			
1.			
2.			
	0	= Total Cover	

% Bare Ground in Herb Stratum 30

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)
Total Number of Dominant Species Across All Strata: 3 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	0
FACW species		x 2 =	0
FAC species		x 3 =	0
FACU species		x 4 =	0
UPL species		x 5 =	0
Column Totals:	0 (A)		0 (B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ☐ 1 - Rapid Test for Hydrophytic Vegetation
- ☒ 2 - Dominance Test is >50%
- ☐ 3 - Prevalence Index is ≤3.0[1]
- ☐ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ☐ 5 - Wetland Non-Vascular Plants[1]
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No

Remarks:

SOIL

Sampling Point: 8B

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0 - 2	10YR 4/4	100					SCL	
2 - 5	10YR 3/2	100					CL	
5+	2.5Y 4/2	100					SC	

[1] Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2] Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ☐ 2 cm Muck (A10)
- ☐ Red Parent Material (TF2)
- ☒ Very Shallow Dark Surface (TF12)
- ☒ Other (Explain in Remarks)

[3] Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______

Depth (inches): ______

Hydric Soil Present? **Yes** ☐ **No** ☒

Remarks:

Reconstructed soil. Early soil genesis.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B)**
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Stunted or Stressed Plants (D1) (**LRR A**)
- ☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ☐ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B)**
- ☐ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Raised Ant Mounds (D6) (**LRR A**)
- ☐ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ☐ No ☒ Depth (inches): ______

Water Table Present? Yes ☐ No ☒ Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ☐ No ☒ Depth (inches): ______

Wetland Hydrology Present? **Yes** ☐ **No** ☒

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

USGS 12423240 - Blacktail Creek at Butte, MT registered 31 cfs and 30-year median is 20 cfs.

Remarks:

Water estimated at 20" based on stream location.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: BPSOU BRW City/County: Butte-Silver Bow Sampling Date: June 14, 2019
Applicant/Owner: ARCO State: MT Sampling Point: 9A
Investigator(s): Strong Section, Township, Range: Section 24 T03N R08W
Landform (hillslope, terrace, etc.): Streambank Local relief (concave, convex, none): none Slope (%): 1%
Subregion (LRR): LRR E Lat: ____ Long: ____ Datum: ____
Soil Map Unit Name: Dumps, mine NWI classification: Riverine
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ____ (If no, explain in Remarks.)
Are Vegetation Yes, Soil Yes, or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes ____ No X
Are Vegetation No, Soil Yes, or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes X No ____
Hydric Soil Present? Yes X No ____
Wetland Hydrology Present? Yes X No ____

Is the Sampled Area within a Wetland? Yes X No ____

Remarks:
The site is a reconstructed floodplain and stream channel developed over 20 years ago. Soils were brought in from a barrow source and are non-native.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ____)			
1.			
2.			
3.			
4.			
	0 = Total Cover		
Sapling/Shrub Stratum (Plot size: 15' radius)			
1.			
2.			
3.			
4.			
5.			
	0 = Total Cover		
Herb Stratum (Plot size: 5' radius)			
1. Carex utricula	7	No	OBL
2. Cirsium arvense	5	No	FAC
3. Bromus inermis	25	Yes	UPL
4. Juncus balticus	20	Yes	FACW
5. Alopercurus pratensis	30	Yes	FAC
6.			
7.			
8.			
9.			
10.			
11.			
	87 = Total Cover		
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
	0 = Total Cover		

% Bare Ground in Herb Stratum 15

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)
Total Number of Dominant Species Across All Strata: 3 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 67% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 = 0
FACW species		x 2 = 0
FAC species		x 3 = 0
FACU species		x 4 = 0
UPL species		x 5 = 0
Column Totals:	0 (A)	0 (B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:

- ☐ 1 - Rapid Test for Hydrophytic Vegetation
- ☒ 2 - Dominance Test is >50%
- ☐ 3 - Prevalence Index is ≤3.0[1]
- ☐ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ☐ 5 - Wetland Non-Vascular Plants[1]
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ____

Remarks:

SOIL

Sampling Point: 9A

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0 - 4	10 YR 2/2	100					L -CL	
4 - 11	10 YR 2/2	95	7.5 YR 4/6	5	CM	M	CL-SCL	
11+	Gley 2.5/N	90	7.5 YR 4/6	10	RM	M	L-CL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

☐ Histosol (A1)
☐ Histic Epipedon (A2)
☐ Black Histic (A3)
☐ Hydrogen Sulfide (A4)
☐ Depleted Below Dark Surface (A11)
☐ Thick Dark Surface (A12)
☐ Sandy Mucky Mineral (S1)
☐ Sandy Gleyed Matrix (S4)
☐ Sandy Redox (S5)
☐ Stripped Matrix (S6)
☐ Loamy Mucky Mineral (F1) (**except MLRA 1**)
☒ Loamy Gleyed Matrix (F2)
☐ Depleted Matrix (F3)
☐ Redox Dark Surface (F6)
☐ Depleted Dark Surface (F7)
☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

☐ 2 cm Muck (A10)
☐ Red Parent Material (TF2)
☐ Very Shallow Dark Surface (TF12)
☒ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type:

Depth (inches):

Hydric Soil Present? **Yes** ☒ **No** ☐

Remarks:

Reconstructed soil. Early genesis. Considered hydric due to presence of groundwater. Exhibits very shallow dark surface (F22).

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

☐ Surface Water (A1)
☐ High Water Table (A2)
☒ Saturation (A3)
☐ Water Marks (B1)
☐ Sediment Deposits (B2)
☐ Drift Deposits (B3)
☐ Algal Mat or Crust (B4)
☐ Iron Deposits (B5)
☐ Surface Soil Cracks (B6)
☐ Inundation Visible on Aerial Imagery (B7)
☐ Sparsely Vegetated Concave Surface (B8)
☐ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B)**
☐ Salt Crust (B11)
☐ Aquatic Invertebrates (B13)
☐ Hydrogen Sulfide Odor (C1)
☐ Oxidized Rhizospheres along Living Roots (C3)
☐ Presence of Reduced Iron (C4)
☐ Recent Iron Reduction in Tilled Soils (C6)
☐ Stunted or Stressed Plants (D1) (**LRR A**)
☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

☐ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B)**
☐ Drainage Patterns (B10)
☐ Dry-Season Water Table (C2)
☐ Saturation Visible on Aerial Imagery (C9)
☐ Geomorphic Position (D2)
☐ Shallow Aquitard (D3)
☐ FAC-Neutral Test (D5)
☐ Raised Ant Mounds (D6) (**LRR A**)
☐ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ☐ No ☒ Depth (inches):
Water Table Present? Yes ☐ No ☒ Depth (inches):
Saturation Present? (includes capillary fringe) Yes ☒ No ☐ Depth (inches): 11

Wetland Hydrology Present? **Yes** ☒ **No** ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

USGS 12423240 - Blacktail Creek at Butte, MT registered 24 cfs and 30-year median is 16 cfs.

Remarks:

Groundwater appears to be seeping under slag wall.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: BPSOU BRW City/County: Butte-Silver Bow Sampling Date: June 14, 2019
Applicant/Owner: ARCO State: MT Sampling Point: 10B
Investigator(s): Strong Section, Township, Range: Section 24 T03N R08W
Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): none Slope (%): <1%
Subregion (LRR): LRR E Lat: ______ Long: ______ Datum: ______
Soil Map Unit Name: Dumps, mine NWI classification: Riverine
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ______ (If no, explain in Remarks.)
Are Vegetation Yes, Soil Yes, or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes ______ No X
Are Vegetation No, Soil Yes, or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No ______	**Is the Sampled Area within a Wetland?** **Yes** ______ **No** X
Hydric Soil Present?	Yes ______	No X	
Wetland Hydrology Present?	Yes ______	No X	

Remarks:
The site is a reconstructed floodplain and stream channel developed over 20 years ago. Soils were brought in from a barrow source and are non-native.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	0	= Total Cover	
Sapling/Shrub Stratum (Plot size: 15' radius)			
1.			
2.			
3.			
4.			
5.			
	0	= Total Cover	
Herb Stratum (Plot size: 5' radius)			
1. Elymus elymoides	30	Yes	FACU
2. Juncus balticus	10	No	FACW
3. Phleum pratensis	30	Yes	OBL
4. Alopercurus pratensis	30	Yes	FAC
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	100	= Total Cover	
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
	0	= Total Cover	

% Bare Ground in Herb Stratum 5

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)
Total Number of Dominant Species Across All Strata: 3 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 67% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	0
FACW species		x 2 =	0
FAC species		x 3 =	0
FACU species		x 4 =	0
UPL species		x 5 =	0
Column Totals:	0 (A)		0 (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** X **No** ______

Remarks:

SOIL

Sampling Point: 10B

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks

[1] Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2] Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3] Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ___
Depth (inches): ___

Hydric Soil Present? **Yes** ___ **No** X

Remarks:

Reconstructed soil. Early soil genesis.
Water not present. No soil pit dug.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B)**
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B)**
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): ___
Water Table Present? Yes ___ No X Depth (inches): ___
Saturation Present? (includes capillary fringe) Yes ___ No X Depth (inches): ___

Wetland Hydrology Present? **Yes** ___ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

USGS 12423240 - Blacktail Creek at Butte, MT registered 31 cfs and 30-year median is 20 cfs.

Remarks:

No saturation or groundwater found.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: BPSOU BRW City/County: Butte-Silver Bow Sampling Date: June 14, 2019

Applicant/Owner: ARCO State: MT Sampling Point: 11A

Investigator(s): Strong Section, Township, Range: Section 24 T03N R08W

Landform (hillslope, terrace, etc.): Streambank Local relief (concave, convex, none): none Slope (%): 1%

Subregion (LRR): LRR E Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: Dumps, mine NWI classification: Riverine

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ______ (If no, explain in Remarks.)

Are Vegetation Yes, Soil Yes, or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes ______ No X

Are Vegetation No, Soil Yes, or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ______	**Is the Sampled Area within a Wetland?** **Yes X No ______**
Hydric Soil Present?	Yes X No ______	
Wetland Hydrology Present?	Yes X No ______	

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
	0	= Total Cover	
Sapling/Shrub Stratum (Plot size: 15' radius)			
1. Salix exigua	15	Yes	FACW
2.			
3.			
4.			
5.			
	15	= Total Cover	
Herb Stratum (Plot size: 5' radius)			
1. Carex utriculata	7	No	OBL
2. Salix exigua	25	Yes	FAC
3. Bromus inermis	35	Yes	UPL
4. Juncus balticus	20	Yes	FACW
5. Alopercurus pratensis	40	Yes	FAC
6.			
7.			
8.			
9.			
10.			
11.			
	127	= Total Cover	
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
	0	= Total Cover	

% Bare Ground in Herb Stratum 5

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 80% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 = 0
FACW species		x 2 = 0
FAC species		x 3 = 0
FACU species		x 4 = 0
UPL species		x 5 = 0
Column Totals:	0 (A)	0 (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

X 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ 5 - Wetland Non-Vascular Plants[1]

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** X **No** ______

Remarks:

SOIL

Sampling Point: 11A

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0 - 8	10 YR 2/1	93	7.5 YR 4/6	7	RM	M	SCL	
8 - 10	10 YR 2/2	97	7.5 YR 4/6	3	CM	M	LS	
10+	10 YR 2/2	97	7.5 YR 4/6	3	RM	M	SC	

[1] Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2] Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
_X_ Other (Explain in Remarks)

[3] Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______
Depth (inches): ______

Hydric Soil Present? Yes _X_ **No** ___

Remarks:

Reconstructed soil. Early genesis. Considered hydric due to presence of groundwater. Exhibits very shallow dark surface (F22).

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
_X_ High Water Table (A2)
_X_ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B)**
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B)**
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ___ No _X_ Depth (inches): ______
Water Table Present? Yes _X_ No ___ Depth (inches): 11
Saturation Present? (includes capillary fringe) Yes _X_ No ___ Depth (inches): 9

Wetland Hydrology Present? Yes _X_ **No** ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

USGS 12423240 - Blacktail Creek at Butte, MT registered 24 cfs and 30-year median is 16 cfs.

Remarks:

Groundwater appears to be seeping under slag wall.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: BPSOU BRW City/County: Butte-Silver Bow Sampling Date: June 14, 2019
Applicant/Owner: ARCO State: MT Sampling Point: 11B
Investigator(s): Strong Section, Township, Range: Section 24 T03N R08W
Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): none Slope (%): <1%
Subregion (LRR): LRR E Lat: ______ Long: ______ Datum: ______
Soil Map Unit Name: Dumps, mine NWI classification: Riverine
Are climatic / hydrologic conditions on the site typical for this time of year? [✓ Yes] No ______ (If no, explain in Remarks.)
Are Vegetation Yes, Soil Yes, or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes ______ [✓ No]
Are Vegetation No, Soil Yes, or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? [✓ Yes] No ______
Hydric Soil Present? Yes ______ [✓ No]
Wetland Hydrology Present? Yes ______ [✓ No]

Is the Sampled Area within a Wetland? **Yes** ______ **[✓ No]**

Remarks:
The site is a reconstructed floodplain and stream channel developed over 20 years ago. Soils were brought in from a barrow source and are non-native.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover	0		
Sapling/Shrub Stratum (Plot size: 15' radius)			
1. Salix exigua	50	Yes	FACW
2.			
3.			
4.			
5.			
= Total Cover	50		
Herb Stratum (Plot size: 5' radius)			
1. Elymus elymoides	5	No	FACU
2. Juncus balticus	20	Yes	FACW
3. Alopecurus pratensis	30	Yes	OBL
4. Poa pratensis	10	Yes	FAC
5. Salix exigua	25	Yes	FACW
6. Cirsium arvense	10	No	FAC
7.			
8.			
9.			
10.			
11.			
= Total Cover	100		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover	0		

% Bare Ground in Herb Stratum 5

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)
Total Number of Dominant Species Across All Strata: 4 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	0
FACW species		x 2 =	0
FAC species		x 3 =	0
FACU species		x 4 =	0
UPL species		x 5 =	0
Column Totals:	0 (A)		0 (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- [✓ 2 - Dominance Test is >50%]
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **[✓ Yes]** **No** ______

Remarks:

SOIL

Sampling Point: 11B

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-2	10 YR 3/2						SCL	
2-11	10 YR 5/4						SC	
11+	10YR 2/2						SL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______________

Depth (inches): ______________

Hydric Soil Present? Yes ______ **No** _×_

Remarks:

Reconstructed soil. Early soil genesis.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B)**
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B)**
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
_×_ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ______ No _×_ Depth (inches): ______________

Water Table Present? Yes ______ No _×_ Depth (inches): ______________

Saturation Present? (includes capillary fringe) Yes ______ No _×_ Depth (inches): ______________

Wetland Hydrology Present? Yes ______ **No** _×_

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

USGS 12423240 - Blacktail Creek at Butte, MT registered 31 cfs and 30-year median is 20 cfs.

Remarks:

Saturated at 16 inches below ground surface

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: BPSOU BRW City/County: Butte-Silver Bow Sampling Date: June 14, 2019
Applicant/Owner: ARCO State: MT Sampling Point: 12A
Investigator(s): Strong Section, Township, Range: Section 24 T03N R08W
Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): none Slope (%): 1%
Subregion (LRR): LRR E Lat: ______ Long: ______ Datum: ______
Soil Map Unit Name: Dumps, mine NWI classification: Riverine
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)
Are Vegetation Yes, Soil Yes, or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes ___ No X
Are Vegetation No, Soil Yes, or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes X No ___
Hydric Soil Present? Yes X No ___
Wetland Hydrology Present? Yes X No ___

Is the Sampled Area within a Wetland? Yes X No ___

Remarks:
The site is a reconstructed floodplain and stream channel developed over 20 years ago. Soils were brought in from a barrow source and are non-native.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
	0 = Total Cover		
Sapling/Shrub Stratum (Plot size: 15' radius)			
1.			
2.			
3.			
4.			
5.			
	0 = Total Cover		
Herb Stratum (Plot size: 5' radius)			
1. Alopercurus pratensis	40	Yes	FACW
2. Juncus balticus	30	Yes	FACW
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	70 = Total Cover		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
	0 = Total Cover		
% Bare Ground in Herb Stratum 5			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)
Total Number of Dominant Species Across All Strata: 2 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 = 0
FACW species		x 2 = 0
FAC species		x 3 = 0
FACU species		x 4 = 0
UPL species		x 5 = 0
Column Totals:	0 (A)	0 (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ___

Remarks:

SOIL

Sampling Point: 12A

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
1-0								Organic Layer
0 - 7	10 YR 5/2	10					SC	
7+	10 YR 5/2	90	10YR 3/1	10	RM	M	SC	

[1] Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2] Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

☐ Histosol (A1)
☐ Histic Epipedon (A2)
☐ Black Histic (A3)
☐ Hydrogen Sulfide (A4)
☐ Depleted Below Dark Surface (A11)
☐ Thick Dark Surface (A12)
☐ Sandy Mucky Mineral (S1)
☐ Sandy Gleyed Matrix (S4)
☒ Sandy Redox (S5)
☐ Stripped Matrix (S6)
☐ Loamy Mucky Mineral (F1) (**except MLRA 1**)
☐ Loamy Gleyed Matrix (F2)
☐ Depleted Matrix (F3)
☐ Redox Dark Surface (F6)
☐ Depleted Dark Surface (F7)
☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

☐ 2 cm Muck (A10)
☐ Red Parent Material (TF2)
☐ Very Shallow Dark Surface (TF12)
☒ Other (Explain in Remarks)

[3] Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes X No ______

Remarks:

Reconstructed soil. Early genesis. Considered hydric due to presence of groundwater. Sandy redox close to requirement (<6" bgs). Exhibits very shallow dark surface (F22).

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

☐ Surface Water (A1)
☒ High Water Table (A2)
☒ Saturation (A3)
☐ Water Marks (B1)
☐ Sediment Deposits (B2)
☐ Drift Deposits (B3)
☐ Algal Mat or Crust (B4)
☐ Iron Deposits (B5)
☐ Surface Soil Cracks (B6)
☐ Inundation Visible on Aerial Imagery (B7)
☐ Sparsely Vegetated Concave Surface (B8)
☐ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B)**
☐ Salt Crust (B11)
☐ Aquatic Invertebrates (B13)
☐ Hydrogen Sulfide Odor (C1)
☐ Oxidized Rhizospheres along Living Roots (C3)
☐ Presence of Reduced Iron (C4)
☐ Recent Iron Reduction in Tilled Soils (C6)
☐ Stunted or Stressed Plants (D1) (**LRR A**)
☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

☐ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B)**
☐ Drainage Patterns (B10)
☐ Dry-Season Water Table (C2)
☐ Saturation Visible on Aerial Imagery (C9)
☐ Geomorphic Position (D2)
☐ Shallow Aquitard (D3)
☒ FAC-Neutral Test (D5)
☐ Raised Ant Mounds (D6) (**LRR A**)
☐ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ______ No X Depth (inches): ______
Water Table Present? Yes X No ______ Depth (inches): 11
Saturation Present? (includes capillary fringe) Yes X No ______ Depth (inches): 9

Wetland Hydrology Present? Yes X No ______

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

USGS 12423240 - Blacktail Creek at Butte, MT registered 24 cfs and 30-year median is 16 cfs.

Remarks:

Groundwater seeping in from base of fill.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: BPSOU BRW City/County: Butte-Silver Bow Sampling Date: June 14, 2019
Applicant/Owner: ARCO State: MT Sampling Point: 12B
Investigator(s): Strong Section, Township, Range: Section 24 T03N R08W
Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): none Slope (%): <1%
Subregion (LRR): LRR E Lat: ______ Long: ______ Datum: ______
Soil Map Unit Name: Dumps, mine NWI classification: Riverine
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)
Are Vegetation Yes, Soil Yes, or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes ___ No X
Are Vegetation No, Soil Yes, or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes X No ___
Hydric Soil Present? Yes ___ No X
Wetland Hydrology Present? Yes ___ No X

Is the Sampled Area within a Wetland? **Yes** ___ **No** X

Remarks:
The site is a reconstructed floodplain and stream channel developed over 20 years ago. Soils were brought in from a barrow source and are non-native.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
	0 = Total Cover		
Sapling/Shrub Stratum (Plot size: 15' radius)			
1.			
2.			
3.			
4.			
5.			
	0 = Total Cover		
Herb Stratum (Plot size: 5' radius)			
1. Phleum pratensis	30	Yes	FACW
2. Juncus balticus	30	Yes	FACW
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	60 = Total Cover		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
	0 = Total Cover		

% Bare Ground in Herb Stratum 20

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)
Total Number of Dominant Species Across All Strata: 2 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 = 0
FACW species		x 2 = 0
FAC species		x 3 = 0
FACU species		x 4 = 0
UPL species		x 5 = 0
Column Totals:	0 (A)	0 (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ 5 - Wetland Non-Vascular Plants[1]
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks:

SOIL

Sampling Point: 12B

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0 - 12	10 YR 5/3	95	10 YR 4/6	5			SC	

[1] Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2] Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3] Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ____________________

Depth (inches): ____________________

Hydric Soil Present? Yes ______ **No** X

Remarks:

Reconstructed soil. Early soil genesis.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B)**
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B)**
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
_X_ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ______ No X Depth (inches): __________
Water Table Present? Yes ______ No X Depth (inches): __________
Saturation Present? (includes capillary fringe) Yes ______ No X Depth (inches): __________

Wetland Hydrology Present? Yes ______ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

USGS 12423240 - Blacktail Creek at Butte, MT registered 31 cfs and 30-year median is 20 cfs.

Remarks:

Saturated at 14 inches below ground surface

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: BPSOU BRW City/County: Butte-Silver Bow Sampling Date: June 14, 2019
Applicant/Owner: ARCO State: MT Sampling Point: 13A
Investigator(s): Strong Section, Township, Range: Section 24 T03N R08W
Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): none Slope (%): 1%
Subregion (LRR): LRR E Lat: ______ Long: ______ Datum: ______
Soil Map Unit Name: Dumps, mine NWI classification: Riverine
Are climatic / hydrologic conditions on the site typical for this time of year? [✓ Yes] No ___ (If no, explain in Remarks.)
Are Vegetation Yes, Soil Yes, or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes ___ [✓ No]
Are Vegetation No, Soil Yes, or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	[✓ Yes] No ___	**Is the Sampled Area within a Wetland?** **[✓ Yes] No ___**
Hydric Soil Present?	[✓ Yes] No ___	
Wetland Hydrology Present?	[✓ Yes] No ___	

Remarks:
The site is a reconstructed floodplain and stream channel developed over 20 years ago. Soils were brought in from a barrow source and are non-native.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover	0		
Sapling/Shrub Stratum (Plot size: 15' radius)			
1.			
2.			
3.			
4.			
5.			
= Total Cover	0		
Herb Stratum (Plot size: 5' radius)			
1. Alopercurus pratensis	40	Yes	FACW
2. Juncus balticus	30	Yes	FACW
3. Elymus elymoides	20	Yes	UPL
4. Achillea millefolium	7	No	FACU
5.			
6.			
7.			
8.			
9.			
10.			
11.			
= Total Cover	97		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover	0		

% Bare Ground in Herb Stratum 5

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)
Total Number of Dominant Species Across All Strata: 3 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 67% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	0
FACW species		x 2 =	0
FAC species		x 3 =	0
FACU species		x 4 =	0
UPL species		x 5 =	0
Column Totals:	0 (A)		0 (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- [✓] 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **[✓ Yes] No ___**

Remarks:

SOIL

Sampling Point: 13A

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix		Redox Features				Texture	Remarks
	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]		
0 - 4	10 YR 4/3	100					SC	
4+	10 YR 5/4	95	10 YR 4/6	5	RM	M	SC	

[1] Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2] Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- _×_ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- _×_ Other (Explain in Remarks)

[3] Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ___

Depth (inches): ___

Hydric Soil Present? **Yes** _×_ **No** ___

Remarks:

Reconstructed soil. Early genesis. Considered hydric due to presence of groundwater. Sandy redox. Exhibits very shallow dark surface (F22).

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- _×_ High Water Table (A2)
- _×_ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B)**
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B)**
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- _×_ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ___ No _×_ Depth (inches): ___

Water Table Present? Yes ___ No _×_ Depth (inches): ___

Saturation Present? (includes capillary fringe) Yes _×_ No ___ Depth (inches): 7

Wetland Hydrology Present? **Yes** _×_ **No** ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

USGS 12423240 - Blacktail Creek at Butte, MT registered 24 cfs and 30-year median is 16 cfs.

Remarks:

Groundwater seeping in from base of fill.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: BPSOU BRW City/County: Butte-Silver Bow Sampling Date: June 14, 2019
Applicant/Owner: ARCO State: MT Sampling Point: 13B
Investigator(s): Strong Section, Township, Range: Section 24 T03N R08W
Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): none Slope (%): <1%
Subregion (LRR): LRR E Lat: ______ Long: ______ Datum: ______
Soil Map Unit Name: Dumps, mine NWI classification: Riverine
Are climatic / hydrologic conditions on the site typical for this time of year? [✓ Yes] No ______ (If no, explain in Remarks.)
Are Vegetation Yes, Soil Yes, or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes ______ [✓ No]
Are Vegetation No, Soil Yes, or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? [✓ Yes] No ______
Hydric Soil Present? Yes ______ [✓ No]
Wetland Hydrology Present? Yes ______ [✓ No]

Is the Sampled Area within a Wetland? **Yes** ______ **[✓ No]**

Remarks:
The site is a reconstructed floodplain and stream channel developed over 20 years ago. Soils were brought in from a barrow source and are non-native.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover	0		
Sapling/Shrub Stratum (Plot size: 15' radius)			
1.			
2.			
3.			
4.			
5.			
= Total Cover	0		
Herb Stratum (Plot size: 5' radius)			
1. Elymus elymoides	15	Yes	UPL
2. Juncus balticus	30	Yes	FACW
3. Bromus inermis	10	No	UPL
4. Medicago sativa	T	No	UPL
5. Linum lewisii	10	No	UNLISTED
6. Alopercurus pratensis	15	Yes	FAC
7. Hedysarum sulphurescens	3	No	UNLISTED
8.			
9.			
10.			
11.			
= Total Cover	83		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover	0		

% Bare Ground in Herb Stratum 20

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC:	2	(A)
Total Number of Dominant Species Across All Strata:	3	(B)
Percent of Dominant Species That Are OBL, FACW, or FAC:	67%	(A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	0
FACW species		x 2 =	0
FAC species		x 3 =	0
FACU species		x 4 =	0
UPL species		x 5 =	0
Column Totals:	0 (A)		0 (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✓ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **[✓ Yes]** **No** ______

Remarks:
Heavy litter cover.

SOIL

Sampling Point: 13B

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0 - 14	10 YR 5/3	100					SCL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)

___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______
Depth (inches): ______

Hydric Soil Present? Yes ______ **No** _X_

Remarks:

Reconstructed soil. Early soil genesis.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)

___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B)**
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B)**
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
_x_ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ______ No _X_ Depth (inches): ______
Water Table Present? Yes ______ No _X_ Depth (inches): ______
Saturation Present? (includes capillary fringe) Yes ______ No _X_ Depth (inches): ______

Wetland Hydrology Present? Yes ______ **No** _X_

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

USGS 12423240 - Blacktail Creek at Butte, MT registered 31 cfs and 30-year median is 20 cfs.

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: BPSOU BRW City/County: Butte-Silver Bow Sampling Date: June 14, 2019

Applicant/Owner: ARCO State: MT Sampling Point: 14A

Investigator(s): Strong Section, Township, Range: Section 24 T03N R08W

Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): none Slope (%): 1%

Subregion (LRR): LRR E Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: Dumps, mine NWI classification: Riverine

Are climatic / hydrologic conditions on the site typical for this time of year? [✓ Yes] No ______ (If no, explain in Remarks.)

Are Vegetation Yes, Soil Yes, or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes ______ [✓ No]

Are Vegetation No, Soil Yes, or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? [✓ Yes] No ______

Hydric Soil Present? [✓ Yes] No ______

Wetland Hydrology Present? [✓ Yes] No ______

Is the Sampled Area within a Wetland? **[✓ Yes] No ______**

Remarks:

The site is a reconstructed floodplain and stream channel developed over 20 years ago. Soils were brought in from a barrow source and are non-native.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover	0		
Sapling/Shrub Stratum (Plot size: 15' radius)			
1.			
2.			
3.			
4.			
5.			
= Total Cover	0		
Herb Stratum (Plot size: 5' radius)			
1. Alopercurus pratensis	30	Yes	FACW
2. Juncus balticus	40	Yes	FACW
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
= Total Cover	70		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover	0		
% Bare Ground in Herb Stratum 30			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 = 0
FACW species		x 2 = 0
FAC species		x 3 = 0
FACU species		x 4 = 0
UPL species		x 5 = 0
Column Totals:	0 (A)	0 (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ☒ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **[✓ Yes] No ______**

Remarks:

Heavy litter of Juncus balticus

SOIL

Sampling Point: 14A

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Redox Features Type[1]	Redox Features Loc[2]	Texture	Remarks
0 - 11	10 YR 5/3	96	10 YR 3/5	4	RM	M	SCL-SC	
11+	10 YR 5/3	70	7.5 YR 4/4	30	RM	M	SC	

[1] Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2] Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
_X_ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
_X_ Very Shallow Dark Surface (TF12)
_X_ Other (Explain in Remarks)

[3] Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes _X_ No ___

Remarks:

Reconstructed soil. Early genesis. Considered hydric due to presence of groundwater. Sandy redox.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
_X_ High Water Table (A2)
_X_ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B)**
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B)**
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
_X_ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ___ No _X_ Depth (inches): ______
Water Table Present? Yes _X_ No ___ Depth (inches): 11
Saturation Present? (includes capillary fringe) Yes _X_ No ___ Depth (inches): 9

Wetland Hydrology Present? Yes _X_ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

USGS 12423240 - Blacktail Creek at Butte, MT registered 24 cfs and 30-year median is 16 cfs.

Remarks:

Groundwater seeping in from base of fill.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: BPSOU BRW City/County: Butte-Silver Bow Sampling Date: June 14, 2019
Applicant/Owner: ARCO State: MT Sampling Point: 14B
Investigator(s): Strong Section, Township, Range: Section 24 T03N R08W
Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): none Slope (%): <1%
Subregion (LRR): LRR E Lat: ______ Long: ______ Datum: ______
Soil Map Unit Name: Dumps, mine NWI classification: Riverine
Are climatic / hydrologic conditions on the site typical for this time of year? [✓ Yes] No ___ (If no, explain in Remarks.)
Are Vegetation Yes, Soil Yes, or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes [✓ No]
Are Vegetation No, Soil Yes, or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes [✓ No]
Hydric Soil Present? Yes [✓ No]
Wetland Hydrology Present? Yes [✓ No]

Is the Sampled Area within a Wetland? Yes [✓ No]

Remarks:

The site is a reconstructed floodplain and stream channel developed over 20 years ago. Soils were brought in from a barrow source and are non-native.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover	0		
Sapling/Shrub Stratum (Plot size: 15' radius)			
1.			
2.			
3.			
4.			
5.			
= Total Cover	0		
Herb Stratum (Plot size: 5' radius)			
1. Elymus elymoides	8	Yes	UPL
2. Juncus balticus	10	Yes	FACW
3. Melilotus Officinalis	5	No	FACU
4. Hedysarum sulphurescens	10	No	UNLISTED
5. Sonchus arvensis	5	No	FACU
6. Alopercurus pratensis	30	Yes	FAC
7.			
8.			
9.			
10.			
11.			
= Total Cover	68		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover	0		

% Bare Ground in Herb Stratum 20

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)
Total Number of Dominant Species Across All Strata: 4 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 67% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	1	x 2 =	2
FAC species	1	x 3 =	3
FACU species	2	x 4 =	8
UPL species	1	x 5 =	5
Column Totals:	4 (A)		18 (B)

Prevalence Index = B/A = 3.25

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
[✓] 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ 5 - Wetland Non-Vascular Plants[1]
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes [✓ No]

Remarks:

SOIL

Sampling Point: 14B

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0 - 14	10 YR 5/4	100					SCL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes ______ No X

Remarks:

Reconstructed soil. Early soil genesis.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B)**
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B)**
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ______ No X Depth (inches): ______

Water Table Present? Yes ______ No X Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ______ No X Depth (inches): ______

Wetland Hydrology Present? Yes ______ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

USGS 12423240 - Blacktail Creek at Butte, MT registered 31 cfs and 30-year median is 20 cfs.

Remarks:

Water at 14 inches below ground surface.

Appendix B
Photographic Log

 **Plot 1. Green flag indicates the transition from a wetland to an upland. Groundwater influenced by streamflow.**	 **Plot 2. Green flag indicates transition from a wetland to a non-wetland riparian area based on depth to saturation. Shrub-scrub community type.**
 **Plot 3. Green flag indicates transition from a wetland to a non-wetland riparian area. Shrub-scrub community type.**	 **East of Plot 4. Green flag indicates transition from a wetland to a non-wetland riparian area based on depth to saturation. Shrub-scrub community type.**
 **Plot 5. Green flag indicates transition from a wetland to a non-wetland riparian area based on depth to saturation. Palustrine emergent community type.**	 **Plot 6. Green flag indicates transition from a wetland to a non-wetland riparian area (behind flag) based on depth to saturation. Palustrine emergent community type and is a low area, possibly historic channel.**

Plot 7. Transition from a non-wetland to a wetland riparian area based on depth to saturation. Palustrine emergent community type.

Plot 8. Green flag indicates transition from a wetland to a non-wetland riparian area. Delineation terminates against the stream area and upstream bank area is not a jurisdictional wetland area.

Plot 9. Green flag indicates delineation route, beginning at creek and terminating at slag pile.

Plot 10. Green flag indicates end of delineation at stream edge. Excavation did not indicate saturation within 16 inches of surface.

Plot 11. Green flag indicates transition from a wetland to a non-wetland riparian area based on depth to saturation. Shrub-scrub community type.

Plot 12. Green flag indicates transition from upland (right) to wetland/terrace (left). Groundwater emanating from upslope area.

Plot 13. Southeast corner of terrace/floodplain, looking southward. Green flag indicates transition from upland (left) to wetland/terrace (right). Groundwater emanating from upslope area.

Plot 14. Southwest end of terrace/floodplain, looking eastward. Transition from upland (right) to wetland/terrace (left). Groundwater emanating from upslope area.

Appendix C
FEWA Evaluation Forms

FEWA Form

Butte Reduction Works – Lower Area Operations

Part A: Definition of Assessment Area

For each functional evaluation to be conducted, it is necessary to define the boundaries of the Assessment Area (AA). The geographical unit to be evaluated may be defined by both natural and administrative boundaries. Natural boundaries are likely to be associated with floodplain edges, steam reaches of similar characteristics, lake complexes, or general hydrological connectivity. Administrative boundaries are most likely to include boundaries of operable units or proposed remedial actions. The AA should be mostly composed of wetland area, although there may also be some non-wetland area intermixed or adjacent to the wetland.

For example, the AA could be an entire operable unit or, if the operable unit is large and complex, it could be subdivided according to physical or biological attributes. Subdividing an operable unit is probably most critical when levels of disturbance or negative impacts to the wetlands vary strongly within the operable unit. However the AA is defined, effective wetland area will be quantified at the level of the operable unit for purposes of accounting total wetland areas before and after remedial actions.

1. What name has been given to this AA? **Butte Reduction Works – Lower Area One Operations (BRW – LAO)**

2. What is the total acreage of the AA? **4.2 acres**

3. In what operable unit is the AA located? **Butte Priority Soils Operable Unit, Silver Bow Creek Butte Area NPL Site.**

4. List any other AAs in this operable unit. **Buffalo Gulch, Butte Reduction Works -BSB, Grove Gulch, Diggings East, Northside Tailings.**

5. Have the boundaries of the AA wetlands been delineated? **Yes**
   Title of delineation report: **2019 Butte Reduction Works Waters of the U.S. Delineation Report**

6. Describe the boundaries of the AA and the location of the wetlands in the AA, including sketch map on following page. Provide a justification for determining the AA boundaries.
   a. **The eastern boundary of the unit is roughly the slag wall located at the west end of the BSB hot plant operation, and the western boundary is a north-south line bisecting the Silver Bow Creek floodplain, 1,800 feet west of Montana Avenue (Figure 1).**

The southern boundary is the Union Pacific Railroad right-of-way and the northern boundary slag walls and LAO operational road.

b. **Justification of the boundary included features which limited any further development including the treatment plant operations access road and the railroad. The western boundary was set as a probable impact limit. The eastern boundary was set based on current use and unremediated areas.**

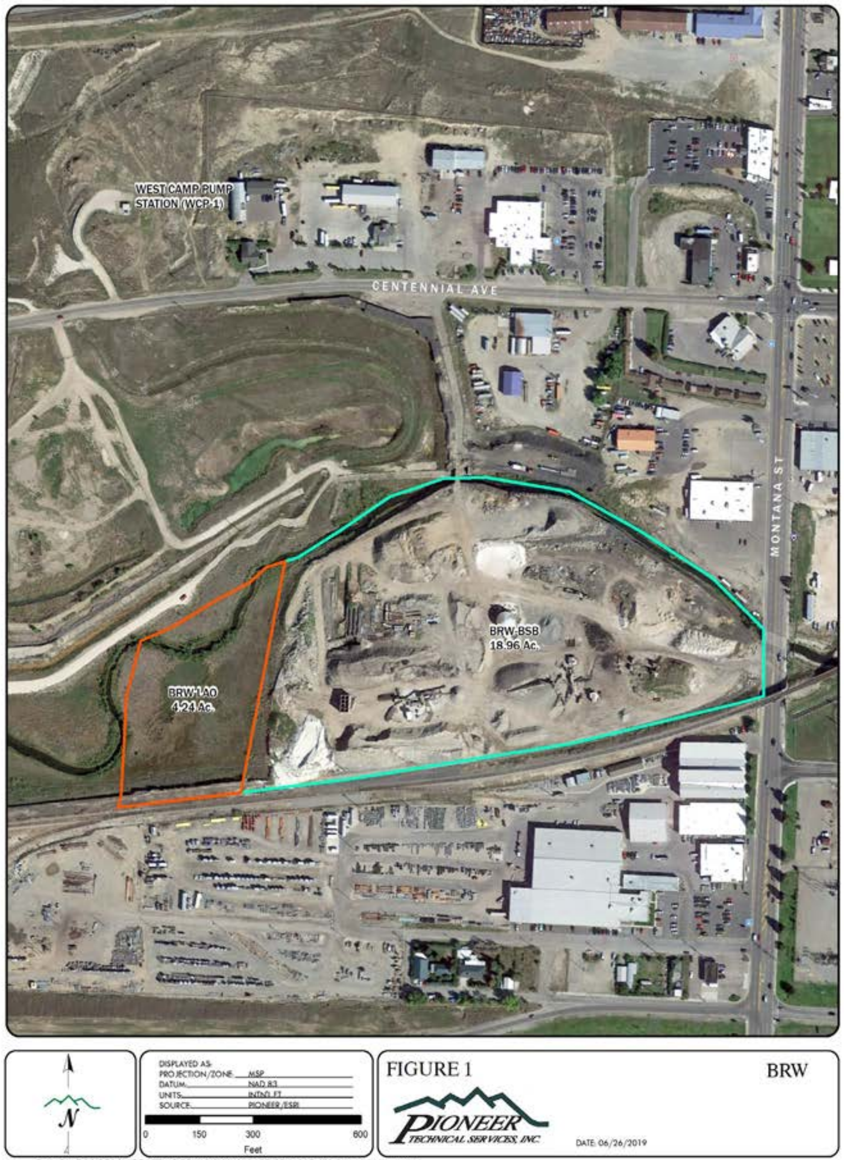


FIGURE 1

Path: P:\ARCO\BPSOU\DRAFTING\BRW\GIS\2018_QAPP\BRW-SAP-002-StMp_18 Murray.mxd

Part B: Characteristics of Assessment Area (AA)

Assessment Area

1. Is the surface area of the wetland within the AA **and** any connected wetlands within one mile of the AA:

   a. less than 5 acres?
   b. between 5 and 40 acres?
   c. between 40 and 200 acres?
   d. greater than 200 acres?

   Comment: Area extends down the creek.

2. The watershed of the AA is:

   a. less than 1 square mile
   b. 1-100 square miles
   c. 101-2,500 square miles
   d. greater than 2,500 square miles

   Comment: **Blacktail Creek Watershed has a watershed of 125 square miles at the gauging site.**

Vegetation and Habitat

3. Which wetland system is dominant (D***) and*** which are also present (P) in the AA?

   a. Lacustrine
   b. **D** Palustrine
   c. **P** Riverine

   Comment: **Palustrine system is found along stream bank and floodplain. A 6- to 20-foot wide channel is classified as riverine.**

4. Which **vegetation class** (as defined by Cowardin et al. 1979) is dominant (D) in the AA wetland *and* which comprise at least 10% or 1 acre of the AA wetland (P)?

	D/P		Percent of Wetland	Major Plant Species Present
a.		Forested		
b.	**P**	**Scrub-Shrub**	**15**	***Narrow-Leaf Willow***
c.	**D**	**Emergent**	**85**	***Field Meadow Fox-Tail,*** ***Baltic Rush,*** ***Northwest Territory Sedge***
d.		Aquatic Bed		

% Vegetative cover of forested, scrub-shrub, and emergent portions of the wetland (in percent of total area): **92%**

Comment:

5. Vegetation/Water Interspersion

If surface water is present in the AA, does the horizontal pattern of obligate emergent vegetation consist of:

a. **relatively few, continuous areas of vegetation with little interspersion with channels or pools, as in Example A of Figure 1? *(Low V/W Interspersion)***

b. a condition intermediate between Examples A and B of Figure 1? ***(Moderate V/W Interspersion)***

c. a mosaic of relatively small patches of vegetation interspersed with channels or pools, as in Example B of Figure 1? ***(High V/W Interspersion)***

Comment: **Reconstructed stream channel and banks. No channelization with vegetation interspersion into channel.**

6. Vegetation Class Interspersion

The horizontal pattern of vegetation classes in the AA consist of:

a. **relatively homogenous areas supporting a single vegetation class with little or no interspersion between these areas? *(Low Vegetation Class Interspersion)***

b. a condition intermediate between (a) and (c)? ***(Moderate Vegetation Class Interspersion)***

c. a highly interspersed mosaic of relatively small areas (at least 100 sq. ft.) that support different vegetation classes? ***(High Vegetation Class Interspersion)***

Comment: **Shrub-scrub habitat along stream channel. Emergent vegetation in areas away from streambank.**

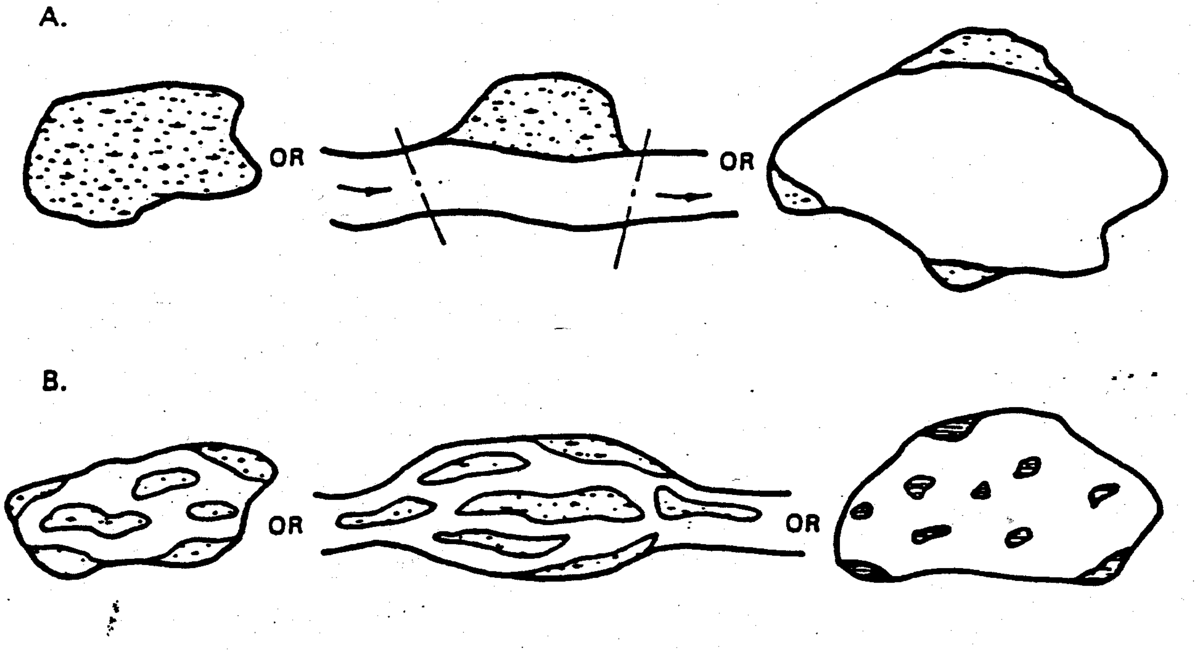


Figure 1. Examples of low (A) and High (B) vegetation/water interspersion.

7. Vegetation Form Richness

   Which of the following conditions best applies to the AA's wetland? **b.**

   a. one vegetation class present and fewer dominance types than in (b). ***(Low Vegetation Form Richness)***
   b. **two vegetation classes present; or at least two dominance types if under 10 acres, four dominance types if 10-100 acres, or six dominance types if greater than 100 acres. *(Moderate Vegetation Form Richness)***
   c. at least three vegetation classes present; **or** at least two vegetation classes *and i)* at least four dominance types if under 10 acres, *ii)* six dominance types of 10-100 acres, or *iii)* eight dominance types if greater than 100 acres. ***(High Vegetation Form Richness)***

   Comment: **Palustrine emergent wetland and scrub-shrub wetland.**

8. This question pertains to the context of the wetland in relation to any nearby wetlands. A wetland is a "cluster" wetland if together with nearby wetlands it has a certain minimum area of emergent or scrub-shrub vegetation. In contrast, it is an "oasis" wetland, if it is a relatively small and isolated amount of emergent or scrub-shrub vegetation (threshold areas for this question are taken directly from WET 2.0).

   a. Within 1,000 yd of the AA's center, is the acreage of emergent wetland greater than 4.6 acres **or** that of scrub-shrub wetland greater than 2.3 acres?

      If so, the wetland is part of a ***cluster*** wetland.

   b. Within 1,000 yd of the AA's center, is the acreage of emergent wetland less than 0.8 acres or that of scrub-shrub wetland less than 0.4 acres?

      If so, the wetland is an ***oasis*** wetland.

   Comment: **Narrow stream corridor within a developed area makes this site and oaisis.**

9. Is the average width of vegetation dominated by emergent, scrub/shrub, or forested vegetation greater than 20 ft (measure perpendicular to flow)? **Yes.**

   Comment: **The north bank is at or less than 20 feet however the broad south bank approaches 200 feet in areas.**

Hydrology

10. Inlet/Outlet Conditions

Does surface water (excluding precipitation or sheet flow) enter and/or exit the AA through an:

a.	**inlet with permanent flow**
b.	inlet with intermittent flow
c.	**outlet with permanent flow**
d.	outlet with intermittent flow

Comment: **Silver Bow Creek.**

11. Does the AA contain a *channel* with at least seasonally flowing water? **Yes.**

Comment: **Silver Bow Creek below the confluence of Blacktail Creek has continuous flow.**

12. If channel flow is present, does *water velocity* average:

a.	0-0.5 ft/sec
b.	0.5-1.5 ft/sec
c.	1.5-3.3 ft/sec
d.	**3.3+ ft/sec**

Comment: **Estimated based on rough flow calc on 6/22/19 ~6 feet/second at surface.**

13. Hydrologic Alteration

a. Have ditches, canals, channels, or levees been constructed in the AA that result in water flowing out of the AA at a significantly faster rate than would occur without these features? **Yes.**

Comment: **The rate of flow through the AA has been increased due to the "slag canyon" and artificially created streambed and floodplain.**

b. Has an outlet been added to the AA or an inlet been recently (i.e., within the last 10 years) blocked off, significantly altering the hydroperiod of the wetland? **No**.

Comment:

c. Is water level in the AA subject to artificial manipulation (other than for purposes of wildlife or fisheries management)? **Yes.**

Comment: **Groundwater is being captured and routed around the AA for treatment as part of engineered remediation within the City of Butte. The Berkley Pit has prevented discharge from the headwaters. This will be somewhat rectified with the pump and treatment operation to be started at the stream's headwaters.**

14. Hydroperiod

What is the dominant (D) and secondary (S) flooding regime in the AA (see Figure 2 and Cowardin et al. (1979) for key to hydroperiod)?

a.	**D**	**permanently flooded**
b.		intermittently exposed
c.		semi permanently flooded
d.	**D**	**seasonally flooded**
e.		saturated (no standing water)
f.	**S**	**temporarily flooded**
g.		intermittently flooded

Comment: **Streamflow is permanent and contributes to soil hydrology along the banks of the creek. The emergent vegetation along the floodplain and southern portion experiences high groundwater at the beginning of the growing season.**

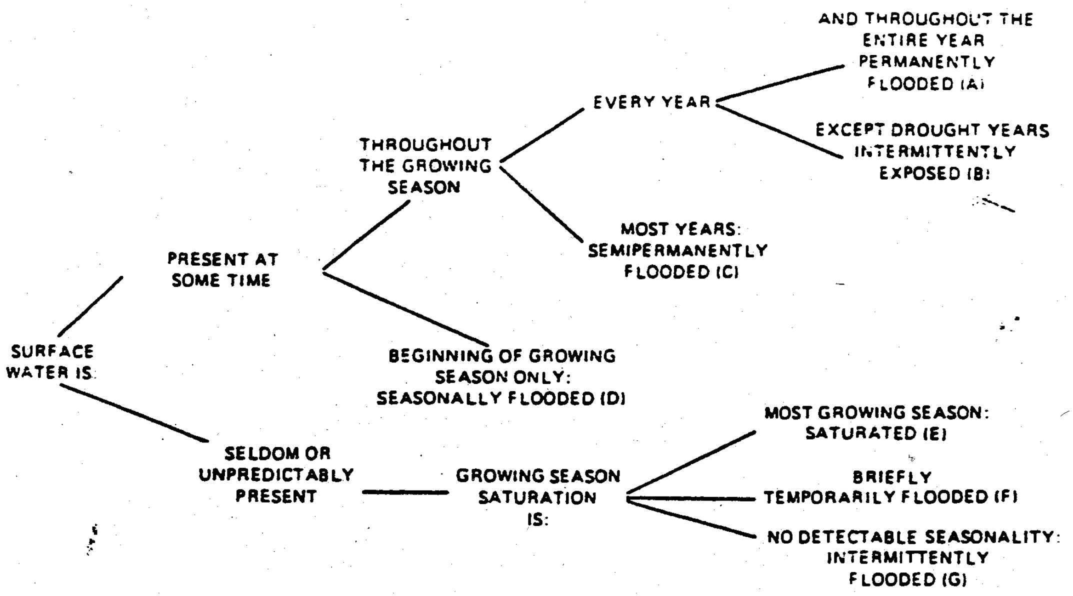


Figure 2. Key for determination of hydroperiod.

Substrate

15. Is the surface substrate (upper 3 inches) in the AA predominantly:

a. organic soil (peat or muck)?
b. fine mineral soil (clay, silt, or loam)? Yes.
c. sand?
d. cobble-gravel?
e. bedrock?
f. rubble?

Comment: **Surface material is imported soil following reconstruction of stream and floodplain.**

Disturbance

16. Is more than 75% of the AA wetland barren tailings surfaces? **No.**

Comment:

17. Has the AA been tilled, filled, bladed, or excavated within the past three years? **No.**

Comment: **Although roughly 75% of the AA is being used for sand and gravel materials storage and processing by Butte-Silver Bow County, the question is assumed to be referring to less impacted areas of the AA.**

18. Are there sediment sources upstream from the AA that may contribute substantial amounts of inorganic sediment to the AA? **Yes.**

Comment: **Upstream sediment sources include urban and suburban areas surrounding Butte and the Blacktail Creek watershed.**

19. Is the AA affected by frequent human activity due to: **Yes.**

    a. visits by people at least three times daily in the AA or areas adjacent and visible to the AA?
    b. human activity common within 1,000 feet if surface water mostly less than 3 feet or within 600 feet if surface water greater than 3 feet deep?

    Although the site specific data requested in this question may not be directly known, the nature of land-use or institutional controls (e.g., zoning, land ownership, permitted land use, etc.) should be a good indicator of whether or not #19(a) or #19(b) are met.

Comment: **Part of the AA is adjacent to BSB maintenance and water treatment facilities.**

Part C: Functional Evaluation

Many questions in Part C are referred to by a three-part notation, such as "B:1,a-b," where B refers to Part B, question #1, answer (a) or (b). Unless otherwise specified, this notation indicates a "yes" answer is needed to the referenced question in Part B. Other questions in Part C occur just once or were considered not pertinent in the general characterization of the AA wetland, and they were therefore not included in part B.

Hydrologic Support (Groundwater Recharge and Discharge)

1. Is the AA in an area known to be a groundwater recharge area? **No.**

   Comment:

2. Is the AA located immediately below a dam? **No.**

   Comment:

3. Does local topography favor groundwater discharge due to any of the following? **Yes.**

   a. geologic fault oriented perpendicular to surface flow
   b. decrease in soil permeability downslope of AA (e.g., bedrock, clay pan)
   c. AA being at base of relatively steep slope
   d. stream adjacent or within AA known to be a "gaining stream"
   e. Other

   Comment:

4. AA has no inlet, but does have permanent outlet? **No.**

   Comment:

Rating for Hydrologic Support

#1 - #4 are all no:	***Low***
#4 is yes: #1, #2 and #3 are all no:	***Moderate***
#1, #2, **or** #3 is yes:	***High***

Floodflow Alteration

5. How many of the following are true of the AA? **(0-2)** (3-4) (5-6)

a. **wetland is within 100-year floodplain of a stream channel**
b. hydroperiod is not permanently flooded or intermittently exposed (B:14, c-g)
c. potential for ponding of high flows is apparent
d. total area of wetland is greater than 200 acres (B:1,d)
e. forest or scrub/shrub vegetation covers greater than 30% of AA wetland (B:4)
f. inlet is wider than outlet

Comment:

Rating for Floodflow Alteration

0-2 of #5 are yes:	***Low***
3-4 of #5 (including #5a) are yes:	***Moderate***
5-6 of #5 (including #5a) are yes:	***High***

Sediment Stabilization and Erosion Control

6. Are potential erosive forces present in AA (e.g., channel flow of high velocity (B:12,d) *or* open water wider than 100 feet) **or** are eroding areas adjacent to wetland? **Yes.**

Comment:

7. Does AA have wetland vegetation that can effectively buffer effects of erosive forces (e.g., well-vegetated stream banks, bands of erect vegetation greater than 20 ft. wide (B:9) adjacent to wide open water, moderate to high water/vegetation interspersion (B:5,b-c)? **Yes.**

Comment: **Stream banks are well vegetated and show no signs of erosion.**

Rating for Sediment Stabilization and Erosion Control

#6 **and/or** #7 are no:	***Low***
Only #7 is yes:	***Moderate***
Both #6 **and** #7 are yes:	***High***

Water Purification (Sediment/Toxicant Reduction, Nutrient Removal/Transformation)

8. Is the AA characterized by **any** of the following? **Yes – b.**

a.	no outlet present (B:10,c **and** d are both *no*) **or** impoundment is by artificial or natural dam
b.	dominated by erect, persistent vegetation that has a dominant hydroperiod of seasonally flooded or wetter (B:14,a-d)
c.	direct evidence of accretion (i.e., accumulation of organic matter or sediment) from historic photos or field sampling an accretion continues to occur
d.	depositional environments with erect vegetation greater than 20 feet wide (B:9)

Comment:

9. Is the AA characterized by three or more of the following? **Yes – c, d, and e.**

a.	constricted outlet
b.	slow-velocity flow (B:12,a but less than 0.3 feet/sec)
c.	**riverine system with good pool-riffle ratios or pools and instream debris**
d.	**relatively long-duration and extent of seasonal flooding (B:14,a-d)**
e.	**having a zone of obligate erect vegetation greater than 20-feet wide (B:9)**

Comment:

10. Is the AA characterized by three or more of the following? **No.**

a.	slow-velocity flow (B:12,a but less than 0.3 feet/sec) **and** AA wetland has greater than 50% vegetation cover (B:4)
b.	fine mineral soils
c.	**50% or greater vegetation cover in the AA wetland (B:4) and nutrient (nitrogen and phosphorus) sources are present upgradient from the AA**
d.	**hydroperiod permanently flooded or saturated or nearly so (B:14,a-e)**
e.	vegetation form richness is high (B:7,c)

Comment:

11. Is the AA characterized by artificial channelization (B:13,a) or tillage (B:17)? **Yes.**

Comment: **Through the reconstructed stream channel.**

12. a. Are there potentially significant non-point or point sources of sediment (B:18), toxicants, or high nitrogen/phosphorus levels upstream within 10 miles? **Yes.**

b. Is AA wetland dominated by barren, tailings surface (B:16)? **No.**

Comment: **Upstream sediment sources include urban and suburban areas surrounding Butte and the Blacktail Creek watershed.**

13. Is channel flow present in the AA or contiguous with the AA (B:11)? **Yes.**

Comment: **Silver Bow Creek**

Rating for Water Purification

#12(b) is yes:	***Very Low***
#12(b) is no **and** #11 is yes:	***Low***
#12(b) **and** #11 are no **and**	
#8, #9, **and** #10 are all no:	***Low***
#8, #9, **or** #10 are yes; #12(a) **or** #13 is no:	***Moderate***
#8, #9, **or** #10 are yes **and** #12(a) and #13 are yes:	***High***

Production Export/Food Chain Support

13. For whatever wetland system is dominant in the AA, how many of the characteristics listed below under that system are present in the AA? (**all**) (more than half) (half or less)

Comment:

Riverine:

a. aquatic habitat is potentially eutrophic
b. significant areas of erect or submerged vegetation are present
c. watershed greater than 100 square miles (B:2,c-d)

Lacustrine:
a. aquatic habitat is potentially eutrophic
b. significant areas of erect or submerged vegetation are present
c. pH not acidic
d. plant productivity high
e. potential for erosion or substantial flooding

Palustrine:
a. True significant areas of erect or submerged vegetation are present
b. True plant productivity high
c. True potential for erosion or substantial flooding
d. True channel flow (B:11) or open water occurs within or adjacent to AA

14. The AA has permanent or intermittent outlet (B:10,c-d)? **Yes.**

Comment:

Rating for Production Export/Food Chain Support

#14 is no	***Low***
#14 is yes and	
#13 is (half or less):	***Low***
#13 is (more than half):	***Moderate***
#13 is (all):	*High*

Aquatic Diversity and Abundance

15. An aquatic bed class (B:4,d) **or** hydroperiod of permanently flooded **or** intermittently exposed (B:14,a-b) is present within the AA? **Yes.**

    Comment: **Stream has a permanently flooded hydroperiod.**

16. Are toxic substances known to enter the aquatic habitat more than once in a year in concentrations high enough to severely depress fish or aquatic invertebrate populations? **Yes.**

    Comment: **Engineered systems have not captured all the heavy metal input from the Butte mining district. Furthermore, the stream receives storm runoff from Butte and the surrounding area.**

17. For whatever wetland system is dominant in the AA, how many of the characteristics listed below under that system are present in the AA? (all) (half or more) (**less than half**)

    Comment:

Riverine:

List A

a. ditches, channels, canals, levees are not present in the AA (B:13,a=no)
b. water velocity is mostly less than 1.5 feet/sec (B:12,a-b)
c. summer water temperatures are less than 20° C

List B

a. a substantial portion of the stream channel is shaded
b. significant areas of good fish cover occur in the stream (e.g., moderately dense aquatic vegetation, crevices, undercut banks, submerged logs and stumps, tree roots, boulders, overhanging vegetation, good pool/riffle ratio)
c. suspended solid concentrations are generally not high (as judged by visual observations or documented measurements)

Lacustrine:

a. has permanent inlet **and** outlet (B:10,a and B:10,c)
b. not dominated by sand bottom
c. high plant form richness (B:7,c) **or** vegetation/water interspersion

(B:5,c)
d. water temperatures greater than 10° C during summer
e. water level not controlled artificially (B:13,c)

Palustrine:

a. has permanent inlet or outlet (B:10,a *or* B:10,c) **or** is fringe or island situation (Note: a fringe wetland is defined as (1) a wetland adjacent to a stream having a width of both channel sides combined less than 1/3 the width of the channel; *or* (2) a wetland adjacent to a body of open water having a cumulative surface area less than 1/3 the surface area of open water.)
b. aquatic habitat has some aquatic bed present (B:4,d) **or** does not have entirely sand substrate (B:15,c = no) *or* some fish cover present
c. high plant form richness (B:7,c) **or** high vegetation/water interspersion (B:5,c)
d. AA wetland is 30-60% open water **and** emergent vegetation is generally obligate wetland species (B:4,c with obligate wetland species)
e. inorganic sediment input does not seriously impact water quality

Rating for Aquatic Diversity and Abundance

#15 is no **or** #16 is yes:	***Low***
#15 is yes **and** #16 is no and	

Riverine:

Any from List A in #17 are no:	***Low***
All from List A are yes **and** less than two from List B in #17 are yes:	***Moderate***
All from List A are yes **and** at least two from List B in #17 are yes:	***High***

Lacustrine and Palustrine:

Less than two from list in #17 are yes:	***Low***
Two to three from list in #17 are yes:	***Moderate***
At least four from list in #17 are yes:	***High***

Wildlife Diversity and Abundance: Breeding

18. Is AA wetland dominated by barren tailings surface (B:16)? **No.**

Comment:

19. Are any of the following true? **No.**
    - a. AA has been tilled, filled, bladed, excavated (B:17)
    - b. AA has been drained or its water supply cut off
    - c. AA wetland and any adjacent wetland total less than 5 acres in surface area (B:1,a) **and** AA wetland has frequent human activity (B:19,a-b)
    - d. substrate is bedrock, rubble, or cobble/gravel (B:15,d-f)
    - e. low vegetation/water interspersion (B:5,a), low vegetation interspersion (B:6,a), **and** low plant form richness (B:7,a)

Comment:

20. For whatever wetland system is dominant in the AA, how many of the characteristics listed below under that system are present in the AA? (all), (more than half), (less than half)

Comment**: Palustrine wetland**

Riverine:

- a. AA and any adjacent wetland total greater than 5 acres (B:1,b-d)
- b. vegetation/water interspersion is moderate to high (B:5,b-c) **or** vegetation interspersion is high (B:6,c) **or** plant form richness is high (B:7,c)
- c. wooded areas (forest or shrub) occur adjacent or connected to AA
- d. water velocity is less than 1.5 feet/sec (B:12,a-b)
- e. adjacent upland vegetation provides suitable nesting sites for dry nesting waterfowl

Lacustrine:

- a. AA and any adjacent wetland total greater than 5 (B:1,b-d)
- b. AA is cluster or oasis wetland (B:8,a-b)
- c. area of mostly obligate emergent species and shallow water (less than 6.6 feet) comprises at lest 10% of AA wetland (B:4)
- d. other wetlands having strongly different hydroperiods are present within 1 mile (B:14,e-g for wetlands within 1 mile)
- e. presence of small island (at least 50 feet from shore) **or** moderate to high vegetation/water interspersion (B:5,b-c) **or** moderate to high vegetation interspersion (B:6,b-c) **or** high plant form richness (B:7,c)

f. adjacent upland vegetation provides suitable nesting sites for dry nesting waterfowl

Palustrine:

a. AA wetland and any adjacent wetland total greater than 5 acres (B:1,b-d)
b. wetlands with a dominant hydroperiod of permanently flooded, intermittently exposed, or seasonally flooded occur within 1 mile of AA (B:14,a-d for wetlands within 1 mile)
c. high vegetation/water interspersion (B:5,c) **or** high vegetation interspersion (B:6,c) **or** high plant form richness (B:7,c)
d. wooded areas (forest or shrub) occur adjacent or connected to AA **or** there is a band of mostly emergent vegetation at least 20 feet wide (B:9)

Rating for Wildlife Diversity and Abundance: Breeding

#18 is yes:	***Very Low***
#18 is no **and** #20 is yes:	***Low***
#18 **and** #19 are no **and**	
less than two of #20 are yes:	***Low***
two to three #20 are yes:	***Moderate***
at least four of #20 are yes:	***High***

Wildlife Diversity and Abundance: Migration

21. Is AA wetland dominated by barren, tailings surface (B:16)? **No.**

Comment:

22. Is either of the following true? **No.**

a. False AA and any adjacent wetland total less than 5 acres in surface area (B:1,a) and frequent human activity occurs in AA (B:19,a-b)
b. False wetland has no outlet (B:10,c *and* d are no) **and** has toxic inputs

Comment: **Stream corridor and adjoining wetlands are continuous downstream.**

23. How many of the following are true of the AA? **None are true.**

a. 30-60% of the AA wetland is open water and emergent vegetation is generally obligate
b. high plant form richness (B:7,c)

c. high vegetation/water interspersion (B:5,c) **or** high vegetation interspersion (B:6,c)
d. wetland vegetation or hydrology not recently (i.e., within last 10 years) disturbed (B:13,a-c **and** B:7,c are all no)
e. wetland in AA and any connected wetlands within 1 mile of the AA are greater than 200 acres (B:1,d)
f. wet mud flat or open water area greater than 20 acres is present

Comment:

Rating for Wildlife Diversity and Abundance: Migration

#21 is yes:	***Very Low***
#21 is no **and** #22 is yes:	***Low***
#21 **and** #22 are no and	
Less than two #23 are yes:	***Low***
Two to three of #23 are yes:	***Moderate***
Four to six of #23 are yes:	***High***

Wildlife Diversity and Abundance: Wintering

24. Is AA dominated by barren, tailings surface (B:16)? **No**.

Comment:

25. Are any of the following true? **No.**

a. all of wetland freezes over for more than one month/year
b. AA and any adjacent wetland total less than 5 acres in surface area (B:1,a) **and** no permanent outlet (B:10,c is no) **and** AA has little or poor shelter for wildlife
c. AA and any adjacent wetland total less than 5 acres in surface area (B:1,a) **and** has frequent human activity during winter (B:19, a-b in winter) **and** no wooded areas (forest or shrub) in or adjacent to AA

Comment: **Adjacent wetland areas are continuous downstream.**

26. Wetland in AA and any adjacent wetland total greater than 5 acres (B:1,b-d) **and** AA wetland is oasis or part of cluster wetland (B:8,a-b)? **True.**

Comment:

27. How many of the following are true of the AA? **One (1).**

a. 30-60% of AA wetland is open water and emergent vegetation is generally obligate wetland species
b. high plant form richness (B:7,c)
c. high vegetation/water interspersion (B:5,c) **or** high vegetation interspersion (B:6,c)
d. wetland vegetation or hydrology not recently disturbed (B:13,a-c **and** B:17 are all no)
e. frequent human activity does not occur in AA (B:19,a-b are no)
f. substrate is not bedrock, rubble, or cobble-gravel (B:15,d-f are no)
g. open water with adjacent grain fields is present in AA

Comment:

Rating for Wildlife Diversity and Abundance: Wintering

#24 is yes:	***Very Low***
#24 is no **and** #25 is yes:	***Low***
#24 **and** #25 are no and	
Less than four of #27 are true:	***Moderate***
#26 is true **and** at least four of #27 are true:	***High***

Threatened, Endangered, or Sensitive (TES) Species Habitat

28. Are there any Federally-listed threatened or endangered plant or animal species that are known to regularly or frequently occur in the AA? **No.**

Comment: **Source Montana Natural Heritage Program Environmental Summary.**

29. Are there any Federally-listed threatened or endangered plant or animal species that are known to occur occasionally in the AA? **No.**

Comment: **Source: Montana Natural Heritage Program Environmental Summary.**

30. Are there any state listed threatened, endangered, or sensitive plant or animal species (Montana Natural Heritage Program status of S1, S2, or S3) that are known to occur regularly in the AA? **No. (See comment.)**

Comment: **Restored habitat could be advantageous to the westslope cutthroat trout. The Little Brown Myotis (S3) could be present based on the Montana Natural**

Heritage Program's Environmental Summary and the description found within the Program's Field Guide ("Most common bat in Montana").

31. No federal or state listed threatened, endangered, or sensitive plant or animal species are known to occur in the AA? **Yes.**

Comment:

Rating for Threatened, Endangered, or Sensitive (TES) Species Habitat

#28, #29, **and** #30 are all no; #31 is yes:	***Low***
#29 **or** #30 is yes:	***Moderate***
#28 is yes:	***High***

Part D: Analysis of Evaluation Results

Summary of Ratings for All Functional Categories

The following procedure should be used to summarize ratings over the ten categories covered in this evaluation, with results entered on the rating sheet on next page:

1. in column (a) list the ratings (very low, low, moderate, or high) in the evaluation of each category;
2. in column (b) fill in the numeric rating as **very low = 0.5, low = 1, moderate = 2,** and **high =3**;
3. if considered necessary, modify given weighting values in column (c) for any category (provide justification below);
4. multiply numeric rating in column (b) by weight in column (c) and recorded in column (d):
5. total scores from all ten categories and enter as “Total;”
6. determine maximum possible score by multiplying weight in column (c) by 3 and total scores from all ten categories, and enter as “Maximum Total” (default = 33);
7. divide “Total” by “Maximum Total” and multiply 3; enter as “Overall Wetland Rating.”

Rating Sheet For Summarizing Results Of Wetland Functional Evaluation – BRW-Lower Area

	Column			
Functional Category	**(a) Rating**	**(b) Numeric Rating**	**(c) Weight***	**(d) Score**
Hydrologic Support	High	3	1.0	3
Floodflow Alteration	Low	1	0.5	0.5
Sediment Stabilization and Erosion Control	High	3	1.0	3
Water Purification	Low	1	1.0	1
Production Export/Food Chain Support	Moderate	2	1.0	2
Aquatic Diversity/Abundance	Low	1	1.5	1.5
Wildlife Diversity/Abundance: Breeding	Moderate	2	1.5	3
Wildlife Diversity/Abundance: Migration	Low	1	1.5	1.5
Wildlife Diversity/Abundance: Wintering	Moderate	2	1.0	2
TES Species Habitat	Low	1	1.0	1
Total (sum of column (d))				18.5
Maximum Total				33
OVERALL RATING FOR AA WETLAND				**1.68**

* The category weight of 0.5 for floodflow alteration is based on the rationale that the floodflow function is generally of less importance on most Superfund site wetlands in the Upper Clark Fork basin due to their position lower down in the watershed; and category weights higher than 1.0 are based on the importance given by regional natural resources agencies to Upper Clark Fork Basin wetlands for wildlife migration/breeding and fisheries habitat. If different widths are used, the rationale for these weightings should be included with this evaluation.

Calculation of Effective Wetland Area

As described in the introduction effective wetland are is the wetland area (in acres) delineated in an operable unit adjusted by its Overall Rating for functional value, as determined on the previous page. This adjustment would be made using the flowing formula:

$$\textbf{Functionally Effective Wetland Area} = \frac{\textbf{Actual Wetland area X Overall Rating}}{\textbf{3}}$$

It should be noted that functionally effective wetland area is a relative area value, i.e., it is some fraction of actual wetland area having an Overall Rating of 3.0. Obviously, an acre value for functionally effective wetland area can only be compared to other such values determined by this method. Functionally effective wetland areas calculated by this formula are intended to be used for comparing pre- and post-remediation wetlands and are not to be considered as actual acres of physical area.

It is evident that choice of the Assessment Area is critical to determining the functionally effective wetland area, since the Overall Rating for each evaluation applies to the entire AA evaluated. Consequently, if the area to be evaluated is made up of areas that have experienced very different levels of disturbance or negative impacts, they should be evaluate desperately.

For all AAs within an operable unit, the acres of functionally effective wetland are to be summed to arrive at a total functionally effective wetland area for that operable unit. This value can then be used as a baseline value for comparison to post-remediation changes in area of functionally effective wetlands. Post-remediation wetland areas can be determined on a preliminary basis using projected outcomes of remediation designs, but a re-evaluation of effective wetland areas should be conducted after remedial actions have taken place. This re-evaluation ideally should be about 10 years following remediation, after any wetlands created or modified as a result of remedial actions have had the opportunity to develop. Preferably, the method described in this form will also be used in the re-evaluation subsequent to remediation actions.

FEWA Form

Butte Reduction Works - BSB

Part A: Definition of Assessment Area

For each functional evaluation to be conducted, it is necessary to define the boundaries of the Assessment Area (AA). The geographical unit to be evaluated may be defined by both natural and administrative boundaries. Natural boundaries are likely to be associated with floodplain edges, steam reaches of similar characteristics, lake complexes, or general hydrological connectivity. Administrative boundaries are most likely to include boundaries of operable units or proposed remedial actions. The AA should be mostly composed of wetland area, although there may also be some non-wetland area intermixed or adjacent to the wetland.

For example, the AA could be an entire operable unit or, if the operable unit is large and complex, it could be subdivided according to physical or biological attributes. Subdividing an operable unit is probably most critical when levels of disturbance or negative impacts to the wetlands vary strongly within the operable unit. However the AA is defined, effective wetland area will be quantified at the level of the operable unit for purposes of accounting total wetland areas before and after remedial actions.

1. What name has been given to this AA? **Butte Reduction Works – Butte Silver Bow Maintenance Facility (BRW-BSB)**

2. What is the total acreage of the AA? **19.0**

3. In what operable unit is the AA located? **Butte Priority Soils Operable Unit, Silver Bow Creek Butte Area NPL Site.**

4. List any other AAs in this operable unit. **Buffalo Gulch, Butte Reduction Works - LAO, Grove Gulch, Diggings East, Northside Tailings.**

5. Have the boundaries of the AA wetlands been delineated?
   Title of delineation report: **2019 Butte Reduction Works Waters of the U.S. Delineation Report**

6. Describe the boundaries of the AA and the location of the wetlands in the AA, including sketch map on following page. Provide a justification for determining the AA boundaries.

a. **The eastern boundary of the unit is Montana Street and the western boundary the area which has already undergone tailings removal. The southern boundary is the Union Pacific Railroad right-of-way and the northern boundary slag walls and LAO operational road.**

b. **Justification of the boundary included features which limited any further development including the treatment plant operations access road and the railroad. The western boundary was set as another AA boundary. The eastern boundary was a city street.**

FIGURE 1 BRW

Path: P:\ARCO\BPSOU\DRAFTING\BRW\GIS\2018_QAPP\BRW-SAP-002-StMp_18 Murray.mxd

Part B: Characteristics of Assessment Area (AA)

Assessment Area

1. Is the surface area of the wetland within the AA **and** any connected wetlands within one mile of the AA:

   a. less than 5 acres?
   b. between 5 and 40 acres?
   c. between 40 and 200 acres?
   d. greater than 200 acres?

   Comment: **Area extends down the creek.**

2. The watershed of the AA is:

   a. less than 1 square mile
   b. 1-100 square miles
   c. 101-2,500 square miles
   d. greater than 2,500 square miles

   Comment: **Blacktail Creek Watershed has a watershed of 125 square miles at the gauging site.**

Vegetation and Habitat

3. Which wetland system is dominant (D***) and*** which are also present (P) in the AA?

   a. Lacustrine
   b. D Palustrine
   c. P Riverine

   Comment: **Palustrine system is found along stream bank and floodplain. The channel is classified as riverine.**

4. Which **vegetation class** (as defined by Cowardin et al. 1979) is dominant (D) in the AA wetland *and* which comprise at least 10% or 1 acre of the AA wetland (P)?

D/P		Percent of Wetland	Major Plant Species Present
a.	Forested		
b.	**Scrub-Shrub**	**50**	***Narrow-Leaf Willow***
c.	**Emergent**	**50**	***Field Meadow Fox-Tail,*** ***Baltic Rush,*** ***Northwest Territory Sedge***
d.	Aquatic Bed		

% Vegetative cover of forested, scrub-shrub, and emergent portions of the wetland (in percent of total area): **6%**

Comment: **Vegetation is limited by the slag walls.**

5. Vegetation/Water Interspersion

If surface water is present in the AA, does the horizontal pattern of obligate emergent vegetation consist of:

a. **relatively few, continuous areas of vegetation with little interspersion with channels or pools, as in Example A of Figure 1? *(Low V/W Interspersion)***
b. a condition intermediate between Examples A and B of Figure 1? ***(Moderate V/W Interspersion)***
c. a mosaic of relatively small patches of vegetation interspersed with channels or pools, as in Example B of Figure 1? ***(High V/W Interspersion)***

Comment: **Channel confined between slag walls.**

6. Vegetation Class Interspersion

The horizontal pattern of vegetation classes in the AA consist of:

a.	**relatively homogenous areas supporting a single vegetation class with little or no interspersion between these areas? *(Low Vegetation Class Interspersion)***
b.	a condition intermediate between (a) and (c)? ***(Moderate Vegetation Class Interspersion)***
c.	a highly interspersed mosaic of relatively small areas (at least 100 sq. ft.) that support different vegetation classes? ***(High Vegetation Class Interspersion)***

Comment: **Vegetation found on adjacent to slag walls where sediments have been deposited on shelves.**

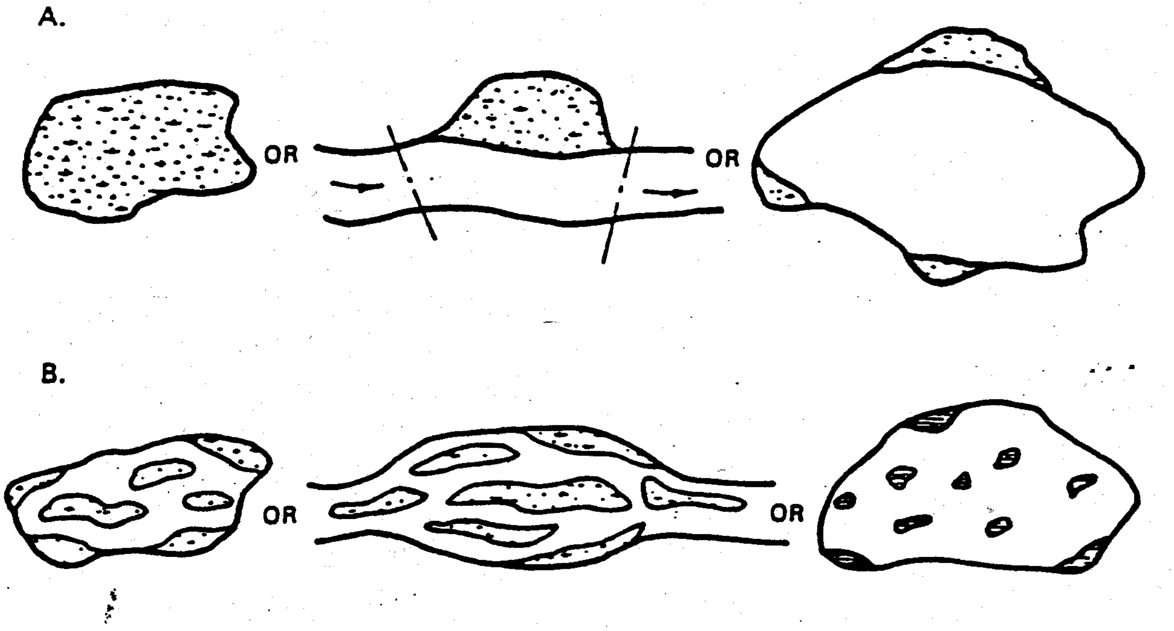


Figure 1. Examples of low (A) and High (B) vegetation/water interspersion.

7. Vegetation Form Richness

   Which of the following conditions best applies to the AA's wetland?

   a. one vegetation class present and fewer dominance types than in (b). ***(Low Vegetation Form Richness)***

   b. **two vegetation classes present; or at least two dominance types if under 10 acres, four dominance types if 10-100 acres, or six dominance types if greater than 100 acres. *(Moderate Vegetation Form Richness)***

   c. at least three vegetation classes present; **or** at least two vegetation classes *and i)* at least four dominance types if under 10 acres, *ii)* six dominance types of 10-100 acres, or *iii)* eight dominance types if greater than 100 acres. ***(High Vegetation Form Richness)***

   Comment: **Vegetation classes present include emergent palustrine and scrub-shrub.**

8. This question pertains to the context of the wetland in relation to any nearby wetlands. A wetland is a "cluster" wetland if together with nearby wetlands it has a certain minimum area of emergent or scrub-shrub vegetation. In contrast, it is an "oasis" wetland, if it is a relatively small and isolated amount of emergent or scrub-shrub vegetation (threshold areas for this question are taken directly from WET 2.0).

   a. Within 1,000 yd of the AA's center, is the acreage of emergent wetland greater than 4.6 acres or that of scrub-shrub wetland greater than 2.3 acres?

   If so, the wetland is part of a ***cluster*** wetland.

   b. Within 1,000 yd of the AA's center, is the acreage of emergent wetland less than 0.8 acres **or** that of scrub-shrub wetland less than 0.4 acres?

   If so, the wetland is an ***oasis*** wetland.

   Comment: **Adjacent wet meadow habitat and downstream connectivity.**

9. Is the average width of vegetation dominated by emergent, scrub/shrub, or forested vegetation greater than 20 ft (measure perpendicular to flow)? **No.**

   Comment: **Slag walls limits vegetation.**

Hydrology

10. Inlet/Outlet Conditions

Does surface water (excluding precipitation or sheet flow) enter and/or exit the AA through an:

a. **inlet with permanent flow**
b. inlet with intermittent flow
c. **outlet with permanent flow**
d. outlet with intermittent flow

Comment: **Silver Bow Creek**

11. Does the AA contain a *channel* with at least seasonally flowing water?

Comment: **Silver Bow Creek**

12. If channel flow is present, does *water velocity* average:

a. 0-0.5 ft/sec
b. 0.5-1.5 ft/sec
c. 1.5-3.3 ft/sec
d. **3.3+ ft/sec**

Comment: **Estimated based on rough flow calc on 6/22/19 ~6 feet/second at surface.**

13. Hydrologic Alteration

   a. Have ditches, canals, channels, or levees been constructed in the AA that result in water flowing out of the AA at a significantly faster rate than would occur without these features? **Yes.**

   Comment: **Slag walls and reconstructed stream channel have significantly increased the rate of flow through the AA.**

   b. Has an outlet been added to the AA or an inlet been recently (i.e., within the last 10 years) blocked off, significantly altering the hydroperiod of the wetland? **No**.

   Comment:

c. Is water level in the AA subject to artificial manipulation (other than for purposes of wildlife or fisheries management)? **Yes.**

Comment: **Groundwater is being captured and routed around the AA for treatment as part of engineered remediation within the City of Butte. The Berkley Pit has prevented discharge from the headwaters. This will be somewhat rectified with the pump and treatment operation to be started at the stream's headwaters.**

14. Hydroperiod

What is the dominant (D) and secondary (S) flooding regime in the AA (see Figure 2 and Cowardin et al. (1979) for key to hydroperiod)?

a.	**D**	**permanently flooded**
b.		intermittently exposed
c.		semi permanently flooded
d.	**D**	**seasonally flooded**
e.	**S**	**saturated (no standing water)**
f.		temporarily flooded
g.		intermittently flooded

Comment:

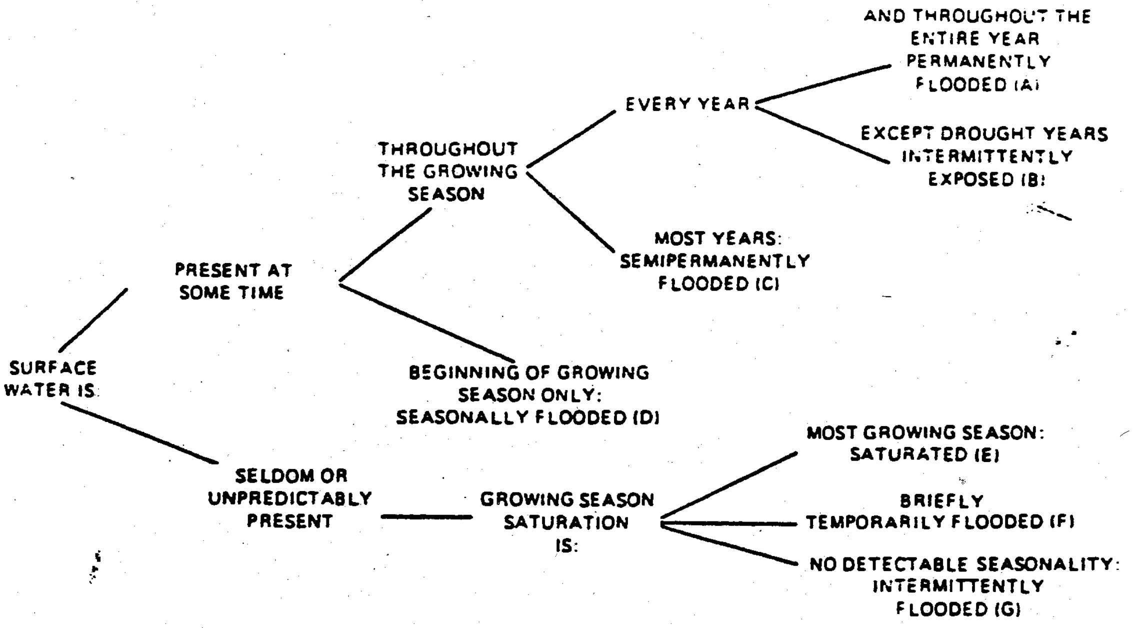


Figure 2. Key for determination of hydroperiod.

Substrate

15. Is the surface substrate (upper 3 inches) in the AA predominantly:

a.	organic soil (peat or muck)?
b.	fine mineral soil (clay, silt, or loam)?
c.	sand?
d.	**cobble-gravel**
e.	bedrock?
f.	rubble?

Comment: **BSB maintenance site dominates AA.**

Disturbance

16. Is more than 75% of the AA wetland barren tailings surfaces? **Yes. See comment.**

Comment: **Colorado Tailings were removed from the BSB maintenance site. However for habitat purposes, the BSB site is "barren." Slag walls will qualify but are less than 25% of the footprint.**

17. Has the AA been tilled, filled, bladed, or excavated within the past three years? **No.**

Comment: **The BSB maintenance site is constantly being filled/excavated but it is a put and take situation. Not in the spirit of the question.**

18. Are there sediment sources upstream from the AA that may contribute substantial amounts of inorganic sediment to the AA? **Yes.**

Comment: **Upstream sediment sources include urban and suburban areas surrounding Butte and the Blacktail Creek watershed.**

19. Is the AA affected by frequent human activity due to: **Yes.**

    a. **visits by people at least three times daily in the AA or areas adjacent and visible to the AA?**
    b. **human activity common within 1,000 feet if surface water mostly less than 3 feet or within 600 feet if surface water greater than 3 feet deep?**

Although the site specific data requested in this question may not be directly known, the nature of land-use or institutional controls (e.g., zoning, land ownership, permitted land use, etc.) should be a good indicator of whether or not #19(a) or #19(b) are met.

Comment: **BSB maintenance facility.**

Part C: Functional Evaluation

Many questions in Part C are referred to by a three-part notation, such as “B:1,a-b,” where B refers to Part B, question #1, answer (a) or (b). Unless otherwise specified, this notation indicates a “yes” answer is needed to the referenced question in Part B. Other questions in Part C occur just once or were considered not pertinent in the general characterization of the AA wetland, and they were therefore not included in part B.

Hydrologic Support (Groundwater Recharge and Discharge)

1. Is the AA in an area known to be a groundwater recharge area? **No.**

   Comment:

2. Is the AA located immediately below a dam? **No.**

   Comment:

3. Does local topography favor groundwater discharge due to any of the following? **No.**

   a. geologic fault oriented perpendicular to surface flow
   b. decrease in soil permeability downslope of AA (e.g., bedrock, clay pan)
   c. AA being at base of relatively steep slope
   d. stream adjacent or within AA known to be a “gaining stream”
   e. Other

   Comment:

4. AA has no inlet, but does have permanent outlet? **No.**

   Comment:

Rating for Hydrologic Support

#1 - #4 are all no:	***Low***
#4 is yes: #1, #2 and #3 are all no:	***Moderate***
#1, #2, **or** #3 is yes:	***High***

Floodflow Alteration

5. How many of the following are true of the AA? (0-2) (3-4) (5-6)

a.	**wetland is within 100-year floodplain of a stream channel**
b.	hydroperiod is not permanently flooded or intermittently exposed (B:14, c-g)
c.	potential for ponding of high flows is apparent
d.	total area of wetland is greater than 200 acres (B:1,d)
e.	forest or scrub/shrub vegetation covers greater than 30% of AA wetland (B:4)
f.	inlet is wider than outlet

Comment:

Rating for Floodflow Alteration

0-2 of #5 are yes:	***Low***
3-4 of #5 (including #5a) are yes:	***Moderate***
5-6 of #5 (including #5a) are yes:	***High***

Sediment Stabilization and Erosion Control

6. Are potential erosive forces present in AA (e.g., channel flow of high velocity (B:12,d) *or* open water wider than 100 feet) **or** are eroding areas adjacent to wetland? **Yes.**

   Comment: **High flows (3.3+ f/s)**

7. Does AA have wetland vegetation that can effectively buffer effects of erosive forces (e.g., well-vegetated stream banks, bands of erect vegetation greater than 20 ft. wide (B:9) adjacent to wide open water, moderate to high water/vegetation interspersion (B:5,b-c)? **Yes.**

   Comment: **Slag walls.**

Rating for Sediment Stabilization and Erosion Control

#6 **and/or** #7 are no:	***Low***
Only #7 is yes:	***Moderate***
Both #6 and #7 are yes:	***High***

Water Purification (Sediment/Toxicant Reduction, Nutrient Removal/Transformation)

8. Is the AA characterized by **any** of the following? **Yes.**

   a. no outlet present (B:10,c **and** d are both *no*) **or** impoundment is by artificial or natural dam
   b. dominated by erect, persistent vegetation that has a dominant hydroperiod of seasonally flooded or wetter (B:14,a-d)
   c. direct evidence of accretion (i.e., accumulation of organic matter or sediment) from historic photos or field sampling an accretion continues to occur
   d. depositional environments with erect vegetation greater than 20 feet wide (B:9)

   Comment:

9. Is the AA characterized by three or more of the following? **No.**

   a. constricted outlet
   b. slow-velocity flow (B:12,a but less than 0.3 feet/sec)
   c. riverine system with good pool-riffle ratios or pools and instream debris
   d. relatively long-duration and extent of seasonal flooding (B:14,a-d)
   e. having a zone of obligate erect vegetation greater than 20-feet wide (B:9)

   Comment: **Limited area within slag canyon.**

10. Is the AA characterized by three or more of the following? **No.**

- a. slow-velocity flow (B:12,a but less than 0.3 feet/sec) **and** AA wetland has greater than 50% vegetation cover (B:4)
- b. fine mineral soils
- c. 50% or greater vegetation cover in the AA wetland (B:4) **and** nutrient (nitrogen and phosphorus) sources are present upgradient from the AA
- **d. hydroperiod permanently flooded or saturated or nearly so (B:14,a-e)**
- e. vegetation form richness is high (B:7,c)

Comment:

11. Is the AA characterized by artificial channelization (B:13,a) or tillage (B:17)? Yes.

Comment: **Slag canyon and reconstructed channel.**

12. a. Are there potentially significant non-point or point sources of sediment (B:18), toxicants, or high nitrogen/phosphorus levels upstream within 10 miles? **Yes.**

b. Is AA wetland dominated by barren, tailings surface (B:16)? **No.**

Comment: **Upstream sediment sources include urban and suburban areas surrounding Butte and the Blacktail Creek watershed. For input purposes, the slag walls could have an input. The BSB site had tailings removed from the footprint previously.**

13. Is channel flow present in the AA or contiguous with the AA (B:11)? **Yes.**

Comment: **Silver Bow Creek**

Rating for Water Purification

#12(b) is yes:	***Very Low***
#12(b) is no and #11 is yes:	***Low***
#12(b) **and** #11 are no **and**	
#8, #9, **and** #10 are all no:	***Low***
#8, #9, **or** #10 are yes; #12(a) **or** #13 is no:	***Moderate***
#8, #9, **or** #10 are yes **and** #12(a) and #13 are yes:	***High***

Production Export/Food Chain Support

13. For whatever wetland system is dominant in the AA, how many of the characteristics listed below under that system are present in the AA? (all) (more than half) (half or less)

Comment:

Riverine:

a.	aquatic habitat is potentially eutrophic
b.	significant areas of erect or submerged vegetation are present
c.	watershed greater than 100 square miles (B:2,c-d)

Lacustrine:

a.	aquatic habitat is potentially eutrophic
b.	significant areas of erect or submerged vegetation are present
c.	pH not acidic
d.	plant productivity high
e.	potential for erosion or substantial flooding

Palustrine:

a.	True	significant areas of erect or submerged vegetation are present
b.	True	plant productivity high
c.	True	potential for erosion or substantial flooding
d.	**True**	**channel flow (B:11) or open water occurs within or adjacent to AA**

14. The AA has permanent or intermittent outlet (B:10,c-d)? **Yes**.

Comment:

Rating for Production Export/Food Chain Support

#14 is no	***Low***
#14 is yes and	
#13 is (half or less):	***Low***
#13 is (more than half):	***Moderate***
#13 is (all):	***High***

Aquatic Diversity and Abundance

15. An aquatic bed class (B:4,d) **or** hydroperiod of permanently flooded **or** intermittently exposed (B:14,a-b) is present within the AA? Yes.

    Comment: **Silver Bow Creek**

16. Are toxic substances known to enter the aquatic habitat more than once in a year in concentrations high enough to severely depress fish or aquatic invertebrate populations? **Yes.**

    Comment: **Engineered systems have not captured all the heavy metal input from the Butte mining district. Furthermore, the stream receives storm runoff from Butte and the surrounding area.**

17. For whatever wetland system is dominant in the AA, how many of the characteristics listed below under that system are present in the AA? (all) (half or more) (less than half)

    Comment: **Palustrine**

Riverine:

List A

a.	ditches, channels, canals, levees are not present in the AA (B:13,a=no)
b.	water velocity is mostly less than 1.5 feet/sec (B:12,a-b)
c.	summer water temperatures are less than 20° C

List B

a.	a substantial portion of the stream channel is shaded
b.	significant areas of good fish cover occur in the stream (e.g., moderately dense aquatic vegetation, crevices, undercut banks, submerged logs and stumps, tree roots, boulders, overhanging vegetation, good pool/riffle ratio)
c.	suspended solid concentrations are generally not high (as judged by visual observations or documented measurements)

Lacustrine:

a.	has permanent inlet **and** outlet (B:10,a and B:10,c)
b.	not dominated by sand bottom
c.	high plant form richness (B:7,c) **or** vegetation/water interspersion (B:5,c)

d. water temperatures greater than 10° C during summer
e. water level <u>not</u> controlled artificially (B:13,c)

Palustrine:

a. **has permanent inlet or outlet** (B:10,a *or* B:10,c) **or** is fringe or island situation (Note: a fringe wetland is defined as (1) a wetland adjacent to a stream having a width of both channel sides combined less than 1/3 the width of the channel; *or* (2) a wetland adjacent to a body of open water having a cumulative surface area less than 1/3 the surface area of open water.)
b. aquatic habitat has some aquatic bed present (B:4,d) **or** does <u>not</u> have entirely sand substrate (B:15,c = no) *or* some fish cover present
c. high plant form richness (B:7,c) **or** high vegetation/water interspersion (B:5,c)
d. AA wetland is 30-60% open water **and** emergent vegetation is generally obligate wetland species (B:4,c with obligate wetland species)
e. inorganic sediment input does <u>not</u> seriously impact water quality

Rating for Aquatic Diversity and Abundance

#15 is no **or** #16 is yes:	***Low***
#15 is yes **and** #16 is no and	

Riverine:

Any from List A in #17 are no:	***Low***
All from List A are yes **and** less than two from List B in #17 are yes:	***Moderate***
All from List A are yes **and** at least two from List B in #17 are yes:	***High***

Lacustrine and Palustrine:

Less than two from list in #17 are yes:	***Low***
Two to three from list in #17 are yes:	***Moderate***
At least four from list in #17 are yes:	***High***

Wildlife Diversity and Abundance: Breeding

18. Is AA wetland dominated by barren tailings surface (B:16)? **Yes.**

Comment: **The slag canyon and walls are considered as tailings material for the purpose of answering this question. The BSB maintenance area has had the Colorado Tailings removed and clean sand and gravel material imported. It is considered barren for wildlife breeding purposes.**

19. Are any of the following true? **Yes.**

a. AA has been tilled, filled, bladed, excavated (B:17)
b. AA has been drained or its water supply cut off
c. AA wetland and any adjacent wetland total less than 5 acres in surface area (B:1,a) **and** AA wetland has frequent human activity (B:19,a-b)
d. **substrate is bedrock, rubble, or cobble/gravel (B:15,d-f)**
e. low vegetation/water interspersion (B:5,a), low vegetation interspersion (B:6,a), **and** low plant form richness (B:7,a)

Comment:

20. For whatever wetland system is dominant in the AA, how many of the characteristics listed below under that system are present in the AA? (all), (more than half), (**less than half**)

Comment**:**

Riverine:

a. AA and any adjacent wetland total greater than 5 acres (B:1,b-d)
b. vegetation/water interspersion is moderate to high (B:5,b-c) **or** vegetation interspersion is high (B:6,c) **or** plant form richness is high (B:7,c)
c. wooded areas (forest or shrub) occur adjacent or connected to AA
d. water velocity is less than 1.5 feet/sec (B:12,a-b)
e. adjacent upland vegetation provides suitable nesting sites for dry nesting waterfowl

Lacustrine:

a. AA and any adjacent wetland total greater than 5 (B:1,b-d)
b. AA is cluster or oasis wetland (B:8,a-b)
c. area of mostly obligate emergent species and shallow water (less than 6.6 feet) comprises at lest 10% of AA wetland (B:4)
d. other wetlands having strongly different hydroperiods are present within 1 mile (B:14,e-g for wetlands within 1 mile)
e. presence of small island (at least 50 feet from shore) **or** moderate to high vegetation/water interspersion (B:5,b-c) **or** moderate to high

vegetation interspersion (B:6,b-c) **or** high plant form richness (B:7,c)

f. adjacent upland vegetation provides suitable nesting sites for dry nesting waterfowl

Palustrine:

a. **AA wetland and any adjacent wetland total greater than 5 acres (B:1,b-d)**

b. **wetlands with a dominant hydroperiod of permanently flooded, intermittently exposed, or seasonally flooded occur within 1 mile of AA (B:14,a-d for wetlands within 1 mile)**

c. high vegetation/water interspersion (B:5,c) **or** high vegetation interspersion (B:6,c) **or** high plant form richness (B:7,c)

d. wooded areas (forest or shrub) occur adjacent or connected to AA **or** there is a band of mostly emergent vegetation at least 20 feet wide (B:9)

Rating for Wildlife Diversity and Abundance: Breeding

#18 is yes:	***Very Low***
#18 is no and ~~#20~~ [#19] is yes:	*Low*
#18 **and** #19 are no **and**	
less than two of #20 are yes:	***Low***
two to three #20 are yes:	***Moderate***
at least four of #20 are yes:	***High***

Wildlife Diversity and Abundance: Migration

21. Is AA wetland dominated by barren, tailings surface (B:16)? **Yes.**

Comment: **Slag walls are considered tailings for the answering of this question. Colorado Tailings were previously removed, however the BSB site is "barren."**

22. Is either of the following true? **Yes**.

a. **False** AA and any adjacent wetland total less than 5 acres in surface area (B:1,a) and frequent human activity occurs in AA (B:19,a-b)

b. False wetland has no outlet (B:10,c *and* d are no) **and** has toxic inputs

Comment: **Site has frequent human activity.**

23. How many of the following are true of the AA? **One (1).**

a. 30-60% of the AA wetland is open water and emergent vegetation is generally obligate

b. high plant form richness (B:7,c)

c. high vegetation/water interspersion (B:5,c) **or** high vegetation interspersion (B:6,c)

d. wetland vegetation or hydrology not recently (i.e., within last 10 years) disturbed (B:13,a-c **and** B:7,c are all no)

e. wetland in AA and any connected wetlands within 1 mile of the AA are greater than 200 acres (B:1,d)

f. wet mud flat or open water area greater than 20 acres is present

Comment: The hydrology was disturbed over 10 years ago with the routing through the slag canyon. Groundwater continues to be routed out of the system upstream of the AA. (The answers in B:13 a and c did not include a time period.)

Rating for Wildlife Diversity and Abundance: Migration

#21 is yes:	***Very Low***
#21 is no **and** #22 is yes:	***Low***
#21 **and** #22 are no and	
Less than two #23 are yes:	***Low***
Two to three of #23 are yes:	***Moderate***
Four to six of #23 are yes:	***High***

Wildlife Diversity and Abundance: Wintering

24. Is AA dominated by barren, tailings surface (B:16)? **Yes. (See comment.)**

Comment: **Colorado Tailings were previously removed. The slag could constitute tailings. The BSB site is "barren" for wildlife habitat evaluation.**

25. Are any of the following true? **No.**

a. all of wetland freezes over for more than one month/year

b. AA and any adjacent wetland total less than 5 acres in surface area (B:1,a) **and** no permanent outlet (B:10,c is no) **and** AA has little or poor shelter for wildlife

c. AA and any adjacent wetland total less than 5 acres in surface area (B:1,a) **and** has frequent human activity during winter (B:19, a-b in winter) **and** no wooded areas (forest or shrub) in or adjacent to AA

Comment:

26. Wetland in AA and any adjacent wetland total greater than 5 acres (B:1,b-d) **and** AA wetland is oasis or part of cluster wetland (B:8,a-b)? **Yes.**

27. Comment: **The wetland is a cluster due to downstream connectivity.**

28. How many of the following are true of the AA?

a.	30-60% of AA wetland is open water and emergent vegetation is generally obligate wetland species
b.	high plant form richness (B:7,c)
c.	high vegetation/water interspersion (B:5,c) **or** high vegetation interspersion (B:6,c)
d.	wetland vegetation or hydrology not recently disturbed (B:13,a-c **and** B:17 are all no)
e.	frequent human activity does not occur in AA (B:19,a-b are no)
f.	substrate is not bedrock, rubble, or cobble-gravel (B:15,d-f are no)
g.	open water with adjacent grain fields is present in AA

Comment:

Rating for Wildlife Diversity and Abundance: Wintering

#24 is yes:	***Very Low***
#24 is no **and** #25 is yes:	***Low***
#24 **and** #25 are no and	
Less than four of #27 are true:	***Moderate***
#26 is true **and** at least four of #27 are true:	***High***

Threatened, Endangered, or Sensitive (TES) Species Habitat

29. Are there any Federally-listed threatened or endangered plant or animal species that are known to regularly or frequently occur in the AA? **No.**

Comment:

30. Are there any Federally-listed threatened or endangered plant or animal species that are known to occur occasionally in the AA? **No.**

Comment:

31. Are there any state listed threatened, endangered, or sensitive plant or animal species (Montana Natural Heritage Program status of S1, S2, or S3) that are known to occur regularly in the AA? **No. (See comment.)**

Comment: **Restored habitat could be advantageous to the westslope cutthroat trout. The Little Brown Myotis (S3) could be present based on the Montana Natural Heritage Program's Environmental Summary and the description found within the Program's Field Guide ("Most common bat in Montana").**

32. No federal or state listed threatened, endangered, or sensitive plant or animal species are known to occur in the AA? **Yes.**

Comment:

Rating for Threatened, Endangered, or Sensitive (TES) Species Habitat

#28, #29, and #30 are all no; #31 is yes:	***Low***
#29 **or** #30 is yes:	***Moderate***
#28 is yes:	***High***

Part D: Analysis of Evaluation Results

Summary of Ratings for All Functional Categories

The following procedure should be used to summarize ratings over the ten categories covered in this evaluation, with results entered on the rating sheet on next page:

1. in column (a) list the ratings (very low, low, moderate, or high) in the evaluation of each category;
2. in column (b) fill in the numeric rating as **very low = 0.5, low = 1, moderate = 2,** and **high =3**;
3. if considered necessary, modify given weighting values in column (c) for any category (provide justification below);
4. multiply numeric rating in column (b) by weight in column (c) and recorded in column (d):
5. total scores from all ten categories and enter as “Total;”
6. determine maximum possible score by multiplying weight in column (c) by 3 and total scores from all ten categories, and enter as “Maximum Total” (default = 33);
7. divide “Total” by “Maximum Total” and multiply 3; enter as “Overall Wetland Rating.”

Rating Sheet For Summarizing Results Of Wetland Functional Evaluation – BRW-BSB

	Column			
Functional Category	**(a) Rating**	**(b) Numeric Rating**	**(c) Weight***	**(d) Score**
Hydrologic Support	Low	1	1.0	1
Floodflow Alteration	Low	1	0.5	0.5
Sediment Stabilization and Erosion Control	High	3	1.0	3
Water Purification	Low	1	1.0	1
Production Export/Food Chain Support	Low	1	1.0	1
Aquatic Diversity/Abundance	Low	1	1.5	0.5
Wildlife Diversity/Abundance: Breeding	Very Low	0.5	1.5	0.75
Wildlife Diversity/Abundance: Migration	Very Low	0.5	1.5	0.75
Wildlife Diversity/Abundance: Wintering	Very Low	0.5	1.0	0.5
TES Species Habitat	Low	1.0	1.0	1
Total (sum of column (d))				10.0
Maximum Total				33
OVERALL RATING FOR AA WETLAND				**0.9**

* The category weight of 0.5 for floodflow alteration is based on the rationale that the floodflow function is generally of less importance on most Superfund site wetlands in the Upper Clark Fork basin due to their position lower down in the watershed; and category weights higher than 1.0 are based on the importance given by regional natural resources agencies to Upper Clark Fork Basin wetlands for wildlife migration/breeding and fisheries habitat. If different widths are used, the rationale for these weightings should be included with this evaluation.

Calculation of Effective Wetland Area

As described in the introduction effective wetland are is the wetland area (in acres) delineated in an operable unit adjusted by its Overall Rating for functional value, as determined on the previous page. This adjustment would be made using the flowing formula:

$$\textbf{Functionally Effective Wetland Area} = \frac{\textbf{Actual Wetland area X Overall Rating}}{\textbf{3}}$$

It should be noted that functionally effective wetland area is a relative area value, i.e., it is some fraction of actual wetland area having an Overall Rating of 3.0. Obviously, an acre value for functionally effective wetland area can only be compared to other such values determined by this method. Functionally effective wetland areas calculated by this formula are intended to be used for comparing pre- and post-remediation wetlands and are not to be considered as actual acres of physical area.

It is evident that choice of the Assessment Area is critical to determining the functionally effective wetland area, since the Overall Rating for each evaluation applies to the entire AA evaluated. Consequently, if the area to be evaluated is made up of areas that have experienced very different levels of disturbance or negative impacts, they should be evaluate desperately.

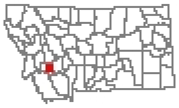
For all AAs within an operable unit, the acres of functionally effective wetland are to be summed to arrive at a total functionally effective wetland area for that operable unit. This value can then be used as a baseline value for comparison to post-remediation changes in area of functionally effective wetlands. Post-remediation wetland areas can be determined on a preliminary basis using projected outcomes of remediation designs, but a re-evaluation of effective wetland areas should be conducted after remedial actions have taken place. This re-evaluation ideally should be about 10 years following remediation, after any wetlands created or modified as a result of remedial actions have had the opportunity to develop. Preferably, the method described in this form will also be used in the re-evaluation subsequent to remediation actions.

Appendix D
Montana Natural Heritage Program Environmental Summary

MONTANA
Natural Heritage Program

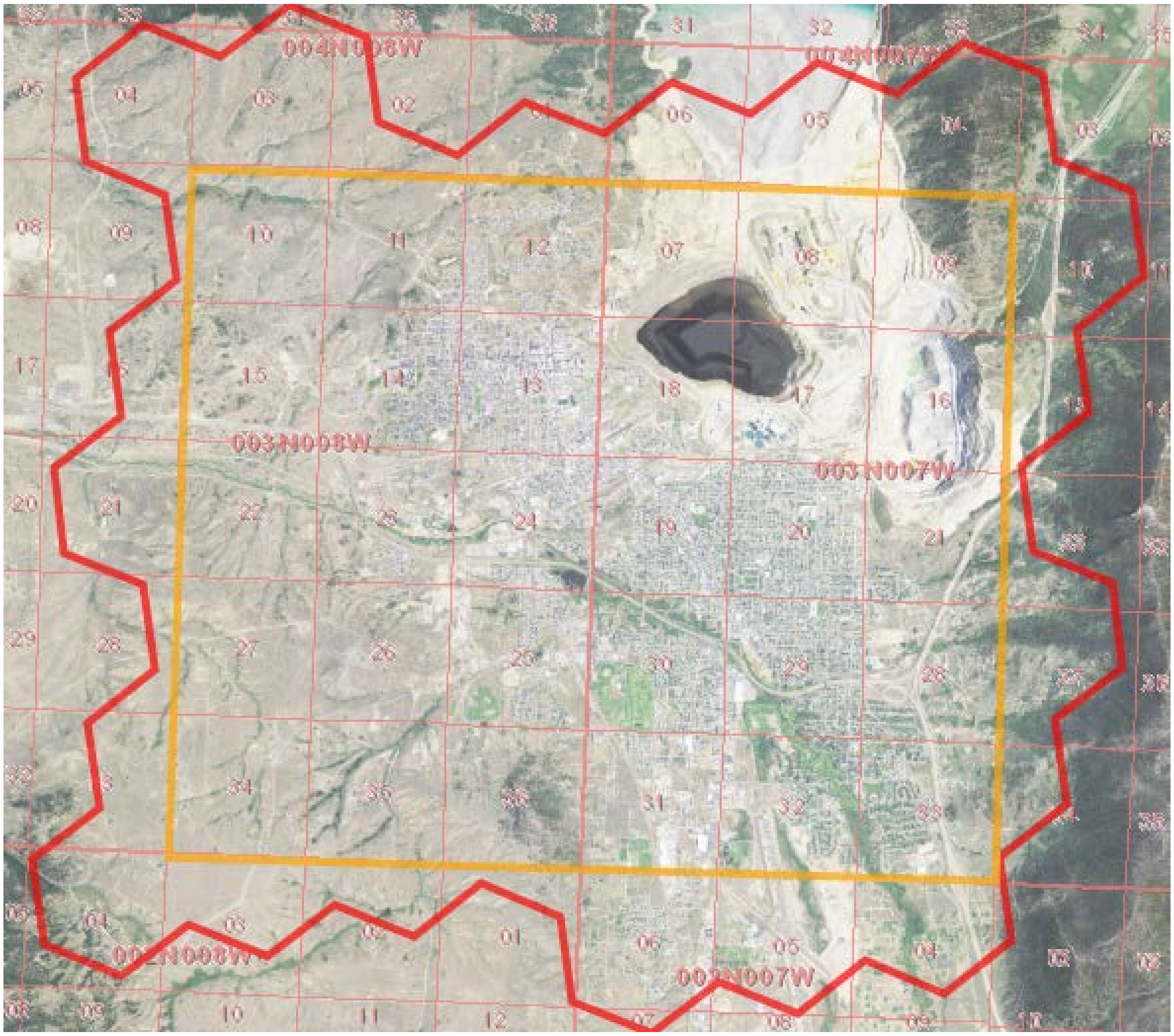
1515 East 6th Avenue
Helena, MT 59620
(406) 444-0241
mtnhp.org

Environmental Summary



Latitude	Longitude
45.94097	-112.44866
46.05368	-112.61057

Summarized by:
19prvt0171 BPSOU Sensitive Species
(Custom Area of Interest)



Suggested Citation
Montana Natural Heritage Program. Environmental Summary Report.
for Latitude 45.94097 to 46.05368 and Longitude -112.44866 to -112.61057. Retrieved on 5/14/2019.

Table of Contents

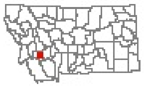
Introduction to Environmental Summary Report

The Environmental Summary report for your area of interest consists of introductory and related materials in this PDF and an Excel workbook with worksheets summarizing information managed in the Montana Natural Heritage Program's (MTNHP) databases for: (1) species occurrences; (2) other observed species without Species Occurrences; (3) other species potentially present based on their range, presence of associated habitats, or predictive distribution model output if available; (4) structured surveys (organized efforts following a protocol capable of detecting one or more species); (5) land cover mapped as ecological systems; (6) wetland and riparian mapping; (7) land management categories; and (8) biological reports associated with plant and animal observations. In order to do this in a consistent manner across Montana and allow for rapid delivery of summaries, we have intersected this information with a uniform grid of hexagons that have been used for planning efforts across the western United States (e.g. Western Association of Fish and Wildlife Agencies - Crucial Habitat Assessment Tool). Each hexagon is one square mile in area and approximately one kilometer in length on each side. Summary information for each data layer is then stored with each hexagon and those summaries are added up to an overall summary for the report area you have requested. Users should be aware that summaries do not correspond to the exact boundaries of the polygon they have specified, but instead are a summary across all hexagons intersected by the polygon they specified.

In presenting this information, MTNHP is working towards assisting the user with rapidly assessing the known or potential species and biological communities, land management categories, and biological reports associated with the report area. We remind users that this information is likely incomplete and may be inaccurate as surveys to document species are lacking in many areas of the state, species' range polygons often include regions of unsuitable habitat, methods of predicting the presence of species or communities are constantly improving, and information is constantly being added and updated in our databases. **Field verification by professional biologists of the absence or presence of species and biological communities in a report area will always be an important obligation of users of our data. Users are encouraged to only use this environmental summary report as a starting point for more in depth analyses and are encouraged to contact state, federal, and tribal resource management agencies for additional data or management guidelines relevant to your efforts. Please see the Appendix for introductory materials to each section of the report, additional information resources, and a list of relevant agency contacts.**

Legend

Model Icons	Habitat Icons	Range Icons	Num Obs
N Suitable (native range)	C Common	I Introduced	Count of obs with 'good precision' (<=1000m)
O Optimal Suitability	O Occasional	Y Year-round	
M Moderate Suitability		S Summer	+ indicates additional 'poor precision' obs (1001m-10,000m)
L Low Suitability		W Winter	
I Suitable (introduced range)		M Migratory	
		H Historic	



Latitude	Longitude
45.94097	-112.44866
46.05368	-112.61057

Native Species

Summarized by: **19prvt0171 BPSOU Sensitive Species** *(Custom Area of Interest)*
Filtered by:
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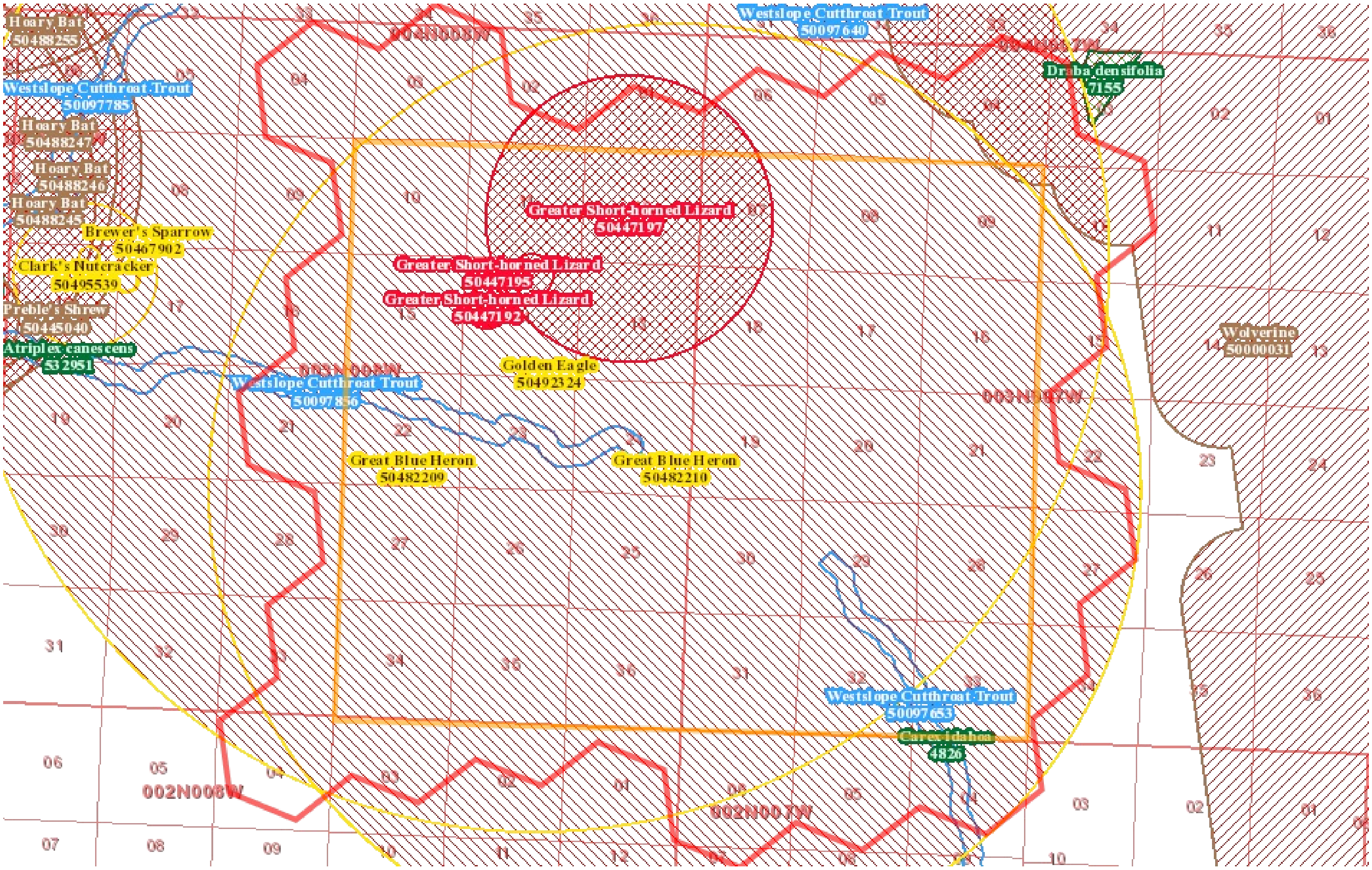

Species Occurrences

	USFWS Sec7	# SO	# Obs	Predictive Model	Associated Habitat	Range
⊟ **F - Westslope Cutthroat Trout** *(Oncorhynchus clarkii lewisi)* SOC		2	10 +		Not Assigned	Y

View in Field Guide **View Predicted Models** **View Range Maps**

Species of Concern - Native Species Global: **G5T4** State: **S2** USFS: **Sensitive - Known on Forests (BD, BRT, CG, HLC, KOOT, LOLO)**
BLM: **SENSITIVE** FWP SWAP: **SGCN2**

Delineation Criteria Stream reaches and standing water bodies where the species presence has been confirmed through direct capture or where they are believed to be present based on the professional judgement of a fisheries biologist due to confirmed presence in adjacent areas. In order to reflect the importance of adjacent terrestrial habitats to survival, stream reaches are buffered 100 meters, standing water bodies greater than 1 acre are buffered 50 meters, and standing water bodies less than 1 acre are buffered 30 meters into the terrestrial habitat based on PACFISH/INFISH Riparian Conservation Area standards. (Last Updated: Mar 30, 2018)

Predictive Models: N 18% Suitable (native range) (deductive)

	USFWS Sec7	# SO	# Obs	Predictive Model	Associated Habitat	Range
⊟ **R - Greater Short-horned Lizard** *(Phrynosoma hernandesi)* SOC		6	8			Y

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**

Species of Concern - Native Species Global: **G5** State: **S3** USFS: **Sensitive - Known on Forests (CG)** **Sensitive - Suspected on Forests (HLC)** BLM: **SENSITIVE**
FWP SWAP: **SGCN3, SGIN**

Delineation Criteria Confirmed breeding area based on the presence of a resident animal of any age. Point observation location is buffered by a minimum distance of 300 meters in order to encompass habitats supporting other individuals and documented distances moved betweeen summer and winter habitats. Otherwise the point observation is buffered by the locational uncertainty associated with the observation up to a maximum distance of 10,000 meters. (Last Updated: Oct 19, 2018)

Predictive Models: O 4% Optimal (inductive), M 20% Moderate (inductive), L 22% Low (inductive)
Associated Habitats: C 11% Common, O 6% Occasional

⊟ **B - Golden Eagle** *(Aquila chrysaetos)* SOC 1 + Y

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**

Species of Concern - Native Species Global: **G5** State: **S3** USFWS: **BGEPA; MBTA; BCC17** BLM: **SENSITIVE** FWP SWAP: **SGCN3**

Delineation Criteria Confirmed nesting area buffered by a minimum distance of 3,000 meters in order to be conservative about encompassing the entire breeding territory and area commonly used for renesting and otherwise buffered by the locational uncertainty associated with the observation up to a maximum distance of 10,000 meters. (Last Updated: May 02, 2019)

Predictive Models: O 2% Optimal (inductive), M 27% Moderate (inductive), L 64% Low (inductive) **Associated Habitats:** C 44% Common

⊟ **B - Great Blue Heron** *(Ardea herodias)* SOC 2 8 Y S M

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**

Species of Concern - Native Species Global: **G5** State: **S3** USFWS: **MBTA** FWP SWAP: **SGCN3**

Delineation Criteria Confirmed nesting area buffered by a minimum distance of 6,500 meters in order to be conservative about encompassing the areas commonly used for foraging near the breeding colony and otherwise buffered by the locational uncertainty associated with the observation up to a maximum distance of 10,000 meters. (Last Updated: Jan 16, 2019)

Predictive Models: M 7% Moderate (inductive), L 56% Low (inductive) **Associated Habitats:** C 1% Common

⊟ **M - Wolverine** *(Gulo gulo)* SOC 7 1 Y

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**

Species of Concern - Native Species Global: **G4** State: **S3** USFWS: **P** USFS: **Proposed on Forests (BD, BRT, CG, HLC, KOOT, LOLO)**
BLM: **SENSITIVE** FWP SWAP: **SGCN3**

Delineation Criteria Confirmed area of occupancy supported by recent (post-1980), nearby (within 10 kilometers) observations of adults or juveniles. Tracking regions were defined by areas of primary habitat and adjacent female dispersal habitat as modeled by Inman et al. (2013). These regions were buffered by 1 kilometer in order to link smaller areas and account for potential inaccuracies in independent variables used in the model. (Last Updated: Sep 03, 2014)

Predictive Models: L 7% Low (inductive) **Associated Habitats:** C 29% Common, O 1% Occasional

⊟ **V - Carex idahoa** *(Idaho Sedge)* SOC 1 1 Not Available Not Assigned

View in Field Guide

Species of Concern - Native Species Global: **G3** State: **S3** USFS: **Sensitive - Known on Forests (BD)** BLM: **SENSITIVE** MNPS: **2**

Delineation Criteria Individual occurrences are generally based upon a discretely mapped area provided by an observer and are not separated by any pre-defined distance. Individual clusters of plants mapped at fine spatial scales (separated by less than approximately 25-50 meters) may be grouped together into one occurrence if they are not separated by distinct areas of habitat or terrain features. Point observations are buffered to encompass any locational uncertainty associated with the observation. (Last Updated: Jan 23, 2019)

MONTANA
Natural Heritage
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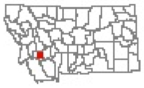
A program of the **Montana State Library's Natural Resource Information System** operated by the **University of Montana**.

Legend

Model Icons	Habitat Icons	Range Icons	Num Obs
N Suitable (native range)	C Common	I Introduced	Count of obs with 'good precision' (<=1000m)
O Optimal Suitability	O Occasional	Y Year-round	
M Moderate Suitability		S Summer	+ indicates additional 'poor precision' obs (1001m-10,000m)
L Low Suitability		W Winter	
I Suitable (introduced range)		M Migratory	
		H Historic	



Latitude	Longitude
45.94097	-112.44866
46.05368	-112.61057

Native Species

Summarized by: **19prvt0171 BPSOU Sensitive Species** *(Custom Area of Interest)*
Filtered by:
MT_Status='Species of Concern', 'Special Status', 'Important Animal Habitat', 'Potential SOC'

Other Observed Species

	USFWS Sec7	# Obs	Predictive Model	Associated Habitat	Range
⊟ **B - Ferruginous Hawk** *(Buteo regalis)* SOC		+			S M

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G4** State: **S3B** USFWS: **MBTA; BCC10; BCC17** BLM: **SENSITIVE** FWP SWAP: **SGCN3** PIF: **2**
Predictive Models: O 7% Optimal (inductive), M 67% Moderate (inductive), L 24% Low (inductive) **Associated Habitats:** C 19% Common

	USFWS Sec7	# Obs	Predictive Model	Associated Habitat	Range
⊟ **M - Porcupine** *(Erethizon dorsatum)* PSOC		3			Y

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Potential Species of Concern - Native Species Global: **G5** State: **S4** FWP SWAP: **SGIN**
Predictive Models: M 38% Moderate (inductive), L 62% Low (inductive) **Associated Habitats:** C 36% Common

	USFWS Sec7	# Obs	Predictive Model	Associated Habitat	Range
⊟ **B - Clark's Nutcracker** *(Nucifraga columbiana)* SOC		1 +			Y

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **S3** USFWS: **MBTA** USFS: **Species of Conservation Concern on Forests (FLAT)** FWP SWAP: **SGCN3** PIF: **3**
Predictive Models: M 16% Moderate (inductive), L 71% Low (inductive) **Associated Habitats:** C 6% Common

	USFWS Sec7	# Obs	Predictive Model	Associated Habitat	Range
⊟ **B - Bald Eagle** *(Haliaeetus leucocephalus)* SSS		5 +			Y

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Special Status Species - Native Species Global: **G5** State: **S4** USFWS: **DM; BGEPA; MBTA; BCC10; BCC11; BCC17** USFS: **Sensitive - Known on Forests (BD, BRT, CG, HLC, KOOT, LOLO)** BLM: **SENSITIVE** PIF: **2**
Predictive Models: M 11% Moderate (inductive), L 67% Low (inductive) **Associated Habitats:** C 7% Common, O 37% Occasional

	USFWS Sec7	# Obs	Predictive Model	Associated Habitat	Range
⊟ **A - Western Toad** *(Anaxyrus boreas)* SOC		+			Y

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G4** State: **S2** USFS: **Sensitive - Known on Forests (BD, BRT, CG, HLC, KOOT, LOLO)** BLM: **SENSITIVE** FWP SWAP: **SGCN2**
Predictive Models: L 89% Low (inductive) **Associated Habitats:** C 29% Common, O 48% Occasional

	USFWS Sec7	# Obs	Predictive Model	Associated Habitat	Range
⊟ **B - Rufous Hummingbird** *(Selasphorus rufus)* PSOC		2			S M

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Potential Species of Concern - Native Species Global: **G5** State: **S4B** USFWS: **MBTA** PIF: **3**
Predictive Models: L 71% Low (inductive) **Associated Habitats:** C 55% Common, O 7% Occasional

	USFWS Sec7	# Obs	Predictive Model	Associated Habitat	Range
⊟ **B - Gray-crowned Rosy-Finch** *(Leucosticte tephrocotis)* SOC		1			Y W M

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **S2B,S5N** USFWS: **MBTA** FWP SWAP: **SGCN2, SGIN**
Predictive Models: L 53% Low (inductive) **Associated Habitats:** C 1% Common, O 1% Occasional

	USFWS Sec7	# Obs	Predictive Model	Associated Habitat	Range
⊟ **M - Canada Lynx** *(Lynx canadensis)* SOC	7	+			Y

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **S3** USFWS: **LT; CH** USFS: **Threatened on Forests (BD, BRT) Threatened, Critical Habitat on Forests (CG, HLC, KOOT, LOLO)** BLM: **THREATENED** FWP SWAP: **SGCN3**
Predictive Models: L 29% Low (inductive) **Associated Habitats:** C 5% Common, O 1% Occasional

	USFWS Sec7	# Obs	Predictive Model	Associated Habitat	Range
⊟ **B - Northern Goshawk** *(Accipiter gentilis)* SOC		+			Y W M

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **S3** USFWS: **MBTA** FWP SWAP: **SGCN3** PIF: **2**
Predictive Models: L 7% Low (inductive) **Associated Habitats:** C 4% Common, O 1% Occasional

	USFWS Sec7	# Obs	Predictive Model	Associated Habitat	Range
⊟ **B - White-faced Ibis** *(Plegadis chihi)* SOC		5	Not Available		S M

View in Field Guide **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **S3B** USFWS: **MBTA** BLM: **SENSITIVE** FWP SWAP: **SGCN3** PIF: **2**
Associated Habitats: C 4% Common

	USFWS Sec7	# Obs	Predictive Model	Associated Habitat	Range
⊟ **B - Franklin's Gull** *(Leucophaeus pipixcan)* SOC		+	Not Available		M

View in Field Guide **View Associated Habitat** **View Range Maps**

Species of Concern - Native Species Global: **G5** State: **S3B** USFWS: **MBTA** BLM: **SENSITIVE** FWP SWAP: **SGCN3** PIF: **2**

Associated Habitats: C 3% Common, O 1% Occasional

⊟ **R - Snapping Turtle** *(Chelydra serpentina)* **SOC** 1 Not Available

View in Field Guide **View Associated Habitat**

Species of Concern - Native Species Global: **G5** State: **S3** BLM: **SENSITIVE** FWP SWAP: **SGCN3, SGIN**

Associated Habitats: C 3% Common

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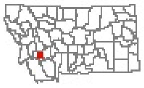
Legend

Model Icons
N Suitable (native range)
O Optimal Suitability
M Moderate Suitability
L Low Suitability
I Suitable (introduced range)

Habitat Icons
C Common
O Occasional

Range Icons
I Introduced
Y Year-round
S Summer
W Winter
M Migratory
H Historic

Num Obs
Count of obs with 'good precision' (<=1000m)
+ indicates additional 'poor precision' obs (1001m-10,000m)



Latitude	Longitude
45.94097	-112.44866
46.05368	-112.61057

Native Species

Summarized by: **19prvt0171 BPSOU Sensitive Species** *(Custom Area of Interest)*
Filtered by:
MT_Status='Species of Concern', 'Special Status', 'Important Animal Habitat', 'Potential SOC'

Other Potential Species

USFWS Sec7 | Predictive Model | Associated Habitat | Range

⊟ **M - Spotted Bat** *(Euderma maculatum)* SOC — S M

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G4** State: **S3** USFS: **Sensitive - Known on Forests (BD, CG)** BLM: **SENSITIVE** FWP SWAP: **SGCN3, SGIN**
Predictive Models: O 13% Optimal (inductive), M 40% Moderate (inductive), L 42% Low (inductive)
Associated Habitats: C 46% Common, O 31% Occasional

⊟ **M - Townsend's Big-eared Bat** *(Corynorhinus townsendii)* SOC — Y

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G4** State: **S3** USFS: **Sensitive - Known on Forests (BD, BRT, CG, HLC, KOOT, LOLO)** BLM: **SENSITIVE** FWP SWAP: **SGCN3**
Predictive Models: O 11% Optimal (inductive), M 18% Moderate (inductive), L 71% Low (inductive)
Associated Habitats: C 26% Common, O 38% Occasional

⊟ **M - Little Brown Myotis** *(Myotis lucifugus)* SOC — Y

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G3** State: **S3** FWP SWAP: **SGCN3**
Predictive Models: O 2% Optimal (inductive), M 76% Moderate (inductive), L 22% Low (inductive)
Associated Habitats: C 64% Common, O 36% Occasional

⊟ **B - Hooded Merganser** *(Lophodytes cucullatus)* PSOC — Y M

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Potential Species of Concern - Native Species Global: **G5** State: **S4** USFWS: **MBTA** FWP SWAP: **SGIN** PIF: **2**
Predictive Models: O 2% Optimal (inductive), M 18% Moderate (inductive), L 31% Low (inductive) **Associated Habitats:** C 4% Common

⊟ **M - Preble's Shrew** *(Sorex preblei)* SOC — Y

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G4** State: **S3** FWP SWAP: **SGCN3**
Predictive Models: M 91% Moderate (inductive), L 9% Low (inductive) **Associated Habitats:** C 31% Common, O 1% Occasional

⊟ **B - Brewer's Sparrow** *(Spizella breweri)* SOC — S M

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **S3B** USFWS: **MBTA; BCC10; BCC17** BLM: **SENSITIVE** FWP SWAP: **SGCN3** PIF: **2**
Predictive Models: M 87% Moderate (inductive), L 13% Low (inductive) **Associated Habitats:** C 6% Common

⊟ **M - Dwarf Shrew** *(Sorex nanus)* SOC — Y

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G4** State: **S2S3** FWP SWAP: **SGCN2-3**
Predictive Models: M 80% Moderate (inductive), L 16% Low (inductive) **Associated Habitats:** C 31% Common, O 19% Occasional

⊟ **B - Sage Thrasher** *(Oreoscoptes montanus)* SOC — S M

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G4** State: **S3B** USFWS: **MBTA; BCC10; BCC17** BLM: **SENSITIVE** FWP SWAP: **SGCN3** PIF: **3**
Predictive Models: M 71% Moderate (inductive), L 24% Low (inductive) **Associated Habitats:** C 6% Common

⊟ **M - Silver-haired Bat** *(Lasionycteris noctivagans)* PSOC — Y

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Potential Species of Concern - Native Species Global: **G3G4** State: **S4**
Predictive Models: M 62% Moderate (inductive), L 38% Low (inductive) **Associated Habitats:** C 27% Common, O 44% Occasional

⊟ **M - Hoary Bat** *(Lasiurus cinereus)* SOC — S M

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G3G4** State: **S3** FWP SWAP: **SGCN3**
Predictive Models: M 60% Moderate (inductive), L 40% Low (inductive) **Associated Habitats:** C 51% Common, O 40% Occasional

⊟ **V - Eleocharis rostellata** *(Beaked Spikerush)* SOC — Not Assigned Y

View in Field Guide **View Predicted Models** **View Range Maps**

Species of Concern - Native Species Global: **G5** State: **S3** USFS: **Sensitive - Known on Forests (BD, CG, HLC) Species of Conservation Concern on Forests (FLAT)** MNPS: **3**

Predictive Models: M 58% Moderate (inductive), L 40% Low (inductive)

⊟ **B - Barrow's Goldeneye** *(Bucephala islandica)* PSOC Y W M

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**

Potential Species of Concern - Native Species Global: **G5** State: **S4** USFWS: **MBTA** FWP SWAP: **SGIN** PIF: **2**

Predictive Models: M 53% Moderate (inductive), L 40% Low (inductive) **Associated Habitats:** C 4% Common

⊟ **B - Green-tailed Towhee** *(Pipilo chlorurus)* SOC S M

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**

Species of Concern - Native Species Global: **G5** State: **S3B** USFWS: **MBTA** FWP SWAP: **SGCN3** PIF: **3**

Predictive Models: M 47% Moderate (inductive), L 53% Low (inductive) **Associated Habitats:** C 24% Common, O 1% Occasional

⊟ **M - Columbia Plateau Pocket Mouse** *(Perognathus parvus)* SOC Y

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**

Species of Concern - Native Species Global: **G5** State: **S3** USFS: **Sensitive - Suspected on Forests (BD)** FWP SWAP: **SGCN3, SGIN**

Predictive Models: M 47% Moderate (inductive), L 31% Low (inductive) **Associated Habitats:** C 6% Common, O 36% Occasional

⊟ **M - Water Vole** *(Microtus richardsoni)* PSOC Y

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**

Potential Species of Concern - Native Species Global: **G5** State: **S4**

Predictive Models: M 36% Moderate (inductive), L 11% Low (inductive) **Associated Habitats:** C 32% Common, O 1% Occasional

⊟ **M - Wyoming Ground Squirrel** *(Urocitellus elegans)* PSOC Y

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**

Potential Species of Concern - Native Species Global: **G5** State: **S3S4**

Predictive Models: M 33% Moderate (inductive), L 22% Low (inductive) **Associated Habitats:** C 59% Common, O 1% Occasional

⊟ **B - Long-billed Curlew** *(Numenius americanus)* SOC S M

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**

Species of Concern - Native Species Global: **G5** State: **S3B** USFWS: **MBTA; BCC10; BCC11; BCC17** BLM: **SENSITIVE** FWP SWAP: **SGCN3** PIF: **2**

Predictive Models: M 31% Moderate (inductive), L 44% Low (inductive) **Associated Habitats:** C 11% Common, O 7% Occasional

⊟ **M - Fringed Myotis** *(Myotis thysanodes)* SOC Y

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**

Species of Concern - Native Species Global: **G4** State: **S3** BLM: **SENSITIVE** FWP SWAP: **SGCN3**

Predictive Models: M 16% Moderate (inductive), L 71% Low (inductive) **Associated Habitats:** C 27% Common, O 50% Occasional

⊟ **B - Yellow-billed Cuckoo** *(Coccyzus americanus)* SOC S M

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**

Species of Concern - Native Species Global: **G5** State: **S3B** USFWS: **PS: LT; MBTA; BCC10** USFS: **Threatened on Forests (BRT, LOLO)** BLM: **SENSITIVE** FWP SWAP: **SGCN3, SGIN** PIF: **2**

Predictive Models: M 9% Moderate (inductive), L 22% Low (inductive) **Associated Habitats:** C 1% Common

⊟ **B - Pinyon Jay** *(Gymnorhinus cyanocephalus)* SOC Y

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**

Species of Concern - Native Species Global: **G3** State: **S3** USFWS: **MBTA; BCC17** FWP SWAP: **SGCN3**

Predictive Models: M 7% Moderate (inductive), L 56% Low (inductive) **Associated Habitats:** C 1% Common, O 12% Occasional

⊟ **V - Adoxa moschatellina** *(Musk-root)* SOC Not Assigned Y

View in Field Guide **View Predicted Models** **View Range Maps**

Species of Concern - Native Species Global: **G5** State: **S3** USFS: **Sensitive - Known on Forests (BD, CG, LOLO)**

Predictive Models: M 7% Moderate (inductive), L 13% Low (inductive)

⊟ **M - Grizzly Bear** *(Ursus arctos)* SOC 7 Y H

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**

Species of Concern - Native Species Global: **G4** State: **S2S3** USFWS: **PS: LT; XN; DM** USFS: **Threatened on Forests (BD, CG, HLC, KOOT, LOLO)** BLM: **THREATENED** FWP SWAP: **SGCN2-3**

Predictive Models: M 4% Moderate (inductive), L 62% Low (inductive) **Associated Habitats:** C 42% Common, O 6% Occasional

⊟ **B - Cassin's Finch** *(Haemorhous cassinii)* SOC Y

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**

Species of Concern - Native Species Global: **G5** State: **S3** USFWS: **MBTA; BCC10** FWP SWAP: **SGCN3** PIF: **3**

Predictive Models: M 4% Moderate (inductive), L 40% Low (inductive) **Associated Habitats:** C 5% Common

⊟ **B - Mountain Plover** *(Charadrius montanus)* SOC S M

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**

Species of Concern - Native Species Global: **G3** State: **S2B** USFWS: **MBTA; BCC11; BCC17** BLM: **SENSITIVE** FWP SWAP: **SGCN2** PIF: **1**

Predictive Models: M 4% Moderate (inductive), L 36% Low (inductive) **Associated Habitats:** O 11% Occasional

⊟ **B - Flammulated Owl** *(Psiloscops flammeolus)* SOC S M

View in Field Guide View Predicted Models View Associated Habitat View Range Maps
Species of Concern - Native Species Global: **G4** State: **S3B** USFWS: **MBTA; BCC10**
USFS: **Sensitive - Known on Forests (BD, BRT, HLC, KOOT, LOLO)**
Sensitive - Suspected on Forests (CG)
Species of Conservation Concern on Forests (FLAT) BLM: **SENSITIVE** FWP SWAP: **SGCN3** PIF: **1**
Predictive Models: M 2% Moderate (inductive), L 36% Low (inductive) **Associated Habitats:** C 4% Common, O 1% Occasional

⊟ **M - Western Spotted Skunk** *(Spilogale gracilis)* PSOC Y

View in Field Guide View Predicted Models View Associated Habitat View Range Maps
Potential Species of Concern - Native Species Global: **G5** State: **SU** FWP SWAP: **SGIN**
Predictive Models: M 2% Moderate (inductive), L 27% Low (inductive) **Associated Habitats:** C 22% Common, O 13% Occasional

⊟ **V - Trichophorum cespitosum** *(Tufted Club-rush)* SOC Y

View in Field Guide View Predicted Models View Associated Habitat View Range Maps
USFS: **Sensitive - Known on Forests (BD, HLC, KOOT)**
Species of Concern - Native Species Global: **G5** State: **S2** **Species of Conservation Concern on Forests (FLAT)** MNPS: **3**
Predictive Models: M 2% Moderate (inductive), L 16% Low (inductive) **Associated Habitats:** C 1% Common

⊟ **B - Lewis's Woodpecker** *(Melanerpes lewis)* SOC S M

View in Field Guide View Predicted Models View Associated Habitat View Range Maps
Species of Concern - Native Species Global: **G4** State: **S2B** USFWS: **MBTA; BCC10; BCC17** BLM: **SENSITIVE** FWP SWAP: **SGCN2** PIF: **2**
Predictive Models: L 87% Low (inductive) **Associated Habitats:** C 1% Common, O 4% Occasional

⊟ **B - Greater Sage-Grouse** *(Centrocercus urophasianus)* SOC Y

View in Field Guide View Predicted Models View Associated Habitat View Range Maps
USFS: **Sensitive - Known on Forests (BD)**
Species of Concern - Native Species Global: **G3G4** State: **S2** **Sensitive - Suspected on Forests (CG, HLC)** BLM: **SENSITIVE**
FWP SWAP: **SGCN2** PIF: **1**
Predictive Models: L 82% Low (inductive) **Associated Habitats:** C 6% Common

⊟ **B - Veery** *(Catharus fuscescens)* SOC S M

View in Field Guide View Predicted Models View Associated Habitat View Range Maps
Species of Concern - Native Species Global: **G5** State: **S3B** USFWS: **MBTA** BLM: **SENSITIVE** FWP SWAP: **SGCN3** PIF: **2**
Predictive Models: L 76% Low (inductive) **Associated Habitats:** C 1% Common, O 3% Occasional

⊟ **B - Black Tern** *(Chlidonias niger)* SOC S M

View in Field Guide View Predicted Models View Associated Habitat View Range Maps
Species of Concern - Native Species Global: **G4G5** State: **S3B** USFWS: **MBTA; BCC11** BLM: **SENSITIVE** FWP SWAP: **SGCN3** PIF: **2**
Predictive Models: L 38% Low (inductive) **Associated Habitats:** C 3% Common, O 1% Occasional

⊟ **V - Phlox kelseyi var. missoulensis** *(Missoula Phlox)* SOC Y

View in Field Guide View Predicted Models View Associated Habitat View Range Maps
USFS: **Sensitive - Known on Forests (BD, HLC)**
Species of Concern - Native Species Global: **G3** State: **S3** **Sensitive - Suspected on Forests (LOLO)** MNPS: **2**
Predictive Models: L 36% Low (inductive) **Associated Habitats:** C 36% Common

⊟ **B - Burrowing Owl** *(Athene cunicularia)* SOC S M

View in Field Guide View Predicted Models View Associated Habitat View Range Maps
USFS: **Sensitive - Known on Forests (CG)**
Species of Concern - Native Species Global: **G4** State: **S3B** USFWS: **MBTA; BCC17** **Sensitive - Suspected on Forests (HLC)** BLM: **SENSITIVE**
FWP SWAP: **SGCN3** PIF: **1**
Predictive Models: L 36% Low (inductive) **Associated Habitats:** C 6% Common, O 18% Occasional

⊟ **B - Western Screech-Owl** *(Megascops kennicottii)* PSOC Y

View in Field Guide View Predicted Models View Associated Habitat View Range Maps
Potential Species of Concern - Native Species Global: **G4G5** State: **S3S4** USFWS: **MBTA** FWP SWAP: **SGIN** PIF: **3**
Predictive Models: L 29% Low (inductive) **Associated Habitats:** C 12% Common, O 1% Occasional

⊟ **B - Evening Grosbeak** *(Coccothraustes vespertinus)* SOC Y W

View in Field Guide View Predicted Models View Associated Habitat View Range Maps
Species of Concern - Native Species Global: **G5** State: **S3** USFWS: **MBTA** FWP SWAP: **SGCN3**
Predictive Models: L 27% Low (inductive) **Associated Habitats:** C 19% Common, O 1% Occasional

⊟ **V - Utricularia intermedia** *(Flatleaf Bladderwort)* SOC Not Assigned Y

View in Field Guide View Predicted Models View Range Maps
Species of Concern - Native Species Global: **G5** State: **S2** USFS: **Sensitive - Known on Forests (KOOT)** MNPS: **3**
Predictive Models: L 24% Low (inductive)

⊟ **B - Short-eared Owl** *(Asio flammeus)* PSOC Y

View in Field Guide View Predicted Models View Associated Habitat View Range Maps
Potential Species of Concern - Native Species Global: **G5** State: **S4** USFWS: **MBTA; BCC11; BCC17** PIF: **3**
Predictive Models: L 22% Low (inductive) **Associated Habitats:** C 43% Common, O 7% Occasional

⊟ **B - Peregrine Falcon** *(Falco peregrinus)* SOC Y

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G4** State: **S3** USFWS: **DM; MBTA; BCC10; BCC11; BCC17**
USFS: **Sensitive - Known on Forests (BD, BRT, CG, HLC, KOOT, LOLO)** BLM: **SENSITIVE** FWP SWAP: **SGCN3** PIF: **2**
Predictive Models: L 20% Low (inductive) **Associated Habitats:** C 40% Common, O 7% Occasional

⊟ **B - Meesia triquetra** *(Meesia Moss)* SOC Not Assigned Y

View in Field Guide **View Predicted Models** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **S2** USFS: **Sensitive - Known on Forests (BRT, CG, KOOT)**
Sensitive - Suspected on Forests (LOLO)
Species of Conservation Concern on Forests (FLAT)
Predictive Models: L 20% Low (inductive)

⊟ **B - Loggerhead Shrike** *(Lanius ludovicianus)* SOC S M

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G4** State: **S3B** USFWS: **MBTA; BCC10; BCC17** BLM: **SENSITIVE** FWP SWAP: **SGCN3** PIF: **2**
Predictive Models: L 11% Low (inductive) **Associated Habitats:** C 30% Common, O 1% Occasional

⊟ **B - Bobolink** *(Dolichonyx oryzivorus)* SOC S M

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **S3B** USFWS: **MBTA** FWP SWAP: **SGCN3** PIF: **3**
Predictive Models: L 7% Low (inductive) **Associated Habitats:** C 49% Common

⊟ **B - Brown Creeper** *(Certhia americana)* SOC Y

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **S3** USFWS: **MBTA** FWP SWAP: **SGCN3** PIF: **1**
Predictive Models: L 7% Low (inductive) **Associated Habitats:** C 5% Common, O 1% Occasional

⊟ **B - Pileated Woodpecker** *(Dryocopus pileatus)* SOC Y

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **S3** USFWS: **MBTA** FWP SWAP: **SGCN3** PIF: **2**
Predictive Models: L 7% Low (inductive) **Associated Habitats:** C 2% Common, O 4% Occasional

⊟ **B - Common Poorwill** *(Phalaenoptilus nuttallii)* PSOC S M

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Potential Species of Concern - Native Species Global: **G5** State: **S4B** USFWS: **MBTA** FWP SWAP: **SGIN** PIF: **3**
Predictive Models: L 4% Low (inductive) **Associated Habitats:** C 43% Common, O 17% Occasional

⊟ **B - Boreal Owl** *(Aegolius funereus)* PSOC Y

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Potential Species of Concern - Native Species Global: **G5** State: **S3S4** USFWS: **MBTA** FWP SWAP: **SGIN** PIF: **3**
Predictive Models: L 4% Low (inductive) **Associated Habitats:** C 29% Common, O 1% Occasional

⊟ **B - Great Gray Owl** *(Strix nebulosa)* SOC Y

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **S3** USFWS: **MBTA** BLM: **SENSITIVE** FWP SWAP: **SGCN3, SGIN** PIF: **3**
Predictive Models: L 2% Low (inductive) **Associated Habitats:** C 30% Common, O 1% Occasional

⊟ **V - Boechera fecunda** *(Sapphire Rockcress)* SOC Y

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G2** State: **S2** USFS: **Sensitive - Known on Forests (BD)**
Sensitive - Suspected on Forests (BRT, LOLO) BLM: **SENSITIVE** MNPS: **1**
Predictive Models: L 2% Low (inductive) **Associated Habitats:** C 18% Common

⊟ **V - Agastache cusickii** *(Cusick's Horsemint)* SOC Y

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G3G4** State: **S2S3** USFS: **Sensitive - Known on Forests (BD)** BLM: **SENSITIVE**
Predictive Models: L 2% Low (inductive) **Associated Habitats:** C 12% Common

⊟ **V - Pinus albicaulis** *(Whitebark Pine)* SOC Y

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G3?** State: **S3** USFWS: **C** USFS: **Candidate on Forests (BD, BRT, CG, HLC, KOOT, LOLO)**
BLM: **SENSITIVE**
Predictive Models: L 2% Low (inductive) **Associated Habitats:** C 1% Common

⊟ **B - American Bittern** *(Botaurus lentiginosus)* SOC S M

View in Field Guide **View Predicted Models** **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **S3B** USFWS: **MBTA; BCC11; BCC17** BLM: **SENSITIVE** FWP SWAP: **SGCN3** PIF: **3**
Predictive Models: L 2% Low (inductive) **Associated Habitats:** C 1% Common

⊟ **M - Bison** *(Bos bison)* SOC Not Available H

View in Field Guide **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G4** State: **S2** FWP SWAP: **SGCN2**
Associated Habitats: C 43% Common, O 1% Occasional

⊟ **M - Black-tailed Prairie Dog** *(Cynomys ludovicianus)* SOC Not Available Y

View in Field Guide **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G4** State: **S3** USFS: **Sensitive - Known on Forests (CG)** BLM: **SENSITIVE** FWP SWAP: **SGCN3**
Associated Habitats: O 31% Occasional

⊟ **B - Northern Hawk Owl** *(Surnia ulula)* SOC Not Available W M

View in Field Guide **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **S3** USFWS: **MBTA** FWP SWAP: **SGCN3, SGIN**
Associated Habitats: C 26% Common, O 1% Occasional

⊟ **M - Yuma Myotis** *(Myotis yumanensis)* PSOC Not Available Y

View in Field Guide **View Associated Habitat** **View Range Maps**
Potential Species of Concern - Native Species Global: **G5** State: **S3** FWP SWAP: **SGIN**
Associated Habitats: C 22% Common, O 19% Occasional

⊟ **B - Sharp-tailed Grouse** *(Tympanuchus phasianellus)* SOC Not Available Y H

View in Field Guide **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **SX,S4** FWP SWAP: **SGCN1** PIF: **2**
Associated Habitats: C 18% Common, O 1% Occasional

⊟ **B - Sagebrush Sparrow** *(Artemisiospiza nevadensis)* SOC Not Available S M

View in Field Guide **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **S3B** USFWS: **MBTA; BCC10; BCC17** BLM: **SENSITIVE** FWP SWAP: **SGCN3**
Associated Habitats: C 6% Common

⊟ **B - Black-backed Woodpecker** *(Picoides arcticus)* SOC Not Available Y

View in Field Guide **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **S3** USFWS: **MBTA**
USFS: **Sensitive - Known on Forests (BD, BRT, CG, HLC, KOOT, LOLO)** BLM: **SENSITIVE** FWP SWAP: **SGCN3** PIF: **1**
Associated Habitats: C 5% Common

⊟ **I - Boloria freija** *(Freija Fritillary)* PSOC Not Available Y

View in Field Guide **View Associated Habitat** **View Range Maps**
Potential Species of Concern - Native Species Global: **G5** State: **S3S5**
Associated Habitats: C 4% Common, O 25% Occasional

⊟ **B - Black-crowned Night-Heron** *(Nycticorax nycticorax)* SOC Not Available M

View in Field Guide **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **S3B** USFWS: **MBTA** FWP SWAP: **SGCN3** PIF: **3**
Associated Habitats: C 4% Common

⊟ **B - Trumpeter Swan** *(Cygnus buccinator)* SOC Not Available M

View in Field Guide **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G4** State: **S3** USFWS: **MBTA** USFS: **Sensitive - Known on Forests (BD, CG)** BLM: **SENSITIVE**
FWP SWAP: **SGCN3** PIF: **1**
Associated Habitats: C 4% Common

⊟ **I - Libellula saturata** *(Flame Skimmer)* PSOC Not Available Y

View in Field Guide **View Associated Habitat** **View Range Maps**
Potential Species of Concern - Native Species Global: **G5** State: **S2S4**
Associated Habitats: C 3% Common, O 1% Occasional

⊟ **I - Somatochlora albicincta** *(Ringed Emerald)* PSOC Not Available Y

View in Field Guide **View Associated Habitat** **View Range Maps**
Potential Species of Concern - Native Species Global: **G5** State: **S1S3**
Associated Habitats: C 3% Common, O 1% Occasional

⊟ **I - Somatochlora minor** *(Ocellated Emerald)* PSOC Not Available Y

View in Field Guide **View Associated Habitat** **View Range Maps**
Potential Species of Concern - Native Species Global: **G5** State: **S2S4**
Associated Habitats: C 3% Common, O 1% Occasional

⊟ **B - Forster's Tern** *(Sterna forsteri)* SOC Not Available S M

View in Field Guide **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **S3B** USFWS: **MBTA** BLM: **SENSITIVE** FWP SWAP: **SGCN3** PIF: **2**
Associated Habitats: C 3% Common, O 1% Occasional

⊟ **B - Black-necked Stilt** *(Himantopus mexicanus)* SOC Not Available M

View in Field Guide **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **S3B** USFWS: **MBTA** FWP SWAP: **SGCN3** PIF: **3**
Associated Habitats: C 3% Common, O 1% Occasional

⊟ **B - Caspian Tern** *(Hydroprogne caspia)* SOC Not Available M

View in Field Guide **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **S2B** USFWS: **MBTA** BLM: **SENSITIVE** FWP SWAP: **SGCN2** PIF: **2**
Associated Habitats: C 3% Common, O 1% Occasional

⊟ **I - Aeshna constricta** *(Lance-tipped Darner)* **PSOC** Not Available Y

View in Field Guide **View Associated Habitat** **View Range Maps**
Potential Species of Concern - Native Species Global: **G5** State: **S1S3**
Associated Habitats: C 3% Common

⊟ **I - Aeshna eremita** *(Lake Darner)* **PSOC** Not Available Y S W

View in Field Guide **View Associated Habitat** **View Range Maps**
Potential Species of Concern - Native Species Global: **G5** State: **S3S4**
Associated Habitats: C 3% Common

⊟ **I - Argia alberta** *(Paiute Dancer)* **PSOC** Not Available Y

View in Field Guide **View Associated Habitat** **View Range Maps**
Potential Species of Concern - Native Species Global: **G4** State: **S2S3**
Associated Habitats: O 3% Occasional

⊟ **I - Argia emma** *(Emma's Dancer)* **PSOC** Not Available Y

View in Field Guide **View Associated Habitat** **View Range Maps**
Potential Species of Concern - Native Species Global: **G5** State: **S3S5**
Associated Habitats: C 3% Common

⊟ **I - Ophiogomphus occidentis** *(Sinuous Snaketail)* **PSOC** Not Available Y

View in Field Guide **View Associated Habitat** **View Range Maps**
Potential Species of Concern - Native Species Global: **G5** State: **S2S4**
Associated Habitats: C 3% Common

⊟ **I - Rhionaeschna multicolor** *(Blue-eyed Darner)* **PSOC** Not Available Y

View in Field Guide **View Associated Habitat** **View Range Maps**
Potential Species of Concern - Native Species Global: **G5** State: **S2S4**
Associated Habitats: C 3% Common

⊟ **B - American White Pelican** *(Pelecanus erythrorhynchos)* **SOC** Not Available M

View in Field Guide **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G4** State: **S3B** USFWS: **MBTA** FWP SWAP: **SGCN3** PIF: **3**
Associated Habitats: C 3% Common

⊟ **B - Clark's Grebe** *(Aechmophorus clarkii)* **SOC** Not Available M

View in Field Guide **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **S3B** USFWS: **MBTA** FWP SWAP: **SGCN3** PIF: **3**
Associated Habitats: C 3% Common

⊟ **B - Common Loon** *(Gavia immer)* **SOC** Not Available M

View in Field Guide **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **S3B** USFWS: **MBTA** USFS: **Sensitive - Known on Forests (KOOT, LOLO)**
FWP SWAP: **SGCN3** PIF: **1**
Associated Habitats: C 3% Common

⊟ **B - Common Tern** *(Sterna hirundo)* **SOC** Not Available M

View in Field Guide **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **S3B** USFWS: **MBTA** BLM: **SENSITIVE** FWP SWAP: **SGCN3** PIF: **2**
Associated Habitats: C 3% Common

⊟ **B - Horned Grebe** *(Podiceps auritus)* **SOC** Not Available M

View in Field Guide **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **S3B** USFWS: **MBTA; BCC11; BCC17** FWP SWAP: **SGCN3** PIF: **2**
Associated Habitats: C 3% Common

⊟ **I - Euphydryas gillettii** *(Gillette's Checkerspot)* **SOC** Not Available Y

View in Field Guide **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G3** State: **S2**
Associated Habitats: C 2% Common, O 37% Occasional

⊟ **M - Fisher** *(Pekania pennanti)* **SOC** Not Available Y W

View in Field Guide **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **S3** USFS: **Sensitive - Known on Forests (BD, BRT, HLC, KOOT, LOLO)** BLM: **SENSITIVE**
FWP SWAP: **SGCN3**
Associated Habitats: C 2% Common, O 4% Occasional

⊟ **I - Polygonia progne** *(Gray Comma)* **SOC** Not Available Y

View in Field Guide **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **S2**
Associated Habitats: C 2% Common, O 1% Occasional

⊟ **B - Pacific Wren** *(Troglodytes pacificus)* SOC Not Available Y

View in Field Guide **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **S3** USFWS: **MBTA** FWP SWAP: **SGCN3** PIF: **2**
Associated Habitats: C 1% Common, O 4% Occasional

⊟ **I - Aeshna juncea** *(Sedge Darner)* PSOC Not Available Y

View in Field Guide **View Associated Habitat** **View Range Maps**
Potential Species of Concern - Native Species Global: **G5** State: **S3S5**
Associated Habitats: C 1% Common, O 3% Occasional

⊟ **I - Argia vivida** *(Vivid Dancer)* PSOC Not Available Y

View in Field Guide **View Associated Habitat** **View Range Maps**
Potential Species of Concern - Native Species Global: **G5** State: **S3S5**
Associated Habitats: C 1% Common, O 3% Occasional

⊟ **I - Enallagma clausum** *(Alkali Bluet)* PSOC Not Available Y

View in Field Guide **View Associated Habitat** **View Range Maps**
Potential Species of Concern - Native Species Global: **G5** State: **S2S4**
Associated Habitats: C 1% Common, O 3% Occasional

⊟ **I - Leucorrhinia borealis** *(Boreal Whiteface)* SOC Not Available Y

View in Field Guide **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **S1**
Associated Habitats: C 1% Common, O 3% Occasional

⊟ **I - Rhionaeschna californica** *(California Darner)* PSOC Not Available Y

View in Field Guide **View Associated Habitat** **View Range Maps**
Potential Species of Concern - Native Species Global: **G5** State: **S3S5**
Associated Habitats: C 1% Common, O 3% Occasional

⊟ **I - Somatochlora hudsonica** *(Hudsonian Emerald)* PSOC Not Available Y

View in Field Guide **View Associated Habitat** **View Range Maps**
Potential Species of Concern - Native Species Global: **G5** State: **S2S4**
Associated Habitats: C 1% Common, O 3% Occasional

⊟ **I - Sympetrum madidum** *(Red-veined Meadowhawk)* PSOC Not Available Y

View in Field Guide **View Associated Habitat** **View Range Maps**
Potential Species of Concern - Native Species Global: **G5** State: **S2S3**
Associated Habitats: C 1% Common, O 3% Occasional

⊟ **B - Harlequin Duck** *(Histrionicus histrionicus)* SOC Not Available S M

View in Field Guide **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G4** State: **S2B** USFWS: **MBTA** USFS: **Sensitive - Known on Forests (BD, CG, HLC, KOOT, LOLO)** FWP SWAP: **SGCN2** PIF: **1**
Associated Habitats: C 1% Common, O 3% Occasional

⊟ **I - Aeshna sitchensis** *(Zigzag Darner)* PSOC Not Available Y

View in Field Guide **View Associated Habitat** **View Range Maps**
Potential Species of Concern - Native Species Global: **G5** State: **S2S3**
Associated Habitats: C 1% Common, O 1% Occasional

⊟ **I - Boloria frigga** *(Frigga Fritillary)* SOC Not Available Y

View in Field Guide **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **S1S2**
Associated Habitats: C 1% Common, O 1% Occasional

⊟ **I - Colias gigantea** *(Giant Sulphur)* PSOC Not Available Y

View in Field Guide **View Associated Habitat** **View Range Maps**
Potential Species of Concern - Native Species Global: **G5** State: **S3**
Associated Habitats: C 1% Common, O 1% Occasional

⊟ **B - Black Rosy-Finch** *(Leucosticte atrata)* SOC Not Available S M

View in Field Guide **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G4** State: **S2** USFWS: **MBTA; BCC10** FWP SWAP: **SGCN2, SGIN** PIF: **2**
Associated Habitats: C 1% Common, O 1% Occasional

⊟ **B - Varied Thrush** *(Ixoreus naevius)* SOC Not Available S M

View in Field Guide **View Associated Habitat** **View Range Maps**
Species of Concern - Native Species Global: **G5** State: **S3B** USFWS: **MBTA** FWP SWAP: **SGCN3** PIF: **3**
Associated Habitats: C 1% Common, O 1% Occasional

⊟ **I - Somatochlora semicircularis** *(Mountain Emerald)* **PSOC** Not Available Y

View in Field Guide **View Associated Habitat** **View Range Maps**

Potential Species of Concern - Native Species Global: **G5** State: **S3S5**

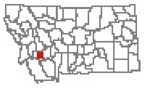
Associated Habitats: C 1% Common

⊟ **B - Tennessee Warbler** *(Oreothlypis peregrina)* **PSOC** Not Available M

View in Field Guide **View Associated Habitat** **View Range Maps**

Potential Species of Concern - Native Species Global: **G5** State: **S3S4B** USFWS: **MBTA**

Associated Habitats: C 1% Common



Latitude	Longitude
45.94097	-112.44866
46.05368	-112.61057

Structured Surveys

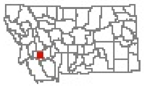
Summarized by: **19prvt0171 BPSOU Sensitive Species** *(Custom Area of Interest)*

The Montana Natural Heritage Program (MTNHP) records information on the locations where more than 80 different types of well-defined repeatable survey protocols capable of detecting an animal species or suite of animal species have been conducted by state, federal, tribal, university, or private consulting biologists. Examples of structured survey protocols tracked by MTNHP include: visual encounter and dip net surveys for pond breeding amphibians, point counts for birds, call playback surveys for selected bird species, visual surveys of migrating raptors, kick net stream reach surveys for macroinvertebrates, visual encounter cover object surveys for terrestrial mollusks, bat acoustic or mist net surveys, pitfall and/or snap trap surveys for small terrestrial mammals, track or camera trap surveys for large mammals, and trap surveys for turtles. Whenever possible, photographs of survey locations are stored in MTNHP databases.

MTNHP does not typically manage information on structured surveys for plants; surveys for invasive species may be a future exception.

Within the report area you have requested, structured surveys are summarized by the number of each type of structured survey protocol that has been conducted, the number of species detections/observations resulting from these surveys, and the most recent year a survey has been conducted.

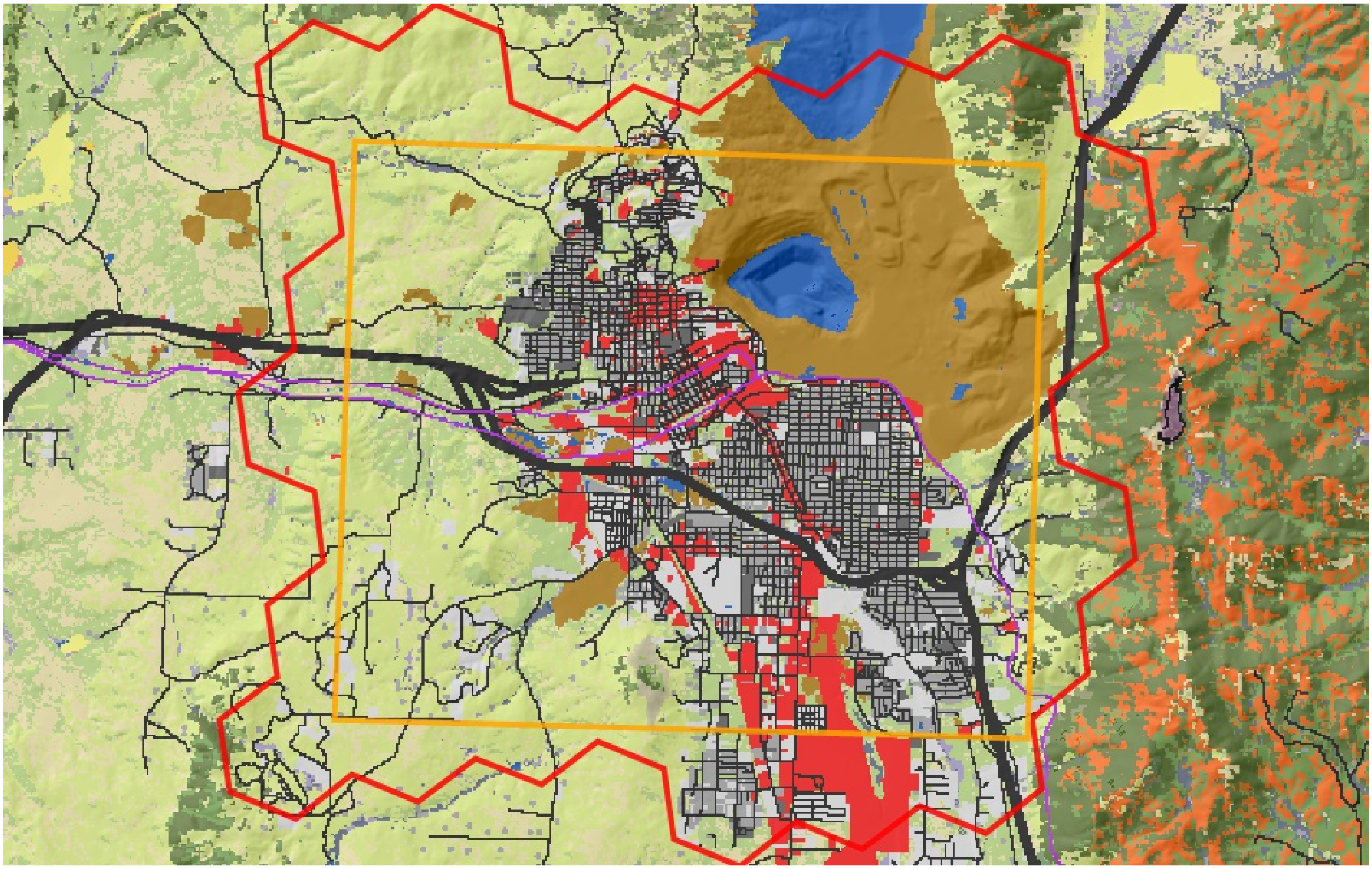
E-Eastern Heath Snail *(Eastern Heath Snail Survey)*	**Survey Count**: 1	**Obs Count**:	**Recent Survey**: 2012
E-Noxious Weed, Road-based *(Noxious Weed Road-based Visual Surveys)*	**Survey Count**: 66	**Obs Count**: 124	**Recent Survey**: 2004
F-Fish Electrofishing *(Fish Electrofishing Surveys)*	**Survey Count**: 29	**Obs Count**: 93	**Recent Survey**: 2015
F-Fish Other Survey *(Fish Other Survey (FWP Survey Type))*	**Survey Count**: 1	**Obs Count**: 1	**Recent Survey**: 1992
I-Bumble Bee *(Bumble Bee Collection Surveys)*	**Survey Count**: 4	**Obs Count**: 7	**Recent Survey**: 2015
M-SMammal Snap/Sherman/Pitfall *(Small Mammal Snap, Sherman, and Pitfall Trap Survey)*	**Survey Count**: 1	**Obs Count**:	**Recent Survey**: 2010



Latitude	Longitude
45.94097	-112.44866
46.05368	-112.61057

Land Cover

Summarized by: **19prvt0171 BPSOU Sensitive Species** *(Custom Area of Interest)*



24% (*7,024* *Acres*)

Grassland Systems

Montane Grassland

🟩 **Rocky Mountain Subalpine-Upper Montane Grassland**

These lush grassland systems are found in upper montane to subalpine, high-elevation,zones, and are shaped by short summers, cold winters, and young soils derived from recent glacial and alluvial material. In subalpine settings, dry grasslands may occur as small meadows or large open parks surrounded by higher elevational forests, but typicall will have no tree cover within them. In general, soil textures are much finer, and soils are often deeper than in the neighboring forests. Most precipitation occurs as heavy snowpack in the mountains with spring and early summer rains. This system is composed of bunch grass species, with a diversity of cool season forbs. It is similar to the Rocky Mountain Lower Montane, Foothill and Valley Grassland ecological system, but is found at higher elevations and has additional floristic components with more subalpine taxa. In Montana, this system generally occurs as two plant communities: a rough fescue-Idaho fescue (*Festuca campestris-Festuca idahoensis*) association occurring on moister sites, such as the north and east-facing slopes and benches in the mountains; and the Idaho Fescue-bluebunch wheatgrass (*Festuca idahoensis-Pseudoroegneria spicata*) association occurring on drier sites, such as ridges, hilltops, and south and west facing slopes and benches. At elevations greater than 2286 meters (7,500 feet), Idaho fescue becomes dominant, sometimes associated with slender wheatgrass (*Elymus trachycaulus*), or in certain areas, tufted hairgrass (*Deschampsia cespitosa*). Noxious species invasion, fire suppression, heavy grazing, and oil and gas development are major threats to this system.

14% (*4,058* *Acres*)

Human Land Use

Mining and Resource Extraction

🟫 **Quarries, Strip Mines and Gravel Pits**

Areas of extractive mining activities with significant surface expression in the form of pits, service roads, and permanently installed processing machinery

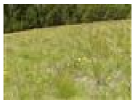
12% (*3,530 Acres*)

Human Land Use

Developed

⬛ Other Roads

County, city and or rural roads generally open to motor vehicles.



11% (*3,130 Acres*)

Grassland Systems

Montane Grassland

🟩 Rocky Mountain Lower Montane, Foothill, and Valley Grassland

This grassland system of the northern Rocky Mountains is found at lower montane to foothill elevations in mountains and valleys throughout Montana. These grasslands are floristically similar to Big Sagebrush Steppe but are defined by shorter summers, colder winters, and young soils derived from recent glacial and alluvial material. They are found at elevations from 548 - 1,650 meters (1,800-5,413 feet). In the lower montane zone, they range from small meadows to large open parks surrounded by conifers; below the lower treeline, they occur as extensive foothill and valley grasslands. Soils are relatively deep, fine-textured, often with coarse fragments, and non-saline. Microphytic crust may be present in high-quality occurrences. This system is typified by cool-season perennial bunch grasses and forbs (>25%) cover, with a sparse shrub cover (<10%). Rough fescue (*Festuca campestris*) is dominant in the northwestern portion of the state and Idaho fescue (*Festuca idahoensis*) is dominant or co-dominant throughout the range of the system. Bluebunch wheatgrass (*Pseudoroegneria spicata*) occurs as a co-dominant throughout the range as well, especially on xeric sites. Western wheatgrass (*Pascopyrum smithii*) is consistently present, often with appreciable coverage (>10%) in lower elevation occurrences in western Montana and virtually always present, with relatively high coverages (>25%), on the edge of the Northwestern Great Plains region. Species diversity ranges from a high of more than 50 per 400 square meter plot on mesic sites to 15 (or fewer) on xeric and disturbed sites. Most occurrences have at least 25 vascular species present. Farmland conversion, noxious species invasion, fire suppression, heavy grazing and oil and gas development are major threats to this system.

7% (*1,919 Acres*)

Human Land Use

Developed

⬜ Developed, Open Space

Vegetation (primarily grasses) planted in developed settings for recreation, erosion control, or aesthetic purposes. Impervious surfaces account for less than 20% of total cover. This category often includes highway and railway rights of way and graveled rural roads.

6% (*1,828 Acres*)

Shrubland, Steppe and Savanna Systems

Sagebrush Steppe

🟨 Montane Sagebrush Steppe

This system dominates the montane and subalpine landscape of southwestern Montana from valley bottoms to subalpine ridges and is found as far north as Glacier National Park. It can also be seen in the island mountain ranges of the north-central and south-central portions of the state. It primarily occurs on deep-soiled to stony flats, ridges, nearly flat ridgetops, and mountain slopes. In general, this system occurs in areas of gentle topography, fine soils, subsurface moisture or mesic conditions, within zones of higher precipitation and areas of snow accumulation. It occurs on all slopes and aspects, variable substrates and all soil types. The shrub component of this system is generally dominated by mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*). Other co-dominant shrubs include silver sagebrush (*Artemisia cana ssp. viscidula)*, subalpine big sagebrush (*Artemisia tridentata ssp. spiciformis*), three tip sagebrush (*Artemisia tripartita* ssp. *tripartita*) and antelope bitterbrush (*Purshia tridentata*). Little sagebrush (*Artemisia arbuscula ssp. arbuscula*) shrublands are only found in southwestern Montana on sites with a perched water table. Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*) sites may be included within this system if occurrences are at montane elevations, and are associated with montane graminoids such as Idaho fescue (*Festuca idahoensis),* spike fescue (*Leucopoa kingii*), or poverty oatgrass (*Danthonia intermedia)*. In ares where sage has been eliminated by human activities like burning, disking or poisoning, other shrubs may be dominant, especially rubber rabbitbrush (*Ericameria nauseosa*), and green rabbitbrush (*Chrysothamnus viscidiflorus*). Because of the mesic site conditions, most occurrences support a diverse herbaceous undergrowth of grasses and forbs. Shrub canopy cover is extremely variable, ranging from 10 percent to as high as 40 or 50 percent.

6% (*1,752 Acres*)

Human Land Use

Developed

⬛ Low Intensity Residential

Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20-50% of total cover. These areas most commonly include single-family housing units in rural and suburban areas. Paved roadways may be classified into this category.

5% (*1,557 Acres*)

Human Land Use

Developed

🟥 Commercial / Industrial

Businesses, industrial parks, hospitals, airports; utilities in commercial/industrial areas.

3% (*967 Acres*)

Forest and Woodland Systems

Conifer-dominated forest and woodland (xeric-mesic)

🟩 Rocky Mountain Montane Douglas-fir Forest and Woodland

In Montana, this ecological system occurs on the east side of the Continental Divide, north to about the McDonald Pass area, and along the Rocky Mountain Front. This system is associated with a dry to submesic continental climate regime with annual precipitation ranging from 51 to 102 centimeters (20-40 inches), with a maximum in winter or late spring. Winter snowpacks typically melt off in early spring at lower elevations. Elevations range from valley bottoms to 1,980 meters (6500 feet) in northern Montana and up to 2,286 meters (7500 feet) on warm aspects in southern Montana. It occurs on north-facing aspects in most areas, and south-facing aspects at higher elevations. This is a Douglas-fir (*Pseudotsuga menziesii*) dominated system without any maritime floristic composition. Fire disturbance intervals are as infrequent as 500 years, and as a result, individual trees and forests can attain great age on some sites (500 to 1,500 years). In Montana, this system occurs from lower montane to lower subalpine environments and is prevalent on calcareous substrates. Common understory shrubs include common ninebark (*Physocarpus malvaceus*), common juniper (*Juniperus communis*), Rocky Mountain juniper (*Juniperus scopulorum*), birch-leaf spiraea (*Spiraea betulifolia*), snowberry (*Symphoricarpos* species), creeping Oregon grape (*Mahonia repens*) and Canadian buffaloberry (*Shepherdia canadensis*). The Douglas-fir/pinegrass (C*alamogrostis rubescens*) type is the most ubiquitous association found within this system in Montana.

No Image

3% (*790 Acres*)

Human Land Use

Developed

⬛ Interstate

National Highway System (NHS) limited access highways and their shoulders and rights of way.

3% (*754 Acres*)

Wetland and Riparian Systems

Open Water

🟦 Open Water

All areas of open water, generally with less than 25% cover of vegetation or soil

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Additional Limited Land Cover

1% (*333 Acres*)	⬛ High Intensity Residential
1% (*201 Acres*)	🟪 Railroad
1% (*170 Acres*)	⬛ Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland
1% (*163 Acres*)	🟩 Rocky Mountain Lodgepole Pine Forest
<1% (*122 Acres*)	🟫 Aspen Forest and Woodland
<1% (*109 Acres*)	🟧 Insect-Killed Forest
<1% (*99 Acres*)	🟪 Alpine-Montane Wet Meadow
<1% (*78 Acres*)	🟫 Rocky Mountain Cliff, Canyon and Massive Bedrock
<1% (*49 Acres*)	🟩 Rocky Mountain Subalpine-Montane Mesic Meadow
<1% (*40 Acres*)	⬛ Major Roads
<1% (*32 Acres*)	🟩 Rocky Mountain Ponderosa Pine Woodland and Savanna
<1% (*29 Acres*)	🟩 Rocky Mountain Subalpine Deciduous Shrubland
<1% (*13 Acres*)	🟩 Rocky Mountain Foothill Limber Pine - Juniper Woodland
<1% (*11 Acres*)	🟩 Rocky Mountain Montane-Foothill Deciduous Shrubland
<1% (*5 Acres*)	🟩 Rocky Mountain Subalpine Woodland and Parkland
<1% (*5 Acres*)	🟩 Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland
<1% (*2 Acres*)	🟩 Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland
<1% (*1 Acres*)	🟩 Aspen and Mixed Conifer Forest
<1% (*0 Acres*)	🟨 Low Sagebrush Shrubland
<1% (*0 Acres*)	🟦 Emergent Marsh
<1% (*0 Acres*)	🟦 Wind Turbine

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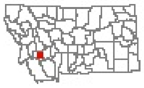
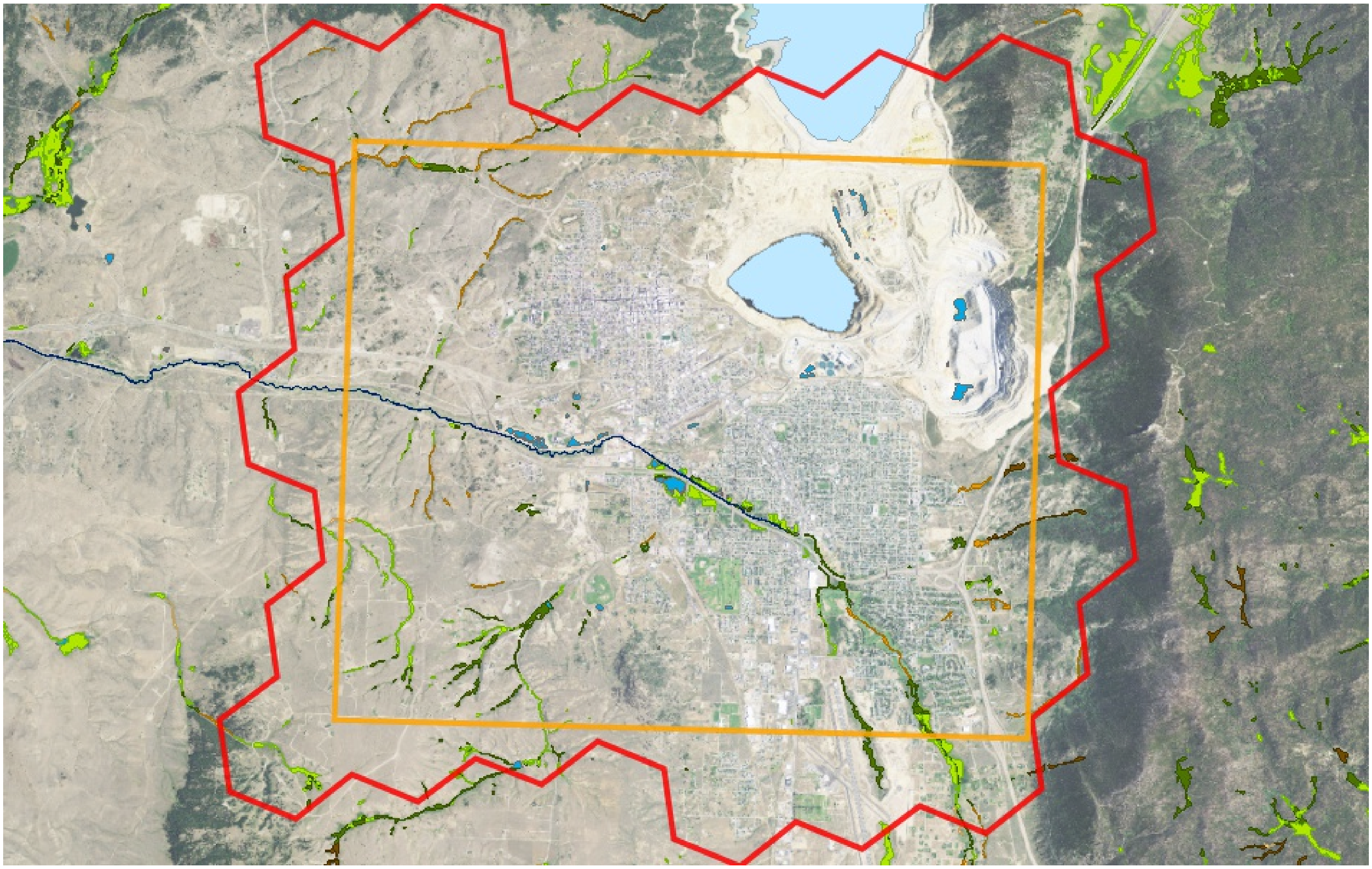


	Latitude	Longitude
	45.94097	-112.44866
	46.05368	-112.61057

Wetland and Riparian

Summarized by: **19prvt0171 BPSOU Sensitive Species** *(Custom Area of Interest)*



Wetland and Riparian Mapping

Explain

P - Palustrine

🟦 UB - Unconsolidated Bottom

F - Semipermanently Flooded	53 Acres		
x - Excavated	**53 Acres**	**PUBFx**	

P - Palustrine, UB - Unconsolidated Bottom
Wetlands where mud, silt or similar fine particles cover at least 25% of the bottom, and where vegetation cover is less than 30%.

🟦 AB - Aquatic Bed

F - Semipermanently Flooded	27 Acres	
(no modifier)	**14 Acres**	**PABF**
h - Diked/Impounded	**6 Acres**	**PABFh**
x - Excavated	**7 Acres**	**PABFx**

P - Palustrine, AB - Aquatic Bed
Wetlands with vegetation growing on or below the water surface for most of the growing season.

🟦 US - Unconsolidated Shore

A - Temporarily Flooded	<1 Acres	
x - Excavated	**<1 Acres**	**PUSAx**

P - Palustrine, US - Unconsolidated Shore
Wetlands with less than 75% areal cover of stones, boulders, or bedrock. AND with less than 30% vegetative cover AND the wetland is irregularly exposed due to seasonal or irregular flooding and subsequent drying.

🟩 EM - Emergent

A - Temporarily Flooded	129 Acres	
(no modifier)	**129 Acres**	**PEMA**
h - Diked/Impounded	**<1 Acres**	**PEMAh**
C - Seasonally Flooded	17 Acres	
(no modifier)	**17 Acres**	**PEMC**

P - Palustrine, EM - Emergent
Wetlands with erect, rooted herbaceous vegetation present during most of the growing season.

h - Diked/Impounded **<1 Acres** **PEMCh**

F - Semipermanently Flooded 5 Acres
(no modifier) **5 Acres** **PEMF**

🟩 SS - Scrub-Shrub

P - Palustrine, SS - Scrub-Shrub
Wetlands dominated by woody vegetation less than 6 meters (20 feet) tall. Woody vegetation includes tree saplings and trees that are stunted due to environmental conditions.

A - Temporarily Flooded 138 Acres
(no modifier) **138 Acres** **PSSA**

C - Seasonally Flooded 4 Acres
(no modifier) **4 Acres** **PSSC**

F - Semipermanently Flooded 3 Acres
(no modifier) **3 Acres** **PSSF**

L - Lacustrine (Lakes)

1 - Limnetic

🟦 UB - Unconsolidated Bottom

L - Lacustrine (Lakes), 1 - Limnetic, UB - Unconsolidated Bottom
Deep waterbodies with mud or silt covering at least 25% of the bottom.

H - Permanently Flooded 661 Acres
x - Excavated **661 Acres** **L1UBHx**

R - Riverine (Rivers)

3 - Upper Perennial

🟦 UB - Unconsolidated Bottom

R - Riverine (Rivers), 3 - Upper Perennial, UB - Unconsolidated Bottom
Stream channels where the substrate is at least 25% mud, silt or other fine particles.

H - Permanently Flooded 12 Acres
(no modifier) **12 Acres** **R3UBH**

Rp - Riparian

1 - Lotic

🟧 SS - Scrub-Shrub
(no modifier) **62 Acres** **Rp1SS**

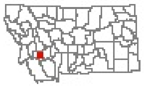
Rp - Riparian, 1 - Lotic, SS - Scrub-Shrub
This type of riparian area is dominated by woody vegetation that is less than 6 meters (20 feet) tall. Woody vegetation includes tree saplings and trees that are stunted due to environmental conditions.

🟫 FO - Forested
(no modifier) **14 Acres** **Rp1FO**

Rp - Riparian, 1 - Lotic, FO - Forested
This riparian class has woody vegetation that is greater than 6 meters (20 feet) tall.

🟨 EM - Emergent
(no modifier) **4 Acres** **Rp1EM**

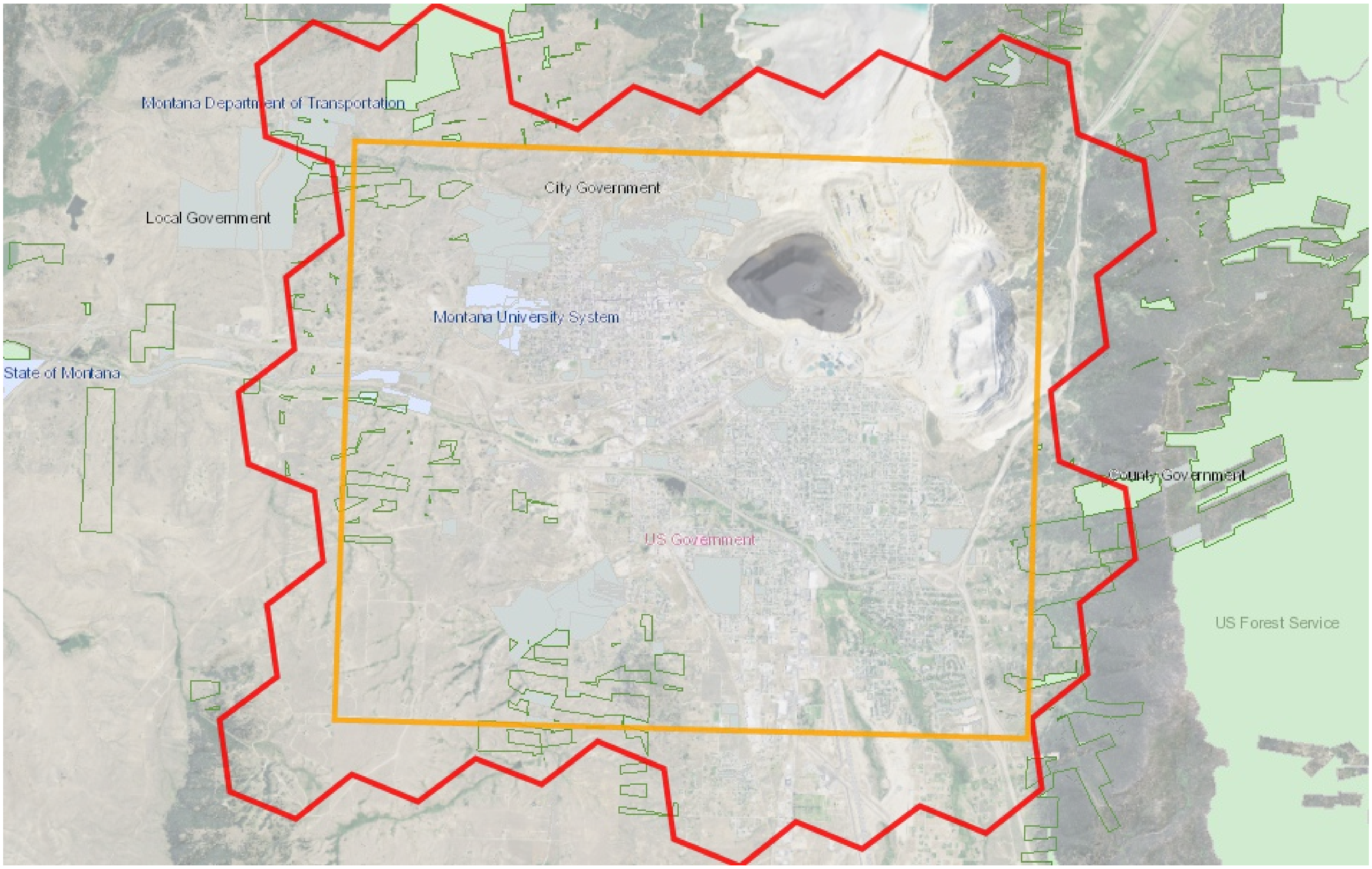
Rp - Riparian, 1 - Lotic, EM - Emergent
Riparian areas that have erect, rooted herbaceous vegetation during most of the growing season.



Latitude	Longitude
45.94097	-112.44866
46.05368	-112.61057

Land Management

Summarized by: **19prvt0171 BPSOU Sensitive Species** *(Custom Area of Interest)*



Land Management Summary

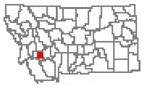
Explain

	Ownership	Tribal	Easements	Other Boundaries (possible overlap)
Public Lands	**2,468 Acres (9%)**			
Federal	**385 Acres (1%)**			
US Forest Service	**379 Acres (1%)**			
🟩 **USFS Owned**	**379 Acres (1%)**			
USFS Ranger Districts				**1,365 Acres**
☐ Beaverhead-Deerlodge National Forest, Butte-Jefferson Ranger District				1,365 Acres
USFS National Forest Boundaries				**1,365 Acres**
☐ Beaverhead-Deerlodge National Forest				1,365 Acres
US Government	**6 Acres (<1%)**			
🟪 **US Government Owned**	**6 Acres (<1%)**			
State	**200 Acres (1%)**			
Montana University System	**134 Acres (<1%)**			
🟦 **MUS Owned**	**134 Acres (<1%)**			
Montana Department of Transportation	**3 Acres (<1%)**			
🟦 **MTDOT Owned**	**3 Acres (<1%)**			
State of Montana	**63 Acres (<1%)**			
🟦 **State of Montana Owned**	**63 Acres (<1%)**			
Local	**1,883 Acres (7%)**			
Local Government	**1,883 Acres (7%)**			

Land Management Summary

Explain

	Ownership	Tribal	Easements	Other Boundaries (possible overlap)
◼ Local Government Owned	1,883 Acres (7%)			
Private Lands or Unknown Ownership	**26,306 Acres (91%)**			



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Biological Reports

Summarized by: **19prvt0171 BPSOU Sensitive Species** *(Custom Area of Interest)*

Within the report area you have requested, citations for all reports and publications associated with plant or animal observations in Montana Natural Heritage Program (MTNHP) databases are listed and, where possible, links to the documents are included.

The MTNHP plans to include reports associated with terrestrial and aquatic communities in the future as allowed for by staff resources. If you know of reports or publications associated with species or biological communities within the report area that are not shown in this report, please let us know: mtnhp@mt.gov

- Saunders, A.A. 1912. Some Birds of Southwest Montana. Condor. Vol. 16, pp. 22-32.

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Invasive and Pest Species

Legend

Model Icons
- N Suitable (native range)
- O Optimal Suitability
- M Moderate Suitability
- L Low Suitability
- I Suitable (introduced range)

Habitat Icons
- C Common
- O Occasional

Range Icons
- T Suspect (invasive / pest)
- D Documented (invasive / pest)
- R Released (biocontrol)
- E Established (biocontrol)

Num Obs
Count of obs with 'good precision' (<=1000m)

+ indicates additional 'poor precision' obs (1001m-10,000m)

Latitude	Longitude
45.94097	-112.44866
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Summarized by: **19prvt0171 BPSOU Sensitive Species** *(Custom Area of Interest)*

	# Obs	Predictive Model	Associated Habitat	Range
Noxious Weeds: Priority 2A				
⊟ **V - Hieracium aurantiacum** *(Orange Hawkweed)* N2A	1	Not Available	Not Assigned	D
View in Field Guide **View Range Maps** Noxious Weed: Priority 2A - Non-native Species Global: **GNR** State: **SNA**				
Noxious Weeds: Priority 2B				
⊟ **V - Centaurea stoebe** *(Spotted Knapweed)* N2B	80	Not Available	Not Assigned	D
View in Field Guide **View Range Maps** Noxious Weed: Priority 2B - Non-native Species Global: **GNR** State: **SNA**				
⊟ **V - Cirsium arvense** *(Canada Thistle)* N2B	4	Not Available	Not Assigned	D
View in Field Guide **View Range Maps** Noxious Weed: Priority 2B - Non-native Species Global: **G5** State: **SNA**				
⊟ **V - Convolvulus arvensis** *(Field Bindweed)* N2B	3	Not Available	Not Assigned	D
View in Field Guide **View Range Maps** Noxious Weed: Priority 2B - Non-native Species Global: **GNR** State: **SNA**				
⊟ **V - Euphorbia virgata** *(Leafy Spurge)* N2B	5	Not Available	Not Assigned	D
View in Field Guide **View Range Maps** Noxious Weed: Priority 2B - Non-native Species Global: **GNRTNR** State: **SNA**				
⊟ **V - Lepidium draba** *(Whitetop)* N2B	21	Not Available	Not Assigned	D
View in Field Guide **View Range Maps** Noxious Weed: Priority 2B - Non-native Species Global: **GNR** State: **SNA**				
⊟ **V - Linaria dalmatica** *(Dalmatian Toadflax)* N2B	29	Not Available	Not Assigned	D
View in Field Guide **View Range Maps** Noxious Weed: Priority 2B - Non-native Species Global: **G5** State: **SNA**				
⊟ **V - Leucanthemum vulgare** *(Oxeye Daisy)* N2B	2	Not Available	Not Assigned	
View in Field Guide Noxious Weed: Priority 2B - Non-native Species Global: **GNR** State: **SNA**				
Biocontrol Species				
⊟ **I - Oberea erythrocephala** *(Red-headed Leafy Spurge Stem Borer)* BIOCNTRL		🟥🟧🟨	Not Assigned	R
View in Field Guide **View Predicted Models** **View Range Maps** Biocontrol Species - Non-native Species Global: **GNR** State: **SNA** **Predictive Models:** O 20% Optimal (inductive), M 56% Moderate (inductive), L 24% Low (inductive)				
⊟ **I - Aphthona lacertosa** *(Brown-legged Leafy Spurge Flea Beetle)* BIOCNTRL		🟥🟧🟨⬜	Not Assigned	R
View in Field Guide **View Predicted Models** **View Range Maps** Biocontrol Species - Non-native Species Global: **GNR** State: **SNA** **Predictive Models:** O 2% Optimal (inductive), M 53% Moderate (inductive), L 33% Low (inductive)				
⊟ **I - Cyphocleonus achates** *(Knapweed Root Weevil)* BIOCNTRL		🟧🟨⬜	Not Assigned	R
View in Field Guide **View Predicted Models** **View Range Maps** Biocontrol Species - Non-native Species Global: **GNR** State: **SNA** **Predictive Models:** M 44% Moderate (inductive), L 24% Low (inductive)				
⊟ **I - Mecinus janthinus** *(Yellow Toadflax Stem-boring Weevil)* BIOCNTRL		🟧🟨⬜	Not Assigned	R
View in Field Guide **View Predicted Models** **View Range Maps** Biocontrol Species - Non-native Species Global: **GNR** State: **SNA** **Predictive Models:** M 22% Moderate (inductive), L 40% Low (inductive)				
⊟ **I - Aphthona nigriscutis** *(Black Dot Leafy Spurge Flea Beetle)* BIOCNTRL		🟧🟨⬜	Not Assigned	R
View in Field Guide **View Predicted Models** **View Range Maps** Biocontrol Species - Non-native Species Global: **GNR** State: **SNA** **Predictive Models:** M 13% Moderate (inductive), L 40% Low (inductive)				
⊟ **I - Mecinus janthiniformis** *(Dalmatian Toadflax Stem-boring Weevil)* BIOCNTRL		🟧🟨	Not Assigned	R

View in Field Guide **View Predicted Models** **View Range Maps**

Biocontrol Species - Non-native Species Global: **GNR** State: **SNA**

Predictive Models: M 7% Moderate (inductive), L 84% Low (inductive)

Introduction to Montana Natural Heritage Program

Montana State Library
MONTANA Natural Heritage Program
The University of Montana

P.O. Box 201800 • 1515 East Sixth Avenue • Helena, MT 59620-1800 • fax 406.444.0266 • tel 406.444.0241 • mtnhp.org

INTRODUCTION

The Montana Natural Heritage Program (MTNHP) is Montana's source for reliable and objective information on Montana's native species and habitats, emphasizing those of conservation concern. MTNHP was created by the Montana legislature in 1983 as part of the Natural Resource Information System (NRIS) at the Montana State Library (MSL). MTNHP is "a program of information acquisition, storage, and retrieval for data relating to the flora, fauna, and biological community types of Montana" (MCA 90-15-102). MTNHP's activities are guided by statute (MCA 90-15) as well as through ongoing interaction with, and feedback from, principal data source agencies such as Montana Fish, Wildlife, and Parks, the Montana Department of Environmental Quality, the Montana Department of Natural Resources and Conservation, the Montana University System, the US Forest Service, and the US Bureau of Land Management. The enabling legislation for MTNHP provides the State Library with the option to contract the operation of the Program. Since 2006, MTNHP has been operated as a program under the Office of the Vice President for Research and Creative Scholarship at the University of Montana (UM) through a renewable 2-year contract with the MSL. Since the first staff was hired in 1985, the Program has logged a long record of success, and developed into a highly respected, service-oriented program. MTNHP is widely recognized as one of the most advanced and effective of over 80 natural heritage programs throughout the Western Hemisphere.

VISION

Our vision is that public agencies, the private sector, the education sector, and the general public will trust and rely upon MTNHP as the source for information and expertise on Montana's species and habitats, especially those of conservation concern. We strive to provide easy access to our information in order for users to save time and money, speed environmental reviews, and inform decision making.

CORE VALUES

- We endeavor to be a single statewide source of accurate and up-to-date information on Montana's plants, animals, and aquatic and terrestrial biological communities.
- We actively listen to our data users and work responsively to meet their information and training needs.
- We strive to provide neutral, trusted, timely, and equitable service to all of our information users.
- We make every effort to be transparent to our data users in setting work priorities and providing data products.

CONFIDENTIALITY

All information requests made to the Montana Natural Heritage Program are considered library records and are protected from disclosure by the Montana Library Records Confidentiality Act (MCA 22-1-11).

INFORMATION MANAGED

Information managed at the Montana Natural Heritage Program includes: (1) lists of, and basic information on, plant and animal species and biological communities; (2) plant and animal surveys, observations, species occurrences, predictive distribution models, range polygons, and conservation status ranks; and (3) land cover and wetland and riparian mapping and the conservation status of these and other biological communities.

Data Use Terms and Conditions

- Montana Natural Heritage Program (MTNHP) products and services are based on biological data and the objective interpretation of those data by professional scientists. MTNHP does not advocate any particular philosophy of natural resource protection, management, development, or public policy.
- MTNHP has no natural resource management or regulatory authority. Products, statements, and services from MTNHP are intended to inform parties as to the state of scientific knowledge about certain natural resources, and to further develop that knowledge. The information is not intended as natural resource management guidelines or prescriptions or a determination of environmental impacts. MTNHP recommends consultation with appropriate state, federal, and tribal resource management agencies and authorities in the area where your project is located.
- Information on the status and spatial distribution of biological resources produced by MTNHP are intended to inform parties of the state-wide status, known occurrence, or the likelihood of the presence of those resources. **These products are not intended to substitute for field-collected data, nor are they intended to be the sole basis for natural resource management decisions.**
- MTNHP does not portray its data as exhaustive or comprehensive inventories of rare species or biological communities. **Field verification of the absence or presence of sensitive species and biological communities will always be an important obligation of users of our data.**
- MTNHP responds equally to all requests for products and services, regardless of the purpose or identity of the requester.
- Because MTNHP constantly updates and revises its databases with new data and information, products will become outdated over time. Interested parties are encouraged to obtain the most current information possible from MTNHP, rather than using older products. We add, review, update, and delete records on a daily basis. Consequently, we strongly advise that you update your MTNHP data sets at a minimum of every three months for most applications of our information.
- MTNHP data require a certain degree of biological expertise for proper analysis, interpretation, and application. Our staff is available to advise you on questions regarding the interpretation or appropriate use of the data that we provide. Contact information for MTNHP staff is posted at: http://mtnhp.org/contact.asp
- The information provided to you by MTNHP may include sensitive data that if publicly released might jeopardize the welfare of threatened, endangered, or sensitive species or biological communities. This information is intended for distribution or use only within your department, agency, or business. Subcontractors may have access to the data during the course of any given project, but should not be given a copy for their use on subsequent, unrelated work.
- MTNHP data are made freely available. Duplication of hard-copy or digital MTNHP products with the intent to sell is prohibited without written consent by MTNHP. Should you be asked by individuals outside your organization for the type of data that we provide, please refer them to MTNHP.
- MTNHP and appropriate staff members should be appropriately acknowledged as an information source in any third-party product involving MTNHP data, reports, papers, publications, or in maps that incorporate MTNHP graphic elements.
- Sources of our data include museum specimens, published and unpublished scientific literature, field surveys by state and federal agencies and private contractors, and reports from knowledgeable individuals. MTNHP actively solicits and encourages additions, corrections and updates, new observations or collections, and comments on any of the data we provide.
- MTNHP staff and contractors do not cross or survey privately-owned lands without express permission from the landowner. However, the program cannot guarantee that information provided to us by others was obtained under adherence to this policy.

Suggested Contacts for Natural Resource Agencies

As required by Montana statute (MCA 90-15), the Montana Natural Heritage Program works with state, federal, tribal, nongovernmental organizations, and private partners to ensure that the latest animal and plant distribution and status information is incorporated into our databases so that it can be used to inform a variety of planning processes and management decisions. In addition to the information you receive from us, we encourage you to contact state, federal, and tribal resource management agencies in the area where your project is located. They may have additional data or management guidelines relevant to your efforts. In particular, we encourage you to contact the Montana Department of Fish, Wildlife, and Parks for the latest data and management information regarding hunted and high-profile management species and to use the U.S. Fish and Wildlife Service's Information Planning and Conservation (IPAC) website http://ecos.fws.gov/ipac/ regarding U.S. Endangered Species Act listed Threatened, Endangered, or Candidate species.

For your convenience, we have compiled a list of relevant agency contacts and links below:

Montana Fish, Wildlife, and Parks

Fish Species	Zachary Shattuck zshattuck@mt.gov (406) 444-1231 or Lee Nelson leenelson@mt.gov (406) 444-2447
American Bison Black-footed Ferret Black-tailed Prairie Dog Bald Eagle Golden Eagle Common Loon Least Tern Piping Plover Whooping Crane	Lauri Hanauska-Brown LHanauska-Brown@mt.gov (406) 444-5209
Grizzly Bear Greater Sage Grouse Trumpeter Swan Big Game Upland Game Birds Furbearers	John Vore jvore@mt.gov (406) 444-5209
Managed Terrestrial Game and Nongame Animal Data	Smith Wells – MFWP Data Analyst smith.wells@mt.gov (406) 444-3759
Fisheries Data	Adam Petersen – MFWP Fish Data Manager apetersen@mt.gov (406) 444-1275
Wildlife and Fisheries Scientific Collector's Permits	http://fwp.mt.gov/doingBusiness/licenses/scientificWildlife/ Karen Speeg for Wildlife kspeeg@mt.gov (406) 444-2612 Kim Wedde for Fisheries kim.wedde@mt.gov (406) 444-5594
Fish and Wildlife Recommendations for Subdivision Development	Renee Lemon RLemon@mt.gov (406) 444-3738 and see http://fwp.mt.gov/fishAndWildlife/livingWithWildlife/buildingWithWildlife/subdivisionRecommendations/
Regional Contacts 	Region 1 (Kalispell) (406) 752-5501 Region 2 (Missoula) (406) 542-5500 Region 3 (Bozeman) (406) 994-4042 Region 4 (Great Falls) (406) 454-5840 Region 5 (Billings) (406) 247-2940 Region 6 (Glasgow) (406) 228-3700 Region 7 (Miles City) (406) 234-0900

United States Fish and Wildlife Service:

Information Planning and Conservation (IPAC) website: http://ecos.fws.gov/ipac/

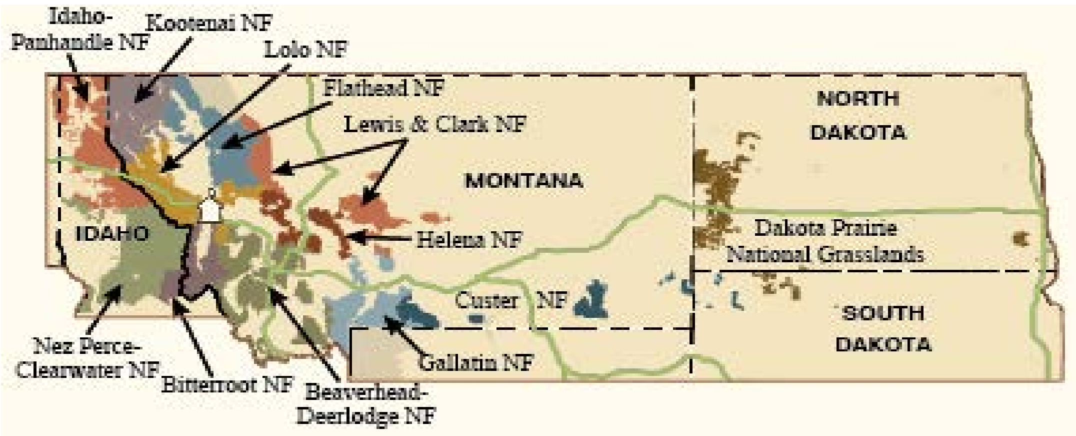
Montana Ecological Services Field Office: http://www.fws.gov/montanafieldoffice/ (406) 449-5225

Bureau of Land Management

Montana Field Office Contacts:

Billings	(406) 896-5013
Butte	(406) 533-7600
Dillon	(406) 683-8000
Glasgow	(406) 228-3750
Havre	(406) 262-2820
Lewistown	(406) 538-1900
Malta	(406) 654-5100
Miles City	(406) 233-2800
Missoula	(406) 329-3914

United States Forest Service



Regional Office – Missoula, Montana Contacts

Wildlife Program Leader	Tammy Fletcher	tammyfletcher@fs.fed.us	(406) 329-3588
Wildlife Ecologist	Cara Staab	cstaab@fs.fed.us	(406) 329-3677
Fish Program Leader	Scott Spaulding	scottspaulding@fs.fed.us	(406) 329-3287
Fish Ecologist	Cameron Thomas	cathomas@fs.fed.us	(406) 329-3087
TES Program	Lydia Allen	lrallen@fs.fed.us	(406) 329-3558
Interagency Grizzly Bear Coordinator	Scott Jackson	sjackson03@fs.fed.us	(406) 329-3664
Regional Botanist	Steve Shelly	sshelly@fs.fed.us	(406) 329-3041

Tribal Nations

Assiniboine & Gros Ventre Tribes – Fort Belknap Reservation

Assiniboine & Sioux Tribes – Fort Peck Reservation

Blackfeet Tribe - Blackfeet Reservation

Chippewa Creek Tribe - Rocky Boy's Reservation

Crow Tribe – Crow Reservation

Little Shell Chippewa Tribe

Northern Cheyenne Tribe – Northern Cheyenne Reservation

Salish & Kootenai Tribes - Flathead Reservation

Introduction to Native Species

Within the report area you have requested, separate summaries are provided for: (1) Species Occurrences (SO) for plant and animal Species of Concern, Special Status Species (SSS), Important Animal Habitat (IAH) and some Potential Plant Species of Concern; (2) other observed non Species of Concern or Species of Concern without suitable documentation to create Species Occurrence polygons; and (3) other non-documented species that are potentially present based on their range, predicted suitable habitat model output, or presence of associated habitats. Each of these summaries provides the following information when present for a species: (1) the number of Species Occurrences and associated delineation criteria for construction of these polygons that have long been used for considerations of documented Species of Concern in environmental reviews; (2) the number of observations of each species; (3) the geographic range polygons for each species that the report area overlaps; (4) predicted relative habitat suitability classes that are present if a predicted suitable habitat model has been created; (5) the percent of the report area that is mapped as commonly associated or occasionally associated habitat as listed for each species in the Montana Field Guide; and (6) a variety of conservation status ranks and links to species accounts in the Montana Field Guide. Details on each of these information categories are included under relevant section headers below or are defined on our Species Status Codes page. In presenting this information, the Montana Natural Heritage Program (MTNHP) is working towards assisting the user with rapidly determining what species have been documented and what species are potentially present in the report area. We remind users that this information is likely incomplete as surveys to document native and introduced species are lacking in many areas of the state, information on introduced species has only been tracked relatively recently, the MTNHP's staff and resources are restricted by declining budgets, and information is constantly being added and updated in our databases. **Thus, field verification by professional biologists of the absence or presence of species and biological communities will always be an important obligation of users of our data.**

If you are aware of observation datasets that the MTNHP is missing, please report them to the Program Botanist apipp@mt.gov or Senior Zoologist dbachen@mt.gov. If you have observations that you would like to contribute, you can submit animal observations using our online data entry system at http://mtnhp.org/AddObs/, plant and animal observations via Excel spreadsheets posted at http://mtnhp.org/observations.asp , or to the Program Botanist or Senior Zoologist.

Observations

The MTNHP manages information on more than 1.8 million animal and plant observations that have been reported by professional biologists and private citizens from across Montana. The majority of these observations are submitted in digital format from standardized databases associated with research or monitoring efforts and spreadsheets of incidental observations submitted by professional biologists and amateur naturalists. At a minimum, accepted observation records must contain a credible species identification (i.e. appropriate geographic range, date, and habitat and, if species are difficult to identify, a photograph and notes on key identifying features), a date or date range, observer name, locational information (ideally with latitude and longitude in decimal degrees), notes on numbers observed, and species behavior or habitat use (e.g., is the observation likely associated with reproduction). Bird records are also required to have information associated with date-appropriate breeding or overwintering status of the species observed. MTNHP reviews observation records to ensure that they are mapped correctly, occur within date ranges when the species is known to be present or detectable, occur within the known seasonal geographic range of the species, and occur in appropriate habitats. MTNHP also assigns each record a locational uncertainty value in meters to indicate the spatial precision associated with the record's mapped coordinates. Only records with locational uncertainty values of 10,000 meters or less are included in environmental summary reports and number summaries are only provided for records with locational uncertainty values of 1,000 meters or less.

Species Occurrences

The MTNHP evaluates plant and animal observation records for species of higher conservation concern to determine whether they are worthy of inclusion in the Species Occurrence (SO) layer for use in environmental reviews; observations not worthy of inclusion in this layer include long distance dispersal events, migrants observed away from key migratory stopover habitats, and winter observations. An SO is a polygon depicting what is known about a species occupancy from direct observation with a defined level of locational uncertainty and any inference that can be made about adjacent habitat use from the latest peer-reviewed science. If an observation can be associated with a map feature that can be tracked (e.g., a wetland boundary for a wetland associated plant) then this polygon feature is used to represent the SO. Areas that can be inferred as probable occupied habitat based on direct observation of a species location and what is known about the foraging area or home range size of the species may be incorporated into the SO. Species Occurrences generally belong to one of the following categories:

Plant Species Occurrences

A documented location of a specimen collection or observed plant population. In some instances, adjacent, spatially separated clusters are considered subpopulations and are grouped as one occurrence (e.g., the subpopulations occur in ecologically similar habitats, and their spatial proximity likely allows them to interbreed). Tabular information for multiple observations at the same SO location is generally linked to a single polygon. Plant SO's are only created for Species of Concern and Potential Species of Concern.

Animal Species Occurrences

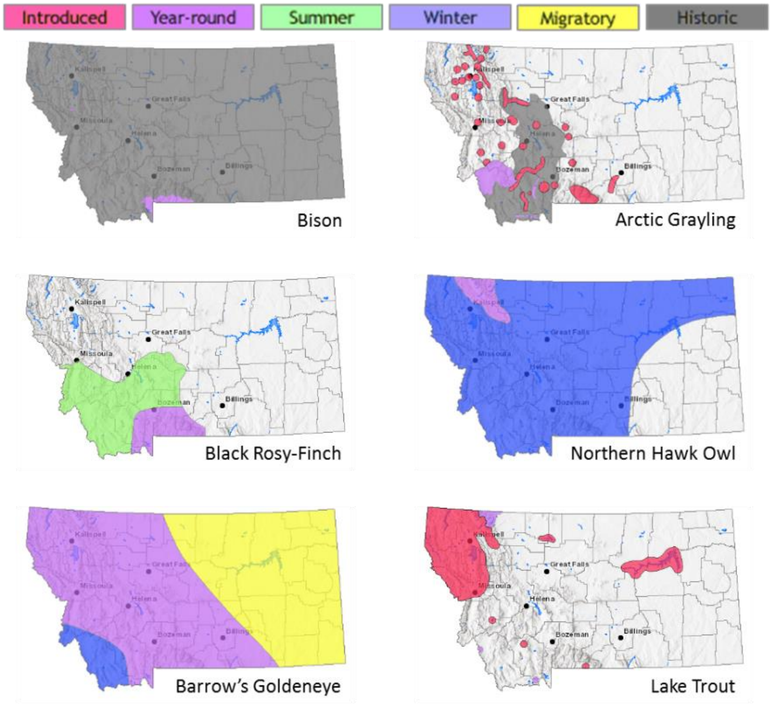
The location of a verified observation or specimen record typically known or assumed to represent a breeding population or a portion of a breeding population. Animal SO’s are generally: (1) buffers of terrestrial point observations based on documented species’ home range sizes; (2) buffers of stream segments to encompass occupied streams and immediate adjacent riparian habitats; (3) polygonal features encompassing known or likely breeding populations (e.g., a wetland for some amphibians or a forested portion of a mountain range for some wide ranging carnivores); or (4) combinations of the above. Tabular information for multiple observations at the same SO location is generally linked to a single polygon. Species Occurrence polygons may encompass some unsuitable habitat in some instances in order to avoid heavy data processing associated with clipping out habitats that are readily assessed as unsuitable by the data user (e.g., a point buffer of a terrestrial species may overlap into a portion of a lake that is obviously inappropriate habitat for the species). Animal SO's are only created for Species of Concern and Special Status Species (e.g., Bald Eagle).

Other Occurrence Polygons

These include significant biological features not included in the above categories, such as Important Animal Habitats like bird rookeries and bat roosts, and peatlands or other wetland and riparian communities that support diverse plant and animal communities.

Geographic Range Polygons

Geographic range polygons have not yet been defined for most plant species. Native year-round, summer, winter, migratory and historic geographic range polygons as well as polygons for introduced populations have been defined for most animal species for which there are enough observations, surveys, and knowledge of appropriate seasonal habitat use to define them (see examples to left). These native or introduced range polygons bound the extent of known or likely occupied habitats for non-migratory and relative sedentary species and the regular extent of known or likely occupied habitats for migratory and long-distance dispersing species; polygons may include unsuitable intervening habitats. For most species, a single polygon can represent the year-round or seasonal range, but breeding ranges of some colonial nesting water birds and some introduced species are represented more patchily when supported by data. Some ranges are mapped more broadly than actual distributions in order to be visible on statewide maps (e.g., fish).



Predicted Suitable Habitat Models

Recent predicted suitable habitat suitability models have not yet been created for most plant species. For animal species for which models have been completed, the environmental summary report includes simple, rule-based, associations with streams for fish and other aquatic species and mathematically complex Maximum Entropy models (Phillips et al. 2006, Ecological Modeling 190:231-259) constructed from a variety of statewide biotic and abiotic layers and presence only data for individual species contributed to Montana Natural Heritage Program databases for most terrestrial species. For the Maximum Entropy models, we reclassified 90 x 90-meter continuous model output into suitability classes (unsuitable, low, moderate, and optimal) then aggregated that into the one square mile hexagons used in the environmental summary report; this is the finest spatial scale we suggest using this information in management decisions and survey planning. Full model write ups for individual species that discuss model goals, inputs, outputs, and evaluation in much greater detail are posted on the MTNHP's Predicted Suitable Habitat Models page. Evaluations of predictive accuracy and specific limitations are included with the metadata for models of individual species. **Model outputs should not be used in place of on-the-ground surveys for species. Instead model outputs should be used in conjunction with habitat evaluations to determine the need for on-the-ground surveys for species.** We suggest that the percentage of predicted optimal and moderate suitable habitat within the report area be used in conjunction with geographic range polygons and the percentage of commonly associated habitats to generate lists of potential species that may occupy broader landscapes for the purposes of landscape-level planning.

Associated Habitats

Within the boundary of the intersected hexagons, we provide the approximate percentage of commonly or occasionally associated habitat for vertebrate animal species that regularly breed, overwinter, or migrate through the state; a detailed list of commonly and occasionally associated habitats is provided in individual species accounts in the Montana Field Guide. We assigned common or occasional use of each of the 82 ecological systems mapped in Montana by: (1) using personal knowledge and reviewing literature that summarizes the breeding, overwintering, or migratory habitat requirements of each species; (2) evaluating structural characteristics and distribution of each ecological system relative to the species' range and habitat requirements; (3) examining the observation records for each species in the state-wide point observation database associated with each ecological system; and (4) calculating the percentage of observations associated with each ecological system relative to the percent of Montana covered by each ecological system to get a measure of numbers of observations versus availability of habitat. Species that breed in Montana were only evaluated for breeding habitat use, species that only overwinter in Montana were only evaluated for overwintering habitat use, and species that only migrate through Montana were only evaluated for migratory habitat use. In general, species were listed as associated with an ecological system if structural characteristics of used habitat documented in the literature were present in the ecological system or large numbers of point observations were associated with the ecological system. However, species were not listed as associated with an ecological system if there was no support in the literature for use of structural characteristics in an ecological system, even if point observations were associated with that system. Common versus occasional association with an ecological system was assigned based on the degree to which the structural characteristics of an ecological system matched the preferred structural habitat characteristics for each species as represented in the scientific literature. The percentage of observations associated with each ecological system relative to the percent of Montana covered by each ecological system was also used to guide assignment of common versus occasional association.

We suggest that the percentage of commonly associated habitat within the report area be used in conjunction with geographic range polygons and the percentage of predicted optimal and moderate suitable habitat from predictive models to generate lists of potential species that may occupy broader landscapes for the purposes of landscape-level planning. Users of this information should be aware that land cover mapping accuracy is particularly problematic when the systems occur as small patches or where the land cover types have been altered over the past decade. Thus, particular caution should be used when using the associations in assessments of smaller areas (e.g., evaluations of public land survey sections).

Introduction to Land Cover

Land Use/Land Cover is one of 15 Montana Spatial Data Infrastructure framework layers considered vital for making statewide maps of Montana and understanding its geography. The layer records all Montana natural vegetation, land cover and land use, classified from satellite and aerial imagery, mapped at a scale of 1:100000, and interpreted with supporting ground-level data. The baseline map is adapted from the Northwest ReGAP (NWGAP) project land cover classification, which used 30m resolution multi-spectral Landsat imagery acquired between 1999 and 2001. Vegetation classes were drawn from the Ecological System Classification developed by NatureServe (Comer et al. 2003). The land cover classes were developed by Anderson et al. (1976). The NWGAP effort encompasses 12 map zones. Montana overlaps seven of these zones. The two NWGAP teams responsible for the initial land cover mapping effort in Montana were Sanborn and NWGAP at the University of Idaho. Both Sanborn and NWGAP employed a similar modeling approach in which Classification and Regression Tree (CART) models were applied to Landsat ETM+ scenes. The Spatial Analysis Lab within the Montana Natural Heritage Program was responsible for developing a seamless Montana land cover map with a consistent statewide legend from these two separate products. Additionally, the Montana land cover layer incorporates several other land cover and land use products (e.g., MSDI Structures and Transportation themes and the Montana Department of Revenue Final Land Unit classification) and reclassifications based on plot-level data and the latest NAIP imagery to improve accuracy and enhance the usability of the theme. Updates are done as partner support and funding allow, or when other MSDI datasets can be incorporated. Recent updates include fire perimeters and agricultural land use (annually), energy developments such as wind, oil and gas installations (2014), roads, structures and other impervious surfaces (various years): and local updates/improvements to specific ecological systems (e.g., central Montana grassland and sagebrush ecosystems). Current and previous versions of the Land Use/Land Cover layer with full metadata are available for download at the Montana State Library's Geographic Information Clearinghouse.

Within the report area you have requested, land cover is summarized by acres of Level 1, Level 2, and Level 3 Ecological Systems.

Literature Cited

Anderson, J.R. E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. U.S. Geological Survey Professional Paper 964.

Comer, P., D. Faber-Langendoen, R. Evans, S. Gawler, C. Josse, G. Kittel, S. Menard, M. Pyne, M. Reid, K. Schulz, K. Snow, and J. Teague. 2003. Ecological systems of the United States: A working classification of U.S. terrestrial systems. NatureServe, Arlington, VA.

Introduction to Wetland and Riparian

Within the report area you have requested, wetland and riparian mapping is summarized by acres of each classification present. Summaries are only provided for modern MTNHP wetland and riparian mapping and not for outdated (NWI Legacy) or incomplete (NWI Scalable) mapping efforts; described here. MTNHP has made all three of these datasets and associated metadata available for separate download on the Montana Wetland and Riparian Framework MSDI download page.

Wetland and Riparian mapping is one of 15 Montana Spatial Data Infrastructure framework layers considered vital for making statewide maps of Montana and understanding its geography. The wetland and riparian framework layer consists of spatial data representing the extent, type, and approximate location of wetlands, riparian areas, and deepwater habitats in Montana.

Wetland and riparian mapping is completed through photointerpretation of 1-m resolution color infrared aerial imagery acquired from 2005 or later. A coding convention using letters and numbers is assigned to each mapped wetland. These letters and numbers describe the broad landscape context of the wetland, its vegetation type, its water regime, and the kind of alterations that may have occurred. Ancillary data layers such as topographic maps, digital elevation models, soils data, and other aerial imagery sources are also used to improve mapping accuracy. Wetland mapping follows the federal Wetland Mapping Standard and classifies wetlands according to the Cowardin classification system of the National Wetlands Inventory (NWI) (Cowardin et al. 1979, FGDC Wetlands Subcommittee 2013). Federal, State, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands differently than the NWI. Similar coding, based on U.S. Fish and Wildlife Service conventions, is applied to riparian areas (U.S. Fish and Wildlife Service 2009). These are mapped areas where vegetation composition and growth is influenced by nearby water bodies, but where soils, plant communities, and hydrology do not display true wetland characteristics. **These data are intended for use in publications at a scale of 1:12,000 or smaller. Mapped wetland and riparian areas do not represent precise boundaries and digital wetland data cannot substitute for an on-site determination of jurisdictional wetlands.**

A detailed overview, with examples, of both wetland and riparian classification systems and associated codes can be found at: http://mtnhp.org/help/MapViewer/WetRip_Classification.asp

Literature Cited

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service, FWS/OBS-79/31. Washington, D.C. 103pp.

Federal Geographic Data Committee. 2013. Classification of wetlands and deepwater habitats of the United States. FGDC-STD-004-2013. Second Edition. Wetlands Subcommittee, Federal Geographic Data Committee and U.S. Fish and Wildlife Service, Washington, D.C.

U.S. Fish and Wildlife Services. 2009. A system for mapping riparian areas in the western United States. Division of Habitat and Resource Conservation, Branch of Resource and Mapping Support, Arlington, Virginia.

Introduction to Land Management

Within the report area you have requested, land management information is summarized by acres of federal, state, and local government lands, tribal reservation boundaries, private conservation lands, and federal, state, local, and private conservation easements. Acreage for “Owned”, “Tribal”, or “Easement” categories represents non-overlapping areas that may be totaled. However, “Other Boundaries” represents managed areas such as National Forest boundaries containing private inholdings and other mixed ownership which may cause boundaries to overlap (e.g. a wilderness area within a forest). Therefore, acreages may not total in a straight-forward manner.

Because information on land stewardship is critical to effective land management, the Montana Natural Heritage Program (MTNHP) began compiling ownership and management data in 1997. The goal of the Montana Land Management Database is to manage a single, statewide digital data set that incorporates information from both public and private entities. The database assembles information on public lands, private conservation lands, and conservation easements held by state and federal agencies and land trusts and is updated on a regular basis. Since 2011, the Information Management group in the Montana State Library’s Digital Library Division has taken an increasingly active role in managing layers of the Montana Land Management Database in partnership with the MTNHP.

Public and private conservation land polygons are attributed with the name of the entity that owns it. The data are derived from the statewide Montana Cadastral Parcel layer. Conservation easement data shows land parcels on which a public agency or qualified land trust has placed a conservation easement in cooperation with the land owner. The dataset contains no information about ownership or status of the mineral estate. For questions about the dataset or to report errors, please contact the Montana Natural Heritage Program at (406) 444-5354 or mtnhp@mt.gov. You can download various components of the Land Management Database and view associated metadata at the Montana State Library’s GIS Data List at the following links:

Public Lands
Conservation Easements
Private Conservation Lands
Managed Areas

Map features in the Montana Land Management Database or summaries provided in this report are not intended as a legal depiction of public or private surface land ownership boundaries and should not be used in place of a survey conducted by a licensed land surveyor. Similarly, map features do not imply public access to any lands. The Montana Natural Heritage Program makes no representations or warranties whatsoever with respect to the accuracy or completeness of this data and assumes no responsibility for the suitability of the data for a particular purpose. The Montana Natural Heritage Program will not be liable for any damages incurred as a result of errors displayed here. Consumers of this information should review or consult the primary data and information sources to ascertain the viability of the information for their purposes.

Introduction to Invasive and Pest Species

Within the report area you have requested, separate summaries are provided for: Aquatic Invasive Species, Noxious Weeds, Agricultural Pests, and Forest Pests that have been documented or potentially occur there based on their known distribution in the state. Definitions for each of these invasive and pest species categories can be found on our Species Status Codes page.

Each of these summaries provides the following information when present for a species: (1) the number of observations of each species; (2) the geographic range polygons for each species, if developed, that the report area overlaps; (3) predicted relative habitat suitability classes that are present if a predicted suitable habitat model has been created; (4) the percent of the report area that is mapped as commonly associated or occasionally associated habitat as listed for each species in the Montana Field Guide; and (5) and links to species accounts in the Montana Field Guide. Details on each of these information categories are included under relevant section headers under the Introduction to Native Species above or are defined on our Species Status Codes page. In presenting this information, the Montana Natural Heritage Program (MTNHP) is working towards assisting the user with rapidly determining what invasive and pest species have been documented and what species are potentially present in the report area. We remind users that this information is likely incomplete as surveys to document introduced species are lacking in many areas of the state, information on introduced species has only been tracked relatively recently, the MTNHP's staff and resources are restricted by declining budgets, and information is constantly being added and updated in our databases. **Thus, field verification by professional biologists of the absence or presence of species will always be an important obligation of users of our data.**

If you are aware of observation or survey datasets for invasive or pest species that the MTNHP is missing, please report them to the Program Coordinator bmaxell@mt.gov Program Botanist apipp@mt.gov or Senior Zoologist dbachen@mt.gov. If you have observations that you would like to contribute, you can submit animal observations using our online data entry system at http://mtnhp.org/AddObs/, plant and animal observations via Excel spreadsheets posted at http://mtnhp.org/observations.asp , or to the Program Botanist or Senior Zoologist.

Additional Information Resources

Home Page for Montana Natural Heritage Program (MTNHP)

MTNHP Staff Contact Information

Montana Field Guide

MTNHP Species of Concern Report - Animals and Plants

MTNHP Species Status Codes - Explanation

MTNHP Predicted Suitable Habitat Models (for select Animals and Plants)

MTNHP Request Information page

Montana Cadastral

Montana Code Annotated

Montana Department of Environmental Quality

Montana Fisheries Information System

Montana Fish, Wildlife, and Parks Subdivision Recommendations

Montana GIS Data Layers

Montana GIS Data Bundler

Montana Greater Sage-Grouse Project Submittal Site

Montana Ground Water Information Center

Montana Legislative Environmental Policy Office Publications
(Including Index of Environmental Permits required in Montana and Guide to the Montana Environmental Policy Act)

Montana Environmental Policy Act (MEPA)

MEPA Analysis Resource List

Laws, Treaties, Regulations, and Permits on Animals and Plants

Montana Spatial Data Infrastructure Layers

Montana State Historic Preservation Office Review and Compliance

Montana Water Information System

Montana Web Map Services

National Environmental Policy Act

U.S. Fish and Wildlife Service Information for Planning and Conservation (Section 7 Consultation)

Web Soil Survey Tool

Appendix F

Risk-Based Corrective Action Guidance Evaluation for Petroleum-Impacted Material at Butte Reduction Works Smelter Area Mine Waste Remediation and Contaminated Groundwater Hydraulic Control Site

PIONEER
TECHNICAL SERVICES, INC.

TECHNICAL MEMORANDUM

Risk-Based Corrective Action Guidance Evaluation for Petroleum-Impacted Material at Butte Reduction Works Smelter Area Mine Waste Remediation and Contaminated Groundwater Hydraulic Control Site

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Date: 5/13/2021
To: Atlantic Richfield Company
From: Pioneer Technical Services, Inc.
Rev or Mod #: 01

Table of Contents

1 INTRODUCTION

The Butte Reduction Works (BRW) Smelter Area Mine Waste Remediation and Contaminated Groundwater Hydraulic Control Site (Site) is one of nine remedial elements addressed in the *Butte Priority Soils Operable Unit Consent Decree* (BPSOU CD) (EPA, 2020). As part of the remedial design (RD) for the Site, Atlantic Richfield Company (Atlantic Richfield) is required to define the nature and extent of petroleum impacts originating within the Site, differentiate primary and secondary source areas, and develop a plan to manage petroleum-impacted soil and groundwater originating within the Site. To achieve these tasks, Atlantic Richfield has completed a risk evaluation for the petroleum-impacted materials within the Site following the Montana Department of Environmental Quality (DEQ) Risk-Based Corrective Action (RBCA) Guidance for Petroleum Releases (DEQ, 2018a) (referred to herein as RBCA Guidance).

This Technical Memorandum (Tech Memo) presents the RBCA evaluation completed to the extent possible and includes a summary of the Montana DEQ RBCA process, a conceptual site model (CSM) based on the Site conditions, and a comparison of Site-specific data to Montana DEQ risk-based screening levels (RBSLs) included in the RBCA Guidance. A summary of the work performed to collect data presented in this Tech Memo is included in Section 2.3 of the Site Pre-Design Investigation Evaluation Report (main BRW PDI Report) to which this Tech Memo is an appendix.

This RBCA evaluation is complete to the extent possible based on the data collected during the Phase I Site Investigation (included in the main BRW PDI Report). Once the Phase II and Phase III Site Investigations are completed, this RBCA evaluation will be revised and resubmitted with the main BRW PDI Report (refer to Section 8).

2 SITE INVESTIGATION

Prior to the RBCA evaluation process, the Phase I Site Investigation occurred. The Phase I Site Investigation included gathering historical information about the Site and adjacent properties then collecting data.

2.1 Site Background

Historically, the Site included several different smelting configurations and was also used by the Domestic Manganese and Development Company (Domestic Manganese) (Sanborn, 1943). The operations left behind a complex distribution of materials (including slag, tailings, manganese waste, demolition debris, foundations, and other historic structures) as well as impacted soil and groundwater.

The Site is also located near properties with recorded petroleum releases. Past petroleum releases were reviewed to assess potential sources of hydrocarbons within the Site. The following information from DEQ reports characterize neighboring sites with documented petroleum releases:

- 400 Oxford Street: Location of a leaking underground storage tank managed by the DEQ in 1995 (DEQ, 2019a).
- 1759 South Montana Street: Formerly the location of a Cenex Convenience Store. The site received reimbursement from the Petroleum Tank Release Compensation Board for releases in 1990 and 2006 (DEQ, 2018b).

From the mid-1990s, Butte-Silver Bow has used the Site for construction-related materials mixing and storage and also operated an asphalt plant at the Site. Beginning in early 2021, Butte-Silver Bow removed the asphalt plant from the Site and is currently in the process of removing other equipment and materials. A detailed discussion of the Site description, history, and previous investigations is included in the BRW Remedial Design Work Plan (RDWP) (Atlantic Richfield, 2020) and the BRW Pre-Design Investigation Work Plan, an attachment to the RDWP.

2.2 Sampling and Laboratory Analysis

A summary of the work performed to collect the data mentioned in this Tech Memo is included in the main BRW PDI Report. The results of the laboratory analyses are described in Section 4.1.1 for soil and 4.1.2 for groundwater.

3 EVALUATION PROCESS

The unique nature of the Site has resulted in an atypical RBCA evaluation process. Extensive mining-related pollution has driven forthcoming remedial action (RA) as described in the BPSOU CD (EPA, 2020); however, the BPSOU CD also calls for the disposal of “Other Waste

Material," which includes petroleum-impacted media. The presence of petroleum-impacted soil and groundwater was suspected because of the Site's past industrial use and industrial activity at adjacent properties. The *BRW Phase I Quality Assurance Project Plan (QAPP)* (Phase I QAPP) (Atlantic Richfield Company, 2021) sought to characterize solid materials and groundwater, which included sampling for petroleum compounds to confirm potential impacted media. Data collected during the Phase I Site Investigation and Site-specific information (e.g., end land use and RD elements) were evaluated for the current RBCA evaluation. Additional Site-specific information and data collected from the Phase II and Phase III Site Investigations will be incorporated into future versions of the RBCA evaluation (in consultation with the DEQ).

The RBCA evaluation process includes three tiers: Tier 1, Tier 2, and Tier 3. The Tier 1 evaluation process is the initial step and is the simplest level of evaluation. A Tier 1 evaluation generally includes the following:

- Site investigation to document site conditions, including historical information, and determine the maximum concentrations of specified petroleum compounds in soil and groundwater.
- A CSM (Table 1) that identifies potential pathways, points of exposure, and exposure routes.
- Comparison of maximum concentrations of specified petroleum compounds in the soil and groundwater to pre-determined RBSLs (specified in the Tier 1 RBSL tables) to determine if additional evaluation and/or corrective action is needed.

For sites where petroleum compounds exceed the Tier 1 RBSLs, either remediation must occur to meet the Tier 1 RBSLs or the site is further assessed with a Tier 2 evaluation. A Tier 2 evaluation allows for the adjustment of Tier 1 RBSLs based on site-specific information and evaluates exposure routes for direct contact and leaching to groundwater separately. A Tier 2 evaluation generally includes the following:

- Initial evaluation to determine if exceedances exist for specified petroleum compounds for the direct contact and/or leaching to groundwater exposure pathways (pre-determined RBSLs in Table 4 of the RBCA Guidance).
- If exceedances exist, site-specific screening levels may be calculated and further evaluation completed for the direct contact and/or leaching to groundwater exposure pathways.

If the petroleum compound concentrations exceed the site-specific screening levels calculated for the Tier 2 evaluation, either remediation must occur to meet the site-specific screening levels or the site is further assessed with a Tier 3 evaluation. A Tier 3 evaluation typically involves conducting site-specific human health and/or ecological risk assessments and fate and transport analyses to calculate site-specific cleanup levels. Additional details on RBCA evaluation process can be found in the RBCA Guidance.

Based on the information collected as part of the Phase I Site Investigation, Atlantic Richfield was able to complete a Tier 1 evaluation and begin the Tier 2 evaluation. The next sections outline the specific steps for the Tier 1 and Tier 2 evaluation and detail the findings.

4 TIER 1 EVALUATION

This section details the procedures used to evaluate the petroleum-impacted materials within the Site using the Tier 1 evaluation process.

4.1 Risk-Based Screening Level Comparison

Data collected from the Phase I Site Investigation were compared to Tier 1 RBSLs listed in three different tables in the RBCA Guidance. The three tables contain the Tier 1 RBSLs for surface soil (0 to 2 feet below ground surface [bgs]), subsurface soil (greater than 2 feet bgs), and groundwater. The distance from the sample depth to groundwater was also considered, along with the current and potential future uses of the Site. Note that the Tier 1 RBSLs are meant to identify potential areas of concern at the Site. Tier 1 RBSLs do not account for Site-specific information and will not be used to execute final corrective action.

4.1.1 Surface and Subsurface Soils

The soil sampling results from the Phase I Site Investigation are listed in Table 2, Table 3, and Table 4 for volatile petroleum hydrocarbons (VPHs), polycyclic aromatic hydrocarbons (PAHs) and extractable petroleum hydrocarbons (EPHs), respectively. The applicable RBSLs used for the Tier 1 evaluation are included at the top of the tables and identified in the third column of the table for each sample. Surface and subsurface samples were collected at depths ranging from 0 to 36 feet bgs, and the sample depth below ground surface is listed in the second column of the tables. Anticipated future Site use is unlikely to include any associated residences and no people are anticipated to live at the Site; therefore, commercial RBSLs were used for the evaluation.

The depth to water from the ground surface is listed in the first column in Table 2, Table 3, and Table 4 beneath the location ID for each location, as compared to the April 2019 groundwater surface (Table 8 and Figure 10 in the main BRW PDI Report). Additionally, the tables indicate which soils are saturated or within the capillary fringe (begins approximately 1 foot above the water table and extends down to the top of the groundwater table) and which soils are above the capillary fringe. Based on the depth to water, there are hydrocarbon-bearing soils both above the capillary fringe, within the capillary fringe, and below the groundwater table.

The following petroleum compounds/groups were identified as chemicals of concern at the Site after comparing the Phase I Site Investigation analytical results (included in the main BRW PDI Report) to the commercial surface and subsurface soil RBSLs:

- Above the capillary fringe:
    - VPHs: Naphthalene, C9 to C10 Aromatics, and C9 to C12 Aliphatics
    - PAHs:1-Methylnaphthalene
    - EPHs: C11 to C22 Aromatics and C9 to C18 Aliphatics
- Within or below the capillary fringe:
    - VPHs: C9 to C10 Aromatics and C9 to C12 Aliphatics
    - PAHs: 1-Methylnaphthalene
    - EPHs: C11 to C22 Aromatics and C9 to C18 Aliphatics

Figure 1 and Figure 2 show the locations of the boreholes, test pits, and piezometers with an observed or suspected presence of hydrocarbons and which had concentrations above RBSLs. Locations with soil concentrations above the RBSLs are differentiated relative to the capillary fringe. Figure 1 shows hydrocarbon soil concentrations that are above the capillary fringe and distinguishes surface soil samples and subsurface samples using triangle and circle symbols, respectively. Figure 2 shows subsurface hydrocarbon soil concentrations that are within or below the capillary fringe. Hydrocarbons that are within or below the capillary fringe may be transported by groundwater.

4.1.2 Groundwater

The groundwater sampling results from the Phase I Site Investigation are listed in Table 5, Table 6, and Table 7 for VPHs, PAHs, and EPHs, respectively. The Tier 1 groundwater RBSLs and the Montana DEQ Circular DEQ-7 human health standards for surface water (DEQ, 2019b) are included at the top of the tables. The numbered screening level and standard (1 and 2, respectively) correspond to superscript values for results with exceedances. Comparison to DEQ-7 human health standards for surface water are discussed in Section 7. The following petroleum compounds currently appear to exceed Tier 1 RBSLs within groundwater:

- Benzene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Dibenzo(a,h)anthracene
- Indeno(1,2,3-cd)pyrene

The distinct nature of the groundwater concentrations suggests two hydrocarbon sources. The first compound, benzene, is a VPH that is a major component in gasoline and many other industrial chemicals. The remaining four compounds are considered PAHs, which are typically contained in coal tars, creosotes, bitumens, asphalts, and used engine oil. Additionally, PAHs can be found from incomplete combustion of wood products, and background soils in urban areas often contain detectable concentrations of PAHs. Figure 3 shows the estimated locations of the areas within the groundwater aquifer (per the Phase I Site Investigation results) that have been impacted with hydrocarbons, and also shows the locations where hydrocarbon sheens and/or light non-aqueous phase liquid (LNAPL) were observed during the 2016 BRW Smelter Site Test Pit Investigation (NRDP, 2016).

Three locations (BRW18-PZ21, BRW19-HCW37, and BRW-HCW38) contained VPHs, particularly benzene, with concentrations that were higher than the RBSLs (Table 5). Piezometers BRW18-PZ13 and BRW18-PZ18 contained nearly identical concentrations of PAHs, of which benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene were at concentrations greater than RBSLs during sampling completed in 2018; however, the concentrations were below RBSLs during the sampling in 2019 (Table 6).

4.2 Conclusion

The Tier 1 evaluation confirmed that there is petroleum-impacted soil and groundwater within the Site. The surface soil impacts (Figure 1) are generally within the southern portion of the Site and appear to be in the vicinity of the current industrial operations. The subsurface soil impacts, particularly those within and below the capillary fringe, are generally located near the center of the Site extending west. The distinct nature of the groundwater concentrations suggests two hydrocarbon sources; however, additional information is needed to better characterize the areas within the groundwater aquifer impacted by hydrocarbons originating within the Site.

The purpose of the Tier 1 evaluation was to verify the suspected presence of petroleum-impacted soil and groundwater. The confirmation of impacted soil and groundwater (i.e., soil and groundwater with concentrations of petroleum-compounds which exceed DEQ RBSLs) enables the assessment of exposure pathways within a CSM of the Site (Table 1). Assessment of exposure pathways considers whether the impacted media has a reasonable route to a receptor based on the anticipated RA (Site-specific information). The impacted media identified in the Tier 1 evaluation is represented in the *Exposure Media* column of the CSM.

5 CONCEPTUAL SITE MODEL

The preliminary CSM (Table 1) illustrates exposure pathways to receptors based on impacted media identified in the Tier 1 evaluation and Site-specific information. Anticipated RA includes removing waste, as defined by the Waste Identification Criteria (EPA, 2020) within a 275-foot average width removal corridor along the southern portion of the Site and installing a soil cap for the areas outside of the removal corridor where waste will be left in place. The depth of the removal corridor varies across its approximate 1,700-foot length (east to west) and will change as more data are collected during the Phase II and Phase III Site Investigations; however, excavated depths will remove the petroleum-impacted soils within the removal corridor.

Past industrial activity was identified as the potential source for impacted material in the CSM (Section 8). The nature of the potential source of contamination limits the transport mechanism to infiltration, percolation, and/or leaching. The impacted material, or exposure media, consists of surface soils, subsurface soils, and groundwater. Surface water/sediment is correlated to groundwater, but the extent of the correlation is unknown and will be addressed during Phase II and Phase III Site Investigations.

Assessment of exposure routes and receptors determines whether a pathway is complete (quantitative evaluation), potentially complete (qualitative evaluation), and probably incomplete (no evaluation). A complete pathway indicates that the potential source of impacted material reaches a potential receptor and analysis quantitatively demonstrates the existence of the pathway. A potentially complete pathway lacks a quantitative basis, but is a suspected pathway based on qualitative site-specific information and RBSLs. A probably incomplete pathway suggests that site-specific information (such as RA) will block the potential source or impacted media from the potential receptor and no quantitative evaluation is needed.

The exposure route dictates the likelihood of an impact to a receptor and the resulting pathway status. The current pathway status depends on the Tier 1 evaluation, the preliminary Tier 2 evaluation, and Site-specific information. None of the pathways listed in Table 1 are considered complete pathways. Pathways will be re-evaluated after the Phase II and III Site Investigations when more data and Site-specific information are available to make a quantitative evaluation (if needed).

The receptors are divided into two categories, *Remedial Action* and *Future Land Use*, which correspond to the activity sequence (left to right) that will occur at the Site. The *Remedial Action* and *Future Land Use* categories are subdivided to include ecological and human receptors. For the *Remedial Action* category, a potentially complete pathway exists between petroleum-impacted soil (surface and subsurface soil), human receptors, and ecological receptors during excavation activity. Tier 2 direct contact construction RBSL exceedances (Section 6.1) are highlighted in Table 8 and shown on Figure 4. These exceedances represent areas within the Site that present potential exposure routes for both human (construction workers) and ecological receptors (wildlife).

During RA, an exposure pathway for ecological and human receptors via groundwater is considered potentially complete based on expected construction plans (dewatering activity). The extent to which groundwater interacts with surface water is unknown and will be evaluated during Phase II and Phase III Site Investigations (Section 7). The CSM conservatively presumes some groundwater and surface water interaction, which potentially exposes ecological and human receptors to petroleum compounds during RA construction and future land use. The potential exposure will likely be addressed by general RA plans, including hydraulically controlling and treating contaminated groundwater; however, current RA plans lack quantitative data to determine a complete or incomplete exposure pathway.

Future Land Use assesses exposure pathways at the Site after the anticipated RA. After RA, petroleum-impacted soil within the removal corridor will be removed, and the area outside the removal corridor will be capped with clean soil. Excavation and a clean soil cap will address current soil and subsurface exposure pathways for ecological and human receptors, rendering the pathway probably incomplete (no evaluation). Direct groundwater exposure pathways are also considered probably incomplete since no public service drinking wells will be installed within the Site for future land use. The potential upwelling of Site groundwater to Silver Bow Creek (SBC) is a potentially complete pathway based on qualitative evaluation. Phase II and Phase III data collection and interpretation will include analyses that will inform a future quantitative evaluation.

The CSM will be updated concurrently in PDI Evaluation Reports for Phase II and Phase III Site Investigations. Additional data to be added to the CSM after Phase II and III Site Investigations include details regarding groundwater and surface water interaction, aquifer characteristics, and other Site-specific information. All pathways currently identified are based on qualitative Site-specific information and RBSLs (Tier 1 and Tier 2). Site-specific screening levels (in consultation with the DEQ) may be required for future CSM exposure pathway evaluation.

6 TIER 2 EVALUATION

A preliminary Tier 2 evaluation was completed to the extent possible based on the data collected from the Phase I Site Investigation. Data collected from the Phase I Site Investigation were compared to direct contact and leaching to groundwater RBSLs listed in Table 4 of the RBCA Guidance. The Tier 2 evaluation process will be completed after Phase II and Phase III Site Investigations.

6.1 Exceedance Evaluation

The preliminary Tier 2 evaluation identified soil exceedances for direct contact and leaching to groundwater RBSLs at the Site. Groundwater sampling results from the Phase I, Phase II, and Phase III Site Investigations will be considered for the final Tier 2 evaluation.

The preliminary Tier 2 evaluation results are in Table 8. The depth to water from the ground surface is listed in the first column beneath the location ID for each location. The 3 RBSLs for the Tier 2 evaluation include leaching to groundwater RBSLs for intervals of 0-10 feet bgs and 10-20 feet bgs, and the construction direct-contact RBSL. The 3 RBSLs for the Tier 2 evaluation are included at the top of the table and the applicable RBSL for each sample is listed in the third column of the table. The applicable RBSLs for BRW18-SS04 and BRW18-BH11 sample result exceedances are denoted with the corresponding superscript value from the third table column. Additionally, the table indicates which soils are saturated or within the capillary fringe and which soils are above the capillary fringe.

The leaching to groundwater RBSLs were evaluated according to the distance between the bottom sample depth and depth to groundwater. While the BRW hydraulic control may lower the groundwater elevation within the Site, it is anticipated this change will be minimal and not impact this evaluation. For example, the depth to groundwater will most likely increase from a soil location that would result in a higher RBSL. Therefore, the current approach is conservative but will be further evaluated after additional data are collected (Section 8).

Figure 4 shows the locations of preliminary Tier 2 soil and groundwater RBSL exceedances. Green, blue, and red font labels for hydrocarbon groups (VPH, PAH, and EPH) indicate direct contact, leaching to groundwater, and groundwater RBSL exceedances, respectively.

All sample locations are located within the removal corridor discussed in Section 5, except BRW18-SS04 and BRW18-BH11. Sample results that are replaced with the acronym SSI (site-specific information) in Table 8 represent leaching to groundwater exceedances that will be addressed during excavation within the removal corridor. Each Tier 2 RBSL is discussed in the following subsections.

6.2 Leaching to Groundwater Evaluation

Leaching to groundwater RBSL exceedances exist for one surface soil location, BRW18-SS04, and one subsurface soil location, BRW18-BH11 (Table 8). For these locations, comparison of leaching to groundwater RBSLs to Tier 2 RBSLs yields the following chemicals of concern at the Site relative to the capillary fringe:

- Above the capillary fringe:
  - EPHs: C11 to C22 Aromatics and C9 to C18 Aliphatics
- Within or below the capillary fringe:
  - VPHs: C9 to C10 Aromatics
  - PAHs: 1-Methylnaphthalene
  - EPHs: C11 to C22 Aromatics

BRW18-SS04 is an area that is outside the removal corridor and will be capped with clean soil; however, Site grading plans are uncertain for this area and the soil may be removed as part of the RA. Further evaluation will assess whether Site-specific information will address leaching to groundwater concerns at this location. BRW18-BH11 lies outside of the removal corridor and near existing infrastructure. The proximity to the infrastructure requires a different approach during RA and will require further evaluation of potential leaching to groundwater. Site-specific leaching to groundwater calculations may be evaluated after Phase II and Phase III Site Investigations.

6.3 Direct Contact Evaluation

Direct contact construction RBSLs were compared to the applicable Tier 1 soil exceedances (Table 8). Comparison of direct contact construction RBSLs to Tier 1 soil exceedances yields the following chemicals of concern at the Site relative to the capillary fringe:

- Above the capillary fringe:
  - VPHs: C9 to C12 Aliphatics
  - EPHs: C11 to C22 Aromatics and C9 to C18 Aliphatics
- Within or below the capillary fringe:
  - VPHs: C9 to C12 Aliphatics
  - EPHs: C9 to C18 Aliphatics

There were no direct contact construction exceedances for PAHs. Tier 2 direct contact construction exceedances identify potential risk to wildlife and construction workers during RA. Site-specific direct contact RBSL adjustments will be evaluated after Phase II and Phase III Site Investigations.

7 POTENTIAL SURFACE WATER IMPACTS

Circular DEQ-7 human health standards for surface water (DEQ, 2019b) were included in Table 5, Table 6, and Table 7 to preliminarily assess potential surface water (SBC) exceedances from hydrocarbon-impacted groundwater interaction. The DEQ-7 aquatic life standards do not exist for the applicable RBCA Guidance petroleum compounds; therefore, human health standards for surface water were used for comparison. The comparison to DEQ-7 standards identified surface water exceedances at BRW18-PZ13 and BRW18-PZ18 for benzo(a)anthracene and benzo(k)fluoranthene. All other groundwater contaminants exceeded both the Tier 1 groundwater RBSLs and the DEQ-7 standards. The extent of hydrocarbon-impacted groundwater within the Site and its interaction with SBC will be determined after the Phase II and Phase III Site Investigations.

8 FURTHER EVALUATION

The preliminary Tier 2 evaluation identified direct contact and leaching to groundwater RBSL soil exceedances. Surface and subsurface samples with RBSL exceedances were generally within the proposed removal corridor except for BRW18-SS04 and BRW18-BH11. Leaching to groundwater RBSLs were exceeded at these two locations, yet the groundwater data do not confirm that soil leaching has occurred. Figure 4 illustrates the lack of corresponding leaching to groundwater RBSL exceedances compared to the groundwater exceedances.

Tier 1 and Tier 2 RBSLs were used to characterize areas of concern within the Site. Development of Tier 3 Site-specific screening levels will be required to address chemicals of concern in soil and groundwater. A groundwater model and Site-specific data, such as Site grading, will help to inform Site-specific screening levels. The groundwater model will also evaluate the groundwater and surface water interaction. Once the Phase II and Phase III Site Investigations are completed, this RBCA evaluation will be revised and resubmitted with the main BRW PDI Report.

9 REFERENCES

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Sanborn, 1943. Map of Survey of Defense Plant Corporation, Domestic Manganese and Development Company and Metals Reserve Tracts and Improvements Theron in the N½ of SW¼ of Section 24 T 3N, R 8W. Silver Bow County, Montana. Surveyed May 4 to 31, 1943, by Francis T. Morris, Surveyor.

FIGURES

Note:
(1) The highest result of all samples collected from each location are indicated in the figure. Please reference Tables 2 through 4 for the depths of samples.
(2) All investigation points were screened with PID instruments. Only those locations that appeared to contain hydrocarbons (via sight and/or smell or detected with PID) were sampled for hydrocarbons.

April 2019 Groundwater Contours (NAVD 88)
Feb. 2019 Groundwater Contours (NAVD 88)

▲ Surface Sample - Sampled and No Results Above RBSLs
● Subsurface Sample - Sampled and No Results above RBSLs
▲ Surface Sample - Soil Concentrations Above RBSLs
● Subsurface Sample - Soil Concentrations Above RBSLs

LABEL KEY
BRW18-PZ10 = Piezometer Name
VPH,EPH = Organics Exceeding in Soil Samples

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTN'L FT
SOURCE: PIONEER/CAD EARTH 2014

0 75 150 300
Feet

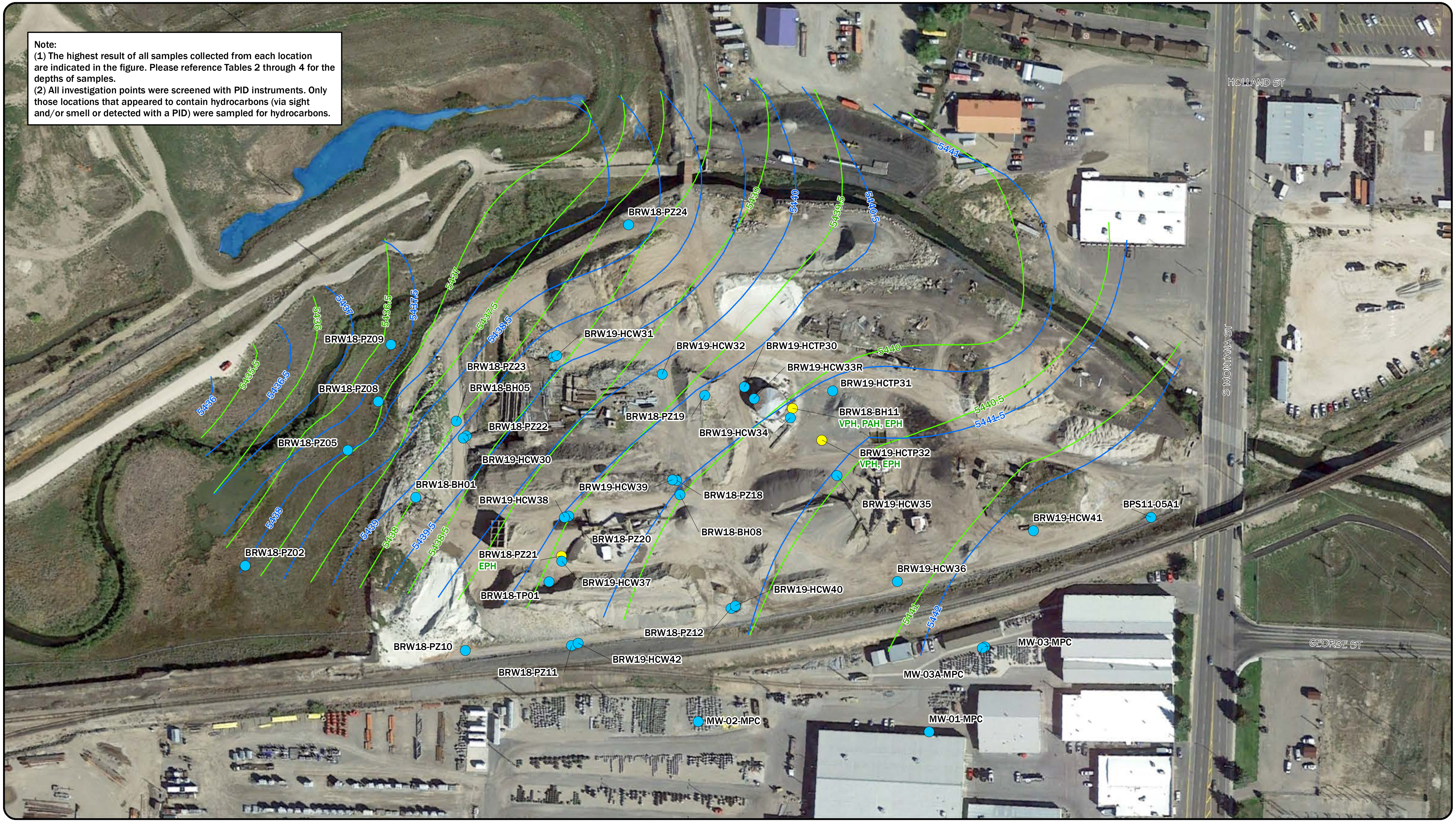
FIGURE 1

HYDROCARBON PRESENCE ABOVE CAPILLARY FRINGE

PIONEER TECHNICAL SERVICES, INC.

DATE: 5/12/2021

Path: Z:\Shared\Active Projects\ARCO\BPSOU\BRW\GIS\Z_PDI Evaluation Report_PI\AppendixF\BRW_PI_PDIER_F_001_PIHC_20.mxd



Note:
(1) The highest result of all samples collected from each location are indicated in the figure. Please reference Tables 2 through 4 for the depths of samples.
(2) All investigation points were screened with PID instruments. Only those locations that appeared to contain hydrocarbons (via sight and/or smell or detected with a PID) were sampled for hydrocarbons.

April 2019 Groundwater Contours (NAVD 88)
Feb. 2019 Groundwater Contours (NAVD 88)
● Sampled and No Results Above RBSLs
● Soil Concentration Above RBSLs

LABEL KEY
BRW18-PZ10 = Piezometer Name
VPH,EPH = Organics Exceeding in Soil Samples

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTN'L FT
SOURCE: PIONEER/CAD EARTH 2014

0 75 150 300
Feet

FIGURE 2

PIONEER TECHNICAL SERVICES, INC.

HYDROCARBON PRESENCE WITHIN AND BELOW CAPILLARY FRINGE

DATE: 5/12/2021

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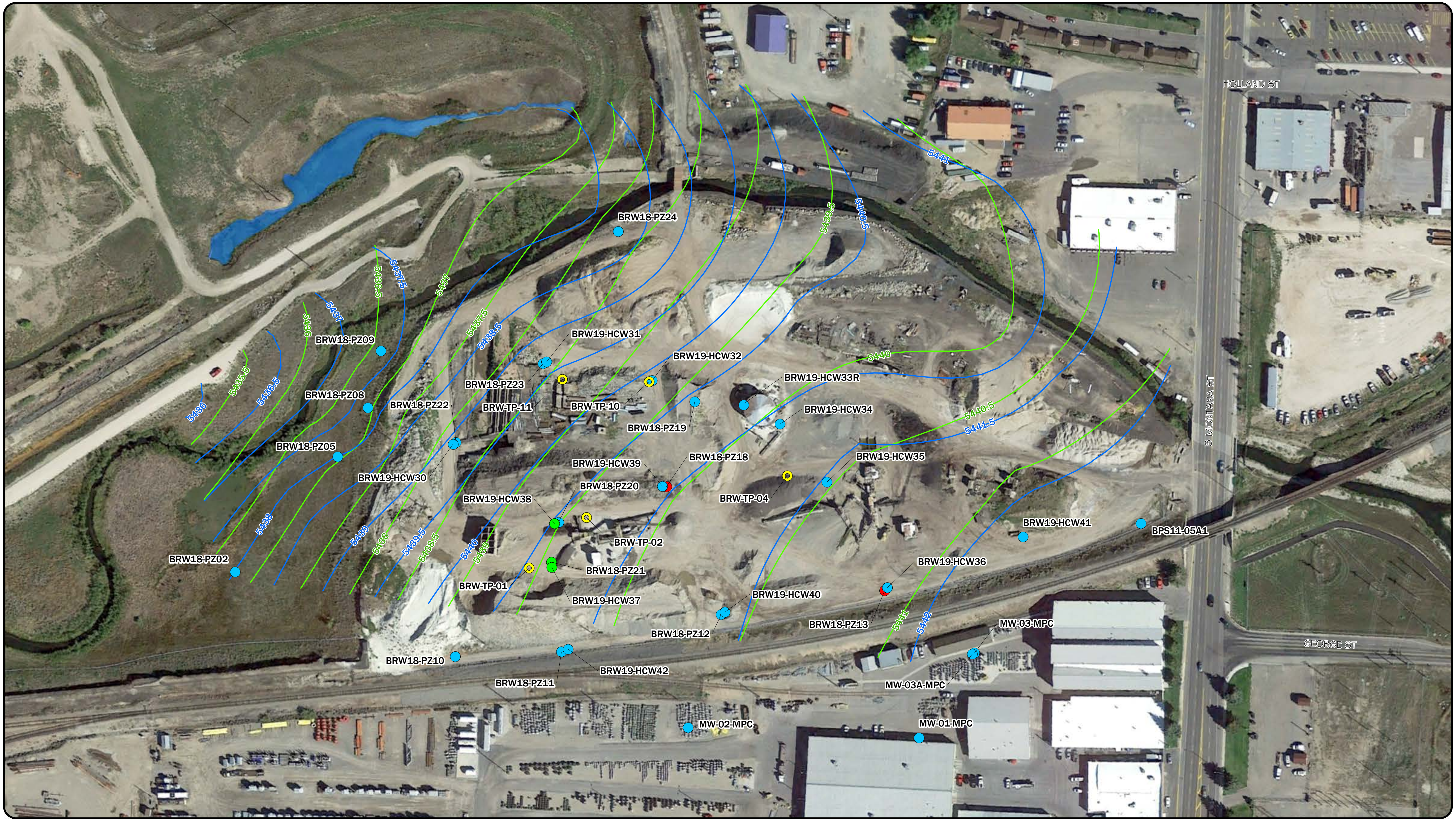


April 2019, Groundwater Contours (NAVD 88)
Feb. 2019 Groundwater Contours (NAVD 88)
○ 2016 Test Pit - Reported HC Sheen or LNAPL (Natural Resource Damage Program, 2016)
● Sampled and No Results Above RBSLs or DEQ-7 Standards
● Groundwater Concentration Above PAH RBSLs and/or DEQ-7 Standards
● Groundwater Concentration Above VPH RBSLs and DEQ-7 Standards

Note: RBSLs are the DEQ RBSLs (DEQ 2018a). DEQ-7 Standards are Montana DEQ's Circular DEQ-7 Human Health Standards for Surface Water. (DEW, 2019b). Please reference table 7 through 9 for sample results.

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTN'L FT
SOURCE: PIONEER/CAD EARTH 2014

0 75 150 300
Feet

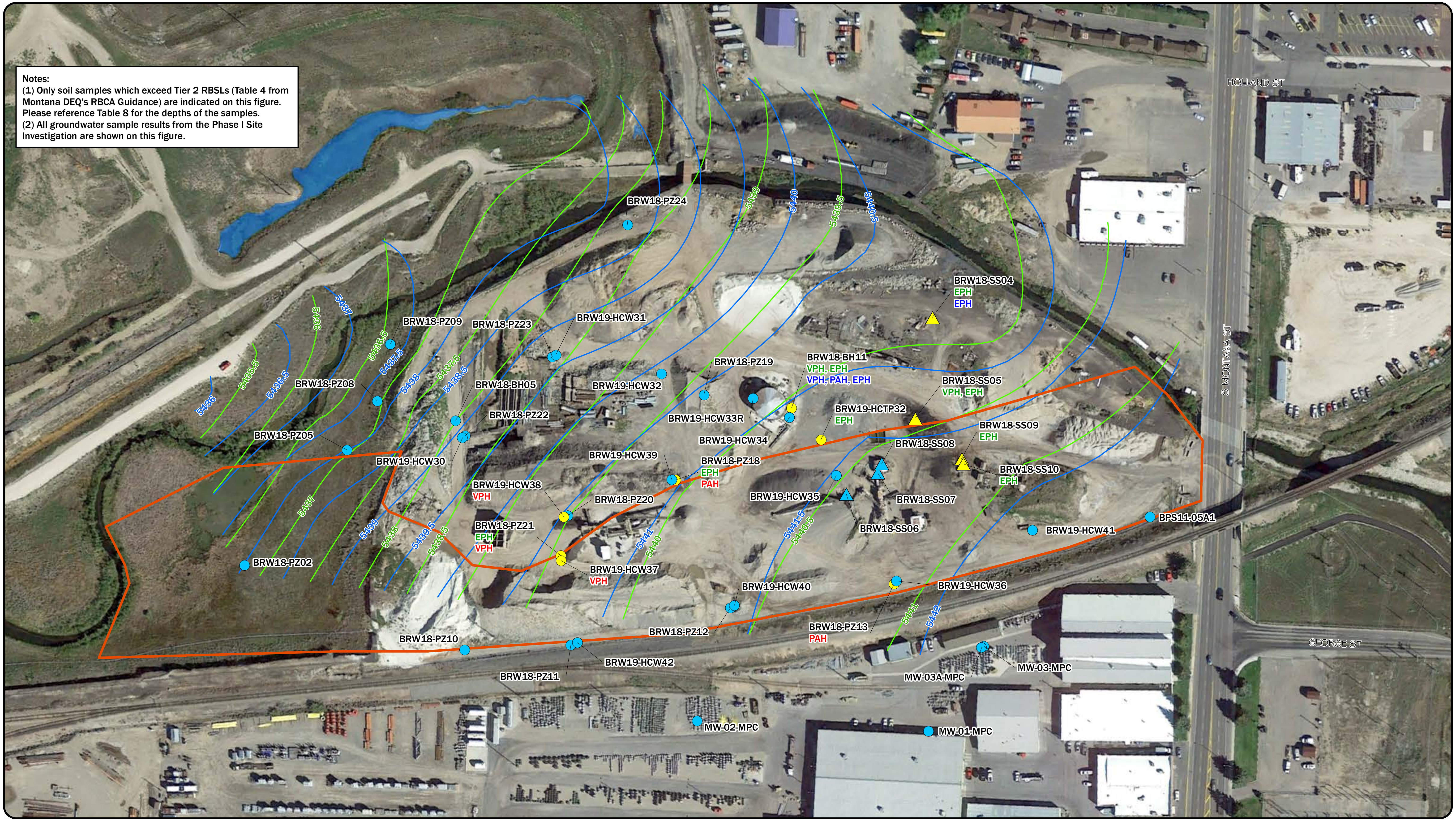
FIGURE 3

HYDROCARBON BEARING GROUNDWATER AND LNAPL OBSERVATIONS

PIONEER
TECHNICAL SERVICES, INC.

DATE: 5/12/2021

Path: Z:\Shared\Active Projects\ARCO\BPSOU\BRW\GIS\Z_PDI Evaluation Report_PI\AppendixF\BRW_PI_PDIER_F_003_Impact_20.mxd



Notes:
(1) Only soil samples which exceed Tier 2 RBSLs (Table 4 from Montana DEQ's RBCA Guidance) are indicated on this figure. Please reference Table 8 for the depths of the samples.
(2) All groundwater sample results from the Phase I Site Investigation are shown on this figure.

- ▲ Surface Sample - No Results Above RBSLs or DEQ-7 Standards
- ● Subsurface Sample - No Results Above RBSLs or DEQ-7 Standards
- ▲ Surface Sample - Soil Concentration Above RBSLs
- ● Subsurface Sample - Soil and/or Groundwater Above RBSLs and/or DEQ-7 Standards
- ▭ Removal Corridor

April 2019 Groundwater Contours (NAVD 88)
Feb. 2019 Groundwater Contours (NAVD 88)

LABEL KEY
BRW18-PZ10 = Piezometer Name
VPH = Organics Exceeding Direct Contact RBSLs
EPH = Organics Exceeding Leaching to Groundwater RBSLs
VPH = Organics Exceeding in Groundwater Samples

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTN'L FT
SOURCE: PIONEER/CAD EARTH 2014

0 75 150 300
Feet

FIGURE 4

PIONEER
TECHNICAL SERVICES, INC.

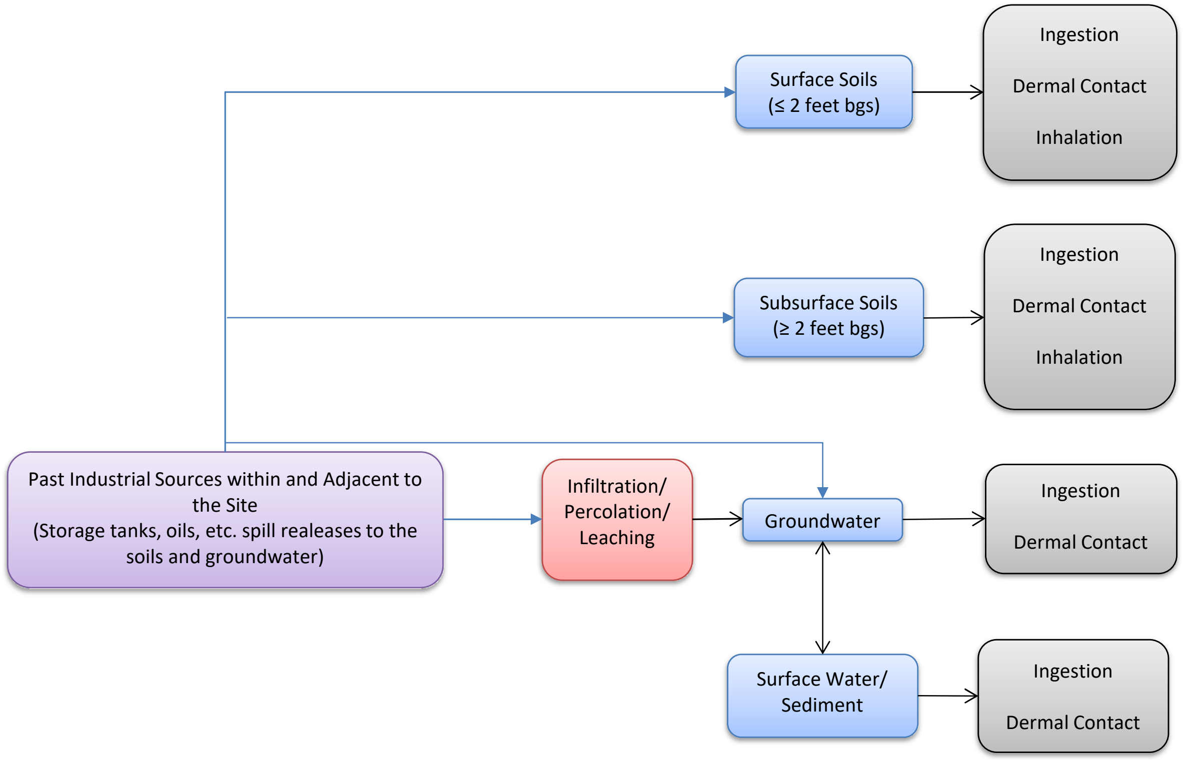
PRELIMINARY TIER 2 EVALUATION RESULTS

DATE: 5/12/2021

Path: Z:\Shared\Active Projects\ARCO\BPSOU\BRW\GIS\Z_PDI Evaluation Report_PI\AppendixF\BRW_PI_PDIER_F_004_PreEval_20.mxd

TABLES

Table 1
Preliminary Conceptual Site Model



Potential Sources	Transport Mechanism	Exposure Media	Exposure Routes	Receptors				Pathway Evaluation	
				Remedial Action (Construction)		Future Land Use (Commercial)		Remedial Action	Future Land Use
				Ecological (wildlife, aquatic species)	Human (Construction Worker)	Ecological (wildlife, aquatic species)	Human (Recreator)		
Past Industrial Sources within and Adjacent to the Site (Storage tanks, oils, etc. spill realeases to the soils and groundwater)		Surface Soils (≤ 2 feet bgs)	Ingestion	▲	▲	●	●	Exposure to surface soil during remedial action (excavation) exists for ecological and human receptors.	Depending on the soil location, excavation or a clean soil cap will address current surface soil exposure pathways for ecological and human receptors.
			Dermal Contact	▲	▲	●	●		
			Inhalation	▲	▲	●	●		
		Subsurface Soils (≥ 2 feet bgs)	Ingestion	▲	▲	●	●	Exposure to subsurface soil during remedial action (excavation) exists for ecological and human receptors.	Depending on the soil location, excavation, clean soil cap, and/or institutional controls will address current subsurface soil exposure pathways for ecological and human receptors.
			Dermal Contact	▲	▲	●	●		
			Inhalation	▲	▲	●	●		
	Infiltration/ Percolation/ Leaching	Groundwater	Ingestion	▲	▲	●	●	Exposure to groundwater during remedial action (dewatering activity) exists for ecological and human receptors.	No public service drinking wells will be installed within the Site for future land use.
			Dermal Contact	▲	▲	●	●		
		Surface Water/ Sediment	Ingestion	▲	▲	▲	▲	Further evaluation to be completed to analyze groundwater and surface water interaction and potential effects to receptors.	Further evaluation to be completed to analyze groundwater and surface water interaction and potential effects to receptors.
			Dermal Contact	▲	▲	▲	▲		

Notes:

▭ Outline indicates areas to be evaluated with additional data from Phase II and Phase III Site Investigations (see Further Evaluation section in the Tech Memo).

"bgs" = Below Ground Surface

Pathway Legend

■	Complete Pathway (quantitive evaluation)
▲	Potentially Complete (qualitative evaluation)
●	Probably Incomplete (no evaluation)

Table 2. VPH Analytical Results for BRW Soil Samples (mg/kg)

Field Sample ID	Sample Interval (feet bgs)	Applicable RBSL Group	Sample Date	MTBE	Benzene	Toluene	Ethylbenzene	Xylenes, Total	Naphthalene	C9 to C10 Aromatics	C5 to C8 Aliphatics	C9 to C12 Aliphatics	Total Purgeable Hydrocarbons
(1) Tier 1 Surface Soil (0-2 ft bgs) RBSL; 0-10 feet to Groundwater; Commercial				**0.078***	**0.07**	**21**	**26**	**310**	**12**	**130**	**220**	**360**	**NA**
(2) Tier 1 Surface Soil (0-2 ft bgs) RBSL; 10-20 feet to Groundwater; Commercial				**0.16**	**0.21**	**65**	**28**	**310**	**19**	**470**	**290**	**360**	**NA**
(3) Tier 1 Subsurface Soil (>2 ft bgs) RBSL; 0-10 feet to Groundwater				**0.078***	**0.07**	**21**	**26**	**320**	**12**	**130**	**220**	**640**	**NA**
Surface Soil Samples													
BRW18-PZ20 (Depth to Water = 9.94 feet bgs)	0 - 1	(1)	10/3/18	<0.11	<0.056	<0.056	<0.056	<0.056	<0.11	<2.2	<2.2	<2.2	**1.3**
BRW18-TP17 (Depth to Water = 7.85 feet bgs)	1.2 - 2.0	(1)	10/25/18	<0.12	<0.059	**0.046 J**	<0.059	**0.074**	<0.12	<2.4	<2.4	**0.85 J**	**1.6**
BRW18-SS01 (Depth to Water = 5.27 feet bgs)	0 - 0.8	(1)	10/26/18	<0.11	<0.054	<0.054	<0.054	<0.054	<0.11	<2.2	<2.2	<2.2	<2.2
BRW18-SS02 (Depth to Water = 5.78 feet bgs)	0 - 0.8	(1)	10/26/18	<0.11	<0.053	<0.053	<0.053	<0.053	<0.11	<2.1	<2.1	<2.1	<2.1
BRW18-SS03 (Depth to Water = 5.28 feet bgs)	0 - 0.17	(1)	10/26/18	<0.1	<0.052	<0.052	<0.052	<0.052	<0.1	<2.1	<2.1	<2.1	**3.4**
BRW18-SS04 (Depth to Water = 18.98 feet bgs)	0 - 0.17	(2)	10/26/18	<0.11	<0.057	<0.057	<0.057	<0.057	**0.31**	**85**	<2.3	**114**	**307**
BRW18-SS05 (Depth to Water = 12.65 feet bgs)	0 - 0.17	(2)	10/26/18	<0.32	<0.16	**1.9**	**4.9**	**22**	**7.7**	**640**	**73**	**1030**	**1900**
BRW18-SS06 (Depth to Water = 6.40 feet bgs)	0 - 0.17	(1)	10/26/18	<0.11	<0.053	<0.053	<0.053	<0.053	<0.11	<2.1	<2.1	**1.4 J**	**2.9**
BRW18-SS07 (Depth to Water = 7.98 feet bgs)	0 - 0.17	(1)	10/26/18	<0.1	<0.052	<0.052	<0.052	<0.052	<0.1	<2.1	**2.6 J**	**1.5 J**	**582**
BRW18-SS08 (Depth to Water = 8.40 feet bgs)	0 - 0.17	(1)	10/26/18	<0.1	<0.051	<0.051	<0.051	<0.051	<0.1	<2	<2	<2	<2
BRW18-SS09 (Depth to Water = 7.34 feet bgs)	0 - 0.17	(1)	10/26/18	<0.21	<0.11	**0.14**	**0.63**	**3.6**	**5.8**	**331**	**10**	**458**	**1090**
BRW18-SS10 (Depth to Water = 7.30 feet bgs)	0 - 0.08	(1)	10/26/18	<0.1	<0.052	**0.036 J**	**0.18**	**1.1**	**2.8**	**187**	**2.1**	**272**	**533**
BRW18-SS11 (Depth to Water = 13.30 feet bgs)	0 - 0.08	(2)	10/26/18	<0.1	<0.052	<0.052	<0.052	<0.052	**0.079 J**	**3.7**	<2.1	**5.1**	**19**
BRW18-SS12 (Depth to Water = 18.02 feet bgs)	0 - 0.08	(2)	10/26/18	<0.11	<0.053	<0.053	<0.053	<0.053	**0.12**	<2.1	<2.1	<2.1	<2.1
BRW18-SS13 (Depth to Water = 17.66 feet bgs)	0 - 0.17	(2)	10/26/18	<0.11	<0.054	<0.054	<0.054	**0.034 J**	<0.11	<2.2	<2.2	<2.2	<2.2
Subsurface Soil Samples													
BRW18-BH01 (Depth to Water = 13.60 feet bgs)	15 - 16.8	(3)	10/12/18	<0.13	<0.063	<0.063	**0.058 J**	<0.063	**0.43**	**31**	<2.5	**75**	**92**

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Value greater than detection limits

Value Exceeds Applicable RBSL

Reporting Limit Increased Due to Sample Matrix

Some or all soils in the interval are saturated or within 1 foot of the water table.

High groundwater contours (Figure 10 from main BRW PDI Report) were compared to Light Detection and Ranging (LiDAR) site data or Survey data to determine depth to water values at each borehole and test pit sample location. The depth to water measurements for the piezometers and hydrocarbon wells are recorded values from the field logs (Appendix B from main BRW PDI Report).

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J = Estimated Value. The analyte was present but less than the reporting limit

Table 2. VPH Analytical Results for BRW Soil Samples (mg/kg)

Field Sample ID	Sample Interval (feet bgs)	Applicable RBSL Group	Sample Date	MTBE	Benzene	Toluene	Ethylbenzene	Xylenes, Total	Naphthalene	C9 to C10 Aromatics	C5 to C8 Aliphatics	C9 to C12 Aliphatics	Total Purgeable Hydrocarbons
(1) Tier 1 Surface Soil (0-2 ft bgs) RBSL; 0-10 feet to Groundwater; Commercial				**0.078***	**0.07**	**21**	**26**	**310**	**12**	**130**	**220**	**360**	**NA**
(2) Tier 1 Surface Soil (0-2 ft bgs) RBSL; 10-20 feet to Groundwater; Commercial				**0.16**	**0.21**	**65**	**28**	**310**	**19**	**470**	**290**	**360**	**NA**
(3) Tier 1 Subsurface Soil (>2 ft bgs) RBSL; 0-10 feet to Groundwater				**0.078***	**0.07**	**21**	**26**	**320**	**12**	**130**	**220**	**640**	**NA**
Subsurface Soil Samples (Cont.)													
BRW18-BH05 (Depth to Water = 14.35 feet bgs)	13.7 - 15	(3)	9/25/18	<0.11	<0.054	<0.054	<0.054	<0.054	**0.15**	**14**	<2.1	**26**	**86**
	15 - 16	(3)	9/25/18	<0.11	<0.056	<0.056	<0.056	<0.056	**0.2**	**4.4**	<2.2	**9.3**	**14**
	20.9 - 21.7	(3)	9/25/18	<0.12	<0.06	<0.06	<0.06	<0.06	**0.071 J**	<2.4	<2.4	**2.7**	**3.5**
	25 - 25.7	(3)	9/25/18	<0.12	<0.058	<0.058	<0.058	<0.058	<0.12	<2.3	<2.3	**1.1 J**	**2.5**
BRW18-BH08 (Depth to Water = 7.08 feet bgs)	3 - 3.7	(3)	9/28/18	<0.11	<0.056	<0.056	**0.17**	**0.12**	**1.7**	**37**	**1.8 J**	**76**	**112**
	12.9 - 14.5	(3)	9/28/18	<0.11	<0.056	<0.056	<0.056	<0.056	<0.11	<2.3	<2.3	**0.77 J**	**0.97**
	14.5 - 16.4	(3)	9/28/18	<0.11	<0.056	<0.056	**0.13**	**0.18**	**0.5**	**33**	**1.7 J**	**56**	**101**
	18.2 - 19.5	(3)	9/28/18	<0.11	<0.055	<0.055	<0.055	<0.055	**0.075 J**	**1.3 J**	<2.2	**2.3**	**3.9**
	19.5 - 19.9	(3)	9/28/18	<0.11	<0.056	<0.056	**0.52**	**0.27**	**4**	**77**	**3.8**	**139**	**210**
	22.9 - 24.5	(3)	9/28/18	<0.12	<0.06	<0.06	<0.06	<0.06	<0.12	<2.4	<2.4	<2.4	<2.4
	27.6 - 27.9	(3)	9/28/18	<0.12	<0.06	<0.06	<0.06	<0.06	<0.12	<2.4	<2.4	<2.4	<2.4
	34.2 - 34.5	(3)	9/28/18	<0.11	<0.054	<0.054	<0.054	<0.054	**0.086 J**	**1.5 J**	<2.2	**2.7**	**4.6**
BRW18-BH11 (Depth to Water = 8.33 bgs)	15 - 17.1	(3)	10/11/18	<0.15	<0.073	**0.056 J**	**3.1**	**3.6**	**0.82**	**320**	**49**	**681**	**1240**
	25 - 25.9	(3)	10/11/18	<0.12	<0.062	**0.049 J**	<0.062	<0.062	**0.1 J**	<2.5	<2.5	**3.1**	**3**
	30 - 32.5	(3)	10/11/18	<0.11	<0.056	<0.056	<0.056	<0.056	<0.11	<2.3	<2.3	<2.3	<2.3
	32.5 - 35	(3)	10/11/18	<0.11	<0.054	<0.054	<0.054	<0.054	<0.11	<2.2	<2.2	<2.2	<2.2
BRW18-PZ12 (Depth to Water = 6.63 feet bgs)	5.8-7.2	(3)	10/5/18	<0.11	<0.056	<0.056	<0.056	<0.056	<0.11	<2.2	<2.2	<2.2	<2.2
BRW18-PZ18 (Depth to Water = 7.76 feet bgs)	5.6 - 5.9	(3)	10/3/18	<0.11	<0.056	<0.056	**3.3**	**1.6**	**14**	**218**	**40**	**466**	**643**
	5 - 5.6	(3)	10/3/18	<0.12	<0.058	<0.058	<0.058	<0.058	**0.26**	**11**	<2.3	**20**	**43**
	10 - 10.6	(3)	10/3/18	<0.12	<0.058	<0.058	**0.14**	**0.036 J**	**0.28**	**25**	**1.7 J**	**54**	**90**
	17 - 17.5	(3)	10/3/18	<0.11	<0.057	<0.057	<0.057	<0.057	<0.11	**2.4**	<2.3	**7.1**	**11**
BRW18-PZ19 (Depth to Water = 13.20 feet bgs)	14.5 - 19.5	(3)	9/27/18	<0.11	<0.053	<0.053	<0.053	<0.053	**0.24**	**5.8**	<2.1	**10**	**31**
	19.8 - 23.0	(3)	9/27/18	<0.12	<0.062	<0.062	<0.062	<0.062	<0.12	**1.5 J**	<2.5	**3.1**	**12**
	21.8 - 23.0	(3)	9/27/18	<0.14	<0.068	<0.068	<0.068	<0.068	<0.14	<2.7	<2.7	<2.7	<2.7
BRW18-PZ20 (Depth to Water = 9.94 feet bgs)	12.2 - 13.9	(3)	10/3/18	<0.1	<0.052	<0.052	<0.052	<0.052	**0.16**	**4**	<2.1	**9.9**	**14**
BRW18-PZ21 (Depth to Water = 13.57 feet bgs)	10 - 12.5	(3)	10/6/18	<0.1	<0.052	<0.052	**1.4**	**0.4**	**1.8**	**179**	**6.2**	**392**	**475**
	12.5 - 15	(3)	10/4/18	<0.1	<0.052	<0.052	**1.2**	**0.36**	**2.7**	**128**	**7.4**	**276**	**345**
	15 - 18.4	(3)	10/4/18	<0.11	<0.053	<0.053	**0.027 J**	<0.053	**0.11**	**14**	<2.1	**32**	**49**
	18.4 - 20	(3)	10/4/18	<0.11	<0.054	<0.054	<0.054	<0.054	<0.11	<2.2	<2.2	<2.2	<2.2
BRW18-PZ22 (Depth to Water = 13.70 feet bgs)	35 - 36	(3)	9/26/18	<0.11	<0.054	<0.054	<0.054	<0.054	<0.11	<2.2	<2.2	<2.2	<2.2
	Slough	(3)	9/26/18	<0.11	<0.056	<0.056	<0.056	<0.056	<0.11	<2.3	<2.3	**0.93 J**	**1.3**

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Value greater than detection limits

Value Exceeds Applicable RBSLs

Reporting Limit Increased Due to Sample Matrix

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Table 2. VPH Analytical Results for BRW Soil Samples (mg/kg)

Field Sample ID	Sample Interval (feet bgs)	Applicable RBSL Group	Sample Date	MTBE	Benzene	Toluene	Ethylbenzene	Xylenes, Total	Naphthalene	C9 to C10 Aromatics	C5 to C8 Aliphatics	C9 to C12 Aliphatics	Total Purgeable Hydrocarbons
(1) Tier 1 Surface Soil (0-2 ft bgs) RBSL; 0-10 feet to Groundwater; Commercial				**0.078***	**0.07**	**21**	**26**	**310**	**12**	**130**	**220**	**360**	**NA**
(2) Tier 1 Surface Soil (0-2 ft bgs) RBSL; 10-20 feet to Groundwater; Commercial				**0.16**	**0.21**	**65**	**28**	**310**	**19**	**470**	**290**	**360**	**NA**
(3) Tier 1 Subsurface Soil (>2 ft bgs) RBSL; 0-10 feet to Groundwater				**0.078***	**0.07**	**21**	**26**	**320**	**12**	**130**	**220**	**640**	**NA**
Subsurface Soil Samples (Cont.)													
BRW18-PZ23 (Depth to Water = 10.21 feet bgs)	5 - 10	(3)	10/9/18	<0.11	<0.053	<0.053	<0.053	<0.053	**0.23**	**5.2**	<2.1	**10**	**18**
	14.2 - 15	(3)	10/9/18	<0.12	<0.06	<0.06	<0.06	<0.06	**0.12**	**1.7 J**	<2.4	**2.2 J**	**4.2**
	15 - 16.3	(3)	10/9/18	<0.13	<0.064	<0.064	<0.064	<0.064	**0.072 J**	**1.5 J**	<2.6	**2.2 J**	**4.3**
BRW18-PZ24 (Depth to Water = 19.99 feet bgs)	4.5 - 5	(3)	10/9/18	<0.13	<0.064	<0.064	<0.064	<0.064	<0.13	<2.6	<2.6	<2.6	**2.7**
BRW18-TP01 (Depth to Water = 5.47 feet bgs)	4.0 - 6.1	(3)	10/25/18	<0.11	<0.054	<0.054	<0.054	<0.054	**0.08 J**	**2 J**	<2.1	**2.3**	**7.5**
BRW18-TP02 (Depth to Water = 13.03 feet bgs)	2.4 - 3.4	(3)	10/25/18	<0.12	<0.061	<0.061	<0.061	<0.061	<0.12	<2.4	<2.4	**1.5 J**	**5.6**
BRW19-HCTP30 (Depth to Water = 7.92 feet bgs)	8.0-10.7	(3)	1/16/2020	<0.10	<0.051	<0.051	<0.051	<0.051	**0.048 J**	**1.1 J**	<2	**1.3 J**	**9.4**
	10.7-13.2	(3)	1/16/2020	<0.10	<0.052	<0.052	<0.052	<0.052	**0.068 J**	**1.6 J**	<2.1	**1.8 J**	**13**
BRW19-HCTP31 (Depth to Water = 7.54 feet bgs)	10.0-11.3	(3)	1/16/2020	<0.13	<0.067	<0.067	<0.067	<0.067	**0.19**	**8.2**	<2.7	**9.9**	**35**
BRW19-HCTP32 (Depth to Water = 6.66 feet bgs)	3.4-4.0	(3)	1/16/2020	<0.11	<0.056	<0.056	<0.056	**0.059**	**0.21**	**6.7**	<2.2	**11**	**26**
	4.0-4.3	(3)	1/16/2020	<0.12	<0.058	**0.38**	**0.46**	**3.7**	**0.9**	**161**	**11**	**134**	**414**
	5.5-9.0	(3)	1/16/2020	<0.11	<0.053	<0.053	**0.47**	**0.44**	**2**	**164**	**3.7**	**139**	**457**
BRW19-HCW30 (Depth to Water = 13.78 feet bgs)	3.8-4.3	(3)	12/18/2019	<0.11	<0.056	<0.056	**0.14**	**0.052 J**	**1.7**	**61**	**1 J**	**54**	**199**
	6.0-6.3	(3)	12/17/2019	<0.10	<0.05	<0.05	<0.05	<0.05	<0.1	<2	<2	<2	**1 J**
	13-14	(3)	12/18/2019	<0.10	<0.05	<0.05	<0.05	<0.05	<0.1	<2	<2	<2	<2
BRW19-HCW31 (Depth to Water = 9.70 feet bgs)	9.25-10.25	(3)	12/17/2019	<0.11	<0.056	<0.056	<0.056	<0.056	<0.11	**1.9 J**	<2.2	**1.4 J**	**3.7**
BRW19-HCW32 (Depth to Water = 12.80 feet bgs)	8.5-9.5	(3)	12/19/2019	<0.10	<0.052	<0.052	<0.052	<0.052	<0.1	<2.1	<2.1	<2.1	**0.91 J**
BRW19-HCW33R (Depth to Water = 10.36 feet bgs)	5.0-6.0	(3)	1/13/2020	<0.10	<0.05	<0.05	<0.05	<0.05	<0.1	<2	<2	<2	<2
	9.0-9.5	(3)	1/13/2020	<0.10	<0.052	<0.052	**0.24**	**0.076**	**3**	**85**	**1.1 J**	**132**	**228**
BRW19-HCW34 (Depth to Water = 9.41 feet bgs)	5.9-8.2	(3)	1/9/2020	<0.10	<0.05	<0.05	<0.05	<0.05	**0.12**	**2.4**	<2	**3.5**	**9.1**
BRW19-HCW35 (Depth to Water = 10.19 feet bgs)	5.0-10.0	(3)	1/9/2020	<0.11	<0.056	<0.056	**0.032 J**	**0.13**	**0.095 J**	<2.2	**1.3 J**	**2.9**	**4**
	10.0-10.5	(3)	1/9/2020	<0.11	<0.056	<0.056	**0.68**	**0.19**	**4**	**86**	**4.1**	**137**	**235**
	15.0-20.0	(3)	1/9/2020	<0.12	<0.06	<0.06	<0.06	<0.06	**0.2**	**5.8**	<2.4	**7.6**	**16**

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Value greater than detection limits

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Reporting Limit Increased Due to Sample Matrix

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Field Sample ID	Sample Interval (feet bgs)	Applicable RBSL Group	Sample Date	MTBE	Benzene	Toluene	Ethylbenzene	Xylenes, Total	Naphthalene	C9 to C10 Aromatics	C5 to C8 Aliphatics	C9 to C12 Aliphatics	Total Purgeable Hydrocarbons
(1) Tier 1 Surface Soil (0-2 ft bgs) RBSL; 0-10 feet to Groundwater; Commercial				**0.078***	**0.07**	**21**	**26**	**310**	**12**	**130**	**220**	**360**	**NA**
(2) Tier 1 Surface Soil (0-2 ft bgs) RBSL; 10-20 feet to Groundwater; Commercial				**0.16**	**0.21**	**65**	**28**	**310**	**19**	**470**	**290**	**360**	**NA**
(3) Tier 1 Subsurface Soil (>2 ft bgs) RBSL; 0-10 feet to Groundwater				**0.078***	**0.07**	**21**	**26**	**320**	**12**	**130**	**220**	**640**	**NA**
Subsurface Soil Samples (Cont.)													
BRW19-HCW37 (Depth to Water = 12.80 feet bgs)	14.0-15.0	(3)	1/6/2020	<0.11	<0.053	<0.053	**0.033 J**	<0.053	**0.69**	**25**	<2.1	**62**	**86**
BRW19-HCW38 (Depth to Water = 8.51 feet bgs)	11.5-13.5	(3)	1/7/2020	<0.10	<0.052	<0.052	<0.052	<0.052	<0.1	<2.1	<2.1	**2.7**	**2.4**
	SLUFF	(3)	1/7/2020	<0.11	<0.056	<0.056	**0.058**	<0.056	**0.2**	**11**	<2.2	**26**	**33**
BRW19-HCW39 (Depth to Water = 13.29 feet bgs)	7.2-8.2	(3)	1/9/2020	<0.11	<0.056	<0.056	<0.056	<0.056	**0.058 J**	<2.2	<2.2	**2.3**	**2.4**
BRW19-HCW40 (Depth to Water = 6.58 feet bgs)	6.0-7.0	(3)	12/17/2020	<0.11	<0.056	<0.056	**0.035 J**	**0.029 J**	<0.11	<2.2	<2.2	**1 J**	**1.4 J**
BRW19-HCW41 (Depth to Water = 6.70 feet bgs)	4.0-5.0	(3)	12/17/2020	<0.10	<0.052	<0.052	<0.052	<0.052	<0.1	<2.1	<2.1	<2.1	<2.1
BRW19-HCW42 (Depth to Water = 6.32 feet bgs)	8.0-9.0	(3)	1/6/2020	<0.12	<0.06	<0.06	<0.06	<0.06	<0.12	<2.4	<2.4	<2.4	<2.4

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Reporting Limit Increased Due to Sample Matrix

Some or all soils in the interval are saturated or within 1 foot of the water table

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Table 3. PAH and Lead Scavengers Analytical Results for BRW Soil Samples (mg/kg)

Field Sample ID	Sample Interval (feet bgs)	Applicable RBSL Group	Sample Date	1,2-Dibromoethane (EDB)	1,2-Dichloroethane (DCA)	1-Methylnaphthalene	2-Methylnaphthalene	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenzo(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene
(1) Tier 1 Surface Soil (0-2 ft bgs) RBSL; 0-10 feet to Groundwater; Commercial				**0.000086***	**0.019**	**2.1**	**6.9**	**27**	**NE**	**2,600**	**6.8**	**2.3**	**23**	**NE**	**230**	**690**	**2.4**	**85**	**35**	**24**	**12**	**NE**	**83**
(2) Tier 1 Surface Soil (0-2 ft bgs) RBSL; 10-20 feet to Groundwater; Commercial				**0.00022***	**0.052**	**7.1**	**23**	**91**	**NE**	**8,800**	**23**	**2.4**	**24**	**NE**	**240**	**2300**	**2.4**	**280**	**120**	**24**	**19**	**NE**	**280**
(3) Tier 1 Subsurface Soil (>2 ft bgs) RBSL; 0-10 feet to Groundwater				**0.000086***	**0.019**	**2.1**	**6.9**	**27**	**NE**	**2,600**	**6.8**	**2.3**	**23**	**NE**	**230**	**690**	**7.5**	**85**	**35**	**77**	**12**	**NE**	**83**
Surface Soil Samples																							
BRW18-PZ20 (Depth to Water = 9.94 feet bgs)	0-1	(1)	10/3/2018	--	--	<0.015	<0.015	<0.015	<0.015	<0.015	**0.033**	**0.085**	**0.06**	**0.088**	<0.015	**0.13**	**0.023**	**0.041**	<0.015	**0.029**	<0.015	**0.032B**	**0.13**
BRW18-TP17 (Depth to Water = 7.85 feet bgs)	1.2 - 2.0	(1)	10/25/2018	--	--	**0.035**	**0.037**	**0.012**	**0.012**	**0.014**	**0.27**	**0.4**	**0.59**	**0.25**	**0.2**	**0.27**	**0.059**	**0.37**	<0.0078	**0.52**	**0.028**	**0.12**	**0.35**
BRW18-SS01 (Depth to Water = 5.27 feet bgs)	0 - 0.8	(1)	10/26/2018	--	--	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071	**0.03**	**0.033**	**0.026**	<0.0071	**0.017**	<0.0071	<0.0071	<0.0071	**0.019**	<0.0071	**0.015B**	**0.0095**
BRW18-SS02 (Depth to Water = 5.78 feet bgs)	0 - 0.8	(1)	10/26/2018	--	--	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071	**0.04**	**0.057**	**0.023**	<0.0071	**0.056**	**0.013**	<0.0071	<0.0071	**0.039**	<0.0071	**0.024B**	**0.039**
BRW18-SS03 (Depth to Water = 5.28 feet bgs)	0 - 0.17	(1)	10/26/2018	--	--	<0.028	<0.028	<0.028	<0.028	<0.028	<0.028	<0.028	<0.028	<0.028	<0.028	<0.028	<0.028	<0.028	<0.028	<0.028	<0.028	**0.038B**	**0.045**
BRW18-SS04 (Depth to Water = 18.98 feet bgs)	0 - 0.17	(2)	10/26/2018	--	--	<0.072	<0.072	<0.072	<0.072	<0.072	<0.072	<0.072	<0.072	<0.072	<0.072	<0.072	<0.072	**0.13**	**1.3**	<0.072	**0.16**	**1.1**	**0.5**
BRW18-SS05 (Depth to Water = 12.65 feet bgs)	0 - 0.17	(2)	10/26/2018	--	--	**4.3**	**7.3**	<0.086	<0.086	<0.086	<0.086	<0.086	<0.086	<0.086	<0.086	<0.086	<0.086	<0.086	**2**	<0.086	**2.2**	**1.4**	**1.4**
BRW18-SS06 (Depth to Water = 6.40 feet bgs)	0 - 0.17	(1)	10/26/2018	--	--	<0.073	<0.073	<0.073	<0.073	<0.073	<0.073	<0.073	<0.073	<0.073	<0.073	<0.073	<0.073	<0.073	<0.073	<0.073	<0.073	<0.073	<0.073
BRW18-SS07 (Depth to Water = 7.98 feet bgs)	0 - 0.17	(1)	10/26/2018	--	--	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28
BRW18-SS08 (Depth to Water = 8.40 feet bgs)	0 - 0.17	(1)	10/26/2018	--	--	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
BRW18-SS09 (Depth to Water = 7.34 feet bgs)	0 - 0.17	(1)	10/26/2018	--	--	**5.2**	**6**	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	**5.2**	<0.21	**1.7**	**3.8**	**5.3**
BRW18-SS10 (Depth to Water = 7.30 feet bgs)	0 - 0.08	(1)	10/26/2018	--	--	**4.4**	**5.6**	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	**3.7**	<0.12	**1.3**	**2.8**	**3.3**
BRW18-SS11 (Depth to Water = 13.30 feet bgs)	0 - 0.08	(2)	10/26/2018	--	--	<0.041	<0.041	<0.041	<0.041	<0.041	<0.041	<0.041	<0.041	<0.041	<0.041	<0.041	<0.041	<0.041	<0.041	<0.041	<0.041	**0.053B**	<0.041
BRW18-SS12 (Depth to Water = 18.02 feet bgs)	0 - 0.08	(2)	10/26/2018	--	--	<0.042	<0.042	<0.042	<0.042	<0.042	<0.042	<0.042	<0.042	<0.042	<0.042	<0.042	<0.042	**0.046**	<0.042	<0.042	<0.042	**0.057B**	<0.042
BRW18-SS13 (Depth to Water = 17.66 feet bgs)	0 - 0.17	(2)	10/26/2018	--	--	<0.043	<0.043	<0.043	<0.043	<0.043	<0.043	<0.043	**0.087**	<0.043	<0.043	**0.064**	<0.043	<0.043	<0.043	<0.043	<0.043	**0.061B**	<0.043
Subsurface Soil Samples																							
BRW18-BH01 (Depth to Water = 13.60 feet bgs)	15 - 16.8	(3)	10/12/2018	--	--	**0.037**	**0.026**	<0.0094	<0.0094	<0.0094	<0.0094	<0.0094	<0.0094	<0.0094	<0.0094	<0.0094	<0.0094	<0.0094	**0.016**	<0.0094	**0.014B**	<0.0094	<0.0094
BRW18-BH05 (Depth to Water = 14.35 feet bgs)	13.7 - 15	(3)	9/25/2018	--	--	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071	**0.009**	<0.0071	<0.0071	**0.03**	<0.0071	<0.0071	**0.018**	<0.0071
	15 - 16	(3)	9/25/2018	--	--	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072
	20.9 - 21.7	(3)	9/25/2018	--	--	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075
	25 - 25.7	(3)	9/25/2018	--	--	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075

NE = Not Established

<X = Value less than detection limit (value in cell (X) is the detection limit)

Value greater than detection limits

Value Exceeds Applicable RBSLs

Some or all soils in the interval are saturated or within 1 foot of the water table

High groundwater contours (Figure 10 from main BRW PDI Report) were compared to Light Detection and Ranging (LiDAR) site data or Survey data to determine depth to water values at each borehole and test pit sample location. The depth to water measurements for the piezometers and hydrocarbon wells are recorded values from the field logs (Appendix B from main BRW PDI Report).

*The best achievable practical quantitation limit (0.20) is greater than the RBSL; therefore, if the compound is detected, additional evaluation may be necessary.

B = The analyte was detected in the method blank

Table 3. PAH and Lead Scavengers Analytical Results for BRW Soil Samples (mg/kg)

Field Sample ID	Sample Interval (feet bgs)	Applicable RBSL Group	Sample Date	1,2-Dibromoethane (EDB)	1,2-Dichloroethane (DCA)	1-Methylnaphthalene	2-Methylnaphthalene	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenzo(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene
(1) Tier 1 Surface Soil (0-2 ft bgs) RBSL; 0-10 feet to Groundwater; Commercial				**0.000086***	**0.019**	**2.1**	**6.9**	**27**	**NE**	**2,600**	**6.8**	**2.3**	**23**	**NE**	**230**	**690**	**2.4**	**85**	**35**	**24**	**12**	**NE**	**83**
(2) Tier 1 Surface Soil (0-2 ft bgs) RBSL; 10-20 feet to Groundwater; Commercial				**0.00022***	**0.052**	**7.1**	**23**	**91**	**NE**	**8,800**	**23**	**2.4**	**24**	**NE**	**240**	**2300**	**2.4**	**280**	**120**	**24**	**19**	**NE**	**280**
(3) Tier 1 Subsurface Soil (>2 ft bgs) RBSL; 0-10 feet to Groundwater				**0.000086***	**0.019**	**2.1**	**6.9**	**27**	**NE**	**2,600**	**6.8**	**2.3**	**23**	**NE**	**230**	**690**	**7.5**	**85**	**35**	**77**	**12**	**NE**	**83**
Subsurface Soil Samples (Cont.)																							
BRW18-BH08 (Depth to Water = 7.08 feet bgs)	3 - 3.7	(3)	9/28/2018	--	--	**0.3**	**0.39**	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	**0.063**	<0.0074	**0.039**	**0.021B**	<0.0074
	12.9 - 14.5	(3)	9/28/2018	--	--	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	**0.011B**	<0.0075
	14.5 - 16.4	(3)	9/28/2018	--	--	**0.13**	**0.16**	<0.0075	<0.0075	<0.0075	<0.0075	**0.011**	<0.0075	<0.0075	<0.0075	**0.012**	<0.0075	<0.0075	**0.03**	<0.0075	**0.02**	**0.018B**	<0.0075
	18.2 - 19.5	(3)	9/28/2018	--	--	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	**0.01B**	<0.0074
	19.5 - 19.9	(3)	9/28/2018	--	--	**0.58**	**0.35**	<0.0074	<0.0074	<0.0074	<0.0074	**0.0095**	<0.0074	**0.012**	<0.0074	**0.017**	<0.0074	<0.0074	**0.13**	<0.0074	**0.06**	**0.031B**	**0.012**
	27.6 - 27.9	(3)	9/28/2018	--	--	<0.0081	<0.0081	<0.0081	<0.0081	<0.0081	<0.0081	<0.0081	<0.0081	<0.0081	<0.0081	<0.0081	<0.0081	<0.0081	<0.0081	<0.0081	<0.0081	**0.012B**	<0.0081
	22.9 - 24.5	(3)	9/28/2018	--	--	<0.0079	<0.0079	<0.0079	<0.0079	<0.0079	<0.0079	<0.0079	<0.0079	<0.0079	<0.0079	<0.0079	<0.0079	<0.0079	<0.0079	<0.0079	<0.0079	**0.01B**	<0.0079
	34.2 - 34.5	(3)	9/28/2018	--	--	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072	**0.011B**	<0.0072
BRW18-BH11 (Depth to Water = 8.33)	15 - 17.1	(3)	10/11/2018	--	--	**3.8**	**5.6**	**0.12**	**0.054**	**0.084**	**0.18**	**0.33**	**0.36**	**0.094**	**0.11**	**0.18**	**0.049**	**0.39**	**0.63**	**0.31**	**1.6**	**0.31**	**0.4**
	25 - 25.9	(3)	10/11/2018	--	--	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	**0.0094B**	<0.0075	<0.0075
	30 - 32.5	(3)	10/11/2018	--	--	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	**0.0078**	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	**0.0099B**	<0.0075	<0.0075
	32.5 - 35	(3)	10/11/2018	--	--	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	**0.0075**	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	**0.0094B**	<0.0075	<0.0075
BRW18-PZ12 (Depth to Water = 6.63 feet bgs)	5.8-7.2	(3)	10/5/2018	--	--	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074
BRW18-PZ18 (Depth to Water = 7.76 feet bgs)	5 - 5.6	(3)	10/3/2018	--	--	**0.046**	**0.064**	<0.0077	<0.0077	<0.0077	**0.011**	**0.039**	**0.021**	**0.027**	<0.0077	**0.053**	**0.0095**	<0.0077	<0.0077	<0.0077	**0.015**	<0.0077	**0.041**
	5.6 - 5.9	(3)	10/3/2018	--	--	**2**	**3**	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	**0.44**	<0.015	**0.7**	**0.066B**	<0.015
	10 - 10.6	(3)	10/3/2018	--	--	**0.034**	**0.042**	<0.0077	<0.0077	<0.0077	<0.0077	**0.0084**	<0.0077	**0.008**	<0.0077	**0.01**	<0.0077	<0.0077	**0.014**	<0.0077	**0.013**	<0.0077	<0.0077
	17 - 17.5	(3)	10/3/2018	--	--	<0.0077	<0.0077	<0.0077	<0.0077	<0.0077	<0.0077	<0.0077	<0.0077	<0.0077	<0.0077	<0.0077	<0.0077	<0.0077	<0.0077	<0.0077	<0.0077	<0.0077	<0.0077
BRW18-PZ19 (Depth to Water = 13.20 feet bgs)	14.5 - 19.5	(3)	11/27/2018	--	--	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	**0.007**	<0.007	<0.007	**0.01B**	<0.007
	19.8 - 23.0	(3)	11/27/2018	--	--	<0.0083	<0.0083	<0.0083	<0.0083	<0.0083	<0.0083	**0.0092**	<0.0083	<0.0083	<0.0083	<0.0083	<0.0083	**0.0094**	<0.0083	<0.0083	<0.0083	**0.015B**	**0.0094**
	21.8 - 23.0	(3)	11/27/2018	--	--	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	**0.012B**	<0.009
BRW18-PZ20 (Depth to Water = 9.94 feet bgs)	12.2 - 13.9	(3)	10/3/2018	--	--	<0.014	<0.014	<0.014	<0.014	<0.014	<0.014	<0.014	<0.014	<0.014	<0.014	<0.014	<0.014	<0.014	<0.014	<0.014	<0.014	<0.014	<0.014
BRW18-PZ21 (Depth to Water = 13.57 feet bgs)	10 - 12.5	(3)	10/6/2018	--	--	**0.48**	**0.3**	<0.014	<0.014	<0.014	<0.014	<0.014	<0.014	<0.014	<0.014	<0.014	<0.014	<0.014	**0.14**	<0.014	**0.027**	**0.025B**	<0.014
	12.5 - 15	(3)	10/4/2018	--	--	**0.37**	**0.3**	<0.0069	<0.0069	<0.0069	<0.0069	<0.0069	<0.0069	<0.0069	<0.0069	<0.0069	<0.0069	<0.0069	**0.088**	<0.0069	**0.03**	**0.014B**	<0.0069
	15 - 18.4	(3)	10/4/2018	--	--	**0.015**	**0.013**	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007
	18.4 - 20	(3)	10/4/2018	--	--	<0.0073	<0.0073	<0.0073	<0.0073	<0.0073	<0.0073	<0.0073	<0.0073	<0.0073	<0.0073	<0.0073	<0.0073	<0.0073	<0.0073	<0.0073	<0.0073	<0.0073	<0.0073
BRW18-PZ22 (Depth to Water = 13.70 feet bgs)	35 - 36	(3)	9/26/2018	--	--	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	**0.015**	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075
	Slough	(3)	9/26/2018	--	--	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	**0.019**	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	**0.018**	<0.0075
BRW18-PZ23 (Depth to Water = 10.21 feet bgs)	5 - 10	(3)	10/9/2018	--	--	<0.0067	<0.0067	<0.0067	<0.0067	<0.0067	<0.0067	**0.0067**	**0.007**	<0.0067	<0.0067	**0.0097**	<0.0067	<0.0067	<0.0067	<0.0067	<0.0067	**0.015B**	<0.0067
	14.2 - 15	(3)	10/9/2018	--	--	**0.017**	**0.015**	<0.0067	<0.0067	<0.0067	<0.0067	<0.0067	<0.0067	<0.0067	<0.0067	**0.0074**	<0.0067	**0.011**	<0.0067	<0.0067	<0.0067	**0.02B**	**0.0081**
	15 - 16.3	(3)	10/9/2018	--	--	<0.0067	<0.0067	<0.0067	<0.0067	<0.0067	**0.015**	**0.011**	**0.01**	<0.0067	<0.0067	**0.018**	<0.0067	**0.024**	<0.0067	<0.0067	<0.0067	**0.022B**	**0.025**
BRW18-PZ24 (Depth to Water = 19.99 feet bgs)	4.5 - 5	(3)	10/9/2018	--	--	<0.0067	<0.0067	<0.0067	<0.0067	**0.024**	**0.07**	**0.064**	**0.077**	**0.032**	**0.039**	**0.073**	<0.0067	**0.15**	**0.011**	**0.039**	**0.0068**	**0.14**	**0.12**
BRW18-TP01 (Depth to Water = 5.47 feet bgs)	4.0 - 6.1	(3)	10/25/2018	--	--	<0.007	<0.007	<0.007	<0.007	<0.007	**0.014**	**0.073**	**0.066**	**0.059**	**0.013**	**0.028**	**0.012**	**0.03**	<0.007	**0.063**	<0.007	**0.034B**	**0.032**

NE = Not Established

<X = Value less than detection limit (value in cell (X) is the detection limit)

Value greater than detection limits

Value Exceeds Applicable RBSLs

Some or all soils in the interval are saturated or within 1 foot of the water table

High groundwater contours (Figure 10 from main BRW PDI Report) were compared to Light Detection and Ranging (LiDAR) site data or Survey data to determine depth to water values at each borehole and test pit sample location. The depth to water measurements for the piezometers and hydrocarbon wells are recorded values from the field logs (Appendix B from main BRW PDI Report).

*The best achievable practical quantitation limit (0.33) is greater than the RBSL; therefore, if the compound is detected, additional evaluation may be necessary.

B = The analyte was detected in the method blank

Table 3. PAH and Lead Scavengers Analytical Results for BRW Soil Samples (mg/kg)

Field Sample ID	Sample Interval (feet bgs)	Applicable RBSL Group	Sample Date	1,2-Dibromoethane (EDB)	1,2-Dichloroethane (DCA)	1-Methylnaphthalene	2-Methylnaphthalene	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenzo(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene
(1) Tier 1 Surface Soil (0-2 ft bgs) RBSL; 0-10 feet to Groundwater; Commercial				0.000086*	0.019	2.1	6.9	27	NE	2,600	6.8	2.3	23	NE	230	690	2.4	85	35	24	12	NE	83
(2) Tier 1 Surface Soil (0-2 ft bgs) RBSL; 10-20 feet to Groundwater; Commercial				0.00022*	0.052	7.1	23	91	NE	8,800	23	2.4	24	NE	240	2300	2.4	280	120	24	19	NE	280
(3) Tier 1 Subsurface Soil (>2 ft bgs) RBSL; 0-10 feet to Groundwater				0.000086*	0.019	2.1	6.9	27	NE	2,600	6.8	2.3	23	NE	230	690	7.5	85	35	77	12	NE	83
Subsurface Soil Samples (Cont.)																							
BRW18-TP02 (Depth to Water = 13.03 feet bgs)	2.4 - 3.4	(3)	10/25/2018	--	--	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	**0.011**	**0.024**	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	**0.0091**	<0.0075	**0.017B**	**0.0079**
BRW19-HCTP30 (Depth to Water = 7.92 feet bgs)	8.0-10.7	(3)	1/16/2020	<0.0002	<0.0051	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	**0.007 B**	<0.0068	<0.0068
	10.7-13.2	(3)	1/16/2020	<0.0002	<0.0052	<0.0069	<0.0069	<0.0069	<0.0069	<0.0069	<0.0069	<0.0069	<0.0069	<0.0069	<0.0069	<0.0069	<0.0069	<0.0069	<0.0069	<0.0069	**0.0076 B**	<0.0069	<0.0069
BRW19-HCTP31 (Depth to Water = 7.54 feet bgs)	10.0-11.3	(3)	1/16/2020	<0.00026	<0.0067	<0.0089	<0.0089	<0.0089	<0.0089	<0.0089	<0.0089	<0.0089	<0.0089	<0.0089	<0.0089	<0.0089	<0.0089	<0.0089	<0.0089	<0.0089	**0.011 B**	<0.0089	<0.0089
BRW19-HCTP32 (Depth to Water = 6.657 feet bgs)	3.4-4.0	(3)	1/16/2020	<0.00022	<0.0056	**0.017**	**0.045**	<0.0074	<0.0074	**0.0085**	**0.072**	**0.084**	**0.13**	**0.083**	**0.041**	**0.12**	**0.021**	**0.18**	<0.0074	**0.083**	**0.017**	**0.095**	**0.17**
	4.0-4.3	(3)	1/16/2020	<0.00023	<0.059	**0.52**	**1.2**	<0.0078	**0.02**	**0.014**	**0.11**	**0.12**	**0.17**	**0.094**	**0.051**	**0.14**	**0.025**	**0.23**	**0.062**	**0.092**	**0.21**	**0.17**	**0.2**
	5.5-9.0	(3)	1/16/2020	<0.00021	<0.026	**0.031**	**0.054**	<0.007	<0.007	<0.007	<0.007	**0.0093**	**0.012**	**0.0098**	<0.007	**0.0078**	<0.007	**0.0084**	**0.024**	**0.0087**	**0.019**	**0.0073**	**0.0093**
BRW19-HCW30 (Depth to Water = 13.78 feet bgs)	3.8-4.3	(3)	12/18/2019	<0.00022	<0.0054	**0.066**	<0.0072	<0.0072	<0.0072	**0.039**	**0.23**	**0.22**	**0.15**	**0.12**	**0.036**	**0.43**	**0.043**	**0.14**	**0.057**	**0.054**	**0.093 B**	**0.22**	**0.35**
	6.0-6.3	(3)	12/17/2019	<0.0002	<0.005	**0.013**	**0.014**	<0.0067	<0.0067	**0.0081**	**0.14**	**0.12**	**0.06**	**0.049**	<0.0067	**0.19**	**0.025**	**0.031**	**0.0068**	<0.0067	**0.012 B**	**0.063**	**0.17**
BRW19-HCW31 (Depth to Water = 9.70 feet bgs)	9.25-10.25	(3)	12/17/2019	<0.00022	<0.0056	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	**0.012 B**	<0.0074	<0.0074
BRW19-HCW32 (Depth to Water = 12.80 feet bgs)	8.5-9.5	(3)	12/19/2019	<0.00021	<0.0052	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	**0.0098**	**0.0081**	**0.0089**	**0.0081**	**0.019**	<0.0068	**0.01**	<0.0068	<0.0068	**0.0098 B**	**0.0088**	**0.018**
BRW19-HCW33R (Depth to Water = 10.36 feet bgs)	5.0-6.0	(3)	1/13/2020	<0.0002	<0.005	<0.0067	<0.0067	<0.0067	<0.0067	<0.0067	<0.0067	<0.0067	<0.0067	<0.0067	<0.0067	<0.0067	<0.0067	**0.0072**	<0.0067	<0.0067	**0.0088 B**	<0.0067	<0.0067
	9.0-9.5	(3)	1/13/2020	<0.00021	<0.0052	**0.026**	**0.035**	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	**0.053**	<0.0068	**0.019 B**	**0.01**	**0.0071**
BRW19-HCW34 (Depth to Water = 9.41 feet bgs)	5.9-8.2	(3)	1/9/2020	<0.0002	<0.005	<0.0067	<0.0067	<0.0067	<0.0067	<0.0067	<0.0067	**0.025**	<0.0067	<0.0067	<0.0067	<0.0067	<0.0067	<0.0067	<0.0067	<0.0067	**0.0074 B**	<0.0067	<0.0067
BRW19-HCW35 (Depth to Water = 10.19 feet bgs)	5.0-10.0	(3)	1/9/2020	<0.00022	<0.0055	**0.023**	**0.028**	<0.015	<0.015	<0.015	**0.096**	**0.15**	**0.15**	**0.13**	**0.029**	**0.2**	**0.044**	**0.059**	<0.015	**0.06**	**0.026**	**0.052**	**0.28**
	10.0-10.5	(3)	1/9/2020	<0.00022	<0.0056	<0.0075	<0.0075	**0.013**	<0.0075	**0.013**	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	**0.18**	<0.0075	**0.044 B**	**0.26**	**0.013**
	15.0-20.0	(3)	1/9/2020	<0.00024	<0.0059	<0.016	<0.016	<0.016	<0.016	<0.016	**0.03**	**0.063**	**0.05**	**0.065**	<0.016	**0.08**	**0.025**	**0.021**	<0.016	**0.028**	<0.016	**0.027**	**0.12**
BRW19-HCW37 (Depth to Water = 12.80 feet bgs)	14.0-15.0	(3)	1/6/2020	<0.00021	<0.0053	**0.048**	**0.045**	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071	**0.0092**	<0.0071	<0.0071	**0.015**	<0.0071	<0.0071	**0.015**	<0.0071	**0.014**	<0.0071	<0.0071
BRW19-HCW38 (Depth to Water = 8.51 feet bgs)	11.5-13.5	(3)	1/7/2020	<0.0002	<0.0051	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068
	SLUFF	(3)	1/7/2020	<0.00022	<0.0055	**0.04**	**0.046**	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	**0.0092**	<0.0074	<0.0074
BRW19-HCW39 (Depth to Water = 13.29 feet bgs)	7.2-8.2	(3)	1/9/2020	<0.00022	<0.0056	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	<0.0075	**0.0084**	<0.0075	<0.0075
BRW19-HCW40 (Depth to Water = 6.58 feet bgs)	6.0-7.0	(3)	12/17/2020	<0.00022	<0.0056	**0.02**	**0.03**	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	**0.044 B**	<0.0074	<0.0074
BRW19-HCW41 (Depth to Water = 6.70 feet bgs)	4.0-5.0	(3)	12/17/2020	<0.0002	<0.0052	<0.0069	<0.0069	<0.0069	<0.0069	**0.0087**	<0.0069	<0.0069	<0.0069	<0.0069	<0.0069	<0.0069	<0.0069	**0.0087**	<0.0069	<0.0069	**0.014**	**0.012**	**0.0075**
BRW19-HCW42 (Depth to Water = 6.32 feet bgs)	8.0-9.0	(3)	1/6/2020	<0.00024	<0.0059	<0.0079	<0.0079	<0.0079	<0.0079	<0.0079	<0.0079	<0.0079	<0.0079	<0.0079	<0.0079	<0.0079	<0.0079	<0.0079	<0.0079	<0.0079	**0.0081**	<0.0079	<0.0079

NE = Not Established

<X = Value less than detection limit (value in cell (X) is the detection limit)

Value greater than detection limits

Value Exceeds Applicable RBSLs

Some or all soils in the interval are saturated or within 1 foot of the water table

High groundwater contours (Figure 10 from main BRW PDI Report) were compared to Light Detection and Ranging (LiDAR) site data or Survey data to determine depth to water values at each borehole and test pit sample location. The depth to water measurements for the piezometers and hydrocarbon wells are recorded values from the field logs (Appendix B from main BRW PDI Report).

*The best achievable practical quantitation limit (0.33) is greater than the RBSL; therefore, if the compound is detected, additional evaluation may be necessary.

B = The analyte was detected in the method blank

Table 4. EPH Analytical Results for BRW Soil Samples (mg/kg)

Field Sample ID	Sample Interval (feet bgs)	Applicable RBSL Group	Sample Date	C11 to C22 Aromatics	C19 to C36 Aliphatics	C9 to C18 Aliphatics	Total Extractable Hydrocarbons
(1) Tier 1 Surface Soil (0-2 ft bgs) RBSL; 0-10 feet to Groundwater; Commercial				**370**	**200,000**	**540**	**NA**
(2) Tier 1 Surface Soil (0-2 ft bgs) RBSL; 10-20 feet to Groundwater; Commercial				**1300**	**200,000**	**540**	**NA**
(3) Tier 1 Subsurface Soil (>2 ft bgs) RBSL; 0-10 feet to Groundwater				**370**	**200,000**	**900**	**NA**
Surface Soil Samples							
BRW18-PZ20 (Depth to Water = 9.94 feet bgs)	0 - 1	(1)	10/3/18	**300**	**282**	<22	**1280**
BRW18-TP17 (Depth to Water = 7.85 feet bgs)	1.2 - 2.0	(1)	10/25/18	**21**	**34**	<12	**68**
BRW18-SS01 (Depth to Water = 5.27 feet bgs)	0 - 0.8	(1)	10/26/18	**45**	**51**	<11	**146**
BRW18-SS02 (Depth to Water = 5.78 feet bgs)	0 - 0.8	(1)	10/26/18	**74**	**448**	<11	**612**
BRW18-SS03 (Depth to Water = 5.28 feet bgs)	0 - 0.17	(1)	10/26/18	**191**	**4250**	**67**	**4820**
BRW18-SS04 (Depth to Water = 18.98 feet bgs)	0 - 0.17	(2)	10/26/18	**2920**	**3160**	**6150**	**12400**
BRW18-SS05 (Depth to Water = 12.65 feet bgs)	0 - 0.17	(2)	10/26/18	**3390**	**2140**	**5600**	**11400**
BRW18-SS06 (Depth to Water = 6.40 feet bgs)	0 - 0.17	(1)	10/26/18	**504**	**13200**	<109	**14800**
BRW18-SS07 (Depth to Water = 7.98 feet bgs)	0 - 0.17	(1)	10/26/18	**1520**	**36700**	<414	**41500**
BRW18-SS08 (Depth to Water = 8.40 feet bgs)	0 - 0.17	(1)	10/26/18	**889**	**42000**	<457	**45700**
BRW18-SS09 (Depth to Water = 7.34 feet bgs)	0 - 0.17	(1)	10/26/18	**10500**	**9730**	**14900**	**35800**
BRW18-SS10 (Depth to Water = 7.30 feet bgs)	0 - 0.08	(1)	10/26/18	**6390**	**6090**	**10600**	**23500**
BRW18-SS11 (Depth to Water = 13.30 feet bgs)	0 - 0.08	(2)	10/26/18	<62	<62	<62	<62
BRW18-SS12 (Depth to Water = 18.02 feet bgs)	0 - 0.08	(2)	10/26/18	<63	<63	<63	<63
BRW18-SS13 (Depth to Water = 17.66 feet bgs)	0 - 0.17	(2)	10/26/18	**121**	**797**	<65	**959**
Subsurface Soil Samples							
BRW18-BH01 (Depth to Water = 13.60 feet bgs)	15 - 16.8	(3)	10/12/18	**9.5 J**	<14	**139**	**150**
BRW18-BH05 (Depth to Water = 14.35 feet bgs)	13.7 - 15	(3)	9/25/18	**35**	**13**	**595**	**656**
	15 - 16	(3)	9/25/18	<11	<11	**26**	**26**
	20.9 - 21.7	(3)	9/25/18	<11	<11	**16**	**23**
	25 - 25.7	(3)	9/25/18	<11	<11	<11	<11
BRW18-BH08 (Depth to Water = 7.08 feet bgs)	3 - 3.7	(3)	9/28/18	**45**	**16**	**137**	**234**
	12.9 - 14.5	(3)	9/28/18	<11	<11	<11	<11
	14.5 - 16.4	(3)	9/28/18	**49**	**32**	**74**	**221**
	18.2 - 19.5	(3)	9/28/18	<11	<11	<11	<11
	19.5 - 19.9	(3)	9/28/18	**103**	**33**	**318**	**533**
	22.9 - 24.5	(3)	9/28/18	<12	<12	<12	<12
	27.6 - 27.9	(3)	9/28/18	<12	<12	<12	<12
	34.2 - 34.5	(3)	9/28/18	<11	<11	<11	<11

<X = Value less than detection limit (value in cell (X) is the detection limit)

Value greater than detection limits

Value Exceeds Applicable RBSLs

Some or all soils in the interval are saturated or within 1 foot of the water table

High groundwater contours (Figure 10 from main BRW PDI Report) were compared to Light Detection and Ranging (LiDAR) site data or Survey data to determine depth to water values at each borehole and test pit sample location. The depth to water measurements for the piezometers and hydrocarbon wells are recorded values from the field logs (Appendix B from main BRW PDI Report).

Table 4. EPH Analytical Results for BRW Soil Samples (mg/kg)

Field Sample ID	Sample Interval (feet bgs)	Applicable RBSL Group	Sample Date	C11 to C22 Aromatics	C19 to C36 Aliphatics	C9 to C18 Aliphatics	Total Extractable Hydrocarbons
(1) Tier 1 Surface Soil (0-2 ft bgs) RBSL; 0-10 feet to Groundwater; Commercial				370	200,000	540	NA
(2) Tier 1 Surface Soil (0-2 ft bgs) RBSL; 10-20 feet to Groundwater; Commercial				1300	200,000	540	NA
(3) Tier 1 Subsurface Soil (>2 ft bgs) RBSL; 0-10 feet to Groundwater				370	200,000	900	NA
Subsurface Soil Samples (Cont.)							
BRW18-BH11 (Depth to Water = 8.33)	15 - 17.1	(3)	10/11/18	**513**	**106**	**2140**	**2880**
	25 - 25.9	(3)	10/11/18	<12	<12	<12	<12
	30 - 32.5	(3)	10/11/18	<11	<11	<11	<11
	32.5 - 35	(3)	10/11/18	<11	<11	<11	<11
BRW18-PZ12 (Depth to Water = 6.63 feet bgs)	5.8-7.2	(3)	10/5/18	<11	<11	<11	<11
BRW18-PZ18 (Depth to Water = 7.76 feet bgs)	5.6 - 5.9	(3)	10/3/18	**307**	<22	**1950**	**2320**
	5 - 5.6	(3)	10/3/18	**97**	**72**	**41**	**367**
	10 - 10.6	(3)	10/3/18	**32**	**21**	**95**	**199**
	17 - 17.5	(3)	10/3/18	<11	<11	<11	<11
BRW18-PZ19 (Depth to Water = 13.20 feet bgs)	14.5 - 19.5	(3)	9/27/18	**18**	<11	**108**	**144**
	19.8 - 23.0	(3)	9/27/18	<12	<12	**14**	**39**
	21.8 - 23.0	(3)	9/27/18	<13	<13	<13	<13
BRW18-PZ20 (Depth to Water = 9.94 feet bgs)	12.2 - 13.9	(3)	10/3/18	<21	<21	<21	<21
BRW18-PZ21 (Depth to Water = 13.57 feet bgs)	10 - 12.5	(3)	10/6/18	**71**	<21	**1780**	**1870**
	12.5 - 15	(3)	10/4/18	**56**	<10	**1010**	**1080**
	15 - 18.4	(3)	10/4/18	<11	<11	**31**	**36**
	18.4 - 20	(3)	10/4/18	<11	<11	<11	<11
BRW18-PZ22 (Depth to Water = 13.70 feet bgs)	35 - 36	(3)	9/26/18	**22**	**20**	<11	**79**
	Slough	(3)	9/26/18	**14**	**16**	<11	**54**
BRW18-PZ23 (Depth to Water = 10.21 feet bgs)	5 - 10	(3)	10/9/18	<10	**11**	**10**	**55**
	14.2 - 15	(3)	10/9/18	<10	<10	<10	**26**
	15 - 16.3	(3)	10/9/18	<10	<10	<10	<10
BRW18-PZ24 (Depth to Water = 19.99 feet bgs)	4.5 - 5	(3)	10/9/18	<10	<10	<10	**12**
BRW18-TP01 (Depth to Water = 5.47 feet bgs)	4.0 - 6.1	(3)	10/25/18	**53**	**67**	<11	**185**
BRW18-TP02 (Depth to Water = 13.03 feet bgs)	2.4 - 3.4	(3)	10/25/18	**23**	**27**	<11	**62**
BRW19-HCTP30 (Depth to Water = 7.92 feet bgs)	8.0-10.7	(3)	1/16/2020	<10	<10	**21**	**23**
	10.7-13.2	(3)	1/16/2020	<10	<10	**19**	**21**
BRW19-HCTP31 (Depth to Water = 7.54 feet bgs)	10.0-11.3	(3)	1/16/2020	**14**	<13	**70**	**88**
BRW19-HCTP32 (Depth to Water = 6.657 feet bgs)	3.4-4.0	(3)	1/16/2020	<11	**20**	**13**	**39**
	4.0-4.3	(3)	1/16/2020	**106**	**11 J**	**886**	**1010**
	5.5-9.0	(3)	1/16/2020	**129**	**23**	**1610**	**1740**
BRW19-HCW30 (Depth to Water = 13.78 feet bgs)	3.8-4.3	(3)	12/18/2019	**354**	**185**	**298**	**943**
	6.0-6.3	(3)	12/17/2019	<10	**5.9 J**	**7.6 J**	**14**

<X = Value less than detection limit (value in cell (X) is the detection limit)

Value greater than detection limits

Value Exceeds Applicable RBSLs

Some or all soils in the interval are saturated or within 1 foot of the water table

High groundwater contours (Figure 10 from main BRW PDI Report) were compared to Light Detection and Ranging (LiDAR) site data or Survey data to determine depth to water values at each borehole and test pit sample location. The depth to water measurements for the piezometers and hydrocarbon wells are recorded values from the field logs (Appendix B from main BRW PDI Report).

Table 4. EPH Analytical Results for BRW Soil Samples (mg/kg)

Field Sample ID	Sample Interval (feet bgs)	Applicable RBSL Group	Sample Date	C11 to C22 Aromatics	C19 to C36 Aliphatics	C9 to C18 Aliphatics	Total Extractable Hydrocarbons
(1) Tier 1 Surface Soil (0-2 ft bgs) RBSL; 0-10 feet to Groundwater; Commercial				**370**	**200,000**	**540**	**NA**
(2) Tier 1 Surface Soil (0-2 ft bgs) RBSL; 10-20 feet to Groundwater; Commercial				**1300**	**200,000**	**540**	**NA**
(3) Tier 1 Subsurface Soil (>2 ft bgs) RBSL; 0-10 feet to Groundwater				**370**	**200,000**	**900**	**NA**
Subsurface Soil Samples (Cont.)							
BRW19-HCW31 (Depth to Water = 9.70 feet bgs)	9.25-10.25	(3)	12/17/2019	<11	<11	<11	**<11**
BRW19-HCW32 (Depth to Water = 12.80 feet bgs)	8.5-9.5	(3)	12/19/2019	**327**	**261**	<10	**761**
BRW19-HCW33R (Depth to Water = 10.36 feet bgs)	5.0-6.0	(3)	1/13/2020	<10	<10	<10	<10
	9.0-9.5	(3)	1/13/2020	**88**	**12**	**577**	**673**
BRW19-HCW34 (Depth to Water = 9.41 feet bgs)	5.9-8.2	(3)	1/9/2020	<10	<10	**36**	**39**
BRW19-HCW35 (Depth to Water = 10.19 feet bgs)	5.0-10.0	(3)	1/9/2020	**317**	**225**	<11	**684**
	10.0-10.5	(3)	1/9/2020	**190**	**74**	**535**	**799**
	15.0-20.0	(3)	1/9/2020	**122**	**143**	**89**	**384**
BRW19-HCW37 (Depth to Water = 12.80 feet bgs)	14.0-15.0	(3)	1/6/2020	**17**	**26**	**206**	**248**
BRW19-HCW38 (Depth to Water = 8.51 feet bgs)	11.5-13.5	(3)	1/7/2020	<10	<10	<10	<10
	SLUFF	(3)	1/7/2020	<11	<11	**37**	**38**
BRW19-HCW39 (Depth to Water = 13.29 feet bgs)	7.2-8.2	(3)	1/9/2020	<11	<11	<11	<11
BRW19-HCW40 (Depth to Water = 6.58 feet bgs)	6.0-7.0	(3)	12/17/2020	<11	<11	<11	<11
BRW19-HCW41 (Depth to Water = 6.70 feet bgs)	4.0-5.0	(3)	12/17/2020	<10	<10	<10	<10
BRW19-HCW42 (Depth to Water = 6.32 feet bgs)	8.0-9.0	(3)	1/6/2020	<12	<12	<12	<12

<X = Value less than detection limit (value in cell (X) is the detection limit)

Value greater than detection limits

Value Exceeds Applicable RBSLs

Some or all soils in the interval are saturated or within 1 foot of the water table

High groundwater contours (Figure 10 from main BRW PDI Report) were compared to Light Detection and Ranging (LiDAR) site data or Survey data to determine depth to water values at each borehole and test pit sample location. The depth to water measurements for the piezometers and hydrocarbon wells are recorded values from the field logs (Appendix B from main BRW PDI Report).

Table 5. VPH Analytical Results for BRW Groundwater Samples (µg/L)

Field Sample ID	Sample Date	MTBE	Benzene	Toluene	Ethylbenzene	Xylenes, Total	Naphthalene	C9 to C10 Aromatics	C5 to C8 Aliphatics	C9 to C12 Aliphatics	Total Purgeable Hydrocarbons
(1) Tier 1 RBSL - Groundwater		**30**	**5**	**1,000**	**700**	**10,000**	**100**	**1,100**	**650**	**1,400**	**NA**
(2) DEQ-7 Human Health Standards - Surface Water		**30**	**5**	**57**	**68**	**10,000**	**100**	**NE**	**NE**	**NE**	**NE**
BRW18-PZ02	10/24/19	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
BRW18-PZ05	10/18/19	<1	**0.97**	<0.5	<0.5	<0.5	**1.5**	**28**	**18 J**	**19 J**	58
BRW18-PZ08	10/17/19	<1	<0.5	**0.26 J**	**0.32 J**	**4.3**	**2.7**	**35**	<20	**25**	56
BRW18-PZ09	10/17/19	<1	<0.5	<0.5	<0.5	<0.5	**0.95 J**	**20**	<20	**18 J**	53
BRW18-PZ10	11/28/18	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
	10/21/19	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
BRW18-PZ11	11/29/18	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
	10/21/19	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
BRW18-PZ12	11/28/18	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
	10/21/19	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
BRW18-PZ13	11/28/18	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
	10/21/19	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
BRW18-PZ18	11/27/18	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
	10/25/19	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
BRW18-PZ19	11/27/18	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
	10/23/19	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
BRW18-PZ20	11/30/18	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
	10/25/19	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
BRW18-PZ21	11/26/18	<1	**14(1)(2)**	**0.34 J**	<0.5	**11**	**18**	**28**	**18 J**	**26**	**93**
	12/5/18	<1	**10(1)(2)**	**0.34 J**	<0.5	**5.4**	**13**	**19 J**	**17 J**	**17 J**	**67**
	10/25/19	<1	**15(1)(2)**	<0.5	<0.5	**4.3**	**12**	**14 J**	**16 J**	**15 J**	**62**
	2/14/20	<1	**1.8**	<0.5	<0.5	<0.5	**1.7**	<20	**5.3 J**	<20	**12 J**
BRW18-PZ22	11/30/18	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
	10/25/19	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
BRW18-PZ23	11/27/18	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
	10/24/19	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
BRW18-PZ24	11/28/18	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
	10/24/19	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
BPS11-05A1	1/27/20	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
MW-01-MPC	10/23/19	<1	<0.5	<0.5	<0.5	**0.42 J**	<1	<20	<20	<20	**7.1 J**
	1/13/20	<1	<0.5	<0.5	**0.94**	**5.8**	**0.67 J**	**17 J**	<20	**8.5 J**	**33**
MW-02-MPC	10/23/19	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
	1/13/20	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
MW-03-MPC	10/23/19	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
	1/13/20	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
MW-03A-MPC	10/23/19	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
	1/13/20	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
BRW19-HCW30	2/4/20	<1	<0.5	<0.5	<0.5	<0.5	**2.1**	**61**	<20	**40**	**168**
BRW19-HCW31	1/28/20	<1	<0.5	<0.5	<0.5	<0.5	**1.7**	**16 J**	<20	**15 J**	**35**
BRW19-HCW32	1/20/20	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	**7 J**
BRW19-HCW33R	2/5/20	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
BRW19-HCW34	2/5/20	<1	**0.36 J**	<0.5	**1**	**0.34 J**	**13**	241	**14 J**	**146**	**585**
BRW19-HCW35	2/4/20	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
BRW19-HCW36	2/5/20	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
BRW19-HCW37	2/5/20	<1	**11(1)(2)**	**0.43 J**	**0.53**	**4.9**	**24**	**171**	**23**	**164**	**362**
BRW19-HCW38	2/6/20	<1	**11(1)(2)**	**0.49 J**	**0.53**	**6.9**	**28**	**186**	**44**	**107**	**393**
BRW19-HCW39	2/5/20	<1	<0.5	<0.5	**0.68**	**0.36 J**	**2.8**	**50**	<20	**26**	**92**
BRW19-HCW40	1/28/20	<1	**2.2**	<0.5	**3.5**	**1.7**	**2.6**	**36**	**17 J**	**31**	**74**
BRW19-HCW41	1/28/20	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20
BRW19-HCW42	1/28/20	<1	<0.5	<0.5	<0.5	<0.5	<1	<20	<20	<20	<20

<X = Value less than detection limit (value in cell (X) is the detection limit)

NE = Not Established

Value greater than detection limits

Value Exceeds RBSL or Standard

Supercript values correspond to the Applicable RBSL Group that was exceeded. For Benzene, the sample results are noted X(1)(2), indicating the value X exceeds the (1) Tier RBSL - Groundwater and the (2) DEQ-7 Human Health Standards - Surface Water.

J = Estimated Value. The analyte was present but less than the reporting limit.

Table 6. PAH and Lead Scavengers Analytical Results for BRW Groundwater Samples (µg/L)

Field Sample ID	Sample Date	1,2-Dibromoethane (EDB)	1,2-Dichloroethane (DCA)	1-Methylnaphthalene	2-Methylnaphthalene	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenzo(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene
(1) Tier 1 RBSL - Groundwater		**0.017**	**4**	**11**	**36**	**70**	**NE**	**2,100**	**0.5**	**0.05***	**0.5**	**NE**	**5**	**50**	**0.05***	**20**	**50**	**0.5**	**100**	**NE**	**20**
(2) DEQ-7 Human Health Standards - Surface Water		**0.017**	**5**	**NE**	**NE**	**70**	**NE**	**300**	**0.012**	**0.0012**	**0.012**	**NE**	**0.12**	**1.2**	**0.0012**	**20**	**50**	**0.012**	**100**	**NE**	**20**
BRW18-PZ02	10/24/19	<0.01	<0.5	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.23B**	<0.19	<0.19
BRW18-PZ05	10/18/19	<0.01	<0.5	**1.6**	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	**0.54B**	<0.20	<0.20
BRW18-PZ08	10/17/19	<0.01	<0.5	**1.0**	**0.91**	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.90B**	<0.19	<0.19
BRW18-PZ09	10/17/19	<0.01	<0.5	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.30B**	<0.19	<0.19
BRW18-PZ10	11/28/18	--	--	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.31B**	<0.19	<0.19
	10/21/19	<0.01	<0.5	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.25B**	<0.19	<0.19
BRW18-PZ11	11/29/18	--	--	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	**0.37B**	<0.21	<0.21
	10/21/19	<0.01	<0.5	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.28B**	<0.19	<0.19
BRW18-PZ12	11/28/18	--	--	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.33B**	<0.19	<0.19
	10/21/19	<0.01	<0.5	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.29B**	<0.19	<0.19
BRW18-PZ13	11/28/18	--	--	**0.27**	**0.34**	**0.22**	**0.21**	**0.24**	**0.44(2)**	**0.53**$^{(1)(2)}$	**0.66**$^{(1)(2)}$	**0.42**	**0.56**$^{(2)}$	**0.44**	**0.64**$^{(1)(2)}$	**0.25**	**0.22**	**0.73**$^{(1)(2)}$	**0.7B**	**0.32**	**0.23**
	10/21/19	<0.01	<0.5	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.27B**	<0.19	<0.19
BRW18-PZ18	11/27/18	--	--	<0.19	<0.19	<0.19	<0.19	<0.19	**0.47**$^{(2)}$	**0.47**$^{(1)(2)}$	**0.61**$^{(1)(2)}$	**0.69**	**0.54**$^{(2)}$	**0.46**	**0.79**$^{(1)(2)}$	**0.39**	<0.19	**0.76**$^{(1)(2)}$	**0.32B**	<0.19	**0.41**
	10/25/19	<0.01	<0.5	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.23B**	<0.19	<0.19
BRW18-PZ19	11/27/18	--	--	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.32B**	<0.19	<0.19
	10/23/19	<0.01	<0.5	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.22B**	<0.19	<0.19
BRW18-PZ20	11/30/18	--	--	**0.31**	**0.34**	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.77B**	<0.19	<0.19
	10/25/19	<0.01	<0.5	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.23B**	<0.19	<0.19
BRW18-PZ21	12/5/18	--	--	**2.6**	**2.2**	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**13**	<0.19	<0.19
	10/25/19	<0.01	<0.5	**1.2**	**0.67**	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**6.2**	<0.19	<0.19
BRW18-PZ22	11/30/18	--	--	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.32B**	<0.19	<0.19
	10/25/19	<0.01	<0.5	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.24B**	<0.19	<0.19
BRW18-PZ23	11/27/18	--	--	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.32B**	<0.19	<0.19
	10/24/19	<0.01	<0.5	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.70B**	<0.19	<0.19
BRW18-PZ24	11/28/18	--	--	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.32B**	<0.19	<0.19
	10/24/19	<0.01	<0.5	<0.19	<0.21	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.52B**	<0.19	<0.19
BPS11-05A1	1/27/20	<0.01	<0.5	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.22B**	<0.19	<0.19
MW-01-MPC	10/23/19	<0.01	<0.5	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.24B**	<0.19	<0.19
	1/13/20	<0.01	<0.5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	**0.68B**	<0.2	<0.2
MW-02-MPC	10/23/19	<0.01	<0.5	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.21B**	<0.19	<0.19
	1/13/20	<0.01	<0.5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	**0.40B**	<0.2	<0.2
MW-03-MPC	10/23/19	<0.01	<0.5	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.22B**	<0.19	<0.19
	1/13/20	<0.01	<0.5	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.52B**	<0.19	<0.19
MW-03A-MPC	10/23/19	<0.01	<0.5	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.23B**	<0.19	<0.19
	1/13/20	<0.01	<0.5	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.20B**	<0.19	<0.19
BRW19-HCW30	2/4/20	<0.01	<0.5	**0.97**	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	**0.31**	<0.2	**0.37B**	<0.2	<0.2
BRW19-HCW31	1/28/20	<0.01	<0.5	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.26B**	<0.19	<0.19
BRW19-HCW32	1/20/20	<0.01	<0.5	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.38B**	<0.19	<0.19
BRW19-HCW33R	2/5/20	<0.01	<0.5	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.23B**	<0.19	<0.19
BRW19-HCW34	2/5/20	<0.01	<0.5	**0.79**	**0.2**	**0.23**	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**1.1**	<0.19	**0.52B**	<0.19	<0.19
BRW19-HCW35	2/4/20	<0.01	<0.5	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.24B**	<0.19	<0.19
BRW19-HCW36	2/5/20	<0.01	<0.5	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.22B**	<0.19	<0.19
BRW19-HCW37	2/5/20	<0.01	<0.5	**6.1**	**4.4**	<0.19	**0.29**	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.21**	**0.32**	<0.19	**5.9**	**0.26**	<0.19
BRW19-HCW38	2/6/20	<0.01	<0.5	**7.1**	**4**	**0.24**	**0.2**	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.22**	<0.19	**11**	**0.19**	<0.19
BRW19-HCW39	2/5/20	<0.01	<0.5	**1.1**	**1.1**	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.62B**	<0.19	<0.19
BRW19-HCW40	1/28/20	<0.01	<0.5	**0.82**	**0.71**	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**1.8B**	<0.19	<0.19
BRW19-HCW41	1/28/20	<0.01	<0.5	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	**0.20B**	<0.19	<0.19
BRW19-HCW42	1/28/20	<0.01	<0.5	<0.2	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	**0.23B**	<0.20	<0.20

NE = Not Established

<X = Value less than detection limit (value in cell (X) is the detection limit)

Value greater than detection limits

Value Exceeds RBSL or Standard

Supercript values correspond to the Applicable RBSL Group that was exceeded. For Benzo(a)anthracene, the sample results are noted X$^{(2)}$, indicating the value X only exceeds the (2) DEQ-7 Human Health Standards - Surface Water.

B = The analyte was detected in the method blank

*The best achievable practical quantitation limit (0.1) is greater than the RBSL; therefore, if the compound is detected, additional evaluation may be necessary.

Table 7. EPH Analytical Results for BRW Groundwater Samples (µg/L)

Field Sample ID	Sample Date	C11 to C22 Aromatics	C9 to C18 Aliphatics	C19 to C36 Aliphatics	Total Extractable Hydrocarbons
(1) Tier 1 RBSL - Groundwater		**1,100**	**1,400**	**1,000**	**NA**
(2) DEQ-7 Human Health Standards - Surface Water		**NE**	**NE**	**NE**	**NE**
BRW18-PZ02	10/24/19	<300	<300	<300	<300
BRW18-PZ05	10/18/19	<300	<300	<300	<300
BRW18-PZ08	10/17/19	<300	<300	<300	<300
BRW18-PZ09	10/17/19	<300	<300	<300	<300
BRW18-PZ10	11/28/18	<300	<300	<300	<300
	10/21/19	<300	<300	<300	<300
BRW18-PZ11	11/29/18	<317	<317	<317	<317
	10/21/19	<300	<300	<300	<300
BRW18-PZ12	11/28/18	<300	<300	<300	<300
	10/21/19	<300	<300	<300	<300
BRW18-PZ13	11/28/18	<300	<300	<300	<300
	10/21/19	<300	<300	<300	<300
BRW18-PZ18	11/27/18	<300	<300	<300	<300
	10/25/19	<300	<300	<300	<300
BRW18-PZ19	11/27/18	<300	<300	<300	<300
	10/23/19	<300	<300	<300	<300
BRW18-PZ20	11/30/18	<300	<300	<300	<300
	10/25/19	<300	<300	<300	<300
BRW18-PZ21	12/5/18	<300	<300	<300	<300
	10/25/19	<300	<300	<300	<300
BRW18-PZ22	11/30/18	<300	<300	<300	<300
	10/25/19	<300	<300	<300	<300
BRW18-PZ23	11/27/18	<300	<300	<300	<300
	10/24/19	<300	<300	<300	<300
BRW18-PZ24	11/28/18	<300	<300	<300	<300
	10/24/19	<300	<300	<300	<300
BPS11-05A1	1/27/20	<300	<300	<300	<300
MW-01-MPC	10/23/19	<300	<300	<300	<300
	1/13/20	<300	<300	<300	<300
MW-02-MPC	10/23/19	<300	<300	<300	<300
	1/13/20	<300	<300	<300	<300
MW-03-MPC	10/23/19	<300	<300	<300	<300
	1/13/20	<300	<300	<300	<300
MW-03A-MPC	10/23/19	<300	<300	<300	<300
	1/13/20	<300	<300	<300	<300
BRW19-HCW30	2/4/20	<300	<300	<300	<300
BRW19-HCW31	1/28/20	<300	<300	<300	<300
BRW19-HCW32	1/20/20	<300	<300	<300	<300
BRW19-HCW33R	2/5/20	<300	<300	<300	<300
BRW19-HCW34	2/5/20	**169 J**	<300	<300	**252 J**
BRW19-HCW35	2/4/20	<300	<300	<300	<300
BRW19-HCW36	2/5/20	<300	<300	<300	<300
BRW19-HCW37	2/5/20	<300	<300	<300	**212 J**
BRW19-HCW38	2/6/20	<300	<300	<300	**208 J**
BRW19-HCW39	2/5/20	<300	<300	<300	<300
BRW19-HCW40	1/28/20	<300	<300	<300	<300
BRW19-HCW41	1/28/20	<300	<300	<300	<300
BRW19-HCW42	1/28/20	<300	<300	<300	<300

<X = Value less than detection limit (value in cell (X) is the detection limit)

NE = Not Established

Table 8. Preliminary Tier 2 Evaluation Results (mg/kg)

				VPH			PAH	EPH	
Field Sample ID	**Sample Interval (feet below ground level)**	**Applicable RBSL Group**	**Sample Date**	**Naphthalene**	**C9 to C10 Aromatics**	**C9 to C12 Aliphatics**	**1-Methylnaphthalene**	**C11 to C22 Aromatics**	**C9 to C18 Aliphatics**
(1) Leaching RBSL; 0-10 feet				**12**	**130**	**11000**	**2.1**	**370**	**53000**
(2) Leaching RBSL; 10-20 feet				**40**	**470**	**40000**	**7.1**	**1300**	**170000**
(3) Direct Contact; Construction				**140**	**1000**	**640**	**1400**	**3900**	**900**
Surface Soil Samples									
BRW18-SS04 (Depth to Water = 18.98 feet bgs)	0 - 0.17	(2) and (3)	10/26/18	DNE	DNE	DNE	DNE	**$2920^{(2)}$**	**$6150^{(3)}$**
BRW18-SS05 (Depth to Water = 12.65 feet bgs)	0 - 0.17	(3)	10/26/18	DNE	SSI	**1030**	DNE	SSI	**5600**
BRW18-SS06 (Depth to Water = 6.40 feet bgs)	0 - 0.17	(3)	10/26/18	DNE	DNE	DNE	DNE	SSI	DNE
BRW18-SS07 (Depth to Water = 7.98 feet bgs)	0 - 0.17	(3)	10/26/18	DNE	DNE	DNE	DNE	SSI	DNE
BRW18-SS06 (Depth to Water = 6.40 feet bgs)	0 - 0.17	(3)	10/26/18	DNE	DNE	DNE	DNE	SSI	DNE
BRW18-SS09 (Depth to Water = 7.34 feet bgs)	0 - 0.17	(3)	10/26/18	DNE	SSI	SSI	SSI	**10500**	**14900**
BRW18-SS10 (Depth to Water = 7.30 feet bgs)	0 - 0.08	(3)	10/26/18	DNE	SSI	DNE	SSI	**6390**	**10600**
Subsurface Soil Samples									
BRW18-BH11 (Depth to Water = 8.33 bgs)	15 - 17.1	(1) and (3)	10/11/18	DNE	**$320^{(1)}$**	**$681^{(3)}$**	**$3.8^{(1)}$**	**$513^{(1)}$**	**$2140^{(3)}$**
BRW18-PZ18 (Depth to Water = 7.76 feet bgs)	5.6 - 5.9	(3)	10/3/18	SSI	SSI	DNE	DNE	DNE	**1950**
BRW18-PZ21 (Depth to Water = 13.57 feet bgs)	10 - 12.5	(3)	10/6/18	DNE	SSI	DNE	DNE	DNE	**1780**
	12.5 - 15	(3)	10/4/18	DNE	DNE	DNE	DNE	DNE	**1010**
BRW19-HCTP32 (Depth to Water = 6.66 feet bgs)	4.0-4.3	(3)	1/16/2020	DNE	SSI	DNE	DNE	DNE	DNE
	5.5-9.0	(3)	1/16/2020	DNE	SSI	DNE	DNE	DNE	**1610**

Value greater than detection limits

Value Exceeds Applicable RBSL

Supercript values correspond to the Applicable RBSL Group that was exceeded. For BRW18-SS04, the C11 to C22 Aromatics sample result is noted $2920^{(2)}$, indicating the value 2920 was compared to RBSL group (2) and (3) but only exceeded the RBSL group (2).

Some or all soils in the interval are saturated or within 1 foot of the water table

The depth to water measurements for the boreholes and test pits were is the difference between high groundwater surface (Figure 9 from main BRW PDI Report) and either Light Detection and Ranging (LiDAR) sit data or Survey data at each field sample location. The depth to water measurements for the piezometers and hydrocarbon wells are recorded values from the field logs (Appendix B from main BRW PDI Report).

DNE = Does Not Exceed

SSI = Site-Specific Information

Cells containing SSI correspond to Tier 1 exceedances that are no longer a concern after considering site-specific information in the Tier 2 evaluation. These areas are within or close to the proposed removal corridor. These locations will be excavated, then screened to verify absence of petroleum compounds.