Draft Final
Phase I Pre-Design Investigation Evaluation Report

Blacktail Creek Riparian Actions
Butte Priority Soils Operable Unit of the Silver Bow Creek/Butte Area Superfund Site
Silver Bow County, Montana

Prepared for:

Montana Department of Environmental Quality
1520 E. 6th Avenue
Helena, Montana 59601

DEQ Contract: 421042
Task Order: 04

Prepared by:

HydroGeoLogic, Inc.
315 North 24th Street
Billings, Montana 59101

May 2, 2025

DRAFT FINAL
PHASE I PRE-DESIGN INVESTIGATION EVALUATION REPORT

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SILVER BOW COUNTY, MONTANA

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CONTRACT 421042

Project:	Blacktail Creek Riparian Action Remedial Design and Pre-Investigation
Task Order Number:	04

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Notes:
CTEC = Citizen’s Technical Environmental Committee
EPA = U.S. Environmental Protection Agency
HGL = HydroGeoLogic, Inc.
DEQ = Montana Department of Environmental Quality
NRDP = Natural Resource Damage Protection

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LIST OF ACRONYMS AND ABBREVIATIONS

%	percent
ABA	acid-base accounting
AR	Atlantic Richfield Company
ACM	asbestos-containing material
bgs	below ground surface
BMFOU	Butte Mine Flooding Operable Unit
BPSOU	Butte Priority Soils Operable Unit
BTC	Blacktail Creek
BTL	Butte Treatment Lagoons
CD	Consent Decree
cfs	cubic feet per second
COC	contaminant of concern
CP	control point
DEQ	Montana Department of Environmental Quality
DQA	Data Quality Assessment
EPA	U. S. Environmental Protection Agency
ER	Evaluation Report
ft	ft/foot
GIS	geographic information system
gpm	gallons per minute
GPS	global positioning system
HGL	HydroGeoLogic, Inc.
ID	identification
LSM	Lorenzen Soil Mechanics, Inc.
MBMG	Montana Bureau of Mines and Geology
MS	matrix spike
MSD	matrix spike duplicate
MT	Montana
NA	Not Applicable
NRDP	Natural Resource Damage Program
NWE	Northwestern Energy
oz	ounce
PARCCS	precision, accuracy, representativeness, completeness, comparability, and sensitivity

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

PDI	Pre-Design Investigation
P.E.	Professional Engineer
PEST	Parameter Estimation Software
PID	photoionization detector
PLM	Polarized Light Microscopy
QAPP	Quality Assurance Project Plan
RA	Remedial Action
RD	Remedial Design
ROD	Record of Decision Amendment
RPD	Relative Percent Difference
SBC	Silver Bow Creek
SD	Settling Defendant
SSTOU	Streamside Tailings Operable Unit
SWMP	Surface Water Management Plan
UFP	Uniform Federal Policy
WET	Water Environment and Technologies, Inc.
XRF	x-ray fluorescence

REVISION TRACKING TABLE

Revision Number	Date	Section Revised	Changes/Comments
0	March 29, 2024	NA	Draft for DEQ Review / EPA Review
1	December 20, 2024	See Response to EPA and CTEC Comments Letters	Draft Final for DEQ Review
1	January 24, 2025	See Response to EPA and CTEC Comments Letters	Draft Final for EPA Review
2	May 2, 2025	See Response to EPA Comments Letter	Draft Final for EPA Review

Notes:
DEQ = Montana Department of Environmental Quality
NA = not applicable

BLACKTAIL CREEK RIPARIAN ACTIONS
DRAFT PHASE I PRE-DESIGN INVESTIGATION EVALUATION REPORT

1.0 INTRODUCTION

The Consent Decree (CD) for the Butte Priority Soils Operable Unit (BPSOU) Partial Remedial Design (RD)/Remedial Action (RA) and Operation and Maintenance (the BPSOU CD) describes numerous RAs to be completed in the BPSOU (EPA, 2020). Appendix A to the BPSOU CD, Record of Decision for the BPSOU of the Silver Bow Creek (SBC)/Butte Area Superfund Site, Butte-Silver Bow County, Montana (MT), includes the 2020 BPSOU Record of Decision Amendment (ROD) (EPA/DEQ, 2020), which modifies the remedy for the BPSOU and includes specific provisions requiring more extensive removal of tailings, waste, and contaminated soils and sediments (Waste) from the stream channel and floodplain of Blacktail Creek (BTC) and SBC between Montana Street and Grove Gulch (ROD, Table 3).

Attachment C to Appendix D of the BPSOU CD (EPA, 2020), the BPSOU Statement of Work for the Butte Priority Soils Operable Unit of the Silver Bow Creek/Butte Area Superfund Site, Butte-Silver Bow County, MT, defines the actions to be performed by the Settling Defendants (SDs) and Montana Department of Environmental Quality (DEQ) for the BTC Riparian Actions and defines the area to be addressed under the BTC Riparian Actions (Figure BTC-1 in Attachment C to Appendix D of the BPSOU CD). Appendix H to the BPSOU CD, the BTC Riparian Actions Outline, describes the RD and RA process for the BTC Riparian Actions including completion of the Pre-Design Investigation (PDI). Figure 1 shows the approximate location of the BTC Riparian Actions within the BPSOU.

This site-specific BTC Riparian Actions Phase I PDI Evaluation Report (ER) was prepared in accordance with the BTC Riparian Actions Outline presented in Appendix H to the BPSOU CD. This PDI ER provides an evaluation and summary of the Phase I PDI and was completed in accordance with the approved PDI Work Plan (HGL, 2023).

The investigation area is located within, or adjacent to, the boundaries shown in Figure 3. The area includes a former tailings pond and has been identified as a potential source of contaminants of concern (COCs) (e.g., arsenic, cadmium, copper, lead, mercury, and zinc) and additional constituents of concern (e.g., hydrocarbons and municipal waste, etc.). Previous studies have been conducted to characterize the site but did not provide enough data to support RD; consequently, additional, design-level data was collected to fill known data gaps and to meet the requirements set forth in the BPSOU CD.

The following additional data and information was collected:

- Horizontal and vertical extent of Waste accessible for removal within the limits shown on Figure BTC-1 of the BPSOU CD to provide an accurate estimate of the volume of contaminated materials to be removed;

- Estimated volume and quality of groundwater associated with dewatering activities related to Waste removal and assessment of the feasibility of dewatering the excavated material; and
- The need for additional field investigation work related to geotechnical conditions and additional groundwater investigations was evaluated. These evaluations used the refined waste removal limits to assess the need for additional investigations with respect to the magnitude of potential impacts associated with the anticipated groundwater dewatering activities.

1.1 Site Location and Description

The BTC Riparian Actions Area site, referred to as the BTC site in this document, is located near Montana Avenue and Lexington Avenue and between Interstate 90 and SBC within the BPSOU as shown on Figure 2 and 3. The SBC channel above the confluence of SBC and BTC has been disconnected from groundwater by a groundwater collection system, which in turn functions as a remedial element. This section of SBC receives most of its flow from stormwater. A discharge point from a water treatment plant at the Montana Resources Mine is located at the confluence area of SBC and BTC that contributes a significant source of flow to SBC. BTC receives most of its baseflow contributions from Summit Valley groundwater in Butte, MT, as a portion of the historical SBC Watershed is now captured by the BPSOU subdrain north of the project area.

The BTC site was investigated to address data gaps and satisfy design needs for the remedy for the site. The site is within the boundaries of the BPSOU. DEQ's obligations for the BTC Riparian Actions are outlined in Appendix H of the ROD for BPSOU and the finalized BPSOU CD. The BPSOU Scope of Work for BTC is described in Section 5 of Attachment C to Appendix D to the BPSOU CD. DEQ is responsible for the removal of Waste from the boundaries as conceptually delineated in Figure BTC-1 of the BPSOU CD; the removal of Waste below the confluence with BTC and its 100-year floodplain in the "Confluence Area" north of George Street and east of Montana Street as depicted in Figure 2 and 3; and the removal of contaminated in-stream sediments and banks in BTC east of the Lexington Ave culvert, also conceptually delineated in Figure BTC-1 of the BPSOU CD.

DEQ is responsible for the reconstruction of BTC and SBC below the confluence with BTC following the removal of wastes. The SDs are responsible for the control of discharge of contaminated groundwater to surface water in the project area at an initial rate of approximately 100 gallons per minute (gpm). Atlantic Richfield Company (AR) is responsible for receiving DEQ's construction dewatering at the Butte Treatment Lagoons (BTL) to the extent treatment is needed and at times when the volume and chemistry of such water will not overwhelm the BTL's capacity or prevent it from meeting discharge standards. Construction water that meets Circular DEQ-7 Surface Water Standards will not need to be treated.

This PDI was performed within the approximate boundaries shown on Figure 3 (BTC Riparian Actions Study Area).

1.2 Site History

In 1879, the first large-scale mineral processing smelter (Colorado Smelter) was built on SBC, at the west end of the valley. Between 1879 and 1888, at least three more smelters of consequence (Butte Reduction Works, Parrot Smelter, and Montana Ore Purchasing Company) were constructed upstream of the Colorado Smelter, which significantly altered the geomorphology and hydrology of both SBC and the lower portion of BTC. A fifth smelter of consequence, the Bell Smelter, located west of present-day Harrison Avenue on the north bank of BTC, was constructed in 1881 and reached a peak production of approximately 30 tons per day in 1883 (primarily silver ore). Production quickly tapered, and the smelter was dismantled sometime in the early 1890s. Water demands during this period increased dramatically, and the stream channels were altered significantly to keep up with the demand. At least three dams were constructed on SBC above its confluence with BTC and the confluence area for tailings impoundment and water clarification. The dam at Montana Street was constructed for settlement of tailings from upstream smelters and resulted in significant ponding on both sides of the stream. Over time, mining and smelting waste materials aggraded in the SBC and BTC channels and floodplain, causing frequent and substantial flooding (Meinzer, 1914) (Figure 2). In an attempt to mitigate flooding issues, berms made mostly of readily available waste were constructed throughout the confluence area. The known waste area referred to as the BTC Berm is an historic remnant of these flood control berms.

1.3 Previous Investigations and Information

The previous investigations conducted at or near the BTC site that provide relevant information for this BTC PDI ER, as described in further detail in the BTC PDI Work Plan, include the following:

- Tailings/Impacted Sediment Delineation of the Diggins East, BTC Berm, and Northside Tailings Areas (MBMG, 2014a);
- Stream Characterization of Blacktail and Silver Bow Creeks (MBMG, 2014b);
- Data Gap Investigation – SBC and BTC Corridors (Tetra Tech, 2016);
- Montana Street Substation Geotechnical Engineering and Environmental Sampling Report Prepared by Pioneer Technical Services for Northwestern Energy (NWE), May 2016 (NWE/Pioneer, 2016);
- *Draft Extent of Impacts Investigation Summary Report/Butte, Montana*. Prepared by Water Environment and Technologies, Inc. (WET) for (NWE/ 11 East Park Street/ Butte, Montana 59701, June 2021 (NWE/WET, 2021); and
- Publicly available data and information from the Groundwater Information Center maintained by the Montana Bureau of Mines and Geology (MBMG) (Montana's Groundwater Information Center 2022 [mtech.edu]).

1.4 Known Data Gaps

Based on review of the previous studies, the following data gaps were identified to be able to support the RD:

- Lateral and vertical extents of Waste located within the BTC Riparian Actions Project boundaries;
- The extent of dewatering and drying that is needed prior to loading and hauling materials to ensure their safe and efficient transport to the repository;
- Dewatering volume, pumping rates, and chemistry;
- Potential for dewatering to allow inaccessible tailings (if applicable) to oxidize and their potential to contribute additional COCs to the ground and surface water;
- The precise depth and alignment of existing buried utilities and other critical infrastructure;
- Potential presence of hydrocarbon contaminated soils, garbage, construction debris, or asbestos-containing materials (ACM) in the excavation areas;
- Geotechnical properties of the subsurface at BTC to determine excavation recommendations and structure/infrastructure protection during removal activities; and
- Potential for groundwater dewatering to cause subsidence or geotechnical concerns beneath Interstate 15/90.

1.4.1 Historical Aerial Photograph

An aerial photograph from 1962 shows the location of the tailing impoundment in the project area during construction of Interstate 15/90 through Butte.

Photograph 1 – 1962 Aerial Image Showing the BTC site

1.5 PDI Purpose And Objectives

The purpose of this PDI was to address known data gaps and collect the information needed to proceed with RD by conducting additional field investigations. Prior investigations demonstrated Waste and municipal waste are buried at the site. However, the previous existing data are not sufficient to estimate the volume to a reasonable accuracy for design purposes. Additionally, groundwater at the BTC site had not been adequately characterized to fully understand the pumping rate or the volume and quality of water that would need to be removed and managed during remedial construction activities. Given that geotechnical data associated with dewatering and excavation had not yet been collected, geotechnical data will be pertinent in protecting structures/infrastructure and ensuring safety during the RA.

The objectives of the PDI deal with solid materials and construction dewatering and have been specified in BTC Riparian Actions Outline in Appendix H of the BPSOU CD and in the BPSOU Scope of Work, Section 5 of Attachment C of Appendix D to the CD and include the following:

- Drill/bore at specific locations to quantify the vertical and lateral extent of Waste as defined by the Waste Identification Criteria in Table 1. The laboratory criteria in Table 1 of this document are identical to those in Table 1 of Appendix 1 to Attachment C to Appendix D in the BPSOU CD.
- Refine the existing groundwater hydraulic models to estimate the volume and quality of water associated with dewatering activities with respect to the refined waste removal surface.
- Generate a report related to geotechnical investigations adequately characterizing subsurface conditions in areas near bridges, culverts, and/or other structural features related to waste removal and groundwater dewatering activities, and provide recommendations for any additional sampling or preventive measures that need to occur before the RD/RA begins.

All of the objectives of the investigation were achieved, and sufficient data were collected to meet all project Data Quality Objectives.

1.6 Remedial Design Objectives

Section 5 of Attachment C and Appendix D of the BPSOU CD define the following selected remedy for the BTC Remediation and Contaminated Groundwater Hydraulic Controls Site along with the party responsible for completing each major component of the remedy:

> *The objective of the remedial activities described below for the Blacktail Creek area is to remove tailings, wastes, contaminated soils and sediments from Blacktail Creek and Silver Bow Creek below the confluence with Blacktail Creek, including the Blacktail Creek wetlands, and control discharge of contaminated groundwater to surface water in the area, as depicted in Figure BTC-1. Remedial activities at the Blacktail Creek and confluence area shall include:*

> *1. Remove All Tailings, Waste, and Contaminated Soils – The State, through the Montana Department of Environmental Quality (DEQ), shall remove all tailings, wastes, contaminated soils, and sediments that exceed the Waste Identification Criteria in Table 1 of Appendix 1, in and along Blacktail Creek and Silver Bow Creek below the confluence with Blacktail Creek and their 100-year floodplains, as delineated in Figure BTC-1.*
>
> *2. Control Contaminated Groundwater – The SDs shall control discharge of contaminated groundwater to surface water and sediments in the BTC area. The initial contaminated groundwater control is generally depicted in Figure BTC-1. Removal of waste materials contributing to groundwater contamination within the BTC area is anticipated through remedial actions identified in item 1. However, some areas north of Blacktail Creek, outside of the floodplain, are known to contain tailings, waste, and/or contaminated soils. Initially, approximately 100 gallons per minute (gpm) of contaminated groundwater will be collected to control discharge to surface water. The goals for the control of contaminated groundwater in this BTC area are to reduce ongoing and potential future groundwater loading of contaminants of concern to sediments and surface water as outlined in the Surface Water Management Plan (SWMP). Following Remedy implementation, further evaluation by the SDs shall be conducted to allow EPA to determine, in consultation with DEQ, if additional groundwater collection is required in accordance with the SWMP to control contaminated groundwater discharge to surface water and sediments as specifically described below (Control Contaminated Groundwater (SDs Responsibilities)) in the BTC area. Collected contaminated groundwater will be treated at the Butte Treatment Lagoons (BTL) facility, and/or an alternative groundwater treatment facility or approach, as approved by EPA, in consultation with DEQ.*
>
> *3. Reconstruct Blacktail Creek and Silver Bow Creek Below the Confluence with Blacktail Creek –DEQ shall replace removed tailings, wastes, contaminated soils, and in-stream sediments with suitable clean soils. DEQ shall also reconstruct Blacktail Creek and Silver Bow Creek below the confluence with Blacktail Creek and their beds, banks, and 100-year floodplains. DEQ shall also revegetate areas addressed by these restoration and remedial actions in accordance with the Material Suitability Criteria in Appendix 1.*

DEQ is responsible for objectives #1 and #3 from the above CD excerpt.

2.0 SUMMARY OF PHASE I PDI

Phase I PDI included drilling 43 sonic boreholes, hand digging 4 trenches, and collecting 4 stream sediment (surface) samples to delineate and characterize Waste, hydrocarbons, and municipal waste at the BTC site. Groundwater modeling and data review were conducted to estimate the rate, extent, and chemistry of groundwater dewatering required for RA. Additionally, data review was conducted to evaluate the need for additional geotechnical and groundwater investigations.

2.1 TAILINGS, WASTES, AND CONTAMINATED SOILS AND SEDIMENTS (WASTE)

The Phase I PDI was conducted at the BTC Area in accordance with the BTC PDI Work Plan and BTC Unified Federal Policy (UFP) – Quality Assurance Project Plan (QAPP)_ (HGL, 2023). The Phase I PDI was conducted to identify Waste as defined in Table 1 of the BPSOU CD. The investigation utilized in situ x-ray fluorescence (XRF) screening in the field to identify an estimated contamination cutoff depth. One sample from the 1-ft interval above the observed contamination cutoff depth and two samples from the 1-ft intervals below the observed cutoff depth were collected in the field during drilling and submitted to the laboratory for mercury analysis in accordance with preservation requirements for mercury. After drilling was completed, modified ex situ (intrusive) XRF was conducted in the field lab to confirm or modify the cutoff depth observed in the field. One sample from the 1-ft interval above the estimated contamination cutoff depth and two samples from the 1-ft intervals below the contamination cutoff depth based on available XRF were submitted to the laboratory for metals concentration analysis. Additional samples for mercury analysis were submitted to the laboratory post-field sampling efforts, if modified ex situ (intrusive) XRF in the field lab indicated a cutoff level differing from what was observed in the field. Samples from four trenches and four stream sediment (surface) samples were also submitted to the lab for mercury and metals analysis. The remaining drilled intervals that had not been scanned in the field via the in situ method or in the field lab via the modified ex-situ (intrusive) method were scanned via the in situ method in the field lab. XRF correlation was conducted using the Passing-Bablok regression method via the software package "MedCalc" on modified ex situ (intrusive) XRF data versus laboratory data, and in situ XRF data versus laboratory data to develop correlations for COCs (arsenic, cadmium, copper, lead, mercury, and zinc). XRF correlation reports are presented in Appendix D and summarized in Section 6.2. (August 2023 to December 2024).

Appendix A presents laboratory results, Appendix B presents laboratory reports, Appendix C presents XRF results, and Appendix D presents XRF correlation reports.

2.2 HYDROCARBONS

A photo ionization detector (PID), olfactory detection (smell), and/or visual detection (eyesight) were utilized in the field to identify samples with a potential for hydrocarbon contamination. No hydrocarbons were detected in the field by the PID. One sample from sonic borehole BTC-35 for the 3 to 4 feet (ft) below ground surface (bgs) sample interval was submitted to the laboratory for hydrocarbon analysis because of a slight hydrocarbon smell and a dark gray, oily visual appearance observed during field sampling efforts. Lab results showed the sample was well below the

Maximum Contaminant Level/Quality Control Limit of 200 mg/kg with a reported concentration of 28 mg/kg Total Extractable Hydrocarbons. (August 2023 to January 2024).

Appendix A presents hydrocarbon analysis results, and the lab report is presented in Appendix B. All PID field data is presented in the field notebook in Appendix H.

2.3 MUNICIPAL WASTE

Municipal waste was visually identified in 14 boreholes and a barren area 70 ft west of BTC-03 at the BTC site. In total, 23 1-ft-drilled intervals at the BTC site were identified to contain municipal waste. Of the 23 identified intervals, ten samples (total) from four 1-ft-drilled intervals from sonic boreholes BTC-09, BTC-22, and BTC-29 were identified as having suspect ACM due to the presence of concrete, mortar, grout, and brick. Suspect materials were separated and gathered from the soil and submitted to Eurofins CEI for EPA 600 Polarized Light Microscopy (PLM) asbestos analysis. Municipal waste observed at the BTC site consisted of glass, ceramic, slag, wood, brick, plastic, mortar, grout, concrete, and a small non-human mammal bone. (August 2023 to December 2023)

Table 8 presents municipal waste data and analysis results. Figure 5 presents inferred Municipal Waste locations based on field observations. Asbestos analysis results are provided in Appendix A, and the asbestos analysis lab report provided by Eurofins CEI is provided in Appendix B. None of the samples submitted for laboratory analysis contained asbestos.

2.4 ACID-BASE ACCOUNTING (ABA)

The potential presence of reduced tailings materials with a potential to oxidize during RA was assessed visually in all materials from boreholes, trenches, and stream samples. No highly reduced tailings with a bluish/greenish tint were observed in the borings or trenches; therefore, no samples were collected or submitted to the laboratory for acid-base accounting (ABA) testing.

2.5 GROUNDWATER CHARACTERIZATION AND DEWATERING MODELING

Groundwater dewatering extent and rates were calculated by calibrating a groundwater model using AR's 2022 pumping test data, Woodard and Curran's 2022 Draft Buffalo Gulch groundwater model, lithologic data from the BTC PDI, and BTC PDI contamination concentration (cutoff depth). Groundwater chemistry was characterized using Tetra Tech's 2016 Data Gap Investigation – Silver Bow Creek and Blacktail Creek Corridors Memo. (March 2023 to February 2024)

Figures 16, 20, 24, 27, and 32 present dewatering rates, and Figures 12 through 15, 17 through 19, 21 through 23, 25 through 26, and 28 through 31 present groundwater drawdown extents. Table 7 and Figure TT-1 (Tetra Tech, 2016) presents groundwater chemistry data from Tetra Tech's 2016 Data Gap Investigation – Silver Bow Creek and Blacktail Creek Corridors Memo.

2.6 GEOTECHNICAL REVIEW

A Geotechnical Review was conducted to analyze existing geotechnical data and to evaluate the need for a Phase II Geotechnical Investigation. The Geotechnical Review was conducted by

Lorenzen Soil Mechanics, Inc. (LSM) and is summarized in Section 6.6 below. The full Geotechnical Report is included in Appendix E. (January 2024)

2.7 GROUNDWATER INVESTIGATION EVALUATION

An evaluation for the need for a groundwater investigation in a Phase II PDI was conducted by HGL. The evaluation concluded that a separate Phase II PDI groundwater investigation is not needed. Existing data from AR and Tetra Tech provided enough information to adequately characterize groundwater chemistry and dewatering rates. Further information is provided in Sections 3.4, 6.5, and 7.1.5.

3.0 SUMMARY OF PHASE I PDI WORK PERFORMED

Work performed during the Phase I PDI was categorized into characterization and delineation of Waste, characterization of hydrocarbons, characterization of municipal waste, estimation of the rate and extent of groundwater dewatering required for RA at the BTC, evaluation for a geotechnical investigation in a Phase II PDI, and XRF correlation. For investigation results, refer to the Table of Contents for lists of Tables, Figures, and Appendices.

Work performed during the Phase I PDI is summarized in the sections below:

3.1 Tailings, Wastes, Contaminated Soils and Sediments (Waste)

The following activities were performed to delineate and characterize tailings, wastes, contaminated soils and sediments (Waste) within the site during the Phase I PDI:

- Drilled 43 boreholes, dug 4 trenches with a hand shovel, and collected 4 stream sediment samples with a hand shovel at sample locations as shown on Figure 3;
- Logged lithology of all sample locations (boreholes, trenches, and sediment sample locations) as presented in Appendix F;
- Collected soil samples from all 1-foot intervals drilled or dug;
- Photographed intervals (boreholes, trenches, and sediment sample locations), suspect ACM, small non-human mammal bone, municipal waste surface area, and site photographs are presented in Appendix G;
- Field notes were recorded and are presented in Appendix H;
- Performed in situ XRF and modified ex situ (intrusive) XRF methods with results provided in Appendix C;
- Input drilling results into Carlson software to model extent and volume of Waste, Municipal Waste, and Fill. Volume results are presented as total excavation volumes in Table 4. Total excavation volumes combine Waste, Municipal Waste, and Fill as a total volume. Visual representations of results are shown in Figures 5 through 7.9. Figure 5 shows inferred lateral extents of Municipal Waste, Figure 7.0 shows inferred lateral extents of Waste, and Figure 6 along with Figures 7.1 through 7.9 show visual representations of

excavation scenarios. Additionally, Figures 7.4 through 7.9 show visual representations of drilling results; and

- Conducted Passing-Bablok regressions via MedCalc program on modified ex situ (intrusive) XRF data versus lab data, and in situ XRF data versus lab data to develop correlations for COCs (arsenic, cadmium, copper, lead, mercury, and zinc) with results provided in Appendix D and summarized in Section 6.2.

Forty-three boreholes were drilled using sonic drilling technology. A 4-inch diameter core was recovered in polyethylene bags and laid out on a tarp for logging, XRF analysis, mercury sampling, and archive sampling. Eighty-nine percent of all intervals drilled were recovered. All mercury samples taken at the time of drilling were preserved in 4-oz glass jars and coolers with ice to meet preservation requirements. Notes were taken in the field notebook. Photographs were taken of the material drilled and dug.

The in situ XRF method was utilized in the field to identify metal concentrations of COCs (arsenic, cadmium, copper, lead, mercury, and zinc) and to guide depth of boreholes and laboratory mercury analysis for drilling sample selection. XRF Screening Levels and XRF Ceiling Levels from Table 1 were utilized in the field to dictate whether the material encountered was considered Waste. Once a contamination cutoff level was identified or the highest concentrations of metals were encountered in a boring that did not contain Waste, three samples were taken for laboratory mercury analysis with one sample from the 1-ft interval above the cutoff level and one sample from the two 1-ft intervals below the cutoff level. Mercury samples taken in the field during drilling adhered to preservation requirements and were preserved in 4-oz amber glass jars and kept in coolers to maintain a temperature ≤6°C (but not frozen). Samples from all recovered intervals (boreholes, trenches, and sediment locations) were collected as “archive samples” for intrusive XRF at the field lab and for laboratory analysis.

At the field lab, samples were dried, sieved with a #10 sieve, placed in plastic bags, and analyzed with intrusive XRF for COCs (mercury, cadmium, arsenic, lead, zinc, and copper) to confirm the cutoff contamination level. One sample from the 1-ft interval above the cutoff level and one sample from the two 1-ft intervals below the cutoff level were submitted to the laboratory for arsenic, cadmium, lead, copper, and zinc concentration analysis. If intrusive XRF indicated the cutoff contamination level differed from what was observed in the field, the samples submitted to the laboratory were also analyzed for mercury concentrations. Mercury preservation of cooling samples to ≤6°C (but not frozen) for samples submitted to the laboratory from the field lab was not adhered to. Hold time requirements for Mercury were adhered to. No observed adverse effects resulted from the lack of Mercury sample preservation adherence, and further information is provided in Section 6.1.

Intervals that had not been scanned by in situ XRF in the field or in the modified ex situ (intrusive) XRF in the field lab were scanned using the in situ XRF method. For all recovered materials 1-ft intervals were scanned by XRF with either the in situ XRF method in the field or field lab, modified ex situ (intrusive) XRF method in the field lab, or both as presented in Appendix C.

Data validation stage 2B was conducted on laboratory data. Validated data were used to confirm lab results and identify 1-ft intervals of Waste. Data validation results are presented in Appendix I. The majority of the data did not require a qualifier, and only 4 results (0.5%) were rejected.

Using identified contamination intervals and Carlson software, contamination excavation extents and volumes were modeled. Estimated Excavation Volume results are presented in Table 4 and shown in Figures 6 through 7.9.

In total, 670 1-ft intervals were recovered and sampled from 750 ft of drilling, 9 1-ft intervals were sampled from 9 ft of trenching, and 4 sediment stream surface samples were collected. There were 137 samples taken at the time of drilling that were submitted to the laboratory for mercury analysis. All intervals were sampled in the field as “archive samples” for further processing in the field lab. Of the 139 samples that were dried, sieved, and submitted to the laboratory after drilling for cadmium, arsenic, lead, zinc, and copper analysis, 15 were also submitted for mercury analysis. The laboratory results are presented in Appendix A, and the associated laboratory reports are presented in Appendix B.

There were 295 XRF scans taken in the field using the in situ XRF method, 167 XRF scans were taken in the field lab using the modified ex situ (intrusive) XRF method, and 365 scans were taken in the field lab using the in situ XRF method. In total, 827 XRF scans were taken by either the in situ method or modified ex situ (intrusive) method. A total of 41 combined duplicate scans were taken of drilled intervals or the National Institute of Standards and Technology standard reference material 2710a by either the in situ method or the modified ex situ (intrusive) method. All XRF scans were analyzed for COCs (arsenic, cadmium, copper, lead, mercury, and zinc). The XRF results are presented in Appendix C.

3.2 Hydrocarbons

Hydrocarbons were analyzed in the field from the boreholes, hand-dug trenches, and sediment stream samples using a Rae Systems MiniRae 3000 10.6ev PID, olfactory detection (smell), and/or visual detection (eyesight). Immediately after material was recovered from a borehole, trench, or stream sediment sample, the PID was used to scan the material. All PID results were recorded in the field notebook, as presented in Appendix H. No hydrocarbons were detected in the field by the PID. One hydrocarbon sample from sonic borehole BTC-35, at 3 to 4 ft bgs, was submitted to the laboratory for hydrocarbon analysis based on a slight hydrocarbon smell and a dark gray, oily visual appearance observed during field sampling efforts. Lab results showed the sample was well below the Maximum Contaminant Level/Quality Control Limit of 200 mg/kg with a reported concentration of 28 mg/kg Total Extractable Hydrocarbons. Appendix A presents hydrocarbon analysis results, and the lab report is presented in Appendix B. All PID field data is presented in the field notebook in Appendix H.

3.3 Municipal Waste

Municipal waste was identified visually in the field and in the field lab. All material drilled, dug, or sampled was visually inspected for municipal waste. Results of visual identification of municipal waste were recorded in the field boring logs as presented in Appendix F. Results are also shown in Table 8 and Figure 5. Additionally, 10 suspect ACM samples from three separate boreholes were submitted to Eurofins CEI for asbestos analysis. Asbestos results are presented in Appendix A, the laboratory report is presented in Appendix B, photographs are provided in Appendix G, and results are summarized in Table 8.

3.4 Groundwater Characterization and Dewatering Modeling

Groundwater dewatering extent and rates were estimated using an updated version of Woodard and Curran's 2022 Draft Buffalo Gulch groundwater model, lithologic data from the BTC PDI, and BTC PDI contamination concentration data (to define the vertical extent of Waste). Groundwater chemistry was characterized using Tetra Tech's 2016 Data Gap Investigation – Silver Bow Creek (Tetra Tech, 2016). Figures 10 through 32 present groundwater modeling results. Groundwater chemistry data from Tetra Tech's 2016 investigation is provided in Table 7, and sample locations are shown in Tetra Tech's Figure (Figure TT-1).

To estimate potential dewatering rates and volumes for the Blacktail Creek riparian area, it was desirable to use a groundwater model. Potential options included development of a new groundwater model or use of an existing groundwater model. Two existing groundwater models that include the Blacktail Creek riparian area were available for use: the Montana Pole model (Tetra Tech, 2010) and the Draft Buffalo Gulch model (Woodard and Curran, 2022). These models were assessed to determine which would be more appropriate for use for the present dewatering assessment.

The Montana Pole model was not selected for use in estimating dewatering volumes for the Blacktail Creek riparian area, primarily due to the highly simplified model geometry. Instead, the draft Buffalo Gulch model was selected, with the recognition that updates were necessary to better match available flow/head data before it would serve as an acceptable predictive tool. Updates to the Buffalo Gulch model and dewatering estimates developed with that updated model are discussed in Section 6.5.

At the time of the development of dewatering assessments presented in this report for the Blacktail Creek riparian area, development of the BPSOU sitewide groundwater flow model (developed by Stantec for AR) was nearing completion. DEQ planned to consider this more comprehensive and detailed BPSOU sitewide model for use in subsequent stages of the Blacktail Creek dewatering assessment, once that model was completed and available. As discussed in Section 6.5, after review of the recent BPSOU sitewide model draft final report (AR, 2024a), DEQ ultimately decided not to use the sitewide model to revisit dewatering predictions for the BTC site.

3.5 Survey

Brown and Associates, Inc. conducted surveying at the BTC site. Six control points were established, 43 sonic boreholes were surveyed for gps coordinates and elevations, and topography was surveyed. The figure provided by Brown and Associates, Inc., BPSOU – Blacktail Creek Existing Conditions Map (Figure B&A), presents topography, borehole locations, and other BTC features. Table 2 provides gps coordinates and elevations of sample locations with borehole and control point gps coordinates and elevations provided by Brown and Associates, Inc.

Numerous buried and overhead utility lines and other critical infrastructure are present within and adjacent to the BTC site. The horizontal alignments of some of these lines have been previously surveyed, and some are apparent from ground disturbance, including the recently installed high voltage line and the fiber optics line. GIS shape files of the horizontal alignments were provided for some of the buried sanitary and waterlines prior to the Phase I PDI. Approximate locations of known utilities are shown in Figure 4.2 and approximate locations of the BPSOU subdrain and 42-inch sanitary sewer main are provided in cross section on Figures 7.4 and 7.5.

3.6 Data Validation

Data validation stage 2B was conducted on metals and mercury concentration laboratory data. Validated data were used to confirm XRF results and identify 1-ft intervals of Waste. Data validation reports are presented in Appendix I, and qualifiers are listed in Appendix A. A total of 884 analyses were submitted to ELI for metals and/or mercury analysis. Laboratory results are presented in Appendix A, and laboratory reports are presented in Appendix B.

Of the 884 metals or mercury concentration analyses conducted by ELI, 734 results did not require qualification, 79 results were qualified J (estimated results), 10 results were qualified J- (estimated results, but biased low), 54 results were qualified U (non-detected results), 3 results were qualified UJ (non-detected estimated results), and 4 results were qualified R (rejected results). In total 83% of metals and mercury test results did not require qualification with 99.5 percent of metals and mercury concentration analysis laboratory results being accepted. The 88.7 percent (no qualification required and non-detected results) of the metals and mercury concentration analysis laboratory results are considered enforcement level, and the 9.3 percent (estimated results) and the 1.1 percent (estimated result, but biased low) and are considered screening level. The 0.5 percent (rejected results) were rejected.

4.0 DATA QUALITY OBJECTIVES AND ASSESSMENT

The Data Quality Assessment (DQA) process (AERL, 2000) objective is to determine whether the project-specific objectives are satisfied and if the data collected are acceptable for project decision making. The DQA process consists of five steps that relate the quality of the results to the intended use of the data:

Step 1: Review DQOs and sampling design.
Step 2: Conduct preliminary data review.
Step 3: Select statistical test(s), as appropriate, to evaluate data quality (not applicable).
Step 4: Verify assumptions (not applicable).
Step 5: Draw conclusions about the quality of the data.

4.1 Data Quality Objectives and Sampling Design Review

The DQOs are statements that define the type, quality, quantity, purpose, and use of data to be collected. The DQOs for the BTC PDI were developed using a systematic planning process in accordance with EPA QA/G-4, *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006). The DQOs and process are provided in Worksheet #11 of the UFP-QAPP.

The goal of the project was to collect data to fill in known data gaps to produce a robust RD to remove Waste from the BTC site. The principal study question has three primary components related to solid materials and groundwater as follows:

Principal Question 1: What are the lateral and vertical extents of tailings, waste, and impacted materials (as defined by the Waste Identification Screening Criteria in Table 1) (EPA, 2020a), within the BTC site?

Principal Question 2: What are the anticipated dewatering volumes and the effects of construction dewatering on the site associated with removal of the required waste materials?

Principal Question 3: Based on the outcomes of the investigation to address principal questions 1 and 2, determine the potential impacts and limitations associated with protecting or working around critical infrastructure.

The data collected during this investigation met the objectives needed to address all Principal Questions. Data associated with Principal Question 1 are discussed below.

4.2 Data Review

This section reviews the data using precision, accuracy, representativeness, completeness, comparability, and sensitivity (PARCCS) as the data quality indicators.

4.2.1 Data Quality Indicators – Soil Sample XRF Data

- **Precision:** A total of 295 XRF scans were taken in the field using the in situ XRF method, 167 XRF scans were taken in the field lab using the modified ex situ (intrusive) XRF method, and 365 scans were taken in the field lab using the in situ XRF method. In total, 827 XRF scans were taken. Of the 41 total duplicate scans, 3 scans did not meet precision objectives of Relative Percent Difference (RPD) less than 50 percent:

  BTC-12-8-9 (Arsenic, Cadmium, Copper, Lead, and Zinc)

  BTC-17-2-4 (Copper and Lead)

  BTC-20-21-22 (Arsenic, Copper, Mercury, Lead, and Zinc)

- **Accuracy:** Accuracy requirements for XRF were not established for XRF.
- **Representativeness:** The representativeness goals were met.
- **Completeness:** 100 percent of drilled intervals that were recovered by sonic drilling methods were scanned by the XRF unit. The completeness goal of 90 percent was exceeded.
- **Comparability:** Data from past and future soil sampling events at the Site using comparable sampling and XRF analyses may be used in concert with this data set.
- **Sensitivity:** The limit of detection for the XRF was appropriate to meet the DQOs.

4.2.2 Data Quality Indicators – Soil Metals & Mercury Laboratory Analysis Data

- **Precision:** A total of 143 samples were sampled in the field and submitted to the laboratory for mercury analysis. Of the 143 samples, 129 were from drilled intervals, six were duplicates from drilled intervals, four were stream surface samples, and four were from trench intervals. After the field sampling event, a total of 145 samples were dried, sieved, and submitted to the laboratory for arsenic, cadmium, copper, lead, and zinc analysis, with 15 of those also submitted for mercury analysis. Of the 145 samples, 131 were from drilled intervals, six were duplicates from drilled intervals, four were stream surface samples, and four were from trench intervals. The number of samples submitted to the laboratory from the field (143) differed from the amount submitted after the field sampling event (145) because one additional interval sample was selected from borings BTC-04 and BTC-40 to better define the vertical extent of Waste. Refer to Appendix A laboratory results. Total analyses of either arsenic, cadmium, copper, lead, mercury, or zinc were 884, with 37 duplicate analyses. Of the 37 total duplicate results, 4 analyses did not meet precision objectives of RPD less than 20 percent:

BTC-12-9-10 (Copper and Lead)

BTC-26-15-16 (Mercury)

BTC-40-8-9 (Mercury)

- **Accuracy:** Of 12 MS/MSD samples, one did not meet accuracy control limits.

  BTC-39-8-10 (Mercury)

- **Representativeness:** The representativeness goals were met.
- **Completeness:** Of the 139 samples submitted to the laboratory, 9 intervals were not included that should have 1 sample above and 2 below the contamination cutoff, resulting in a 93.5 percent completeness for laboratory analysis. The completeness goal of 90 percent was exceeded.
- **Comparability:** Data from past and future soil sampling events at the Site using comparable sampling and XRF analyses may be used in concert with this data set.
- **Sensitivity:** The limit of detection for the laboratory analysis was appropriate to meet the DQOs.

4.3 Conclusion on the Quality of the Data

As a result of DQA process outlined above, it is determined that the data summarized in this PDI ER are appropriate for use in evaluating the DQOs as described in the BTC UFP-QAPP and are usable for the BTC RD and RA effort.

5.0 DEVIATIONS FROM THE QUALITY ASSURANCE PROJECT PLAN

A detailed list of deviations from the approved BTC UFP-QAPP along with an explanation for each deviation and description of the effect on data quality and usability are provided below.

1. Out of 51 sample locations, only 2 (BTC-18 & BTC-31) differed in Waste categorization between modified ex situ (intrusive) XRF results and laboratory analysis results. The 9- to 10-ft interval from BTC-18 was identified as Waste with modified ex situ (intrusive) XRF and as Fill in laboratory results due to Copper and Lead concentrations varying by 12 to 16 percent, respectively. Lead was qualified J with a laboratory result of 909 mg/kg.

Similarly, the 11 to 12 ft interval from BTC-31 was identified as Fill with modified ex situ (intrusive) XRF but as Waste with laboratory results due to lead concentration varying by 24 percent. In each instance, the more conservative, deeper identified Waste interval was used for estimated volume calculations, meaning that for BTC-18 the bottom of Waste was set to 10 ft bgs and for BTC-31 the bottom of Waste was set to 12 ft bgs. This situation is not likely to alter findings significantly as it is understood that contamination at BTC does not display a perfectly linear spatial relationship, and minor vertical contamination variability during RA is expected. This finding confirms the need for post-removal sampling to supplement the design data to ensure the completeness of the RA.

2. All borings except for one, BTC-24, successfully delineated Waste. BTC-24 ended in Waste due to field XRF indicating 2 ft of material at the bottom of the boring that did not meet the Waste criteria in Table 1 of the BPSOU CD. Both modified ex situ (intrusive) XRF and laboratory results confirmed that the last interval, 20 to 21 ft, meets the criteria in Table 1 of the BPSOU CD for Waste. In this instance, data was compared to neighboring borings, and it was concluded that the 20- to 21-ft interval was at the bottom of Waste or near to it. For this area, it is known that Waste may be deeper than what was observed, but based on neighboring borings and data collected, not more than 1 to 2 ft deeper than what was observed. For this reason, this situation is not considered to alter findings significantly, and the data collected in BTC-24 and neighboring borings provide enough points to confidently estimate the bottom of Waste for the purposes of RD. This finding confirms the need for post-removal sampling to supplement the design data to ensure the completeness of the RA.

3. The naming convention for all samples and sample locations associated with borings was changed from "BTC-Sonic-01-00-01" to "BTC-01-00-01," removing "Sonic" from the boring naming convention. It was identified that so long as the two other sample locations, "Surface" and "Trench," were identified with the original naming convention it would simplify the majority of the sample labeling since the majority of the samples taken were from borings. This new naming convention had no adverse effect on results but simplified the PDI data collection and management process.

4. Homogenization in the field was not conducted as it was found to significantly delay drilling operations and increased the possibility of cross-contamination of samples. However, homogenization occurred in the field lab for all ex situ (intrusive) XRF samples that were submitted to the laboratory for metals and mercury analysis. This did not adversely impact results of the PDI and helped to ensure accurate results.

5. All drilled intervals were not scanned with XRF in the field. Scanning all intervals in the field was found to significantly delay drilling operations. However, all drilled intervals were either scanned in the field by the in situ XRF method, in the field lab by the ex situ (intrusive) XRF method, in the field lab by the in situ XRF method, or in some instances by both the ex situ (intrusive) XRF method and in situ XRF method as presented in Appendix C. Of the 139 samples submitted to the laboratory from ex situ (intrusive) XRF results, nine intervals were not included that should have one sample above and two below the contamination cutoff, resulting in a 93.5 percent completeness for laboratory analysis. The completeness goal of 90 percent was met and exceeded. In instances where one sample above the contamination cutoff and two below the contamination cutoff were not successfully identified by ex situ (intrusive) XRF and corresponding metals and mercury

laboratory analysis results, in situ XRF was relied on to conservatively estimate the intervals that define the bottom of Waste. This was the case less than 10 percent of the time, and a completeness of 93.5 percent was achieved. This does not significantly affect the findings.

6.0 INTERPRETATION OF RESULTS

The following sections provide interpretation of results for the Phase I PDI regarding the data gaps presented in Section 1.4.

6.1 Tailings, Wastes, Contaminated Soils and Sediments (Waste)

The 1-foot interval samples were collected from 43 boreholes, 4 hand-dug trenches, and 4 surface stream sample locations, as detailed in Section 3.1. XRF scans, either in situ or modified ex situ (intrusive), were taken of all 1-foot intervals recovered and collected to aid in laboratory sample selection and waste interval identification. The primary goal was to identify the bottom of Waste using a combination of XRF and laboratory analysis, both testing for concentrations of COCs (arsenic, cadmium, copper, lead, mercury, and zinc).

Using all available XRF data and laboratory concentration analysis data, bottom elevations of Waste were identified using Table 1 Criteria. For all in situ XRF results, modified XRF Screening Levels and XRF Ceiling Levels from Table 1 were applied for identification of Waste. Both modified ex situ (intrusive) XRF and laboratory analysis results utilized BPSOU CD Laboratory Action Level and BPSOU CD Laboratory Ceiling Criteria from Table 1 for identification of Waste.

Waste was identified in 36 boreholes and was not identified in BTC-1, BTC-3, BTC-5, BTC-6, BTC-7, BTC-8, BTC-11, BTC-Trench-01 through BTC-Trench-04, and BTC-Surface-01 through BTC-Surface-04. To create a conservative excavation surface in Carlson, an additional foot of depth was added to the deepest 1-ft interval of Waste identified in boreholes to account for complete removal of Waste. In past projects it has been shown that Waste can intermix during excavation and often at least a foot more of depth is required for complete removal. A 1.5 Horizontal (H):1 Vertical (V) excavation slope was considered for the edges of excavation for a more accurate representation of excavation volumes. Final excavation and backfill slopes will be considered during the RD. The volume of material that cannot be excavated due to existing infrastructure such as utilities was not considered and will be estimated during the RD. Backfill Material Suitability Criteria volumes required for import will be considered during RD. Visual representations of excavation surfaces are provided in Figures 6 through 7.9. The inferred lateral extent of Waste at the BTC site is shown in Figure 7.0. Estimated total excavation volumes are provided in Table 4.

As outlined in Section 3.1, field sampling at the time of drilling for mercury was conducted to adhere to mercury preservation requirements (i.e., keeping samples cool to ≤6°C (but not frozen)). Additionally, 15 mercury samples and one duplicate were submitted to the laboratory for analysis post-drilling which did not follow preservation requirements of keeping the samples cool to ≤6°C (but not frozen). However, in no instance were the mercury findings a deciding factor in Waste characterization. In cases where mercury levels exceeded 10 mg/kg (the BPSOU CD Table 1 threshold) in samples obtained either at the time of drilling or post-drilling for intervals categorized as Waste, there were consistently at least three other COCs exceeding BPSOU CD Table 1 thresholds. Mercury in any instance did not exceed BPSOU CD Laboratory Ceiling levels. Thus, mercury never served as the sole determinant in Waste characterization.

Not preserving Mercury samples by cooling them for samples submitted to the laboratory from the field lab did not adversely affect this investigation and DQOs. The primary DQO that Mercury preservation applies to, characterizing the lateral and vertical extent of Waste within the BTC site, was successfully addressed and more information is provided in Section 7.1. Further sampling of Mercury at the BTC site in regard to this investigation and associated DQOs is not necessary. The extent of Waste at the BTC site was successfully characterized.

6.2 XRF Correlation

XRF correlation was conducted using the Passing-Bablok regression bootstrapping method via the software package “MedCalc” on modified ex situ (intrusive) XRF data versus laboratory data to develop correlations for COCs (arsenic, cadmium, copper, lead, mercury, and zinc). Additionally, XRF correlation was conducted using the Passing-Bablok regression bootstrapping method via MedCalc on in situ XRF data versus laboratory data to develop correlations for COCs (arsenic, cadmium, copper, lead, mercury, and zinc). XRF correlation reports are presented in Appendix D.

A total of 645 ex situ (intrusive) XRF/laboratory data pairs were used to perform a regression analysis, and a total of 438 in situ XRF/laboratory data pairs were used to perform a regression analysis. The methods of analysis and associated detection limits vary significantly between the XRF and laboratory analytical methods. The XRF analysis typically has significantly higher detection limits than the laboratory for all analytes. Treatment of below detection limit data is an important preliminary step in a comparison of this type. Laboratory analysis data that were below the analytical detection limit were reported as Non-detect (ND). These laboratory analytical results were omitted (e.g., <10 mg/Kg was omitted). Similarly, XRF analysis data that were below the analytical detection limit were reported as Non-detect (ND), and omitted. XRF correlation reports are provided in Appendix D.

Analytical data generated by the two different methods were compared on a sample pair basis using the Passing-Bablok regression method, which produces a test of linearity comparing p-value (two-tailed) to the alpha value. If the computed p-value is greater than the significance level alpha=0.05, one cannot reject the null hypothesis H0 (the relationship between the two variables is linear) and can reject the alternative hypothesis Ha (the relationship between the two variables is not linear). Results of the XRF correlation are presented in Table 3.

The strength of the correlation between XRF and laboratory results was also measured by the Spearman Correlation Coefficient, and noted below:

- Strong correlation (coefficient > 0.9): Arsenic, copper, lead, and zinc ex situ XRF results are considered highly reliable, comparable to laboratory results.
- Good correlation (coefficient > 0.7): Cadmium ex situ and zinc in situ XRF results are suitable for screening purposes.

- Moderate correlation (coefficient 0.5 - 0.7): Mercury ex situ and arsenic, copper, mercury, and lead in situ XRF results show some correlation but don't meet screening criteria.
- Poor correlation (coefficient < 0.5): Cadmium in situ XRF results are not considered reliable.

Using the Passing-Bablok regression bootstrapping method, linear relationships were identified for COCs (arsenic, cadmium, copper, lead, mercury, and zinc) for both ex situ (intrusive) XRF/laboratory data pairs and in situ XRF/laboratory data pairs. Table 3 provides predicted XRF concentrations for ex situ (intrusive) XRF results in relation to the action levels from Table 1 of the BPSOU CD. Developing predicted XRF concentrations for arsenic, copper, lead, and zinc allows for ex situ (intrusive) XRF methods or in situ XRF methods to be implemented during RA.

Confirming waste removal to the Table 1 Criteria in a timely manner will be crucial to cost-effective removal of Waste during RA. Ex situ (intrusive) XRF results can be utilized in a timely manner to confirm depth of Waste in an approximate 24-hour time frame. In situ XRF results can be utilized in an even more timely manner to confirm the depth of Waste in a near real-time time frame. Being able to confirm depth of Waste in 24-hours or less will help avoid costly construction delays associated with the longer laboratory testing turnaround time of a week or longer to get results.

6.3 2B Data Validation

Of the 884 metals or mercury concentration analyses conducted by ELI, 734 results did not require qualification, 79 results were qualified J (estimated results), 10 results were qualified J- (estimated results, but biased low), 54 results were qualified U (non-detected results), 3 results were qualified UJ (non-detected estimated results), and 4 results were qualified R (rejected results). In total 83 percent of metals and mercury test results did not require qualification with 99.5 percent of metals and mercury concentration analysis laboratory results being accepted. The 89.1 percent (no qualification required and non-detected results) of the metals and mercury concentration analysis laboratory results are considered enforcement level, and the 9.3 percent (estimated results) and the 1.1 percent (estimated result, but biased low) and are considered screening level. The 0.5 percent (rejected results) were rejected. The 4 results qualified R (rejected results) were Mercury results from intervals that did not exhibit any exceedance of Table 1 BPSOU CD thresholds, and for this reason, the rejected results did not adversely impact findings of this PDI.

6.4 Municipal Waste

Municipal waste was identified in 14 borings and a barren area 70 ft west of BTC-03. Glass, ceramic, wood, slag, mortar, brick, plastic, concrete, metal, grout, and a small non-human mammal bone were visually identified in 23 1-ft-drilled intervals and in the barren area on the surface. Ten suspect ACM samples from 4 intervals total and three borings total (BTC-09, BTC-22, and BTC-29) were submitted to Eurofins CEI in Cary, North Carolina (NC) for EPA 600 PLM bulk asbestos analysis. Asbestos was not detected in any of the samples submitted to Eurofins CEI. Asbestos analysis results are provided in Appendix A and in the Eurofins CEI report in Appendix B. Municipal Waste observations are provided in Table 8 and Figure 5.

6.5 Groundwater Characterization and Dewatering Modeling

Groundwater characterization was conducted by reviewing water chemistry data from Tetra Tech's 2016 Data Gap Investigation – Silver Bow Creek and is included as Table 7. All groundwater samples analyzed in the BTC area or surrounding areas provided in the Tetra Tech's 2016 report had a reported pH between 6.4 and 7.9. Of the six COCs, three COCs (arsenic, cadmium, and zinc) exceeded MT-DEQ-7 Human Health **Surface Water Standards** at maximums of 0.302 mg/l, 0.037 mg/l, and 24.1 mg/l, respectively. Groundwater chemistry in the BTC area is considered near circumneutral and within acceptable parameters of the existing BTL treatment process.

Groundwater dewatering extent and rates were estimated using an updated version of the Draft Buffalo Gulch groundwater model prepared for AR (Woodard and Curran, 2022), lithologic data from the BTC PDI, and BTC PDI contamination concentration data (to define vertical extent of Waste). The updated model is expected to provide sufficient accuracy for estimating construction dewatering rates for RD purposes.

6.5.1 Model Selection

To estimate potential dewatering rates and volumes for the Blacktail Creek riparian area, available groundwater models were considered. Two existing groundwater models that include the Blacktail Creek riparian area were available for use: the Montana Pole model (Tetra Tech, 2010) and the Draft Buffalo Gulch model (Woodard and Curran, 2022). These models were assessed to determine which would be more appropriate for use for the present dewatering assessment.

Table 5 compares key aspects of the Montana Pole and Draft Buffalo Gulch models. The Montana Pole model geometry/framework was highly simplified with respect to the understanding of geology in the area. The Buffalo Gulch model honors overall aquifer thickness from available borehole data; however, each of the nine layers in this model represents a continuous geologic/lithologic unit (with a uniform hydraulic conductivity [K]), which is unlikely to be representative of field conditions. Both models were well-calibrated to heads at a single point in time, but no calibration was conducted to flow rate data (e.g., stream flow rates, groundwater extraction rates, etc.). As part of the model assessment, simulated groundwater discharge to Blacktail Creek in each model was compared to the observed groundwater discharge data to Blacktail Creek from Tucci (2014). Both models significantly underpredicted observed groundwater discharge to Blacktail Creek, with greater underpredictions found with the Buffalo Gulch model.

Woodard and Curran's 2022 Draft Buffalo Gulch model was selected for use, primarily due to the highly simplified geometry/framework of the Montana Pole model. Several key updates to and recalibration of the Buffalo Gulch model were conducted to provide a model that is more representative of conditions in the Blacktail Creek riparian area and so better equipped for estimating construction dewatering rates; these updates and recalibration are described in the following section.

Finally, at the time of the development of dewatering assessments presented in this report for the Blacktail Creek riparian area, development of the BPSOU sitewide groundwater flow model (developed by Stantec for AR) was nearing completion. DEQ planned to consider this more comprehensive and detailed BPSOU sitewide model for use in subsequent stages of the Blacktail Creek dewatering assessment, once that model was completed and available. After review of the recent BPSOU sitewide model draft final report (AR, 2024a), DEQ ultimately decided not to use the sitewide model to revisit dewatering predictions for the BTC site. Although the sitewide model is more comprehensive than the updated Buffalo Gulch model and has the advantage of being calibrated to transient conditions over a 4-year period from 2018 through 2021, the two models perform similarly in reproducing observed water levels and drawdowns in and near the BTC site during the September 2022 BTC pumping test. This can be seen by comparing hydrographs presented in the following section of this report to hydrographs in Attachment C-5 Calibration of Stantec (2024); for the latter hydrographs, see page 1476 of 1535 (Figure 10, AMW-11), page 1481 of 1535 (Figure 15, BPS11-04), and page 1471 of 1535 (Figure 5, BTC-PZ05S and BTC-PZ05D) in Stantec (2024). This similar performance in reproducing the September 2022 BTC pumping test results indicates that dewatering predictions for the BTC site using the BPSOU sitewide model would be similar to those already produced with the updated Buffalo Gulch model.

6.5.2 Buffalo Gulch Model Updates and Re-Calibration

Prior to re-calibrating the Buffalo Gulch model, the upgradient boundary conditions were modified. These boundary conditions supply groundwater influx to the model area and were specified only in the thin, uppermost portion of the model (1 to 2 layers). Thus, no groundwater influx occurred over the majority of the model thickness; the underprediction of groundwater discharge to Blacktail Creek was likely tied to this limited groundwater influx to the model. In addition, the specified boundary heads were inconsistent with observed water level maps in the northeast portion of model. The upgradient boundary conditions were modified to extend through the entire model thickness, and the boundary heads in the northeast portion of the model were adjusted to be consistent with observed water level maps.

After these modifications were made, the Buffalo Gulch model was recalibrated to two stress conditions:

- Steady state baseflow conditions from September 2019, which was the time frame used for the original model calibration by Woodard and Curran; and
- Transient conditions associated with the August/September 2022 AR pumping test, which occurred across Blacktail Creek from the Blacktail Creek riparian area. While the drawdown in this pumping test was focused on the northeast side of Blacktail Creek, drawdown was also observed on the southwest side of Blacktail Creek.

For the steady-state calibration to September 2019 water levels, Woodard and Curran had used 25 water level targets. For the model recalibration, an additional 59 water level targets were available for September 2019 from the Stantec water level database for the BPSOU sitewide groundwater flow model. Thus, the steady-state recalibration used a total of 84 water level targets.

Groundwater discharge rates to Blacktail Creek from Tucci (2014) were also used as steady-state calibration targets. Although these rates were from a different time frame than the water level data (September 2011 versus September 2019), both were under baseflow conditions. The addition of flux data as model calibration targets helps to narrow model non-uniqueness and make the model more representative of site conditions.

For the transient calibration to the August/September 2022 AR pumping test, a total of about 5,000 water level data points from 43 monitoring wells were used as transient head targets. Both drawdown and recovery data were included as targets.

During the recalibration process, K was allowed to vary within each model layer as opposed to the original model, which had a uniform K within each model layer. The specific yield (S_y) was held uniform within each model layer. Calibration was conducted using Parameter Estimation (PEST) software (Watermark Numerical Computing, 2018).

Model calibration was assessed using scatterplots of simulated versus observed heads, head calibration statistics, hydrographs of transient observed and simulated water levels versus time, and comparison of observed and simulated groundwater flux to Blacktail Creek. Figure 8 presents a scatterplot of simulated versus observed target heads for the steady-state calibration. Points are clustered closely along the ideal 45-degree line, indicating that the differences between observed and simulated heads (i.e., head residuals) are small. The steady-state head residual mean is -0.07 ft and the scaled head residual standard deviation (i.e., the head residual standard deviation divided by the range in observed heads) is 2.6 percent (Table 6). These statistics are well within the groundwater modeling standards of a residual mean near zero and a scaled residual standard deviation less than 10 percent.

For the steady-state flux calibration, groundwater discharge data to Blacktail Creek under baseflow conditions were extracted from Tucci (2004). Over the reach from Tucci's stations 1 through 12, Blacktail Creek gained about 2.2 cubic ft per second (cfs). Of this, about 0.8 cfs was from surface water tributaries to Blacktail Creek over this reach. Thus, groundwater discharge to Blacktail Creek was about 1.4 cfs. For the purposes of model calibration, a target range from 0.8 to 1.75 cfs was used to reflect uncertainty and variability in this baseflow groundwater discharge. For the steady-state calibration simulation, the simulated groundwater discharge to Blacktail Creek over the reach from stations 1 through 12 was 0.9 cfs, within the target range of 0.8 to 1.75 cfs.

For the transient calibration to the 2022 AR pumping test, a scatterplot of simulated versus observed target head changes is presented in Figure 9. More deviation is evident from the ideal 45-degree line than in the steady-state calibration scatterplot (Figure 8), but differences between observed and simulated head changes (i.e., head change residuals) are still small. The steady-state head change residual mean is 0.05 ft, and the scaled head change residual standard deviation is 2.6 percent (Table 6). Again, these statistics are well within the groundwater modeling standards of a desired residual mean near zero and a scaled residual standard deviation less than 10 percent.

Hydrographs of transient observed and simulated water levels versus time were generated for all target monitoring wells from the 2022 AR pumping test. Hydrographs are presented in Figures 10 and 11 for four selected monitoring wells. Two of these (AMW-11 and BPS11-04; see Figure 10) are on the southwest side of Blacktail Creek, in or near the Blacktail Creek riparian area. The other two (BTC-PZ05S and -PZ05D; see Figure 11) are just northeast across the creek from the Blacktail

Creek riparian area. Simulated heads match observed heads reasonably well. Overall, there is some underprediction of head changes in these wells nearest to the Blacktail Creek riparian area.

The Buffalo Gulch model updates and recalibration described above yielded a model that is more representative of conditions in the Blacktail Creek riparian area, and therefore, better equipped for estimating construction dewatering rates. However, the subsurface is highly variable in the Blacktail Creek riparian area due to past excavation, disposal, and stream course re-working in the area, in addition to natural geologic variability. Consequently, actual water level responses to construction dewatering may vary significantly from simulated responses. The fact that the updated Buffalo Gulch model underpredicted water level decreases (i.e., drawdown) in/near the Blacktail Creek riparian area for the 2022 AR pumping test suggests that the construction dewatering estimates developed for the Blacktail Creek riparian area will err on the conservative side (i.e., a given dewatering rate will likely lower water levels more than predicted by the updated Buffalo Gulch model).

Although the target dewatering interval for the BTC riparian action will be shallower than the interval pumped by BTC-PW-01 (screened 42.5 to 52.5 ft bgs) during the 2022 AR pumping test, the pumping test data demonstrate that these intervals are in strong hydraulic communication. Observed water levels in shallow wells in/near the BTC site responded strongly to extraction at BTC-PW-01. This is shown, for example, in the *target observed* series for AMW-11 (screened 4 to 14 ft bgs) and BTC-PZ05S (screened 20.5 to 25.5 ft bgs), which are the upper graphs in Figures 10 and 11, respectively. Responses were similarly responsive in these shallow monitoring wells as in the co-located deeper monitoring wells BPS11-04 and BTC-PZ05D (see lower graphs in Figures 10 and 11, respectively), which are screened at similar intervals as BTC-PW-01. Thus, despite BTC-PW-01 being screened deeper than the target dewatering interval for the BTC riparian action, the moderate underprediction by the updated Buffalo Gulch model of drawdown observed in the BTC pumping test indicates that the updated Buffalo Gulch model will conservatively underpredict drawdown in the BTC site for a given dewatering extraction rate in that area.

6.5.3 Construction Dewatering Simulations

After the updates described in the preceding section, the Buffalo Gulch model was used to simulate construction dewatering for the Blacktail Creek riparian area. Target dewatering elevation maps were developed based on boring data identifying the bottom of waste material, with the goal of lowering simulated water levels to these elevations after 2 to 3 weeks of simulated dewatering. Separate dewatering simulations were conducted for the project area south of George Street versus north of George Street. For each of these two areas, dewatering simulations were conducted with (1) Blacktail Creek in place and (2) Blacktail Creek removed from the excavation area (e.g., Blacktail Creek piped around or through the excavation area). For the former simulations with Blacktail Creek in place, dewatering was simulated on the southwest side of Blacktail Creek. After dewatering, excavation, and backfill of the southwest side, Blacktail Creek would presumably be temporarily rerouted through the remediated area, and the remainder of the area would be dewatered, excavated, and backfilled. This second stage was not simulated. The dewatering rate required to achieve a given drawdown in an area of a given size will be greater with Blacktail Creek in place due to surface water contributions to groundwater during dewatering.

Dewatering was simulated in both a non-phased approach and a phased approach. In the non-phased approach, the entire area south of George Street was dewatered at once, and a similar, separate simulation was conducted for the entire area north of George Street. In this approach, no limits were placed on the dewatering rate. In the phased approach, the dewatering rate was limited to 200 gpm, and each area (south of George and north of George) was broken up into phased areas so as not to exceed this 200 gpm rate.

Simulated dewatering for the non-phased approach on the south side of George Street is shown in Figure 12 (Blacktail Creek in place; dewatering on southwest side of creek) and Figure 13 (Blacktail Creek piped around or through the excavation area). Simulated dewatering for the non-phased approach on the north side of George Street is shown in Figure 14 (Blacktail Creek in place; dewatering on southwest side of creek) and Figure 15 (Blacktail Creek piped around or through the excavation area). All four of these simulated water level maps are for model layer 4 (the layer within which the target dewatering elevations lie) after 30 days of dewatering. Simulated dewatering rates over time for each of these four non-phased scenarios are shown in Figure 16. South of George Street, near steady-state simulated rates (after 30 days, in this case) were about 400 gpm with or without Blacktail Creek in place. The case with Blacktail Creek in place involves dewatering of a smaller area, which compensates for the otherwise increased dewatering required due to surface water contributions to groundwater. As noted above for this case, a second stage would need to be conducted near and potentially beneath the present course of Blacktail Creek. North of George Street, near steady-state simulated rates (after about 10 days, in this case) were about 250 gpm with Blacktail Creek in place and 300 gpm with Blacktail Creek piped around or through the excavation area. The slightly smaller rate with Blacktail Creek in place is tied to the much smaller simulated dewatering area on the southwest side of the creek (about half the area simulated with Blacktail Creek piped around or through the excavation area).

Simulated dewatering for the phased approach on the south side of George Street with Blacktail Creek in place (dewatering on southwest side of creek) is shown in Figures 17 through 19 for three phases of dewatering. These simulated water level maps are for model layer 4 (the layer within which the target dewatering elevations lie) after 10 days of dewatering. With a dewatering rate limit of 200 gpm, the simulated area that can be dewatered to the target elevations is relatively small for each phase, and three to four additional phases would likely be required beyond the three displayed in Figures 17 through 19. Dewatering rates over time for each of the three simulated phases are shown in Figure 20. Simulated dewatering rates exceed the limit of 200 gpm in early time (until about 3 to 10 days), but the additional complication/effort required to keep the simulated rate near 200 gpm during this relatively short period is not warranted for the present analysis.

Simulated dewatering for the phased approach on the south side of George Street with Blacktail Creek piped around or through the excavation area is shown in Figures 21 through 23 for three phases of dewatering. These simulated water level maps are for model layer 4 (the layer within which the target dewatering elevations lie) after 10 days of dewatering. With a dewatering rate limit of 200 gpm, the simulated area that can be dewatered to the target elevations is again relatively small for each phase, and four to five additional phases would likely be required beyond the three displayed in Figures 21 through 23. Dewatering rates over time for each of the three simulated phases are shown in Figure 24. Again, simulated dewatering rates exceed the limit of 200 gpm in early time (until about 3 to 10 days), but the additional complication/effort required to keep the simulated rate near 200 gpm during this relatively short period is not warranted for the present analysis.

Simulated dewatering for the phased approach on the north side of George Street with Blacktail Creek in place (dewatering on southwest side of creek) is shown in Figures 25 and 26 for two phases of dewatering. These simulated water level maps are for model layer 4 (the layer within which the target dewatering elevations lie) after 10 days of dewatering. Again, with a dewatering rate limit of 200 gpm, the simulated area that can be dewatered to the target elevations is relatively small for each phase. Dewatering rates over time for the two simulated phases are shown in Figure 27. Simulated dewatering rates exceed the limit of 200 gpm in early time (until about 3 days), but the additional complication/effort required to keep the simulated rate near 200 gpm during this relatively short period is not warranted for the present analysis.

Simulated dewatering for the phased approach on the north side of George Street with Blacktail Creek piped around or through the excavation area is shown in Figures 28 through 31 for four phases of dewatering. These simulated water level maps are for model layer 4 (the layer within which the target dewatering elevations lie) after 10 days of dewatering. With a dewatering rate limit of 200 gpm, the simulated area that can be dewatered to the target elevations is again relatively small for each phase. Dewatering rates over time for each of the four simulated phases are shown in Figure 32. Again, simulated dewatering rates exceed the limit of 200 gpm in early time (until about 5 days), but the additional complication/effort required to keep the simulated rate near 200 gpm during this relatively short period is not warranted for the present analysis.

6.5.4 Model Simulation Interpretations

Both a non-phased approach (no limit placed on the simulated dewatering rate), and a phased approach (200 gpm limit for each phase) were modeled. For the non-phased approach, dewatering rates were about 400 gpm for south of George Street and 250 to 300 gpm for north of George Street. For the phased approach (200 gpm limit for each phase), the simulated area that can be dewatered to the target elevations was relatively small for each phase. Consequently, multiple phases were predicted to be required, especially for the area south of George Street (six to eight phases), which is larger than the area north of George Street.

6.5.5 AR BTC Groundwater Hydraulic Control RA

The proposed BTC groundwater hydraulic control RA to be implemented by AR on the northeast side of BTC will utilize extraction wells (AR, 2024b). This groundwater control is expected to lower water levels in the area once implemented, as demonstrated by the September 2022 AR pumping test in well BTC-PW-01. Therefore, if the BTC groundwater hydraulic control RA is implemented before the BTC site RA, this will tend to reduce the dewatering rates required for the BTC site RA. DEQ will coordinate with AR on timing of projects.

6.6 GEOTECHNICAL REVIEW

LSM conducted a Geotechnical Review to review boring logs, preliminary cross sections, and estimated groundwater drawdown to develop geotechnical recommendations and assess the need for an additional Phase II Geotechnical Investigation. Based on the review, an additional Phase II

Geotechnical Investigation is not recommended at this time, and the main points of the Geotechnical Review as presented in Appendix E are as follows:

- LSM recommends cut slope excavations along the boundary limits adjacent to the infrastructure (bridges, roadways, walkways) be no steeper than 3.5H:1V. Based on the available boring data, drained slopes flatter than 3.5H:1V (16 degrees) will be stable throughout the excavating and the backfilling processes and will provide the counterbalance buttresses to the infrastructure.
- LSM believes the 3.5H:1V slopes adjacent to the infrastructures can be steepened for a short period of time to allow removal of the Wastes. Approved backfill would need to be placed to restore the 3.5H:1V slopes within a few hours after their removal.
- Field judgement can be used to determine whether slopes steeper than 1.5H:1V can be made.
- The drawdown of the groundwater table can be expected to produce some settlement. Pumping groundwater from sand soils increases the effective pressure but the corresponding settlement is usually small unless the sand is very loose. The magnitude of the settlement of the ground surface adjacent to a cut depends on a number of factors. Its variation with distance from the cut, the nature of the soil, and the success with which groundwater has been controlled are three of the more important factors. The medium dense to dense granular soil layers and the intermixed medium stiff to stiff, fine-grained soil layers can expect to undergo less than 1 percent of the maximum depth of the open cut excavation. The amount of settlement percentage decreases rapidly as the ratio between the distance from the excavation and the depth of the excavation increases.

  It is LSM's geotechnical opinion at this time that the information collected during the August and September 2023 subsurface investigation is adequate to continue with the design without collection of additional geotechnical data.

7.0 CONCLUSIONS

All the objectives of the investigation were achieved, and sufficient data were collected to meet all project Data Quality Objectives. Key conclusions or recommendations related to the Phase I PDI are summarized below.

7.1 Excavation Design

This the key findings of the waste removal investigation are summarized below.

7.1.1 Waste Removal Extents

Final Waste Removal Extents will be developed during RD. In general, in order to remove Waste as completely as feasible within the extents as delineated in BTC-1 of the BPSOU CD, in areas where critical infrastructure does not require protection, the toe of the excavation slope will align with the removal extents as delineated in BTC-1 of the BPSOU CD. Figure 7.1 presents conceptual excavation slopes within the Riparian Action Study Area boundary, and Figure 7.2 presents the conceptual excavation toe starting at the Riparian Action Study Area boundary in south excavation area where critical infrastructure roads along the boundaries of the excavation would not be affected. Critical infrastructure utilities in the northern excavation area were not factored into these excavation scenarios and will be addressed during RD. Table 4 provides estimated excavation volumes of the two different excavation scenarios with boundary excavation slopes of 1.5:1 in the steepest areas along the boundaries. Depending on proximity to critical infrastructure and field conditions, boundary excavation slopes will achieve at least a 3.5H:1V slope with up to 1.5H:1V slope if timing and conditions allow. Waste beneath excavation slopes and critical infrastructure will be left in place. Final excavation design, extent (boundaries), and associated volumes will be developed during RD.

7.1.2 Waste Characterization for Proper Disposal

Material categorized as Waste per Table 1 in the BPSOU CD will be disposed of at the agreed upon BPSOU repository. Municipal waste that does not exceed criteria in Table 1 of the BPSOU CD and meets landfill requirements will be segregated and disposed of at an agreed upon licensed landfill. Municipal waste that does not meet landfill requirements will be disposed of at a repository agreed upon within BPSOU. All fill removed above Waste that is not categorized as Waste per Table 1 in the BPSOU CD and does not meet Backfill Criteria in Table 2: Backfill Material Suitability Criteria of the BPSOU CD will be disposed of at a repository agreed upon within BPSOU. Further Backfill Criteria reuse information is provided in Section 7.1.5 below.

It is recommended that a borrow source investigation be completed concurrently with RD to identify a suitable borrow source or sources for the variety of materials that will be required for stream, wetland, and floodplain reconstruction.

7.1.3 Preservation of Critical Infrastructure

Per the CD, critical infrastructure will be protected during removal constructions actions, and removal of waste around those features will not be required. All critical infrastructure at the BTC site is shown in Figure 4.2 and listed below.

- Paved streets and associated stormwater culverts
- Railroad bridge and abutments
- Sewer lines
- BPSOU subdrain
- Electrical lines (overhead and buried)
- Waterlines (Silver Lake Waterline and Butte Mine Flooding Operable Unit (BMFOU) Discharge Line)
- Fiber Optic Lines

Preservation of existing utilities will affect the total amount of Waste able to be removed, especially in the proposed excavation north of George Street, where most of the utilities are located. Further information will be provided in RD.

7.1.4 XRF Correlation/Removal Verification Sampling

The results of the paired ex-situ (intrusive) XRF/laboratory samples and paired in situ XRF/laboratory samples showed that a suitable correlation can be developed to support near real-time removal verification sampling during construction. A removal verification and confirmation sampling approach that utilizes field-portable XRF and laboratory confirmation sampling can be developed during the RD.

7.1.5 Backfill and Site Grading

A backfill source will be identified during the Remedial RD phase. On-site soils at BTC that meet Criteria A and B requirements as set forth in Table 2: Backfill Material Suitability Criteria in the BPSOU CD that meet both soil texture and metals requirements do not exist on site in continuous layers that could be reliably segregated for reuse. Seven intervals that meet Criteria A or Criteria B requirements were identified from six sample locations as shown in the table below. None of the identified intervals are continuous from one location to the next, indicating that a reliable fill source does not exist on site. Backfill intervals identified at the BTC site that meet Criteria A for BTC or Criteria B for other projects within the BPSOU cannot be removed without risk of cross contamination or textural intermixing. Therefore, reliable backfill is not anticipated to exist at the BTC site.

Table 7.1.5: Potential Backfill Intervals

Sampling Location ID	Interval (ft)	Meets Backfill Criteria
BTC-04	0 to 3	Criteria A or B
BTC-09	0 to 4	Criteria B
BTC-14	0 to 3	Criteria A or B
BTC-15	0 to 1	Criteria B
BTC-25	0 to 1	Criteria A or B
BTC-25	1 to 6	Criteria B
BTC-43	0 to 2	Criteria B

Notes:
ID = Identification

7.2 Construction Dewatering

The existing groundwater models are sufficient and suitable for the purposes of the RD. All construction dewatering water that is above applicable surface water standards will be sent to BTL and/or a portable treatment system at an estimated starting rate of 450 gpm to 650 gpm +/- 100 gpm and estimated desired rate of 250 gpm to 400 gpm +/- 100 gpm after 10 days of dewatering. In general, for a non-phased approach, dewatering rates are estimated to be 400 gpm south of George Street and 250 to 300 gpm north of George Street. It is critical that BTC dewatering efforts are scheduled with other remedial activities in the corridor to avoid overwhelming BTL. The potential to send construction dewatering discharge to BTL and a potential need for a portable treatment system will be further discussed and developed in the RD. Construction dewatering chemistry is within acceptable parameters for BTL or a portable treatment system. Dewatering efforts would likely be achieved with a combination of extraction wells, sump pumping, and trench pumping and general requirements will be detailed in the RD to the extent necessary to support project sequencing decisions, bidding, and construction management. Dewatering scheduling and planning will be developed during RD.

7.3 Geotechnical Conditions

The Geotechnical Review concluded that the existing data collected during this Phase I PDI are sufficient to proceed with RD and an additional Phase II Geotechnical Investigation is not recommended at this time.

7.4 Blacktail Creek And Silver Bow Creek Reconstruction

Blacktail Creek, Silver Bow Creek, and their confluence will be reconstructed per Section 5.1.3 of Attachment C to Appendix D to the BPSOU CD. More information will be provided in RD.

7.5 Wetland Protection

Approximately 5 years following completion of the RA, the Site will be delineated and reevaluated to determine the post-construction FEWA scores in accordance with the “no net loss” Superfund goal for wetlands. Due to the nature of the RA, it is anticipated that from pre- to postconstruction, wetland acreage and function will improve. If there is a net wetland loss, DEQ will assess options for mitigation/offset.

7.6 Recommendations For Additional Investigations

A borrow source investigation is needed to support the RD and should be completed as an additional design investigation during the early stages of RD. Additionally, this Phase I PDI indicated that wastes may be present at depth under the Greenway Demonstration Project area (aka, BTC-West) and a Phase II investigation may be warranted to delineate Waste, Municipal Waste, Hydrocarbons, and possibly other contaminates if deemed necessary by the Agencies. BTC-West is conceptually delineated as UR-41 in Figure UR-1 of the BPSOU CD and only the upper 18 inches would be remediated.

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FIGURES

TABLES

Table 1
BPSOU Consent Decree and XRF Screening Criteria for the BTC site

Contaminant of Concern	BPSOU CD Laboratory Action Level (mg/kg) (1)	BPSOU CD Laboratory Ceiling Criteria (2)	XRF Screening Level (mg/kg) (3,4)	XRF Ceiling Level (mg/kg) (3,4)
Arsenic	200	5000	<150	> 2500
Cadmium	20	5000	<20	>50
Copper	1,000	5000	<700	> 2500
Lead	1,000	5000	<700	> 2500
Mercury	10	5000	<10	>25
Zinc	1,000	5000	<700	> 2500

Notes:

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

(2) Any single analyte above 5,000 mg/kg.

(3) Adapted from SSTOU Screening Criteria and methodology for typical XRF pass-fail criteria for the SSTOU. Screening criteria will be updated after completion of the investigation if a suitable XRF to laboratory correlation can be developed.

(4) If three of the six contaminant XRF screening criteria listed are exceeded or any one contaminant is above XRF Ceiling Level then the material will be considered tailings, waste, or contaminated soil. The field XRF results will be used to screen samples in the field to select appropriate samples near the base of contamination to submit for laboratory analysis.

BPSOU = Butte Priority Soils Operable Unit
BTC = Blacktail Creek
mg/kg = milligrams per kilogram
SSTOU = Streamside Tailings Operable Unit
XRF = x-ray fluorescence

Table 2
Sample Locations and Control Points

Location ID	Easting	Northing	Elevation	Location ID	Easting	Northing	Elevation
BTC-01	1198425	650256	5448.287	BTC-30	1197309	651020	5449.769
BTC-02	1198236	650294	5449.685	BTC-31	1197103.51	651144.63	5446.396
BTC-03	1198405	650309.5	5448.186	BTC-32	1196905	651141	5447.498
BTC-04	1197978	650331.9	5450.155	BTC-33	1197330	651145	5446.404
BTC-05	1198535	650341	5447.813	BTC-34	1196707	651152	5448.106
BTC-06	1197836	650355.1	5450.362	BTC-35	1197364	651216	5446.479
BTC-07	1198394	650429.3	5445.739	BTC-36	1197162.23	651235.15	5444.311
BTC-08	1197472	650403.9	5449.961	BTC-37	1196959	651238	5446.071
BTC-09	1198280	650511.7	5447.745	BTC-38	1196760	651249	5448.22
BTC-10	1198107	650491	5446.98	BTC-39	1197312	651264	5446.262
BTC-11	1197278	650494.2	5449.773	BTC-40	1197123.34	651276.17	5444.556
BTC-12	1198039	650539.3	5446.154	BTC-41	1196909	651316	5446.037
BTC-13	1198181	650582.3	5452.223	BTC-42	1196835	651337	5446.839
BTC-14	1197249	650556.5	5451.598	BTC-43	1197686.18	650376.06	5450.66
BTC-15	1198094	650616	5452.624	BTC-Surface-01	1199337	649839	5444.46
BTC-16	1197277	650587.7	5451.611	BTC-Surface-02	1199322.7	649841.6	5444.68
BTC-17	1197381	650650.8	5451.855	BTC-Surface-03	1199204.9	649885	5444.3
BTC-18	1197778	650687	5447.044	BTC-Surface-04	1199282	649842	5444.3
BTC-19	1197931	650742.5	5455.319	BTC-Trench-01	1199401.3	649810.88	5446.99
BTC-20	1197428	650737.7	5453.138	BTC-Trench-02	1199321.89	649877.44	5448.39
BTC-21	1197699	650747	5448.741	BTC-Trench-03	1199258.43	649924.89	5447.28
BTC-22	1197853	650800.9	5455.975	BTC-Trench-04	1199209	649900.3	5444.3
BTC-23	1197820	650815	5456.203	CP 101	1199026.37	650129.51	5448.761
BTC-24	1197773	650855	5454.408	CP 102	1198184.99	650585.36	5453.067
BTC-25	1197454	650895.6	5451.111	CP 103	1197368.37	651129.26	5449.4
BTC-26	1197694	650916	5455.386	CP 104	1196670.28	651254.39	5447.255
BTC-27	1197619	650958.9	5453.111	CP 105	1196987.39	651145.48	5447.378
BTC-28	1197367	650973	5450.346	CP 106	1197050.42	650474.78	5451.696
BTC-29	1197524	651019	5452.771				

Notes:
The coordinates above are in Montana State Plane North American Datum of 1983 International Ft.
CP = control point

Table 3
Passing-Bablok Regression Olympus-Evident Vanta C Series XRF Correlation Results

Analyte Pair	Spearman Rank Correlation Coefficient	SRCC Lower 95% CI	SRCC Upper 95% CI	P-value (Cusum)	Slope Intercept	Slope Coefficient	Lower 95% Slope	Upper 95% Slope	Lower 95% Intercept	Upper 95% Intercept	Action Level (mg/kg)	Approximate Lower 95% Confidence Limit Bias at Action Level	Approximate Prediction XRF Concentration	Approximate Upper 95% Confidence Limit Bias at Action Level	N pairs	Linear (Y/N)
As-Ex Situ XRF & As-Lab	0.971	0.959	0.979	0.720	2.753	0.865	0.817	0.944	1.271	4.477	200	166	176	191	137	Y
Cd-Ex Situ XRF & Cd-Lab	0.869	0.777	0.925	0.880	6.000	0.800	0.688	0.936	4.292	7.794	20	20	22	24	48	Y
Cu-Ex Situ XRF & Cu-Lab	0.975	0.966	0.982	0.950	20.332	0.868	0.798	0.942	5.325	32.675	1000	822	889	950	138	Y
Hg-Ex Situ XRF & Hg-Lab	0.558	0.32	0.73	0.620	5.174	2.174	1.184	5.670	0.000	8.086	10	19	27	56	46	Y
Pb-Ex Situ XRF & Pb-Lab	0.957	0.94	0.969	0.950	10.071	0.948	0.905	0.977	6.786	13.502	1000	918	958	986	138	Y
Zn-Ex Situ XRF & Zn-Lab	0.981	0.973	0.986	0.450	15.500	1.000	0.954	1.052	1.720	31.855	1000	977	1016	1060	138	Y
As-In Situ XRF & As-Lab	0.611	0.464	0.726	0.130	9.772	0.567	0.412	0.769	2.000	27.742	200	101	123	162	91	Y
Cd-In Situ XRF & Cd-Lab[1]	0.161	-0.233	0.51	0.260	9.429	0.429	0.181	1.294	3.766	13.000	20	-	-	-	27	Y
Cu-In Situ XRF & Cu-Lab	0.656	0.527	0.755	0.260	33.657	0.625	0.500	0.868	-10.831	92.471	1000	559	659	875	100	Y
Hg-In Situ XRF & Hg-Lab[1]	0.503	0.0908	0.768	0.720	8.797	1.003	0.210	1.974	7.255	10.000	10	-	-	-	21	Y
Pb-In Situ XRF & Pb-Lab	0.649	0.518	0.751	0.360	16.135	0.595	0.523	0.760	5.055	33.520	1000	543	611	771	99	Y
Zn-In Situ XRF & Zn-Lab	0.732	0.626	0.812	0.700	20.353	0.674	0.542	0.799	-31.971	110.314	1000	579	694	810	100	Y

Notes:
[1] Approximate Prediction XRF Concentration, Approximate Lower 95% Confidence Limit, and Approximate Upper 95% Confidence Limit were excluded for cadmium and mercury in situ analyte pairs due to their low Spearman Rank Correlation Coefficient and low number of pairs (<50).
% = percent

Table 4
Estimated Excavation Volumes

Blacktail Creek Excavation Areas	Figure 7.1 Volume (Yd^3)	Figure 7.2 Volume (Yd^3)
Estimated Excavation Volume South of George Street	109,000	137,000
Estimated Excavation Volume North of George Street	61,000	61,000
Total Estimated Excavation Volume	170,000	198,000

Table 5
Comparison of Montana Pole Model and Draft Buffalo Gulch Model

	Montana Pole Model	**Draft Buffalo Gulch Model**
Developer	Tetra Tech (for DEQ)	Woodard and Curran (for AR)
Model Framework	Highly simplified with respect to CSM. Includes three layers, with uniform bottom elevation for each layer. Layer thicknesses: • Layer 1: about 20 ft; varies with water table • Layer 2: 2 ft (low-K) • Layer 3: 18 ft	Honors overall aquifer thickness from available borehole data • 9 layers • Each representing a continuous lithologic unit
Calibration	Well calibrated to selected head targets. No calibration to flux data.	Well calibrated to selected head targets. No calibration to flux data.
Issues / Concerns for Application to Blacktail Creek Dewatering	Inability of simplified model geometry to support dewatering simulation for Blacktail Creek. Underpredicts GW discharge to Blacktail Creek from Tucci (2014). Uniform hydraulic conductivity for each material type.	Upgradient boundary conditions (supplying water to model) set only in thin, uppermost portion of model (1 to 2 layers). Greatly underpredicts (by factor of 10) the groundwater discharge to Blacktail Creek from Tucci (2014). Uniform hydraulic conductivity for each layer.
Selected for Update/Use?	*No, primarily due to highly simplified geometry.*	*Yes. Update necessary to better match available flux/head data before using as predictive tool.*

Table 6
Residual Head Calibration Statistics

Target Type	Residual Mean (ft)	Scaled Residual Standard Deviation
Head for Steady-State Calibration	-0.07	2.60%
Head Change for Transient Calibration	0.05	2.60%
Groundwater Modeling Standard	*near 0*	*<10%*

Table 7
BTC Groundwater Chemistry from Tetra Tech 2016 Study

Location ID	Sample Date	Laboratory pH (s.u.) DEQ-7 2019 (6.5 - 8.5)	Arsenic (mg/L) DEQ-7 2019 (0.01)	Cadmium (mg/L) DEQ-7 2019 (0.005)	Chromium (mg/L) DEQ-7 2019 (0.1)	Copper (mg/L) DEQ-7 2019 (1.3)	Iron (mg/L) DEQ-7 2019 (N/A)	Lead (mg/L) DEQ-7 2019 (0.015)	Manganese (mg/L) DEQ-7 2019 (N/A)	Mercury (mg/L) DEQ-7 2019 (0.00005)	Zinc (mg/L) DEQ-7 2019 (7.4)
AMC-23	3/11/2016	7.1 H	< 0.001	0.00514	< 0.01	0.004	3.89	< 0.0003	0.3	< 0.00005	0.493
AMC-24	3/8/2016	6.6 H	< 0.001	0.00083	< 0.01	< 0.002	0.78	< 0.0003	0.07	< 0.00005	0.549
AMC-24B	3/8/2016	6.4 H	0.005	0.00646	< 0.01	0.12	< 0.02	< 0.0003	< 0.02	< 0.00005	1.28
AMC-24C	3/8/2016	6.6 H	0.008	0.00406	< 0.01	0.056	< 0.02	< 0.0003	< 0.02	< 0.00005	0.433
AMW-11	3/11/2016	7.4 H	0.013	0.00045	< 0.01	< 0.002	1.11	< 0.0003	1.47	< 0.00005	0.163
AMW-11	3/11/2016	7.4 H	0.014	0.00046	< 0.01	0.002	1.11	< 0.0003	1.47	< 0.00005	0.162
AMW-13A	3/7/2016	6.7 H	0.001	0.00174	< 0.01	0.01	17.5	< 0.0003	0.32	< 0.00005	0.388
AMW-13A*	3/7/2016	--	0.0011	0.0017	0.00059 J	0.01465	15.778	< 0.00015	0.276	--	0.36732
AMW-13B	3/8/2016	7.4 H	0.004	0.00032	< 0.01	< 0.002	< 0.02	< 0.0003	< 0.02	< 0.00005	0.026
AMW-13B*	3/8/2016	--	0.00327	0.00023 J	0.00084	0.00117 J	0.015	< 0.00006	< 0.002	--	0.02321
AMW-13B2	3/8/2016	7.4 H	0.005	0.00048	< 0.01	0.002	< 0.02	< 0.0003	< 0.02	< 0.00005	0.052
AMW-13B2*	3/8/2016	--	0.0046	0.00045	0.0005	0.00181 J	< 0.015	< 0.00006	< 0.002	--	0.04586
AMW-13C	3/8/2016	6.8 H	0.006	0.00219	< 0.01	< 0.002	< 0.02	< 0.0003	< 0.02	< 0.00005	0.197
AMW-13C*	3/8/2016	--	0.00478	0.00199	0.00029 J	0.0007 J	< 0.015	< 0.00006	< 0.002	--	0.17727
BPS07-08A	3/9/2016	7.1 H	0.092	0.00247	< 0.01	0.129	< 0.02	< 0.0003	13.1	< 0.00005	0.306
BPS07-08A	3/9/2016	7.1 H	0.089	0.0025	< 0.01	0.128	< 0.02	< 0.0003	13.3	< 0.00005	0.313
BPS07-14A	3/9/2016	6.9 H	0.123	0.00042	< 0.01	0.017	11	0.0013	2.2	< 0.00005	4.07
BPS07-15A	3/9/2016	7.1 H	0.302	0.00273	< 0.01	0.008	< 0.02	< 0.0003	0.03	< 0.00005	0.284
BPS07-16A	3/10/2016	6.5 H	< 0.001	0.00207	< 0.01	0.003	< 0.02	< 0.0003	< 0.02	< 0.00005	0.828
BPS07-16B	3/10/2016	7.4 H	0.001	0.00035	< 0.01	< 0.002	< 0.02	< 0.0003	< 0.02	< 0.00005	0.011
BPS07-21B	3/11/2016	7.1 H	0.007	0.002	< 0.01	< 0.002	< 0.02	< 0.0003	< 0.02	< 0.00005	0.221
BPS07-21C	3/11/2016	6.9 H	0.006	0.00251	< 0.01	< 0.002	< 0.02	< 0.0003	< 0.02	< 0.00005	0.208

Location ID	Sample Date	Laboratory pH (s.u.) DEQ-7 2019 (6.5 - 8.5)	Arsenic (mg/L) DEQ-7 2019 (0.01)	Cadmium (mg/L) DEQ-7 2019 (0.005)	Chromium (mg/L) DEQ-7 2019 (0.1)	Copper (mg/L) DEQ-7 2019 (1.3)	Iron (mg/L) DEQ-7 2019 (N/A)	Lead (mg/L) DEQ-7 2019 (0.015)	Manganese (mg/L) DEQ-7 2019 (N/A)	Mercury (mg/L) DEQ-7 2019 (0.00005)	Zinc (mg/L) DEQ-7 2019 (7.4)
BPS07-24	3/8/2016	6.5 H	0.01	0.0175	< 0.01	0.667	< 0.02	< 0.0003	< 0.02	< 0.00005	4.05
BPS07-25	3/9/2016	7.4 H	0.032	0.00203	< 0.01	0.086	< 0.02	< 0.0003	2.03	< 0.00005	0.34
BPS11-19A2	3/10/2016	6.9 H	0.001	0.00063	< 0.01	< 0.002	< 0.02	< 0.0003	< 0.02	< 0.00005	0.072
BPS11-19B	3/10/2016	6.8 H	0.005	0.00294	< 0.01	0.041	< 0.02	< 0.0003	< 0.02	< 0.00005	0.349
BT98-01	3/10/2016	7.3 H	0.001	< 0.00003	< 0.01	< 0.002	< 0.02	< 0.0003	< 0.02	< 0.00005	< 0.008
BT98-01*	3/10/2016	--	0.00101	< 0.0001	0.00052	< 0.0005	< 0.015	< 0.00006	< 0.002	--	< 0.0005
BT98-02B	3/10/2016	6.7 H	< 0.001	0.00143	< 0.01	< 0.002	< 0.02	< 0.0003	< 0.02	< 0.00005	0.062
BT98-05	3/10/2016	7.2 H	0.001	< 0.00003	< 0.01	< 0.002	< 0.02	< 0.0003	< 0.02	< 0.00005	< 0.008
BT98-05*	3/10/2016	--	0.00088	< 0.0001	0.00047 J	< 0.0005	< 0.015	< 0.00006	< 0.002	--	< 0.0005
BT99-01	3/10/2016	7.2 H	0.003	< 0.00003	< 0.01	0.002	< 0.02	< 0.0003	< 0.02	< 0.00005	< 0.008
BT-99-01*	3/10/2016	--	0.00228	< 0.0001	0.00061	0.00178 J	< 0.015	< 0.00006	< 0.002	--	< 0.0005
BT99-04	3/10/2016	7.4 H	0.004	< 0.00003	< 0.01	0.002	< 0.02	< 0.0003	< 0.02	< 0.00005	< 0.008
BT-99-04*	3/10/2016	--	0.0036	< 0.0001	0.00111	0.00176	< 0.015	< 0.00006	< 0.002	--	< 0.0005
BTC-DPT-01	4/8/2016	7 H	0.062	0.00046	< 0.01	< 0.002	10.3	0.0005	2.7	< 0.00005	0.442
BTC-DPT-02	4/8/2016	7.2 H	0.004	0.00017	< 0.01	< 0.002	0.31	< 0.0003	0.53	< 0.00005	0.051
BTC-DPT-02	4/8/2016	7.2 H	0.003	0.00018	< 0.01	< 0.002	0.33	< 0.0003	0.54	< 0.00005	0.049
BTC-DPT-03	4/8/2016	7.3 H	0.005	0.00051	< 0.01	0.003	0.16	< 0.0003	1.34	< 0.00005	< 0.008
FP98-1	3/9/2016	6.7 H	0.087	0.037	< 0.01	0.531	16.4	< 0.0003	56.9	< 0.00005	24.1
FP98-1B	3/9/2016	7.1 H	0.001	0.00482	< 0.01	0.003	< 0.02	< 0.0003	1.11	< 0.00005	0.488
GS-29D	3/9/2016	7.9 H	0.025	0.00011	< 0.01	< 0.002	< 0.02	< 0.0003	< 0.02	< 0.00005	0.028
GS-29D*	3/9/2016	--	0.02063	< 0.00025	0.00025	0.00128	< 0.038	< 0.00015	< 0.005	--	0.02365
GS-29SR	3/9/2016	7 H	0.005	0.00861	< 0.01	0.505	< 0.02	< 0.0003	0.16	< 0.00005	1.83
GS-29SR*	3/9/2016	--	0.00415	0.00814	0.00042 J	0.54845	< 0.015	< 0.00006	0.152	--	1.67742
MF-10	3/8/2016	6.6 H	0.019	0.00487	< 0.01	0.042	2.06	< 0.0003	0.67	< 0.00005	16
MT98-05	3/10/2016	7.1 H	0.001	< 0.00003	< 0.01	< 0.002	< 0.02	< 0.0003	< 0.02	< 0.00005	< 0.008
MT98-05*	3/10/2016	--	0.00111	< 0.0001	0.00052	0.00113 J	< 0.015	< 0.00006	< 0.002	--	0.00641

Location ID	Sample Date	Laboratory pH (s.u.) DEQ-7 2019 (6.5 - 8.5)	Arsenic (mg/L) DEQ-7 2019 (0.01)	Cadmium (mg/L) DEQ-7 2019 (0.005)	Chromium (mg/L) DEQ-7 2019 (0.1)	Copper (mg/L) DEQ-7 2019 (1.3)	Iron (mg/L) DEQ-7 2019 (N/A)	Lead (mg/L) DEQ-7 2019 (0.015)	Manganese (mg/L) DEQ-7 2019 (N/A)	Mercury (mg/L) DEQ-7 2019 (0.00005)	Zinc (mg/L) DEQ-7 2019 (7.4)
MT98-06	3/10/2016	7.2 H	0.001	< 0.00003	< 0.01	0.003	< 0.02	< 0.0003	< 0.02	< 0.00005	< 0.008
MT98-06*	3/10/2016	--	0.00089	< 0.0001	0.0004 J	0.00186 J	< 0.015	< 0.00006	< 0.002	--	0.00228

Notes:

Values highlighted in red indicate exceedance.

* - Samples collected/analyzed by Montana Bureau of Mines and Geology

H - Analysis performed past recommended holding time

J - Estimated quantity above detection limit but below reporting limit

Table 8
BTC Municipal Waste Intervals and Asbestos Testing Results

	Top Depth (ft bgs)	Bottom Depth (ft bgs)	USCS	Description	Eurofins Asbestos % Results
BTC-02	5	6	SC	sand, clayey, wet, **glass, ceramic, wood**, debris size: 0.2" to 2", 10YR 3/1	N/A
BTC-05	2	2.5	SP	sand, sl. silty, moist, dense, **wood debris,** 10YR 5/4	N/A
BTC-09	3	3.3	SC	sand clayey, sl. Gravelly, m-c, sa-sr, **glass, slag, mortar?, plastic,** 10YR 2/1	None Detected
BTC-09	3.3	5	SC	sand, clayey, gravelly, wet, dense, m-c, sa-sr, up to 1.5" gravel, **glass, slag, plastic,** 10YR 5/4	N/A
BTC-11	3	3.5	SP	sand, clean, moist, dense, med. grain, **glass,** 10YR 4/3 to 10YR 2/2 to 10YR 4/1	N/A
BTC-19	1.8	3	CL	clay, sandy, sl. gravelly, stiff, v. moist, **glass,** 10YR 4/1	N/A
BTC-19	3	4	SP	sand, silty, v. moist, med. Dense, f-m, **glass,** sa, 10YR 3/1	N/A
BTC-19	8	10	SP	sand, silty, v. moist, med. dense, f-m, sa, **glass,** 10YR 3/1	N/A
BTC-22	1.5	2	SC	sand, clayey, gravelly, moist, dense, sr-sa, f-c, **concrete**, 0 to 0.7 ft bgs 10YR 5/4	None Detected
BTC-23	1	2	SC	sand, clayey, gravelly, moist, med. Dense, **glass**, 10YR 3/2	N/A
BTC-23	12	12.5	SP	sand, sl. silty, moist, dense, m-c, sr-sa, **metal piece**, 10 YR 4/3	N/A
BTC-24	1	2.4	SC	sand, clayey, sl. gravelly, moist, dense, sa-sr, m-c, 0.2 inch to 1 inch, **glass**, 10YR 3/2 to 10YR 4/3	N/A
BTC-26	1	2	SC	sand, clayey, sl. Gravelly, moist, med. dense, m-c, sa-sr, **glass**, 10YR 3/3	N/A
BTC-26	7	7.5	SC	sand, clayey, sl. Gravelly, moist, med. dense, m-c, sa-sr, **slag**, 10YR 3/3	N/A
BTC-27	2	4	SM	sand, silty, gravelly, **glass**, dense, moist, m-c, sa, 10YR 3/1 to 2.5YR 4/6	N/A
BTC-27	7	7.5	CL	clay, sandy, gravelly, **glass**, moist, 10 YR 4/2	N/A
BTC-28	4	5	GW	cobble, gravel, sandy, sl. moist, **ceramic**, 10YR 5/3	N/A
BTC-29	1	2	SP	sand, clayey, moist, dense, sa-sr, f-c, **glass, slag**, 10YR 4/3	N/A
BTC-29	2	3	SP	sand, clayey, moist, dense, sa-sr, f-c, **considerable glass**, **slag, grout?**, 10YR 4/3	None Detected
BTC-29	3	4	SM	sand, silty, moist to wet, m-c, **glass, slag, brick,** 10YR 5/4 to 10YR 3/1	None Detected
BTC-29	6	7	SM	sand, silty, moist to wet, m-c, **glass**, 10YR 5/4 to 10YR 3/1	N/A
BTC-34	9	9.5	SM	sand, silty, wet, dense, m-f, sa, **small non-human mammal bone**, 10 YR 3/1	N/A
BTC-40	4.5	5	ML	silt, clayey, v. moist, med. dense, **glass,** 10YR 3/1	N/A
70 ft West of BTC-03	surface		SW/SP	sand, gravelly, clayey, moist, dense, r-a, **glass**, **brick**, **ceramic**, 10 YR 6/3	N/A

APPENDIX A
LABORATORY RESULTS

APPENDIX B
EUROFINS AND ENERGY LABORATORIES REPORTS

APPENDIX C
XRF RESULTS

APPENDIX D
XRF CORRELATION REPORTS

APPENDIX E
LORENZEN SOIL MECHANICS, INC. GEOTECHNICAL REPORT

APPENDIX F
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APPENDIX I
2B DATA VALIDATION REPORTS