Summer 7-2022

Final Butte Reduction Works (BRW) Phase I Quality Assurance Project Plan (QAPP)

Pioneer Technical Services, Inc.

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

Final

Butte Reduction Works (BRW) Phase I
Quality Assurance Project Plan (QAPP)

Atlantic Richfield Company

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Prepared for:

Atlantic Richfield Company
317 Anaconda Road
Butte, Montana 59701

Prepared by:

Pioneer Technical Services, Inc.
1101 S. Montana Street
Butte, Montana 59701

July 2022

APPROVAL PAGE

Silver Bow Creek/Butte Area NPL Site
Butte Reduction Works Phase I
Quality Assurance Project Plan (QAPP)

Approved: ______________________________________ Date: ______________
Nikia Greene, Site Project Manager, EPA, Region 8

Approved: ______________________________________ Date: ______________
Daryl Reed, Project Officer, Montana DEQ

Approved: ______________________________________ Date: ______________
Josh Bryson, Operations Project Manager
Atlantic Richfield Company

Approved: ______________________________________ Date: ______________
David Gratson, Quality Assurance Manager
Environmental Standards, Inc.

Plan is effective on date of approval.

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Silver Bow Creek/Butte Area NPL Site
Butte Reduction Works Phase I
Quality Assurance Project Plan

Key Personnel QAPP Recipients	Title	Organization	Telephone Number	E-mail Address
Nikia Greene	Remedial Project Manager	EPA	(406) 457-5019	Nikia.Greene@epa.gov
Erin Agee	Legal Counsel	EPA	(303) 312-6374	Erin.Agee@epa.gov
Daryl Reed	State Project Officer	DEQ	(406) 444-6433	dreed@mt.gov
Jonathan Morgan	Legal Counsel	DEQ	(406) 444-6589	JMorgan3@mt.gov
Josh Bryson	Operations Project Manager	Atlantic Richfield	(406) 782-9964	josh.bryson@bp.com
Irene Montero	Senior Technologist – RET Lead	Atlantic Richfield	(713) 538-0875	terry.moore@bp.com
David Gratson	Atlantic Richfield Quality Assurance Manager	Environmental Standards	(505) 660-8521	dgratson@envstd.com
David Shanight	EPA Contractor	CDM Smith	(406) 441-1400	ShanightDT@cdmsmith.com
Eric Hassler	Superfund Program Manager	Butte Silver Bow	(406) 497-5042	ehassler@bsb.mt.gov
Julia Crain	Superfund Program Data Administrator/Quality Assurance Manager	Butte Silver Bow	(406) 497-6264	jcrain@bsb.mt.gov
Abigail Peltomaa	Manager, Data Management Division/Quality Assurance Officer	Butte-Silver Bow	(406) 497-5045	apeltomaa@bsb.mt.gov

Chad Anderson	Manager, Human Health/RMAP Division	Butte-Silver Bow	(406) 497-6278	canderson@bsb.mt.gov
Brandon Warner	Manager, Environmental Division	Butte-Silver Bow	(406) 497-5022	bwarner@bsb.mt.gov
Jeremy Grotbo	GIS Data Specialist	Butte-Silver Bow	(406) 497-6261	jgrotbo@bsb.mt.gov
Pat Sampson	Atlantic Richfield Contractor – Project Oversight	Pioneer Technical Services, Inc.	(406) 490-0706	psampson@pioneer-technical.com

For Information Only QAPP Recipients	Organization	E-mail Address		
Joe Vranka	EPA	vranka.joe@epa.gov		
Jean Martin	Atlantic Richfield	jean.martin@bp.com		
Brianne McClafferty	Holland & Hart	bcmcclafferty@hollandhart.com		
Mave Gasaway	Davis, Graham & Stubbs, LLP	Mave.Gasaway@dgslaw.com		
Patricia Gallery	Atlantic Richfield	patricia.gallery@bp.com		
Loren Burmeister	Atlantic Richfield	loren.burmeister@bp.com		
Irene Montero	Atlantic Richfield	irene.montero@bp.com		
Chris Greco	Atlantic Richfield	chris.greco@bp.com		
Dave Griffis	Atlantic Richfield	dave.griffis@bp.com		
Mike Mc Anulty	Atlantic Richfield	mcanumc@bp.com		
Curt Coover	CDM	CooverCA@cdmsmith.com		
James Freeman	DOJ	james.freemen2@usdoj.gov		
John Sither	DOJ	john.sither@usdoj.gov		
Dave Bowers	DEQ	dbowers@mt.gov		
Carolina Balliew	DEQ	carolina.balliew@mt.gov		
Matthew Dorrington	DEQ	matthew.dorrington@mt.gov		
Wil George	DEQ	william.george@mt.gov		
John Gilmour	Kelley Drye	jgilmour@kelleydrye.com		
Jim Ford	NRDP	jford@mt.gov		
Pat Cunneen	NRDP	pcunneen@mt.gov		
Harley Harris	NRDP	harleyharris@mt.gov		
Katherine Hausrath	NRDP	khausrath@mt.gov		
Meranda Flugge	NRDP	nrdp@mt.gov		
Ted Duaime	MBMG	TDuaime@mtech.edu		
Gary Icopini	MBMG	gicopini@mtech.edu		
Robert Bylsma	Union Pacific	rcbylsma@up.com		
Kristen Stevens	Union Pacific	kmsteven@up.com		

Leo Berry	BNSF	leo@bkbh.com
Robert Lowry	BNSF	rlowry@kelrun.com
Brooke Kuhl	BNSF	brooke.kuhl@bnsf.com
Lauren Knickrehm	BNSF	lauren.knickrehm@bnsf.com
Jeremie Maehr	Kennedy/Jenks	jeremiemaehr@kennedyjenks.com
Annika Silverman	Kennedy/Jenks	annikasilverman@kennedyjenks.com
Matthew Mavrinac	RARUS	Matthew.Mavrinac@patriotrail.com
Harrison Roughton	RARUS	harrison.roughton@patriotrail.com
Brad Gordon	RARUS	brad.gordon@patriotrail.com
Becky Summerville	MR	bsummerville@mtresourcesinc.com
Mark Neary	BSB	mneary@bsb.mt.gov
Jeremy Grotbo	BSB	jgrotbo@bsb.mt.gov
Eileen Joyce	BSB	ejoyce@bsb.mt.gov
Sean Peterson	BSB	speterson@bsb.mt.gov
Gordon Hart	BSB	gordonhart@paulhastings.com
Josh Vincent	WET	jvincent@waterenvtech.com
Craig Deeney	TREC	cdeeney@woodardcurran.com
Scott Bradshaw	TREC	sbradshaw@woodardcurran.com
Brad Archibald	Pioneer Technical Services, Inc.	barchibald@pioneer-technical.com
Joe McElroy	Pioneer Technical Services, Inc.	jmcelroy@pioneer-technical.com
Andy Dare	Pioneer Technical Services, Inc.	adare@pioneer-technical.com
Karen Helfrich	Pioneer Technical Services, Inc.	khelfrich@pioneer-technical.com
Leesla Jonart	Pioneer Technical Services, Inc.	ljonart@pioneer-technical.com
Randa Colling	Pioneer Technical Services, Inc.	rcolling@pioneer-technical.com

Ian Magruder	Citizen's Environmental Technical Committee	ianmagruder@wwcengineering.com
CTEC of Butte	Citizen's Environmental Technical Committee	BUTTECTEC@hotmail.com
Montana Tech Library	Montana Tech	Hard Copy Only
Mining Sharepoint	Atlantic Richfield	MiningSharePoint@bp.com

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ACRONYMS

Acronym	Definition	Acronym	Definition
ABA	Acid base accounting		
bgs	below ground surface	**NRDP**	Natural Resource Damage Program
BPSOU	Butte Priority Soils Operable Unit	OPM	Operations Project Manager
BRW	Butte Reduction Works	**ORP**	Oxidation reduction potential
BSB	Butte-Silver Bow	**PAH**	polycyclic aromatic hydrocarbons
CAR	corrective action report	**PARCC**	precision, accuracy, representativeness, comparability, and completeness
CD	Consent Decree	**PDF**	Portable Document Format
CFRSSI	Clark Fork River Superfund Site Investigation	**PDI**	Pre-Design Investigation
CLP	Contract Laboratory Program	**PID**	photoionization detector
COC	contaminant of concern	**PCB**	polychlorinated biphenyls
CPM	Contractor Project Manager	**PCP**	pentachlorophenol

Acronym	Definition	Acronym	Definition
DEQ	Department of Environmental Quality	**PDS**	Post digestion spikes
DI	deionized	**PPE**	personal protective equipment
DO	Dissolved oxygen	**PPM**	Parts per million
DQA	Data quality assessment	**PVC**	polyvinyl chloride
DQO	Data Quality Objective	**QA**	quality assurance
EDD	Electronic data deliverables	**QAM**	Quality Assurance Manager
Eh	redox potential	**QAO**	Quality Assurance Officer
EPA	Environmental Protection Agency	**QAPP**	Quality Assurance Project Plan
EPH	extractable petroleum hydrocarbon	**QC**	quality control
eV	electron volt	**RA**	Remedial action
FDS	Field data sheets	**RBSL**	Risk-Based Screening Level
GPS	global positioning system	**RCRA**	Resource Conservation and Recovery Act
ICP-OES	inductively coupled plasma optical emission spectrometry	**RD**	Remedial design
LAO	Lower Area One	**RPD**	Relative percent difference
LCS	Laboratory control sample	**SBC/BTC**	Silver Bow Creek/Blacktail Creek
LCSD	Laboratory control sample duplicate	**SC**	specific conductance
LMS	Laboratory matrix spike	**SOP**	standard operating procedure
LNAPL	light non-aqueous phase liquid	**SPLP**	Synthetic Precipitation Leaching Procedure
MASW	multichannel analysis of surface waves	**SSHASP**	Site-Specific Health and Safety Plan
MB	Method blank	**SRM**	standard reference material
mg/kg	milligrams per kilogram	**TEH**	total extractable hydrocarbon
mL	milliliter	**TOC**	total organic carbon
MP	measuring point	**USDA**	U.S. Department of Agriculture
MS	Matrix spike	**USCS**	Unified Soil Classification System
MSD	Matrix spike duplicate	**USGS**	U.S. Geological Survey
MSHA	Mine Safety and Health Administration	**VPH**	volatile petroleum hydrocarbon
NPL	National Priorities List	**XRF**	X-ray fluorescence

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1.0 INTRODUCTION

This site-specific Butte Reduction Works (BRW) Phase I Quality Assurance Project Plan (QAPP) (BRW Phase I QAPP) has been developed to provide the procedures and protocols necessary to collect and analyze data needed to refine the characterization of groundwater and solid materials within the BRW Phase I Site Investigation Area (BRW Site).

The BRW Site is located within Lower Area One (LAO) (Figure 1), which has a history of multiple industrial uses. As a result, there are accumulations of slag, tailings, demolition debris, and other impacted materials that may be a source of contaminants of concern (COCs) (i.e., arsenic, cadmium, copper, mercury, lead, and zinc) and additional constituents of concern (e.g., manganese, trace elements, hydrocarbons, etc.) to the underlying groundwater. Additional information is needed to refine the characterization of groundwater and solid materials within the BRW Site to guide remedy design and implementation.

For this BRW Phase I QAPP, the Data Quality Objective (DQO) process was completed according to the U.S. Environmental Protection Agency (EPA) *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006).

This BRW Phase I QAPP has been updated to reflect changes in the content and technical approach, as requested by Agencies, and to incorporate Request for Changes (RFC) BRW-2019-01 and BRW-2019-03. The procedures and protocols in this BRW Phase I QAPP have been updated to reflect any changes determined necessary to meet the DQOs (e.g., changes in sampling technique). The BRW Phase I QAPP has not been updated to reflect any changes in the locations or number of samples collected. Details regarding the actual number of samples collected and analyses completed are included in the BRW Pre-Design Investigation Evaluation Report.

1.1 Purpose

The BRW Site is located within LAO, to the immediate west of Montana Street between Silver Bow Creek (SBC) and the Burlington Northern Santa Fe (BNSF) railroad line (Figure 2). Limited prior investigations have confirmed that waste materials are present at the BRW Site; however, additional data are needed to guide the decision making for future response actions in the area. The primary purpose of this BRW Phase I QAPP is to provide the procedures and protocols necessary to collect the additional information to refine the characterization of groundwater and solid materials within the BRW Site and guide remedy design and implementation.

Additionally, the Hydrocarbon Investigation is necessary to attempt to identify the source(s) of the hydrocarbon-impacted material, determine if light non-aqueous phase liquid (LNAPL) exists on the Site, and further refine the nature and extent of dissolved hydrocarbons in groundwater and petroleum-impacted soil exceeding risk-based screening levels (RBSLs) (DEQ, 2018a).

It is anticipated that a subsequent investigation phase (i.e., Phase II) may be needed to provide design-level information to optimize the balance between any potential additional source removal outside the conceptual excavation footprint (Figure 3) and/or groundwater capture. For instance, a second phase of the project may include a pumping test to determine the potential effectiveness of a hydraulic control system and/or the impact of a particular waste source on SBC. The need and design of any additional investigations cannot be determined until the data evaluation and interpretation are completed for Phase I and the waste materials present at the BRW Site have been properly characterized. At that time, if additional investigations are required, specific DQO processes will be completed to identify the investigation goals and the data needed to accomplish those goals, and an addendum will be issued for Agency review that will include the details of the proposed investigation.

1.2 Objectives

The specific objectives under this BRW Phase I QAPP have been identified through the DQO process (EPA, 2006):

1. **Solid Materials:** Determine the distribution and/or properties of solid materials within the BRW Site including slag, demolition debris, tailings, remaining infrastructure, other material (including peat/alluvium) and associated metals, hydrocarbons, polychlorinated biphenyls (PCBs), and/or manganese concentrations and particularly those materials with leachable quantities of these constituents. These data will be used to improve the characterization of materials within the BRW Site and will be used to guide design and cleanup activities in the area.

   As stated in Section 1.1, the target of this investigation includes solid materials both within and outside the conceptual excavation footprint (Figure 3), as per the BRW Smelter Area fact sheet (EPA, 2018a) which states, "*The final depth and removal volume of the excavation would be determined during the design phase of the project*." The purpose of including materials outside the excavation footprint is to identify other potential source areas within the BRW Site to facilitate decision making for future response actions in the area, including design-level information to optimize the balance between any potential additional source removal outside the conceptual excavation footprint and groundwater capture.

2. **Groundwater:** Determine the direction of groundwater flow and spatial variability of groundwater chemistry within the alluvial aquifer at the BRW Site. These data will be used to improve the characterization of groundwater within the BRW Site and will be used to guide a subsequent Phase II hydrogeological investigation.

3. **Hydrocarbon Investigation:** Further refine the nature and extent of the hydrocarbon-impacted material. This will include investigating the presence of potential LNAPL within the BRW Site by installing strategically located wells that have screen sections straddling the groundwater table. Groundwater samples and soil samples will be collected to further define the nature and extent of hydrocarbon-impacted soil within the BRW Site and the hydrocarbon-impacted areas within the groundwater aquifer. Additional opportunistic soil and groundwater samples will be collected and analyzed for COCs to aid in achieving the first two objectives (i.e., solid materials and groundwater).

1.3 Site Description

The BRW Site covers approximately 24 acres and is located in Butte, Montana, to the immediate west of Montana Street between SBC and the BNSF railroad line (Figure 2). Historical operations within the BRW Site left behind a complex distribution of materials (including slag, tailings, manganese waste, demolition debris, foundations, and other historical structures) as well as impacted soil and groundwater (Section 2.1).

2.0 BACKGROUND

Details of the BRW Site, its history, and previous investigations are included in the *Butte Reduction Works (BRW) Smelter Area Mine Waste Remediation and Contaminated Groundwater Hydraulic Control Site Remedial Design Work Plan* (Atlantic Richfield Company, 2021a) and the corresponding Pre-Design Investigation (PDI) Work Plan included as an attachment to the remedial design work plan. These documents are working documents that will be updated as needed. Current summaries relevant to the BRW Phase I Site Investigation are included in the sections below.

2.1 Site History

The BRW Site has had multiple industrial operations resulting in a complex site history. Industrial operations at the BRW Site began in 1885 and continue to present day (GCM Services, Inc., 1991). A summary timeline of activities at the BRW Site is below.

- 1868 to 1900 (approximately): Silver mill and mine operations near Missoula Gulch disposed of mine and mill wastes into the gulch. The wastes flowed downhill onto the BRW Site and into SBC.
- 1883 (approximately) to 1910: The BRW was constructed and operated by the Butte Smelting Co., Butte Reduction Co., William A. Clark, and/or Colusa Parrot Mining & Smelting Co., producing copper and copper tailings on the BRW Site. A zinc concentrator was added in 1909. Additional waste from zinc mills and concentrators in Missoula Gulch was disposed in the gulch, flowing downhill onto the BRW Site and into SBC.
- 1910 to 1911: Atlantic Richfield Company's (Atlantic Richfield's) predecessor purchased the BRW Site in 1910 and shut down the copper smelter. The BRW Site was leased back to Clark, who continued to process zinc ore on the site until the zinc concentrator was destroyed in a fire in 1911.
- 1928 to 1945: Domestic Manganese & Development Company processed and stored manganese on the BRW Site. From 1943 to 1945, U.S. agencies constructed a flotation mill, produced manganese, disposed of manganese tailings, and stored manganese ore on the BRW Site.
- 1945 to 1992: U.S. agencies (General Services Administration, Department of Defense's Defense Logistics Agency) continued stockpiling manganese ore on the BRW Site.
- Early 1960s: Rocky Mountain Phosphates, Inc. Phosphate Plant was active.
- Mid-1990s to Date: Butte Silver Bow (BSB) operated an asphalt plant to late 2020. Currently, BSB uses the BRW Site to store materials.

Response activities at the BRW Site began with the removal of stockpiled manganese ore in 1992. Response activities on other land in the LAO area began in 1994 and continued until approximately 2014. Additional detail on the industrial operations and previous response activities is provided in the *Butte Reduction Works (BRW) Smelter Area Mine Waste Remediation and Contaminated Groundwater Hydraulic Control Site Remedial Design Work* Plan (Atlantic Richfield, 2021a) and the corresponding PDI Work Plan included as an attachment to the remedial design work plan.

2.2 Relevant Previous Investigations

A number of investigations have previously occurred at the BRW Site that are relevant to this BRW Phase I QAPP including the following:

1991 GCM Services, Inc. Cultural Resource Inventory (GCM Services, Inc., 1991).
In 1991, GCM Services, Inc. completed a cultural resource inventory within LAO (including the BRW Site) to locate, record, and evaluate the type and nature of the cultural resources (i.e., buildings, features, and artifacts). The cultural resource inventory included a basic literature and records review followed by a field investigation and survey of the project area in accordance with standard archaeological field techniques. The project area and all features were photographed, mapped, and evaluated. Of the features remaining on the BRW Site, the most relevant features identified appeared to be the foundation of the Domestic Manganese plant, the BRW furnace remains, the aqueduct, various structural foundations, and manganese ore stockpiles. However, most of the remaining features identified were not sufficiently intact or extensive enough to be matched with specific components of the original plants (GCM Services, Inc., 1991).

BRW Capture Effectiveness Monitoring Technical Memorandum (Atlantic Richfield Company, 2016).
The *BRW Capture Effectiveness Monitoring Technical Memorandum* (Atlantic Richfield Company, 2016) incorporated relevant investigations that occurred at the BRW Site including monitoring well installations, radon and thermal investigations, low flow sampling events, geo-forensics work, and evaluations of groundwater loading to surface water and groundwater capture by the BRW-00 pond. The relevant previous investigations that directly or indirectly contributed to the collective knowledge of the BRW Site include, but are not limited to:

- Field Inspection of the Abandoned Aqueduct (Atlantic Richfield Company, 2009a).
- Test Pitting Along the Abandoned Aqueduct (Atlantic Richfield Company, 2009b).
- Blue Seep Investigation (WET, 2010; TREC, 2011).
- 2012 Monitoring Well Construction Completion Report (Atlantic Richfield Company, 2011).
- Radon Thermal Technical Memorandum (Atlantic Richfield Company, 2012).
- 2012 Data Collection Effort (Atlantic Richfield Company, 2010).
- Gap Study (Atlantic Richfield Company, 2015).

Information from all these investigations, along with additional data collected from 2014 to 2016, was collectively used to determine the extent of effective groundwater capture in the BRW area and evaluate the connectedness of SBC to the aquifer located on the north and south side of the creek. Additionally, the report recommended future maintenance and monitoring to ensure that protectiveness of SBC is maintained. Figure 4 shows the locations of existing monitoring wells installed as part of previous investigations.

BRW Smelter Site Test Pit Report (NRDP, 2016a).

In 2016, Tetra Tech, Inc. conducted a test pit investigation and subsurface material sampling for the National Resource Damage Program (NRDP) within the BRW Site to characterize subsurface mine waste deposits, slag, impacted soil, and miscellaneous fill materials placed within the area.

Thirty test pits were excavated, screened, and sampled (Figure 5). Multiple samples were collected from each test pit and screened with a portable X-ray fluorescence (XRF) device for arsenic, cadmium, copper, lead, mercury, and zinc. Based on the screening results, distribution of the samples, and their respective material types, specific samples were selected for laboratory analysis for total acid extractable metals (total metals), nitrogen as nitrate, total phosphorous, total organic carbon (TOC), pH, soil conductivity, etc. Approximately 20% of the samples submitted for total metals analysis were also analyzed for Synthetic Precipitation Leaching Procedure (SPLP) and acid base accounting (ABA) analysis.

Soil sample results were compared to Streamside Tailings Operable Unit field screening criteria. Soil samples exceeded the Streamside Tailings Operable Unit screening criteria for arsenic, cadmium, copper, lead, mercury, and zinc. The SPLP leachate results were compared to Montana Department of Environmental Quality (DEQ) Circular DEQ-7 standards for groundwater. The SPLP leachate results exceeded the DEQ-7 standards for arsenic, lead, and zinc. The presence of hydrocarbons was detected using a flame ionization detector in 6 test pits. Field technicians observed a hydrocarbon sheen on the groundwater surface in 4 test pits and an LNAPL layer on the groundwater surface in 1 test pit (Figure 6).

Figures and tables with results, photographic logs, field sampling notes, and laboratory reports are included in the appendices of the *BRW Smelter Site Draft Test Pit Report* (NRDP, 2016a).

2016 Data Gap Site Investigation – Silver Bow Creek and Blacktail Creek Corridors (NRDP, 2016b).

In 2016, NRDP conducted an investigation of soil, sediment, surface water, groundwater, and pore water along Blacktail Creek (BTC) and SBC corridors. Out of the 53 pore water samples, the investigation noted elevated pore water concentrations for arsenic, cadmium, copper, and zinc within and just downstream of the slag canyon reach. Figures and tables with results, photographic logs, field sampling notes, and laboratory reports are included in the appendices of the *Data Gap Investigation – Silver Bow Creek and Blacktail Creek Corridors Memorandum* (NRDP, 2016b).

2017 Groundwater and Surface Water Interaction Report (EPA, 2017a).

In 2016, EPA conducted a pore water investigation along both banks of BTC and SBC from just upstream of the confluence with Grove Gulch to just downstream of SS-05B along SBC to determine the following objectives:

1. *Is groundwater discharging or potentially discharging into SBC/BTC (Silver Bow Creek/Blacktail Creek)?*
2. *Is discharging pore water similar in composition to nearby groundwater?*
3. *Is surface water being impacted by local contaminated sediments?*

As part of the investigation, EPA collected pore water samples along the left and right banks, finding that pore water concentrations for copper and zinc were elevated on both banks through the slag canyon and downstream of the BRW Site. The location of the source for this impacted pore water was also evaluated using a weight-of-evidence approach for being a local or distant source; the analysis concluded that the source(s) of impacted pore water was local.

The *Groundwater and Surface Water Interaction Report* (EPA, 2017a) includes figures and tables with results.

2.3 Remaining Durable Historical Infrastructure

Most of the durable historical infrastructure at the BRW Site was removed after the industrial operations were discontinued. However, some infrastructure items were not demolished and remain, or potentially remain, at the BRW Site. It is important to identify the location of the infrastructure items because they could create challenges and add costs to the future construction plans for the BRW Site. An assessment of the infrastructure remaining from the industrial operations within the BRW Site came from reviewing a variety of sources including the following:

- Historical reports/records.
- Historical and present-day aerial imagery and Light Detection and Ranging (LiDAR) contours.
- Previous site investigations.

A summary of remaining historical infrastructure is provided in Table 1. Sanborn Insurance Company maps from 1900, 1914, and 1953 along with other historical records (Wethey, 1909) were used to show the configuration of the BRW and Domestic Manganese structures shown on Figure 7 and Figure 8. On Figure 7, 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. On Figure 8, two subsurface flumes/culverts are shown that may potentially be intact.

To further confirm the existence of durable infrastructure, test pits will be placed in areas where there is uncertainty as to whether durable infrastructure still exists (Figure 7).

Subsurface Flumes/Culverts

The potential presence of a conduit that could feed impacted groundwater into the redesigned SBC channel or affect groundwater flow is a concern. Based on historical records, two subsurface flumes/culverts were identified that could potentially be intact. Figure 8 shows the approximate alignment of the two subsurface flumes/culverts. However, different maps show these flumes/culverts in different locations. To further confirm the existence of these flumes/culverts, a geophysical Multichannel Analysis of Surface Waves (MASW) seismic survey will be completed along the proposed transects shown on Figure 8.

Domestic Manganese Stockpiles

The Domestic Manganese operations generated numerous stockpiles of manganese-rich materials as shown on Figure 9. Some remnants of these stockpiles may have been left behind, which could provide a source of manganese at the BRW Site. Test pits previously excavated by Tetra Tech (Natural Resource Damage Program, 2016) appear to provide a fairly comprehensive coverage of the stockpile locations (Figure 9). One additional test pit (BRW18-TP04) will be placed to specifically sample for manganese. In addition, analysis of manganese will be conducted at all other boreholes and test pits except those test pits with the sole purpose of identifying historical infrastructure to refine the extent of manganese concentrations.

2.4 BRW Remedial Action

The BRW Remedial Action (RA) includes removing tailings, waste, COC-impacted soil, and slag within the SBC 100-year floodplain reconstruction area to a depth to be determined during the remedial design (RD) activities. The conceptual RD will include the following additional elements:

- Removing waste (as defined by the Butte Priority Soils Operable Unit Consent Decree [BPSOU CD] Waste Identification Screening Criteria [EPA, 2020]) from the designated and approved 275-foot average width removal corridor (referred to herein as the waste removal corridor).
- Managing soil and groundwater within the BRW Site impacted by organic pollutants as appropriate and in a manner that is complementary with the remedy. Organic pollutants (petroleum compounds, PCB, pentachlorophenol [PCP], and dioxins) are secondary concerns for the BRW Site. Soil and groundwater within the BRW Site have been impacted by these pollutants above; therefore, site-specific action levels will be properly addressed/managed as part of the RA. 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 (EPA, 2020).
- Realigning SBC and constructing the bank-full channel and 100-year floodplain within the 275-foot average width waste removal corridor.
- Regrading and constructing caps over the waste left in place (e.g., tailings, slag, and impacted soil). Some slag walls will remain exposed on the BRW Site for cultural and historical preservation.
- Hydraulically managing COC-impacted groundwater from the BRW Site to control discharge of COC-impacted groundwater to surface water and sediment in the BPSOU generally, and within the BRW Site specifically.

2.5 Data Quality Objectives and Criteria

The U.S. Environmental Protection Agency (EPA) DQO process (EPA, 2006) is used to establish performance or acceptance criteria that serve as the basis for designing a plan to collect data of sufficient quality and quantity to support the goals of a study. Each step of the DQO process defines criteria that will be used to establish the final data collection designs. This QAPP follows the EPA process to develop criteria for each site. The process consists of seven steps as follows:

Step 1: State the Problem.
Step 2: Identify the Goals of the Study.
Step 3: Identify Information Inputs.
Step 4: Define the Boundaries of the Study.
Step 5: Develop the Analytical Approach.
Step 6: Specify Performance and Acceptance Criteria.
Step 7: Develop the Plan for Obtaining Data.

2.5.1 Initial Phase I Site Investigation (Stage 1) and Additional Groundwater Sampling (Stage 2)

This DQO process was followed to define the data collection effort and the levels of confidence necessary to guide future activities in the area. Appendix 1 includes the analytical test methods and sampling efforts that will follow standard operating procedures (SOPs) in Appendix 2. The following DQO steps will be used to guide the data collection and analyses activities for Stage 1 and Stage 2 of the BRW Phase I Site Investigation:

Step 1: State the Problem
The purpose of this step is to describe the problem to be studied so that the focus of the investigation will not be ambiguous.

The BRW Site is located within LAO (Figure 1), which has a history of multiple industrial uses. As a result, there are accumulations of slag, tailings, demolition debris, and other impacted materials that may be a source of COCs (i.e., arsenic, cadmium, copper, mercury, lead, and zinc) and additional constituents of concern (e.g., manganese, trace elements, hydrocarbons, etc.) to the underlying groundwater.

The BRW Site has been characterized to some degree by previous investigations (Section 2.2); however, finer detail is needed to guide future activities at the site. The primary need of the study is to refine the characterization of groundwater and solid materials within the BRW Site and particularly the leachable component from solid materials, while guiding remedy design and implementation.

Step 2: Identify the Goals of the Study
This step identifies the principal question the study will attempt to resolve and what actions may result.

The principal study question has two primary components related to solid materials and groundwater as follows:

- Principal Question 1: What are the distribution and/or properties of solid materials and the chemical stability/leachability of these solid materials within the BRW Site?
- Principal Question 2: What is the direction of flow and chemical variability of groundwater within the alluvial aquifer at the BRW Site?

Principal Question 1 will be answered by documenting the lithology of and collecting samples from boreholes and test pits. The lithological logs and sample results will be used to estimate the distribution and/or properties of slag, demolition debris, tailings, remaining infrastructure, and other material (including peat/alluvium) and associated metals, hydrocarbons, PCBs, and/or manganese concentrations within the BRW Site, and particularly those materials with leachable quantities of these constituents. These data will be used to improve the characterization of materials within the BRW Site and will be used to answer future design questions.

Principal Question 2 will be answered by installing piezometers throughout the BRW Site to continuously measure water elevations and collect groundwater samples. The water elevations and groundwater samples will be used to estimate the direction of groundwater flow and spatial variability of groundwater chemistry within the BRW Site. These data will be used to improve the characterization of groundwater within the BRW Site and will be used to guide a subsequent Phase II hydrogeological investigation.

Step 3: Identify Information Inputs
The purpose of this step is to identify the informational variables that will be required to answer the principal study questions and determine which variables require environmental measurements.

Data from original design documents, previous investigations (Section 2.2), relevant guidance documents, and the data collected as part of Stage 1 and Stage 2 will be used to refine the characterization of groundwater and solid materials within the BRW Site to guide the remedy design and implementation. Data for the Initial BRW Site Investigation will be collected using the following methods:

1. **Test Pits:** The data below will be collected from excavated test pits to estimate the distribution and/or properties of solid materials at the BRW Site.
    - Location and depth of remaining historical infrastructure.
    - Location coordinates for all test pits.
    - Depth and thickness of solid materials.
    - Presence of hydrocarbons will be detected through visual screening (sight and/or smell) and with a photoionization detector (PID).

- Metals analysis via XRF for specified analytes (Table 2 and Table 3). The metals analysis will be used to refine estimates of total metals mass within the BRW Site. These results will also inform the selection of samples to be sent to the laboratory for SPLP analysis.
- Estimate of nitrate concentration from select materials via a soil nitrate test to help inform the selection of samples to be sent to the laboratory for SPLP analysis (see Step 5 of the DQO process in this section).
- Laboratory analyses and validation (i.e., Level 4 data validation) for analytes specified below depending on the type and thickness of solid material encountered (Table 2 and Table 3).
    - General parameters (pH and specific conductance [SC]) will be conducted for all laboratory analyses.
    - Metals analyses via inductively coupled plasma optical emission spectrometry (ICP-OES) will be conducted for each major material horizon that is greater than 2 feet in thickness. The metals analysis will be used to refine estimates of total metals mass within the BRW Site. Additional samples for minor material horizons (i.e., less than or greater than 2 feet in thickness) may be taken at the discretion of field personnel.
    - Volatile petroleum hydrocarbon (VPH) and extractable petroleum hydrocarbon (EPH) fractionation with polycyclic aromatic hydrocarbons (PAH) analyses will be conducted to identify if hydrocarbon concentrations exist within the BRW Site at levels above current applicable standards (DEQ, 2018a). In addition to VPH and EPH analyses, the samples will also be submitted to Torkelson Geochemistry, Inc. (Torkelson Geochemistry) for hydrocarbon ranges and Pristane/Phytane Ratio analysis to determine the type and relative age of petroleum hydrocarbons encountered.
    - Asbestos analyses will be conducted to identify any demolition debris with potential asbestos.
- SPLP analyses for up to 4 discrete samples (1 from demolition debris and up to 3 from other material, not including slag, tailings, or peat/alluvium materials) based on XRF analysis and soil nitrate test results detailed in Step 5. The SPLP results will provide data that will be used to estimate chemical stability/leachability of the solid materials.

2. **Boreholes:** The data below will be collected from boreholes to estimate the distribution and/or properties of solid materials at the BRW Site.
    - Location and depth of remaining historical infrastructure.
    - Depth and thickness of solid materials.
    - Location coordinates for all boreholes.
    - Presence of hydrocarbons will be detected through visual screening (sight and/or smell) and/or with a PID.
    - Metals analyses via XRF for specified analytes depending on the type and thickness of solid material encountered (Table 2 and Table 3). The XRF analyses will be

conducted for each minor material horizon that is less than 2 feet in thickness at the discretion of field personnel. The metals analysis will be used to refine estimates of total metals mass within the BRW Site. These results will also inform the selection of samples to be sent to the laboratory for SPLP analysis detailed in Step 5.

- Estimate of nitrate concentration from select materials via a soil nitrate test to help inform the selection of samples to be sent to the laboratory for SPLP analysis.
- Laboratory analyses and validation (i.e., Level 4 data validation) for analytes specified below depending on the type and thickness of solid material encountered (Table 2 and Table 3).
    - General parameters (pH and SC) will be conducted for all laboratory analyses.
    - Metals analyses via ICP-OES will be conducted for each major material horizon that is greater than 2 feet in thickness. The metals analysis will be used to refine estimates of total metals mass within the BRW Site. These results will also inform the selection of samples to be sent to the laboratory for SPLP analysis as detailed in Step 5. Additional samples for minor material horizons (i.e., less than or greater than 2 feet in thickness) may be taken at the discretion of field personnel.
    - VPH and EPH fractionation with PAH analyses will be conducted to identify if hydrocarbons exist within the BRW Site at levels above current applicable standards (DEQ, 2018a). In addition to VPH and EPH analyses, the samples will also be submitted to Torkelson Geochemistry for hydrocarbon ranges and Pristane/Phytane Ratio analysis to determine the type and relative age of petroleum hydrocarbons encountered.
    - PCB analyses will be conducted to evaluate historical transformer locations for signs of notable PCB spillage.
- SPLP analyses for up to 10 discrete samples from each type of solid material (i.e., slag, demolition debris, tailings, peat/alluvium, and other material encountered) based on metals analyses and soil nitrate test results as detailed in Step 5. The SPLP results will provide data that will be used to estimate chemical stability/leachability of the solid materials.

3. **Piezometers:** The following data will be collected from piezometers to estimate the direction of groundwater flow and spatial variability of groundwater chemistry within the alluvial aquifer at the BRW Site:

4. Laboratory analyses and validation (i.e., Level 4 data validation) for specified analytes depending on the location (Table 2 and Table 3).
    - Field measurements of pH, SC, dissolved oxygen (DO), oxidation-reduction potential (ORP), temperature, turbidity, and depth-to-groundwater.
    - Descriptive data about the samples (e.g., color, visual presence of waste, etc.).
    - Location coordinates for all sampling locations.
    - Continuous groundwater elevation and temperature from transducers.

5. **Hydrocarbon Screening:** At the discretion of the field personnel, samples will be collected from any additional areas where surface soil appears to contain hydrocarbons (via sight and/or smell or detection with a PID) and analyzed for VPH and EPH fractionation with PAHs. In addition to the VPH and EPH analyses, the samples will also be submitted to Torkelson Geochemistry for hydrocarbon ranges and Pristane/Phytane Ratio analysis to determine the type and relative age of petroleum hydrocarbons encountered.

6. **Seismic Survey:** To determine the location and depth of the BTC Flume and other subsurface flumes/culverts.

7. **Quantification of Existing Durable Historical Infrastructure:** Measurements and photographs will be taken to document existing durable historical infrastructure.

8. **Additional Groundwater Sampling:** Additional groundwater sampling is necessary to collect additional analytical data to guide remedy design and implementation.

Data for Step 3 will be obtained from sampling as detailed in the following sections. The sampling procedures outlined in the QAPP follow the applicable SOPs developed by Pioneer Technical Services, Inc. (Pioneer) (Appendix 2), which adhere to or expand upon the *Clark Fork River Superfund Site Investigation* (CFRSSI) *Standard Operating Procedures* (ARCO, 1992a). Specific parameters, laboratory methods, holding times, and sample preservation requirements are provided in Table 2 and Table 3.

Step 4: Define the Study Boundaries

The purpose of this step is to define the spatial and temporal boundaries of the problem.

The study area is contained within the BRW Site shown on Figure 2. Boreholes will extend to a depth of approximately 5 feet below the peat or waste layer as determined by field lithologic logs and/or field XRF analyses. Piezometers will be drilled to bedrock with lithology logged for the entire borehole; however, piezometers will be screened in the uppermost layer of conductive alluvium as determined by field lithology logs. At the discretion of field personnel, samples will be collected at each visually observed lithological layer from each borehole and test pit. Groundwater will be collected from each piezometer.

The target of this investigation includes solid materials both within and outside the conceptual excavation footprint (Figure 3) and below the prescribed excavation depth provided in the BRW Smelter Area fact sheet (EPA, 2018a). The purpose of including materials outside the excavation footprint is to identify other potential source areas within the BRW Site to facilitate decision making for future response actions in the area, including design level information to optimize the balance between any potential additional source removal outside the conceptual excavation footprint and groundwater capture.

Field work will be performed as weather conditions permit. Potential constraints that could delay fieldwork include adverse weather conditions, staffing challenges, contractor availability, coordination with land managers/users, challenges with drilling and test pitting caused by site conditions, or other unforeseen issues. Major project delays resulting from these constraints will be recorded in the field logbooks and reported to the Agencies.

Step 5: Develop the Analytical Approach
The purpose of this step is to define the parameters of interest, specify action levels, and integrate any previous DQO inputs into a single statement.

This step develops an approach that guides how data are interpreted and how conclusions are drawn from the data. The approach in this section corresponds with the information inputs defined in Step 3.

Identification of Leachable Metals Analyses: The identification of notable sources of COCs to groundwater (i.e., with elevated leachable metals) is a primary component to this sampling effort. Because the location of notable sources of COCs to groundwater will shape the design of any additional groundwater remedy, this investigation includes an evaluation that will help quantify potential sources of COCs and identify notable sources of COCs to groundwater. The primary methodology for quantifying a source to groundwater is through SPLP analysis.

In evaluating existing, co-located total metals and SPLP analyses, it is noted that correlation of total copper to leachable copper from SPLP analyses is relatively poor (i.e., r^2 value of ~0.13). It is unknown why this relationship is poor; however, selecting SPLP samples based on total metals concentrations appears to be a poor approach in identifying notable sources of COCs to groundwater. Using available data, it was determined that elevated leachable copper concentrations correlated well with elevated lead concentrations (i.e., r^2 value of 0.59) and non-detect nitrates (i.e., r^2 value of 0.44). While not perfect, it is anticipated that this additional screening step will assist in improving the selection of SPLP samples for laboratory analyses that have high concentrations of leachable copper.

Also based on available data for 1 alluvial SPLP test, the results showed total copper concentration was very low (397 milligram per kilogram [mg/kg]), however the leachable SPLP copper was the 4th highest at 220 micrograms per liter (µg/L), providing the highest recorded soil-water partitional coefficient (K_d) at the BRW Site. Because this sample also had elevated concentrations of total chromium and iron, these 2 analytes will be used as indicators of similar deposits of elevated leachable copper to determine the potential extent of this source.

The initial metals analyses (ICP-OES and XRF) for lead, chromium, copper, iron, and soil nitrate test results will be used to determine which samples will be sent for SPLP analysis (Section 3.10).

Step 6: Specify Performance and Acceptance Criteria
The purpose of this step is to specify the decision maker's tolerable limits on decision errors, which are used to establish performance goals for the data collection design.

There are limitations in evaluating data over a given area and the inherent variability of the matrix being sampled. Measurement error occurs from the inherent variability in the collection, preparation, and analysis of an environmental sample. Sampling design and measurement errors will be minimized by following the procedures outlined in the QAPP and the SOPs in Appendix 2.

All data gathered during Stage 1 and Stage 2 will be checked to ensure they are usable for their intended purposes. Specific data validation processes that will be followed to ensure analytical results are within acceptable limits are detailed in Section 9.0. The data validation process will include an evaluation of analytical control limits and the precision, accuracy, representativeness, comparability, and completeness parameters (PARCCs). Acceptance criteria for analytical data are detailed in Section 4.0. If significant issues with the data are found, results will be discussed with EPA.

Step 7: Develop the Plan for Obtaining Data.
The purpose of this step is to identify a resource-effective data collection design to generate data that satisfies the DQOs.

The QAPP is designed to ensure that the data will be of sufficient quality and quantity to answer the principal study questions outlined in Step 2 and to inform future activities in the area. This QAPP provides the detailed descriptions of the field work to be completed.

2.5.2 Hydrocarbon Investigation (Stage 3)

The DQOs were developed for the Initial Site Investigation (Stage 1) according to the EPA Guidance on Systematic Planning Using the Data Quality Objectives Process (EPA, 2006) under the decision-making process. For the Hydrocarbon Investigation, the existing Phase I DQOs apply, and portions will be repeated in this section along with any notable changes. The following steps come from the EPA DQO guidance document.

Step 1: State the Problem
The purpose of this step is to describe the problem to be studied so that the focus of the investigation will not be ambiguous.

The BRW Site aquifer was characterized to some degree during past investigations; however, more information is needed to determine the nature and extent of petroleum hydrocarbon-impacted material within the Site. The Hydrocarbon Investigation is required to characterize groundwater quality including petroleum hydrocarbon concentrations. The Hydrocarbon Investigation will continue to collect data to further define the nature and extents of COCs within the BRW Site, which will aid in the design of the BRW hydraulic control and assist in determining the appropriate waste removal depth for the RA.

A pumping test and construction dewatering will be required as part of the RD, and one of the unknown effects of these activities is whether they will result in expanding the impacts of existing hydrocarbons horizontally and/or vertically (e.g., the pumping test may cause on-site hydrocarbons to migrate within the Site) or if an increase in water flow will improve conditions for aerobic biodegradation of hydrocarbons. The previous investigations determined that surface and subsurface soil and groundwater contain hydrocarbons. However, the purpose of Stage 1 and Stage 2 was not to determine the source of hydrocarbons, the extent of the areas within the groundwater aquifer that have been impacted with hydrocarbons, or the extent of the impacted soil within the Site. The main purpose of the Hydrocarbon Investigation is to map the hydrocarbon-impacted groundwater and soil and gather sufficient data to help the Phase II efforts determine a location for the pumping test well that will not result in the potential migration of hydrocarbons away from the present areas with LNAPL (if any).

Step 2: Identify the Goals of the Study

This step identifies the principal questions that the study will attempt to resolve and what actions may result.

The key questions for the Hydrocarbon Investigation are as follows:

Hydrocarbon Investigation:

- What are the probable sources of the hydrocarbons impacting the soil and groundwater?
- Does the BRW Site have LNAPL and if so, what is the extent of the LNAPL?
- What are the lateral and vertical extents of the areas within the groundwater aquifer that have been impacted with hydrocarbons?
- What is the lateral and vertical extent of hydrocarbon-impacted soil exceeding Montana's RBSLs?
- What are the concentrations and contaminant components of the hydrocarbon-impacted soil and groundwater?

The above questions will be answered by installing 13 hydrocarbon monitoring wells and constructing 3 test pits, with the option for field personnel to install additional hydrocarbon monitoring wells and test pits at their discretion based on field observations (Figure 10). Field personnel will document lithology and the presence of hydrocarbons in the soil and groundwater and collect soil samples from the boreholes and test pits, as necessary. Soil samples will be submitted for the analyses outlined in Table 2 and Table 3. Any field observations of hydrocarbons will be confirmed with analytical test results on selected samples as noted in Table 2 and Table 3. After installation, the groundwater in the hydrocarbon monitoring wells, four wells located on the NorthWestern Energy site and one existing well on the eastern edge of the BRW Site (BPS11-05A1 [Figure 10]), will be sampled for LNAPL and tested for hydrocarbons as described in Table 2 and Table 3. Depending on field conditions, additional wells may be sampled for additional water quality data (at discretion of the Field Team Leader [FTL], Contractor Project Manager [CPM], or Contractor Quality Assurance Officer [QAO]). Based on the results of those tests, Atlantic Richfield may conduct additional sampling. The documented occurrence and analytical sample results will be used to estimate the distribution, source, and/or properties of hydrocarbons within the BRW Site. These data will be collected to help the Phase II efforts determine a location for the pumping test well that will not result in the potential migration of hydrocarbons away from the present areas with LNAPL (if detected). These data will also be used to answer future design questions related to the management of hydrocarbons on the BRW Site.

In addition to the main questions listed above, the Hydrocarbon Investigation will also include documenting the lithology for each borehole and test pit along with collecting opportunistic soil and groundwater samples to help further refine the distribution and/or properties of solid materials and groundwater chemistry within the BRW Site. These data will be used to improve the characterization of materials within the BRW Site and to answer future design questions specifically related to the BRW hydraulic control.

The key questions for the Hydrocarbon Investigation will follow the DQOs that were included in Stage 1 and Stage 2, which were developed to guide aspects of environmental field sampling, data collection, and laboratory analytical activities.

Step 3: Identify Information Inputs

The purpose of this step is to identify the informational variables that will be required to answer the principal study questions and determine which variables require environmental measurements.

The following information is required to satisfy or produce the estimates that will be used to answer the goals of the study (Step 2 of the DQO process). The data listed below will be collected during installation of hydrocarbon monitoring wells and test pits to determine the extent of the hydrocarbon-impacted soil. The groundwater will be sampled for the presence of hydrocarbons after installation of the monitoring wells. Opportunistic soil and groundwater samples will be collected for metals analysis. These data will be used with data collected under future site investigations to further define the appropriate waste removal depth and to use in the design of the BRW hydraulic control. Table 2 and Table 3 list the sampling requirements for each location.

- Historical records that describe the BRW Site and neighboring sites' usage and possible sources of hydrocarbons impacting the Site.
- Survey-grade Global Positioning System (GPS) location coordinates and measuring point elevations for each hydrocarbon monitoring well.
- Survey-grade GPS location coordinates for each test pit.

Soil Sampling:

- Depth and thickness of solid materials.
- Descriptive data about the samples (e.g., color, visual and olfactory presence of hydrocarbons, etc.).
- Presence of hydrocarbons. The presence will be detected in the soil through visual screening (sight and/or smell) and with two types of PIDs. All visual and olfactory observations of suspected hydrocarbons will be confirmed with a PID prior to collecting a sample.
    - For locations where the presence of hydrocarbons is confirmed with one or both PID instruments, VPH, EPH fractionation with PAH, and lead scavengers analyses will be conducted to identify if hydrocarbon concentrations exist within the BRW Site at levels above current applicable standards.

- When possible, a soil sample will be collected near the top of the saturated layer for VPH, EPH fractionation with PAH, and lead scavengers analyses for all locations.
  - Hydrocarbon analyses will not be conducted at locations that are paired with deeper Initial Phase I Site Investigation (Stage 1) points if that location was previously sampled for hydrocarbons.
- Lithological layer samples. In addition to hydrocarbon screening, samples will be collected from each lithological layer to be analyzed either in the field or in the laboratory. Level 4 data validation will be completed for samples submitted to the laboratory. The data will be used with data collected under future site investigations to help define the nature and extent of impacted materials within the BRW Site.
  - For all soil intervals, samples from the borings will be field screened for metals analysis for specified analytes depending on the boring location (Table 2 and Table 3) using XRF.
  - Laboratory analyses for the metal analytes will depend on the location (Table 2 and Table 3). Based on the XRF analyses, a confirmation sample will be collected from the first lithological layer in each boring or test pit that passes the Waste Identification Screening Criteria (EPA, 2018b) and submitted for laboratory analysis. Samples will be analyzed and validated as follows:
    - General parameters (pH and SC) will be conducted for all laboratory analyses.
    - Metals analyses for specified analytes via ICP-OES will be conducted to refine the depth of waste, as per the Waste Identification Screening Criteria (EPA, 2018b).
    - Metals analysis will not be conducted at locations immediately adjacent to the deeper paired investigation points from the Phase I Site Investigation.

Groundwater Sampling:

- Field measurements of pH, SC, DO, ORP, temperature, turbidity, and depth-to-groundwater will be collected.
  - Following the manufacturer's instructions, the ORP probe will be cleaned between wells to remove any hydrocarbons that may interfere with the readings.
- Groundwater elevation and presence of LNAPL in groundwater will be detected with an interface probe.
  - For locations with sufficient thickness of LNAPL to determine LNAPL transmissivity, baildown tests will be conducted (Section 3.4.7) and a sample of LNAPL will be collected and submitted for laboratory analysis (Table 3).
- Groundwater samples will be collected and analyzed for the following:
  - Hydrocarbons in all hydrocarbon monitoring wells and select existing monitoring wells (Figure 10). Table 2 lists which wells will be sampled for hydrocarbons, and Table 3 details the analyses.
  - Other analytes as outlined in Table 2 and Table 3.
  - All laboratory results will go through a Level 4 validation.

Step 4: Define the Boundaries

The purpose of this step is to define the spatial and temporal boundaries of the study.

The spatial boundary of the study area is primarily the BRW Site as shown on Figure 2. Thirteen hydrocarbon monitoring wells will be installed near locations where hydrocarbons have been observed in the groundwater and soil (Figure 10). Figure 11 shows the locations of those piezometers, boreholes, and test pits that contained detectible amounts of hydrocarbons from previous BRW Site investigations. Seven hydrocarbon monitoring wells will be paired with existing piezometers. Paired wells will be drilled to a depth necessary to install the hydrocarbon monitoring well. Unpaired wells will be drilled to bedrock to collect soil samples which will be used to further define the appropriate waste removal depth of impacted aquifer materials and to supplement the data needed to design the BRW hydraulic control. The wells will be installed so the screen extends 5 feet above and 10 feet below the groundwater table, or as determined by field personnel. To aid in determining the appropriate screen depth, field personnel will have a groundwater contour map that includes the approximate elevation and depth below ground surface (bgs) for groundwater at that location. This map will help field personnel anticipate the depth interval at which the piezometer screen may best detect the presence of potential LNAPL.

Soil samples will be collected from the core of unpaired wells during drilling and tested for hydrocarbons and metals (Table 2 and Table 3).

Once the wells have been installed and developed, groundwater samples will be collected and tested for hydrocarbons and metals (Table 2 and Table 3). Based on the laboratory results, Atlantic Richfield may take additional samples.

Three test pits will be placed to the northeast of borehole BRW18-BH11 to further define the extent of the hydrocarbons in the subsurface soil (Figure 10). Soil samples will be collected from each test pit and tested for hydrocarbons and metals (Table 2 and Table 3). Construction and testing methods and procedures for the test pits will follow those laid out in the sections below.

Groundwater samples will also be taken from 5 existing monitoring wells (i.e., BPS11-05A1) located on the eastern side of the BRW Site and MW-01-MPC, MW-02-MPC, MW-03MPC, and MW-03A-MPC on the NorthWestern Energy property to the south of the Site) and tested as specified in Table 2 and Table 3. Figure 10 shows the locations of the wells. These wells will be tested to determine if a source(s) of hydrocarbon-impacted groundwater is located upgradient of the BRW Site. Based on the laboratory results, Atlantic Richfield may collect additional samples.

A records review of petroleum-based spills in the area will be completed. This review will encompass the physical boundaries of the BRW Site (Figure 2) as well as neighboring sites where activities could have contributed to the hydrocarbon-impacted material.

Schedule:

Fieldwork will begin once Agency approval has been received and is anticipated to take approximately 8 weeks. Work will be performed as weather conditions permit. Potential constraints that could delay fieldwork include adverse weather conditions, contractor availability, coordination with land managers/users, challenges with drilling caused by BRW Site conditions, or other unforeseen issues. Major project delays resulting from these constraints (i.e., greater than 5 days) will be recorded in the field logbooks and reported to the Agencies.

Step 5: Develop the Analytical Approach

The purpose of this step is to define the parameters of interest, specify action levels, and integrate any previous DQO inputs into a single statement. This step develops an approach that guides how data are interpreted and how conclusions are drawn from the data. The approach in this section corresponds with the information inputs defined in Step 3.

During the Hydrocarbon Investigation, 13 hydrocarbon monitoring wells and 3 test pits, with the option for field personnel to install additional monitoring wells and/or test pits, will be installed to determine the extent of the hydrocarbon-impacted soil and groundwater. Four existing monitoring wells located on NorthWestern Energy property and one existing well located on the eastern side of the BRW Site will be sampled since these wells are upgradient of the observed hydrocarbon presence. Other locations identified in the records review (Step 4) may be added by the FTL, Contractor CPM, and/or Contractor QAO.

During installation of the hydrocarbon monitoring wells and construction of the hydrocarbon test pits, the soil lithology and associated characteristics will be recorded. Any observed evidence of hydrocarbons through visual screening (sight and/or smell) will be noted and confirmed with a PID. If the presence of hydrocarbons is detected (via sight, smell, and/or detection with a PID) in the soil from boreholes or test pits, a soil sample will be collected for hydrocarbon analyses. All visual and olfactory observations of suspected hydrocarbons will be confirmed with a PID prior to collecting a sample. In all boreholes and test pits (if field conditions allow), a soil sample will be collected near the top of the saturated layer (in the capillary fringe) for hydrocarbon analyses (Table 2 and Table 3) even if no there is no evidence of hydrocarbons.

Soil and groundwater samples will be collected from all locations identified in Table 2 and sent for laboratory analysis. The action levels for hydrocarbons are specified by the Montana's RBSLs (DEQ, 2018a) and any soil or groundwater sample containing concentrations exceeding those levels will be noted.

Additional Solid Material Characterization:

In addition to meeting the objectives above, opportunistic soil samples will be taken from a selection of borings for metals analyses to further define the appropriate waste removal depth and to aid in the design of the BRW hydraulic control. Table 2 and Table 3 summarize the sampling techniques and analyses for each location.

- Metals analyses via XRF will be completed for specified analytes (Table 2 and Table 3) for each lithological layer. Metals analyses will not be conducted at locations near an investigation point from the Initial Phase I Site Investigation (Stage 1).
- Laboratory metals analyses for specified analytes (Table 3) via ICP-OES will be conducted to further define the depth of waste. Based on the XRF analyses, a sample will be collected from the first lithological layer in each boring or test pit which passes the Waste

Identification Screening Criteria (EPA, 2018b). Metals analyses will not be conducted at locations near an investigation point from the Initial Phase I Site Investigation (Stage 1).

Additional Groundwater Characterization:

The groundwater samples will be analyzed for COCs to aid in the design of the BRW hydraulic control. Table 2 and Table 3 summarize the sampling techniques and analyses for each location.

- The groundwater samples taken for hydrocarbon analyses will also be analyzed for COCs as indicated in Table 2 and Table 3.
- If an interface probe detects an LNAPL layer on the groundwater surface, the well will not be developed. If sufficient LNAPL thickness is observed (at least 0.2 feet), baildown tests will be performed to determine the LNAPL transmissivity of the subsurface material (Section 3.4.7). During the baildown test, a sample of LNAPL will be collected for laboratory analysis (Table 3). Once the LNAPL layer has been sampled, field personnel will bail out any remaining LNAPL and use low flow sampling to take groundwater samples for dissolved metals analysis.
- If an interface probe does not detect an LNAPL layer on the groundwater surface, the well will be developed as instructed in the SOPs and the groundwater will be analyzed for both total recoverable and dissolved metals.

Step 6: Specify Performance or Acceptance Criteria:
The purpose of this step is to define the performance or acceptance criteria that the collected data will need to achieve.

All analytical data gathered during the Hydrocarbon Investigation will be validated to ensure that the data are suitable for their intended purpose. Specific data validation processes that will be followed to ensure analytical results are within acceptable limits are detailed in Section 9.0. The data validation process will include evaluating analytical control limits and the PARCCs. If significant issues with the data are found, results will be discussed with EPA.

Step 7: Develop the Plan for Obtaining the Data
This step identifies a resource-effective data collection design for generating data expected to satisfy the DQOs.

Section 3.4 outlines the applicable data collection design for the Hydrocarbon Investigation. The procedures outlined in Section 3.4 are designed to ensure that the data will be of sufficient quality and quantity to answer the principal study questions outlined in Step 2 and to inform future activities in the area.

2.5.3 Measurement Performance Criteria for Data

Specific data validation processes ensure that analytical results are within acceptable limits. All the information and data gathered during the QAPP will be checked to ensure they are usable for their intended purposes. An evaluation of analytical control limits and of the PARCC parameters will be performed. If significant issues with the data are found, data results will be discussed with EPA and Montana DEQ project managers. The EPA, in consultation with Montana DEQ, will then decide if the total study error could cause them to make an incorrect decision. Using this approach, the probability of making an incorrect decision (i.e., either a false negative or positive) based on the information collected is considered small.

The definitions of PARCC are provided below along with the acceptance criteria for data collected. Equations for calculating precision, accuracy, and completeness are provided in Table 4.

Precision

Precision is the amount of scatter or variance that occurs in repeated measurements of a particular analyte. Acceptance or rejection of precision measurements is based on the relative percent difference (RPD) of the laboratory and field duplicates. For example, perfect precision would be a 0% RPD between duplicate samples (both samples have the same analytical result). For this study, acceptable precision will be an RPD of plus or minus 20.0% for groundwater samples and plus or minus 35.0% for soil samples. This precision requirement is derived from the *CFRSSI Laboratory Analytical Procedure* (ARCO, 1992b), the *National Functional Guidelines for Inorganic Superfund Methods Data Review* (EPA, 2017b), and the *CFRSSI QAPP* (ARCO, 1992c).

Accuracy

Accuracy is the ability of the analytical procedure to determine the actual or known quantity of a particular substance in a sample. The laboratory control sample (LCS) and laboratory matrix spike (LMS) are used to measure accuracy, and accuracy acceptance or rejection is based on the percent recovery (% R) of the LMS and LCS. Perfect recovery will be 100% (the analysis result is exactly the known concentration of the LMS or LCS). An acceptable accuracy range is 80.0% to 120.0% in groundwater samples and 75.0% to 125.0% for soil samples. Accuracy requirements for this project are derived from the EPA *Contract Laboratory Program* (CLP) *Statement of Work for Inorganic Superfund Methods* (EPA, 2016) and the *CFRSSI QAPP* (ARCO, 1992c).

Representativeness

Representativeness is a qualitative parameter that is addressed through proper design of the sampling program. The sampling program described in the QAPP will be designed to obtain a sufficient number of samples that adequately represent the range of conditions present in the medium being sampled and will specify suitable sampling methods and procedures.

The CPM will review each stage of the QAPP (Stage 1, Stage 2, and Stage 3) to ensure that it is designed to collect the data and information necessary to meet the purpose of the investigation. The review will consider the volume, variability, and intended use of the data to ensure proper sampling methods and adequate spatial distribution of samples.

After the data have been collected and analyzed, the FTL,CPM, and Contractor QAO will review the data and qualitatively assess if the data adequately represent the site conditions and intended purpose of the investigation. Sample representativeness may also be evaluated using the RPDs for field duplicate sample results, if applicable. The representativeness will be addressed in the PARCC.

Completeness
Completeness determines if enough valid data have been collected to meet the investigation needs. Completeness is assessed by comparing the number of valid sample results to the number of sample results planned for the investigation. Although not all the analytes measured in this sampling effort have completeness objectives outlined in the *CFRSSI QAPP* (ARCO, 1992c), the completeness target for this investigation is 95.0% or greater as designated in the CFRSSI QAPP.

Comparability
Comparability determines if one set of data can be compared to another set of data. Comparability is assessed by determining if an EPA-approved analysis method was used, if values and units are sufficient for the database, if specific sampling points can be established and documented, and if field collection methods are similar. All analysis methods are listed in Table 3. The EPA Method 8015M for high resolution gas chromatography and EPA Method 600 for asbestos are included in Appendix 1, and all SOPs for these investigations are included in Appendix 2. An SOP for operating the CHEMetrics V-2000 Photometer was not available, but the manual is included as Appendix 3.

Method Sensitivity
Method sensitivity is related to the method detection limits. The method sensitivity or lower limit of detection depends on several factors, including the analyte of interest, the method used, the type of detector used, matrix effects, etc. Appropriate methods must be selected with sufficient method sensitivity to accomplish the project's goals.

XRF Analysis: The method sensitivity or lower limit of detection for XRF analysis depends on several factors, including the analyte of interest, the type of detector used, the type of excitation source, the strength of the excitation source, count times used to irradiate the sample, physical matrix effects, chemical matrix effects, and interelement spectral interferences. Example lower limits of detection for analytes of interest in environmental applications are shown in Table 5. These limits apply to a clean spiked matrix of quartz sand (silicon dioxide) free of interelement-spectral interferences using long (100 to 600 second) count times. These sensitivity values are given for guidance only and may not always be achievable because they will vary depending on the sample matrix, which instrument is used, and operating conditions.

Laboratory Analysis: The method sensitivity for laboratory analyses is determined as part of the laboratory's SOPs. A review of these detection limits will be conducted as part of the data validation process (Section 9.1).

3.0 SCOPE OF PROJECT

This BRW Phase I QAPP identifies an initial data collection effort to refine the characterization of solid materials and groundwater within the BRW Site and is made up of the following three stages:

- **Stage 1: Initial Phase I Site Investigation.**
- **Stage 2: Additional Groundwater Sampling.**
- **Stage 3: Hydrocarbon Investigation.**

Efforts conducted under this plan will include excavating test pits, drilling boreholes, collecting soil samples from test pits for laboratory analyses, and collecting and archiving core samples (with certain intervals being submitted for laboratory analysis). Efforts will also include installing piezometers and collecting water levels and groundwater samples. Additional efforts completed as part of the Hydrocarbon Investigation will include a records review, installing hydrocarbon monitoring wells, and collecting groundwater samples.

3.1 Preparation for Fieldwork

The following tasks will be completed prior to conducting field activities.

Training

All field personnel will have current certification for both the *40-hour Occupational Safety and Health Administration Hazardous Waste Site and Emergency Response Training* and the *24-hour Mine Safety and Health Administration (MSHA) Training*. Current certification records are maintained at Pioneer's headquarters at 1101 S. Montana Street in Butte, Montana.

In a project meeting held prior to fieldwork, all field personnel will review the BRW Phase I QAPP and receive training per the BRW Phase I QAPP. Field personnel will review sampling and monitoring procedures and requirements prior to field activities to ensure collecting and handling methods are completed according to these BRW Phase I QAPP requirements. Field personnel will be trained in how to properly use field equipment and complete activities according to field data collection SOPs (Appendix 2).

The FTL will conduct a review of the BRW Site-Specific Health and Safety Plan (SSHASP) with all field personnel prior to fieldwork to assess the site's specific hazards and the control measurements put in place to mitigate these hazards. The BRW SSHASP review will cover all other safety aspects of the site including site personnel responsibilities and contact information, additional site-specific safety requirements and procedures, and the emergency response plan.

The FTL will be responsible for training field personnel on how to calibrate field measurement instruments. The FTL will be experienced in the use and calibration of the equipment that will be used and responsible for training and overseeing the support staff.

One hard copy of the current approved version of the BRW Phase I QAPP will be maintained for reference purposes in the field vehicle and/or field office. All field team personnel will have access to Portable Document Format (PDF) format files of all documents pertaining to sampling. All field team personnel will sign the BRW Phase I QAPP after receiving training.

Utility Locates

There is a possibility that test pit, borehole, and piezometer locations could shift once underground utilities are located throughout the BRW Site. Utility locates will be performed prior to any field work and will follow BP Remediation Management Defined Practices for ground disturbance in addition to applicable control measures addressed in the internal BRW SSHASP.

Property Access

Atlantic Richfield owns the BRW Site where hydrocarbon wells and test pits will be installed; therefore, no property access agreements are necessary for these locations. Groundwater samples will be collected within the BRW Site and on NorthWestern Energy's property to the south of the Site. For the sampling locations on NorthWestern Energy's property, Atlantic Richfield will use an existing access agreement with the property owner, or will obtain updated access agreements as necessary to complete the groundwater sampling. Copies of the access agreements will be placed in the field binder to have on hand during the field investigation.

3.2 Stage 1: Initial Phase I Site Investigation

This BRW Phase I QAPP is intended to address the work activities required to provide the following:

1. **Solid Materials Characterization:** General locations and quantities of solid materials (slag, demolition debris, tailings, peat/alluvium, etc.) and durable historical infrastructure are known, but additional quantification is necessary. To complete the additional quantification, the following actions will be conducted:
    a. Excavate test pits and drill boreholes (Section 3.2.2 and Section 3.2.3).
    b. Document lithology to determine distribution of solid materials (Section 3.2.2.2 and Section 3.2.3.2).
    c. Collect solid samples from lithological layers and analyze for specified analytes (Table 2 and Table 3) to determine the properties of solid materials including the chemical stability/leachability of these solid materials (Section 3.2.2.3 and Section 3.2.3.3)
2. **Groundwater Characterization:** General groundwater flow direction and water chemistry is known, but additional quantification is necessary. To complete the additional quantification, the following actions will be conducted:
    a. Install piezometers to continuously measure water elevations to estimate the direction of groundwater flow (Section 3.2.4).
    b. Manually measure water elevations on a monthly basis for a minimum of 2 years in selected monitoring wells and surface water locations (Table 2) to estimate the direction of groundwater flow (Section 3.2.4.2).
    c. Collect groundwater samples and analyze for specified analytes (Table 2 and Table 3) to estimate the chemical variability of groundwater.

The sampling procedures in this section follow the applicable SOPs developed by Pioneer (Appendix 2), which adhere to or expand upon the CFRSSI SOPs (ARCO, 1992a). Additionally, Appendix 4 contains flowcharts (one for boreholes and one for test pits) to help field personnel identify sampling tasks required based on material type encountered.

3.2.1 Location and Identification

The location of each test pit, borehole, and piezometer to be installed is shown on Figure 5 and Figure 12 and is listed in Table 2. Figure 7, Figure 9, and Figure 13 through Figure 19 identify locations based on the type of data to be collected (i.e., characterize groundwater, refine slag volume, etc.). Please note, however, that several locations serve multiple purposes. For example, a groundwater piezometer may serve to characterize groundwater, but the borehole may also be used to refine slag volume and identify the presence/absence of hydrocarbons.

3.2.2 Test Pits

Excavation and sampling of test pits within the BRW Site will be oriented at determining if any durable historical infrastructure exists in key locations (Figure 7), evaluating any remaining manganese impacts (Figure 9), and determining the distribution and properties of solid materials (Figure 13 through Figure 16). Each figure indicates the design purpose for the test pit. In regard to historical infrastructure, additional detail on the rational for placement of the test pits is provided in Table 1.

Prior to excavation of test pits, utility locates will be performed. Test pit sampling will be conducted as per SOP-S-06, included in Appendix 2. Specific to this investigation, certain modifications to the SOP are provided in this section.

Test Pit Excavation

Test pits will be excavated using the appropriate excavating equipment capable of collecting samples up to a maximum depth of 20 feet. During excavation of the test pit, the following limits will be observed:

- **Shallow Test Pit Sampling (ground surface to 4-foot depth):**
    - From the ground surface to a depth of 4 feet, 1 wall of the test pit will be prepared for evaluation and sampling.
    - Excavated materials will be stockpiled a minimum of 3 feet from the edge of the excavation.
    - The test pit should have 1 vertical smooth wall for sample collection and 1 sloping or stepped wall for egress into and out of the test pit.
    - If it is safe to enter the pit (as per SOP-S-06 in Appendix 2), field personnel may collect samples from the vertical face of the test pit.
    - If conditions are unsafe and site conditions allow, a scoop on an extension device will be used to obtain the sample directly from the test pit. If this is not feasible, the

excavator operator will obtain a representative sample using the excavator and the sample will be collected from the appropriate excavated piles of soil and/or excavator bucket. Samples collected from the excavated piles will be flagged for special consideration in the data validation process.

- **Deep Test Pit Sampling (beyond 4-foot depth):**
  - During excavation for depths greater than 4 feet, the excavator operator will obtain the sample using the excavator, and the sample will be collected from the appropriate excavated piles of soil and/or excavator bucket. Samples collected in this manner will be flagged for special consideration in the data validation process.
  - No personnel will be permitted access to test pits deeper than 4 feet during performance of this work.
- **Excavation or sampling challenges:**
  - If a specific area has excavation or sampling challenges (e.g., encounters groundwater, durable slag layer, etc.) and it becomes necessary to sample deeper, then a borehole will be drilled using the appropriate equipment and personnel (Section 3.2.3).
  - Dewatering of test pits will not be conducted due to the considerations of impacted groundwater. If groundwater is encountered and it is necessary to continue sampling deeper, then a borehole will be drilled using the appropriate equipment and personnel (Section 3.2.3).

Depth and Location
The general location of each test pit is specified in Table 2 and on Figure 5. Because the configuration of the BRW Site changes with BSB operations and because a utility locate has not yet been conducted within the BRW Site since August 2017, the actual location and number of test pits may be modified, as determined by the FTL, CPM, and/or Contractor QAO (Section 6.0). The general depth of each test pit is specified in Table 2 and may be limited or increased based on field personnel observations.

3.2.2.1 Test Pit Sampling Equipment

Test pits will be excavated using a track-mounted or rubber-tired excavator to provide access for sampling soil at depth. Equipment used to collect soil samples will include, but is not limited to, the following:

- Sharpshooter shovels and spoons or disposable sampling scoops.
- Field logbook and pens.
- Measuring tape.
- Unified Soil Classification System (USCS) chart (ASTM D-2488) (Appendix 4).
- Munsell color chart (Munsell, 2009).
- XRF field unit-- Niton™ XL3 XRF Analyzer (XL3).
- Sieve.

- Portable heater or oven.
- One and/or both PIDs (9.8 electron volt [eV] and 10.6 eV lamps) with humidity filter.
- Sample containers and labels.
- Chain of custody forms.
- Coolers.
- Decontamination supplies (tap water, dilute nitric acid, liquinox soap, decontamination containers, paper towels, scrub brushes, and spray bottles) (refer to SOP-DE-02 in Appendix 2).
- Camera and film, digital camera, or digital video camera.
- Portable pump.
- Personal Protective Equipment (PPE).
- GPS unit.
  - Field pH meter, SC, and redox potential (Eh) meters (for any groundwater in test pit).

3.2.2.2 Test Pit Logging and Sampling Procedure

The sampling team will collect samples from each stratigraphic layer to the maximum depth of the test pit and record the information in the Test Pit Excavation log provided in Appendix 4. The test pit sampling procedure is described fully in SOP-S-06 (Appendix 2) and additional project-specific detail is provided below. The sampling team will record the GPS coordinates of all test pits.

Logging

The classification and lithology of the test pit sidewalls will be logged, and the areas photographed and/or videoed. This will include a soil log of the test pit sidewall that lists the USCS classification (Appendix 4); visual estimate of rock content (2-inch plus fraction); color (as per Munsell color chart [Munsell, 2009]); depth to top and bottom of each stratigraphic unit; presence or absence of soil staining, odors, nodules, organic matter, and/or groundwater; and bedrock depth (if encountered). All relevant observations will be recorded on field data sheets (FDS) and referenced in a bound field logbook and on the forms included in Appendix 4 and provided by the safety personnel, as per the BRW SSHASP.

PID Screening Analysis

During excavation of the test pit, visual observations (sight and/or smell) and a PID will be used to identify sources of hydrocarbons. Any findings will be evaluated with a combustible gas meter, appropriate actions taken, if necessary, and the results recorded in the field logbook. The procedures for using the PID and combustible gas meter are detailed in Section 3.9.

Sampling

At the discretion of field personnel, one sample will be collected for each material horizon. Samples will be conducted as per SOP-S-06 (Appendix 2) with the exception of potential test pit samples of slag, additional coarse, and/or massive fragments that will be collected for potential use during SPLP sampling (Section 3.10).

If the presence of hydrocarbons is detected (via sight and/or smell or detection with a PID) on the surface, a surface sample will be collected for hydrocarbon analyses. When field conditions allow, if the presence of hydrocarbons is detected (via sight and/or smell or detection with a PID) and groundwater is present, an additional soil sample will be collected near the top of the saturated layer (in the capillary fringe) for hydrocarbon analyses (Table 3). However, during potholing and other field conditions that encounter the groundwater, a saturated layer may not be collected for hydrocarbon analysis.

Samples will be collected using a disposable hand scoop or decontaminated shovel by scraping soil from the sidewall or collecting it from the appropriate excavated piles or from the excavator bucket. The FTL will determine if a larger sample is appropriate. An appropriate sample volume will be collected to provide enough material for each required analysis (Table 3).

No water samples will be collected for laboratory analysis; however, the pH, SC, and Eh of groundwater that enters the pit will be tested, if feasible. All field water sampling results will be recorded in the field logbook.

3.2.2.3 Analysis of Test Pit Samples

Because there are multiple different objectives for individual test pits (i.e., identify durable historical infrastructure, evaluate remaining manganese impacts, etc.), the analysis of the test pit materials is separated below and in Table 2 and Table 3.

Identify Durable Historical Infrastructure (Figure 7)
As per Section 2.3, some historical infrastructure items have not been demolished within the BRW Site and remain, or potentially remain, at the site. To identify and confirm the location of this infrastructure in the field, additional test pits are planned and will be excavated in locations where there is uncertainty as to whether durable infrastructure still exists. If materials are observed that could potentially contain asbestos (i.e., any building materials other than foundation slabs), laboratory analysis for asbestos will be conducted. Unless any noticeable impacted material is encountered in the field, no further analysis will be conducted at these locations related to identifying durable historical infrastructure.

Evaluate Remaining Manganese Impacts (Figure 9)
Some remnants of manganese-rich material stockpiles may remain at the BRW Site. Prior investigations were comprehensive, and a single new test pit (BRW18-TP04) will be excavated to refine the extent of manganese concentrations. At this test pit, surface samples will be collected, and field and laboratory analyses will be conducted, for manganese and other analytes specified in Table 3. In addition to this test pit, all test pit and borehole samples analyzed for metals analysis will also be analyzed for manganese (Table 2 and Table 3). Table 3 also lists sample containers and holding times. Soil sample designation and labeling will be conducted as per the appropriate field procedures outlined in Section 3.6.

Determine Distribution and Properties of Solid Materials (Figure 13 to 16)
At the discretion of the field personnel, a sample will be collected from each lithological layer observed in the test pit.

Field metals analysis will be conducted for all samples via the XRF unit. A soil nitrate test will be conducted for select locations, as per the defined SPLP action level described in Section 3.10.2. Samples collected from any major material horizon that is greater than 2 feet thick will be sent to the laboratory for analyses as specified Table 2 and Table 3. Additional samples for minor material horizons (i.e., less than or equal to 2 feet in thickness) may be taken at the discretion of field personnel.

If materials are observed that could potentially contain asbestos (i.e., any building materials other than foundation slabs), laboratory analysis for asbestos will be conducted. If the presence of hydrocarbons is detected (via sight and/or smell or detection with a PID) on the surface, a surface sample will be collected for hydrocarbon analyses. If the presence of hydrocarbons is detected (via sight and/or smell or detection with a PID) and groundwater is present, an additional soil sample will be collected near the top of the saturated layer (in the capillary fringe) for hydrocarbon analyses.

Up to 4 samples (1 from demolition debris and up to 3 from other material, not including slag or tailings) will be sent to the laboratory for analysis via SPLP, as per the defined SPLP action level described in Section 3.10.2.

3.2.3 Boreholes

Drilling and sampling of boreholes within the BRW Site will be oriented at identifying remaining historical infrastructure (Figure 7), determining the distribution and properties of solid materials (Figure 13 thorugh Figure 16), and evaluating the presence of any hydrocarbons (Figure 18) or PCBs (Figure 17).

Prior to drilling boreholes, utility locates will be performed for the proposed locations as necessary. Drilling and sampling are to be conducted as per all relevant and applicable SOPs (Appendix 2). Specific to this investigation, certain modifications to the SOPs are provided in this section.

3.2.3.1 Borehole Drilling Procedures

Boreholes and piezometers are anticipated to be drilled and constructed using either a sonic drilling rig or Geoprobe® unit, which provides high-quality core samples. These samples will be examined to produce a detailed lithologic characterization log of the subsurface materials at each borehole location.

The following general procedures will be performed at each borehole or piezometer location (at the depth intervals). Note that this list is not intended to be a complete list.

- Perform utility locates prior to drilling boreholes or installing piezometers.

- Prepare drill rig/Geoprobe® unit for operation. This includes, but is not limited to, decontaminating drilling tools and sampling equipment, leveling the rig, preparing the down-hole tool, and establishing the drill location.
- Begin advancing the core barrel. Advance the core barrel (anticipated to be 10 feet for the sonic rig and 5 feet for the Geoprobe® unit) to collect the core sample, then retrieve the inner core barrel to recover the core sample. Continue adding core barrel segments and collecting core samples until desired depth has been reached.
- Decontaminate the drill rig core barrel(s) between samples by rinsing with tap water and/or using a high-pressure washer.

Sonic Drilling Rig

- The sonic drilling rig will provide continuous core samples, which are anticipated to be 10 feet in length by 4 inches in diameter. In areas where recovery is poor or it is critical to obtain maximum sample volume, drilling core lengths will be reduced to 5-foot intervals. To temporarily store the sediment core, 600 polyethylene sleeves designed to fit over the core barrels will be used. Each 10-foot length will be properly labeled to split the core into manageable units for storage.

Geoprobe®

- The Geoprobe® unit will provide continuous core samples using the dual tube soil sampling system. These core samples are anticipated to be 5 feet in length by 2 inches in diameter. To temporarily store the sediment core from the sonic rig, plastic liners will be used within the inner core barrel to collect the core samples. Each 5-foot length will be properly labeled for storage.

Depth and Location

The general borehole and piezometer locations are specified in Table 2 and on Figure 12. Because the configuration of the BRW Site changes with BSB operations and because a utility locate has not been conducted within the BRW Site since August 2017, the actual location and number of boreholes and piezometers may be modified as determined by the FTL, CPM, and/or Contractor QAO (Section 6.0). Field personnel will record all GPS location coordinates for all borehole and piezometer locations.

The general depth of each borehole and piezometer is specified in Table 2 and may be limited or increased based on field personnel observations. Depending on the location, the target depth will be one of two general configurations:

- **Boreholes without piezometers:** Unless determined otherwise (e.g., limitations based on existing infrastructure), boreholes with no associated piezometers are anticipated to be drilled to a depth of approximately 5 feet below the contact of peat/organic soil interface and the underlying alluvium. This depth may change based on field XRF results and visual inspections. Anticipated depths for each boring may be adjusted to provide more data to complete the remedial design within the BRW Site.
- **Boreholes with piezometers:** Unless determined otherwise (e.g., limitations based on existing infrastructure), boreholes with associated piezometers are anticipated to be drilled to

bedrock, but this depth may change based on field XRF results and visual inspection. **If the depth of a piezometer borehole will be notably deeper than the screen depth of the piezometer, a second borehole may be drilled for purposes of installing the piezometer.**

For the area identified on Figure 16, because it is unknown how much impacted material still remains, drilling in this area will commence at or near BRW18-BH20 and move outward, as determined by the FTL, CPM, and/or, the Contractor QAO (Section 6.0). If a definable extent of impacted materials is identified, the location and/or number of boreholes in this area may change.

3.2.3.2 Borehole Logging and Sampling Procedures

During stage one of the BRW Phase I QAPP, the sampling team will collect samples from each stratigraphic layer to the maximum depth of the borehole and record the information in the field logbook. The core sampling procedure is described fully in SOP-S-12 and SOP-S-13 (Appendix 2) and additional project-specific detail is provided below.

Logging
The classification and lithology of the core will be logged and photographed. This will include a soil log of the borehole that lists the USCS classification (Appendix 4); visual estimate of rock content; color (as per Munsell color chart [Munsell, 2009]); depth to top and bottom of each stratigraphic unit; presence or absence of soil staining, odors, nodules, organic matter, and/or groundwater; percent recovery; type of drilling equipment; and bedrock depth (if encountered). All relevant observations will be recorded in a bound field logbook.

PID Screening Analysis
Visual observations (sight and/or smell) and a PID will be used to identify sources of hydrocarbons on the surface. Any findings will be recorded in the field logbook. The procedures for using the PID are detailed in Section 3.9.3. If the presence of hydrocarbons is detected (via sight and/or smell or detection with a PID) on the surface, a surface sample will be collected for hydrocarbon analyses.

Sampling
Core samples will be collected from boreholes using a sonic drilling rig or Geoprobe® unit. Core samples will be collected according to all applicable SOPs (Appendix 2) with the exception of samples of slag, additional coarse and/or massive fragments that will be collected for potential use during SPLP sampling (Section 3.10.2). The list of specific analytes and analyses are provided in Table 2 and Table 3. Samplers will collect core samples from each soil boring. Equipment used to collect core samples will include, but not be limited to, the following:

- Field logbook and pens.
- Measuring tape.
- USCS chart (ASTM D-2488) (Appendix 4).
- Munsell color chart (Munsell, 2009).
- Field XRF unit.

- Sieve.
- Portable heater or oven.
- One and/or both PIDs (9.8 eV and 10.6 eV lamps) with humidity filter.
- Sample containers and labels.
- Chain of custody forms.
- Coolers.
- Decontamination equipment (pressure washer, tap water, dilute nitric acid, liquinox soap, decontamination containers, paper towels, scrub brushes, and spray bottles) (refer to SOP-DE-02 in Appendix 2).
- Camera and film, digital camera, or digital video camera.
- GPS unit.
- CHEMetrics V-2000 photometer and ampules.
- Appropriate safety PPE.

The following general procedures will be performed at each borehole or piezometer location (at the depth intervals). Note that this is not intended to be a complete list.

- Prior to use, and between samples, wash all utensils with a detergent solution, followed by a tap water rinse, a diluted acid rinse, and a final rinse with distilled/deionized water.
- Open the core sleeve and lay out the core samples in order on strips of visqueen or other appropriate material where the boring depth footage has been pre-labeled.
- Split the core lengthwise using a plastic spatula and/or stainless-steel blades.
- Use the PID immediately to screen for any hydrocarbons. If hydrocarbons are detected, immediately collect samples for headspace detection method (Section 3.9.3) and laboratory hydrocarbon analyses (Table 3).
- Photograph the complete length of the core in 2-foot segments from directly overhead using parallel camera movement and a high-resolution setting.
    - The photographs can be stitched together later to provide a continuous photographic record of the core.
    - Take additional photographs of subsamples for documentation as necessary.
- Collect samples from each lithological layer. If the presence of hydrocarbons is detected (via sight and/or smell or detection with a PID) and groundwater is present, an additional soil sample will be collected near the top of the saturated layer (in the capillary fringe).
- Place the core samples in properly labeled sample core boxes for transport (the labels will include location, depth interval, and core orientation). It is imperative that the core sample is marked clearly and is carefully transported horizontally, as it will be used for further observation, sample selection, and analysis.
- If the borehole will be advanced deeper, and after recovery of the sample, add a drill rod to the drill string to advance core barrel beyond the sonic casing.
- Repeat these steps to advance the drill to the desired depth.

While all core is anticipated to be archived, specific samples will be selected based on analytical results for additional laboratory analyses. Sediment cores from every borehole drilled during this project will be stored in 2-foot increments in their entirety at the Pioneer field office at 244 Anaconda Road in Butte, Montana, or an alternate suitable location. When it is determined that enough sample is present for design-related purposes, additional samples will be shared with other parties, transferred off site, or disposed of appropriately.

Additional core samples may be collected for geochemical analyses at the discretion of field personnel. While general samples are identified by test pit, borehole, or piezometer in Table 2 and Table 3, the specific horizons will be identified for sampling by field personnel.

3.2.3.3 Analysis of Core Samples

At the discretion of field personnel, a sample will be collected from each lithological layer of at least 2 feet in thickness observed in the core. Field metals analysis will be conducted for each minor material horizon that is less than 2 feet in thickness via the XRF unit, unless determined otherwise by field personnel. Additional samples may be analyzed by XRF from lithological layers that are greater than 2 feet, as determined by field personnel. For all samples (except alluvium) with a lead concentration anticipated to be greater than 3,140 mg/kg, a soil nitrate test will be conducted (Section 3.9.2).

If the presence of hydrocarbons is detected (via sight and/or smell or detection with a PID) on the surface, a surface sample will be collected for hydrocarbon analyses. If the presence of hydrocarbons is detected (via sight and/or smell or detection with a PID) and groundwater is present, an additional soil sample will be collected near the top of the saturated layer (in the capillary fringe) for hydrocarbon analyses.

Samples collected from any major material horizon that is at least 2 feet in thickness will be sent to the laboratory for analyses specified in Table 2 and Table 3, unless determined otherwise by field personnel.

For tailings, slag, demolition debris, and other materials (including alluvium), up to 10 samples from each material will be sent to the laboratory for SPLP analysis, as per the defined SPLP action level described in Section 3.10.2.

3.2.3.4 Other Considerations

To provide stable conditions for the drill rig, it may be necessary to use drilling mats or something similar. Based on visual inspection or other means, it might be determined that drill cuttings need to be contained for disposal or storage at a location on the BRW Site. This determination will be made by field personnel.

Heaving sands have previously been encountered on the BRW Site and need to be anticipated. To prevent formation of heave inside the drill rod, potable water will be added to the drill strings as they are advanced. This added water will minimize the entry of heaving sands into the drill string by providing positive pressure inside the drill string as the core sample is retrieved or the well screen is set. Water will be added only when needed and not on a routine basis.

3.2.4 Piezometers

In 2007 and 2011, BPSOU site-wide monitoring well construction efforts installed several BRW monitoring wells at various depths (Figure 4). To obtain additional information and fill design-specific data gaps, additional piezometers will be installed. The locations are listed in Table 2 and shown on Figure 19.

Data from the new piezometer locations will provide the best possible information to refine the estimates of groundwater flow and quality, and analyses of the data from the boreholes will help to identify and refine the volumes of tailings, slag, demolition debris, hydrocarbon extent, peat layer, and location of bedrock.

3.2.4.1 Installing Piezometers

Following the collection of core samples, new piezometers will be installed, as best suits the field conditions. While there may be organic COCs, the primary COCs of interest will be groundwater metals and, therefore, polyvinyl chloride (PVC) material will be appropriate to use with the piezometers.

All piezometers will be installed according to SOP-GW-11 included in this section. Specific details for the piezometer construction are provided on Figure 20 and Figure 21. The procedures below assume that either a vibratory roto-sonic drilling rig or Geoprobe® unit will be used to install the piezometers. These procedures may change based on field conditions and equipment availability.

The general target depth for the piezometer screen will be within the shallowest conductive alluvium below the top of the water table, or other appropriate location as determined by the FTL CPM, and the Contractor QAO. For example, if there is evidence of significant hydrocarbon soil staining, the screen may be set straddling the water table. Equipment, materials, and supplies used to install the piezometer will include, but is not limited to, the following:

- 1.5 inch by 5- or 10-foot Schedule 40 PVC (flush-threaded) casing (number to vary per piezometer).
- One 1.5-inch by 5-foot Schedule 40 PVC screen 0.010 slot (flush-threaded) per piezometer.
- One 1.5-inch PVC bottom cap.
- One 1.5-inch slip cap.
- One 40- to 50-foot rope.
- Field logbook and pens.
- Measuring tape.
- Sharpie marker.
- Water level interface probe.

- Metal tag with the identification.
- Camera and film, digital camera, or digital video camera.
- Appropriate safety PPE.

The following procedures will be performed at each new piezometer location. Construction details are provided on Figure 20 and Figure 21.

- Once the target depth is reached (Table 2), select the well screen interval according to the objectives for the piezometer location.
- Backfill any over-drilled boring with hydrated bentonite chips or bentonite pellets to a depth of at least 2 feet below the expected total depth of the well, and transition to building the filter pack. This will help ensure that bentonite does not swell into the screened zone.
    - Alternatively, field personnel may elect to backfill the original borehole with bentonite, drill an adjacent borehole to the desired bottom depth of the piezometer, and install the piezometer in this second borehole.
    - Depending on field conditions, backfilling a borehole or around a piezometer may be adjusted. Heaving sands and other factors may alter the well installation of the monitoring wells. However, the monitoring wells will be installed sufficiently to characterize the groundwater within the BRW Site.
- For the Screen and Riser:
    - Each piezometer will consist of 5 feet of 1.5-inch nominal diameter schedule 40 flush-threaded PVC well screen with a slot size of 0.010-inches, with 1.5-inch nominal diameter schedule 40 flush-threaded PVC blank casing extending to approximately 2 feet above the ground surface or finished as a flush-mount at locations where an aboveground surface finish is not possible (e.g., access roads, etc.).
    - Install an appropriately sized schedule 40 slip-fit cap on top of the PVC blank casing before installing the filter pack and other components described below.
- For the Filter Pack:
    - Install the filter pack to at least 3 feet above the top of the screen.
    - Install the annular seal of hydrated bentonite chips from the top of the filter pack to 3 feet bgs. For shallower completions of piezometers, the thickness of the seal may be reduced by field personnel as necessary.
    - Install bentonite grout from 3 feet bgs to 6 inches bgs (may be altered for shallower completions).
- For the Stickup Configuration (Figure 20):
    - Install a 6-inch by 5-foot steel surface casing from approximately 2.5 feet bgs to approximately 2.5 feet above ground surface.
    - If the location is anticipated to be subject to frost-heave, such as to the west of the BRW Site, install a longer steel surface casing that extends below the frost line.
    - A small drain or "weep hole" should be located just above the surface seal to prevent the accumulation of water between the casings.

    - In areas susceptible to flooding, the protective casing should extend high enough to be above flood level (OhioEPA, 2008).
    - In high traffic areas, 3 bollards should be installed around the piezometer.
    - Install 20-40 mesh Colorado Silica Sand from 6 inches bgs to approximately 2 inches below the top of the 2-inch diameter PVC.
    - Mark a measuring point on the north side of the inner casing using permanent marker.
    - Install a 2.5-foot by 2.5-foot by 6-inch-thick concrete pad around the surface casing.
    - Provide a locking steel cap for each piezometer.
    - Write the piezometer name, depth, and installation data on the underside of the locking steel cap.
- For the Flush Mount Configuration (Figure 21):
    - Install an appropriately sized flush mount cover to be level with the ground surface.
    - Install 20-40 mesh Colorado Silica Sand from 6 inches bgs to approximately 2 inches bgs.
    - Install a square or round 2.5-foot by 6-inch-thick concrete pad around the flush mount cover.
    - Trim the piezometer riser to approximately 1 inch below the flush mount cover.
    - Mark a measuring point on the north side of the inner casing using permanent marker.
    - Provide an expandable piezometer cap and lock.
    - Write the piezometer name, depth, and installation data on the underside of the locking steel cap.

Pioneer will prepare a piezometer completion log for the location and, at a minimum, it will contain the following:

- Time and date installed.
- Borehole, casing, and screen diameters.
- Bottom cap length.
- Boring depth (plus or minus 0.1 foot) in relation to the ground surface.
- Well depth (plus or minus 0.1 foot) in relation to the ground and final measuring point.
- Lithology logs.
- Casing materials.
- Screen size, length, and depth to top and bottom of screen from ground surface.
- Filter pack material, size, and thickness in relation to the ground surface.
- Seal thickness and depth below ground in relation to the ground surface.
- Depth to groundwater at time of completion, in relation to the ground and final measuring point.

- Survey-grade X and Y coordinates and elevations for the measuring point (marked on the north side of the well), top of protective casing, and ground surface.

All drilling equipment and accessories will be decontaminated at the completion of the piezometer installation. If groundwater is present in the piezometer, the piezometer will be sampled as per Table 2 and Table 3.

3.2.4.2 Collecting Water Levels and Groundwater Sampling

Manual Groundwater Level Measurements

Manual water levels will be collected from the locations identified in Table 2 using an electronic depth to water indicator tape (E-tape) for a minimum of two years unless the location must be removed or an alternate location is designated. Select monitoring wells and piezometers will be outfitted with transducers to collect continual water levels (Table 2), however these locations may be modified based on field observations and as approved by the FTL or the CPM.

Manual water levels will be measured from the measuring point as indicated on the inner PVC well or piezometer casing and located on the north side of the inner PVC casing. Measuring point locations and elevations of all monitoring wells and piezometers will be surveyed using a survey grade GPS unit. All ground surface elevations will be measured at the base of each monitoring well and piezometer.

In some cases, the water level may not be recorded due to field conditions (such as frozen or dry).

Continuous Groundwater Level Measurements

Continual water level recorders (transducers) will be monitored at the piezometer locations in Table 2. These transducers will be set to collect a data point every 15 minutes in a linear mode. Transducers will be installed and monitored according to SOP-GW-15 included in Appendix 2.

Data from transducers will be downloaded on a monthly basis for a minimum of two years (unless the location must be removed or an alternate location is designated), concurrently with synoptic monthly water level measurements. At the time the data from the transducers are downloaded, the transducers will be checked for proper functionality and visually inspected for fouling. If the transducer is becoming fouled, it will be rinsed with tap water. When removing transducers from piezometers, care will be taken to avoid contacting the transducer and any suspension cables with the ground surface. Should contact with the ground surface occur, the transducer and suspension cable will be rinsed with tap water to remove all foreign material.

Groundwater Sampling

Once the piezometers are complete and developed, field personnel will collect a water sample using the appropriate sampling equipment (e.g., peristaltic pump, submersible pump, or bladder pump) in conjunction with a low-flow sampling methodology approved by the FTL or CPM. All water sampling results will be recorded in a bound field logbook.

Prior to groundwater sampling, depth-to-groundwater will be measured at each piezometer location according to SOP-GW-03 (Appendix 2). After water levels have been collected, the piezometers will be purged with the appropriate sampling equipment (e.g., peristaltic pump, submersible pump, or bladder pump) (SOPs in Appendix 2) until the water quality parameters (temperature, SC, and pH) and water level have stabilized. Water quality measurements will be collected at 3- to 5-minute intervals to monitor stabilized water quality parameters. The key stabilization parameters are turbidity and water level. The turbidity is considered stabilized when 3 consecutive readings are within 10% of each other. However, field conditions may require samples to be collected prior to water quality parameters stabilizing, at the discretion of the FTL, CPM, and the Contractor QAO. If an LNAPL layer is detected on the groundwater table using an interface probe, the well will not be developed. Field personnel will bail out the LNAPL and use low flow sampling to take groundwater samples for dissolved metals analysis. Field personnel will attempt to make sure the pump's inlet is slightly below the top of the groundwater table to avoid interference of hydrocarbons with the probe. Additionally, the ORP probe will be cleaned between wells, following the manufacturer's instructions, to remove any hydrocarbons that may interfere with the readings.

Water quality parameters will be collected according to the applicable and relevant SOPs (Appendix 2). Once the water quality parameters stabilize, samplers will collect the groundwater samples directly from the sampling equipment and place it into appropriate sample containers.

3.2.5 Additional Efforts

Additional efforts to be completed at the BRW Site include sampling for hydrocarbons in areas with evidence of soil staining, geophysics tasks to identify locations of underground voids (i.e., historical flumes/culverts), and physical measurements and photographs to quantify and characterize existing durable historical infrastructure.

3.2.5.1 Hydrocarbon Screening

During field activities, the BRW Site will be examined and any soil that appears to contain hydrocarbons (via sight and/or smell or detection with a PID) will be sampled and analyzed for VPH and EPH fractionation with PAH. In addition to VPH and EPH fractionation with PAH analyses, splits of the soil samples may also be collected and submitted to Torkelson Geochemistry for hydrocarbon ranges and Pristane/Phytane Ratio analysis to determine the type and relative age of any petroleum hydrocarbons encountered (Table 2 and Table 3). Potential locations where additional hydrocarbon sampling may occur are areas with heavy vehicle traffic, maintenance areas, or areas with industrial activities (historical and current). Any additional samples will be collected at the discretion of the field personnel, and samples will be collected as per SOP-S-06 (Appendix 2).

3.2.5.2 Geophysics Tasks

A geophysical MASW seismic survey will be completed to locate subsurface flumes/culverts within the BRW Site area. If a void space remains from the flumes/culverts, it may be identifiable using MASW methods. BRW Site historical research indicates there may be at least two remaining flumes/culverts within the BRW Site area (BTC flume and the south culvert; see Table 1); however, different maps show these flumes/culverts in different locations. The approximate location of the flumes/culverts and the approximate MASW transect locations are shown on Figure 8.

3.2.5.3 Quantification of Existing Durable Historical Infrastructure

Measurements and photographs of existing durable infrastructure will be collected. The existing durable infrastructure to be documented is specified in Table 1. At a minimum, the following equipment will be needed to document the infrastructure:

- Field logbook and pens.
- Measuring tape.
- Sharpie marker.
- Camera and film, digital camera, or digital video camera.
- GPS.
- Appropriate safety PPE.

3.3 Stage 2: Additional Groundwater Sampling

The Initial Phase I Site Investigation (Stage 1) identifies the initial data collection effort to refine the characterization of solid materials and groundwater within the BRW Site. To supplement the data collected during the Initial Phase I Site Investigation (Stage 1), field personnel will collect a water sample from each piezometer and monitoring well identified in Table 2. Each sample will be collected using the appropriate sampling equipment (e.g., peristaltic pump, submersible pump, or bladder pump) in conjunction with a low-flow sampling methodology identified in the applicable SOPs (Appendix 2) and approved by the FTL or CPM. Locations MW-01-MPC, MW-02-MPC, MW-03-MPC, and MW-03A-MPC have been added to the sampling locations for this additional sampling event. The samples will be submitted to the laboratory for the specified analyses identified in Table 3.

3.4 Stage 3: Hydrocarbon Investigation

The main objectives of the Hydrocarbon Investigation include:

- Further refine the nature and extent of the hydrocarbon-impacted material and differentiate primary and secondary source areas.
- Provide sufficient data to develop a groundwater flow model as part of the Phase II Site Investigation to determine the effect of the pumping test and/or future construction dewatering activities to on-site dissolved hydrocarbons and/or LNAPL.

Efforts completed as part of the Hydrocarbon Investigation will include a records review, installing hydrocarbon monitoring wells, and collecting groundwater samples. During the Hydrocarbon Investigation, opportunistic soil and groundwater samples will be taken and tested for COCs in order to aid in the design of the BRW hydraulic control and assist in determining the appropriate waste removal depth for the RA.

Data collected from the Initial Phase I Site Investigation will be used to inform the efforts completed as part of the Hydrocarbon Investigation. Preliminary data from the Initial Phase I Site Investigation are listed in Table 6 through Table 11 and shown on Figure 23 and Figure 24.

3.4.1 Records Review

Prior to the Hydrocarbon Investigation, previous investigations (such as the 2016 Test Pit Investigation by TetraTech and the 2018 Phase I Site Investigation) observed LNAPL and/or a sheen on the groundwater surface in some areas on the BRW Site, and the initial Phase I Site Investigation (Stage 1) determined that there are dissolved hydrocarbons in the groundwater within the Site. Determining the source of dissolved hydrocarbons and LNAPL is to mitigate further impacts to the groundwater.

The long history of mining and industrial use of the BRW Site was examined in preparation of this BRW Phase I QAPP. However, the initial investigation of the Phase I Site Investigation (Stage 1) focused on the COC-impacted materials and did not thoroughly examine the potential hydrocarbon impacts from the mining and industrial activities at the BRW Site. The records review will examine historical and contemporary records to identify potential sources of the hydrocarbons.

The records review will also cover examination of the storage tank releases in the neighboring sites. For example, the following neighboring sites have documented releases of hydrocarbons:

- 400 Oxford Street: Location of a leaking underground storage tank managed by Montana DEQ in 1995 (DEQ, 2019).
- 1759 South Montana Street: Formerly the location of Cenex Convenience Store. The site received reimbursement from the Petroleum Tank Release Compensation Board for releases in 1990 and 2006 (DEQ, 2018b).

3.4.2 Hydrocarbon Monitoring Wells

The purpose of the hydrocarbon monitoring wells is to better delineate hydrocarbon groundwater impact at the BRW Site and detect potential LNAPL on the groundwater table. Note that initial Phase I (Stage 1) piezometers are not appropriate for detecting LNAPL on the groundwater table because the screens were installed below the groundwater table and within the shallowest conductive alluvium.

Thirteen 2-inch monitoring wells will be installed at the locations shown on Figure 10 (see Figure 22). Field personnel will have the option to install additional wells depending on BRW Site conditions and initial field evaluations of LNAPL and PID readings.

The location of each hydrocarbon well may be adjusted based on the information obtained during the field investigation and/or to accommodate BSB activities on the BRW Site. Field personnel will contact BSB to determine a location that accomplishes the purpose of the monitoring well while not greatly impeding BSB activities.

Below is a summary of the purpose and justification for each well.

BRW19-HCW30

Purpose: Monitoring well BRW19-HCW30 is paired with piezometer BRW18-PZ22 (Figure 10). Monitoring well BRW19-HCW30 will be used to determine if LNAPL exists or if dissolved hydrocarbon concentrations in groundwater exceed RBSLs (DEQ, 2018a) near piezometer BRW18-PZ22, where the presence of hydrocarbons was detected during a previous investigation.

Justification: During the Initial Phase I Site Investigation (Stage 1), piezometer BRW18-PZ22 did not contain detectible hydrocarbons in the soil at the groundwater table (approximately 13.7 feet bgs). Hydrocarbons were detected much lower, at approximately 35 feet bgs. The absence of hydrocarbon-impacted soil near the groundwater table could be due to the hard layer of slag within which the groundwater table rests. Field personnel logged a significant slag presence above and below the groundwater table. The drillers noted that the drilling was very difficult through the slag layers and they had to use 225 gallons of water to drill from 2 feet to 20 feet (Appendix 5 and Appendix 6).

Hydrocarbons were detected near the groundwater table in borehole BRW18-BH05, which is located very near to piezometer BRW18-PZ22. While the slag layer at piezometer BRW18-PZ22 might prevent an LNAPL from moving through this layer, the presence of hydrocarbons in borehole BRW18-BH05, which is downgradient from piezometer BRW18-PZ22, may indicate that the hydrocarbons are moving through this layer and were not detected in the drill cuttings due to the addition of water during drilling (Appendix 5 and Appendix 6).

BRW19-HCW31

Purpose: Monitoring well BRW19-HCW31 will be paired with piezometer BRW18-PZ23 (Figure 10). Monitoring well BRW19-HCW31 will be used to determine if LNAPL exists or if dissolved hydrocarbon concentrations in groundwater exceed RBSLs (DEQ, 2018a) near piezometer BRW18-PZ23 and test pit BRW-TP-11 (Figure 11), where the presence of hydrocarbons was detected during previous investigations.

Justification: Piezometer BRW18-PZ23 has hydrocarbon impacts in the slag layer located at the groundwater table (Appendix 5 and Appendix 6). The nearby test pit BRW-TP-11 had a reported hydrocarbon sheen on the groundwater surface (NRDP, 2016a) (Figure 11).

It is important to note that the hydrocarbons and the groundwater table at piezometer BRW18-PZ23 are located near the same elevation as the slag layer (Appendix 5 and Appendix 6). The presence of hydrocarbons in the slag suggests that this layer is fractured enough to allow LNAPL (and groundwater) to move through the slag.

BRW19-HCW32

Purpose: Monitoring well BRW19-HCW32 (Figure 10) is an unpaired well. Monitoring well BRW19-HCW32 will be used to determine if LNAPL exists or if dissolved hydrocarbon concentrations in groundwater exceed RBSLs (DEQ, 2018a) to the north and downgradient of test pit BRW-TP-10 (Figure 11) and piezometer BRW19-PZ19, where the presence of hydrocarbons was detected during previous investigations.

Justification: NRDP test pit BRW-TP-10 had a reported hydrocarbon sheen on the groundwater surface and a flame ionization detector reading of 138 parts per million (ppm) from the soil at 10 feet bgs (NRDP, 2016a). The field logs for piezometer BRW18-PZ19 indicate the presence of hydrocarbons (indicated with PID measurements) in the soil near the groundwater table (Appendix 5).

BRW19-HCW33 and BRW19-HCW34

Purpose: Monitoring wells BRW19-HCW33 and BRW19-HCW34 are unpaired wells placed downgradient (BRW19-HCW33) and near (BRW19-HCW34) borehole BRW18-BH11. Monitoring wells BRW19-HCW33 and BRW19-HCW34 will be used to determine if LNAPL exists or if dissolved hydrocarbon concentrations in groundwater exceed RBSLs (DEQ, 2018a) near the confirmed hydrocarbon-impacted soil at borehole BRW18-BH11 (Figure 10).

Justification: Soil from borehole BRW18-BH11 has the highest total extractable hydrocarbon soil concentrations observed during the initial Phase I Site Investigation (Stage 1) (Table 6 through Table 8).

BRW19-HCW35

Purpose: Monitoring well BRW19-HCW35 (Figure 10) is an unpaired well and will be used to determine if LNAPL exists or if dissolved hydrocarbon concentrations in groundwater exceed RBSLs (DEQ, 2018a) downgradient of reported hydrocarbon impacts at test pits BRW-TP-04 and BRW18-TP17 and piezometer BRW18-PZ13.

Justification: Field personnel reported a hydrocarbon sheen in test pit BRW-TP-04 (NRDP, 2016a), and hydrocarbons were observed near the soil surface in test pit BRW18-TP17 (Appendix 5). Reported dissolved hydrocarbons concentrations at piezometer BRW18-PZ13 exceed RBSLs (DEQ, 2018a).

BRW19-HCW36

Purpose: Monitoring well BRW19-HCW36 will be paired with piezometer BRW18-PZ13 (Figure 10). Monitoring well BRW19-HCW36 will be used to determine if LNAPL exists or if dissolved hydrocarbon concentrations in groundwater exceed the RBSLs (DEQ, 2018a) near the groundwater table at this location, which is along the southern boundary of the BRW Site.

Justification: The groundwater sample from piezometer BRW18-PZ13 contained dissolved groundwater hydrocarbons in concentrations exceeding RBSLs (Table 9 through Table 11; and DEQ, 2018a).

BRW19-HCW37

Purpose: Monitoring well BRW19-HCW37 will be paired with piezometer BRW18-PZ21 (Figure 10). Monitoring well BRW19-HCW37 will be used to determine if LNAPL exists or if dissolved hydrocarbons concentrations in groundwater exceed RBSLs (DEQ, 2018a) near the groundwater table at this location.

Justification: During the drilling of piezometer BRW18-PZ21, hydrocarbons were reported in the soil above and below the groundwater table, and the groundwater sample from this piezometer had dissolved hydrocarbon concentrations above RBSLs (DEQ, 2018a) (Table 9 through Table 11).

BRW19-HCW38

Purpose: Monitoring well BRW19-HCW38 will be paired with piezometer BRW18-PZ20 (Figure 10). Monitoring well BRW19-HCW38 will be used to determine if LNAPL exists in conjunction with the reported hydrocarbon impacts at paired piezometer BRW18-PZ20 and/or test pit BRW-TP02 (Figure 11).

Justification: Soil samples collected while installing piezometer BRW18-PZ20 contained hydrocarbons at the ground surface and near the groundwater table (Appendix 5). Field personnel reported free-phase hydrocarbon product in nearby test pit BRW-TP-02 (NRDP, 2016a).

BRW19-HCW39

Purpose: Monitoring well BRW19-HCW39 will be paired with piezometer BRW19-PZ18 (Figure 10). Monitoring well BRW19-HCW39 will be used to determine if LNAPL exists or if dissolved hydrocarbon concentrations in groundwater exceed RBSLs (DEQ, 2018a) near piezometer BRW19-PZ18, where the presence of hydrocarbons was detected during a previous investigation.

Justification: Piezometer BRW18-PZ18 contained dissolved groundwater hydrocarbons in concentrations exceeding RBSLs (Table 9 through Table 11) (DEQ, 2018a), and field personnel also found hydrocarbons in the soil above and below the groundwater table (Appendix 5).

BRW19-HCW40

Purpose: Monitoring well BRW19-HCW40 will be paired with piezometer BRW18-PZ12 (Figure 10). Monitoring well BRW19-HCW40 will be used to determine if LNAPL exists or if dissolved hydrocarbon concentrations in groundwater exceed RBSLs (DEQ, 2018a) along the southern boundary of the BRW Site near BRW18-PZ12, where the presence of hydrocarbons was detected during a previous investigation.

Justification: Field personnel found hydrocarbons in the soil near the groundwater table while drilling piezometer BRW18-PZ12 (Appendix 5).

BRW19-HCW41

Purpose: Monitoring well BRW19-HCW41 (Figure 10) is an unpaired well and will be used to determine if LNAPL exists or if dissolved hydrocarbon concentrations in the groundwater exceed RBSLs (DEQ, 2018a) along the southern boundary of the BRW Site. Note, the location of monitoring well BRW19-HCW41 may need to be adjusted to accommodate existing utilities.

Justification: Monitoring well BRW19-HCW41 is located along the southern boundary of the BRW Site and upgradient from the proposed hydrocarbon test pits and the hydrocarbon monitoring wells BRW19-HCW33, BRW19-HCW34, and BRW19-HCW35.

3.4.2.1 Hydrocarbon Well Construction

The hydrocarbon wells will be installed using a rotary sonic drill rig to provide continuous core samples and to drill through the slag. The general borehole drilling procedures outlined in Section 3.2.3 will be followed, including the collection and logging of soil core and screening with PIDs. Hydrocarbon and metals samples, however, will only be collected at unpaired well locations as indicated in Table 2, unless field personnel find it necessary based on field conditions.

Installation of hydrocarbon monitoring wells will follow the general procedures in Section 3.2.4. The screen will be placed across the groundwater table to detect potential LNAPL and may be extended to the first layer of conductive material below the groundwater table. After drilling to the specified depth (Table 2), a 15-foot, schedule 40, 2-inch PVC well screen will be set approximately 5 feet above and 10 feet below the groundwater table (Figure 22). Field personnel will be provided with an updated groundwater elevations map to assist in determining the appropriate screened interval at each location.

3.4.3 Site-Specific Installation Concerns

Heaving sands have previously been encountered on the BRW Site and need to be anticipated. To prevent formation of heave inside the drill rod, potable water will be added to the drill strings as they are advanced. This added water will minimize the entry of heaving sands into the drill string by providing positive pressure inside the drill string as the core sample is retrieved or the well screen is set. Water will be added only when needed and not on a routine basis.

3.4.4 Hydrocarbon Test Pits

Additionally, three test pits (BRW19-HCTP30, BRW19-HCTP31, and BRW19-HCTP32) will be excavated for the Hydrocarbon Investigation to fill data gaps to the north and east of borehole BRW18-BH11 (Figure 10). The test pits will be excavated until the excavator hits refusal, 2 to 3 feet below the groundwater table to a maximum depth of 15 feet. Soil samples will be taken according to Section 3.2.2.2. At the discretion of field personnel, additional test pits may be constructed to fill additional data gaps.

3.4.5 Logging and Soil Sampling

Classification and lithology of the core from each borehole and the sidewalls of each test pit will be logged and photographed following the general procedures presented in Section 3.2.2.2 and Section 3.2.3.2. Prior to photographing and logging, the core will be split down the center and laid out in two halves. The depth of the core below the ground surface will be marked along the side of the core on a white board. Photographs will be framed to capture 2-foot segments of the core at a time, with minimal overlap. Cores will be stored as described in Section 3.2.3.3.

If the presence of hydrocarbons is detected (via sight, smell, and/or detection with a PID) in the cores from the sonic rig or in the test pit soil, a sample will be collected for hydrocarbon analyses. All visual and olfactory observations of suspected hydrocarbons will be confirmed with a PID prior to collecting a sample. If a visual or olfactory observation is not confirmed with a PID or sampling results, this will be noted in the field logbook. For all boreholes and test pits, a soil sample will be collected, when possible, near the top of the saturated layer (in the capillary fringe) for hydrocarbon analyses (Table 2 and Table 3) even if no there is no evidence of hydrocarbons. Hydrocarbon analyses will not be conducted at locations that are paired with deeper Initial Phase I Site Investigation (Stage 1) points if that location was previously sampled for hydrocarbons.

Samples for metals analyses will be collected as per the general procedures outlined in Section 3.2.2.2 (test pits) and Section 3.2.3.2 (boreholes) with the following exceptions. For unpaired hydrocarbon monitoring wells and for the hydrocarbon test pits, a sample will be collected from each lithological layer observed in the core at the discretion of the field personnel. Opportunistic field metals analysis will be conducted for each material horizon via the XRF unit, unless determined otherwise by field personnel. Based on the XRF analyses, a sample will be collected from the first lithological layer in each boring or test pit which passes the Waste Identification Screening Criteria (EPA, 2018b) and submitted for metals analysis via ICP-OES, unless determined otherwise by field personnel. Samples will not be collected at locations immediately adjacent to the deeper paired investigation points from the Phase I Site Investigation.

Samples will be collected as per SOP-S-06 (Appendix 2). The general procedures for the field analysis methods for the XRF and PID units are included in Section 3.9.

3.4.6 Groundwater Sampling

Once the hydrocarbon wells have been installed, field personnel will collect samples from the hydrocarbon wells (BRW19-HCW30 to BRW19-HCW41), from two existing monitoring wells within the BRW Site (BPS11-05A1 and BPS07-13A), and four existing monitoring wells on NorthWestern Energy property (MW-01-MPC, MW-02-MPC, MW-03-MPC, and MW-03A-MPC) located to the south of the BRW Site. Depending on field conditions, additional groundwater samples may be collected from additional monitoring wells to ensure sufficient data are collected during field activities. The field observations and analytical results will be used to determine the existence of LNAPL and the nature and extent of hydrocarbon impact.

If an LNAPL layer is detected on the groundwater table using an interface probe, the well will not be developed. If sufficient LNAPL thickness is observed (at least 0.2 feet), baildown tests will be performed to determine the LNAPL transmissivity of the subsurface material (Section 3.4.7). During the baildown test, a sample of LNAPL will be collected for laboratory analysis (Table 3). Once the LNAPL layer has been sampled, field personnel will bail out any remaining LNAPL and use low flow sampling to take groundwater samples for dissolved metals analysis. If the interface probe shows no presence of LNAPL, field personnel will develop the well and take samples as indicated in the SOPs, Table 2, and Table 3

If LNAPL is detected, field personnel will attempt to make sure the pump's inlet is slightly below the top of the groundwater table to avoid interference of hydrocarbons with the probe. Additionally, the ORP probe will be cleaned between wells, following the manufacturer's instructions, to remove any hydrocarbons that may interfere with the readings.

Table 2, Table 3, and the SOPs list the sampling and analysis procedures.

3.4.7 Hydrocarbon Baildown Tests

If the new hydrocarbon monitoring wells have measurable LNAPL (at least 0.2 feet), a baildown test will be performed where the rapid removal of floating hydrocarbons is performed followed by monitoring the hydrocarbon recovery. The tests will be conducted following the baildown tests procedures described in the *American Petroleum Institute LNAPL Transmissivity Workbook: A Tool for Baildown Test Analysis User Guide* (Appendix 2) (API, 2016). These tests, if performed, will provide a useful measure of potential hydrocarbon lateral mobility (transmissivity) within the groundwater environment. By conducting baildown tests, LNAPL transmissivity can be calculated to help determine if active LNAPL recovery is a viable remedial alternative.

3.5 Standard Operating Procedures

This BRW Phase I QAPP includes SOPs that apply to particular field activities, and the SOPs are referenced in the appropriate sections throughout this report and are included in Appendix 2. Depending on circumstances and needs, it may not be possible or appropriate to follow the SOPs exactly in all situations due to BRW Site conditions, equipment limitations, and limitations of the standard procedures. When necessary to perform an activity that does not have a specific SOP or when the SOP cannot be followed, existing SOPs may be used as a general guidance or similar SOPs (not listed in this report) may be adopted if they meet the project DQOs. All modifications or adoptions will be approved by the FTL, CPM, and Contractor QAO and documented in the field logbook and/or the final project report, as appropriate.

3.6 Sample Labeling and Identification

Soil Samples

A sample number system will be used to uniquely identify the project site, the sample medium, and the specific sample location and depth interval. The sample identification number will be derived from the test pit, borehole, or piezometer number with the Site Name followed by the sample interval enclosed in parentheses. For example, a sample designated BRW18-TP02(1.6-3.1) describes a sample from test pit BRW18-TP02 taken from a depth of 1.6-3.1 feet below existing grade. All measurements will be decimal feet. There will be no blank spaces permitted in the identification. The following is an example of the sample numbering system:

Sample Number: **BRW18-TP02(1.6-3.1)-07192018**

Location/Year: *"BRW18"* - BRW project area, collected in 2018.
Media: *"TP"* – Test Pit, *"BH"* – Borehole.
Number: *"02"* – Sample Location (corresponds with Test Pit or Borehole ID No.). All sample locations will be plotted on the sampling maps.
Depth Interval: *"(1.6-3.1)"* (upper limit-lower limit). If sample is a duplicate, label the interval "A" or "T". Do not use specific intervals. Intervals and duplicates will be recorded in the field log or logbook.
Date: *"07192018"* - sample collected on July 19, 2018.

All subsample locations and depths will be described in the data log. The field logbook will include the subsample locations plotted on the site sketch. All samples will be labeled in the field with documentation of the date and time of sample collection, the sample number, analyses requested, and the sampler's initials. A permanent marker will be used for labeling.

All test pit/soil boring samples will be collected and sealed in plastic bags or jars. The sample ID, date, and depth interval of the sample will be written on the sample container with an indelible marker. If the sample is collected from a soil boring, the core will be sealed in a plastic bag and then that bag and an adhesive sample tag with the number will be placed inside a second bag to ensure the sample does not become separated from the tag.

Samples will be stored, handled, and packaged as described in Section 3.8 and Table 3. A copy of the chain of custody record will accompany the samples during shipment and will serve as the laboratory request form. The chain of custody form will specify the type of analysis requested for each individual sample. The original form will be maintained with the field notes and in the project records.

Groundwater Samples
As with soil sampling, a sample number system will be used to uniquely identify the project site, the sample type, and the specific sample location. The following is an example of the sample numbering system:

Sample Number: BRW18-PZ02T-07192018

Location/Year: *"BRW18"* - BRW project area, collected in 2018.
Media: "*PZ*" – Sampled from a piezometer in BRW.
Location: "*02*" – Piezometer location.
Duplicates: "T" or "A"– Duplicates or "Twin" samples will be recorded on the field log or logbook .
Date: *"07192018"* - sample collected on July 19, 2018.

A permanent marker will be used for labeling. All groundwater samples will be collected in the appropriate groundwater sample container, with preservative in place from the laboratory (if necessary). Samples will be taken or shipped to the identified laboratory for analyses. Samples will be stored, handled, and packaged as described in Section 3.8 and Table 3. A copy of the chain of custody record will accompany the samples during shipment and will serve as the laboratory request form. A chain of custody form will be completed that specifies the type of analysis requested for each individual sample. The original form will be maintained with the field notes and in the project records.

3.7 Field Documentation

3.7.1 Field Logbook

To provide a permanent record of all field activities, field personnel will document all activities in a bound field logbook (refer to field SOPs in Appendix 2). This will include a description of site conditions during sampling activities. When field logbooks are used, each logbook will have a unique document control number, be bound, and have consecutively numbered pages. All entries will be in waterproof ink, and any mistakes will be lined out with a single line and initialed by the person making the correction. Whenever a sample is collected or a measurement is made, a detailed description of the sample location and any additional observations will be recorded. The GPS coordinates will be recorded when appropriate. Individual field team members may be responsible for required documentation based on specific tasks assigned by the FTL or CPM.

All significant observations, measurements, relevant data, and results will be clearly documented in the data log or the field logbook. At a minimum, the following will be recorded:

- A description of the field task.
- Time and date fieldwork started.
- Location and description of the work area including sketches if possible, map references, and references to photographs collected.
- Names and titles of field personnel.
- Name, address, and phone number of any field contacts or site visitors (e.g., Agency representatives, auditors, etc.).
- Meteorological conditions at the beginning of fieldwork and any ensuing changes in the weather conditions.
- Details of the fieldwork performed and the FDS used.
- All field measurements made.
- Any field analysis results.
- Personnel and equipment decontamination procedures.
- Deviations from this BRW Phase I QAPP or applicable field SOPs (Appendix 2).

For test pits, boreholes, and piezometers the following entries will be made:

- Lithologic log of the test pit/test boring indicating material types, from and to depths, rock content, color, presence of water, etc. will reference FDS completed in the field.
- Depth intervals from the ground surface for each soil horizon and total depth of the test pit/test boring.

- Depth-to-groundwater from the ground surface, identifying the depth at which water is seen initially flowing into the test pit (if applicable).
- Water pH, SC, and Eh when it begins flowing into pit and after the water level in the test pit stabilizes (if applicable).
- After a piezometer is installed (if applicable), record the height of stickup from the ground surface and the distance from the measuring point (MP) at the top of the piezometer to the water table.
- Photograph or video of each test pit/test boring or trench with a staff gage or tape measure for scale to document existing conditions. Include site name ID in photograph using a white board or note pad.
- Abnormal occurrences, deviations from this BRW Phase I QAPP, or other relevant observations.

For any field sampling work the following entries will be made:

- Sample location and ID number.
- Sample type collected.
- Date and time of sample collection.
- Sample location descriptions and designations, soil type and texture (e.g., sand, silt, etc.), grain-size, and color (in the field). Further sample information will be included with the laboratory results.
- Split samples taken by other parties (note the type of sample, sample location, time/date, name of individual, individual's company, and any other pertinent information).
- Sampling method, particularly any deviations from the field SOPs (Appendix 2).
- Documentation or reference of preparation procedures for reagents or supplies that will become an integral part of the sample (if any used in the field).
- Sample preservation (if used).

For boreholes and piezometers, the lithologic and completion information will be transcribed into a spreadsheet or database that can be used with Strater® or other appropriate lithologic log software.

3.7.2 Field Photographs

Photographs will be taken of sampling locations and field activities using a digital camera. When practical, photographs should include a scale in the picture as well as a white board with relevant information (e.g., time, date, location, sample number, etc.). Additional photographs documenting site conditions will be taken, as necessary. Documentation of all photographs taken during sampling activities will be recorded on FDS and/or referenced in the bound field logbook or appropriate FDS (refer to field SOPs in Appendix 2), and will specifically include the following for each photograph taken:

- Time, date, and location.

- Photograph or video number from the camera or video recorder.
- The identity of the person taking the photograph/video.
- Direction that the photograph was taken and description of the subject photographed.

The digital files will be placed with the electronic project files with copies of supporting documentation from the bound field logbooks.

3.8 Sample Handling, Documentation, and Shipping

As applicable, samples will be either hand-delivered or shipped via Federal Express to the appropriate laboratory under strict EPA chain of custody procedures. Samples will be shipped in appropriate containers that will prevent detrimental effects to the sample.

Sample containers and holding times are listed in Table 3. All procedures will strictly follow appropriate protocols and field SOPs in Appendix 2. Chain of custody records will be kept with the samples and custody seals will be placed on the sample storage containers (coolers).

All samples not submitted to the laboratory will be archived. When it is determined that the samples are no longer needed, they will be disposed at the Mine Waste Repository.

3.8.1 Chain of Custody

The SOP for chain of custody (SOP-SA-04) is in Appendix 2. Maintaining the integrity of the sample from collection through data reporting is critical to the sampling and analytical program. This process includes the ability to trace the possession and handling of samples from the time of collection through analysis and final disposition. This documentation of the sample's history is referred to as chain of custody. A sample is considered to be under an individual's custody if it is in that individual's physical possession, in view of the individual after taking possession, or secured by that individual so that no one can tamper with the sample.

The components of the field chain of custody (chain of custody form, labels, and custody seals) and laboratory chain of custody (chain of custody form, custody seals, and laboratory custody) are described in this section.

3.8.2 Chain of Custody Form

A chain of custody form will be completed and will accompany every sample. A standard form will be provided from each laboratory. The form will include the following information:

- Project code.
- Project name.
- Sampler’s signature.
- Sample identification.
- Date sampled.

- Time sampled.
- Analysis requested.
- Remarks.
- Relinquishing signature, date, and time.
- Receiving signature, date, and time.

3.8.3 Custody Seals

Custody seals are used to detect unauthorized tampering with samples following sample collection up to the time of analysis. Custody seals will be applied to the shipping containers when the samples are not in the sampler's custody.

3.8.4 Laboratory Custody

Laboratory custody procedures will conform to procedures established for the EPA CLP (EPA, 2016). These procedures include the following:

- Designation of sample custodian.
- Correct completion of the chain of custody form, recording of sample identification numbers, and documentation of sample condition upon receipt.
- Laboratory sample tracking and documentation procedures.
- Secure sample storage.

The samples will be delivered to the laboratory for analysis in a timely manner to ensure the requested analyses can be performed within the specified allowable holding times. The sample will be hand delivered or addressed to a person in the laboratory who is authorized to receive samples (laboratory sample custodian).

3.9 Field Analysis Methods

This section describes field analysis methods, including XRF analysis, field soil nitrate testing, PID Screening, and CHEMetrics Field Kit testing.

3.9.1 XRF Analysis

Limited XRF analysis will be conducted in the field to refine the total mass of arsenic, cadmium, calcium, chromium, copper, iron, lead, manganese, and zinc from materials within the BRW Site. Field XRF analysis will be used mainly as a guide to determine the depth of test pits and boreholes, to identify materials from test pits that are to be submitted to the laboratory for SPLP (Section 3.10.2), and as deemed necessary based on field observations, as outlined in Table 2 and Table 3. Most XRF analysis will be conducted at Pioneer's field office at 244 Anaconda Road in Butte, Montana, after sampling activities have finished.

Sample Preparation

Prior to completing analysis with the XRF, any large aggregate will be removed from the sample. For gravel or rocky soil, a sieve may be used to remove the large aggregates. For analysis completed at Pioneer's field office, samples will be dried prior to analysis. For analysis completed in the field, samples will be dried if conditions allow and deemed necessary by field personnel. If a portable heater or oven is used to dry samples, the sample will be dried while maintaining a temperature that does not exceed the boiling point of water (100 degrees Celsius [°C]).

Use of XRF Meter

The XRF analysis will be conducted using a Niton™ XL3 XRF Analyzer (XL3) and following the procedures outlined in SOP-SFM-02 (Appendix 2) and the XL3 user manual to ensure that the techniques employed are appropriate for the analytes of interest (Table 2 and Table 3). Samples will be collected in a ziplock bag and mixed. The samples will then be placed in a small plastic cup with a mylar film cover for analysis. Depending on field conditions, sample preparations and XRF analysis run times may be adjusted to suit each field condition encountered as determined by the FTL, CPM, and the Contractor QAO.

3.9.2 Soil Nitrate Test

As defined in the DQOs (Section 2.5), part of selecting appropriate samples for SPLP analysis includes conducting a soil nitrate test on select samples. It is anticipated that the soil nitrate tests will be performed in the field and at Pioneer's field office at 244 Anaconda Road in Butte, Montana. The materials needed to complete the soil nitrate test include the following:

- 1/8-cup (30 milliliters [mL]) measuring scoop.
- 120-mL plastic containers with lids.
- Filter paper.
- Eye dropper.
- Nitrate/nitrite test strips (with a low detection limit).
- Stopwatch or timer.
- Distilled water.

The following procedures will be followed to complete the soil nitrate test:

- **Extract subsample**: Mix the soil sample thoroughly before taking a subsample. Measure a 1/8-cup level scoop subsample of soil and place it in the plastic container.
- **Add water to subsample and mix**: Add 1/8 cup (30 mL) of distilled water to the container with the subsample. Put the lid on the container and shake vigorously about 25 times.
- **Insert filter paper into subsample**: Fold the filter paper in half (into a semicircle). Fold it again, but not quite into a quarter-circle. Open the filter paper into the shape of a cone and push it (pointed part first) quickly into the jar with the soil/water mixture until it touches the bottom of the jar. Wait until about an eye dropper full of the solution has seeped through to the inside of the filter paper.
- **Place drops on nitrate strips:** Using the eye dropper and one nitrate/nitrite test strip, place 1

or 2 drops of the filtered solution onto the test strip. Note the time.

- **Measure and record nitrate:** After 60 seconds, align the nitrate/nitrite test strip with the nitrate scale shown on the bottle. Estimate the nitrate amount according to the degree of color change. Enter the value from the nitrate scale in the field logbook. This value is an estimate of nitrate-N concentration in the extract, and it will be used with lead as a predictable surrogate for identifying the presence of extractable copper.

The procedure for soil nitrate test above is adopted from the U.S. Department of Agriculture (USDA) Soil Quality Test Kit Guide (USDA, 1999).

3.9.3 PID Screening Analysis

The hydrocarbon screening will be conducted using one and/or two PIDs, one with a 9.8 eV lamp and another with a 10.6 eV lamp. The procedures for using the PID unit are summarized below, and additional detail is included in the MiniRae 3000 User's Manual (Appendix 7). If another PID unit is used, the user's manual for that unit will be followed.

Initially, the PIDs will be used to detect hydrocarbons from soil with visual evidence of soil staining or if an odor is detected. A slow sweeping motion will be used to detect hydrocarbons with the PID for surface samples, soil from test pits, and borehole cores. For surface samples, the PIDs will be used to screen areas with heavy vehicle traffic, maintenance areas, or areas with industrial activities (historical and current). For soil from test pits, the PIDs will be used to screen the soil within the test pit immediately after excavation (if it is safe to enter the pit) or the PIDs will be used to screen the soil immediately after they are excavated. For boreholes, the PIDs will be used to screen the cores immediately after they are split.

Once it has been determined that VPHs might be present, a combustible gas meter will be used to monitor the atmosphere for hazardous conditions. If these conditions are present, appropriate action will be taken by safety personnel; if not present, a portion of the sample will immediately be collected in the appropriate sample container (Table 3) and the remainder placed in a ziplock bag with air space at the top above the sample (headspace) to allow testing using the headspace screening method. For the headspace screening method, the sample is brought to room temperature, the sample is mixed or shaken depending on soil type to allow the contaminants to volatilize, and then the PID probe is inserted into the bag and the headspace concentration is measured and recorded.

3.9.4 CHEMetrics Field Kit

Samples will be collected in the field sample cups provided in the CHEMetrics field kits. Using the glass vacuum ampules, pre-filled with the appropriate colorimetric reagents, field personnel will snap open the ampule at the base of the sample cup and pull in a water sample. After the prescribed color development time, field personnel will place the ampule in a colorimeter that has been previously calibrated at the correct analytical wavelength, as provided in the manual. A CHEMetrics V-2000 multi-analyte photometer (or equivalent) will be used along with CHEMetrics V-2000 ampules and field samples cups (or equivalent). Detailed procedures can be downloaded from CHEMetrics V-2000 multi-analyte photometer (or equivalent) before the analysis of each sample. Sample cups will be rinsed and decontaminated following SOP-DE-02 (Appendix 2) between each sample.

3.10 Laboratory Analysis Methods

This section details laboratory analysis required for total metals, SPLP, hydrocarbons, PCBs, asbestos, and groundwater. Sample locations and types are provided in Table 2 and Table 3. Standard laboratory turnaround times will be requested.

Additionally, for each stage of the BRW Phase I Site Investigation (Stage 1, Stage 2, and Stage 3) the anticipated laboratory methods to be used are listed in Table 3. Laboratory analyses of samples collected during the course of this study will be performed by laboratories with established protocols and quality assurance (QA) procedures that meet or exceed EPA guidelines.

3.10.1 Total Metals and General Parameters

Samples collected from test pits and boreholes will be sent for laboratory metals analysis and analyzed by ICP-OES. Additionally, samples will be collected for pH and SC during Stage 1 and Stage 3 of the BRW Phase I Site Investigation. Table 3 includes the analyte list and a description of the analytical technique. The ICP-OES laboratory sample results will also be used to identify materials that are to be analyzed for SPLP (Section 3.10.2).

3.10.2 SPLP Method

During Stage 1 and Stage 3, a select group of soil samples (from each major type of impacted material including poured slag, tailings, demolition debris, peat/organic soil, and alluvium) will be selected by field personnel to be analyzed for SPLP for the groundwater analytes detailed in Table 3. Sufficient material will be provided to the selected laboratory (Table 2 and Table 3) for the additional SPLP analysis and those samples selected for blind duplicate analysis. Note that SPLP samples will be analyzed "as received" by the laboratory as per the SPLP extraction method and that the equilibrium pH of the SPLP extraction fluid will be recorded. All splitting of samples for duplicate and SPLP analysis will be completed prior to submittal. Extraction fluid #2 will be used for all SPLP.

Selection and Number of Samples
Those samples selected for SPLP analysis may come from the sample material previously collected in the field or from the archived core itself. Selection of these samples will be based on visual inspection of impacted material, the total number of SPLP samples per lithologic unit, and the following concentration action levels:

- For demolition debris material from test pits, one sample with the highest lead concentration (anticipated to be greater than 3,140 mg/kg) and no detectable nitrate concentration will be sent to the laboratory for SPLP analysis, unless determined otherwise by the FTL, CPM, and Contractor QAO. The lead concentration will be based on XRF results, and the nitrate concentrations will be based on the soil nitrate test results.

- For other material from test pits (not including tailings, slag, and demolition debris), up to 3 samples with the highest lead concentrations (anticipated to be greater than 3,140 mg/kg) and no detectable nitrate concentrations will be sent to the laboratory for SPLP analysis unless determined otherwise by the FTL, CPM, and Contractor QAO. The lead concentration will be based on XRF results, and the nitrate concentrations will be based on the soil nitrate test results. 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.
- For tailings, slag, demolition debris, and other materials (not including alluvium), up to 8 samples from each material taken from boreholes with the highest lead concentrations (anticipated to be greater than 3,140 mg/kg) and no detectable nitrate concentrations will be sent to the laboratory for SPLP analysis unless determined otherwise by the FTL, CPM, and Contractor QAO. 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. The lead and copper concentrations will be based on XRF or ICP-OES results (depending on the thickness of the material), and the nitrate concentrations will be based on the soil nitrate test results. 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.
    - For SPLP tests on massive slag material, it has been observed that SPLP test results can be greatly influenced by the degree of freshly fractured material that is included in the sample. Because slag is a form of glass, *in-situ* slag essentially encapsulates reactive material from weathering and is typically relatively inert. As grinding and crushing slag exposes fresh reactive material, laboratory SPLP testing on crushed slag has the potential to overestimate the leachability of the *in-situ* weathered slag found in soil and alluvium. To determine a more representative source term for *in-situ* weathered slag and separate out the potential effects of methodology, the following modifications to the SPLP procedures will be completed:
        - Prior to sample submission, smaller diameter slag pieces will be selected, but the pieces will not be crushed or ground further unless necessary.
        - For each slag sample, an SPLP test will be run at least twice, as follows:
            - The first SPLP test is anticipated to be representative of COC concentrations leaching from ground slag.
            - The second SPLP test (using the same sample material) is anticipated to be representative of COC concentrations leaching from *in-situ* weathered slag. Based on initial results, Atlantic Richfield may refine this approach and complete additional SPLP leaching tests on select slag samples (e.g., EPA Method 1315 or additional runs using EPA Method 1312).
- For alluvium from boreholes, up to 8 samples with the highest chromium (anticipated to be greater than 65 mg/kg) and iron (anticipated to be greater than 110,000 mg/kg) concentrations will be sent to the 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. The chromium, iron, and copper concentrations will be based on XRF or ICP-OES results (depending on thickness of material). 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.

At the discretion of the CPM and/or Contractor QAO, the analytical approach may be altered based on field observations or analytical results (e.g., no samples having concentrations greater than the thresholds listed above). Agency personnel will be notified prior to implementing a new analytical approach.

Correlation of Total Metals to SPLP Leachable Metals

Considering the selection of SPLP samples to quantify the source term, it should be noted that the correlation of concentrations for total lead concentrations in soil and SPLP lead leachate concentrations collected previously by Tetra Tech (NRDP, 2016a) was good (i.e., correlation coefficient [r^2] of 0.975). However, all other correlations between COCs by material were poor by comparison (i.e., 0.13 r^2 or less). Based on these correlations, identifying good candidates for SPLP samples by using total metals concentration alone would realistically only occur for elevated lead concentrations. Therefore, Step 5 of the DQOs (Section 2.5) contains an improved strategy.

3.10.3 Hydrocarbons

Soil that appears to contain hydrocarbons (via sight and/or smell or detection with a PID) will be analyzed for VPH and EPH fractionation with PAH. In addition to VPH and EPH fractionation with PAH analyses, Stage 1 will require splits of the soil samples also be collected and submitted to Torkelson Geochemistry for hydrocarbon range and Pristane/Phytane Ratio analysis to determine the type and relative age of any petroleum hydrocarbons encountered (Table 2 and Table 3).

During Stage 2 and 3 of this site investigation, soil that appears to be hydrocarbon impacted (via sight and/or smell or detection with a PID) will be analyzed for VPH, EPH fractionation with PAH, and lead scavengers (1,2 dichloroethane and 1,2 dibromoethane). Additional analysis of lead scavengers will determine the hydrocarbon impact to the groundwater table within the BRW Site.

It should be noted that Atlantic Richfield is not requesting Agency approval on hydrocarbon age dating. Hydrocarbon dating is not needed for remediation purposes; however, Atlantic Richfield is conducting this analysis as part of the initial Phase I investigation (Stage 1) for other purposes.

3.10.4 Polychlorinated Biphenyl

During Stage 1, the installation of boreholes near the historical transformer location (Figure 17) or any other test pit or borehole, field personnel will identify any signs of oily staining. If field personnel observe any oily staining, they will collect samples for laboratory analysis of PCBs (Table 2 and Table 3) and/or other appropriate analyses.

3.10.5 Asbestos

During Stage 1, the excavation of test pits near demolition debris (Figure 13), field personnel will identify any signs of building materials. If building materials are observed (with the exception of slab foundations), samples will be collected for laboratory analysis of asbestos (Table 2 and Table 3).

3.10.6 Groundwater Analysis

Groundwater samples will be analyzed for analytes specified in Table 2 and Table 3. The analytical procedures for these analytes are identified in Table 3. Low-flow sampling parameters will be used to estimate the hydraulic conductivity of the screened aquifer interval (Robbins et al., 2009).

Stage 1: Initial BRW Phase I Site Investigation

During the Initial BRW Phase I Site Investigation, groundwater samples will be collected for laboratory analysis as specified in Table 2 and Table 3. Groundwater samples will be collected to analyze for total and dissolved metals, bicarbonate (HCO_3), carbonate (CO_3), total alkalinity (as $CaCO_3$), sulfate (SO_4), and total and dissolved arsenic. Hydrocarbon groundwater samples will be collected and sent for laboratory analysis for VPH and EPH fractionation with PAH.

Stage 2: Additional Groundwater Sampling

Stage 2 includes collecting additional groundwater samples for total and dissolved metals, bicarbonate (HCO_3), carbonate (CO_3), total alkalinity (as $CaCO_3$), sulfate (SO_4), phosphate (PO_4), nitrate (NO_3)/nitrite (NO_2), and total and dissolved metals. Hydrocarbon groundwater samples will include collecting samples for VPH, EPH fractionation with PAH, and lead scavengers (1,2 dichloroethane and 1,2 dibromoethane). Laboratory analysis and hold times are shown in Table 2 and Table 3.

Stage 3: Hydrocarbon Investigation

Groundwater samples collected for the Stage 3 of the BRW Phase I Site Investigation are to be collected for the laboratory analysis listed in Table 2 and Table 3. Groundwater samples will be collected for total and dissolved metals, phosphate (PO_4), nitrate (NO_3)/nitrite (NO_2), and PCB. Hydrocarbon or LNAPL laboratory samples will be collected for VPH, EPH fractionation with PAH, lead scavengers (1.2 dichloroethane and 1.2 dibromoethane) and hydrocarbon fingerprinting scan. Laboratory analysis and hold times are shown in Table 2 and Table 3.

4.0 QUALITY ASSURANCE/QUALITY CONTROL

4.1 Field Quality Control Samples

Field quality control (QC) samples are used to identify any biases from transportation, storage, and field handling processes during sample collection, and to determine sampling precision. All field QC samples will be shipped with field samples to the laboratory per SOP-SA-01 (Appendix 2). Brief descriptions of the field QC samples are below along with when and how many are to be collected.

Field Duplicate

Field duplicates will be collected for the soil and groundwater sampling. A field duplicate is an identical, second sample collected from the same location, in immediate succession of the primary sample, using identical techniques. This applies to all groundwater and soil sampling procedures including instream grab samples, pumps, and other water sampling devices. The duplicate sample will have its own sample number. Duplicate samples will be sealed, handled, stored, shipped, and analyzed in the same manner as the primary sample. Both the primary sample and duplicate sample will be analyzed for identical chemical parameters by the laboratory. The analytical results of the primary and duplicate sample will be compared to determine sampling precision. Field duplicate samples will be collected at a frequency of 1 per 20 samples (for all soil and groundwater samples) or once per sampling event, whichever is more frequent.

Within the BPSOU area, all soil and water are required to be collected and contained within a specified containment area. Additional samples may need to be collected for determining proper treatment and/or disposal requirements for hydrocarbon-bearing soil and water. Duplicate samples are not required to be collected if these circumstances occur during field work.

Equipment, Cross Contamination, or Rinsate Blank

Equipment contamination blanks will be collected for the groundwater sampling effort. No equipment contamination blanks will be collected for the test pit and core collection sampling effort. All soil sampling equipment is anticipated to be *one time use*; the drilling augers, casing, drill rods, and samplers will be properly decontaminated between boreholes, and the excavator bucket will have gross contamination removed with a shovel between test pits. Therefore, no equipment, cross contamination, or rinsate blank samples will be submitted for soil sampling unless the equipment must be decontaminated and used between samples.

If equipment, cross contamination, or rinsate blank samples are necessary, they will be collected after sampling equipment is decontaminated or prior to sampling activities. An equipment blank is prepared by running distilled, deionized (DI) or analyte-free water through or over the cleaned, decontaminated sampling equipment, gathering the water in a sample collection bottle, and adding the appropriate chemical preservatives (Table 3). Analysis of the equipment blanks will assess the adequacy of the decontamination process as well as the potential contamination of samples by the containers, preservatives, and filters. The appropriate sample number will be placed on the collection bottle and recorded in the project logbook as an equipment blank. All sample containers collected for a natural sample should be duplicated for an equipment blank. A minimum of 1 equipment blank is required for every 20 natural samples collected.

Field Blank

Field blanks will be collected for the groundwater sampling effort. A field blank is a sample bottle containing DI or analyte-free water and appropriate preservatives that is prepared in the field. A sample bottle is randomly chosen from each lot of bottles received by the contract laboratory or supplier, and DI or analyte-free water is poured directly into the sample bottle while in the field and the bottle is preserved and shipped to the laboratory with the field samples. Field blanks must be prepared in the field and help evaluate the potential for possible contamination from the sampling environment. The field blank will have its own unique sample number and will be recorded in the project logbook as a field blank or bottle blank. Field blanks will be prepared at a frequency of 1 per 20 natural samples collected.

Temperature Blank

A temperature blank is a vial of water that accompanies the samples that will be opened and tested upon arrival at the laboratory to ensure that the temperature of the shipping container was within the required 4 °C plus or minus 2 °C. One temperature blank is required for each cooler shipped to the laboratory.

4.2 XRF Quality Control Samples

The XRF QC samples will be collected and used to assess the accuracy and precision of the field-generated XRF data. The XRF QC samples required are described below.

Energy Calibration Check

Field personnel will run a preprogrammed energy calibration check on the equipment at the beginning of each working day. If the individual believes that drift is occurring during analysis, that individual will run the energy calibration check. The energy calibration check determines whether the characteristic X-ray lines are shifting, which would indicate drift within the instrument.

Silicon Dioxide Standard

The silicon dioxide (SiO_2) sample, as provided by Niton, is a "clean" quartz or silicon dioxide matrix that contains concentrations of selected analytes near or below the machine’s lower limit of detection. These samples are used to monitor for cross contamination. Field personnel will analyze this sample at the beginning of each day, once per every 20 samples, and at the end of each day’s analysis. The sample information will be recorded as “SIO2” on the XRF FDS. This sample will also be analyzed whenever field personnel suspect contamination of the XRF aperture. Any elements with concentrations above the established lower limit of detection will be evaluated for potential contamination. If it is determined that the concentration is higher than that recorded at the start of the day, the probe window and the silicon dioxide sample will be checked for contamination. If it is determined that contamination is not a problem and the concentration is significantly above the limit of detection, the sample result will be qualified by the XRF operator as ‘J’ estimated and the problem recorded on the XRF field data sheet and in the logbook. If the problem persists, the XRF will be returned to Niton for calibration.

Calibration Verification Check Samples (Standards)
Calibration verification check samples help check the accuracy of the XL3 and assess the stability and consistency of the analysis for the analytes of interest. At least 1, and preferably 3, of the check samples will be analyzed at the start of each day, once per every 20 samples, and as the last analysis. Results for the check sample (standard reference material [SRM]) will be recorded on the individual site XRF FDS and identified as a check sample. There are 3 Niton-provided SRM check samples: NIST 2709a-Joaquin Soil (2709), USGS SdAR-M2 (SRM created by the U.S. Geological Survey [USGS]), and a Resource Conservation and Recovery Act (RCRA) sample. There are also Niton-provided, machine-specific expected results for several elements for the check samples. Pioneer has refined the range of expected results for each SRM standard for each of the field XRF units in use. The measured values of a standard will be compared to the expected results. If a measured value falls outside this range, then the check sample will be reanalyzed. If the value continues to fall outside the acceptance range, this information will be noted on the XRF log. If any of the check sample results indicate that the XRF is not analyzing accurately, the XRF will be cleaned, turned off, and the energy calibration rerun. This information will be noted in the logbook and on the XRF field data sheet. The batch of samples analyzed prior to the unacceptable calibration verification check samples will be reanalyzed. If one standard continues to be outside of the expected range, it may indicate that the standard has gotten contaminated and needs replacing. If more than one standard is falling outside of the expected range, Niton will be contacted and the machine may be returned for calibration.

Duplicate Samples
The XRF duplicate samples will be analyzed to assess reproducibility of field procedures and soil heterogeneity. To run a duplicate sample on the Niton XL3, field personnel will remove the sample cup from the analytical stand, knead it once or twice, and replace it in the stand to be analyzed a second time. Duplicate samples will be recorded on the XRF field data form with a D designator in the sample identification number. One duplicate sample will be analyzed per site or at the rate of 1 per 20 samples.

Replicate Samples
Field personnel will analyze a replicate sample at the rate of 1 per site or 1 per 20 XRF samples. To run a replicate sample on the Niton XL3, once the primary sample analysis has been completed, requires restarting the XRF to analyze the same sample a second time with the same soil in the XRF aperture. Replicate samples help in assessing the stability and consistency of the XRF analysis. Replicate sample results will be recorded on the XRF field data form and designated with an R in the sample identification number.

Confirmatory samples
The comparability of the XRF analysis with laboratory samples will be determined by submitting XRF-analyzed samples to the laboratory for analysis. The confirmatory analyses can be used to verify the quality of the field XRF data. All samples submitted to the laboratory will be analyzed using the field XRF prior to submittal, unless determined otherwise by the FTL, CPM, or Contractor QAO. The samples analyzed by XRF will be submitted to the laboratory for metals

testing, and the results will be used to verify XRF results and to develop a statistical relationship to the XRF results.

During verification and validation, it may be necessary to run additional XRF samples for analyses to collect sufficient data to aid the remedial design.

4.3 Laboratory Quality Control Samples

Laboratory QC samples are introduced into the measurement process to evaluate laboratory performance and sample measurement bias. Laboratory QC samples can be prepared from environmental samples or generated from standard materials in the laboratory per the internal laboratory SOPs. Available laboratory SOPs for this effort are included in Appendix 8. The various laboratory QA sample information is listed below.

Method Blank
The method blank (MB) samples will be prepared and analyzed for every 20 samples analyzed. The MB is laboratory deionized water that has gone through the applicable sample preparation and analysis procedure. Control limits vary based on the laboratory method performed and are contained in the applicable laboratory method and SOP. Failure will trigger corrective action, and the blanks will be reanalyzed. All samples affected will be footnoted with the appropriate flag to document contamination in the blank.

Laboratory Control Sample
The LCSs will be prepared and analyzed for every 20 samples analyzed. Control limits vary based on the laboratory method performed and are contained in the applicable laboratory method and SOP. Failure will trigger corrective action, and the analysis will be terminated, the problem corrected, and the samples associated with that LCS reanalyzed. If reanalysis of the samples fails, the samples affected by the failing LCS elements need to be redigested and reanalyzed.

Matrix Spike/Matrix Spike Duplicate
The matrix spike (MS) and matrix spike duplicate (MSD) samples will be prepared and analyzed at different frequencies based on the laboratory method performed. The control limits also depend on the method used and are contained in the applicable laboratory method and SOP. If the percent recovery for the MS and MSD falls outside the control limits, the results are flagged as outside acceptance criteria along with the parent sample. If the RPD exceeds the acceptance criteria, the MSD sample and associated parent sample will be flagged.

Post Digestion Spike
Post Digestion Spikes (PDS) will be prepared and analyzed at different frequencies based on the laboratory method performed. The control limits also depend on the method used and are contained in the applicable laboratory method and SOP.

Laboratory Control Sample Duplicate
The laboratory control sample duplicate (LCSD) samples will be prepared and analyzed for every 20 samples analyzed. Control limits will vary based on the QC action used. Failure will trigger corrective action and a single reanalysis of the respective failing QC is allowed. If the

reanalysis is outside the acceptance criteria, the analysis must be terminated, the problem corrected, the instrument recalibrated, and the calibration reverified.

4.4 Instrument/Equipment Testing, Inspection, Maintenance, and Calibration

To ensure continual quality performance of all instruments and equipment, testing, inspection, and maintenance will be performed and recorded as described in this section. All field and laboratory equipment will be operated, maintained, calibrated, and standardized according to all EPA and manufacturer's recommended procedures.

4.4.1 Field Equipment

Field equipment will be examined to verify that it is in proper operating order prior to its first use. Equipment, instruments, tools, gauges, and other items requiring preventative maintenance will be serviced and/or calibrated according to the manufacturer’s specified recommendations, as necessary. Field equipment will be cleaned (decontaminated) and safely stored between each use. Any routine maintenance recommended by the equipment manufacturer will also be performed and documented in field logbooks. Calibration of field equipment will be completed in the field at the beginning of each day and recorded in the field logbooks. Any equipment deficiencies or malfunctions during fieldwork will be recorded, as appropriate, in the field logbooks.

The SOPs for the field equipment (water level, temperature, SC, DO, ORP, and pH) are in Appendix 2 along with the XRF SOP (SOP-SFM-02). The manual for the CHEMetrics V-2000 photometer is included in Appendix 3, which will be used to analyze ferrous and total iron in the field. The user manual for the PID unit (MiniRae 3000) is included in Appendix 7.

Groundwater Meters
Multi-Parameter Probe
The multi-parameter probe will be used to record parameters during purging to ensure field measurements for pH, ORP, temperature, SC, and depth to water have stabilized as defined in the field equipment SOPs (Appendix 2). To accommodate field meters, discharge from the sampling pump will be directed through a flow-through cell for the multi-parameter probe so that parameters can be measured until stabilized. Once parameters have stabilized, the flow-through cell will be disconnected and samples for field and laboratory analysis will be collected directly from the tubing. This will ensure that the tubing has acclimated to the water chemistry and the water being sampled is represented by the stabilized field parameters.

CHEMetrics V-2000 Photometer
Once field parameters have stabilized as defined in the field equipment SOPs (Appendix 2), water samples will be collected in the field sample cups provided in the CHEMetrics field kits for field analysis with the CHEMetrics V-2000 photometer. Using the glass vacuum ampules, pre-filled with the appropriate colorimetric reagents, field personnel will snap open the ampule at the base of the sample cup and pull in a water sample that has had minimal contact with the atmosphere. After the prescribed color development time, field personnel will place the ampule in a colorimeter that has been previously calibrated at the correct analytical wavelength, as provided in the manual (Appendix 3). A CHEMetrics V-2000 multi-analyte photometer (or

equivalent) will be used along with CHEMetrics V-2000 ampules. Detailed procedures are included in Appendix 3 or can be downloaded from CHEMetrics website (www.chemetrics.com). Dilution of some samples may be necessary prior to analysis.

Each CHEMetrics kit includes a zero solution that will be used to zero the CHEMetrics V-2000 multi-analyte photometer (or equivalent) before the analysis of each sample. Sample cups will be rinsed and decontaminated following SOP-DE-02 (Appendix 2) between each sample. As an additional quality step, field testing accuracy will be validated in a climate-controlled area using appropriate standards (where feasible).

XRF Unit

The XRF analysis will be conducted using a Niton™ XL3 XRF Analyzer (XL3) and following the procedures outlined in SOP-SFM-02 (Appendix 2) as well as the XL3 user manual to ensure that the techniques employed are appropriate for the analytes of interest (Table 3).

PID Unit

If field conditions allow, hydrocarbon screening will be conducted using one and/or two PIDs, one with a 9.8 electron volt (eV) lamp and another with a 10.6 eV lamp. The procedures for using the PID unit are included in Section 3.9 as well as in the MiniRae 3000 User's Manual (Appendix 7). If another PID unit is used, the user's manual for that unit will be followed.

Transducers

Transducers will be installed and programmed according to SOP-GW-15 (Appendix 2). Transducers will be maintained per manufacture specifications. Table 2 provides the specific details including the locations where transducers will be installed. Transducers will be site-dedicated to prevent potential cross-contamination.

Transducers will be set to record on 15-minute intervals, and their data will be downloaded monthly, concurrently with synoptic monthly manual water level measurements.

The following data screening steps will be taken to ensure the water level measuring device data accurately represents field conditions.

Compensation: Raw water level data will be barometrically compensated and manually adjusted in a Microsoft Excel spreadsheet to match acceptable manual water level measurements recorded in the field notes. The compensated data will then be downloaded into the project database and plotted and analyzed for abnormalities (e.g., spikes, drops, inconsistencies, fluctuations, etc.).

Comparison:

a. To justify atypical water level fluctuations, water level data will be compared to precipitation events at Bert Mooney Airport in Butte, Montana.
b. Trends in water levels will also be compared between nearby wells.
c. Any discrepancies will be flagged in the data.

4.4.2 Laboratory Equipment

Instruments used by the laboratory will be maintained according to the laboratory QA plan requirements and analytical method requirements. All analytical measurement instruments and equipment used by the laboratory will be controlled by a formal calibration and preventive maintenance program.

The laboratory will keep maintenance records and make them available for review, if requested. Laboratory preventive maintenance will include routine equipment inspection and calibration at the beginning of each day or each analytical batch, per the laboratory internal SOPs and method requirements.

4.5 Inspection/Acceptance of Supplies and Consumables

All supplies and consumables received for the project (e.g., sampling equipment, calibration standards, etc.) will be checked to ensure their condition is satisfactory, such as free of defects that would affect performance. The types of equipment needed to complete sampling activities are described in the relevant field SOPs (Appendix 2). Inspections of field supplies will be performed by the FTL or field team members.

The personnel at each laboratory will be responsible for inspecting laboratory supplies according to the laboratory QA program.

4.6 Data Management

This section describes how the data for the project will be managed, including field and laboratory data. Data will be managed according to the *Butte Area NPL Site Butte Priority Soils Operable Unit (BPSOU) Final Draft Data Management Plan* (Atlantic Richfield Company, 2017). The BRW Phase I QAPP (Stages 1-3) quality records will be maintained by Atlantic Richfield. These records, in either electronic or hard copy form, may include the following:

- Project work plans with any approved modifications, updates, and addenda.
- Project QAPP with any approved modifications, updates, addenda, and any approved corrective or preventative actions.
- Field documentation (including logbooks, data sheets, and photographs) in accordance with SOP-SA-05 (Appendix 2).
- Chain of custody records (see Section 3.8 and SOP-SA-04 (Appendix 2).
- Field forms are provided in Appendix 4.
- Laboratory documentation (results received from the laboratory will be documented in hard copy and in an electronic format).
- PDI Evaluation Report.

Hard copy field and laboratory records will be maintained in the project's central data file, where original field and laboratory documents are filed chronologically for future reference. These records are also scanned to produce electronic copies. The electronic versions of these records will be maintained on a central Microsoft SQL server system that is backed up regularly. The data will be stored on the SQL server, and a Microsoft Access database will be set up to access the data, which can then be exported to Excel if necessary for further graphing and interpretive analysis. Using a Microsoft-based software configuration is widely accepted with support from Microsoft and allows for easy data sharing with most hardware configurations.

All field and laboratory data and supporting documentation will be subject to appropriate review to ensure the accuracy and completeness of original data records prior to uploading into the project database. Field data that are reviewed and approved in a hard copy format will be entered into an electronic system to be uploaded to the project database. Laboratory electronic data deliverables (EDDs) provided in Microsoft Excel format and correlating PDF Level 4 data packages (simplified format) will be reviewed as part of the internal data review process. Following these review steps, field and laboratory electronic data files will be imported to the project database.

Standardized data import formats and procedures will be used to upload both field and laboratory data into the electronic database. Standardized parameter names, numerical formats, and units of measure will be applied to the original information to facilitate comparability across all datasets and within the database. Using these standardized formats will allow for quick and easy querying to retrieve data as desired. Data can be retrieved by exporting into an Excel file and, because the data will be formatted with parameter names, easily made into a pivot table for data processing.

5.0 ASSESSMENT AND OVERSIGHT

Assessment and oversight of data collection and reporting activities are designed to verify that sampling and analyses are performed according to the procedures established in this Phase I QAPP. The audits of field and laboratory activities include two independent parts: internal and external audits. Internal audits will be performed by Atlantic Richfield, their contractor, or a contracted laboratory consultant as necessary. External audits will be performed by EPA as necessary. Performance and systems audits of field and laboratory data collection and reporting procedures are described in this section.

5.1 Field Activities Oversight

Oversight personnel will have the ability to inspect each test pit, soil boring, and piezometer completion interval and determine the appropriateness of the recorded data and ensure that the appropriate samples are collected. Copies of field logbook pages will be provided to oversight personnel as part of the data summary report.

Any deviations from this BRW Phase I QAPP will be brought to the attention of oversight personnel. If the deviation is first determined by oversight personnel, Atlantic Richfield and/or field representatives will be immediately notified. Reasons for such deviations will be recorded in the field logbook along with corrective actions to be implemented, if required. If oversight personnel request a deviation from this BRW Phase I QAPP, the deviation and the reasons for the deviation will be noted and then signed by the agency personnel.

5.2 Corrective Action Procedures

Corrective action is the process of identifying, recommending, approving, and implementing measures to counter unacceptable procedures or out-of-QC performance, which can affect data quality. Corrective action can occur during field activities, laboratory analyses, and data assessment.

Non-conforming equipment, items, activities, conditions, and unusual incidents that could affect data quality and attainment of the project's quality objectives will be identified, controlled, and reported in a timely manner. For this BRW Phase I QAPP, a non-conformance is defined as a malfunction, failure, deficiency, or deviation that renders the quality of an item unacceptable or indeterminate in meeting the project's quality objectives. Corrective actions implemented by field personnel will follow appropriate field SOPs (Appendix 2), as necessary.

Corrective action in the laboratory may occur prior to, during, and after initial analyses. A number of conditions such as broken sample containers, preservation or holding-time issues, and potentially high-concentration samples may be identified during sample log in or just prior to analyses. Corrective actions to address these conditions will be taken in consultation with the CPM and reported on a Corrective Action Report (CAR) form included in Appendix 9. In the event that corrective action requests are not in complete accordance with approved project planning documents, EPA will be consulted and concurrence will be obtained before the change is implemented.

If during sample analyses, the associated laboratory QC results fall outside of the project's performance criteria, the laboratory should initiate corrective actions immediately. If laboratory QC results are outside of the project specifications, the laboratory should take the appropriate corrective actions for the specific analytical method. Following consultation with laboratory analysts and section leaders, it may be necessary for the CPM to approve implementing a corrective action. These conditions may include dilution of samples, additional sample extract cleanup, or automatic reanalysis when certain QC criteria are not met. If the laboratory cannot correct the situation that caused the non-conformance and an out-of-control situation continues to occur or is expected to occur, then the laboratory will immediately contact the CPM and request instructions regarding how to proceed with sample analyses.

Completion of any corrective action should be evidenced by data once again falling within the project's performance criteria. If this is not the case and an error in laboratory procedures or sample collection and handling procedures cannot be found, the results will be reviewed by the CPM and FTL to assess whether reanalysis or resampling is required.

All corrective actions taken by the laboratory will be documented in writing by the Laboratory Project Manager and reported to the FTL and CPM. In the event that corrective action requests are not in complete accordance with approved project planning documents, EPA will be consulted and concurrence will be obtained before the change is implemented. All corrective action records will be included with the QAPP records.

5.3 Corrective Action During Data Assessment

During data assessment, the Contractor QAO could identify the need for corrective action. Potential types of corrective action include resampling by the field team, reanalyzing samples by the laboratory, or resubmitting level 4 data packages with corrected clerical errors. The appropriate and feasible corrective actions are dependent on the ability to mobilize the field team and whether the data to be collected are necessary to meet the required QA objectives (e.g., the holding time for samples is not exceeded [Table 3], etc.). If corrective action requests are not in complete accordance with approved project planning documents, EPA will be consulted and concurrence will be obtained before the change is implemented. Corrective actions of this type will be documented by the Contractor QAO on a CAR and will be included in any subsequent reports.

5.4 Quality Assurance Reports to Management

After the investigation is complete, Atlantic Richfield's contractor will prepare a PDI Evaluation Report summarizing and interpreting the sampling activities. The report will include the following:

- Summary of the investigations performed.
- Summary of investigation results.
- Summary of validated data (i.e., tables and graphics).
- Data validation reports and laboratory data reports.
- Narrative interpretation of data and results.
- Results of statistical and modeling analyses.
- Photographs documenting the work conducted.
- Conclusions and recommendations for remedial design, including design parameters and criteria.
- Recommendations for an additional phase(s) (if necessary).

The CPM and Contractor QAO are responsible for preparing the PDI Evaluation Report. The report will be submitted in draft final form to EPA and Montana DEQ for review. Upon receipt of comments, the draft final report will be revised to address the comments and resubmitted to EPA and Montana DEQ for final approval.

6.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

An organizational chart showing the overall organization of the project team is shown on Figure 25. The roles and responsibilities of key individuals comprising the project team are listed below. Individuals who fill these roles are identified on the organizational chart. Any changes to project personnel will be reflected in an updated Agency-approved organizational chart. The organizational chart will include the date, revision number, and annotation with any previous and replacement personnel listed by name and responsibility. Changes will be communicated by the Project Manager and distributed to personnel identified on the project distribution list.

Atlantic Richfield Operations Project Manager

The Atlantic Richfield Operations Project Manager (OPM), Josh Bryson, monitors the performance of the company's contractors. The OPM consults with the Contractor QAO and CPM on deficiencies and aids in finalizing resolution actions.

Atlantic Richfield Quality Assurance Manager

The Atlantic Richfield Quality Assurance Manager (QAM), Terry Moore, interfaces with the Atlantic Richfield OPM on company policies regarding quality and has the authority and responsibility to approve quality assurance documents specific to the project, including this BRW Phase I QAPP.

Contractor Project Manager

The CPM, Karen Helfrich from Pioneer, is responsible for scheduling all sampling work to be completed and ensuring that the work is performed according to the requirements contained herein. The CPM is also responsible for consulting with the quality assurance personnel identified for the project regarding any deficiencies and finalizing resolution actions.

Field Team Leader

The FTL, Julie Flammang and Kendra Jackson from Pioneer, ensures that all members of the field team review and follow this BRW Phase I QAPP when implementing field activities. The FTL is also responsible for maintaining the QAPP. The FTL will conduct daily safety meetings, assist in field activities, and document activities in the logbook. The FTL is responsible for equipment coordination, problem solving, and decision making in the field, and is also responsible for technical aspects of the project. Additionally, the FTL provides “on-the-ground” overviews of project implementation by observing site activities to ensure compliance with technical project requirements; Health, Safety, Security, and Environment requirements; and the SSHASP. Finally, the FTL identifies potential Integrity Management issues, as appropriate, and prepares required project documentation.

Contractor Quality Assurance Officer

The Contractor QAO, Mike Borduin from Pioneer, is responsible for reviewing field and laboratory data and evaluating data quality, including conducting on-site reviews and preparing site review reports for the QAM.

The Contractor QAO represents the assigned project as the primary spokesperson on matters relating to quality management system implementation. In matters of project QA, this individual will have a direct line of communication to the QAM to ensure issues are resolved.

The Contractor QAO is authorized to stop work if, in the judgment of that individual, the work is performed contrary to or in the absence of prescribed quality controls or approved methods and further work would make it difficult or impossible to obtain acceptable results. The Contractor QAO may also stop work if completion of quality corrective actions is not acceptable. The Contractor QAO is responsible for conducting field audits to ensure the integrity of field measurements, sample collection, and documentation.

The Contractor QAO is responsible for evaluating information from nonconformance instances, inspection reports, surveillance reports, audit and assessment reports, quality system reviews, CARs, corrective action plans, stop work orders, and other sources. The information can be used to identify trends or conditions averse to quality, which the Contractor QAO will bring to the attention of the QAM.

Project Safety and Health Manager

The Project Safety and Health Manager, Tara Schleeman from Pioneer, conducts the initial safety meeting prior to starting fieldwork. This individual ensures that work crews comply with all site health and safety requirements and revises the BRW SSHASP, if necessary.

Analytical Laboratories

The Pace Analytical, LLC Minneapolis Laboratory, Energy Laboratories, Inc., and Torkelson Geochemistry. will be responsible for performing the inorganic laboratory methodologies identified in Table 3. The Pace Analytical, LLC Minneapolis Laboratory and Energy Laboratories, Inc. are certified by the Montana Department of Public Health and Human Services to perform inorganic chemical analyses for this program. Additionally, the Pace Analytical, LLC Minnesota Laboratory and Energy Laboratories, Inc. are also accredited under the National Environmental Laboratory Accreditation Program. Both laboratories will ensure that trained laboratory personnel are familiar with the QAPP, methods specified, and are available to perform the work as specified. Pace Analytical, LLC personnel will be responsible for reviewing final analytical reports produced by the laboratory, scheduling laboratory analyses, and supervising in-house chain of custody procedures.

Torkelson Geochemistry is a laboratory specializing in characterization of physical and chemical properties of liquid petroleum hydrocarbons or materials containing hydrocarbons. Torkelson Geochemistry will be responsible for performing the organic analyses for petroleum hydrocarbons in Table 3.

Subcontractors

At least two subcontractors (O’Keefe Drilling and Hunter Brothers Construction) will assist with the Hydrocarbon Investigation. These companies will subcontract to Pioneer and follow all health and safety protocols established by Pioneer to work on the BRW Site. These subcontractors have been selected due to their unique skillset and specialized equipment.

O’Keefe Drilling (O’Keefe). O’Keefe will supply the rotary sonic drill rig and personnel to drill and install the Hydrocarbon Investigation wells.

Hunter Brothers Construction (Hunter). Hunter will be responsible for excavating the hydrocarbon test pits and assisting with the installation of the hydrocarbon wells when necessary.

7.0 HEALTH AND SAFETY

Potential hazards associated with this work include the following:

- Drilling activities.
- Collection of samples within test pits.
- Working around heavy equipment hazards.
- Exposure to heavy metals from impacted soil and groundwater.

Site-specific hazards and applicable control measures are addressed in the BPSOU SSHASP. All tasks will be risk assessed prior to starting work.

8.0 SCHEDULE

Fieldwork is anticipated to begin in the fall of 2018 (August) and will proceed until completed. Potential constraints that could delay fieldwork include adverse weather conditions, staffing challenges, contractor availability, coordination with land managers/users, challenges with drilling and test pitting caused by site conditions, or other unforeseen issues. Major project delays resulting from these constraints will be recorded in the field logbooks and reported to the Agencies.

9.0 DATA VALIDATION AND USABILITY

This section addresses the final project checks conducted after the data collection phase of the project is completed to confirm that the data obtained meet the project objectives and to estimate the effect of any deviations on data usability for the express purposes of achieving the stated DQOs (Section 2.5). Based on a review of EPA guidance, all stages of the BRW Phase I QAPP will use a Level 4 data validation.

9.1 Data Review and Verification

This section describes the review and verification process for field data and the internal laboratory data reduction process. The section also details laboratory data reporting requirements, which describe how results are conveyed to data users.

9.1.1 Field Data Review

Raw field data will be entered in field logbooks and/or FDS per appropriate field SOPs (Appendix 2), and the data will be reviewed for accuracy and completeness by the FTL before the records are considered final. The overall quality of the field data from any given sampling round will be further evaluated during the process of data reduction and reporting.

Field data reduction procedures will be minimal in scope compared to those implemented in the laboratory setting. Field data review will include verification that any QC checks and calibrations, if necessary, are recorded properly in the field logbooks and/or data sheets and that any necessary and appropriate corrective actions were implemented and recorded. Such data will be written into the field logbook and/or data sheets immediately after measurements are taken. If errors are made, results will be legibly crossed out, initialed and dated by the field member, and corrected in a space adjacent to the original (erroneous) entry. Later, the FTL will proof the field logbooks and/or data sheets to determine whether any transcription errors have been made by the field crew. If transcription errors have been made, the FTL and field crew will address the errors to provide resolution.

If appropriate, field measurement data will be entered into electronic files for import to the project database. Data entries will be made from the reviewed FDS or logbooks, and all data entries will be reviewed for accuracy and completeness before the electronic file is provided to the database manager. Electronic files of field measurement data will be maintained as part of the project's quality records.

9.1.2 Laboratory Data Review

Internal laboratory data reduction procedures will be according to each laboratory's quality management plan. At a minimum, analysists will maintain paper records to document sample identification number and the sample tag number with sample results and other details, such as the analytical method used (e.g., method SOP #), name of analyst, the date of analysis, matrix sampled, reagent concentrations, instrument settings, and the raw data. The analyst will sign and date these records. Secondary review of these records by laboratory personnel will take place prior to final data reporting to Atlantic Richfield. The laboratory will appropriately flag unacceptable data in the data package.

9.1.3 Laboratory Data Reporting Requirements

The laboratory will prepare Level 4 data packages for transmittal of results and associated QC information to Atlantic Richfield or its designee within a standard turnaround time, unless otherwise required. At a minimum, the data packages will include the case narrative and all sample results, units, and QC sample results.

The laboratory will prepare Level 4 data packages for transmittal of results and associated QC information to Atlantic Richfield or its designee in general accordance with the US EPA *CLP Statement of Work for Inorganic Superfund Methods (Multi-Media, Multi-Concentration)* (EPA, 2016). Deviations from these specifications should be acceptable provided the report presents all the requested types of information in an organized, consistent, and readily reviewable format.

9.1.4 Laboratory Electronic Data Deliverable

Each data package, as described above, will be accompanied by an EDD prepared by the laboratory. Additional laboratory QC data can be included in the EDD. The EDDs will be cross checked against corresponding data reports to confirm consistency in results reported in these two separate formats. This cross check will take place as part of the data review process.

9.1.5 Specific Quality Control/Assessment Procedures

The accuracy, precision, completeness, and representativeness of analytical data will be described relative to the project's control limits through a process of field and laboratory data quality review. Results from these reviews will be documented in the PDI Evaluation Report. Any qualification of the data resulting from the review will also be incorporated into the project's electronic database so that all data users are aware of any uncertainties associated with individual results.

9.2 Internal Data Review

Internal data review is the process of verifying that information generated relative to a given sample is complete and accurate. Data review procedures will be performed for both field and laboratory operations as described below.

9.2.1 Field Quality Control Data

The results of field QC sample analyses associated with each laboratory data package will be reviewed to evaluate the results from field blanks and other field QC samples and further indications of the data quality. If a problem is identified, all related field samples will be identified and, if possible, corrective actions will be instituted and documented on a CAR. If corrective action requests are not in complete accordance with approved project planning documents, EPA will be consulted and concurrence will be obtained before the change is implemented. If data are compromised from a problem identified via field QC sample review, appropriate data qualifications will be used to identify the data for future data users.

Handling, preservation, and storage of samples collected will be monitored on an ongoing basis. When the laboratory receives and logs in the sample, the laboratory will document the sample receipt and note the containers (whether they are proper and in good condition) and preservation requirements. The sample receipt records (a required data package deliverable) and the chain of custody documentation will also be assessed during data review.

9.2.2 Laboratory Chemistry Data

The second level of review will be performed by the Contractor QAO, or designee, and will include a review of laboratory performance criteria and sample-specific criteria. One hundred percent (100%) of the data will be reviewed. Additionally, the Contractor QAO will determine whether the DQOs have been met and will calculate the data completeness for the project.

Data quality review is a process to determine if the data meet project-specific DQOs. The data quality review will include verification of the following:

- Compliance with the QAPP.
- Proper sample collection and handling procedures.
- Holding times (Table 3).
- Field QC results.
- Instrument calibration verification.
- Laboratory blank analysis.

- Detection limits.
- Laboratory duplicates.
- MS/MSD percent recoveries and RPDs.
- Surrogate percent recoveries.
- Data completeness and format.
- Data qualifiers assigned by the laboratory.

Qualifiers to be applied to the data, as necessary, include the following:

- U: The analyte was analyzed for but was not detected above the reporting limit.
- J: The analyte was positively identified; the associated numerical value is an estimate of the concentration of the analyte in the sample.
- UJ: The analyte was not detected above the sample reporting limit. However, the reporting limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
- R: The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet QC criteria. The presence or absence of the analyte cannot be verified.

A Data Quality Assessment (DQA) will be performed to determine whether the project-specific DQOs have been satisfied. The DQA consists of five steps that relate the quality of the results to intended use of the data:

- Step 1: Review DQOs and sampling design.
- Step 2: Conduct preliminary data review.
- Step 3: Apply statistical test(s), as appropriate, to evaluate data quality.
- Step 4: Verify assumptions.
- Step 5: Draw conclusions about the quality of the data (data report will not include interpretation of results but will state conclusions regarding the quality of the results).

If, as a result of the DQA process, it is determined that data do not satisfy all DQOs, then corrective action will be recommended and documented in the data reporting. Corrective actions can include, but are not limited to, revising the DQOs based on the results of the investigation or collecting more information. It could be determined that corrective actions are not required or the decision process should continue with the existing data with recognition of the limitations of the data.

Data validation checklists for metals analysis by ICP-OES and other laboratory analyses are included in Appendix 10. A checklist for summarizing the field QC results is also included in Appendix 10 along with a level A/B criteria screening checklist. Results of the QA review and/or validation will be included in any subsequent report, which will provide a basis for meaningful interpretation of the data quality and evaluate the need for corrective actions.

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