Final
Red Devil Mine
Groundwater and Surface Water Report
Red Devil, Alaska

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List of Abbreviations and Acronyms

µg/L	micrograms per liter
ASTM	ASTM International (formerly the American Society of Testing and Materials)
bgs	below ground surface
BLM	Bureau of Land Management
BTEX	benzene, toluene, ethylbenzene, xylenes
BTV	background threshold value
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	contaminant of concern
E	east
E & E	Ecology and Environment, Inc.
EPA	U.S. Environmental Protection Agency
FS	Feasibility Study
ft/second	feet per second
K	hydraulic conductivity
mm	millimeters
N	north
NAVD88	North American Vertical Datum 1988
NE	northeast
ng/L	nanograms per liter
NNE	north-northeast
NTCRA	non-time-critical removal action
NW	northwest
ppm	parts per million
Q-Q	quantile-quantile
RCRA	Resource Conservation and Recovery Act

List of Abbreviations and Acronyms (cont.)

RDM	Red Devil Mine Site
RG	remedial goal
RI	Remedial Investigation
S	south
SE	southeast
SSE	selective sequential extraction
SVOC	semivolatile organic compound
SW	southwest
T	transmissivity
TAL	Target Analyte List
TCLP	toxicity characteristic leaching procedure
UPL	Upper Prediction Limit
USL	Upper Simultaneous Limit
UTL	Upper Tolerance Limit
W	west
WNW	west-northwest
XRF	X-ray fluorescence (spectroscopy)

1 Introduction

This document presents results of hydrological investigative activities conducted at the Red Devil Mine Site (RDM), located in Red Devil, Alaska (see Figure 1-1). The RDM consists of an abandoned mercury mine and ore processing facility located on public lands managed by the U.S. Department of the Interior Bureau of Land Management (BLM) in southwest Alaska. The BLM initiated a Remedial Investigation (RI)/Feasibility Study (FS) at the RDM in 2009 pursuant to its delegated Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) lead agency authority.

Several studies and baseline monitoring efforts have been performed at the RDM to evaluate groundwater and surface water conditions at the RDM. An RI/FS was performed by Ecology and Environment, Inc. (E & E) on behalf of the BLM under Delivery Order Number L09PD02160 and General Services Administration Contract Number GS-10F-0160J. The RI and FS were conducted following the *Work Plan, Remedial Investigation/ Feasibility Study, Red Devil Mine, Alaska* (RI/FS Work Plan; E & E 2011). Results of the RI are presented in the *Final Remedial Investigation Report, Red Devil Mine, Alaska* (RI report; E & E 2014). Results of the FS are presented in the *Final Feasibility Study, Red Devil Mine, Alaska* (FS report; E & E 2016a). Data collected during the RI were used to define the site physical setting, the nature and extent of contamination, and the fate and transport of contaminants. The RI results were used to assess risk to human health and the environment due to exposure to site contaminants. The FS addressed contaminated tailings/waste rock, soil, and Red Devil Creek sediments. Neither the RI nor FS fully evaluated possible site impacts to the adjacent Kuskokwim River. The FS did not address remedies for groundwater or Kuskokwim River sediments because the need for, and extent of, cleanup of these media had not yet been completely assessed.

An RI Supplement was conducted to address data gaps associated with soil, groundwater, and Kuskokwim River sediments that were identified as part of the development of site-wide remedial alternatives during the preparation of the FS. The RI Supplement also addressed changes in the groundwater and surface water monitoring network, and possible changes to the groundwater and surface water conditions at the RDM stemming from implementation of a non-time-critical removal action (NTCRA) performed by the BLM at the RDM during the summer of 2014. E & E performed the RI Supplement on behalf of the BLM under BLM National Environmental Services Blanket Purchase Agreement Number L14PA00149 and Delivery Order Numbers L14PB00938 and L17PB00236. The RI Supplement was performed per applicable CERCLA statutes, regulations, and guidance following the *Final Work Plan for 2015 Soil, Groundwater, Surface Water, and Kuskokwim River Sediment Characterization, Supplement to Remedial Investigation, Red Devil Mine, Alaska* (RI Supplement Work Plan; E & E 2015) and the final *Proposed Technical Approach for the Kuskokwim River Risk Assessment Supplement, Red Devil Mine, Alaska* (BLM 2017). Results of the RI Supplement are presented in the *Final Soil, Groundwater, Surface Water, and Kuskokwim River Sediment Characterization, Supplement to Remedial Investigation, Red Devil Mine, Alaska* report (RI Supplement report; E & E 2018a).

The BLM initiated baseline groundwater and surface water monitoring in 2012 to augment the RI results to characterize pre-remedial action conditions and identify seasonal and annual trends in flow, contaminant concentrations, and loading. The 2012 baseline monitoring was performed following the 2012 *Baseline Monitoring Work Plan, Red Devil Mine, Alaska* (2012 Baseline Monitoring Work Plan; E & E 2012), which is generally consistent with the RI/FS Work Plan (E & E 2011). Through analysis of 2011 data, it was determined that some data gaps had yet to be adequately addressed, and the overall RI effort was extended. Thus, the 2012 baseline data were appended to the RI report. A second round of baseline monitoring of groundwater and surface water was performed in the spring and fall 2015. The 2015 baseline monitoring was performed in conjunction with additional groundwater characterization conducted as part of the RI Supplement, and was performed following the RI Supplement Work Plan (E & E 2015). Results of the 2015 baseline monitoring are presented in the RI Supplement report. After the 2015 monitoring, the BLM performed further baseline monitoring in 2016, 2017, and 2018. E & E performed this baseline monitoring on behalf of the BLM under National Environmental Services Blanket Purchase Agreement Number L14PA00149 and Delivery Order Number L16PB00958. This additional baseline monitoring was conducted following the *Final Work Plan, Groundwater and Surface Water Baseline Monitoring, Red Devil Mine, Alaska* (2016 Baseline Monitoring Work Plan; E & E 2016b). Results of this additional baseline monitoring are presented in this report.

The BLM is presently performing additional characterization of groundwater and tailings/waste rock at the RDM. This hydrogeologic characterization is designed to generate additional information that may help facilitate a more detailed hydrologic analysis of the proposed repository and to support the development of a groundwater monitoring network for the repository proposed under 2016 FS Alternatives 3a and 3c. E & E is performing the additional characterization on behalf of the BLM under National Environmental Services Blanket Purchase Agreement Number L14PA00149 and Delivery Order Number L17PB00325. The additional 2017 characterization activities are being conducted in accordance with the *Final Work Plan for 2017 Groundwater Monitoring Well Installation and Tailings/Waste Rock Characterization, Red Devil Mine, Alaska* (2017 Groundwater and Tailings Characterization Work Plan; E & E 2017). Selected preliminary results of the 2017 groundwater characterization were presented in the *Draft Feasibility Study Supplement, Red Devil Mine, Alaska* (draft FS Supplement report; E & E 2018b) to support the development of remedial alternatives for groundwater. Results of this 2017 groundwater characterization are presented in this report.

1.1 Definition of the Site

The RDM encompasses the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for implementation of a response action. Historical mining operations left tailings and other remnants that have affected local soil, surface water, sediment, and groundwater. Key areas at the site are:

- The Main Processing Area.
- Red Devil Creek, extending from a reservoir upstream of the Main Processing Area to the creek's delta at its confluence with the Kuskokwim River.
- The area west (W) of the Main Processing Area where historical surface exploration and mining occurred, referred to as the Surface Mined Area. The Surface Mined Area is underlain by the area of underground mine workings. The "Dolly Sluice" and "Rice Sluice" and their respective deltas on the bank of the Kuskokwim River are associated with the Surface Mined Area.
- Sediments in the Kuskokwim River. The river bed sediments are located within submerged lands of the Kuskokwim River owned by the State of Alaska and managed by the Alaska Department of Natural Resources.

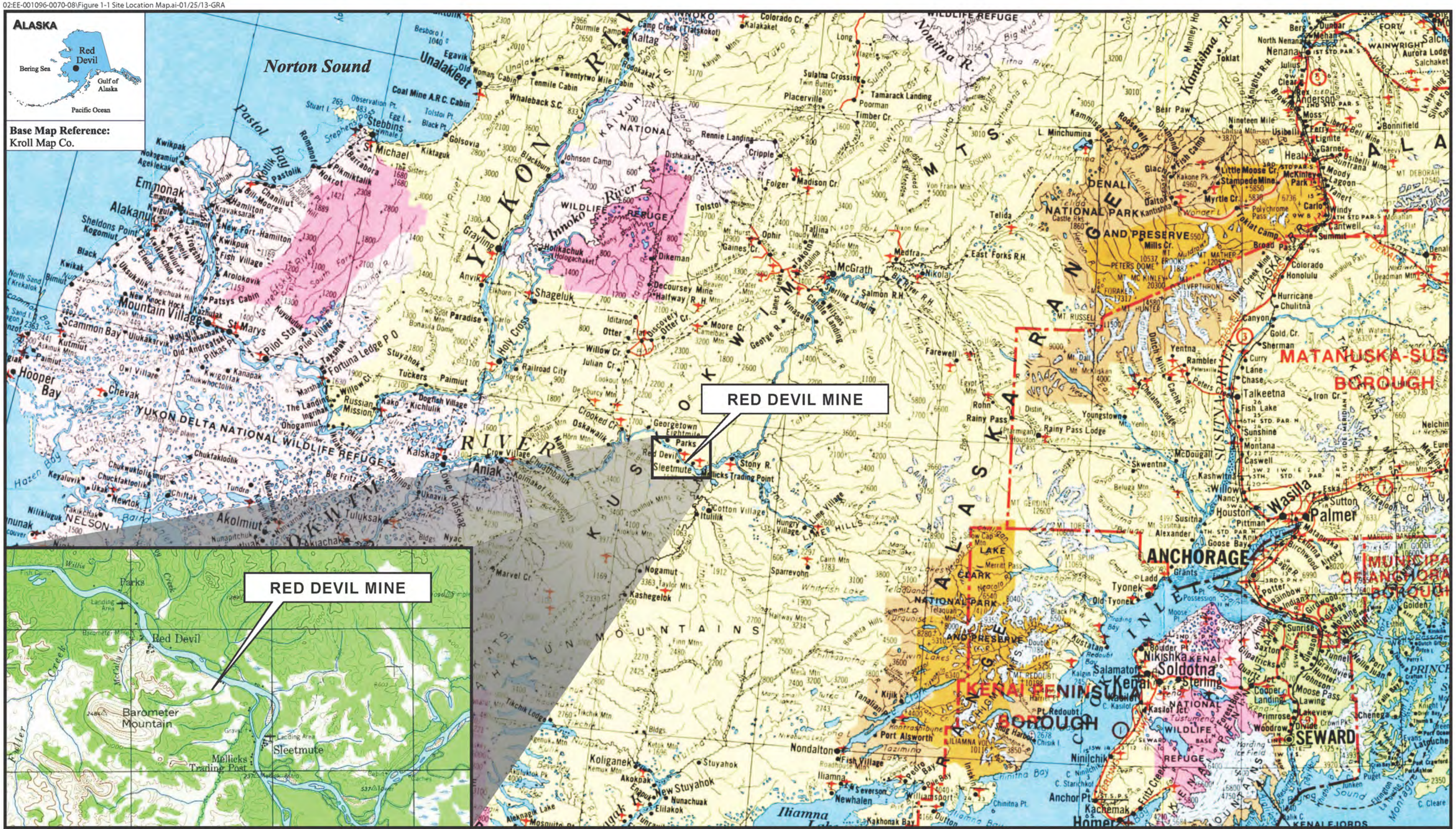
Figure 1-2 illustrates the upland area encompassed by the RI, RI Supplement, baseline monitoring, and additional 2017 characterization and the major features identified above based on aerial photographs taken in 2010 (Aero-Metric, Inc. 2010a) and 2001 (Aero-Metric, Inc. 2010b).

The Main Processing Area contains most of the former site structures and is where ore beneficiation and mineral processing were conducted. The area is split by Red Devil Creek. Underground mine openings (shafts, adits, and stopes to the surface) and ore processing and mine support facilities (housing, warehousing, and so forth) were located on the W side of Red Devil Creek until 1955. After 1955, all ore processing was conducted at structures and facilities on the east (E) side of Red Devil Creek. The Main Processing Area includes three monofills. The monofills contain demolished mine structure debris and other material. Two monofills are unlined (Monofills #1 and #3). Monofill #2, on the E side of Red Devil Creek, is an engineered and lined containment structure for building debris and materials from the demolished Post-1955 Retort structure.

1.2 Purpose of this Report

The purpose of this report is to provide a compilation of data and results of groundwater and surface water characterization and baseline monitoring performed by the BLM at the RDM as part of the RI and subsequent efforts. The report also presents results of soil and bedrock characterization pertinent to groundwater and surface water characterization. Much of the information provided in this report has been presented previously in the RI and RI Supplement reports. Selected results from these reports are included in this report. This report presents new results of the baseline groundwater and surface water monitoring performed between 2016 and 2018, as well as results of the additional characterization of groundwater and tailings/waste rock that is being performed following the 2017 Groundwater and Tailings Characterization Work Plan (E & E 2017).

02:EE-001096-0070-08\Figure 1-1 Site Location Map.ai-01/25/13-GRA



ecology and environment, inc.
International Specialists in the Environment
Seattle, Washington

0 40 80
Approximate Scale in Miles

RED DEVIL MINE
Red Devil, Alaska

Figure 1-1
SITE LOCATION MAP

Date: 04/18/13	JSS	02:EE-001096-0070-08

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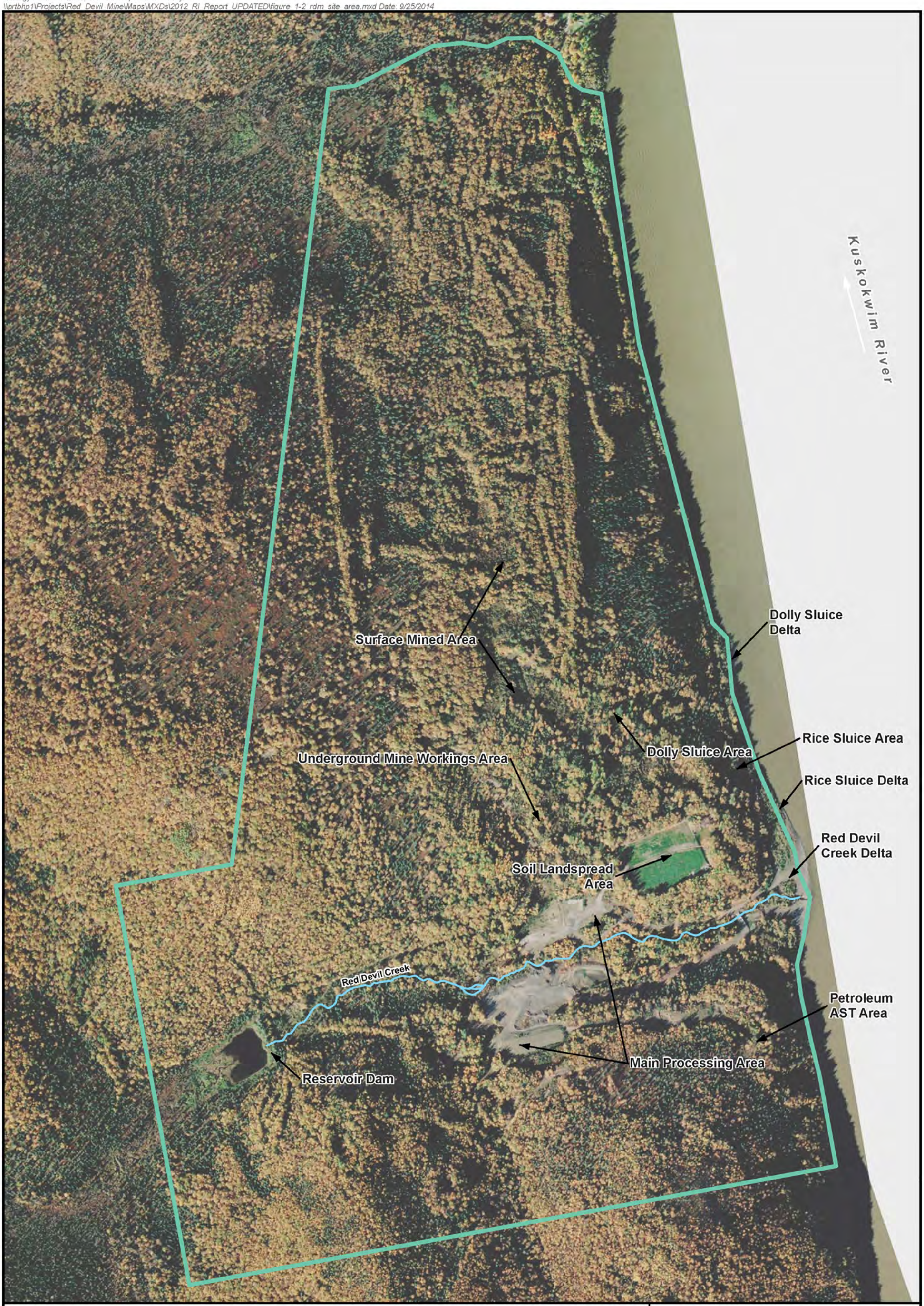


Upland Area Encompassed by Remedial Investigation

RED DEVIL MINE

Red Devil, Alaska

Figure 1-2
Upland Area Encompassed by Remedial Investigation

0 75 150 300 450 600 750
Feet
0 37.5 75 150 225
Meters
Scale 1:4,562

Image Source: Aero-Metric, Inc. 2010a

2 Soil and Bedrock Characterization

Bedrock and soil, including mine waste, have been characterized as part of the RI and RI Supplement. In 2017, the BLM performed additional characterization of soil and bedrock in the Surface Mined Area in the area of the proposed repository. In 2017, the BLM also performed additional characterization of tailings/waste rock in the Main Processing Area. Methods and results of the RI and RI Supplement characterization were presented in the RI and RI Supplement reports and are briefly summarized in Sections 2.1.1 and 2.2.1. Methods of the additional characterization performed in 2017 are described in Sections 2.1.2 and 2.1.3, and results are presented in Sections 2.2.2 and 2.2.3. Key findings of soil and bedrock characterization performed to date are synthesized in Sections 2.2.4 through 2.2.6.

2.1 Soil and Bedrock Characterization Activities

2.1.1 RI and RI Supplement

Soil and bedrock at the RDM were characterized as part of the RI and RI Supplement. Characterization activities and methods are presented in Chapter 2 of the RI report and Chapter 2 of the RI Supplement report. Locations of RI soil borings and monitoring wells are shown in Figure 2-1. Locations of RI and RI Supplement soil borings and monitoring wells are shown in Figures 2-2 and 2-3. Selected RI and RI Supplement results are included in this report.

2.1.2 2017 Tailings/Waste Rock TCLP Characterization

The BLM is conducting additional characterization of tailings/waste rock in the Main Processing Area. FS Alternatives 3a and 3c specified excavation of approximately 210,000 cubic yards of contaminated material for consolidation into the proposed repository. This material includes tailings/waste rock from the Post-1955 Main Processing Area known or expected to have arsenic toxicity characteristic leaching procedure (TCLP) concentrations greater than the Resource Conservation and Recovery Act (RCRA) limit of 5 milligrams per liter. FS Alternatives 3a and 3c include treatment of the tailings/waste rock by solidification using portland cement as a binding agent prior to consolidation into the proposed repository. RI data include limited TCLP data that indicate arsenic TCLP RCRA exceedances in surface and subsurface soils (mostly tailings/waste rock) within a portion of the Post-1955 Main Processing Area. The FS estimated that approximately 15 percent of the total proposed repository contents (approximately 31,500 cubic yards) would fail TCLP testing for arsenic.

Data collected as part of the RI regarding the lateral and vertical extents of materials expected to fail TCLP testing for arsenic were not sufficient for designing the planned excavation. In 2017, additional characterization of tailings/waste rock was performed to address data gaps regarding the lateral and vertical extents of tailings/waste rock in the Post-1955 Main Processing Area expected to have TCLP concentrations greater than the RCRA limit for arsenic. The tailings/waste rock characterization is being performed to gather information identified in Section 3.3.2 of the 2017 Groundwater and Tailings Characterization Work Plan (E & E 2017). The 2017 tailings/waste rock data also may be useful for further refining the estimates of depths and volume of tailings/waste rock and contaminated soil proposed for excavation under Alternatives 3 and 4 in the FS (E & E 2016a).

Soil characterization field activities were performed by installing additional soil borings and collecting soil samples. Field activities were conducted during the summer of 2017. Field procedures and laboratory analyses were performed following the 2017 Groundwater and Tailings Characterization Work Plan (E & E 2017), except as noted below. A brief description of field sampling and other procedures is provided below.

2.1.2.1 Soil Boring Installation and Soil Sampling

A total of 20 soil borings were installed at locations in the Post-1955 Main Processing Area shown in Figure 2-4. Actual drilling locations were refined from the locations proposed in the 2017 Groundwater and Tailings Characterization Work Plan (E & E 2017) during the investigation based on conditions encountered in the field.

Soil borings were installed using a drill rig operated by a subcontracted, Alaska-licensed driller. The driller used a track-mounted Geoprobe 8040 drill rig outfitted to use direct-push equipment and methods. Soil cores were collected continuously using 5-foot-long direct-push soil core samplers from the ground surface to a minimum of 2 feet into weathered bedrock below the base of unconsolidated materials (tailings/waste rock or native materials).

After boreholes were successfully advanced, they were abandoned at the completion of sampling or the end of the day in accordance with State of Alaska regulations. Drill cuttings and other investigation-derived waste were managed in accordance with the 2017 Groundwater and Tailings Characterization Work Plan (E & E 2017).

In order to assess soil stockpiled during the NTCRA and underlying soils, it was necessary to drill soil borings in a NTCRA soil stockpile area. Five of the proposed soil borings were positioned on the top of the stockpile. The soil stockpile is covered with plastic sheeting held in place by a network of rope and sandbags. Drilling on the stockpile was performed with care to minimize damage to the plastic cover, to the extent feasible. Following completion of drilling activities, the cover system was repaired.

2.1.2.2 Soil Sampling and Field Screening

Soil characterization was performed using a combination of field observations, results of X-ray fluorescence spectroscopy (XRF) field screening for total inorganic elements, and laboratory analysis for total arsenic and TCLP arsenic. Soil samples were collected continuously from ground surface to the total depth of the borehole. For each 4-foot interval, material from the interval was composited and homogenized for laboratory analysis for total and TCLP arsenic. Each composited and homogenized sample was field screened for total arsenic using XRF. Subsurface soil sample collection is summarized in Table 2-1. Samples of tailings/waste rock and native soil/alluvium were submitted to ALS, located in Kelso, Washington, under subcontract to E & E, for laboratory analysis for total and TCLP arsenic. Analytical data were validated by an E & E chemist. The results of laboratory analytical data validation are summarized in Data Review Memoranda for each laboratory data deliverable and are presented in Appendix A. Results of the soil characterization are presented in Section 2.2.2.

2.1.3 2017 Characterization in the Vicinity of the Proposed Repository

The BLM is conducting additional characterization of soil, bedrock, and groundwater in the vicinity of the proposed repository (see FS Alternatives 3a and 3c). The additional characterization is being performed to generate additional information that may be useful for a more detailed hydrologic analysis of the proposed repository. The additional characterization also is being performed to generate data necessary to establish a detection groundwater monitoring network for the repository. The additional characterization is being performed to gather the types of additional information identified in Section 3.3.1 of the 2017 Groundwater and Tailings Characterization Work Plan (E & E 2017). The components of the repository characterization pertaining to soil and bedrock are discussed in this section; components that pertain to groundwater are discussed in Section 3.1.3.

The additional soil and bedrock characterization is being performed using a combination of field data collection and laboratory analysis. Additional characterization included installation of additional soil borings and monitoring wells and collection of soil samples for field observations and laboratory analyses for chemical and geotechnical parameters. Field activities were performed during the summer of 2017. Field procedures and laboratory analyses were performed following the 2017 Groundwater and Tailings Characterization Work Plan (E & E 2017), except as noted below. A brief description of field sampling and other procedures pertinent to the soil and bedrock characterization is provided below.

2.1.3.1 Soil Boring and Monitoring Well Installation

A total of 16 soil borings were installed at locations anticipated to be upgradient of, near, and downgradient of the proposed repository and the potentially extended repository footprint area. A new monitoring well was installed in each soil boring. Actual drilling locations were refined from the locations proposed in the 2017 Groundwater and Tailings Characterization Work Plan (E & E 2017) during the investigation based on conditions encountered in the field. Locations of new soil borings/monitoring wells are illustrated in Figure 2-5.

Soil boring and monitoring well installations were performed using a drill rig operated by a subcontracted, Alaska-licensed driller. The driller used a track-mounted Geoprobe 8040 drill rig outfitted to use direct-push equipment/method for drilling in unconsolidated material and weathered bedrock, and air rotary/down-the-hole hammer equipment/method for drilling in bedrock. Soil borings were advanced to the total depths presented in Table 2-2. Soil samples for chemical analyses were collected using a 5-foot-long direct-push soil core sampler was used for subsurface soil sampling using direct-push methods. Geotechnical soil samples were collected using a combination of 5-foot-long direct-push soil coring devices and, for tests that require undisturbed soil samples, Shelby tubes. Soil cores were collected continuously from the ground surface through the base of the unconsolidated materials and various depths into weathered bedrock. While drilling with air rotary/down-the-hole hammer in competent bedrock, drill cuttings were typically collected every 2.5 feet.

Drill cuttings and other investigation-derived waste were managed in accordance with the 2017 Groundwater and Tailings Characterization Work Plan (E & E 2017).

Monitoring wells were installed in completed boreholes. Monitoring well installation and associated activities are discussed in Section 3.1.3.

2.1.3.2 Lithological Characterization

The soil material recovered was visually characterized and logged by the field geologist following the procedures specified in the 2017 Groundwater and Tailings Characterization Work Plan (E & E 2017). Geologic logging was typically performed at 1-foot intervals in unconsolidated materials and 2.5-foot intervals in bedrock. Geologic logging included visual observations of soil and bedrock lithological and mineralogical characteristics; field United Soil Classification System soil group classification; color; mineralization (including sulfide minerals, veins, and iron staining); weathering; moisture content; and depths to groundwater in boreholes. Results of the lithological characterization are presented in Section 2.2.3.1.

2.1.3.3 XRF Field Screening

Although the 2017 Groundwater and Tailings Characterization Work Plan (E & E 2017) does not specify that XRF field screening of drill cuttings would be conducted, XRF field screening was performed on most drill cuttings samples to assist in the identification of mineralized zones. XRF field screening was typically performed at 1-foot intervals in unconsolidated materials and 2.5-foot intervals in bedrock. XRF field screening was performed in a manner consistent with the XRF field screening method described in the RI Supplement Work Plan (E & E 2015). Results of the XRF field screening are presented in Section 2.2.3.2.

2.1.3.4 Soil Sampling for Laboratory Chemical Analysis

Selected soil samples were submitted to TestAmerica in Seattle, Washington, under subcontract to E & E, for laboratory analysis for:

- Total Target Analyte List (TAL) metals (U.S. Environmental Protection Agency [EPA] 6010/6020/7471); and
- Total organic carbon (EPA 9060).

Subsurface soil samples submitted to the laboratory for these analyses are summarized in Table 2-2. Analytical data were validated by an E & E chemist. The results of laboratory analytical data validation are summarized in Data Review Memoranda for each laboratory data deliverable and are presented in Appendix A. Results of the laboratory chemical analysis are presented in Section 2.2.3.3.

2.1.3.5 Soil Sampling for Laboratory Geotechnical Analysis

Soil samples were collected from selected boreholes for laboratory geotechnical testing. Geotechnical soil samples were collected using a combination of 5-foot-long direct-push soil coring devices for bulk samples and Shelby tubes for tests that require undisturbed soil samples. Selected soil samples were submitted to Shannon and Wilson, Inc., located in Anchorage, Alaska, under subcontract to E & E, for laboratory geotechnical analysis. Samples collected for laboratory geotechnical analysis were collected and tested as described below and in Table 2-2.

Disturbed Native Soil

Disturbed soil samples were collected with soil coring devices for laboratory analysis to assess soil conditions expected to locally exist in the area of the proposed repository and the potentially extended footprint. The samples were analyzed for the following geotechnical tests:

- Moisture content (ASTM International [ASTM] D2216);
- Specific gravity of soil solids (ASTM D854/C127);
- Grain size distribution with hydrometer (ASTM D422); and
- Liquid limit, plastic limit, and plasticity index of soils (ASTM D4318).

To evaluate the effects of soil compaction expected to occur as part of construction of the proposed repository, the soil samples were tested for compaction characteristics using:

- Compaction Characteristics of Soil Using Standard Effort (Standard Proctor) (ASTM D698).

Results of the compaction testing were used to remold the soil to 90 percent compaction at optimal moisture content. The compacted soil was then tested for:

- Hydraulic conductivity (K) using a flexible wall permeameter (ASTM D5084); and
- Bulk density (ASTM D7263).

Porosity of the compacted soil samples was estimated (calculated per Appendix X1 of ASTM D7263) using laboratory results of bulk density (ASTM D7263), grain density (ASTM D854), and moisture content (ASTM D2216).

Undisturbed Native Soil

Undisturbed soil samples were collected with Shelby tubes for laboratory analysis to assess native soil conditions expected to locally exist in the area of the proposed repository and the potentially extended footprint. Undisturbed samples were analyzed for the following geotechnical tests:

- K using a flexible wall permeameter (ASTM D5084); and
- Bulk density (ASTM D7263).

The undisturbed samples also were analyzed for the following geotechnical tests:

- Moisture content (ASTM D2216);
- Specific gravity of soil solids (ASTM D854/C127);
- Grain size distribution with hydrometer (ASTM D422); and
- Liquid limit, plastic limit, and plasticity index of soils (ASTM D4318).

Porosity of the undisturbed soil samples was estimated (calculated per Appendix X1 of ASTM D7263) using laboratory results of bulk density (ASTM D7263), grain density (ASTM D854), and moisture content (ASTM D2216).

Porosity of the compacted soil samples was estimated (calculated per Appendix X1 of ASTM D7263) using laboratory results of bulk density (ASTM D7263), grain density (ASTM D854), and moisture content (ASTM D2216).

Results of laboratory geotechnical testing are presented in Section 2.2.3.4.

2.2 Soil and Bedrock Characterization Results

Soil and bedrock at the RDM have been characterized over the course of the RI, RI Supplement, 2017 tailings/waste rock TCLP characterization, and 2017 groundwater characterization. Results of the RI and RI Supplement are discussed in Section 2.2.1. Results of the additional 2017 tailings/waste rock TCLP characterization are presented in Section 2.2.2, and results of the additional characterization in the vicinity of the proposed repository are presented in Section 2.2.3. Combined findings of the RI, RI Supplement, and 2017 additional characterization are presented in Sections 2.2.4 through 2.2.6.

2.2.1 RI and RI Supplement

The RI and RI Supplement soil characterization employed a similar approach to identify types of mine wastes and native soils, and to attempt to identify naturally mineralized soils and soils impacted by contamination. Field lithological and mineralogical observations were used, in conjunction with XRF field screening data and laboratory analytical results, to identify mine waste and soil types and their thicknesses. The interpreted mine waste and soil types identified in the soil borings are presented in Chapter 3 of the RI report and Chapter 2 of the RI Supplement report.

Concentrations of inorganic contaminants in mine waste (mixed tailings/waste rock and waste rock), native soils, and bedrock were determined using XRF field screening data and laboratory analytical results. Results are presented in Chapters 4 and 5 of the RI report and Chapter 2 of the RI Supplement report.

Information on depth to bedrock was gathered during drilling at each RI and RI Supplement borehole. Naturally mineralized bedrock and native soils were identified using visually observable lithological and mineralogical observations and XRF field screening data. Mineralized zones associated with the underground mine workings were targeted during the borehole/monitoring well installation in the Surface Mined Area as part of the RI Supplement. Depths to bedrock and information regarding mineralization are presented in Chapters 4 and 5 of the RI report and Chapter 2 and Section 3.2.1 of the RI Supplement report.

2.2.2 2017 Tailings/Waste Rock TCLP Characterization

Field lithological and mineralogical observations were used, in conjunction with XRF field screening data and laboratory analytical results, to identify mine waste (tailings/waste rock) and soil types and their thicknesses. Field procedures and laboratory analyses were performed as described in Section 2.1.2.

Results of geologic logging, including interpreted mine waste and soil types identified in the soil borings, are presented in Table 2-3. Results of laboratory analysis of total arsenic and TCLP arsenic in soil samples are presented in Tables 2-3 and 2-4. Results of XRF field screening for arsenic, as well as antimony and mercury, are presented in Table 2-3.

2.2.3 2017 Characterization in the Vicinity of the Proposed Repository

The subsections below present results of the additional characterization of soil and bedrock conducted in the vicinity of the proposed repository as part of the 2017 Groundwater and Tailings Characterization Work Plan (E & E 2017).

Results of associated groundwater characterization activities are described in Chapter 3.

2.2.3.1 Lithological Characterization
Sampling and geologic logging were performed as described in Sections 2.1.3.1 and 2.1.3.2. Results are summarized in Table 2-5.

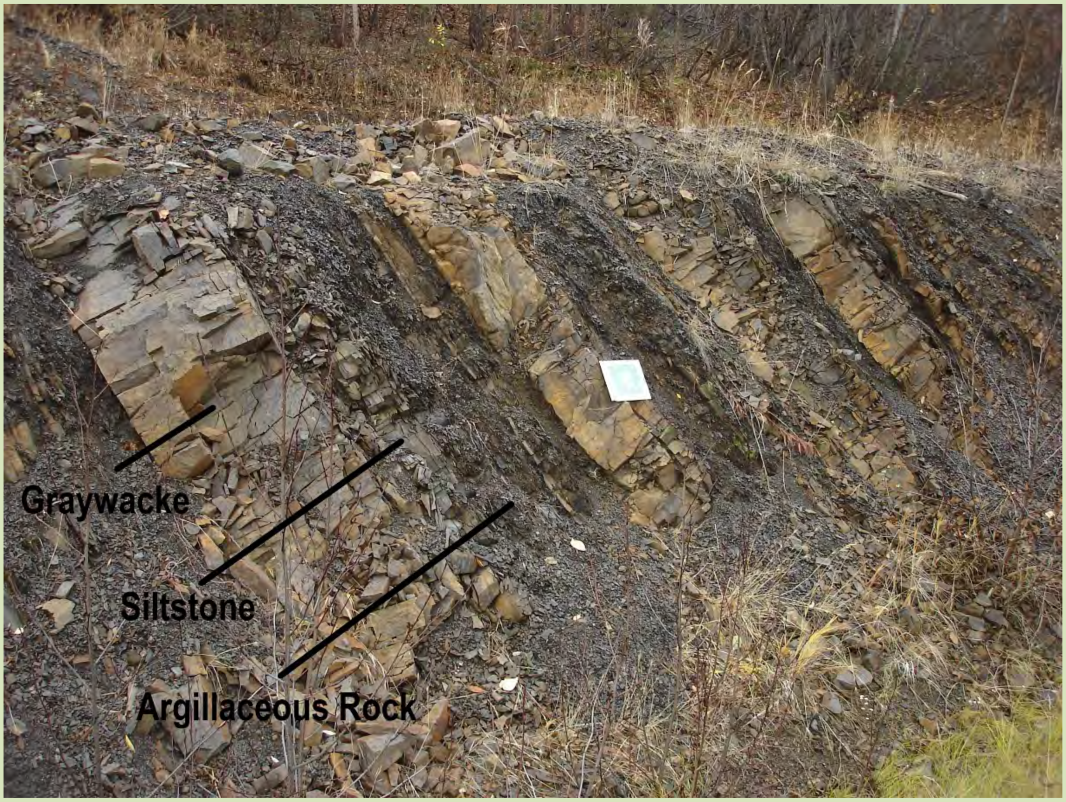
2.2.3.2 XRF Field Screening
Field screening of soil samples for total metals using a field portable XRF was performed on soil and bedrock materials samples as described in Section 2.1.3.3. XRF results for the primary contaminants of concern (COCs) at the RDM—antimony, arsenic, and mercury—are presented in Table 2-5.

2.2.3.3 Soil Laboratory Chemical Analysis
Soil sampling for laboratory chemical analysis was performed as described in Section 2.1.3.4. Laboratory analytical results for total TAL inorganic elements and total organic carbon are presented in Table 2-6. The results of laboratory analytical data validation are summarized in Data Review Memoranda for each laboratory data deliverable and are presented in Appendix A.

2.2.3.4 Soil Geotechnical Analysis
Soil sampling for laboratory geotechnical analysis was performed as described in Section 2.1.3.5. Results of laboratory geotechnical testing are presented in Table 2-7.

2.2.4 Bedrock Lithology, Stratigraphy, and Structure
Information regarding bedrock geology based on regional studies, documentation taken during mining, and BLM studies at the RDM is summarized below.

2.2.4.1 Kuskokwim Group Lithology and Stratigraphy
The regional geology is dominated by the folded sedimentary rocks of Cretaceous age known as the Kuskokwim Group. The Kuskokwim Group in the area of the RDM comprises a thick marine turbidite sequence consisting of interbedded graded graywacke, siltstone, and argillaceous rock. The graywacke beds range in thickness from half a foot to about 20 feet, and commonly are 2 to 3 feet thick. Most of the argillaceous rocks exposed underground during mining are argillites, but some of their surface and near-surface counterparts are shales. Some of them are fissile, and many tend to fracture sub conchoidally. Additional detailed information on lithology, mineralogy, and chemistry on the bedrock units is provided in MacKevett and Berg (1963). An exposure of Kuskokwim Group bedrock located in the Main Processing Area of the RDM is shown in Photograph 1.



Photograph 1. SE-facing view of Kuskokwim Group bedrock exposure in Post-1955 Main Processing Area, Red Devil Mine. Notebook used for scale.
Note blocky, brownish graywacke beds, dark gray argillaceous beds, and, in places, intermediate siltstone beds. Labels denote graywacke, siltstone, and argillaceous beds of a single fining-upward (upward to the right) Bouma sequence. Note southwesterly dip of bedding.

The graywacke is a medium- or dark-gray rock that weathers brown and is fine grained and well indurated. Its fine-grained character makes macroscopic identification of its minerals and textures difficult. Descriptions of similar graywackes from throughout the central Kuskokwim region indicate that many of them contain a variety of detrital rock fragments. Microscopic examination reveals that the graywacke is poorly sorted and composed of subrounded to angular lithic fragments and mineral grains ranging from less than 0.001 to 0.5 millimeters (mm) in average diameter. The larger and more abundant minerals consist of quartz, muscovite, pyrite, plagioclase, and calcite. These minerals and the lithic fragments, which were principally derived from slate, schist, and volcanic rocks, are surrounded by very fine-grained assemblages of quartz, calcite, plagioclase, muscovite, clay minerals, epidote, and chlorite. Calcite is the dominant cementing mineral, and it also forms veinlets (MacKevett and Berg 1963).

The very fine-grained argillaceous rocks of the Kuskokwim Group are dark gray or black and weather brown. Most of these rocks that are exposed underground are argillites, but some of their surface and near surface counterparts are shales. Discrete argillaceous beds are commonly a few inches thick, but locally they have a cumulative thickness of 20 or 30 feet. Commonly, the argillaceous rocks are well indurated. Some of them are fissile, and many tend to fracture subconchoidally. The argillites are flecked with fine crystals of muscovite, the only megascopically visible mineral. The argillaceous rocks are similar to the graywackes in composition. A typical argillite from the RDM consists of subangular grains of quartz, epidote, muscovite, and pyrite that are less than 0.03 mm in average diameter, associated with clots and lamellar aggregates of very fine-grained clay minerals and mica (MacKevett and Berg 1963).

2.2.4.2 Dikes

The Kuskokwim Group sedimentary rocks are intruded by hydrothermally altered dikes described as being composed of quartz basalt (MacKevett and Berg 1963) or altered biotite basalt and as andesite (Malone 1962). The dikes range from 1 foot to about 14 feet in thickness. The main dike at the RDM has a few plug-like

and sill-like offshoots and a few small discontinuous branching dikes. In underground exposures, the dikes are light gray. At the surface, the dikes are masked by pervasive hydrous iron oxides and are difficult to distinguish from similarly weathered graywacke. The dikes consist entirely of fine-grained and very fine-grained masses of calcite, chalcedony, limonite, and sericite, and subordinate amounts of quartz, hematite, and clay minerals. Small relict phenocrysts are largely replaced by calcite in a very fine-grained groundmass. A few veinlets composed of calcite and minor amounts of quartz cut the dikes. As of 1963, surface exposures of bedrock at the RDM were largely confined to road cuts, stripped areas, and trenches (MacKevett and Berg 1963). Three dikes are exposed in the mine workings. Dike contacts are irregular in places, but over any distance they are parallel to the J-l joint direction, described below (Malone 1962). The three dikes located in the area of the Red Devil Mine played a key role in the development of the ore bodies (discussed in Section 2.2.6.2 below).

Igneous dike material likely associated with ore zones has been observed mixed with other tailings/waste rock materials consisting of Kuskokwim Group bedrock in boreholes installed in the Main Processing Area. Igneous dikes also have been encountered during drilling in the Main Processing Area in boreholes MP098 and MP099 (see RI Supplement report Appendix B) and the Surface Mined Area in boreholes SM68a, SM68b, SM68c, SM70c, and SM71a (see RI Supplement report Appendix B) and SM82 (see Table 2-5).

2.2.4.3 Folding

The RDM is located on the SW limb of the Sleetmute anticline, a northwest (NW)-trending fold whose axis is mapped within the Kuskokwim River valley over a length approximately 2 miles SE (upriver) and 5 miles MW (downriver) of the RDM (Cady et al. 1955). The bedding of the Kuskokwim Group in the RDM area strikes from between north (N) 10° W to N 60° W but strikes predominantly from N 30° W to N 45° W at the mine. The bedding dips toward the SW, predominantly from 45° to 60° SW (MacKevett and Berg 1963). Photograph 1 illustrates an exposure of Kuskokwim Group bedrock at the RDM exhibiting the typical NW-striking, SW-dipping bedding of the area.

The few steeper and, in places, overturned beds are attributed to surface creep or to the drag associated with faulting (MacKevett and Berg 1963). Local smaller scale folds were observed during the RI in a pit near the Red Devil village site about 1.5 miles NW of the RDM and along strike of the NW-striking, SW-dipping bedding on the SW limb of the Sleetmute anticline (see Photograph 2).

2.2.4.4 Joints and Fractures

Malone (1962) describes two sets of joints, referred to as J-1 and J-2, documented throughout the Red Devil Mine during mine operations as follows. At any one place the joint orientations are erratic, but the average orientations of many joints taken within a 50-foot radius is close to average orientations taken elsewhere in the mine. Joint set J-1 has an average strike of N 37° E and average dip of 63° SE, and joint set J-2 has an average strike of N 69° E and average dip of 60° NW.

Photograph 2. SE-facing view of Kuskokwim Group bedrock exposure in pit near Red Devil Village located approximately 1.5 miles NW of RDM and along strike of the NW-striking, SW-dipping bedding on SW limb of the Sleetmute anticline.
Note general southwesterly dip of bedding typically seen on SW limb of the Sleetmute anticline (center and right) and smaller scale fold (left).

Both sets are perpendicular to the bedding, and the acute bisector of the two is parallel to the dip of the beds. Generally, during folding in which the bedding plane slip is active, the direction of maximum stress lies along the bedding in a plane perpendicular to the fold axis. At Red Devil Mine, the direction of maximum stress during the deformation that gave rise to the joint sets was parallel to the dip of the beds. The joints at Red Devil Mine lie symmetrically on either side of the maximum stress direction and thus are interpreted to have been formed during the folding of the Sleetmute anticline (Malone 1962).

At the Red Devil Mine, joints are reported to be best developed in the thicker graywacke beds (MacKevett and Berg 1963). No information specifically addressing the development of joints in the argillaceous beds, which include shale and argillite, is available. Commonly, relatively soft shaley rocks deform ductilely rather than by fracturing. In such cases, development of joints in the shaley rocks is less than observed in adjacent, comparatively competent sandstone beds.

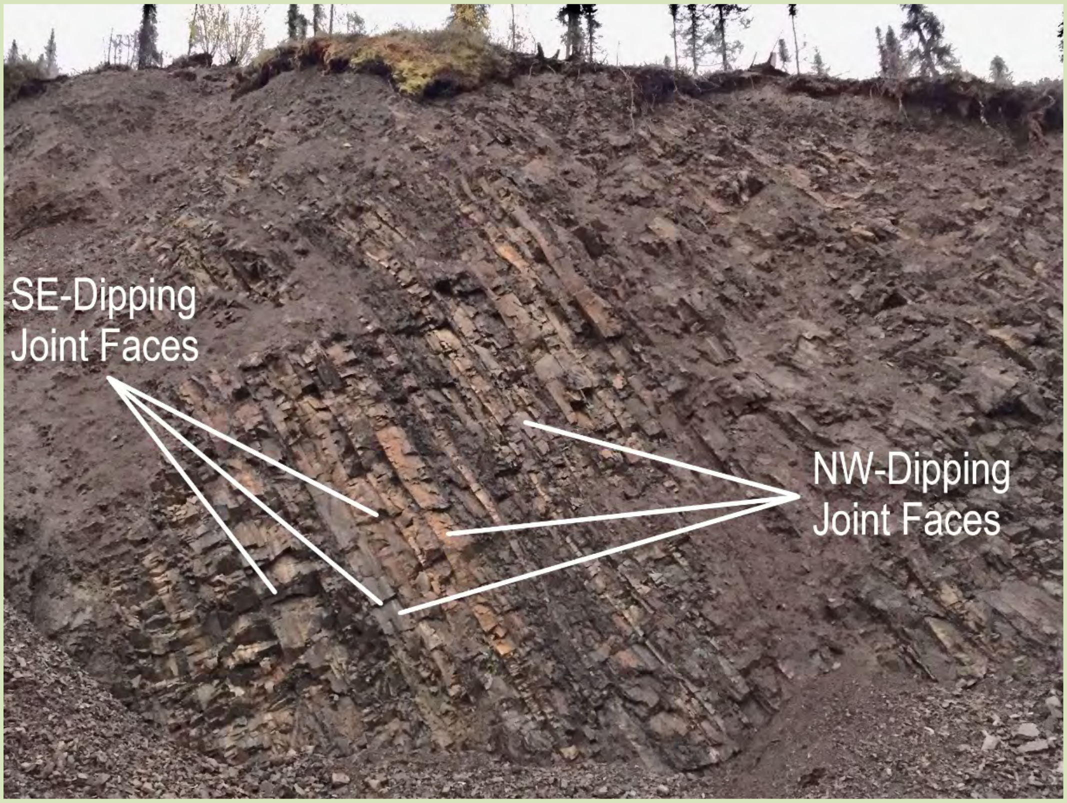
No information specifically regarding joint spacing or aperture at the RDM is available. Photograph 3 illustrates SE- and NW-dipping joint surfaces in graywacke beds exposed in a pit near Red Devil Village located approximately 1.5 miles NW of RDM and along strike of the NW-striking, SW-dipping bedding on the SW limb of the Sleetmute anticline described at the RDM. The SE- and NW-dipping joint surfaces at the pit likely are similar to the joints (J-1 and J-2, respectively) described by Malone (1962) and MacKevett and Berg (1963) at the RDM.

Bedrock drill cuttings observed during the RI, RI Supplement, and 2017 additional characterization activities exhibit indications of fracturing likely associated with these joint sets. Such indications include both light-colored veins deposited along planar fractures and weathering along generally planar fracture surfaces.

Groundwater within the Kuskokwim Group bedrock unit appears to occur primarily within bedrock fractures, including joints, as discussed in Section 3.3.1.

2.2.4.5 Faults

No Quaternary faults are mapped within approximately 75 kilometers of the RDM (USGS 2017). Older faults were mapped in detail along with other structural features during mine development. In general, the dominant faults at the mine strike northwestward, are commonly parallel to bedding, and are particularly well developed and numerous in the argillaceous rocks. They are characterized by grooved and slickensided surfaces that are locally curved, by minor gouge and breccia, and by contorted and plicated argillite throughout zones as much as 10 feet thick. A few of these northwestward-striking faults transect the bedding and in places are vertical or dip steeply southwest or northeast (MacKevett and Berg 1963).



Photograph 3. SE-facing view of Kuskokwim Group bedrock exposure in pit near Red Devil Village, located approximately 1.5 miles NW of RDM and along strike of the NW-striking, SW-dipping bedding on SW limb of the Sleetmute anticline.
Note blocky character of graywacke beds attributable to breaking along SE- and NW-dipping joints.

Faults at the RDM are described in further detail below.

- **Red Devil Fault.** The dominant fault at the mine is the complex, NW-striking Red Devil Fault zone. Movement direction along the fault parallels the strike of bedding and is within 10 to 15 degrees of horizontal. Movement was a compromise between the tendency of strike slip faults to be vertical and the tendency for movement to occur along the planes of easiest slip, which are the bedding planes. Consequently, the fault follows bedding for the most part, but in many places, individual faults lace from one bedding plane to another along steep slip surfaces. In addition, in many places, minor flat dipping faults lace between bedding plane faults. They were reported to be well exposed in both the underground and the surface workings and particularly well developed and numerous in the argillaceous rocks. A few of these NW-striking faults transect the bedding and in places are vertical or dip steeply SW or NE. Some of the faults are traceable for several hundred feet, but discrete faults are generally difficult to trace for long distances because of their myriad constituent fractures and the lack of exposure. Many of the faults appear to be *en echelon*. Some of the faults probably are not continuous but represent the combined effect of numerous individual fractures (Malone 1962; MacKevett and Berg 1963).

The major component of movement on the NW-striking faults was right lateral, as indicated by the offset dikes associated with mineralization. Individual right-lateral displacements on these faults range from a few inches to about 40 feet, and their cumulative right-lateral displacement is several hundred feet. Steep, fine slickensides that rake nearly 90 degrees are superposed on some of the right lateral surfaces. These probably indicate minor dip-slip movement after the main period of faulting. Transverse faults are uncommon at the mine. (Malone 1962; MacKevett and Berg 1963)

- **Wrench Faults Subsidiary to the Red Devil Fault Zone.** Subsidiary, bedding-parallel strike slip faults also accommodated right-lateral strike slip movement. Exposures of the faults are limited in the hanging wall of the Red Devil Fault, but in the footwall subsidiary, right-lateral strike slip movements occur for a width of at least 300 feet on the 300 level. The total right-lateral strike slip movement between the known dike segments is about 800 feet; half or less is in the Red Devil Fault, and the rest is taken up by the subsidiary movements in the footwall. These faults occur because of the strong preferred orientation of slip planes along the shaley bedding planes. Therefore, subsidiary faults are not parallel to the parent fault, although the movement directions of the two are parallel. (Malone 1962)

- **Cross Faults.** The ore shoots have been cut by two major cross faults, which postdate both wrench faulting and ore deposition. Both faults are marked by a gray, rubbery gouge a few inches thick. Other steep, crosscutting left lateral faults of similar orientation may exist along the Red Devil fault; however, none have been identified. (Malone 1962)

No specific information regarding fracture apertures or sealing of the various faults is available. However, MacKevett and Berg (1963) note that generally, the poor development of open spaces in the sedimentary rocks is attributed mainly to the localization of most of the bedding-plane faults in incompetent argillaceous rocks.

2.2.4.6 Structural Sequence

The sequence of primary structural events at the RDM is as follows:

1) Folding of the sedimentary rocks forming the Sleetmute anticline and the probable concurrent development of the steep, NE-striking tensional joints (J-1 and J-2).
2) Intrusion of dikes into a few of these joints (J-1).

3) Development of steep, NW-striking (parallel to sub-parallel to bedding) faults of the Red Devil Fault that offset the dikes and joint systems.
4) Further right lateral faulting of the NW-trending faults, accompanied by introduction of ore solutions and resulting ore deposition.
5) Post-mineralization cross faulting. (MacKevett and Berg 1963)

Mineralization is discussed further in Section 2.2.6.2.

2.2.5 Identification and Characterization of Tailings/Waste Rock and Native Soil

As described in Chapter 3 of the RI report, the distribution and arrangement of soils and mine and ore processing wastes at the site play an important role in determining the nature and extent of contamination, as well as the fate and transport of contaminants at the RDM. This and other factors and processes that affect the nature and extent and fate and transport of inorganic elements at the RDM are discussed in Chapter 5 of the RI report.

Native soils at the RDM consist of loess, soils derived from Kuskokwim Group bedrock, and alluvial deposits associated with the Kuskokwim River and Red Devil Creek. The loess deposits are buff colored and friable, range from a few inches to about 30 feet in thickness, and commonly lack bedding. The loess locally overlies soil derived from weathering of the Kuskokwim Group bedrock. Minor quantities of recently deposited alluvium, including slope wash, are exposed on the lower slopes of some of the hills, in the valley of Red Devil Creek and along the Kuskokwim River (MacKevett and Berg 1963).

Non-native materials at the site consist of various types of mining and ore processing wastes and fill. Mining-related waste consists of waste rock, dozed and sluiced overburden, flotation tailings, and tailings (thermally processed ore, also known as calcines, burnt ore, and retorted ore). Tailings and waste rock are typically mixed at the RDM and are referred to as tailings/waste rock in the RI and RI Supplement reports and this document. Native materials have been removed, disturbed, relocated, covered, and/or mixed with other native soils and/or mine waste and tailings and fill locally across the site. Some of the native soils are naturally mineralized. The presence and nature of naturally mineralized soils at the RDM is discussed in Section 4.1.7 of the RI report, in Chapter 2 of the RI Supplement report, and summarized in Section 2.2.6 of this report.

During the RI, RI Supplement, and 2017 additional soil characterization activities, multiple lines of evidence were used to identify the various mine wastes and soil types and to define their distribution. These lines of evidence are discussed below. In conjunction with other information, visual observations of the presence of red porous rock and rock fragments with a distinctive rust-colored rind are shown to be useful to identify the presence of tailings (calcines). Visual observations of the presence of primary ore minerals cinnabar (mercury sulfide) and stibnite (antimony sulfide), and related gangue minerals realgar and orpiment (arsenic sulfides), and calcite and quartz veins, combined with other information, are useful to identify waste rock and naturally mineralized bedrock and rock fragments within native soils. Combined with other information, results of mercury selective sequential extraction (SSE) analysis were used to identify the presence of cinnabar and other forms of mercury in soils.

Results of the efforts to delineate the lateral and vertical extents of tailings/waste rock, other mine wastes, and site-specific soil types during the RI are presented in Chapter 3 of the RI report and Chapter 2 of the RI Supplement report.

Results of the RI were used to estimate the depths and volume of tailings/waste rock and contaminated soil proposed for excavation under Alternatives 3 and 4 of the FS (E & E 2016a). It is anticipated that data collected as part of the RI Supplement soil investigation will be used to refine the estimated depths and volume. The 2017 tailings/waste rock characterization activities in the Main Processing Area (see Sections 2.1.2 and 2.2.2) address data gaps regarding the lateral and vertical extents of tailings/waste rock in this area that are expected to have TCLP concentrations greater than the RCRA limit for arsenic. The 2017 tailings/waste rock characterization results also may be useful for further refining the estimates of depths and volume of tailings/waste rock and contaminated soil proposed for excavation under Alternatives 3 and 4 of the FS (E & E 2016a).

Each subsurface soil sample collected as part of the RI and RI Supplement was assigned a site-specific soil type. The site-specific soil types are described in Appendix B, Table B-1 in the RI report. The interpreted soil types are presented in Tables 4-17 through 4-29 and Appendices B, E, and F of the RI report and Tables 2-2 and Appendix B of the RI Supplement report. Geologic cross sections illustrating the general distribution of mine wastes, native soils, bedrock, and other pertinent features are presented in Figures 2-7 through 2-16. A cross section reference map is presented in Figure 2-6.

2.2.6 Characterization of Bedrock

Bedrock has been characterized as part of the RI, RI Supplement, and 2017 characterization activities. Results of this characterization are summarized below.

2.2.6.1 Depth to Bedrock

Depths to bedrock have been determined as part of the RI, RI Supplement, and 2017 soil characterization efforts. Information on depth to bedrock observed in soil borings is presented in Appendices B, E, and F of the RI report; Table 2-2 and Appendix B of the RI Supplement report; and Tables 2-3 and 2-5 of this report. Depths to bedrock across the RDM are illustrated in geologic cross sections presented in Figures 2-7 through 2-16. A cross section reference map is presented in Figure 2-6.

2.2.6.2 Mineralization of Bedrock

Naturally mineralized bedrock was characterized as part of the RI, RI Supplement, and 2017 additional characterization activities. Information on natural mineralization may be used to evaluate the nature and extent and fate and transport of COCs at the RDM.

Natural mineralization at the RDM comprises not only the discrete high-grade mercury ore bodies targeted during mining, but also sub-ore grade zones peripheral to the ore bodies. This peripheral mineralization includes not only mercury and antimony sulfide minerals (primarily cinnabar and stibnite, respectively), but also arsenic sulfides (realgar and orpiment). Weathering of these natural sulfides, and possibly other minerals, results in naturally elevated levels of arsenic, mercury, and antimony in groundwater. Bedrock and soil in zones hydraulically downgradient of the mineralized zones also likely contain naturally elevated metals concentrations from deposition of the mobilized metals (e.g., oxidation of arsenic sulfide and adsorption of resulting arsenate onto clay particles or iron oxide/hydroxide). Migration of inorganic elements in groundwater at the RDM is complicated and is affected by multiple complex groundwater migration pathways and various geochemical conditions present at any given time at any given location along those pathways. Previously gathered information and conclusions regarding these factors are discussed in Section 5.4 of the RI report and Chapter 3 of the RI Supplement report. Available information regarding the ore geology and peripheral mineralization is detailed in Section 4.1.7 in the RI report and summarized below.

2.2.6.2.1 Ore Zones

The Red Devil ore bodies are epithermal hydrothermal deposits (Gray et al. 2000). The ore minerals are cinnabar (mercury sulfide) and stibnite (antimony sulfide). Other sulfide minerals locally present are realgar and orpiment (arsenic sulfides) and pyrite (iron sulfide). The mineral-laden hydrothermal solutions were derived from dehydration of hydrous minerals in the argillite/shale and mobilization of formation waters of the Kuskokwim Group host rock by heat from igneous plutons that locally intruded the host rock. The hydrothermal solutions migrated through permeable rocks and along fractures and faults (e.g., Gray et al. 2000). Such fractures and faults include the NE-striking joints and NW-trending Red Devil fault and associated faults that run through the RDM area (see Sections 2.2.4.4 through 2.2.4.6). Sulfide minerals and possibly other species, along with quartz, carbonate, and clay gangue, were deposited where the chemical and physical conditions favored their formation. Concentrations of mercury in the RDM ore were typically 2 to 5% (20,000 to 50,000 parts per million [ppm]) and ranged as high as 30% (300,000 ppm).

Mineralization of the ore body is described in Sections 1.4.3.2 and 4.17 of the RI report. The geometry of the ore body is strongly controlled by bedrock structure. The richest ore mined occurred in numerous discrete elongate bodies (ore shoots) that are mainly localized along and near intersections of the three dikes described in Section 2.2.4.2 (average strike and dip of N 37° E, 63° SE) and numerous right lateral faults associated with the Red Devil Fault (average strike and dip of N 40° W, 60° SW), which cut the dikes into segments (see Section 2.2.4.5). The intersections of the dikes and faults, and thus the main ore shoots, plunge on average approximately 39° on a bearing of S 10° E (Malone 1962). The main ore shoots that were mined are associated with two dikes: the Dolly dike and the "F" zone dike. The right lateral slip along the numerous faults that cut these dikes results in two arrays of ore shoots that comprise the ore zones that were targeted during mining: the zone associated with the Dolly and Rice ore shoots and the zone associated with the "F" ore zone shoots (Malone 1962). Stopes were driven along these ore shoots, and locally reached the surface or were terminated a short distance below the ground surface.

The age of the mercury mineralization and associated faulting (at least along the Red Devil Fault and other wrench faults subsidiary to the Red Devil Fault) is Late Cretaceous to Early Tertiary, based on its association with magmatism (including dike emplacement) of that age (Gray et al. 2000). No information on the age of post-mineralization cross-faulting is available.

At a minimum, the extent of ore-grade mercury mineralization would be defined by the extent of mining; however, high concentrations of cinnabar that were not economically recoverable likely are present beyond the extent of mining. Similarly, high concentrations of other sulfide minerals as well as elevated concentrations of mercury, antimony, and arsenic in non-sulfide forms, are present in the mineralized zone beyond the extent of mining.

Mining operations at the RDM included surface exploration and mining and underground mining. Mining operations are discussed in detail in Section 1.4.2.1 of the RI report and summarized below.

A map illustrating the configuration of the underground mine workings as of 1962 (based on Malone 1962 and MacKevett and Berg 1963) is presented in Figure 2-3. A cross section illustrating the cross-sectional configuration of the underground mine workings as of 1962 (Alaska Mines and Minerals, Inc. and Decoursey Mountain Mining Co., Inc. 1962) is presented in Figure 2-17. A portion of the mine workings cross section shown in Figure 2-17 is projected onto geologic cross section B-B', presented in Figure 2-8. Information on estimated elevations of key underground mine features is shown in Figures 2-3 and 2-8. Underground mining occurred after 1962 (see Section 1.4.2.1 of the RI report). Therefore, the extent of ore zones illustrated in Figures 2-3, 2-8, and 2-17 represents the minimum extent of the mercury ore zones.

Stope surface openings and other mine openings generally mark the locations where the ore zones reached the top of the bedrock and illustrate the west-northwest (WNW)-trending alignments of the two primary ore zones (see Figures 2-3, 2-8, and 2-17). The surface expression of the "F" ore zone is approximated by the "F" Zone Shaft Collar, 325 Adit and 311 Adit Portals, the Main Shaft

Collar, and intervening stope surface openings. The surface expression of the Dolly and Rice ore zone is approximated by the Dolly Shaft Collar, the Rice Shaft Collar, and intervening stope surface openings (MacKevett and Berg 1963; Malone 1962).

The “F” ore zone extends to the SE beyond the Main Shaft Collar at least as far as the center of the Main Processing Area, as evidenced by the stopes that branch off the 200 level and approach the surface beneath Red Devil Creek in the vicinity of the seep (see Figures 2-3, 2-8, and 2-17). The ore shoots that these stopes followed may extend to the top of bedrock.

The elevation of Red Devil Creek where underground workings approach the surface beneath the creek (near the seep) is approximately 210 feet above mean sea level referenced to the North American Vertical Datum 1988 (NAVD88). Results of a geophysical survey conducted by the U.S. Geological Survey at the RDM using surface-based, direct-current resistivity and electromagnetic induction methods support the presence of near-surface stopes (Burton and Ball 2011). The resistivity results indicated the presence of several anomalies in the subsurface along Red Devil Creek in the Main Processing Area, including two anomalies that appear likely to be associated with underground mine workings. Anomaly D is interpreted to be an elongate conductive anomaly that underlies Red Devil Creek for a distance of at least approximately 200 feet. Anomaly E is interpreted to be a nearly vertical anomaly that extends to within approximately 6 feet of the surface. Anomaly E is in close proximity to the seep on the NW bank of Red Devil Creek (Burton and Ball 2011). The approximate cross-sectional positions of these resistivity anomalies are shown in Figures 2-8 and 2-9.

2.2.6.2.2 Mineralization Peripheral to the Ore Zones

Existing information on local geology and mine operations and RI soil data indicate the presence of mineralization associated with, but beyond the extent of, the mercury ore zones targeted by mining. The rich ore shoots exploited during mining grade along the NW-trending faults and associated fractures into zones characterized by networks of closely spaced cinnabar-bearing veinlets, widely spaced veinlets that form proto-ore containing less than 1% mercury, and more distally into a peripheral zone of “barren veinlets” and clay alteration (MacKevett and Berg 1963; Malone 1962). Sub-ore grade mineralization also extended some distance laterally (i.e., toward the NE and SW) from the ore zones. Such sub-ore grade mineralization is discussed further below.

For simplicity, the mercury ore zones and the associated zones of sub-ore grade mercury deposits and deposits of other sulfide minerals are collectively referred to as the “mineralized zone” in this report. Pre-RI information on the extent of the mineralized zone and the distribution of inorganic element concentrations within the zone is limited. This is likely because during mine exploration and development little information was gathered regarding the extent of mineralization at levels below ore grade. Compounding the lack of historical information, the surface mining and exploration activities that took place locally within the Surface Mined Area, and the disposal of tailings and waste rock throughout the Main Processing Area, make it difficult to characterize pre-mining conditions in these areas at the present time. Nonetheless, some information regarding the sub-ore grade mineralized zone is available. Pertinent available information is summarized below.

Surface exploratory work performed by the U.S. Bureau of Mines in the 1940s includes mapping of target mineral concentrations in trenches arrayed across and roughly perpendicular to the ore zones. Sub-ore grade concentrations of mercury and antimony up to several hundred ppm were reported at locations more than 150 feet laterally away from the “F” ore zone. No information on arsenic concentrations is provided (Webber et al. 1947).

Sulfide mineralization and related elevated concentrations of antimony, arsenic, and mercury outside of the ore zones is further characterized by RI, RI Supplement, and 2017 characterization data. Information gathered during the RI is detailed in Sections 4.17 and 4.3 of the RI report and summarized in Section 2.2.6.2.3 below. Information gathered during the RI Supplement is presented in Section 2.5 of the RI Supplement report and summarized in Section 2.2.6.2.4. Information obtained during the 2017 characterization is presented in Section 2.2.6.2.5 below.

2.2.6.2.3 RI Characterization of the Mineralized Zone

Collectively, the historical mining information and RI data indicate that the natural mineralized zone (including the mercury ore zones and associated sub-ore grade deposits of mercury and deposits of antimony and arsenic sulfides and other minerals) lies within an elongate area that trends approximately WNW, perpendicular to the Red Devil Creek valley. This mineralized zone underlies part of the Main Processing Area as well as the Surface Mined Area. Historical site information indicates that naturally mineralized Kuskokwim Group bedrock, and soils derived from it, occurred locally at the surface prior to mine development. As evidenced by the incised nature of the Red Devil Creek valley, Red Devil Creek has eroded into the bedrock, exposing the ore and mineralized zones in the Main Processing Area and transporting eroded ore and other mineralized rock and soil downstream. This is indicated by reports on the early mine history—the mine was discovered when cinnabar float was found in the creek bed. The cinnabar float was followed upstream to the lode, described as being located approximately 1,000 feet up Red Devil Creek from the Kuskokwim River (Webber et al. 1947). This description corresponds to the location where the “F” ore zone intercepts the creek (see Figures 2-3, 2-8, and 2-17). Cinnabar float in the Red Devil Creek alluvium and other soils in the area of the discovery, described as “detritus material in the vicinity of the lode” (interpreted here to be slope wash or other soils derived from mineralized Kuskokwim Group bedrock), were the source of cinnabar ore during the initial mining (Webber et al. 1947).

As a result of the exposure and erosion of the ore and mineralized zones, the alluvium adjacent to and downstream of the mineralized zone would contain higher natural concentrations of mineralization-related inorganic elements than alluvium found upstream of the ore and mineralized zones. Similarly, soils derived from mineralized Kuskokwim Group bedrock, including colluvium and slope wash transported downslope into Red Devil Creek valley, would contain higher natural concentrations of inorganic elements than Kuskokwim Group-derived soils from areas outside of the ore and mineralized zones. Naturally mineralized geologic materials, including mineralized Kuskokwim Group bedrock and soils and alluvium derived from it that underlie portions of the Main Processing Area and Surface Mined Area, pre-date mining activities. As such, the natural mineralization of these materials represents pre-mining “background” conditions for those areas that are mineralized. Historical mining and ore processing activities, including disposal of the tailings and waste rock, occurred within the Main Processing Area, coinciding with part of the area where the naturally mineralized zone is expected to be present in the shallow subsurface. The presence of tailings/waste rock throughout most of the Main Processing Area makes characterization of naturally mineralized soil conditions in the Main Processing Area difficult because of elevated concentrations of inorganic elements in these mine waste materials, which may leach from the waste materials and be deposited in the native soils. Similarly, deposition onto native soils of inorganic elements derived from weathering of naturally mineralized bedrock or flow of groundwater through the mine also could occur.

RI results indicated the presence of mineralization outside of the ore zones in the Surface Mined Area as evidenced by elevated arsenic and mercury concentrations in samples of weathered Kuskokwim Group bedrock collected at RI soil borings SM10 and SM11. Soil overlying the Kuskokwim Group bedrock in borehole SM10 consists of disturbed native soil comprising loess mixed with Kuskokwim Group derived soil from 0 to 4 feet below ground surface (bgs), and undisturbed loess from 4 to 8 feet bgs. Soil overlying the Kuskokwim Group bedrock in borehole SM11 consists of loess from 0 to 12 feet bgs. The soils in boreholes SM10 and SM11 did not exhibit visual indications of mineralization and the XRF and laboratory concentrations of arsenic, antimony, and mercury are generally low. The Kuskokwim Group bedrock in boreholes SM10 exhibited comparatively high concentrations of arsenic (up to 6,240 mg/kg for laboratory results and 7,267 ppm for XRF field screening results) and mercury (up to 48.3 mg/kg for laboratory results and 80 ppm for XRF field screening results). See Table 4-29 and Appendix F, Table F-14, in the RI report.

Within the Surface Mined Area, varying degrees of disturbance by exploration and mining activities have occurred. A detailed discussion of surface exploration and mining operations is presented in Section 1.4.2.1 of the RI report. Documented surface mining operations included bulldozer and hand trenching and sluicing of overburden in 1941 and 1942; surface exploration and mining, possibly sluicing of overburden sometime after 1956; exploration of the Rice series by shallow trenches and pits some time before 1962; and surface mining over a large area of the Surface Mined Area by trenching, bulldozing, pit excavation, and possibly sluicing. The extent and types of surface disturbance is visible in an aerial photographic image dated 1974. An interpreted 1974 aerial photograph is presented in Figure 2-18. The overall areas of mining-related surface disturbance are illustrated in Figure 2-18. Included within the overall areas of surface disturbance are sub-areas with degrees of surface disturbance ranging from minimal to intensive (e.g., pit excavation). Figure 2-18 illustrates areas where particular types of surface mining activities are known to have taken place. A version of the interpreted photograph with the mapped underground mine workings is presented in Figure 2-19. A map illustrating the mapped extent of loess as of 1963, before the final phase of surface mining, is presented in Figure 2-20. It is possible that the distribution of loess in parts of the site, including the vicinity of boreholes SM10 and SM11, was modified after 1963 due to dozing and other surface disturbance evident in the 1974 photograph.

Locally the surface disturbance makes it difficult to definitively identify naturally mineralized conditions, particularly in near surface soils, because the potential effects of mining-related disturbance on underlying soils is difficult to rule out. RI efforts to identify and characterize areas of naturally mineralized surface and shallow subsurface soils in the Surface Mined Area during the RI are presented in Section 4.1.7 and Appendix E of the RI report.

2.2.6.2.4 RI Supplement Soil and Bedrock Characterization

During the RI Supplement, identification and characterization of natural mineralization in bedrock included visual observations of the presence of cinnabar (see Photograph 4), stibnite, realgar, and orpiment (see Photograph 5); calcite and quartz veins; XRF field screening results for antimony, arsenic, and mercury; and results for total TAL inorganics and mercury SSE analyses. The presence of cinnabar, the primary ore mineral at the RDM, and stibnite, realgar, and orpiment, is interpreted to indicate that the bedrock containing these minerals is naturally mineralized.

Photograph 4. Weathered bedrock in split spoon sampler from depth interval 44 to 45 feet bgs, borehole MP098.
Note cinnabar (the red grains).

Where visual evidence of sulfide mineralization was not directly observed in drill cuttings, elevated concentrations of antimony, arsenic, and mercury in bedrock samples (as measured using XRF field screening) provide evidence to evaluate whether the bedrock is naturally mineralized. Where elevated COC concentrations are observed in discrete intervals with comparatively low concentrations in intervals above and below (if the borehole extended to below the interval), the elevated COC concentrations may be attributable to natural mineralization.

Photograph 5. Drill cuttings from borehole SM70b (monitoring well MW42) from depth interval 127 to 128 feet bgs.
Note orpiment (the orange grains).

Information on bedrock intervals in the RI Supplement boreholes that exhibit these features is presented in Table 2-2 and Appendix B of the RI Supplement report. Such naturally mineralized bedrock was observed at various depths in most of the boreholes installed in the Surface Mined Area and, within the Main Processing Area, at borehole MP098. The mineralization observed at borehole MP098 is associated with the unmined portions of ore zones targeted by stopes stemming upward from the 150 Level / 200 Level of the underground mine workings (see discussion of Ore Zone Geology above and Figures 2-3, 2-8, and 2-17).

A primary objective of the RI Supplement was to assess potential impacts of naturally mineralized bedrock and underground mine workings on groundwater flow paths and inorganic element concentrations. A total of eight soil borings were installed in the Surface Mined Area in 2015 as part of an effort to install monitoring wells. A total of four new monitoring wells were installed. A summary of the soil boring and monitoring well installation are presented in Tables 2-1 and 3-1 of the RI Supplement Report, respectively. Well construction details are provided in Table 3-1 of the RI Supplement report. Information regarding bedrock mineralized zones and the occurrence of groundwater is presented in RI Supplement report Table 2-2 and Appendix B and discussed in Section 3.6.

2.2.6.2.5 2017 Soil and Bedrock Characterization in the Vicinity of the Repository

The 2017 bedrock characterization included visual observations of the presence of cinnabar, stibnite, orpiment, and realgar (see Photograph 6); calcite and quartz veins; and XRF field screening for antimony, arsenic, and mercury. As with the RI Supplement bedrock characterization, the presence of primary ore-related sulfide minerals cinnabar, stibnite, realgar and orpiment is interpreted to indicate that the bedrock is naturally mineralized. Where visual evidence of sulfide mineralization was not directly observed in drill cuttings, elevated concentrations of antimony, arsenic, and mercury in bedrock samples (as measured using XRF field screening) provide evidence to evaluate whether the bedrock is naturally mineralized. Where elevated COC concentrations are observed in discrete intervals with comparatively low concentrations in the intervals above and below (if the borehole extended to below the interval), the elevated COC concentrations may be attributable to natural mineralization. Observations regarding soil and bedrock conditions and occurrence of groundwater for the 2017 monitoring wells are summarized in Table 2-5 and discussed in Section 3.6.

Photograph 6. Drill cuttings from borehole SM78 (monitoring well MW50) from depth interval 72.5 to 75 feet bgs.
Note the small red grains (suspected to be realgar) embedded within several pieces of black argillite cuttings and white vein material.

Table 2-1 2017 Main Processing Area Tailings/Waste Rock Characterization Soil Sample Collection Summary

Soil Boring ID	Depth to Bedrock (feet bgs)	Borehole Total Depth (feet bgs)	Sample ID	Sample Interval Depth (feet bgs)		XRF Field Screening	Total Arsenic (EPA 6010)	TCLP Arsenic (EPA 1311/6010)
				Top	Bottom			
MP102	16	24	17MP102SB04	0	4	X	X	X
			17MP102SB08	4	8	X	X	X
			17MP102SB12	8	12	X	X	X
			17MP102SB16	12	16	X	X	X
MP103	18.4	24	17MP103SB04	0	4	X	X	X
			17MP103SB08	4	8	X	X	X
			17MP103SB12	8	12	X	X	X
			17MP103SB16	12	16	X	X	X
			17MP103SB18.4	16	18.4	X	X	X
MP104	29.5	32	17MP104SB04	0	4	X	X	X
			17MP104SB08	4	8	X	X	X
			17MP104SB12	8	12	X	X	X
			17MP104SB16	12	16	X	X	X
			17MP104SB20	16	20	X	X	X
			17MP104SB24	20	24	X	X	X
			17MP104SB28	24	28	X	X	X
			17MP104SB29.5	28	29.5	X	X	X
MP105	28	32	17MP105SB04	0	4	X	X	X
			17MP105SB08	4	8	X	X	X
			17MP105SB12	8	12	X	X	X
			17MP105SB16	12	16	X	X	X
			17MP105SB20	16	20	X	X	X
			17MP105SB24	20	24	X	X	X
			17MP105SB28	24	28	X	X	X
MP106	12	16	17MP106SB04	0	4	X	X	X
			17MP106SB08	4	8	X	X	X
			17MP106SB12	8	12	X	X	X
MP107	24	28	17MP107SB04	0	4	X	X	X
			17MP107SB08	4	8	X	X	X
			17MP107SB12	8	12	X	X	X
			17MP107SB16	12	16	X	X	X
			17MP107SB20	16	20	X	X	X
			17MP107SB24	20	24	X	X	X
MP108	24	28	17MP108SB04	0	4	X	X	X
			17MP108SB08	4	8	X	X	X
			17MP108SB12	8	12	X	X	X
			17MP108SB16	12	16	X	X	X
			17MP108SB20	16	20	X	X	X
			17MP108SB24	20	24	X	X	X
			17MP108SB28	24	28	X	X	X
MP109	25.3	28	17MP109SB04	0	4	X	X	X
			17MP109SB08	4	8	X	X	X
			17MP109SB12	8	12	X	X	X
			17MP109SB16	12	16	X	X	X
			17MP109SB20	16	20	X	X	X
			17MP109SB24	20	24	X	X	X
			17MP109SB25.5	24	25.5	X	X	X
MP110	20	24	17MP110SB04	0	4	X	X	X
			17MP110SB08	4	8	X	X	X
			17MP110SB12	8	12	X	X	X
			17MP110SB16	12	16	X	X	X
			17MP110SB20	16	20	X	X	X
MP111	18.4	20	17MP111SB04	0	4	X	X	X
			17MP111SB08	4	8	X	X	X
			17MP111SB12	8	12	X	X	X
			17MP111SB16	12	16	X	X	X
			17MP111SB18.4	16	18.4	X	X	X
MP112	20	24	17MP112SB04	0	4	X	X	X
			17MP112SB08	4	8	X	X	X
			17MP112SB12	8	12	X	X	X
			17MP112SB16	12	16	X	X	X
			17MP112SB20	16	20	X	X	X

Table 2-1 2017 Main Processing Area Tailings/Waste Rock Characterization Soil Sample Collection Summary

Soil Boring ID	Depth to Bedrock (feet bgs)	Borehole Total Depth (feet bgs)	Sample ID	Sample Interval Depth (feet bgs)		XRF Field Screening	Total Arsenic (EPA 6010)	TCLP Arsenic (EPA 1311/6010)
				Top	Bottom			
MP113	28.9	32	17MP113SB04	0	4	X	X	X
			17MP113SB08	4	8	X	X	X
			17MP113SB12	8	12	X	X	X
			17MP113SB16	12	16	X	X	X
			17MP113SB20	16	20	X	X	X
			17MP113SB24	20	24	X	X	X
			17MP113SB28	24	28	X	X	X
			17MP113SB29	28	29	X	X	X
MP114	21.2	28	17MP114SB04	0	4	X	X	X
			17MP114SB08	4	8	X	X	X
			17MP114SB12	8	12	X	X	X
			17MP114SB16	12	16	X	X	X
			17MP114SB20	16	20	X	X	X
			17MP114SB21.2	20	21.2	X	X	X
MP115	21.1	28	17MP115SB04	0	4	X	X	X
			17MP115SB08	4	8	X	X	X
			17MP115SB12	8	12	X	X	X
			17MP115SB16	12	16	X	X	X
			17MP115SB20	16	20	X	X	X
			17MP115SB21.1	20	21.1	X	X	X
MP116	22.2	28	17MP116SB04	0	4	X	X	X
			17MP116SB08	4	8	X	X	X
			17MP116SB12	8	12	X	X	X
			17MP116SB16	12	16	X	X	X
			17MP116SB20	16	20	X	X	X
			17MP116SB22.2	20	22.2	X	X	X
MP117	32	36	17MP117SB04	0	4	X	X	X
			17MP117SB08	4	8	X	X	X
			17MP117SB12	8	12	X	X	X
			17MP117SB16	12	16	X	X	X
			17MP117SB20	16	20	X	X	X
			17MP117SB24	20	24	X	X	X
			17MP117SB28	24	28	X	X	X
			17MP117SB32	28	32	X	X	X
MP118	26	28	17MP118SB04	0	4	X	X	X
			17MP118SB08	4	8	X	X	X
			17MP118SB12	8	12	X	X	X
			17MP118SB16	12	16	X	X	X
			17MP118SB20	16	20	X	X	X
			17MP118SB24	20	24	X	X	X
			17MP118SB26	24	26	X	X	X
MP119	27	28	17MP119SB04	0	4	X	X	X
			17MP119SB08	4	8	X	X	X
			17MP119SB12	8	12	X	X	X
			17MP119SB16	12	16	X	X	X
			17MP119SB20	16	20	X	X	X
			17MP119SB24	20	24	X	X	X
			17MP119SB27	24	27	X	X	X
MP120	18.3	20	17MP120SB04	0	4	X	X	X
			17MP120SB08	4	8	X	X	X
			17MP120SB12	8	12	X	X	X
			17MP120SB16	12	16	X	X	X
			17MP120SB18.3	16	18.3	X	X	X
MP121	12	16	17MP121SB04	0	4	X	X	X
			17MP121SB08	4	8	X	X	X
			17MP121SB12	8	12	X	X	X

Key

bgs = below ground surface
EPA = U.S. Environmental Protection Agency
ID = identifier
TCLP = toxicity characteristic leaching procedure
XRF = X-ray fluorescence spectroscopy

Table 2-2 Sample Collection Summary - Soil Borings, Soil Sampling, and Monitoring Well Installation, Proposed Repository Area

Drilling, Soil Sampling, and Monitoring Well Installation						Chemical Analyses				Geotechnical Tests																
						Direct Push Soil Core (Disturbed)				Direct Push Soil Core (Disturbed)									Shelby Tube (Undisturbed)							
Soil Boring ID	Monitoring Well ID	Location Descrip-tion	Rationale for Soil Boring and Monitoring Well Location	Depth to Bedrock (feet bgs)	Borehole Total Depth (feet bgs)	Sample ID	Sample Depth Interval (ft bgs)	Total TAL Metals (EPA 6010/6020/ 7471)	Total Organic Carbon (EPA 9060)	Sample ID	Sample Depth Interval (ft bgs)	Moisture Content (ASTM D2216)	Specific Gravity of Soil Solids (ASTM D854/C127)	Grain Size Distribution with Hydrometer (ASTM D422)	Liquid Limit, Plastic Limit, and Plasticity Index of Soils (ASTM D4318)	Compaction Characteristics of Soil Using Standard Effort (Standard Proctor) (ASTM D698)	Hydraulic Conductivity Using Flexible Wall Permeameter (ASTM D5084) - Sample Remolded to 90% Compaction at Optimal Moisture Content	Bulk Density (ASTM D7263) - Sample Remolded to 90% Compaction at Optimal Moisture Content	Sample ID	Sample Depth Interval (ft bgs)	Hydraulic Conduc-tivity Using Flexible Wall Permeameter (ASTM D5084) - Undisturbed Sample	Bulk Density (ASTM D7263) - Undis-turbed Sample	Moisture Content (ASTM D2216)	Specific Gravity of Soil Solids (ASTM D854/ C127)	Grain Size Distribution with Hydro-meter (ASTM D422)	Liquid Limit, Plastic Limit, and Plasticity Index of Soils (ASTM D4318)
SM72	MW44	East of proposed repository	Characterize aquifer conditions in area potentially downgradient (Red Devil Creek or Kuskokwim River drainage) of proposed repository.	2.2	69																					
SM73	MW45	Northeast of proposed repository	Characterize aquifer conditions in area potentially downgradient (Kuskokwim River drainage) of proposed repository. The proposed well are located along an abandoned dirt road reasonably accessible to drilling equipment. Northeast of these proposed locations the topography slopes steeply to the Kuskokwim River, with poor access to drilling equipment.	8.4	82																					
SM74	MW46			1.6	57																					
SM75	MW47			2.6	67																					
SM76	MW48	Southeast of proposed repository	Characterize aquifer conditions in Surface Mined Area and area potentially downgradient of proposed repository.	6	44.5																					
SM77	MW49			20	62																					
SM78	MW50	Within footprint of proposed repository	Characterize vadose zone (soil and bedrock) and aquifer conditions within proposed repository footprint.	17.6	92	17SM78SB09 17SM150SB09 (duplicate of 17SM78SB09)	0-9	X	X	17SM78SB09	0-9	X	X	X	X	X	X	X								
																			17SM78SB12	9-12	X	X	X	X	X	X
						17SM78SB17	9-17.6	X	X	17SM78SB17	10-17							X								
SM79	MW51			11.3	77	17SM79SB05	0-5	X	X	17SM79SB05	0-5	X	X	X		X	X	X								
																			17SM79SB08	5-8	X	X	X	X	X	X
						17SM79SB11	5-11	X	X	17SM79SB11	5-11					X	X	X								
SM80	MW52	Northwest of proposed repository	Characterize aquifer conditions in area potentially downgradient (McCally Creek drainage) of proposed repository.	5.2	56																					

Table 2-2 Sample Collection Summary - Soil Borings, Soil Sampling, and Monitoring Well Installation, Proposed Repository Area

Drilling, Soil Sampling, and Monitoring Well Installation						Chemical Analyses				Geotechnical Tests																
						Direct Push Soil Core (Disturbed)				Direct Push Soil Core (Disturbed)									Shelby Tube (Undisturbed)							
Soil Boring ID	Monitoring Well ID	Location Descrip-tion	Rationale for Soil Boring and Monitoring Well Location	Depth to Bedrock (feet bgs)	Borehole Total Depth (feet bgs)	Sample ID	Sample Depth Interval (ft bgs)	Total TAL Metals (EPA 6010/6020/ 7471)	Total Organic Carbon (EPA 9060)	Sample ID	Sample Depth Interval (ft bgs)	Moisture Content (ASTM D2216)	Specific Gravity of Soil Solids (ASTM D854/C127)	Grain Size Distribution with Hydrometer (ASTM D422)	Liquid Limit, Plastic Limit, and Plasticity Index of Soils (ASTM D4318)	Compaction Characteristics of Soil Using Standard Effort (Standard Proctor) (ASTM D698)	Hydraulic Conductivity Using Flexible Wall Permeameter (ASTM D5084) - Sample Remolded to 90% Compaction at Optimal Moisture Content	Bulk Density (ASTM D7263) - Sample Remolded to 90% Compaction at Optimal Moisture Content	Sample ID	Sample Depth Interval (ft bgs)	Hydraulic Conduc-tivity Using Flexible Wall Permeameter (ASTM D5084) - Undisturbed Sample	Bulk Density (ASTM D7263) - Undis-turbed Sample	Moisture Content (ASTM D2216)	Specific Gravity of Soil Solids (ASTM D854/ C127)	Grain Size Distribution with Hydro-meter (ASTM D422)	Liquid Limit, Plastic Limit, and Plasticity Index of Soils (ASTM D4318)
SM81	MW53	Southwest of proposed repository	Characterize aquifer conditions in area potentially upgradient of proposed repository, and vadose zone (soil and bedrock) and aquifer conditions near potentially extended footprint of proposed repository.	7.3	62	17SM81SB03	0-3	X	X	17SM81SB03	0-3	X	X	X	X	X	X	X								
																			17SM81SB06	3-6	X	X	X	X	X	X
						17SM81SB07	3-7.2	X	X	17SM81SB07	3-7					X	X	X								
SM82	MW54		Characterize aquifer conditions in area potentially upgradient of proposed repository, and vadose zone (soil and bedrock) and aquifer conditions in area near and potentially downgradient (McCally Creek drainage) of potentially extended footprint of proposed repository.	7.3	50	17SM82SB06	0-5.5	X	X	17SM82SB06	0-6	X	X	X		X	X	X								
																			17SM82SB8.5	5.5-8.5	X	X	X	X	X	X
						17SM82SB09	5.5-8.5	X	X	17SM82SB09	6-9					X	X	X								
SM83	MW55	Northwest of proposed repository	Characterize aquifer conditions in area potentially downgradient (McCally Creek drainage) of proposed repository or potentially extended footprint of proposed repository.	16	27																					
SM84	MW56	Southeast of proposed repository	Characterize aquifer conditions in area near and potentially downgradient (Red Devil Creek drainage) of proposed repository and within anticipated area of influence of underground mine workings.	6.6	76																					

Table 2-2 Sample Collection Summary - Soil Borings, Soil Sampling, and Monitoring Well Installation, Proposed Repository Area

Drilling, Soil Sampling, and Monitoring Well Installation						Chemical Analyses				Geotechnical Tests																
						Direct Push Soil Core (Disturbed)				Direct Push Soil Core (Disturbed)									Shelby Tube (Undisturbed)							
Soil Boring ID	Monitoring Well ID	Location Descrip-tion	Rationale for Soil Boring and Monitoring Well Location	Depth to Bedrock (feet bgs)	Borehole Total Depth (feet bgs)	Sample ID	Sample Depth Interval (ft bgs)	Total TAL Metals (EPA 6010/6020/ 7471)	Total Organic Carbon (EPA 9060)	Sample ID	Sample Depth Interval (ft bgs)	Moisture Content (ASTM D2216)	Specific Gravity of Soil Solids (ASTM D854/C127)	Grain Size Distribution with Hydrometer (ASTM D422)	Liquid Limit, Plastic Limit, and Plasticity Index of Soils (ASTM D4318)	Compaction Characteristics of Soil Using Standard Effort (Standard Proctor) (ASTM D698)	Hydraulic Conductivity Using Flexible Wall Permeameter (ASTM D5084) - Sample Remolded to 90% Compaction at Optimal Moisture Content	Bulk Density (ASTM D7263) - Sample Remolded to 90% Compaction at Optimal Moisture Content	Sample ID	Sample Depth Interval (ft bgs)	Hydraulic Conduc-tivity Using Flexible Wall Permeameter (ASTM D5084) - Undisturbed Sample	Bulk Density (ASTM D7263) - Undis-turbed Sample	Moisture Content (ASTM D2216)	Specific Gravity of Soil Solids (ASTM D854/ C127)	Grain Size Distribution with Hydro-meter (ASTM D422)	Liquid Limit, Plastic Limit, and Plasticity Index of Soils (ASTM D4318)
SM85	MW57	South of proposed repository	Characterize aquifer conditions in area near and potentially downgradient (Red Devil Creek drainage) of proposed repository and potentially extended repository footprint, and within anticipated area of influence of underground mine workings.	12	59.5																					
SM86	MW58	Southwest of proposed repository	Characterize vadose zone (soil and bedrock) and aquifer conditions in area near proposed repository and potentially extended repository footprint.	10	58	17SM86SB03	0-3	X	X	17SM86SB1.5	0-1.5	X	X	X	X	X	X	X								
																			17SM86SB04	1-4	X	X	X	X	X	X
SM87	MW59	Near existing well MW39	Near existing well MW39 (possibly dry). Characterize aquifer conditions in area near and potentially downgradient (Red Devil Creek drainage) of proposed repository and within anticipated area of influence of underground mine workings.	10.4	161																					

Key

ASTM = ASTM International (formerly American Society of Testing and Materials)
EPA = U.S. Environmental Protection Agency
ft bgs = below ground surface
ID = identifier
TAL = Target Analyte List

Table 2-3 Soil Characterization Summary, 2017 Tailings/Waste Rock Characterization

Soil Boring ID	Sample Depth Interval (feet bgs)		Llithology	Lithological Description	Moisture Observed in Soil Sample or Drill Cuttings	Mineralogical/Lithological Observations												Lab Total Arsenic (mg/kg)	Lab TCLP Arsenic (mg/L)	XRF Arsenic		XRF Antimony		XRF Mercury	
	Top	Bottom				Red Porous Rock	Vitrious "Slag"	Stibnite	Elemental Mercury	Cinnabar	Realgar	Orpiment	Vein Material	Red Rind	Sulfides	Iron Stain	Odor			Conc. (ppm)	Error	Conc. (ppm)	Error	Conc. (ppm)	Error
MP102	0	4	well-graded Gravel with silt and sand well-graded Gravel with silt and sand	0.0 - 1.3 ft.: Moist, dark gray silty Gravel with sand. Mostly fine to medium, angular, weathered greywacke and argillite gravel. Some gravel has distinctive red rind, some has vein material. Some silt and few coarse to fine sand likely tailings/waste rock material. 1.3 - 2.9 ft.: As above, but without tailings/waste rock, and medium to dark brown in color. 2.9 - 4.0 ft.: No recovery.	Moist						X	X	X	X	X			2630	8	3757	29	7178	35	225	10
MP102	4	8	well-graded Gravel with silt and sand sandy Silt with gravel	4 - 6 ft.: Moist to wet, dark gray silty Gravel with sand. No indications of tailings/waste rock. 6 - 7 ft.: Moist sandy Silt with gravel. Mostly medium stiff silt, some very fine sand, and trace fine to medium, angular greywacke gravel. 7 - 8 ft.: No recovery.	Moist to Wet													1610	18	1755	19	2893	23	16	5
MP102	8	12	well-graded Gravel with silt and sand Organic soil silty Gravel with sand	8.0 - 9.0 ft.: Wet, grayish brown silty Gravel with sand. Mostly fine to coarse, angular greywacke gravel. 9.0 - 9.3 ft.: Moist organic layer, moss and roots; possible buried former ground surface. 9.3 - 10.5 ft.: Wet, medium to light grayish brown, silty Gravel with sand. Mostly fine to coarse angular, weathered greywacke gravel, with some medium stiff silt, and some medium to very fine sand. 10.5 - 12.0 ft.: No recovery.	Wet													520	0.432	213	7	49	10	<LOD	6
MP102	12	16	sandy Silt with gravel silty Gravel with sand	12 - 13 ft.: Moist, grayish brown, sandy Silt with gravel. Mostly medium stiff silt with some fine to very fine sand and trace medium, angular weathered greywacke gravel. 13 - 15 ft.: Moist, orangish brown to gray, silty gravel with sand. Mostly subrounded to angular, fine to coarse, weathered greywacke and shale gravel. Some medium stiff silt, and few medium to fine sand. 15 - 16 ft.: No recovery.	Moist													231	0.187	124	6	98	10	<LOD	6
MP102	16	20	Weathered Bedrock - Shale, Argillite, and Greywacke	16.0 - 19.3 ft.: Moist, orangish brown weathered shale/argillite and greywacke bedrock. 19.3 - 20.0 ft.: No recovery.	Moist																				
MP102	20	24	Weathered Bedrock	Moist, dark gray weathered bedrock.	Moist																				
MP103	0	4	silty Gravel with sand	0.0 - 3.2 ft.: Moist, dark grayish brown silty Gravel with sand. Gravel is mostly fine to very coarse angular, weathered greywacke and argillite gravel. Some medium stiff silt and few medium to fine sand. 3.2 - 4.0 ft.: No recovery.	Moist													606	1.78	372	9	136	11	7	4
MP103	4	8	silty Gravel with sand sandy Silt with gravel	4.0 - 5.2 ft.: Moist, dark brown, as above, silty Gravel with sand. 5.2 - 6.0 ft.: Medium to dark brown, moist, sandy Silt with gravel. Mostly medium stiff silt, some very fine sand and trace fine to medium, angular greywacke and argillite gravel. 6.0 - 8.0 ft.: No recovery.	Moist													787	2.46	278	8	125	10	56	5
MP103	8	12	well-graded Gravel with silt and sand sandy Silt silty Gravel with sand	8.0 - 9.0 ft.: Moist to wet, brown sandy Gravel with silt. Mostly angular to subangular, fine to coarse greywacke gravel. Some fine to very fine sand, and few silt. 9.0 - 9.9 ft.: Wet, brown sandy Silt. Mostly soft. Silt with few very fine sand. 9.9 - 11.2 ft.: Moist, medium brown silty Gravel with sand. Mostly angular to subangular fine to very coarse greywacke and argillite gravel. Some medium stiff silt, and few fine to very fine sand. 11.2 - 12.0 ft.: No recovery.	Moist to Wet													172	0.078	2063	18	93	9	<LOD	5
MP103	12	16	silty Gravel with sand	12.0 - 15.5 ft.: Moist, brownish gray, as above, silty gravel with sand. 15.5 - 16.0 ft.: No recovery..	Moist													174	0.05 U	116	5	<LOD	13	<LOD	6
MP103	16	20	silty Gravel with sand Weathered Bedrock - Shale	16 - 18.4 ft.: Moist, dark reddish gray, as above, silty Gravel with sand. Silt grading into clay. Gravel consists of greywacke and argillite. 18.4 - 19.2 ft.: Weathered shale bedrock. 19.2 - 20.0 ft.: No recovery.	Moist													218	0.05 U	113	5	<LOD	13	<LOD	6
MP103	20	24	Weathered bedrock	Moist, brown weathered bedrock.	Moist																				

Table 2-3 Soil Characterization Summary, 2017 Tailings/Waste Rock Characterization

Soil Boring ID	Sample Depth Interval (feet bgs)		Llithology	Lithological Description	Moisture Observed in Soil Sample or Drill Cuttings	Mineralogical/Lithological Observations												Lab Total Arsenic (mg/kg)	Lab TCLP Arsenic (mg/L)	XRF Arsenic		XRF Antimony		XRF Mercury	
	Top	Bottom				Red Porous Rock	Vitreous "Slag"	Stibnite	Elemental Mercury	Cinnabar	Realgar	Orpiment	Vein Material	Red Rind	Sulfides	Iron Stain	Odor			Conc. (ppm)	Error	Conc. (ppm)	Error	Conc. (ppm)	Error
MP104	0	4	silty Gravel with sand silty Gravel with sand	0.0 - 0.3 ft.: Moist, brown, silty Gravel with sand. Mostly fine to medium, angular, weathered greywacke and argillite gravel. Some gravel has distinctive red rind, some has vein material, and some is red porous rock. Some silt and few coarse to fine sand. Likely tailings/waste rock material. 0.3 - 3.2 ft.: Moist, medium grayish brown silty Gravel with sand. Mostly subrounded to angular, fine to cobble, greywacke and argillite gravel. Some medium stiff silt, and few fine to very fine sand. Does not appear to be tailings/waste rock material. 3.2 - 4.0 ft.: No recovery.	Moist	X							X	X	X			923	2.23	644	12	1484	18	40	5
	4	8	silty Gravel with sand	4.0 - 6.6 ft.: Moist, brown, as above, silty Gravel with sand. 6.6 - 8.0 ft.: No recovery.	Moist													97	0.05 U	75	5	<LOD	14	<LOD	6
	8	12	silty Gravel with sand	8.0 - 10.9 ft.: Moist, grayish brown, as above, silty Gravel with sand. 10.9 - 12.0 ft.: No recovery.	Moist													117	0.05 U	32	4	<LOD	14	<LOD	6
	12	16	silty Gravel with sand sandy Silt with gravel silty Gravel with sand	12.0 - 12.9 ft.: Moist to wet, brown, as above, moist silty Gravel with sand. 12.9 - 13.8 ft.: Moist to wet, brown sandy Silt with gravel. Mostly medium stiff silt, with some very fine sand, and few angular to subangular, medium to coarse weathered greywacke gravel. 13.8 - 15.2 ft.: Moist, medium grayish brown silty Gravel with sand. Mostly angular, fine to very coarse, greywacke and argillite gravel. Some medium stiff silt, and few medium to very fine sand. 15.2 - 16.0 ft.: No recovery.	Moist to Wet													194	0.05 U	57	4	<LOD	13	<LOD	5
	16	20	silty Gravel with sand	16.0 - 19.5 ft.: Moist, brown, as above, silty Gravel with sand. Darker brown in color. 19.5 - 20.0 ft.: No recovery.	Moist													621	0.05 U	84	5	<LOD	13	<LOD	5
	20	24	silty Gravel with sand	20.0 - 23.6 ft.: Moist, dark grayish brown, as above, silty Gravel with sand. 23.6 - 24.0 ft.: No recovery.	Moist to Wet													183	0.05 U	150	7	31	10	<LOD	6
	24	28	silty/clayey Gravel with sand	24.0 - 27.1 ft.: Moist to wet, grayish brown, as above, with silt transitioning into clay. 27.1 - 28.0 ft.: No recovery.	Moist to Wet													139	0.05 U	76	5	<LOD	13	<LOD	5
	28	32	clayey Gravel with sand Weathered Bedrock - Greywacke	28.0 - 29.5 ft.: Moist to wet, grayish brown, as above, clayey Gravel with sand. 29.5 - 31.2 ft.: Weathered greywacke bedrock. 31.2 - 32.0 ft.: No recovery.	Moist to Wet													65	0.05 U	35	4	<LOD	15	<LOD	6
MP105	0	4	silty Gravel with sand	0.0 - 3.4 ft.: Moist, grayish brown silty Gravel with sand. Mostly fine to coarse angular weathered greywacke gravel with some stiff silt and trace to few coarse to very fine sand. 3.4 - 4.0 ft.: No recovery.	Moist													1340	1.62	1503	17	3956	25	60	6
	4	8	silty Gravel with sand	4.0 - 6.2 ft.: Moist, brown, as above, silty Gravel with sand. 6.2 - 8.0 ft.: No recovery.	Moist													39	0.05 U	27	4	<LOD	13	6	4
	8	12	silty Gravel with sand	8.0 - 10.8 ft.: Moist, brown, as above, silty Gravel with sand. 10.8 - 12.0 ft.: No recovery.	Moist													62	0.05 U	35	4	<LOD	13	<LOD	5
	12	16	silty Gravel with sand	12.0 14.8 ft.: Moist, brown, as above, with slightly less gravel. 14.8 - 16.0 ft.: No recovery.	Moist													68	0.05 U	41	4	<LOD	13	<LOD	6
	16	20	silty Gravel with sand	16.0 - 19.5 ft.: Moist, brown, as above, silty Gravel with sand. 19..5 - 20.0 ft.: No recovery.	Moist													114	0.05 U	72	5	78	9	<LOD	5
	20	24	silty Gravel with sand	20.0 - 23.2 ft.: Moist, brown, as above, Silty gravel with sand. Diesel odor from 22.0 - 23.2 ft. 23.2 - 24.0 ft.: No recovery.	Moist												X	87	0.05 U	59	5	<LOD	15	<LOD	7
	24	28	silty Gravel with sand	24.0 - 27.4 ft.: Moist, brown, as above, except some gravel is subrounded, and silt is stiff. Diesel odor from 24 - 25 ft. 27.4 - 28.0 ft.: No recovery.	Moist												X	45	0.05 U	26	4	<LOD	14	<LOD	6
	28	32	Weathered Bedrock - Shale	28.0 - 31.7 ft.: Moist, dark grayish brown, weathered shale bedrock . 31.7 - 32.0 ft.: No recovery.	Moist																				
MP106	0	4	NR	NR	NR													1290	1.45	39	5	706	12	990	15
	4	8	NR	NR	NR													37	0.05 U	<LOD	5	22	3	<LOD	13
	8	12	NR	NR	NR													62	0.05 U	<LOD	6	35	4	<LOD	14
	12	16	Weathered Bedrock	Bedrock	NR																				

Table 2-3 Soil Characterization Summary, 2017 Tailings/Waste Rock Characterization

Soil Boring ID	Sample Depth Interval (feet bgs) Top	Bottom	Lithology	Lithological Description	Moisture Observed in Soil Sample or Drill Cuttings	Mineralogical/Lithological Observations: Red Porous Rock	Vitrious "Slag"	Stibnite	Elemental Mercury	Cinnabar	Realgar	Orpiment	Vein Material	Red Rind	Sulfides	Iron Stain	Odor	Lab Total Arsenic (mg/kg)	Lab TCLP Arsenic (mg/L)	XRF Arsenic Conc. (ppm)	XRF Arsenic Error	XRF Antimony Conc. (ppm)	XRF Antimony Error	XRF Mercury Conc. (ppm)	XRF Mercury Error
MP107	0	4	well-graded Gravel with silt and sand	Moist, black Gravel with silt and sand, tailings/waste rock.	Moist	X				X		X	X		X			5290	10	5450	37	17644	56	235	11
	4	8	well-graded Gravel with silt and sand	As above. > 4 cm fragment of siltstone reduced recovery.	Moist	X						X	X	X	X			6100	14	5126	35	14009	50	358	12
	8	12	silty Gravel	As above to 8.5 ft., then dark gray silty Gravel. Gravel is angular siltstone and greywacke, 1 - 4 cm. Some fine sand. Apparent disturbed native soil. 10.5 - 11.3 ft. is tailings/waste rock again, dark gray.	Moist	X							X	X				1420	0.691	840	12	2099	18	123	6
	12	16	silty Gravel with sand	Moist, gray silty Gravel with sand, with calcines and red porous rock. More silt and lighter color than tailings/waste rock above, may be tailings/waste rock mixed with disturbed native soil. Gravel fine to 2 cm angular Kuskokwim Group. At 13.8 ft. abrupt transition to tan silty Gravel. 13.8 ft. gravel is 3 to > 4 cm siltstone, some dark gray fine greywacke. Angular, no tailings/waste rock.	Moist	X												2390	2.44	1508	18	2494	21	343	10
	16	20	silty Gravel with sand	Moist, brown, as above, some shale in angular gravel.	Moist													574	0.551	373	9	43	9	25	4
	20	24	silty Gravel with sand Weathered Bedrock - Siltstone, Greywacke	As above to 20.7 ft., then transition to wet weathered bedrock of siltstone and greywacke. Apparent bedding dip 30 degrees.	Wet													251	0.223	177	6	22	9	6	3
	24	28	Weathered Bedrock - Siltstone, Greywacke, Shale	Moist, grayish brown weathered bedrock. 24.0 - 26.0 ft. siltstone. 26.0 to 26.7 ft. greywacke, some light gray. 26.7 to 27.7 ft. shale. 27.7 to 28.0 ft. siltstone. Apparent bedding dip 45 degrees.	Moist															30	4	<LOD	14	<LOD	6
MP108	0	4	Gravel with sand and silt	Moist black Gravel with sand and silt. Tailings/waste rock, includes igneous dike clasts. Mostly siltstone and argillite, trace greywacke.	Moist	X	X			X		X	X		X			5180	14	5671	37	17396	55	191	10
	4	8	Gravel with sand and silt	Moist black Gravel with sand and silt. Igneous dike clasts. Tailings/waste rock. Gravel is shale, greywacke, and calcines.	Moist	X				X			X	X	X			7110	7	5181	36	15235	53	241	11
	8	12	Gravel with sand and silt Silt with gravel	8.0 - 10.4 ft.: Moist black Gravel with silt and sand, tailings/waste rock. Gravel is > 4 cm greywacke, some shale, igneous dike, gangue. 10.4 - 11.7 ft.: Olive Silt with gravel. Gravel is vein material, greywacke, and igneous dike.	Moist	X				X			X		X			4570	7	4314	31	12052	44	257	10
	12	16	poorly graded Gravel with sand	As above to 13.5 ft., with trace wood debris, then abrupt transition at 13.5 ft. to very red tailings/waste rock. Red tailings/waste rock has abundant sand-sized calcines. At 15.0 ft. is thin band of black, glassy, porous material. Moist, overall color is dusky red.	Moist	X	X						X	X				2150	10	1812	19	4222	27	41	5
	16	20	poorly graded Gravel with silt and sand	As above to 17 ft., black tailings/waste rock below. Gravel is red porous rock, shale, siltstone, greywacke. Moist.	Moist	X	X					X	X	X	X			4230 J	30	4611	31	11611	42	56	6
	20	24	poorly graded Gravel with silt and sand Silt with gravel	As above to 21.9 ft., wet at 21.0 ft. Very dark gray. 21.9 - 23.5 ft. is wet, light brown Silt with gravel. Silt is non-plastic, with trace organics, native. Gravel is 4 cm angular siltstone and greywacke. Transition at 23 ft. to weathered bedrock, apparent bedding dip of 30 degrees.	Wet													3440	14	3089	28	4291	29	1635	23
	24	28	Weathered Bedrock - Siltstone, Greywacke	Moist, light brownish gray weathered bedrock. Apparent bedding dip of 30 - 60 degrees. Siltstone and greywacke, trace iron stain.	Wet											X		206	0.434	191	7	75	10	8	4
MP109	0	4	silty Gravel with sand	0.0 - 3.1 ft.: Moist, dark gray silty Gravel with sand. Mostly fine to medium, angular to subrounded, weathered greywacke and argillite gravel. Some gravel has distinctive red rind, some has vein material, and some is red porous rock. Some silt and few coarse to fine sand. Likely tailings/waste rock material. 3.1 - 4.0 ft.: No recovery.	Moist	X							X	X				4490	9	4121	30	11876	44	255	10
	4	8	silty Gravel with sand	4.0 - 6.2 ft.: As above, tailings/waste rock. One cobble encountered from 4.6 - 5.1 ft. 6.2 - 8.0 ft.: No recovery.	Moist	X							X	X				4730	10	4853	34	13114	48	216	10
	8	12	silty Gravel with sand	8.0 - 11.5 ft.: As above, tailings/waste rock. 11.5 - 12.0 ft.: No recovery.	Moist	X		X					X	X	X			4980	10	5165	35	13984	49	292	11
	12	16	silty Gravel with sand	12.0 - 14.8 ft.: As above, tailings/waste rock. 14.8 - 16.0 ft.: No recovery.	Moist	X							X	X				4820	10	4245	30	7916	36	221	9
	16	20	silty Gravel with sand	16.0 - 16.6 ft.: Moist to wet, dark grayish brown, as above, tailings/waste rock. Water at 16.5 ft. 16.6 - 18.5 ft.: Medium to dark brown, moist with wet sections, gravelly Silt with sand. Mostly medium stiff to stiff silt, some angular to subrounded, fine to coarse, greywacke gravel and few very fine sand. 18.5 - 20.0 ft.: No recovery.	Moist to Wet	X							X	X				2320	8	2094	19	2067	18	40	5
	20	24	clayey Gravel with sand	Moist, brown clayey to silty Gravel with sand. Mostly fine to coarse, angular to subrounded, weathered greywacke gravel. Some stiff silt/clay, and few very fine sand.	Moist													186	0.05 U	66	5	25	9	<LOD	6

Table 2-3 Soil Characterization Summary, 2017 Tailings/Waste Rock Characterization

Soil Boring ID	Sample Depth Interval (feet bgs)		Llithology	Lithological Description	Moisture Observed in Soil Sample or Drill Cuttings	Mineralogical/Lithological Observations												Lab Total Arsenic (mg/kg)	Lab TCLP Arsenic (mg/L)	XRF Arsenic		XRF Antimony		XRF Mercury	
	Top	Bottom				Red Porous Rock	Vitrious "Slag"	Stibnite	Elemental Mercury	Cinnabar	Realgar	Orpiment	Vein Material	Red Rind	Sulfides	Iron Stain	Odor			Conc. (ppm)	Error	Conc. (ppm)	Error	Conc. (ppm)	Error
MP109	24	28	clayey Gravel with sand Weathered Bedrock - Shale	24 - 25.3 ft.: As above, clayey Gravel with sand. 25.3 - 27.0 ft.: Moist, brown, weathered shale bedrock. 27.0 - 28.0 ft.: No recovery.	Moist													79	0.05 U	64	5	<LOD	15	<LOD	6
MP110	0	4	silty Gravel with sand	0.0 - 3.2 ft.: Moist, dark gray silty Gravel with sand. Mostly fine to medium, angular to subrounded, weathered greywacke and argillite gravel. Some gravel has distinctive red rind, some has vein material, and some is red porous rock. Some silt and few coarse to fine sand. Faint diesel odor. Likely tailings/waste rock material. 3.2 - 4.0 ft.: No recovery.	Moist	X							X	X			X	3100	5	2600	22	8625	35	117	7
	4	8	silty Gravel with sand	4.0 - 6.4 ft.: As above, tailings/waste rock. 6.4 - 8.0 ft.: No recovery.	Moist	X							X	X				4370	6	4166	31	10236	42	145	8
	8	12	silty Gravel with sand	8.0 - 11.2 ft.: As above, but dark grayish brown. Tailings/waste rock. 11.2 - 12.0 ft.: No recovery.	Moist	X				X			X	X	X			5410	5	3687	29	10077	42	156	9
	12	16	gravelly Silt with sand	12.0 - 14.2 ft.: Moist, brown gravelly Silt with sand. Mostly medium stiff silt with some, fine to coarse angular to subangular, weathered greywacke gravel and few very fine sand; gravelly loess. Gravel decreases in abundance with depth. 14.2 - 16.0 ft.: No recovery.	Moist													794	0.706	483	9	988	14	11	4
	16	20	clayey Gravel with silt and sand	16 - 18 ft.: Moist, brown clayey Gravel with silt and sand. Mostly medium to very coarse, angular to subangular, weathered greywacke gravel. Some medium stiff clay/silt, and few very fine sand. 18 - 20 ft.: No recovery.	Moist													71	0.05 U	35	4	120	11	<LOD	6
	20	24	Weathered Bedrock - Greywacke, Shale	Moist, grayish brown weathered greywacke and shale bedrock. Apparent bedding dip of 30 degrees.	Moist																				
MP111	0	4	silty Gravel with sand	0.0 - 3.2 ft.: Moist, dark gray silty Gravel with sand. Mostly fine to medium, angular, weathered greywacke and argillite gravel. Some gravel has distinctive red rind, some has vein material, and some is red porous rock. Some silt and few coarse to fine sand. Likely tailings/waste rock material. 3.2 - 4.0 ft.: No recovery.	Moist	X							X	X				6300	6	2843	25	10664	42	91	7
	4	8	silty Gravel with sand	4.0 - 6.9 ft.: As above, tailings/waste rock. Diesel odor near 6 ft. 6.9 - 8.0 ft.: No recovery.	Moist	X		X					X	X	X		X	3570	4.79	2843	28	8607	43	92	8
	8	12	silty Gravel with sand sandy Silt	8.0 - 10.3 ft.: As above, tailings/waste rock with faint diesel odor. 10.3 - 10.8 ft.: Medium brown, sandy Silt. Mostly medium stiff silt, few very fine sand. 10.8 - 12.0 ft.: No recovery.	Moist	X							X	X			X	3930	3.39	3066	25	8574	36	102	7
	12	16	silty Gravel with sand	12.0 - 14.6 ft.: As above, but brown. Loess. Trace to few, medium to coarse, subrounded to subangular greywacke gravel. 14.6 - 16.0 ft.: No recovery.	Moist													42	0.05 U	19	4	27	10	<LOD	6
	16	20	clayey Gravel with sand Weathered Bedrock - Shale, Greywacke	16.0 - 18.4 ft.: Moist, grayish brown clayey Gravel with sand. Mostly medium to coarse subrounded to angular, weathered greywacke and argillite gravel. Some medium stiff to stiff clay, and few fine to very fine sand. 18.4 - 19.3 ft.: Weathered shale and greywacke bedrock. 19.3 - 20.0 ft.: No recovery.	Moist													64	0.05 U	32	4	<LOD	15	<LOD	6
MP112	0	4	silty Sand with gravel	0.0 - 1.7 ft.: Moist, dark brown silty Sand with gravel. Mostly medium to very fine sand, some soft. silt and few, fine to very coarse, angular greywacke gravel. Some of the gravel had abundant veins and some mineralization including realgar and orpiment. Woody debris from 1 - 1.4 ft. 1.7 - 4.0 ft.: No recovery.	Moist						X	X	X		X			3170	1.7	1527	18	3110	24	94	7
	4	8	silty Gravel with sand	4.0 - 5.3 ft.: Moist, dark gray silty Gravel with sand. Mostly fine to very coarse, angular, greywacke and argillite gravel. Some medium stiff silt and trace very fine sand. 5.3 - 8.0 ft.: No recovery.	Moist													394	0.05 U	413	9	764	14	59	5
	8	12	silty Gravel sandy Silt	8.0 - 9.6 ft.: As above, silty Gravel. Moist to 9.2 ft., then wet. 9.6 - 10.9 ft.: Wet, dark grayish brown sandy Silt. Mostly medium stiff silt, some to few very fine sand. Diesel odor noted at 10.9 ft. 10.9 - 12.0 ft.: No recovery.	Moist to Wet								X				X	503	0.062	145	12	1092	31	26	11
	12	16	gravelly Silt with sand gravelly Clay	12.0 - 13.9 ft.: Wet, Medium to dark gray gravelly Silt with sand. Diesel odor. Mostly medium stiff silt. some angular, medium to very coarse weathered greywacke gravel, and few very fine sand. 13.9 - 14.9 ft.: Moist, dark gray gravelly Clay and silt. Mostly very stiff clay and silt with some angular to subrounded, medium to coarse, weathered greywacke and argillite gravel. Trace very fine sand. 14.6 - 16.0 ft.: No recovery.	Moist to Wet												X	66	0.05 U	209	6	98	9	8	4

Table 2-3 Soil Characterization Summary, 2017 Tailings/Waste Rock Characterization

Soil Boring ID	Sample Depth Interval (feet bgs) Top	Bottom	Llithology	Lithological Description	Moisture Observed in Soil Sample or Drill Cuttings	Mineralogical/Lithological Observations: Red Porous Rock	Vitrious "Slag"	Stibnite	Elemental Mercury	Cinnabar	Realgar	Orpiment	Vein Material	Red Rind	Sulfides	Iron Stain	Odor	Lab Total Arsenic (mg/kg)	Lab TCLP Arsenic (mg/L)	XRF Arsenic Conc. (ppm)	XRF Arsenic Error	XRF Antimony Conc. (ppm)	XRF Antimony Error	XRF Mercury Conc. (ppm)	XRF Mercury Error
MP112	16	20	silty Gravel with sand	16.0 - 19.3 ft.: Moist to wet, dark grayish brown silty Gravel with sand. Mostly angular to subangular, fine to cobble, weathered greywacke, shale and argillite gravel. Some med stiff to stiff silt/clay. Few very fine sand. Diesel odor from 16 - 18.3 ft. 19.3 - 20.0 ft.: No recovery.	Moist to Wet												X	34	0.05 U	33	5	<LOD	17	<LOD	8
MP112	20	24	Weathered Bedrock - Shale	20 - 23 ft.: Moist to wet, dark grayish brown weathered shale bedrock. 23 - 24 ft.: No recovery.	Moist to Wet																				
MP113	0	4	well-graded Gravel with silt and sand	0.0 - 3.4 ft.: Moist, dark gray sandy Gravel with silt. Mostly well-graded fine to coarse subangular gravel, with some well-graded medium to very coarse sand and few silt. Gravel consists of greywacke, argillite and vein material with evidence of processing via distinctive red rind and common mineralization observed including stibnite, realgar, and orpiment. Likely tailings/waste rock. 3.4 - 4.0 ft.: No recovery.	Moist			X			X	X	X	X	X			8300	17	6734	41	16204	54	549	14
MP113	4	8	well-graded Gravel with silt and sand	4 - 7 ft.: As above. Tailings/waste rock. 7 - 8 ft.: No recovery.	Moist	X		X			X	X	X	X	X			6260	24	5781	38	14623	51	541	14
MP113	8	12	well-graded Gravel with silt and sand	8.0 - 10.3 ft.: As above, but moist. Tailings/waste rock. 10.3 - 12.0 ft.: No recovery.	Moist	X		X			X	X	X		X			8060	28	8873	48	19115	60	584	15
MP113	12	16	well-graded Gravel with silt and sand	12 - 14.7 ft.: As above. Tailings/waste rock. 14.7 - 16 ft.: No recovery.	Moist	X		X			X	X	X	X	X			11400	19	11805	65	29405	87	5403	50
MP113	16	20	well-graded Gravel with silt and sand Woody Debris sandy Silt with gravel	16.0 - 16.3 ft.: As above. Tailings/waste rock. 16.3 - 16.9 ft.: Medium grayish brown sandy Gravel with silt. Moist to 16.7 ft., wet below. Mostly fine to medium angular greywacke gravel, some fine to very coarse sand and few silt. 16.9 - 17.4 ft.: Woody debris, possibly a large rotten root. 17.4 - 18.7 ft.: Top of undisturbed material. Medium brown to gray, wet, sandy Silt with gravel. Mostly medium stiff silt, some very fine sand and trace medium angular weathered greywacke gravel. 18.7 - 20.0 ft.: No recovery.	Moist to Wet	X							X	X				3960	7	11217	55	24491	70	1347	23
MP113	20	24	silty Gravel with sand gravelly Silt	20 - 21.3 ft.: Wet, grayish brown silty Gravel with sand. Mostly round to subrounded, medium to coarse, weathered greywacke gravel; some soft. silt, and fine to very fine sand. 21.3 - 23.2 ft.: Medium orangish brown, gravelly silt. Mostly very stiff silt, with some to some angular, medium to very coarse, weathered greywacke gravel. 23.2 - 24.0 ft.: No recovery.	Wet													411	1.05	659	11	36	9	39	5
MP113	24	28	gravelly Silt	24.0 - 27.2 ft.: Moist, grayish brown gravelly Silt. Mostly very stiff silt, with few to some subrounded to angular, medium to very coarse, weathered greywacke and argillite gravel. 27.2 - 28.0 ft.: No recovery.	Moist													345	0.24	432	11	<LOD	15	18	5
MP113	28	32	gravelly Silt Weathered Bedrock - Greywacke, Argillite	28.0 - 28.9 ft.: As above, but wet. 28.9 - 31.3 ft.: Wet, grayish brown weathered greywacke and argillite bedrock. Bedding dip approximately 75 degrees. 31.3 - 32.0 ft.: No recovery.	Wet													138	0.073	181	6	<LOD	13	<LOD	5
MP114	0	4	well-graded Gravel with silt and sand	0.0 - 2.9 ft.: Moist, dark gray sandy Gravel with silt. Mostly well-graded fine to coarse subangular gravel, with some well-graded medium to very coarse sand and few silt. Gravel consists of greywacke, argillite and vein material. Distinctive red rind, red porous rock, and abundant evidence of mineralization including stibnite, realgar, and orpiment. Gray tarp material observed at 1.2 ft. Likely tailings/waste rock. 2.9 - 4.0 ft.: No recovery.	Moist	X		X			X	X	X	X	X			3610	12	3963	31	10235	43	254	10
MP114	4	8	sandy Gravel with silt silty Gravel with sand	4.0 - 5.5 ft.: As above, tailings/waste rock. 5.5 - 6.6 ft.: Medium grayish brown, moist, silty Gravel with sand. Mostly well-graded, fine to cobble, angular to subangular, weathered greywacke gravel, some medium stiff silt, and trace to few medium to fine sand. 6.6 - 8.0 ft.: No recovery.	Moist			X					X	X	X			2740	13	1604	19	3923	27	83	7
MP114	8	12	silty Gravel with sand sandy Silt with gravel	8.0 - 8.4 ft.: As above, silty Gravel with sand, but moist to wet and dark gray.. 8.4 - 11.0 ft.: Dark brownish gray, moist, sandy Silt with gravel. Mostly medium stiff silt with few very fine sand and trace medium, angular, argillite and greywacke gravel. 11.0 - 12.0 ft.: No recovery.	Moist to Wet													180	0.055	46	4	42	9	<LOD	5
MP114	12	16	sandy Silt with gravel	12.0 - 14.7 ft.: Moist to wet, dark grayish brown, as above, sandy Silt with gravel. 14.7 - 16.0 ft.: No recovery.	Moist to Wet													51	0.064	24	3	69	8	<LOD	5
MP114	16	20	gravelly Silt with sand	16.0 - 18.5 ft.: Moist to wet, dark grayish brown gravelly Silt with sand. Mostly very stiff silt (possibly clay), with some medium to very coarse subangular to subrounded weathered greywacke gravel, and some very fine sand. 18.5 - 20.0 ft.: No recovery.	Moist to Wet													83 J-	0.05 U	20	3	<LOD	13	<LOD	5

Table 2-3 Soil Characterization Summary, 2017 Tailings/Waste Rock Characterization

Soil Boring ID	Sample Depth Interval (feet bgs) Top	Bottom	Lithology	Lithological Description	Moisture Observed in Soil Sample or Drill Cuttings	Mineralogical/Lithological Observations: Red Porous Rock	Vitrious "Slag"	Stibnite	Elemental Mercury	Cinnabar	Realgar	Orpiment	Vein Material	Red Rind	Sulfides	Iron Stain	Odor	Lab Total Arsenic (mg/kg)	Lab TCLP Arsenic (mg/L)	XRF Arsenic Conc. (ppm)	XRF Arsenic Error	XRF Antimony Conc. (ppm)	XRF Antimony Error	XRF Mercury Conc. (ppm)	XRF Mercury Error
MP114	20	24	silty Gravel with sand Weathered Bedrock - Shale, Argillite	20.0 - 21.2 ft.: Moist, brown, silty Gravel with sand. Mostly well-graded angular to subangular, fine to medium weathered greywacke gravel, some stiff silt (possibly clay) and some fine to very fine sand. It is difficult to tell if the 20 - 21.2 ft. interval is weathered bedrock or unconsolidated material. 21.2 - 23.5 ft.: Weathered shale and argillite bedrock. 23.5 - 24.0 ft.: No recovery.	Moist													162	0.05 U	172	7	20	10	<LOD	7
	24	28	Weathered Bedrock - Greywacke, Argillite	24.0 - 26.8 ft.: Moist, grayish brown weathered greywacke and argillite bedrock. 26.8 - 28.0 ft.: No recovery.	Moist																				
MP115	0	4	well-graded Gravel with silt and sand	0.0 - 3.5 ft.: Moist, dark gray sandy Gravel with silt. Mostly well-graded fine to coarse subangular gravel, with some well-graded medium to very coarse sand and few silt. Gravel consists of greywacke, argillite and vein material. Distinctive red rind and abundant mineralization observed including stibnite, realgar, and orpiment. Likely tailings/waste rock. 3.5 - 4.0 ft.: No recovery.	Moist			X			X	X	X	X	X			5590	12	2833	28	5892	36	266	11
	4	8	well-graded Gravel with silt and sand sandy Silt with gravel	4.0 - 4.9 ft.: As above, tailings/waste rock. 4.9 - 7.5 ft.: Medium brown to gray, moist, sandy Silt with gravel. Mostly medium stiff silt with few very fine sand and trace, fine to coarse, angular, weathered greywacke gravel. 7.5 - 8.0 ft.: No recovery.	Moist			X			X	X	X	X	X			3680	6	3487	29	4386	29	172	9
	8	12	sandy Silt with gravel sandy Silt	8.0 - 8.8 ft.: As above, sandy Silt with gravel, except gray. 8.8 - 10.8 ft.: Moist, medium gray sandy Silt. Mostly medium stiff silt, and few very fine sand. 10.8 - 12.0 ft.: No recovery.	Moist													75	0.05 U	10	3	<LOD	12	<LOD	5
	12	16	sandy Silt	12.0 - 15.2 ft.: As above except dark gray, sandy Silt with some woody debris. 15.2 - 16.0 ft.: No recovery.	Moist													15.4	0.05 U	8	3	<LOD	11	<LOD	4
	16	20	sandy Silt silty Gravel with sand	16.0 - 16.7 ft.: As above, sandy Silt. 16.7 - 18.8 ft.: Reddish-brown to gray, moist silty Gravel with sand. Mostly medium to coarse, subrounded to subangular weathered greywacke gravel, some stiff silt, and few fine to very fine sand. 18.8 - 20.0 ft.: No recovery.	Moist													173	0.05 U	56	4	30	9	<LOD	5
	20	24	sandy Silt Weathered Bedrock - Greywacke	20.0 - 21.1 ft.: Moist sandy Silt. Mostly medium stiff silt with few very fine sand. 21.1 - 22.7 ft.: Medium brown, moist, weathered greywacke bedrock. 22.7 - 24.0 ft.: No recovery.	Moist													92	0.05 U	27	4	<LOD	13	<LOD	5
	24	28	Weathered Bedrock - Greywacke	24.0 - 26.9 ft.: As above, weathered bedrock. 26.9 - 28.0 ft.: No recovery.	Moist																				
MP116	0	4	well-graded Gravel with silt and sand	0.0 - 3.1 ft.: Moist, dark gray sandy Gravel with silt. Mostly well-graded fine to coarse subangular gravel, with some well-graded medium to very coarse sand and few silt. Gravel consists of greywacke, argillite and vein material. Distinctive red rind and mineralization observed including stibnite and orpiment. Likely tailings/waste rock. 3.1 - 4.0 ft.: No recovery.	Moist			X				X	X	X	X			6890	14	4733	32	10716	41	672	15
	4	8	well-graded Gravel with silt and sand	4.0 - 6.9 ft.: As above. Tailings/waste rock. Moist to 6.2 ft., wet below. 6.9 - 8.0 ft.: No recovery.	Moist to Wet			X		X		X	X	X	X			6610	7	4612	33	10882	43	432	12
	8	12	well-graded Gravel with silt and sand sandy Silt with gravel	8.0 - 8.9 ft.: As above, sandy Gravel with silt. Tailings/waste rock. Wet. 8.9 - 10.9 ft.: Medium brown, moist, sandy Silt with gravel. Mostly medium stiff silt, some very fine sand, and trace to few, coarse, subangular weathered greywacke gravel. 10.9 - 12.0 ft.: No recovery.	Moist to Wet			X		X		X		X	X			4150	5	2824	25	14069	47	23	6
	12	16	sandy Silt silty Gravel with sand	12.0 - 12.5 ft.: Moist, brown sandy Silt. Mostly medium stiff silt with some very fine sand. 12.5 - 15.1 ft.: Medium brown silty Gravel with sand. Mostly well-graded; fine to very coarse, angular to subrounded, weathered greywacke gravel. Some stiff silt, and trace fine sand. 15.1 - 16.0 ft.: No recovery.	Moist													241	0.115	146	6	569	13	<LOD	6
	16	20	silty Gravel with sand sandy Silt	16.0 - 17.0 ft.: As above. 17.0 - 18.7 ft.: Moist, dark gray sandy Silt. Mostly medium stiff silt with few very fine sand. 18.7 - 20.0 ft.: No recovery.	Moist													184	0.05 U	76	5	75	10	<LOD	5
	20	24	sandy Silt silty Gravel with sand sandy Silt Weathered Bedrock	20.0 - 20.4 ft.: As above, moist dark gray sandy Silt. 20.4 - 21.4 ft.: Medium brown, moist, silty Gravel with sand. Mostly fine to coarse, subrounded to subangular weathered greywacke gravel, some stiff silt and some fine to very fine sand. 21.4 - 22.2 ft.: Moist, dark gray, sandy Silt. Mostly medium stiff silt with some very fine sand. 22.2 - 22.8 ft.: Gray to orangish-brown, moist, clayey Gravel (weathered greywacke bedrock). 22.8 - 24.0 ft.: No recovery.	Moist													147	0.05 U	50	4	<LOD	13	<LOD	5
	24	28	Weathered Bedrock - Greywacke, Shale	24.0 - 26.7 ft.: Moist, dark brown, weathered greywacke and shale bedrock. 26.7 - 28.0 ft.: No recovery.	Moist																				

Table 2-3 Soil Characterization Summary, 2017 Tailings/Waste Rock Characterization

Soil Boring ID	Sample Depth Interval (feet bgs)		Llithology	Lithological Description	Moisture Observed in Soil Sample or Drill Cuttings	Mineralogical/Lithological Observations												Lab Total Arsenic (mg/kg)	Lab TCLP Arsenic (mg/L)	XRF Arsenic		XRF Antimony		XRF Mercury	
	Top	Bottom				Red Porous Rock	Vitrious "Slag"	Stibnite	Elemental Mercury	Cinnabar	Realgar	Orpiment	Vein Material	Red Rind	Sulfides	Iron Stain	Odor			Conc. (ppm)	Error	Conc. (ppm)	Error	Conc. (ppm)	Error
MP117	0	5	well-graded Sand with silt and gravel well-graded Sand with silt and gravel	0.0 - 2.0 ft.: Moist, dark gray gravelly Sand with silt. Mostly fine to very fine sand with some fine to coarse, angular gravel and few silt. Gravel consists mostly of greywacke and weathered greywacke, some with orangish staining along fractures, few friable argillite, and trace light brown/tan fine grained sandstone-like material (possibly firebrick). 2.0 - 2.5 ft.: Moist, dark gray gravelly Sand with silt. Mostly fine to very fine sand with some fine to coarse, angular gravel and few silt. Gravel consists mostly of greywacke and weathered greywacke, some with orangish staining along fractures, some friable argillite. 2.5 - 5.0 ft.: No recovery.	Moist													466	0.05 U	440	10	104	11	24	5
	5	10	well-graded Gravel with sand	5 - 7 ft.: Moist, dark gray, mostly fine to very coarse angular Gravel, some fine to very fine sand and few silt. Gravel consists mostly of greywacke and weathered greywacke, some with orangish staining along fractures, some friable argillite, and trace weathered or altered igneous dike material, and trace white vein material. 7 - 10 ft.: No recovery.	Moist								X			X		2740	0.183	2505	26	575	15	220	10
	10	12	silty Gravel with sand	Moist, dark gray, silty Gravel with sand. Mostly fine to very coarse, angular gravel with some silt and few very fine to fine sand. Gravel consists mostly of shale with some greywacke, and few argillite. Some of the greywacke had a distinctive tan/orange rind. Trace vein material observed.	Moist								X	X				3980	0.542	878	14	438	13	30	5
	12	16	well-graded Gravel with silt	Mostly fine to coarse, angular gravel, some to few silt. Gravel consists mostly of greywacke and weathered greywacke, some of which has a distinctive rind. some friable argillite, and trace mineralization and vein material. Vein material contained cinnabar, stibnite, and orpiment. Woody debris in cutting shoe.	Moist			X		X		X	X	X	X			6830	1.55	3751	30	1929	21	55	6
	16	20	poorly graded Gravel sandy Silt with gravel	16.0 - 16.5 ft.: Moist, dark gray, greywacke cobble with white vein material. 16.6 - 18.0 ft.: Sandy Silt with gravel. Mostly silt, medium stiff, some very fine to fine sand, and trace coarse, angular gravel consisting of weathered greywacke. Trace to few woody debris. 18.0 - 20.0 ft.: No recovery.	Moist								X					639	0.05 U	20	3	<LOD	12	<LOD	4
	20	22	sandy Silt with gravel	Moist, dark reddish gray sandy Silt with few gravel. Mostly silt with some fine to very fine sand and trace medium to coarse, angular gravel. Silt is medium stiff. Gravel consists of argillite and greywacke.	Moist													51	0.05 U						
	22	24	sandy Silt with gravel silty Gravel with sand	22.0 - 22.5 ft.: As above. 22.5 - 23.3 ft.: Wet, dark gray silty Gravel with sand. Gravel consists of medium to very coarse, angular weathered greywacke. 23.3 - 24.0 ft.: No recovery.	Wet															37	3	<LOD	11	<LOD	4
	24	28	silty Gravel	24.0 - 26.4 ft.: Wet, brown, mostly medium to very coarse, angular gravel with some silt. Gravel consists of weathered greywacke ranging in color from dark gray to rusty orange. The orangish fragments are much soft.er. Trace argillite. 26.4 - 28.0 ft.: No recovery.	Wet													73	0.05 U	54	4	<LOD	12	6	3
	28	32	Silt	28.0 - 30.8 ft.: Moist, dark gray, stiff Silt with trace medium to coarse, angular argillite. 30.8 - 32.0 ft.: No recovery.	Moist													34	0.05 U	69	5	<LOD	14	<LOD	5
	32	36	Silt silty Gravel silty Gravel with sand	32.0 - 32.7 ft.: As above. Wet, dark brown. 32.7 - 33.8 ft.: Wet, reddish-brown, silty Gravel. Mostly medium to very coarse, angular weathered greywacke, some Silt, medium stiff. 33.8 - 35.4 ft.: Wet, silty Gravel with sand. Mostly fine to medium, angular argillite, with some soft. silt and trace fine to very fine sand. 35.4 - 36.0 ft.: No recovery.	Wet															77	5	<LOD	15	<LOD	6
MP118	0	4	silty Gravel	0 - 2 ft.: Moist, dark gray, mostly medium to very coarse, angular Gravel with some silt and trace fine sand. Gravel consists mostly of greywacke and weathered greywacke, and some argillite and few shale. Few greywacke were light gray in color and had a distinctive rind, trace greywacke had orangish staining along fractures, and one fragment had pyrite mineralization. Trace argillite had orangish staining along fractures. 2 - 4 ft.: No recovery.	Moist									X	X	X		383	0.05 U	161	7	115	11	<LOD	6
	4	8	silty Gravel	4.0 - 5.5 ft.: Moist, dark gray, mostly fine to very coarse, angular Gravel, some to few silt and trace fine sand. Gravel consists of mostly greywacke with trace weathered greywacke, few argillite and trace shale. Trace greywacke had distinctive rind, and trace greywacke and argillite had orangish staining along fractures. 5.5 - 8.0 ft.: No recovery.	Moist									X		X		326	0.05 U	248	8	<LOD	15	<LOD	6
	8	12	silty Gravel	8.0 - 9.8 ft.: Moist, dark gray, mostly fine to very coarse Gravel with some silt and trace fine sand. Gravel consists mostly of friable weathered shale, some argillite and some greywacke. Pyrite crystals (cubic form) observed in several fragments of very fine grained greywacke. 9.8 - 12.0 ft.: No recovery.	Moist								X		X			430	0.05 U	468	12	17	11	23	5

Table 2-3 Soil Characterization Summary, 2017 Tailings/Waste Rock Characterization

Soil Boring ID	Sample Depth Interval (feet bgs)		Lithology	Lithological Description	Moisture Observed in Soil Sample or Drill Cuttings	Mineralogical/Lithological Observations												Lab Total Arsenic (mg/kg)	Lab TCLP Arsenic (mg/L)	XRF Arsenic		XRF Antimony		XRF Mercury	
	Top	Bottom				Red Porous Rock	Vitreous "Slag"	Stibnite	Elemental Mercury	Cinnabar	Realgar	Orpiment	Vein Material	Red Rind	Sulfides	Iron Stain	Odor			Conc. (ppm)	Error	Conc. (ppm)	Error	Conc. (ppm)	Error
MP118	12	16	silty Gravel	12.0 - 13.3 ft.: Moist, dark gray, mostly fine to very coarse Gravel with some silt and trace fine sand. Gravel consists mostly of greywacke with few argillite and few shale. Several large pieces of vein material. 13.3 - 14.0 ft.: No recovery.	Moist								X					660	0.05 U	543	12	92	11	79	7
	16	20	silty Gravel	16.0 - 18.3 ft.: Wet, dark gray, mostly fine to coarse Gravel with some silt and trace fine sand. Gravel consists mostly of greywacke and weathered greywacke with some argillite and few shale. Trace vein material observed in greywacke. Notably different light gray, soft. clay encountered at ~17.9 ft. 18.3 - 20.0 ft.: No recovery.	Wet								X					7420	29	5088	35	6783	35	1396	21
	20	24	sandy Silt gravelly Silt sandy Silt silty Gravel	20.0 - 20.8 ft.: Wet, dark gray to orangish brown mottled, micaceous, very fine sandy Silt. 20.8 - 21.6 ft.: Moist to wet medium brown gravelly Silt. Gravel is medium to coarse, subangular, weathered greywacke and argillite. 21.6 - 22 ft.: Moist, dark gray to orangish-brown mottled, micaceous, very fine sandy Silt. 22.0 - 22.7 ft.: Moist to wet, silty Gravel. Gravel is fine to very coarse, angular to subangular and consists of weathered greywacke that is orangish-brown in color. 22.7 - 24.0 ft.: No recovery.	Wet													1050	2.86	452	14	166	15	<LOD	9
	24	26	silty Gravel with sand	Wet, dark gray, well-graded silty Gravel with sand. Mostly medium to coarse subrounded to subangular weathered greywacke gravel. Some silt, and few very fine to coarse sand.	Wet													112	0.069	70	5	<LOD	14	<LOD	6
	26	28	Weathered Bedrock	26 - 27 ft.: Moist, brown weathered bedrock. 27 - 28 ft.: No recovery.	Moist																				
MP119	0	4	silty Gravel	0.0 - 2.1 ft.: Moist to wet, dark brownish gray, mostly subangular to subrounded, fine to coarse Gravel with some silt and few medium to very coarse sand. Gravel consists primarily of greywacke and argillite with vein material. Some fragments had one or more of the following, red porous rock, distinctive red rind, stibnite, realgar, and orpiment. 2.1 - 4.0 ft.: No recovery.	Moist to Wet	X		X			X	X	X	X	X			3970	15	2847	28	11080	47	28	6
	4	8	silty Gravel with sand gravelly Silt with sand	4.0 - 5.5 ft.: Moist to wet, dark brownish gray silty Gravel with sand. Mostly medium to very coarse, subangular gravel, some silt, and few very fine sand. Gravel consists of brownish weathered greywacke. 5.5 - 6.8 ft.: Dark brownish gray gravelly Silt with sand. Mostly silt with few to trace subangular to subrounded, coarse gravel, and trace very fine sand. Gravel consists of weathered greywacke. 6.8 - 8.0 ft.: No recovery.	Moist to Wet													167	0.05 U	44	4	219	10	<LOD	5
	8	12	silty Gravel Silt silty Sand with gravel	8.0 - 8.8 ft.: Moist, dark brown, mostly subangular, coarse Gravel with some silt. Gravel consists of weathered greywacke and trace weathered argillite. 8.8 - 9.8 ft.: Moist, dark gray to black, stiff Silt with decomposing woody debris. 9.8 - 10.6 ft.: Dark grayish-brown, moist, silty Sand with gravel. Mostly very fine sand with some silt and trace subangular, weathered greywacke. 10.6 - 12.0 ft.: No recovery.	Moist													81	0.05 U	99	6	<LOD	15	<LOD	6
	12	16	well-graded Sand with silt and gravel	12 - 15 ft.: Moist, dark brownish gray gravelly Sand with silt. Mostly very fine sand with some gravel and some silt. Gravel is medium to very coarse subrounded to angular, consisting of weathered greywacke. 15 - 16 ft.: No recovery.	Moist													62	0.05 U	68	5	35	10	<LOD	6
	16	20	silty Gravel	16.0 - 18.5 ft.: Moist to wet, dark brownish gray, mostly angular to subrounded, fine to very coarse Gravel, with some silt and few fine to very fine sand. Gravel consists of weathered bedrock. 18.5 - 20.0 ft.: No recovery.	Moist to Wet													105	0.05 U	53	5	64	12	<LOD	7
	20	24	Silt	20.0 - 23.2 ft.: Moist, dark gray, mostly stiff Silt with trace gravel and few very fine sand. Gravel is fine to very coarse, subrounded to angular weathered greywacke. 23.2 - 24.0 ft.: No recovery.	Moist													14	0.05 U	53	6	50	11	<LOD	7
	24	27	silty Gravel	24.0 - 26.8 ft.: Moist to wet, dark grayish brown, mostly medium to very coarse angular Gravel with some silt and few fine to very fine sand. Gravel consists of weathered greywacke. Wet from 25.7 to 26.4 ft.	Moist to Wet													148	0.05 U	120	7	27	11	<LOD	7
	27	28	Weathered Bedrock - Greywacke	26.8 - 27.3 ft.: Moist to wet, reddish brown weathered greywacke bedrock, dipping at approximately 45 degrees. 27.3 - 28.0 ft.: No recovery.	Moist to Wet																				
MP120	0	4	silty Gravel Silt	0.0 - 1.7 ft.: Moist to wet, dark gray, mostly subangular to subrounded, fine to coarse Gravel with some silt and few medium to very coarse sand. Gravel consists primarily of greywacke and argillite with vein material. Some fragments included one or more of the following: red porous rock, distinctive red rind, stibnite, realgar, and orpiment. 1.7 - 3.0 ft.: Moist, dark brown Silt with few very fine sand. Silt is medium stiff with low plasticity, and trace large woody debris. 3.0 - 4.0 ft.: No recovery.	Moist	X		X			X	X	X	X	X			3110	3.03	1054	14	3630	23	56	5

Table 2-3 Soil Characterization Summary, 2017 Tailings/Waste Rock Characterization

Soil Boring ID	Sample Depth Interval (feet bgs)		Llithology	Lithological Description	Moisture Observed in Soil Sample or Drill Cuttings	Mineralogical/Lithological Observations												Lab Total Arsenic (mg/kg)	Lab TCLP Arsenic (mg/L)	XRF Arsenic		XRF Antimony		XRF Mercury	
	Top	Bottom				Red Porous Rock	Vitrious "Slag"	Stibnite	Elemental Mercury	Cinnabar	Realgar	Orpiment	Vein Material	Red Rind	Sulfides	Iron Stain	Odor			Conc. (ppm)	Error	Conc. (ppm)	Error	Conc. (ppm)	Error
MP120	4	8	Sand with silt	4.0 - 6.6 ft.: Moist, dark grayish brown, mostly very fine Sand with some medium stiff silt and few gravel. Silty Sand lenses from 5.1 - 5.5 ft. and 6.3 - 6.6 ft. Gravel consists of angular to subangular, medium to coarse weathered greywacke. 6.6 - 8.0 ft.: No recovery.	Moist													269	0.05 U	144	6	117	10	7	4
MP120	8	12	silty Sand sandy Silt with gravel silty Gravel with sand	8.0 - 8.5 ft.: Wet, dark brownish gray silty Sand. Sand is very fine, silt is soft. 8.5 - 9.4 ft.: Medium to dark brown sandy Silt with gravel. Mostly stiff silt, some fine to very fine sand and trace to few coarse angular weathered greywacke gravel. 9.4 - 10.6 ft.: Medium to dark brown silty Gravel with sand. Mostly fine to very coarse, subangular to angular, weathered greywacke gravel, with some medium stiff silt, and few fine to very fine sand. 10.6 - 12.0 ft.: No recovery.	Wet													90	0.05 U	31	3	<LOD	12	<LOD	5
MP120	12	16	silty Gravel with sand gravelly Silt with sand	12.0 - 14.1 ft.: Wet, brown, as above, silty Gravel with sand. 14.1 - 14.9 ft.: Moist, gravelly Silt with sand. Mostly stiff silt with some fine angular weathered argillite and greywacke gravel and few very fine sand. 14.9 - 16.0 ft.: No recovery.	Wet													74	0.05 U	55	4	32	9	<LOD	5
MP120	16	20	gravelly Silt with sand silty Gravel with sand Weathered Bedrock - Greywacke	16.0 - 16.6 ft.: Moist to wet, dark brown, as above, gravelly Silt with sand. 16.6 - 18.3 ft.: Medium brown to dark gray, moist to wet, silty Gravel with sand. Mostly well-graded angular, very fine to coarse weathered greywacke and argillite gravel, some stiff silt and trace medium to coarse sand. Wet from 17.3 - 18.4 ft. on top of weathered bedrock. 18.3 - 18.9 ft.: Weathered greywacke bedrock with ~45 degree bedding dip. 18.9 - 20.0 ft.: No recovery.	Moist to Wet													104	0.05 U	56	4	<LOD	13	<LOD	5
MP121	0	4	silty Gravel with sand silty Sand with gravel	0.0 - 2.1 ft.: Moist to wet, dark gray silty Gravel with sand. Mostly well-graded, fine to coarse angular gravel consisting of weathered argillite and greywacke; some with distinctive red rind and some with vein material. Some silt medium stiff and few coarse to med sand. Likely tailings/waste rock. 2.1 - 2.3 ft.: Wet, dark gray silty Sand with gravel. Mostly fine to very fine sand, with some med stiff silt and trace coarse angular greywacke gravel. 2.3 - 4.0 ft.: No recovery.	Moist to Wet								X	X				3020	1.67	2517	28	2648	27	186	10
MP121	4	8	gravelly Silt with sand silty Gravel with sand	4.0 - 4.5 ft.: Moist, dark brown gravelly Silt with sand. Mostly stiff silt with some medium, angular argillite gravel, and few very fine sand. Appears to be undisturbed native material. 4.5 - 6.6 ft.: Moist, medium to dark brown, silty Gravel with sand. Well-graded from fine to cobble sized, angular greywacke gravel, some stiff silt and few medium to fine sand. 6.6 - 8.0 ft.: No recovery.	Moist													1120	3.34	431	9	362	11	9	4
MP121	8	12	silty Gravel with sand sandy Silt with gravel gravelly Silt with sand	8.0 - 8.8 ft.: As above, but dark gray. 8.8 - 10.2 ft.: Moist, dark gray, sandy Silt with gravel. Mostly medium stiff silt with few very fine sand and trace med to fine, subrounded to subangular argillite gravel. 10.2 - 10.8 ft.: Medium brown, moist, gravelly Silt with sand. Mostly medium to very coarse subangular weathered greywacke gravel, some stiff silt and few medium to fine sand. Appears to be weathered greywacke bedrock. 10.8 - 12.0 ft.: No recovery.	Moist													249	0.168	98	4	49	8	5	3
MP121	12	16	Weathered Bedrock - Greywacke	12 - 15 ft.: Moist to wet, dark brown weathered greywacke bedrock. 15 - 16 ft.: No recovery.	Moist to Wet																				

Key
<LOD = Less than level of detection for XRF
bgs = below ground surface
ft. = feet
Conc. = Concentration
ID = identifier
J- = The analyte was detected. The associated result is estimated. Biased low.
mg/kg = milligrams per kilogram
mg/L = milligrams per liter
NR = not reported
ppm = parts per million
Sb - Antimony
TCLP = toxicity characteristic leaching procedure
U = The analyte was analyzed for but not detected. The value provided is the method detection limit.
XRF = X-ray fluoresence spectroscopy

Table 2-4 2017 Main Processing Area Tailings/Waste Rock Characterization Laboratory Soil Sample Results

Soil Boring ID	Sample ID	Sample Interval Depth (feet bgs)		Total Arsenic (mg/kg)	TCLP Arsenic (mg/L)
		Top	Bottom		
MP102	17MP102SB04	0	4	2630	7.99
	17MP102SB08	4	8	1610	17.8
	17MP102SB12	8	12	520	0.432
	17MP102SB16	12	16	231	0.187
MP103	17MP103SB04	0	4	606	1.78
	17MP103SB08	4	8	787	2.46
	17MP103SB12	8	12	172	0.078
	17MP103SB16	12	16	174	0.05 U
	17MP103SB18.4	16	18.4	218	0.05 U
MP104	17MP104SB04	0	4	923	2.23
	17MP104SB08	4	8	96.8	0.05 U
	17MP104SB12	8	12	117	0.05 U
	17MP104SB16	12	16	194	0.05 U
	17MP104SB20	16	20	621	0.05 U
	17MP104SB24	20	24	183	0.05 U
	17MP104SB28	24	28	139	0.05 U
	17MP104SB29.5	28	29.5	65.3	0.05 U
MP105	17MP105SB04	0	4	1340	1.62
	17MP105SB08	4	8	38.5	0.05 U
	17MP105SB12	8	12	62.2	0.05 U
	17MP105SB16	12	16	68	0.05 U
	17MP105SB20	16	20	114	0.05 U
	17MP105SB24	20	24	86.8	0.05 U
	17MP105SB28	24	28	44.6	0.05 U
MP106	17MP106SB04	0	4	1290	1.45
	17MP106SB08	4	8	37	0.05 U
	17MP106SB12	8	12	62.1	0.05 U
MP107	17MP107SB04	0	4	5290	9.69
	17MP107SB08	4	8	6100	13.5
	17MP107SB12	8	12	1420	0.691
	17MP107SB16	12	16	2390	2.44
	17MP107SB20	16	20	574	0.551
	17MP107SB24	20	24	251	0.223
MP108	17MP108SB04	0	4	5180	13.9
	17MP108SB08	4	8	7110	7.45
	17MP108SB12	8	12	4570	7.24
	17MP108SB16	12	16	2150	10.3
	17MP108SB20	16	20	4230 J	29.7
	17MP108SB24	20	24	3440	13.6
	17MP108SB28	24	28	206	0.434
MP109	17MP109SB04	0	4	4490	8.91
	17MP109SB08	4	8	4730	9.73
	17MP109SB12	8	12	4980	10.4
	17MP109SB16	12	16	4820	10.2
	17MP109SB20	16	20	2320	7.5
	17MP109SB24	20	24	186	0.05 U
	17MP109SB25.5	24	25.5	78.9	0.05 U
MP110	17MP110SB04	0	4	3100	5.2
	17MP110SB08	4	8	4370	5.97
	17MP110SB12	8	12	5410	5.19
	17MP110SB16	12	16	794	0.706
	17MP110SB20	16	20	70.8	0.05 U
MP111	17MP111SB04	0	4	6300	5.63
	17MP111SB08	4	8	3570	4.79
	17MP111SB12	8	12	3930	3.39
	17MP111SB16	12	16	41.9	0.05 U
	17MP111SB18.4	16	18.4	64.2	0.05 U
MP112	17MP112SB04	0	4	3170	1.7
	17MP112SB08	4	8	394	0.05 U
	17MP112SB12	8	12	503	0.062
	17MP112SB16	12	16	65.9	0.05 U
	17MP112SB20	16	20	34.2	0.05 U

Table 2-4 2017 Main Processing Area Tailings/Waste Rock Characterization Laboratory Soil Sample Results

Soil Boring ID	Sample ID	Sample Interval Depth (feet bgs)		Total Arsenic (mg/kg)	TCLP Arsenic (mg/L)
		Top	Bottom		
MP113	17MP113SB04	0	4	8300	17.4
	17MP113SB08	4	8	6260	23.7
	17MP113SB12	8	12	8060	28.1
	17MP113SB16	12	16	11400	18.5
	17MP113SB20	16	20	3960	6.74
	17MP113SB24	20	24	411	1.05
	17MP113SB28	24	28	345	0.24
	17MP113SB29	28	29	138	0.073
MP114	17MP114SB04	0	4	3610	12.3
	17MP114SB08	4	8	2740	13.3
	17MP114SB12	8	12	180	0.055
	17MP114SB16	12	16	50.7	0.064
	17MP114SB20	16	20	83 J-	0.05 U
	17MP114SB21.2	20	21.2	162	0.05 U
MP115	17MP115SB04	0	4	5590	12.3
	17MP115SB08	4	8	3680	5.76
	17MP115SB12	8	12	75.3	0.05 U
	17MP115SB16	12	16	15.4	0.05 U
	17MP115SB20	16	20	173	0.05 U
	17MP115SB21.1	20	21.1	91.6	0.05 U
MP116	17MP116SB04	0	4	6890	13.6
	17MP116SB08	4	8	6610	7.29
	17MP116SB12	8	12	4150	5.28
	17MP116SB16	12	16	241	0.115
	17MP116SB20	16	20	184	0.05 U
	17MP116SB22.2	20	22.2	147	0.05 U
MP117	17MP117SB04	0	4	466	0.05 U
	17MP117SB08	4	8	2740	0.183
	17MP117SB12	8	12	3980	0.542
	17MP117SB16	12	16	6830	1.55
	17MP117SB20	16	20	639	0.05 U
	17MP117SB24	20	24	50.9	0.05 U
	17MP117SB28	24	28	73.1	0.05 U
	17MP117SB32	28	32	34.3	0.05 U
MP118	17MP118SB04	0	4	383	0.05 U
	17MP118SB08	4	8	326	0.05 U
	17MP118SB12	8	12	430	0.05 U
	17MP118SB16	12	16	660	0.05 U
	17MP118SB20	16	20	7420	29.2
	17MP118SB24	20	24	1050	2.86
	17MP118SB26	24	26	112	0.069
MP119	17MP119SB04	0	4	3970	15
	17MP119SB08	4	8	167	0.05 U
	17MP119SB12	8	12	81.1	0.05 U
	17MP119SB16	12	16	61.5	0.05 U
	17MP119SB20	16	20	105	0.05 U
	17MP119SB24	20	24	14	0.05 U
	17MP119SB27	24	27	148	0.05 U
MP120	17MP120SB04	0	4	3110	3.03
	17MP120SB08	4	8	269	0.05 U
	17MP120SB12	8	12	89.5	0.05 U
	17MP120SB16	12	16	74.2	0.05 U
	17MP120SB18.3	16	18.3	104	0.05 U
MP121	17MP121SB04	0	4	3020	1.67
	17MP121SB08	4	8	1120	3.34
	17MP121SB12	8	12	249	0.168

Key

J = The analyte was detected. The associated result is estimated.

J- = The analyte was detected. The associated result is estimated. Biased low.

mg/kg = milligrams per kilogram.

mg/L = milligrams per liter.

U = The analyte was analyzed for but not detected. The value provided is the method detection limit.

Table 2-5 Field Data Summary, 2017 Groundwater Monitoring Well Installation

Soil Boring ID	Sample Depth Interval (feet bgs)		Llithology	Lithological Description	Mineralogical/Lithological Observations												XRF Antimony		XRF Arsenic		XRF Mercury		Groundwater Observations		Monitoring Well Installation	
	Top	Bottom			Red Porous Rock	Vitrious "Slag"	Stibnite	Elem-ental Mercury	Cinnabar	Realgar	Orpiment	Vein Material	Red Rind	Sulfides	Iron Stain	Odor	Conc. (ppm)	Error	Conc. (ppm)	Error	Conc. (ppm)	Error	Moisture Observed in Soil Sample or Drill Cuttings	Static Water Level in Completed Well, 9/26/17 (feet bgs)	Monitoring Well ID	Monitoring Well Screened Interval (feet bgs)
SM72	0	2	Silt with sand Silt with sand and gravel	0 - 1 ft.: Moist, grayish brown loess. Thin (5 mm thick) bands of iron stain in very fine sand. 1 - 2 ft.: Silt with sand and gravel. Gravel is dark gray siltstone, blocky, 1-3 cm. Sand is very fine to fine. Silt low plasticity. Trace roots. At this location drill pad was established by scraping approx. 3 ft. of soft. soil to make flat, stable surface.																			Moist		MW44	
	2	4	Silt with sand and gravel Weathered Bedrock - Greywacke Weathered Bedrock - Siltstone Weathered Bedrock - Shale	2.0 - 2.2 ft.: As above, but brownish gray. 2.2 - 4.0 ft.: Weathered bedrock at 2.2 ft. with > 4cm cobbles of well-lithified greywacke. Greywacke is dark gray, silty, very fine sandstone with occasional weathered to brown with iron staining. Interstitial silt is stiff, sand is very fine to fine. 2.6 to 3.3 ft. is dark gray siltstone. 3.3 to 3.8 ft. is black shale with apparent 30 degree bedding dip. Shale is friable, weathered to clay in places.											X								Moist			
	4	6	Weathered Bedrock - Shale, Argillite	Moist, dark gray weathered bedrock. Mostly black friable shale, locally weathered to clay, with some blocky argillite. Apparent bedding dip 30 degrees.																			Moist			
	6	8	Weathered Bedrock - Argillite, Shale	As above, but moist, with more blocky argillite than friable shale. Iron stain 7.5 - 7.9 ft. Apparent bedding dip 30 degrees.											X								Moist			
	8	10	Weathered Bedrock - Shale	Moist, dark gray weathered bedrock. Friable black shale readily weathered to brown clay. Apparent bedding dip of 45 degrees on iron-stained bedding planes.											X								Moist			
	10	12	Weathered Bedrock - Shale, Greywacke	As above, with band of dark gray, poorly-lithified greywacke at 10.5 to 11.0 ft. between shale layers.																			Moist			
	12	14	Weathered Bedrock - Shale	Moist, dark grayish brown shale weathering significantly to tight, lean clay. Vey stiff. Apparent bedding dip 45 degrees. Direct push becoming difficult.																			Moist			
	14	15	Weathered Bedrock - Argillite	As above transitioning to blockier argillite at 14.7 ft. Refusal by direct push at 15 ft.																			Moist			
	15	17	Bedrock - Argillite, Greywacke, Shale	Argillite and greywacke with iron staining. Some shale possible. Dry, dark brown.											X								Dry			
	17	19.5	Bedrock - Greywacke, Silstone	Greywacke and brown siltstone. Dry.																			Dry			
	19.5	22	Bedrock - Shale, Argillite	Cuttings are mostly pulverized rock (suspected friable shale). Very few flat black shale cuttings and few blocky argillite cuttings. Orangish-yellow iron stain in argillite. Dry, very dark gray.											X								Dry			
	22	24.5	Bedrock - Argillite, Shale, Siltstone	Dry, very dark gray, blocky to platy weak argillite and friable shale. Few brown siltstone with brownish-yellow iron stain.											X								Dry			
	24.5	27	Bedrock - Siltstone, Greywacke	Siltstone and weak brownish-gray greywacke. Some iron stain. Dry, dark grayish brown.											X								Dry			
	27	29.5	Bedrock - Greywacke	Dry, dark brown, greywacke.																			Dry			
	29.5	32	Bedrock - Argillite, Siltsone, Shale	Dry, very dark gray argillite and very dark brown siltstone. Some platy shale.																			Dry	29.84		
	32	34.5	Bedrock - Greywacke	Dry, gray greywacke .																			Dry			
	34.5	37	Bedrock - Shale, Argillite, Greywacke	Mostly shale, very few cuttings and very light colored pulverized rock. Some Argillite and greywacke. Dry, dark gray.																			Dry			
	37	39.5	Bedrock - Argillite, Shale	Dry black argillite and shale.																			Dry			
	39.5	42	Bedrock - Greywacke	Weak greywacke with a salt and pepper appearance, with visible grains of quartz and calcite. Drill returns have fine white dust. Few cuttings. Dry, light gray.																			Dry			
	42	44.5	Bedrock - Argillite	Black, blocky argillite with brown iron stain on fractures. Larger cuttings. Moist at 44 ft.											X								Moist			
	44.5	47	Bedrock - Argillite	Dry black argillite, smaller cuttings.																			Dry			
	47	49.5	Bedrock - Siltstone	Dry black siltstone, angular to blocky, trace iron stain.											X								Dry			48 - 68
	49.5	52	Bedrock - Siltstone	Dark gray siltstone, subangular, with brown iron stain on fractures. Moist from 50 to 51 ft.																			Dry			
	52	54.5	Bedrock - Greywacke	Dry, mostly light gray pulverized cuttings, with medium gray greywacke with visible quartz and calcite. Poorly lithified.																			Dry			
	54.5	57	Bedrock - Siltstone, Argillite	Dry black siltstone and argillite, blocky to platy.																			Dry			
	57	59.5	Bedrock - Argillite, Siltstone	Dry black argillite with some very dark gray siltstone.																			Dry			
	59.5	62	Bedrock - Argillite, Siltstone	As above with more siltstone.																			Dry			
	62	64.5	Bedrock - Argillite, Siltstone	As above, but very dark gray. Occasional quartz veins in siltstone. Moist at 64 ft.																			Moist			
	64.5	67	Bedrock - Siltstone, Greywacke	Gray, siltstone and greywacke. Trace quartz. Moist below 65 ft.																			Moist			
	67	69	Bedrock - Greywacke	Gray greywacke with quartz veins. Iron staining in veins. Slower rate of penetration due to harder rock compared to intervals above. Wet below 68 ft.											X								Wet			

Table 2-5 Field Data Summary, 2017 Groundwater Monitoring Well Installation

Soil Boring ID	Sample Depth Interval (feet bgs)		Llithology	Lithological Description	Mineralogical/Lithological Observations												XRF Antimony		XRF Arsenic		XRF Mercury		Groundwater Observations		Monitoring Well Installation	
	Top	Bottom			Red Porous Rock	Vitrious "Slag"	Stibnite	Elem-ental Mercury	Cinnabar	Realgar	Orpiment	Vein Material	Red Rind	Sulfides	Iron Stain	Odor	Conc. (ppm)	Error	Conc. (ppm)	Error	Conc. (ppm)	Error	Moisture Observed in Soil Sample or Drill Cuttings	Static Water Level in Completed Well, 9/26/17 (feet bgs)	Monitoring Well ID	Monitoring Well Screened Interval (feet bgs)
SM73	0	2	Silt with sand Silt with gravel	0.0 - 0.8 ft.: Moist, light reddish brown loess with low plasticity. Occasional rootlets and reddish streaks of decomposing organics. 0.8 - 2.0 ft.: Firm Silt with gravel. Loess, disturbed. Occasional pieces of fissile shale with subrounded to subangular gravel. Gravel is 5 mm to 2 cm.													<LOD	12	17	3	<LOD	5	Moist		MW45	
	2	4	Silt	Moist light reddish brown, firm Silt with trace gravel. Disturbed loess. Low plasticity and rootlets and evidence of decomposition throughout. Base of interval is moist peat layer, 1" thick (suspected pre-mining soil surface).													<LOD	12	12	3	<LOD	4	Moist			
	4.2	6	Peat Silt	4.0 - 4.2: Moist, very dark brown Peat. Suspected pre-mining soil surface. 4.2 - 5.3 ft.: No recovery. 5.3 to 6 ft.: Firm inorganic Silt with bands of red and grey throughout interval. Trace angular gravel 2 mm to 5mm. Low plasticity. Loess.													<LOD	12	12	3	<LOD	4	Moist			
	6	8	Silt with sand Silt with gravel	6.0 - 6.3 ft.: Moist, light reddish brown, inorganic silt with low-mod plasticity. Very firm loess throughout. 6.3 - 7.3 ft.: Some subangular to angular gravel, 1-3 cm, mostly siltstone with iron staining (weathering). 7.3 - 8.0 ft.: No recovery.											X		<LOD	12	16	3	<LOD	5	Moist			
	8	10	Silt Weathered Bedrock - Greywacke, Shale	8.0 - 8.4 ft.: Moist, light reddish brown, very firm inorganic Silt with low to moderate plasticity. 8.4 - 8.9 ft.: Weathered greywacke and highly weathered shale. 8.9 - 10.0 ft.: No recovery.													<LOD	14	51	4	<LOD	6	Moist			
	10	12	Weathered Bedrock - Graywack, Siltstone	Moist, weathered bedrock consisting of dark gray Gravel with Silt. Greywacke and siltstone. Dense silt throughout. Iron staining present on siltstone.											X		<LOD	13	30	3	<LOD	5	Moist			
	12	14	Weathered Bedrock - Siltstone	Moist, weathered bedrock consisting of dark gray gravel with silt. 12.0-12.5 ft.:: Siltstone with visible quartz grains and iron staining (weathering) along fracture planes. No bedding apparent. 12.5 - 14.0 ft.: siltstone with less Fe weathering. Apparent bedding dip at base of interval is approximately 45 degrees.											X		<LOD	13	39	4	<LOD	6	Moist			
	15	17	Weathered Bedrock - Siltstone	Dry, dark gray siltstone with iron staining (weathering) along bedding planes.											X		<LOD	13	34	4	<LOD	5	Dry			
	17	19.5	Weathered Bedrock - Siltstone	Dry, dark grayish brown siltstone with apparent grains of quartz and iron staining (weathering).								X			X		<LOD	13	30	4	<LOD	5	Dry			
	19.5	22	Weathered Bedrock - Siltstone, Argillite	Dry, very dark gray siltstone with iron staining (weathering). Some argillite.											X		<LOD	12	31	4	<LOD	5	Dry			
	22	24.5	Weathered Bedrock - Greywacke	Comparably larger fragments of greywacke. Iron staining and possible realgar. Dry, brownish gray.						X				X	X		<LOD	13	68	5	<LOD	6	Dry			
	24.5	27	Weathered Bedrock - Greywacke	As above, except dark gray.						X				X	X		<LOD	13	30	4	<LOD	6	Dry			
	27	29.5	Weathered Bedrock - Shale, Greywacke	Dry, dark reddish brown weathered shale with very small cuttings of possible greywacke.													<LOD	13	27	3	<LOD	5	Dry			
	29.5	32	Weathered Bedrock - Shale	Dry, dark reddish brown weathered shale with some iron staining.											X		<LOD	13	23	3	<LOD	6	Dry			
	32	34.5	Bedrock - Siltstone	Dry, dark reddish brown siltstone with iron staining.											X		<LOD	14	18	3	<LOD	6	Dry			
	34.5	37	Bedrock - Siltstone	As above, but dark gray.											X		<LOD	13	11	3	<LOD	6	Dry			
	37	39.5	Bedrock - Greywacke	Dry, dark grayish brown greywacke with iron staining along fracture planes.											X		<LOD	14	13	3	<LOD	6	Dry			
	39.5	42	Weathered Bedrock - Shale	Dry, dark reddish brown weathered shale.													<LOD	13	16	3	5	4	Dry			
	42	44.5	Weathered Bedrock - Siltstone	Dry, dark grayish brown siltstone with iron staining (weathering).											X		<LOD	13	20	3	<LOD	6	Dry	42.39		
	44.5	47	Weathered Bedrock - Shale	Dry, dark gray weathered shale. Iron staining (weathering) apparent along bedding or fracture planes.											X		<LOD	13	31	4	<LOD	5	Dry			
	47	49.5	Bedrock - Siltstone	Dry, dark gray siltstone. Larger cuttings (harder) than siltstone above.													<LOD	14	36	4	<LOD	6	Dry			
	49.5	52	Weathered Bedrock -Shale	Dry, dark gray weathered shale.													<LOD	12	50	4	<LOD	5	Dry			
	52	54.5	Bedrock - Greywacke, Silstone	Dry, dark gray, greywacke with few siltstone with visible quartz grains. Pulverized rock cuttings.													<LOD	13	26	3	<LOD	5	Dry			

Table 2-5 Field Data Summary, 2017 Groundwater Monitoring Well Installation

Soil Boring ID	Sample Depth Interval (feet bgs)		Llithology	Lithological Description	Mineralogical/Lithological Observations												XRF Antimony		XRF Arsenic		XRF Mercury		Groundwater Observations		Monitoring Well Installation	
	Top	Bottom			Red Porous Rock	Vitrious "Slag"	Stibnite	Elem-ental Mercury	Cinnabar	Realgar	Orpiment	Vein Material	Red Rind	Sulfides	Iron Stain	Odor	Conc. (ppm)	Error	Conc. (ppm)	Error	Conc. (ppm)	Error	Moisture Observed in Soil Sample or Drill Cuttings	Static Water Level in Completed Well, 9/26/17 (feet bgs)	Monitoring Well ID	Monitoring Well Screened Interval (feet bgs)
SM73	54.5	57	Weathered Bedrock - Greywacke	Comparably larger (up to 2 cm) cuttings of greywacke. Visible grains and iron staining (weathering). Pulverized cuttings. Dry, dark gray.											X		<LOD	13	25	3	<LOD	5	Dry	42.39	MW45	
	57	59.5	Weathered Bedrock - Greywacke	Dry, dark gray, greywacke, heavily weathered to reddish brown. Iron staining. Pulverized cuttings.											X		<LOD	12	24	3	<LOD	5	Dry			
	59.5	62	Weathered Bedrock - Greywacke	Dry, dark gray, greywacke, heavily weathered to reddish brown. Iron staining. Pulverized cuttings.											X		<LOD	13	32	3	<LOD	5	Dry			61 - 81
	62	64.5	Bedrock - Greywacke, Argillite	Dry, black, greywacke and possible argillite. Pulverized cuttings.													<LOD	13	45	4	<LOD	5	Dry			
	64.5	67	Bedrock - Greywacke	Greywacke with visible quartz grains and iron staining throughout. Greywacke grainsize slightly larger (fine sand) than previous intervals. Reported by driller as hardest drilling in boring. Cuttings are moist much water in returns. Wet below 66 ft.								X			X		<LOD	14	47	4	<LOD	6	Wet			
	67	69.5	Bedrock - Argillite, Greywacke	Black argillite and greywacke. Argillite has iron staining along fractures. Cuttings slightly moist. Wet.											X		<LOD	13	66	5	<LOD	6	Wet			
	69.5	72	Weathered Bedrock - Greywacke	Dark reddish brown weathered greywacke. Cuttings are mostly pulverized loose fines with some greywacke weathered to brownish red. Iron staining. Cuttings slightly moist. Wet.											X		<LOD	13	87	5	<LOD	6	Wet			
	72	74.5	Bedrock - Greywacke	As above. Cuttings slightly moist. Wet.											X		<LOD	13	59	4	<LOD	6	Wet			
	74.5	77	Bedrock - Greywacke	As above, but color is light reddish brown.											X		<LOD	13	85	5	<LOD	5	Wet			
	77	79.5	Bedrock - Greywacke	As above. but dark reddish brown and dry.											X		<LOD	13	56	4	<LOD	5	Wet			
	79.5	82	Bedrock - Argillite, Greywacke, Shale	Dark gray argillite and some weathered greywacke and weathered shale with minimal iron staining. Dry.													<LOD	13	62	4	<LOD	6	Wet			
SM74	0	2	silty Gravel Clay Weathered Bedrock - Argillite, Shale	0.0 - 1.4 ft.: Moist, grayish brown silty Gravel. Gravel is fine to 4 cm, decomposed greywacke with iron staining, and fine friable black shale. 1.4 to 1.6 ft.: Clay. 1.6 - 2.0 ft.: weathered bedrock: argillite, shale.											X		<LOD	13	64	4	<LOD	5	Moist		MW46	
	2	4	Weathered Bedrock - Shale, Siltstone	Moist weathered bedrock. Mostly shale with some siltstone. Iron stain in siltstone, shale weathered to clay in places. Apparent bedding dip in shale 30 degrees.											X		<LOD	13	46	4	<LOD	5	Moist			
	4	6	Weathered Bedrock - Shale, Siltstone	Dry, light brownish gray weathered bedrock, mostly siltstone with iron staining in shale. Shale weathered to clay.											X		<LOD	14	85	5	<LOD	6	Dry			
	6	8	Weathered Bedrock - Shale, Siltstone	Dry, light brownish gray weathered bedrock, mostly siltstone with iron staining, bottom 0.3 ft. is shale weathered to clay.											X		<LOD	14	97	5	<LOD	6	Dry			
	8	10	Weathered Bedrock - Shale	Moist, light brownish gray weathered bedrock, shale weathered to clay. Apparent 45 degree bedding dip. Trace vein material								X					<LOD	13	119	6	<LOD	6	Moist			
	10	12	Weathered Bedrock - Shale, Siltstone	Moist, light reddish brown weathered bedrock. Interbedded shale and siltstone with iron staining. heavy iron staining in shale at 11.5 ft.											X		<LOD	15	80	5	<LOD	6	Moist			
	12	14	Weathered Bedrock - Greywacke, Shale	Moist, brownish gray weathered bedrock. Greywacke with iron staining 12.0 to 12.5 ft., above shale weathered to clay. Vein material at 13.5 ft.								X			X		<LOD	14	66	5	<LOD	6	Moist			
	14	15	No recovery.	No recovery.																			No Recovery			
	15	17	Bedrock - Shale	Dry, brownish gray friable shale.													<LOD	13	58	4	<LOD	6	Dry			
	17	19.5	Bedrock - Argillite, Siltstone	Dry, dark gray argillite and siltstone with iron staining along bedding planes.											X		<LOD	14	78	5	<LOD	6	Dry			
	19.5	22	Bedrock - Greywacke	Dry, dark reddish brown greywacke with some iron staining.											X		<LOD	14	88	5	<LOD	6	Dry			
	22	24.5	Weathered Bedrock - Greywacke, Shale	Dry, dark reddish brown greywacke weathered to brown, with few shale.													<LOD	13	75	4	<LOD	5	Dry			
	24.5	27	Weathered Bedrock - Greywacke, Shale	Dry, dark reddish brown greywacke weathered to brown, with pulverized clay.													<LOD	13	53	4	<LOD	6	Dry			
	27	29.5	Weathered Bedrock - Greywacke, Shale	Dry, dark reddish brown greywacke weathered to brown with pulverized clay.													<LOD	13	36	4	<LOD	5	Dry			
	29.5	32	Bedrock - Siltstone	Dry, dark gray siltstone with iron staining.											X		<LOD	13	47	4	<LOD	6	Dry	28.93		
	32	34.5	Weathered Bedrock - Greywacke	Dry, brownish gray greywacke weathered to brown.													<LOD	14	28	4	<LOD	6	Dry			
	34.5	37	Bedrock - Siltstone	Dry, dark gray siltstone with iron staining.											X		<LOD	13	28	4	<LOD	6	Dry			36 - 56
	37	39.5	Bedrock - Siltstone	Dry, dark gray siltstone with some iron staining.											X		<LOD	14	54	5	<LOD	6	Dry			
	39.5	42	Bedrock - Argillite, Shale	Darky gray argillite with weathered shale (clay). Wet below 41 ft.													<LOD	14	46	5	<LOD	6	Wet			

Table 2-5 Field Data Summary, 2017 Groundwater Monitoring Well Installation

Soil Boring ID	Sample Depth Interval (feet bgs)		Llithology	Lithological Description	Mineralogical/Lithological Observations												XRF Antimony		XRF Arsenic		XRF Mercury		Groundwater Observations		Monitoring Well Installation	
	Top	Bottom			Red Porous Rock	Vitrious "Slag"	Stibnite	Elem-ental Mercury	Cinnabar	Realgar	Orpiment	Vein Material	Red Rind	Sulfides	Iron Stain	Odor	Conc. (ppm)	Error	Conc. (ppm)	Error	Conc. (ppm)	Error	Moisture Observed in Soil Sample or Drill Cuttings	Static Water Level in Completed Well, 9/26/17 (feet bgs)	Monitoring Well ID	Monitoring Well Screened Interval (feet bgs)
SM74	42	44.5	Weathered Bedrock - Greywacke	Dark grayish brown greywacke weathered to brown. Wet.													<LOD	14	37	4	<LOD	6	Wet	28.93	MW46	36 - 56
	44.5	47	Weathered Bedrock - Greywacke	Dark reddish brown greywacke weathered to brown. Wet.													<LOD	13	35	4	<LOD	5	Wet			
	47	49.5	Bedrock - Siltstone	Dark grayish brown siltstone with iron staining. Wet.											X		<LOD	13	35	4	<LOD	6	Wet			
	49.5	52	Bedrock - Shale, Greywacke	Grayish brown pulverized shale with greywacke. Wet.													<LOD	12	31	3	<LOD	5	Wet			
	52	54.5	Bedrock - Siltstone	Dark gray siltstone and quartz vein with visible calcite and quartz crystals. Wet.								X					<LOD	13	37	4	<LOD	6	Wet			
	54.5	57	Bedrock - Greywacke, Silstone	Wet, dark gray greywacke and siltstone with some quartz crystals.								X					<LOD	13	47	4	<LOD	5	Wet			
SM75	0	2	silty Gravel Gravel with silt Silt with sand	0.0 - 0.7 ft.: Moist, brown silty Gravel (disturbed) placed over 0.7 to 1 ft. interval of organics (wood compost with green color). 1.0 to 1.7 ft.: Moist Gravel with silt. 1.7 to 2 ft.: Moist loess.																			Moist		MW47	
	2	4	Loess Weathered Bedrock - Greywacke	2.0 to 2.6 ft.: Moist, light brown Loess. 2.6 to 4.0 ft.: Moist weathered greywacke with iron staining.											X								Moist			
	4	6	Weathered Bedrock - Siltstone, Shale	Moist, brownish gray weathered bedrock, mostly siltstone with iron staining, few shale.											X								Moist			
	6	8	Weathered Bedrock - Shale, Siltstone	Moist, brownish gray weathered bedrock, mostly shale weathered to clay, some siltstone with calcite along bedding planes at 6.2 to 6.4 ft.								X											Moist			
	8	10	Weathered Bedrock - Greywacke	Dry, reddish brown, slightly weathered greywacke.																			Dry			
	10	12.5	Weathered Bedrock - Greywacke, Shale	Dry, brownish gray, greywacke weathered to brown, some iron staining and few shale weathered to clay.											X								Dry			
	12.5	15	Bedrock - Greywacke	Dry, grayish brown, greywacke with iron staining.											X								Dry			
	15	17.5	Bedrock - Siltstone	Dry, reddish brown, siltstone with iron staining.											X								Dry			
	17.5	20	Bedrock - Greywacke, Shale	Dry, reddish brown, mostly greywacke with iron staining with pulverized shale, vein material on greywacke								X			X								Dry			
	20	22.5	Bedrock - Shale, Greywacke	Dry, brownish gray, mostly pulverized shale with some greywacke																			Dry			
	22.5	25	Bedrock - Siltstone, Greywacke, Shale	Dry, dark grayish brown, mostly siltstone with few greywacke and trace weathered shale (clay)																			Dry			
	25	27.5	Bedrock - Siltstone	Dry, dark gray siltstone with iron staining.											X								Dry			
	27.5	30	Bedrock - Siltstone	Dry, dark gray, siltstone with some iron staining at bedding planes.											X								Dry			
	30	32.5	Bedrock - Greywacke, Silstone	Dry, dark grayish brown greywacke and trace siltstone.																			Dry			
	32.5	35	Bedrock - Greywacke	Dry, dark gray greywacke with trace iron staining.											X								Dry	32.88		
	35	37.5	Weathered Bedrock - Shale, Greywacke	Dry, brown, mostly weathered shale (clay), with trace greywacke.																			Dry			
	37.5	40	Bedrock - Silstone	Dry, dark gray siltstone with iron staining along bedding surfaces.											X								Dry			
	40	42.5	Bedrock - Silstone, Greywacke	Dry, dark gray siltstone with iron staining, with reddish brown greywacke.											X								Dry			
	42.5	45	Bedrock - Argillite	Dry, black, argillite, blocky.																			Dry			
	45	47.5	Weathered Bedrock - Siltstone, Greywacke	Dry, reddish brown siltstone with iron staining and greywacke weathered to brown.											X								Dry			46 - 66
	47.5	50	Bedrock - Siltstone	Dry, dark gray, siltstone with iron staining along bedding planes.											X								Dry			
	50	52.5	Bedrock - Siltstone	Dry, dark gray siltstone with iron staining, blocky.											X								Dry			
	52.5	55	Weathered Bedrock - Greywacke	Wet, dark gray greywacke starting to weather to brown. Some visible quartz.								X											Wet			
	55	57.5	Bedrock - Argillite	Wet, black argillite, blocky.																			Wet			
	57.5	60	Bedrock - Greywacke	Wet, dark gray greywacke with trace quartz, quartz has yellow stain.								X											Wet			
	60	62.5	Bedrock - Siltstone, Greywacke	Wet, dark gray, mostly siltstone, few greywacke containing calcite/quartz along fractures with iron staining.								X			X								Wet			
	62.5	65	Bedrock - Siltstone	Wet, dark gray siltstone, blocky, larger pieces.																			Wet			
	65	67	Bedrock - Greywacke, Shale	Wet, dark gray, small pieces of greywacke with pulverized shale.																			Wet			

Table 2-5 Field Data Summary, 2017 Groundwater Monitoring Well Installation

Soil Boring ID	Sample Depth Interval (feet bgs)		Llithology	Lithological Description	Mineralogical/Lithological Observations												XRF Antimony		XRF Arsenic		XRF Mercury		Groundwater Observations		Monitoring Well Installation	
	Top	Bottom			Red Porous Rock	Vitrious "Slag"	Stibnite	Elem-ental Mercury	Cinnabar	Realgar	Orpiment	Vein Material	Red Rind	Sulfides	Iron Stain	Odor	Conc. (ppm)	Error	Conc. (ppm)	Error	Conc. (ppm)	Error	Moisture Observed in Soil Sample or Drill Cuttings	Static Water Level in Completed Well, 9/26/17 (feet bgs)	Monitoring Well ID	Monitoring Well Screened Interval (feet bgs)
SM76	0	2	Silt with gravel	Moist, yellowish brown Silt with sand and gravel. Disturbed by establishment of drilling pad. Gravel is angular to subangular 1-3 cm Kuskokwim Group. Sand is very fine, silt is low plasticity. Disturbed loess.													42	10	169	7	6	4	Moist		MW48	
	2	4	Silt with sand	Moist, grayish brown disturbed loess. Some large 2 - 4 cm gravel (greywacke), low plasticity.													<LOD	13	50	4	<LOD	5	Moist			
	4	6	Silty Sand	Moist, brownish gray silty Sand with gravel. Gravel is 1 - 4 cm greywacke occasionally weathered to brown, well lithified, angular. Sand is very fine to fine grained, occasionally dark gray. Occasional iron staining. Disturbed soil.											X		61	10	217	7	11	4	Moist			
	6	8	Weathered Bedrock - Argillite, Shale, Greywacke	Moist, orangish brown weathered bedrock. Black, blocky argillite layer shows apparent bedding dip of 50 degrees. Shale below argillite is weathered and iron-stained clay. 7.0 - 8.0 ft. is weathered brown greywacke with no obvious bedding dip.											X		<LOD	13	60	4	7	4	Moist			
	8	10	Weathered Bedrock - Siltstone, Argillite	Moist, orangish brown weathered bedrock. Siltstone and argillite appear to have a bedding dip of 30 degrees. Occasional iron stain.											X		<LOD	14	36	4	<LOD	6	Moist			
	10	12	Weathered Bedrock - Greywacke, Siltstone, Shale	Moist, grayish brown weathered bedrock. Greywacke and siltstone to 11.0 ft., shale to 11.4 ft., greywacke below. Occasional iron stain 11.0 ft. Shale has bedding dip of 30 degrees.											X		<LOD	14	56	5	<LOD	6	Moist			
	12	14.2	Weathered Bedrock - Siltstone, Greywacke	Moist, grayish brown weathered bedrock. Poorly lithified siltstone and greywacke. Greywacke is occasionally weathered to gray sand. Iron staining in thin veins that form fracture surfaces. No bedding dip apparent. Low moisture.											X		<LOD	14	78	5	7	4	Moist			
	14.2	15	No Recovery	No recovery.													<LOD	16	42	5	<LOD	8	No Recovery			
	15	17	Bedrock - Siltstone, Greywacke	Moist, dark gray siltstone and greywacke. Poorly lithified.																			Moist	16.59		
	17	19.5	Bedrock - Siltstone	Dark grayish brown siltstone with occasional iron stain in fractures. Possible pulverized shale.											X		<LOD	13	61	4	<LOD	5	Moist			
	19.5	22	Bedrock - Argillite	Black argillite. Blocky, well lithified. Occasional Fe accretions in fractures.											X		<LOD	14	58	5	<LOD	6	Moist			
	22	24.5	Bedrock - Argillite	Black argillite in large chips, trace iron stain.											X		<LOD	13	39	4	<LOD	6	Moist			23 - 43
	24.5	27	Bedrock - Argillite, Siltstone, Shale	Very dark gray blocky argillite and dark gray siltstone. Some shale (pulverized light gray coating on larger cuttings).													<LOD	13	47	4	<LOD	6	Moist			
	27	29.5	Bedrock - Siltstone	Wet, dark gray siltstone, blocky.													<LOD	9	31	3	<LOD	4	Wet			
	29.5	32	Bedrock - Argillite	Wet, black argillite. Trace iron stain.											X		<LOD	12	40	4	<LOD	5	Wet			
	32	34.5	Bedrock - Argillite, Shale	Wet, black argillite with some friable shale. Trace iron stain.													<LOD	10	25	3	4	2	Wet			
	34.5	37	Bedrock - Argillite	Wet, black argillite, blocky.													<LOD	15	31	4	<LOD	6	Wet			
	37	39.5	Weathered Bedrock - Siltstone, Shale	Wet, dark gray siltstone, weaker lithification than the argillite above. Trace iron stain. Some thin friable shale.											X		<LOD	12	33	3	<LOD	5	Wet			
	39.5	42	Bedrock - Siltstone	Wet, dark gray blocky siltstone. Trace quartz vein.								X					<LOD	14	31	4	<LOD	6	Wet			
	42	44	Bedrock - Argillite	Wet, black to very dark gray argillite. Blocky to platy, moderately well lithified.													<LOD	14	38	4	<LOD	6	Wet			
SM77	0	2	Silt with sand	Moist, grayish brown silt with sand. Sand is very fine, silt is firm, trace organic debris, roots and sand increasing with depth. Loess.													<LOD	12	8	3	<LOD	5	Moist		MW49	
	2	5	Silt with sand	Wet, grayish brown, as above, more very fine sand. Occasional bands of iron stain. Loess.											X		<LOD	12	9	3	<LOD	5	Wet			
	5	6	Silt with gravel	Moist, grayish brown, as above to 5.5 ft., then Silt with gravel. Gravel is coarse angular.													<LOD	12	5	2	<LOD	4	Moist			
	6	8	silty Gravel	Moist, grayish brown silty Gravel, gravel content increasing with depth. Gravel is angular argillite.													<LOD	14	142	6	11	4	Moist			
	8	10	gravelly Silt	Moist, brownish yellow gravelly Silt. Gravel is abundant, mostly black angular argillite with some very weathered shale. Stiff.													<LOD	15	79	5	<LOD	7	Moist			
	10	12	silty Gravel	Moist, grayish brown silty Gravel. 1 - 4 cm black angular siltstone fragments. Interstitial silt is firm, soil is dense.													<LOD	14	57	5	<LOD	6	Moist			
	12	14	poorly graded Gravel with silt and sand	Moist, grayish brown Gravel with silt and sand. Gravel is fine to 4 cm, angular, composed of siltstone, shale, and sandstone. Weathered in place, dense. Silt and clay is gray weathered shale.													<LOD	15	56	5	8	4	Moist			
	14	16	poorly graded Gravel with silt and sand	Moist, gray, as above, weathered bedrock with faint bedding, shale transitioning to clay appears to have 30 degree bedding dip.													<LOD	14	41	4	<LOD	6	Moist			
	16	18	clayey Gravel	Moist, grayish brown silty, clayey Gravel. 1 - 4 cm angular shale cuttings and occasional dark brown greywacke.													<LOD	15	49	5	9	4	Moist			
	18	20	silty Gravel	Moist, brown silty Gravel, some clay where shale is decomposing. Silt is low to medium plasticity. Gravel is fine to 4 cm angular weathered Kuskokwim Group shale, greywacke, and occasional siltstone. Dense.													<LOD	14	46	4	10	4	Moist			

Table 2-5 Field Data Summary, 2017 Groundwater Monitoring Well Installation

Soil Boring ID	Sample Depth Interval (feet bgs)		Llithology	Lithological Description	Mineralogical/Lithological Observations												XRF Antimony		XRF Arsenic		XRF Mercury		Groundwater Observations		Monitoring Well Installation	
	Top	Bottom			Red Porous Rock	Vitrious "Slag"	Stibnite	Elem-ental Mercury	Cinnabar	Realgar	Orpiment	Vein Material	Red Rind	Sulfides	Iron Stain	Odor	Conc. (ppm)	Error	Conc. (ppm)	Error	Conc. (ppm)	Error	Moisture Observed in Soil Sample or Drill Cuttings	Static Water Level in Completed Well, 9/26/17 (feet bgs)	Monitoring Well ID	Monitoring Well Screened Interval (feet bgs)
	20	22	Weathered Bedrock - Shale, Greywacke, Siltstone	Moist, grayish brown weathered bedrock. Kuskokwim Group shale, greywacke, and siltstone. Shale shows apparent bedding dip of 30 degrees.													<LOD	14	27	4	<LOD	6	Moist			
	22	24	Weathered Bedrock - Siltstone, Greywacke	Dry, brown weathered bedrock, very dense. 30 degree apparent bedding dip. Siltstone and greywacke.													<LOD	13	27	4	<LOD	5	Dry			
	24	25	Weathered Bedrock	Dry, grayish brown Gravel with silt, as above. Refusal of direct push drilling at 25 ft.													<LOD	13	30	3	<LOD	5	Dry			
	25	32	No recovery	No recovery.																			No Recovery	25.18		
	32	34.5	Bedrock - Siltstone, Greywacke	Dry, black siltstone and dark brown greywacke. Occasional iron stain.											X		<LOD	13	49	4	<LOD	5	Dry			
	34.5	37	Bedrock - Greywacke	Dry, dark gray greywacke. Sand grains are very fine, well lithified. Trace iron stain.											X		<LOD	13	64	4	<LOD	6	Dry			
	37	39.5	Bedrock - Shale, Siltstone	Dry, dark gray. Black shale and occasional dark gray siltstone.													<LOD	13	39	4	<LOD	8	Dry			
SM77	39.5	42	No Recovery	No recovery.																			No Recovery		MW49	
	42	44.5	Bedrock - Greywacke	Greywacke, fine grained. Pulverizes readily.													<LOD	13	16	3	<LOD	6	Dry			
	44.5	47	Bedrock - Greywacke	Wet, dark gray greywacke as above. Trace iron stain, trace quartz. Productive fracture(s).													<LOD	12	25	3	<LOD	5	Wet			
	47	49.5	Bedrock - Greywacke	Moist, dark gray, as above, trace stibnite.			X							X			15	10	20	4	<LOD	6	Moist			
	49.5	52	Bedrock - Greywacke, Siltstone, Shale	Dry, dark grayish brown. dark gray greywacke and siltstone, with shale appearing as a light gray coating of clay on cuttings. Trace quartz.								X					<LOD	13	19	3	<LOD	5	Dry			40 - 60
	52	54.5	Bedrock - Greywacke, Siltstone, Shale	Wet, dark grayish brown, as above, trace quartz and trace stibnite.			X					X		X			<LOD	11	36	3	<LOD	4	Wet			
	54.5	57	Bedrock - Greywacke, Shale	Wet, dark gray greywacke and shale (pulverized). Trace iron stain, occasional stibnite, trace cinnabar.			X		X					X			<LOD	15	24	4	8	4	Wet			
	57	59.5	Bedrock - Greywacke, Shale	Wet, dark gray, as above. No cinnabar, less stibnite, less shale.			X							X			<LOD	11	28	3	<LOD	4	Wet			
	59.5	62	Bedrock - Greywacke, Shale	Wet, dark gray, as above. No visible minerals.													<LOD	12	18	3	<LOD	5	Wet			
	0	1	silty Sand	Moist, brown silty Sand. Fine sand grains with some iron staining. Some well-graded angular gravel, trace organics (roots) disturbed from drilling pad construction.											X		<LOD	12	81	4	<LOD	5	Moist			
	1	2	silty Sand	Moist, light reddish brown silty Sand As above, with few gravel consisting of mostly siltstone and trace shale.													<LOD	13	10	3	<LOD	5	Moist			
	2	3	Silt	Moist, grayish brown silt with few fine to very fine loose sand grains. Loess.													<LOD	12	8	3	<LOD	5	Moist			
	3	4	Silt	Dry, light brown, as above.													<LOD	12	5	3	<LOD	5	Dry			
	4	5	No Recovery	No recovery.																			No Recovery			
	5	6	Silt	Dry, light brown Silt with few fine to very fine loose sand grains. Loess.													<LOD	13	6	3	<LOD	5	Dry			
	6	7	Silt	Dry, light brown, as above, with trace iron staining.											X		<LOD	13	6	3	<LOD	5	Dry			
	7	8	Silt	Dry, light brownish gray, as above, with trace wood at 7.8 ft.													<LOD	12	5	3	<LOD	5	Dry			
	8	9	Silt	Dry, grayish brown, as above, with thin color change to dusky red at 8.3 and 8.5 ft.													<LOD	12	9	3	<LOD	4	Dry			
	9	10	No recovery	No recovery.																			No Recovery			
	10	11	Silt	Reddish brown Silt with fine to very fine loose sand, becomes moist at 10.5 feet. Loess.													<LOD	12	9	2	<LOD	4	Dry to Moist		MW50	
SM78	11	12	Silt	Wet, gray Silt with fine to very fine sand, Loose. Organics (wood and roots) at 11.9 ft. with decomposing organic matter odor. Loess.													<LOD	11	5	2	<LOD	4	Wet			
	12	13	Silt	Moist, gray Silt with very fine to fine sand, loose. Loess. 12 - 12.5 ft. is brown to dark brown with organics (woody material). 12.5 ft. color changes to gray with more moisture.													<LOD	12	7	3	<LOD	4	Moist			
	13	14	Silt	Wet, grayish brown, as above.													<LOD	12	24	3	<LOD	5	Wet			
	14	15	No Recovery	No recovery.																						
	15	16	Silt	As above, but dark reddish brown. Some iron staining, very wet.													<LOD	11	10	3	<LOD	4	Wet			
	16	17	Silt	Reddish brown Silt with very fine to fine sand, with trace fine gravel. Loess. Change in color at 16.6 ft. to brown. Wet.													<LOD	12	12	3	<LOD	4	Wet			
	17	18	Weathered Bedrock - Shale, Greywacke	Reddish brown, as above until weathered bedrock at 17.6 ft., mostly weathered shale (clay) below 17.6 ft. with some angular greywacke weathered to brown. Wet to moist.													<LOD	12	20	3	<LOD	5	Moist to Wet			
	18	19	Weathered Bedrock - Greywacke Shale	Moist, dark reddish gray weathered bedrock. Mostly fine grained greywacke weathered to brown with trace quartz and some dark gray shale, with apparent bedding dip of 35 degrees. At 18.2 ft. becomes dry.								X					<LOD	15	310	9	8	4	Dry to Moist			
	19	20	No Recovery	No recovery.																			No Recovery			

Table 2-5 Field Data Summary, 2017 Groundwater Monitoring Well Installation

Soil Boring ID	Sample Depth Interval (feet bgs)		Llithology	Lithological Description	Mineralogical/Lithological Observations												XRF Antimony		XRF Arsenic		XRF Mercury		Groundwater Observations		Monitoring Well Installation	
	Top	Bottom			Red Porous Rock	Vitrious "Slag"	Stibnite	Elem-ental Mercury	Cinnabar	Realgar	Orpiment	Vein Material	Red Rind	Sulfides	Iron Stain	Odor	Conc. (ppm)	Error	Conc. (ppm)	Error	Conc. (ppm)	Error	Moisture Observed in Soil Sample or Drill Cuttings	Static Water Level in Completed Well, 9/26/17 (feet bgs)	Monitoring Well ID	Monitoring Well Screened Interval (feet bgs)
SM78	20	21	Weathered Bedrock - Shale, Siltstone	Dry, dark reddish brown weathered bedrock. Mostly shale weathered to clay with few siltstone and iron staining.											X		<LOD	13	142	6	15	4	Dry		MW50	
	21	22	Weathered Bedrock - Greywacke	Dry, reddish gray weathered bedrock. Mostly coarse grained greywacke weathered to brown.													<LOD	13	262	8	13	4	Dry			
	22	23	Weathered Bedrock - Shale, Greywacke, Siltstone	Dry, dark reddish gray weathered bedrock. 22.3 to 22.9 ft. is shale weathered entirely to a low plasticity clay, below 22.9 ft. is greywacke weathered to brown. Trace siltstone with iron staining.											X		<LOD	13	1040	14	16	4	Dry			
	23	24	Weathered Bedrock - Shale, Siltstone	Dry, yellowish brown weathered bedrock. Mostly shale weathered to clay with few siltstone, iron staining.											X		<LOD	14	214	7	14	4	Dry			
	24	25	Weathered Bedrock - Shale, Siltstone	Dry, reddish brown weathered bedrock. Mostly shale weathered to clay with iron staining. Trace siltstone with iron staining.											X		36	10	347	9	<LOD	7	Dry			
	25	27.5	Bedrock - Greywacke, Shale	Dry, reddish gray. Small pieces of coarse grained greywacke, with evidence of shale (pulverized clay clumps).																			Dry			
	27.5	30	Bedrock - Siltstone, Shale	Dry, dark grayish brown. Mostly siltstone, subangular with iron staining. Evidence of shale (pulverized clay).											X								Dry			
	30	32.5	Bedrock - Argillite, Shale	Dry, dark gray. Mostly small pieces of poorly indurated argillite with trace iron staining and evidence of shale (pulverized clay clumps).											X								Dry			
	32.5	35	Weathered Bedrock - Greywacke, Shale	Moist, reddish brown. Mostly small cuttings of coarse grained greywacke weathered to brown, with evidence of shale pulverized to clay.																			Moist			
	35	37.5	Bedrock - Argillite, Siltstone	Dry, dark gray argillite. Trace siltstone with iron staining.											X								Dry			
	37.5	40	Bedrock - Siltstone, Argillite	Dry, dark grayish brown. Mostly blocky to small pieces of subangular siltstone with iron staining and few argillite.											X								Dry			
	40	42.5	Weathered Bedrock - Shale, Greywacke	Dry, brown. Mostly pulverized shale (clay), with small pieces of coarse grained greywacke weathered to brown.																			Dry			
	42.5	45	Bedrock - Argillite	Dry, dark gray. Small pieces of argillite with trace iron staining. Red mineral (suspected realgar).						X					X								Dry			
	45	47.5	Bedrock - Argillite	Dry, dark gray, argillite with some iron staining. Slow drilling.											X								Dry	47.40		
	47.5	50	Bedrock - Argillite	Dry, dark gray, as above, without iron staining.																			Dry			
	50	52.5	Bedrock - Argillite	Dry, dark gray, as above, with larger cuttings. Continued slow drilling.																			Dry			
	52.5	55	Bedrock - Argillite	Dry, dark gray, as above, but with smaller cuttings.																			Dry			
	55	57.5	Bedrock - Argillite	Dry, dark gray, as above, but with trace evidence of shale (clay chunks in cuttings). Trace iron staining.											X								Dry			
	57.5	60	Bedrock - Argillite, Greywacke	Dry, dark gray, argillite with few fine grained greywacke, with some iron staining. Slow drilling.											X								Dry			
	60	62.5	Weathered Bedrock - Greywacke	Dry, dark gray greywacke, some weathered to brown, with trace unidentified tan mineral.																			Dry			
	62.5	65	Bedrock - Greywacke, Argillite	Dry, dark gray, mostly greywacke with trace iron staining and quartz. Trace argillite.								X			X								Dry			
	65	67.5	Bedrock - Argillite	Dry, dark gray, argillite. Slow drilling.																			Dry			
	67.5	70	Bedrock - Argillite	Dry, dark gray, as above.																			Dry			
	70	72.5	Bedrock - Argillite	Dry, dark gray, as above, but with quartz, slow drilling.								X											Dry			71 - 91
	72.5	75	Bedrock - Argillite	Dry, dark gray, as above, but with quartz/calcite. Slow drilling. Red mineral (suspected realgar).						X		X											Dry			
	75	77.5	Bedrock - Argillite	Dry, dark gray, as above, with trace calcite/quartz. Slow drilling.								X											Dry			
	77.5	80	Weathered Bedrock - Greywacke, Argillite	Gray, mostly fine grained greywacke, some weathered to brown. Some quartz/calcite, trace argillite. Wet.								X											Wet			
	80	82.5	Bedrock - Shale, Argillite, Siltstone	Dark grayish brown, mostly pulverized shale observed as clumps of clay, with few argillite and siltstone. Wet.																			Wet			
	82.5	85	Bedrock - Argillite, Greywacke	Moist, dark gray, mostly argillite with trace fine grained greywacke.																			Moist			
	85	87.5	Bedrock - Greywacke, Argillite	Moist, dark gray to gray, medium grained greywacke with some calcite/quartz and trace argillite.								X											Moist			
	87.5	90	Bedrock - Greywacke, Shale	Moist, gray, fine grained greywacke with calcite/quartz veins, trace shale (clay).								X											Moist			
	90	92	Bedrock - Greywacke, Shale	Moist, dark gray, as above, but with abundant calcite/quartz veins and iron staining on quartz.								X			X								Moist			

Table 2-5 Field Data Summary, 2017 Groundwater Monitoring Well Installation

Soil Boring ID	Sample Depth Interval (feet bgs)		Llithology	Lithological Description	Mineralogical/Lithological Observations												XRF Antimony		XRF Arsenic		XRF Mercury		Groundwater Observations		Monitoring Well Installation	
	Top	Bottom			Red Porous Rock	Vitrious "Slag"	Stibnite	Elem-ental Mercury	Cinnabar	Realgar	Orpiment	Vein Material	Red Rind	Sulfides	Iron Stain	Odor	Conc. (ppm)	Error	Conc. (ppm)	Error	Conc. (ppm)	Error	Moisture Observed in Soil Sample or Drill Cuttings	Static Water Level in Completed Well, 9/26/17 (feet bgs)	Monitoring Well ID	Monitoring Well Screened Interval (feet bgs)
SM79	0	1	silty Sand	Moist, brown silty Sand. Fine to very fine poorly-graded sand.													<LOD	12	9	3	<LOD	5	Moist		MW51	
	1	2	silty Sand	Moist, brown silty Sand, as above.													<LOD	12	7	3	<LOD	5	Moist			
	2	3	silty Sand	Moist, brown silty Sand, as above.													<LOD	12	8	3	<LOD	5	Moist			
	3	4	silty Sand	Moist, light reddish brown silty Sand, sand is fine to very fine and poorly-graded. Dark reddish brown layer at 3.1 - 3.2 ft. transitioning to orangish yellow.													<LOD	12	8	3	<LOD	5	Moist			
	4	5	silty Sand	Moist, light reddish brown silty Sand. As above with more silt.													<LOD	12	6	3	<LOD	5	Moist			
	5	6	silty Sand	Moist, light reddish brown silty Sand. Sand is fine to very fine, poorly graded. Trace organics (roots) and iron staining.											X		<LOD	12	6	3	<LOD	5	Moist			
	6	7	silty Sand	Moist, light reddish brown silty Sand, as above.											X		<LOD	12	<LOD	4	<LOD	5	Moist			
	7	8	silty Sand	Moist, light reddish brown silty Sand, as above.											X		<LOD	12	8	3	<LOD	5	Moist			
	8	9	silty Sand	Moist, light reddish brown silty Sand, as above with more iron staining.											X		<LOD	12	9	3	<LOD	5	Moist			
	9	10	silty Sand	Moist, light reddish brown silty Sand, as above.											X		<LOD	11	6	2	<LOD	4	Moist to Wet			
	10	11	Silt	Wet, light brownish gray Silt with very fine sand and trace clay. Some iron staining. At 10.7 ft., color changes to light gray with a dark reddish brown layer.											X		<LOD	12	8	3	<LOD	5	Wet			
	11	12	Silty Sand Weathered Bedrock - Shale, Siltstone	11.0 - 11.3 ft.: Wet to Moist, light gray silty Sand. Sand is fine. 11.3 - 12.0 ft.: Wet to moist well-graded Gravel with silt (weathered bedrock), consisting mostly of weathered shale with few siltstone, with some iron staining. Weathered bedrock is dark gray to dark reddish brown .											X		<LOD	12	23	3	<LOD	5	Moist to Wet			
	12	13	Weathered Bedrock - Shale, Greywacke	Moist, dark grayish brown well-graded Gravel with clay. Weathered bedrock is mostly shale weathered to clay with few blocky greywacke weathered to brown.													<LOD	11	172	5	<LOD	5	Moist			
	13	14	Weathered Bedrock - Greywacke, Shale	Moist to dry, dark grayish brown well-graded Gravel with silt. Weathered bedrock is mostly greywacke with some weathered to brown and some shale weathered to clay.													46	9	654	11	15	4	Dry to Moist			
	14	15	No Recovery	No recovery.																			No Recovery			
	15	16	Weathered Bedrock - Greywacke, Siltstone, Shale	Dry, reddish brown well-graded Gravel with silt. Weathered bedrock is mostly blocky greywacke weathered to brown with siltstone and few shale weathered to clay.													<LOD	15	161	7	<LOD	6	Dry			
	16	17	Weathered Bedrock - Greywacke	Dry, reddish brown well-graded Gravel with silt. Weathered bedrock with apparent bedding dip of 20 degrees is mostly blocky greywacke weathered to brown. Greywacke sand grains are medium to fine grained.													<LOD	13	131	6	<LOD	6	Dry			
	17	18	Weathered Bedrock - Shale, Siltstone	Dry, dark grayish brown poorly-graded Gravel with clay. Weathered bedrock is mostly shale weathered to clay. Trace siltstone.													<LOD	13	172	7	<LOD	6	Dry			
	18	19	Weathered Bedrock - Shale	Moist to dry, dark grayish brown poorly-graded Gravel with clay. Weathered bedrock is heavily weathered shale (clay.) Competent shale bedrock at 18.8 ft.													<LOD	13	101	5	<LOD	5	Dry to Moist			
	19	20	No Recovery	No recovery.																			No Recovery			
	20	22.5	Weathered Bedrock - Shale, Greywacke	Moist, brown. Mostly pulverized shale (clay), few very small pieces of fine grained greywacke weathered to brown.													<LOD	14	101	5	<LOD	6	Moist			
	22.5	25	Bedrock - Shale	Moist, light brownish gray pulverized shale (clay), small poorly indurated shale fragments present in clay.													<LOD	14	142	6	<LOD	6	Moist			
	25	27.5	Bedrock - Silstone	Dry, dark grayish brown siltstone, angular with iron staining.											X		<LOD	14	95	5	<LOD	6	Dry			
	27.5	30	Weathered Bedrock - Greywacke, Shale	Dry, dark grayish brown. Small fragments of mostly fine grained greywacke weathered to brown. Shale seen as pulverized clay and poorly indurated shale pieces.													<LOD	15	81	5	<LOD	7	Dry			
	30	32.5	Weathered Bedrock - Shale, Greywacke, Siltstone	Dry, dark grayish brown. Mostly poorly indurated shale with some pulverized to clay. Some coarse grained greywacke weathered to brown and some siltstone with iron staining.											X		<LOD	13	76	5	<LOD	5	Dry			
	32.5	35	Bedrock - Argillite, Siltstone	Dry, dark gray, blocky argillite with iron staining. Trace siltstone.											X		<LOD	13	157	6	<LOD	6	Dry			
	35	37.5	Weathered Bedrock - Greywacke	Dry, dark reddish gray greywacke in mostly small fragments with significant weathering to brown.													<LOD	14	77	5	<LOD	6	Dry	36.02		
	37.5	40	Weathered Bedrock - Greywacke	Dry, dark reddish gray, as above, but with less weathering to brown.													<LOD	15	112	6	<LOD	7	Dry			
	40	42.5	Bedrock - Greywacke, Argillite	Dry, dark reddish gray, as above, but with trace argillite.													28	9	46	4	<LOD	6	Dry			
	42.5	45	Bedrock - Siltstone, Argillite	Dry, dark gray, mostly poorly indurated siltstone. Trace argillite.													<LOD	14	87	5	<LOD	6	Dry			
	45	47.5	Bedrock - Siltstone	Dry, dark gray, poorly indurated siltstone, angular cuttings, with trace iron staining.													<LOD	15	85	5	<LOD	6	Dry			
	47.5	50	Bedrock - Siltstone	Dry, dark gray, as above, but with larger fragments.													<LOD	14	95	5	<LOD	6	Dry			

Table 2-5 Field Data Summary, 2017 Groundwater Monitoring Well Installation

Soil Boring ID	Sample Depth Interval (feet bgs)		Llithology	Lithological Description	Mineralogical/Lithological Observations												XRF Antimony		XRF Arsenic		XRF Mercury		Groundwater Observations		Monitoring Well Installation	
	Top	Bottom			Red Porous Rock	Vitrious "Slag"	Stibnite	Elem-ental Mercury	Cinnabar	Realgar	Orpiment	Vein Material	Red Rind	Sulfides	Iron Stain	Odor	Conc. (ppm)	Error	Conc. (ppm)	Error	Conc. (ppm)	Error	Moisture Observed in Soil Sample or Drill Cuttings	Static Water Level in Completed Well, 9/26/17 (feet bgs)	Monitoring Well ID	Monitoring Well Screened Interval (feet bgs)
	50	52.5	Bedrock - Siltstone, Argillite	Dry, dark gray, blocky siltstone with some argillite and trace iron staining.											X		<LOD	14	128	6	<LOD	6	Dry	36.02		
	52.5	55	Bedrock - Argillite, Siltstone	Dry, dark gray, mostly blocky argillite with few siltstone. Some iron staining.											X		<LOD	14	87	5	<LOD	6	Dry			
	55	57.5	Bedrock - Argillite, Siltstone	Dry, dark gray, as above.											X		<LOD	14	64	5	<LOD	6	Dry			
	57.5	60	Bedrock - Argillite, Siltstone	Dry, dark grayish brown. Mostly argillite with some brownish gray blocky medium grained, poorly indurated greywacke.													<LOD	14	67	5	<LOD	6	Dry			
	60	62.5	Bedrock - Siltstone, Argillite	Dry, dark reddish gray, siltstone with iron staining. Trace argillite.											X		<LOD	15	101	6	<LOD	6	Dry			
SM79	62.5	65	Weathered Bedrock - Greywacke, Shale	Wet, dark reddish gray, blocky greywacke weathered to brown. Some shale pulverized to clay.													<LOD	14	89	5	<LOD	6	Wet		MW51	
	65	67.5	Weathered Bedrock - Greywacke	Wet, dark reddish brown, blocky greywacke, mostly weathered to brown.													<LOD	15	62	5	<LOD	6	Wet			56 - 76
	67.5	70	Weathered Bedrock - Greywacke	Wet, dark grayish brown, as above, but with less weathering to brown, and trace shale (clay).													<LOD	13	46	4	<LOD	6	Wet			
	70	72.5	Weathered Bedrock - Greywacke	Wet, dark gray, coarse grained greywacke, with some weathering to brown.													<LOD	11	46	3	<LOD	4	Wet			
	72.5	75	Bedrock - Argillite, Siltstone, Shale	Wet, dark gray, argillite. Trace siltstone and shale (clay).													<LOD	11	68	4	<LOD	5	Wet			
	75	77	Bedrock - Greywacke	Wet, dark gray, greywacke with trace iron staining.											X		<LOD	10	37	3	<LOD	4	Wet			
	0	2	Silt Silt	0.0 - 0.3 ft.: Moist brown Silt with gravel and organics, previously disturbed. 0.3 - 1.0 ft.: Moist, light brownish gray, Silt with gravel and organics. Silt has some very fine sand and trace small gravel, gravel decreases with depth. Thin layer of fine sand, brown to reddish brown, at 0.9 ft.																			Moist			
	2	4	Silt	Moist to wet, brown Silt with very fine sand. Notable increase in moisture at 2.9 ft. At 3.6 ft. thin layer with iron staining. Clear transition to gray color below 3.9 ft.											X								Moist to Wet			
	4	5	SIlt	Moist, gray to dusky red Silt with very fine sand and trace organics (roots), trace clay. Soft. At 4.7 ft. dusky red silty clay with few fine sand grains. Possible perched water zone.																			Moist			
	5	6	Gravel with silt Weathered Bedrock - Shale	5.0 - 5.2 ft.: Moist, reddish brown, well-graded Gravel with clay and silt, iron staining. Gravel is weathered siltstone. 5.2 - 6.0 ft.: Weathered shale with clay.											X								Moist			
	6	8	Weathered Bedrock - Siltstone, Shale	Moist, dark grayish brown weathered bedrock is mostly siltstone with trace amounts of shale weathered to clay. At 7.3 ft. is reddish brown shale weathered to clay with iron staining and white vein material.											X								Moist			
	8	10	Weathered Bedrock - Shale, Siltstone	Dry, dark gray weathered shale with few blocky siltstone.																			Dry			
	10	12	Weathered Bedrock - Siltstone, Greywacke	Dry, dark grayish brown weathered blocky siltstone with iron staining and greywacke weathered to brown.											X								Dry			
SM80	12	14	Weathered Bedrock - Greywacke, Shale, Argillite, Siltstone	Dry, dark grayish brown Greywacke weathered to brown, some shale weathered to clay, with trace white clay. Argillite and shale weathered to clay at 13 - 13.7 ft., with small layer of siltstone.																			Dry		MW52	
	14	15	No Recovery	No recovery.																			No Recovery			
	15	17.5	Bedrock - Argillite, Siltstone	Dry, dark gray, mostly argillite with some siltstone. Iron staining.											X								Dry			
	17.5	20	Bedrock - Siltstone, Greywacke	Dry, brown siltstone with iron staining. Few greywacke.											X								Dry			
	20	22.5	Bedrock - Greywacke	Dry, dark gray greywacke. Sand grains are fine, iron staining.											X								Dry			
	22.5	25	Bedrock - Greywacke	Dry, dark gray greywacke with trace amount of iron staining, Sand grains are fine.											X								Dry			
	25	27.5	Bedrock - Shale	Dry, dark gray shale. Small, poorly indurated lithic fragments. Laminated. Iron staining.											X								Dry	26.75		
	27.5	30	Bedrock - Greywacke	Dry, dark grayish brown greywacke with iron staining.											X								Dry			
	30	32.5	Weathered Bedrock - Shale, Siltstone	Dry, light brownish gray shale (weathered to clay) and siltstone with some iron staining.											X								Dry			
	32.5	35	Weathered Bedrock - Greywacke	Dry, dark reddish brown, fine grained greywacke weathered to brown.																			Dry			
	35	37.5	Bedrock - Greywacke	Dry, dark grayish brown, fine grained greywacke with iron staining.											X								Dry			
	37.5	40	Weathered Bedrock - Greywacke, Shale	Dry, dark grayish brown greywacke weathered to brown, fine cuttings. Some shale weathered to clay.																			Dry			
	40	42.5	Bedrock - Argillite	Dry, black argillite. No visible grains, blocky.																			Dry			35 - 55
	42.5	45	Bedrock - Argillite	Wet, black argillite. Blocky, with trace iron staining.											X								Wet			
	45	47.5	Bedrock - Argillite, Greywacke, Shale	Wet, dark gray. Lots of fines in cuttings. Argillite with quartz veins, few fine grained greywacke, and trace shale as pulverized clay. Iron stained.								X			X								Wet			

Table 2-5 Field Data Summary, 2017 Groundwater Monitoring Well Installation

Soil Boring ID	Sample Depth Interval (feet bgs)		Llithology	Lithological Description	Mineralogical/Lithological Observations												XRF Antimony		XRF Arsenic		XRF Mercury		Groundwater Observations		Monitoring Well Installation	
	Top	Bottom			Red Porous Rock	Vitrious "Slag"	Stibnite	Elem-ental Mercury	Cinnabar	Realgar	Orpiment	Vein Material	Red Rind	Sulfides	Iron Stain	Odor	Conc. (ppm)	Error	Conc. (ppm)	Error	Conc. (ppm)	Error	Moisture Observed in Soil Sample or Drill Cuttings	Static Water Level in Completed Well, 9/26/17 (feet bgs)	Monitoring Well ID	Monitoring Well Screened Interval (feet bgs)
SM80	47.5	50	Weathered Bedrock - Shale, Greywacke, Argillte	Wet, dark gray. Mostly shale weathered to clay in clumps, few fine grained greywacke and argillite with quartz veins.								X											Wet	26.75	MW52	35 - 55
	50	52.5	Bedrock - Argillite	Wet, dark gray argillite with quartz/calcite veins in many cuttings.								X											Wet			
	52.5	55	Bedrock - Argillite	Wet, dark gray argillite with quartz veins and trace pyrite.								X		X									Wet			
	55	56	Bedrock - Argillite	Wet, dark gray, as above but without pyrite.								X											Wet			
SM81	0	1	silty Sand Silt with sand Silt with sand	0.0 - 0.3 ft.: Moist, light brown silty sand, sand is fine. 0.3 - 0.8 ft.: Color changes to light reddish gray to dark reddish brown Silt with fine sand. Organics (roots) and organic layer of woody debris observed 0.3 - 0.4 ft. Moist. 0.8 - 1.0 ft.: Moist, reddish brown Silt with fine sand.													4	2	<LOD	4	<LOD	10	Moist		MW53	
	1	2	Silt	Moist, light brown Silt with fine to very fine sand. Loose. Loess.													5	3	<LOD	5	<LOD	12	Moist			
	2	3	Silt	Moist, light brown Silt with fine to very fine sand. Loose. Loess. Small iron stained layers.											X		10	3	<LOD	5	<LOD	12	Moist			
	3	4	Silt	As above, but becomes wet at 3.3 ft.													7	3	<LOD	5	<LOD	13	Wet			
	4	5	No Recovery	No recovery.																			No Recovery			
	5	6	Silt Silt Silt	Wet, brown Silt with low plasticity. 5.0 - 5.6 ft.: As above, but medium brown. 5.6 - 5.7 ft.: Color change to reddish brown with some well-graded gravel. 5.7 - 6.0 ft.: Color change to gray Silt with fine to very fine sand, trace clay. Loose. Loess.													6	3	<LOD	5	<LOD	12	Wet			
	6	7	silty Clay, Shale	Moist, dark reddish gray silty Clay with low plasticity. Few fine sand, becomes more clayey with depth below 6.3 ft. Thin iron staining layers interbedded with dark gray. Few gravel of subangular shale.											X		7	3	<LOD	5	<LOD	12	Moist			
	7	8	Clay with gravel Weathered Bedrock - Shale, Greywacke	7.0 - 7.3 ft.: Moist gray Clay with some well-graded gravel of subangular shale 7.3 - 8.0 ft.: Moist, grayish brown weathered bedrock, mostly shale with clay and some fine grained greywacke.													55	5	<LOD	6	<LOD	14	Moist			
	8	9	Weathered Bedrock - Greywacke	Moist, brown weathered bedrock, greywacke weathered to brown, very compact.													57	4	<LOD	5	<LOD	13	Moist			
	9	10	No Recovery	No recovery.																			No Recovery			
	10	11	Weathered Bedrock - Greywacke, Siltstone	Dry, reddish brown to brown weathered bedrock, mostly gray medium grained greywacke weathered to brown. Trace siltstone with trace quartz deposits.								X					58	4	<LOD	6	<LOD	14	Dry			
	11	12	Weathered Bedrock - Greywacke Weathered Bedrock - Shale, Siltstone	11.0 - 11.5 ft.: Dry reddish brown weathered bedrock, mostly greywacke weathered to reddish brown. Subangular cuttings. 11.5 - 12.0 ft.: Dry, dark gray, mostly subangular cuttings of shale weathered to clay, with few iron staining and some siltstone.											X		115	5	<LOD	6	<LOD	13	Dry			
	12	13	Weathered Bedrock - Siltstone, Shale	Dry, dark brown to brown weathered bedrock, mostly blocky siltstone with iron staining. Trace shale weathered to clay. Competent bedrock at 12.1 ft., apparent bedding dip of 75 degrees.													66	5	<LOD	6	<LOD	14	Dry			
	13	14	Weathered Bedrock - Greywacke	Dry, light reddish brown, competent bedrock. Mostly coarse grained greywacke weathered to brown sand.													129	6	<LOD	6	<LOD	13	Dry			
	14	15	Weathered Bedrock - Greywacke	Dry, light reddish brown, as above.													113	5	<LOD	6	<LOD	14	Dry			
	15	17.5	Weathered Bedrock - Greywacke, Shale	Dry, reddish brown, coarse grained greywacke weathered to brown, with some shale pulverized to clay.													<LOD	13	131	6	<LOD	6	Dry			
	17.5	20	Weathered Bedrock - Greywacke, Argillite	Dry, dark grayish brown, mostly coarse to medium grained greywacke weathered to brown, with few argillite .													56	11	59	5	<LOD	7	Dry			
	20	22.5	Weathered Bedrock - Greywacke	Dry, dark reddish gray, coarse grained greywacke weathered to brown.													<LOD	13	410	9	7	4	Dry			
	22.5	25	Bedrock - Argillite, Siltstone, Greywacke	Dry, dark gray, cuttings of argillite and larger cuttings of siltstone. Trace reddish brown greywacke.													<LOD	14	73	5	<LOD	6	Dry			
	25	27.5	Weathered Bedrock - Greywacke	Dry, dark grayish brown, subrounded to subangular cuttings of greywacke weathered to brown.													<LOD	13	108	5	<LOD	6	Dry	26.94		
	27.5	30	Weathered Bedrock - Greywacke	Dry, dark grayish brown, as above.													<LOD	13	140	6	8	4	Dry			
	30	32.5	Weathered Bedrock - Shale	Dry, gray shale weathered to clay.													<LOD	13	68	5	<LOD	6	Dry			
	32.5	35	Bedrock - Greywacke	Dry, gray, coarse grained greywacke. Very friable, most is pulverized.													<LOD	13	53	4	<LOD	6	Dry			
	35	37.5	Bedrock - Argillite	Dry, dark gray, argillite, with iron staining.											X		<LOD	14	76	5	<LOD	6	Dry			

Table 2-5 Field Data Summary, 2017 Groundwater Monitoring Well Installation

Soil Boring ID	Sample Depth Interval (feet bgs)		Llithology	Lithological Description	Mineralogical/Lithological Observations												XRF Antimony		XRF Arsenic		XRF Mercury		Groundwater Observations		Monitoring Well Installation	
	Top	Bottom			Red Porous Rock	Vitrious "Slag"	Stibnite	Elem-ental Mercury	Cinnabar	Realgar	Orpiment	Vein Material	Red Rind	Sulfides	Iron Stain	Odor	Conc. (ppm)	Error	Conc. (ppm)	Error	Conc. (ppm)	Error	Moisture Observed in Soil Sample or Drill Cuttings	Static Water Level in Completed Well, 9/26/17 (feet bgs)	Monitoring Well ID	Monitoring Well Screened Interval (feet bgs)
SM81	37.5	40	Bedrock - Argillite, Siltstone	Dry, dark gray, mostly argillite with trace quartz veins. Few blocky siltstone with iron staining.								X			X		<LOD	14	66	5	<LOD	6	Dry	26.94	MW53	
	40	42.5	Bedrock - Argillite	Dry, dark gray, argillite.													<LOD	15	84	5	9	5	Dry			41 - 61
	42.5	45	Bedrock - Argillite	Dry, dark gray, mostly pulverized friable argillite with trace quartz veins.								X					<LOD	13	112	5	11	4	Dry			
	45	47.5	Bedrock - Greywacke	Dry, gray, greywacke with few calcite/quartz veins.								X					<LOD	13	71	4	7	4	Dry			
	47.5	50	Bedrock - Greywacke	Wet, light gray greywacke.													<LOD	13	32	4	6	4	Wet			
	50	52.5	Bedrock - Greywacke	Moist, dark gray, as above.													<LOD	13	50	4	<LOD	6	Moist			
	52.5	55	Bedrock - Argillite	Moist, dark gray argillite.													<LOD	13	59	4	6	4	Moist			
	55	57.5	Weathered Bedrock - Greywacke	Dry, dark grayish brown, coarse grained greywacke with localized weathering to brown. Fine to pulverized cuttings.													<LOD	13	50	4	7	4	Dry			
	57.5	60	No Recovery	No recovery.													<LOD	13	43	4	7	4	Dry			
	60	62	Bedrock - Argillite	Dry, black, argillite.													<LOD	14	79	5	12	4	Dry			
SM82	0	1	silty Sand	Moist, light brown, silty Sand. Sand is fine to very fine.																			Moist		MW54	
	1	2	silty Sand	Moist, light reddish brown silty Sand. Sand is fine to very fine. Thin iron stained layers, with a dark brown to black layer at 1.6 ft.											X		7	3	<LOD	4	<LOD	11	Moist			
	2	3	Sand with silt	Moist to Wet, brown, fine Sand with silt, appears wet at 2.4 ft.													9	3	<LOD	4	<LOD	11	Moist to Wet			
	3	4	Sand with silt Organic Silt	3.0 - 3.3 ft.: As above. Moist. 3.3 - 3.6 ft.: Moist, dark brown organic Silt. Roots, wood, possibly former ground surface.													6	3	<LOD	5	<LOD	13	Moist			
	4	5	No Recovery	No recovery.																			No Recovery			
	5	6	silty Sand	Wet, dark reddish brown silty Sand. Fine to very fine grained, becomes more grayish at 5.6 ft.													6	2	<LOD	4	<LOD	11	Wet			
	6	7	Silt	Moist, dark reddish gray Silt, medium dense, iron staining, with trace fine, poorly-graded sand.											X		21	5	<LOD	9	<LOD	19	Moist			
	7	8	Gravel with silt Weathered Bedrock - Shale	7.0 - 7.3 ft.: As above. 7.3 - 8.0 ft.: Moist, dark reddish brown weathered bedrock. Shale weathered to clay, some iron stained siltstone.											X		77	5	<LOD	6	<LOD	14	Moist			
	8	9	Weathered Bedrock - Shale Weathered Bedrock - Shale	8.0 - 8.6 ft.: As above. 8.6 - 9.0 ft.: Moist, white to dusky red, lean Clay from weathered shale. Some silt and very fine sand in the dusky red color change at 9.0 ft.'. Dense.													127	6	9	4	16	10	Moist			
	9	10	Weathered Bedrock - Shale	Moist, gray to dusky red shale weathered to clay, iron staining and multiple color layers of black, gray, tan and reddish white.											X		131	5	<LOD	5	<LOD	12	Moist			
	10	11	Weathered Bedrock - Shale Weathered Bedrock - Shale	10.0 - 10.1 ft.: As above. 10.1 - 11.0 ft.: Moist, tan to yellowish orange Shale weathered to lean clay with silt and fine sand. Iron staining.											X		174	6	<LOD	6	<LOD	13	Moist			
	11	12	Weathered Bedrock - Shale, Siltstone	Moist, tan to yellowish orange, as above, with layer of iron stained siltstone with quartz veins at 11.7 ft.								X			X		191	7	8	4	<LOD	14	Moist			
	12	13	Weathered Bedrock - Shale, Siltstone	12.0 - 12.3 ft.: As above. 12.3 - 13.0 ft.: Moist, tan to yellowish orange weathered siltstone, blocky with quartz veins, angular, becomes dark grayish brown at 12.7 ft.								X					347	10	8	5	<LOD	15	Moist			
	13	14	Weathered Bedrock - Shale, Siltstone	Moist, dark grayish brown weathered bedrock, mostly shale, with few blocky angular siltstone cuttings containing broken quartz.								X					122	6	9	4	<LOD	13	Moist			
	14	15	No Recovery	No recovery.																			No Recovery			
	15	17.5	Bedrock - Shale, Greywacke	Dry, dark gray shale pulverized to clay (in clumps and loose fines). Few greywacke with calcite deposits.								X					<LOD	13	276	7	<LOD	6	Dry			
	17.5	20	Weathered Bedrock - Siltstone, Greywacke	Dry, dark grayish brown siltstone, angular, weathered to brown, with trace greywacke.								X					25	11	182	8	8	5	Dry			
	20	22.5	Weathered Bedrock - Greywacke, Shale	Dry, dark reddish gray, coarse grained greywacke weathered to brown, with some shale as indicated by clay coating larger cuttings.													<LOD	14	551	11	8	4	Dry			
	22.5	25	Bedrock - Shale, Siltstone	Dry, dark gray, mostly competent shale with some siltstone. Shale is very friable and some is pulverized to clay, iron staining present.											X		<LOD	14	133	6	8	4	Dry			

Table 2-5 Field Data Summary, 2017 Groundwater Monitoring Well Installation

Soil Boring ID	Sample Depth Interval (feet bgs)		Llithology	Lithological Description	Mineralogical/Lithological Observations												XRF Antimony		XRF Arsenic		XRF Mercury		Groundwater Observations		Monitoring Well Installation	
	Top	Bottom			Red Porous Rock	Vitrious "Slag"	Stibnite	Elem-ental Mercury	Cinnabar	Realgar	Orpiment	Vein Material	Red Rind	Sulfides	Iron Stain	Odor	Conc. (ppm)	Error	Conc. (ppm)	Error	Conc. (ppm)	Error	Moisture Observed in Soil Sample or Drill Cuttings	Static Water Level in Completed Well, 9/26/17 (feet bgs)	Monitoring Well ID	Monitoring Well Screened Interval (feet bgs)
	25	27.5	Bedrock - Siltstone, Argillite	Dry, dark grayish brown, mostly siltstone with iron staining on some surfaces. Few black argillite present.											X		<LOD	14	166	7	<LOD	7	Dry	27.07		
	27.5	30	Weathered Bedrock - Greywacke, Argillite	Dry, dark grayish brown, mostly small pieces of greywacke weathered to brown with few argillite. Greywacke has iron staining on some surfaces.											X		<LOD	14	125	6	8	4	Dry			
	30	32.5	Bedrock - Shale, Greywacke	Dry, brown, mostly shale pulverized to clay as seen in clumps. Trace greywacke present in small fragments, iron staining on the greywacke.											X		<LOD	14	563	11	<LOD	6	Dry			
	32.5	35	Bedrock - Argillite, Greywacke	Moist, dark gray argillite with trace calcite veins. Some greywacke with iron staining.								X			X		<LOD	14	132	6	8	4	Moist			
	35	37.5	Bedrock - Argillite	Wet, dark gray argillite. Larger fragments have quartz coating on surfaces.								X					<LOD	15	232	8	14	5	Wet			
SM82	37.5	40	Bedrock - Argilite, Quartz Vein	Wet, dark gray, trace fragments of argillite with 5 cm chunks of quartz. Slow drilling (possible quartz vein).								X					<LOD	16	135	7	11	5	Wet		MW54	
	40	42.5	Bedrock - Igneous Dike	Wet, light gray igneous dike. Blocky, poorly indurated with small fragments of clay mineral (dickite?) on most surfaces, and limonite on few cuttings. Trace quartz pieces less than 3 cm, very hard, drilling difficult.								X					<LOD	15	150	7	18	5	Wet			29 - 49
	42.5	45	Bedrock - Igneous Dike	Wet, light gray, as above, without limonite, thin quartz veins.								X					17	10	63	5	15	5	Wet			
	45	47.5	Bedrock - Igneous Dike	Wet, light gray, as above, with more clay mineral (dickite?) present and trace black mineral (possibly stibnite). Abundant water.			X							X			<LOD	11	135	5	11	3	Wet			
	47.5	50	Bedrock - Igneous Dike	Wet, light gray, as above, with a lot more quartz as both veins and individual pieces 2 - 5 cm. Trace orpiment.							X	X		X			<LOD	11	97	4	8	3	Wet			
	0	2	Silt	Moist, brown Silt with well-graded gravel. Gravel consists of greywacke with quartz veins and secondary black mineral. Appears to be disturbed overburden, with a mix of well-graded gravel and silt.																			Moist			
	2	4	Silt	Moist, grayish brown Silt with well-graded gravel. At 2.6 ft. a distinct color change to gray occurs. Gravel is greywacke with cinnabar and quartz.					X			X		X									Moist			
	4	6	Silt	Moist, dark grayish brown. 5.0 - 5.3 ft.: Mostly dark gray to black organic Silt, possibly the original ground surface (soil) before disturbance. 5.3 - 6.0 ft.: brown inorganic Silt. Loess.																			Moist			
	6	8	Silt	Moist, dark gray Silt with trace gravel. Iron staining seen at 7.2 - 7.5 ft. Loess.										X									Moist			
	8	10	Silt	Moist, dark grayish brown Silt with trace coarse to fine gravel. Fine sand below 8.7 ft. Loess.																			Moist	9.44		
	10	12	Silt	Moist, dark grayish brown Silt, with trace fine to medium sand and angular fine gravel. White banding in sandy Silt from 11.3 - 11.7 ft.																			Moist			
	12	14	Silt	Moist to Wet, dark grayish brown Silt with clay and fine sand, trace fine to coarse angular gravel. Gravel is angular siltstone, increases below 13 ft.																			Moist to Wet			
SM83	14	16	Silt	Moist, dark grayish brown Silt with white material at 15.7 ft.																			Moist		MW55	
	16	18	Weathered Bedrock - Greywacke, Siltstone, Shale	Wet, dark grayish brown weathered bedrock, mostly greywacke with beds of siltstone and shale. Greywacke weathered to brown at 17.5 ft., trace fine sand at 17.1 - 17.4 ft.																			Wet			
	18	20	Weathered Bedrock - Greywacke, Siltstone, Shale Shale, Siltstone	Wet, dark grayish brown. 18.0 - 18.2 ft.: As above. 18.2 - 20.0 ft.: Bedrock. Tan to black shale overlying reddish brown siltstone with iron staining.											X								Wet			10 - 20
	20	22	Bedrock - Shale	Moist, dark gray bedrock, composed of weak dark gray shale. Apparent bedding dip of 80 degrees. Trace quartz veins.								X											Moist			
	22	24	Bedrock - Shale Bedrock - Greywacke	Moist to Dry, dark reddish Greywacke bedrock. 22.0 - 22.3 ft.: As above. 22.3 - 24.0 ft.: Greywacke with iron staining. Quartz/calcite veins.								X			X								Dry to Moist			
	24	25	Bedrock - Greywacke	Dry, dark grayish brown, as above.								X			X								Dry			
	25	27	Bedrock - Argillite, Greywacke	Dry, dark gray bedrock, mostly argillite with quartz veins, trace orpiment. Trace greywacke.							X	X		X									Dry			

Table 2-5 Field Data Summary, 2017 Groundwater Monitoring Well Installation

Soil Boring ID	Sample Depth Interval (feet bgs)		Llithology	Lithological Description	Mineralogical/Lithological Observations												XRF Antimony		XRF Arsenic		XRF Mercury		Groundwater Observations		Monitoring Well Installation	
	Top	Bottom			Red Porous Rock	Vitrious "Slag"	Stibnite	Elem-ental Mercury	Cinnabar	Realgar	Orpiment	Vein Material	Red Rind	Sulfides	Iron Stain	Odor	Conc. (ppm)	Error	Conc. (ppm)	Error	Conc. (ppm)	Error	Moisture Observed in Soil Sample or Drill Cuttings	Static Water Level in Completed Well, 9/26/17 (feet bgs)	Monitoring Well ID	Monitoring Well Screened Interval (feet bgs)
	0	2	Silt	Moist, grayish brown Silt with gravel. Silt is soft., low plasticity, with some very fine sand. Trace organics. Gravel is 3 cm to >4 cm greywacke, weathered greywacke, and shale. Disturbed loess.													59	9	224	7	<LOD	5	Moist			
	2	5	Silt	Moist, dark grayish brown. 2.0 - 2.5 feet: dark brown, organic-rich Silt. 2.5 to 4 ft.: Loess with trace subrounded gravel. Silt is firm, low to medium plasticity.													<LOD	14	55	4	<LOD	6	Moist			
	5	7	Silt Weathered Bedrock - Shale	Moist, grayish brown Silt with gravel to 6.6 ft. Abundant gravel includes various Kuskokwim Group lithologies, subangular to angular. Silt has some very fine sand, no plasticity, is stiff. 6.6 to 7.0 ft. is beginning of weathered bedrock with decomposed shale showing apparent bedding dip of 30 degrees. Trace vein material at 6.6 ft.								X					<LOD	14	127	6	<LOD	6	Moist			
	7	10	Weathered Bedrock - Siltstone, Shale	Moist, reddish gray weathered bedrock, significantly decomposed. Siltstone, crumbly gray sandy greywacke with iron staining in fractures, and shale decomposing to clay. Iron stain throughout, apparent bedding dip of 60 degrees at 8.6 ft.											X		<LOD	13	102	5	<LOD	6	Moist			
	10	12	Weathered Bedrock - Siltstone, Greywacke	Moist, grayish brown weathered bedrock, dense. Siltstone and greywacke, some iron staining. Interstitial silt and very fine sand.											X		<LOD	13	108	5	11	4	Moist			
	12	14	Weathered Bedrock - Greywacke, Siltstone	Moist, dark grayish brown weathered greywacke with very fine sand grains, and some siltstone. Trace vein material at 12.1 ft.								X					<LOD	14	164	7	7	4	Moist			
	14	15	No Recovery	No recovery.													<LOD	14	157	6	<LOD	6	No Recovery			
	15	17	Bedrock - Siltstone, Greywacke	Dry, dark gray micaceous siltstone grading to greywacke.													<LOD	14	318	8	7	4	Dry			
	17	19.5	Weathered Bedrock - Greywacke	Dry, brownish gray greywacke weathered to brown, one grain of stibnite noted.			X							X			<LOD	13	527	10	11	4	Dry			
	19.5	22	Bedrock - Siltstone, Greywacke	Dry, dark gray siltstone with one grain of stibnite. Some greywacke and iron stain.			X							X	X		<LOD	15	257	8	11	5	Dry			
SM84	22	24.5	Bedrock - Shale	Dry, gray shale. Almost no larger cuttings, mostly clumps of pulverized clay.													<LOD	13	96	5	7	4	Dry		MW56	
	24.5	27	Bedrock - Argillite	Dry, black argillite. Weakly indurated, blocky.													30	10	203	7	6	4	Dry			
	27	29.5	Bedrock - Greywacke	Dry, gray greywacke. Very fine grained, with iron staining on fractures.											X		<LOD	13	183	7	<LOD	6	Dry			
	29.5	32	Bedrock - Shale, Argillite	Dry, black shale and argillite. Argillite is blocky.													<LOD	14	116	6	<LOD	6	Dry	29.92		
	32	34.5	Bedrock - Siltstone, Greywacke	Dry, dark gray siltstone grading to very fine greywacke. One stibnite crystal.			X							X			<LOD	13	106	5	8	4	Dry			
	34.5	37	Bedrock - Shale	Dry, black shale. Occasionally black and friable cuttings, otherwise light gray clay clumps.													<LOD	13	127	6	6	4	Dry			
	37	39.5	Bedrock - Argillite, Siltstone	Dry, black argillite and siltstone. Trace quartz.								X					<LOD	13	167	6	<LOD	6	Dry			
	39.5	42	Bedrock - Greywacke	Dry, gray greywacke. Fine grained, trace very fine stibnite and quartz grains. Iron stain in fractures.			X					X		X	X		<LOD	13	61	4	6	4	Dry			
	42	44.5	Bedrock - Greywacke, Shale	Dry, dark gray greywacke and shale.													<LOD	13	78	5	6	4	Dry			
	44.5	47	Bedrock - Shale, Greywacke	Dry, dark gray shale, some greywacke. Very few cuttings, mostly fines.													<LOD	13	75	5	<LOD	6	Dry			
	47	49.5	Weathered Bedrock - Greywacke	Dry, brownish gray, weak greywacke, weathered brown, few cuttings.													<LOD	13	109	5	<LOD	6	Dry			
	49.5	52	Bedrock - Greywacke	Dry, dark gray, as above.													<LOD	14	350	9	<LOD	6	Dry			
	52	54.5	Bedrock - Greywacke	Dry, gray, as above, trace quartz.								X					<LOD	13	1733	18	10	4	Dry			
	54.5	57	Bedrock - Argillite	Dry, black, argillite with quartz veins.								X					<LOD	14	120	6	<LOD	6	Dry			
	57	59.5	Bedrock - Argillite	Dry, black, blocky argillite with quartz veins.								X					<LOD	13	73	5	<LOD	6	Dry			
	59.5	62	Bedrock - Argillite, Siltstone	Wet, very dark gray, argillite and hard dark gray siltstone.													<LOD	13	69	5	<LOD	6	Wet			
	62	64.5	Bedrock - Argillite	Wet, black argillite, hard, blocky, with trace quartz.								X					<LOD	14	73	5	<LOD	6	Wet			
	64.5	67	Bedrock - Greywacke, Argillite	Wet, black to dark gray greywacke and argillite. Trace iron stain.											X		<LOD	13	83	5	<LOD	6	Wet			55 - 75
	67	69.5	Bedrock - Greywacke	Wet, gray, greywacke with slightly larger grain size (fine sand). Trace quartz veins.								X					<LOD	14	48	4	<LOD	6	Wet			
	69.5	72	Bedrock - Argillite	Wet, black argillite with trace quartz vein. Blocky to platy, larger cuttings.								X					<LOD	13	86	5	<LOD	6	Wet			
	72	74.5	Bedrock - Siltstone, Shale	Wet, very dark gray micaceous siltstone, occasionally iron stained brown. Some shale (as clumps of clay).											X		<LOD	14	73	5	<LOD	6	Wet			
	74.5	76	Bedrock - Siltstone	Wet, black siltstone. Trace quartz.								X					<LOD	13	65	4	<LOD	6	Wet			
SM85	0	1	Silt	Moist, medium brown Silt. Loess.																			Moist		MW57	
	1	2	Silt	Medium brown, moist to wet Silt. Loess. Moist from 1 - 1.5 ft., wet from 1.5 - 2 ft. Medium stiff.																			Moist to Wet			

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Soil Boring ID	Sample Depth Interval (feet bgs)		Llithology	Lithological Description	Mineralogical/Lithological Observations												XRF Antimony		XRF Arsenic		XRF Mercury		Groundwater Observations		Monitoring Well Installation	
	Top	Bottom			Red Porous Rock	Vitrious "Slag"	Stibnite	Elem-ental Mercury	Cinnabar	Realgar	Orpiment	Vein Material	Red Rind	Sulfides	Iron Stain	Odor	Conc. (ppm)	Error	Conc. (ppm)	Error	Conc. (ppm)	Error	Moisture Observed in Soil Sample or Drill Cuttings	Static Water Level in Completed Well, 9/26/17 (feet bgs)	Monitoring Well ID	Monitoring Well Screened Interval (feet bgs)
	2	3	Silt	Medium brown, moist to wet Silt. Loess. Wet from 2.0 - 2.5 ft., moist from 2.5 - 3.0 ft. Medium stiff.																			Moist to Wet			
	3	3.5	Silt	Medium brown, moist to wet Silt. Loess. Medium stiff.																			Moist			
	3.5	5	No Recovery	No recovery.																			No Recovery			
	5	7	Silt	Brown, wet, Silt. Soft. Color changes from brown to gray brown and red brown as depth increases. Angular gravel (fine to medium) occurs from 6.5 - 7 ft. Moisture changes from wet to moist from 6 - 7 ft.																			Moist to Wet			
	7	8.5	silty Sand	Moist light gray to reddish brown silty Sand. Appears to be a mixing of weathered sandstone and loess.																			Moist			
	8.5	10	No Recovery	No recovery.																			No Recovery			
	10	12	Gravel with sand	Moist, poorly-graded Gravel with sand. Gravel is broken weathered bedrock.																			Moist			
	12	13.75	Weathered Bedrock - Shale	Dark, reddish gray weathered shale bedrock. Fragments of competent shale with clayey/silty friable weathered shale bedrock.																			Moist			
	13.8	15	No Recovery	No recovery.																			No Recovery			
	15	17	Bedrock - Shale, Siltsone	Dry, dark brown, mostly weak and small friable shale cuttings with significant pulverized shale (clay) and few larger siltstone cuttings, with some iron staining.											X								Dry			
	17	19.5	Bedrock - Shale, Siltstone	Dry, dark brown friable shale with some siltstone cuttings, easily broken. Some iron staining along bedding/fractures.											X								Dry			
SM85	19.5	22	Bedrock - Shale	Dry, dark gray fragments of shale, some more friable than others. Orangish staining observed along fractures.											X								Dry		MW57	
	22	24.5	Bedrock - Shale	Dry, dark grayish brown. Dark gray friable shale with few more competent fragments. One fragment of yellowish white vein material observed. Fragments also had orangish staining in fractures.								X			X								Dry			
	24.5	27	Bedrock	Moist, brown, cuttings contained no fragments larger than coarse sand.																			Moist			
	27	29.5	Bedrock - Shale	Moist, brown, few rock fragments in recovery. Mostly friable shale. Orangish staining observed along fractures.											X								Moist	27.84		
	29.5	32	Bedrock - Greywacke, Shale	Dry, reddish brown, greywacke and few shale.																			Dry			
	32	34.5	Bedrock - Greywacke	Moist, reddish brown, hard to somewhat friable greywacke.																			Moist			
	34.5	37	Weathered Bedrock - Greywacke	Moist, reddish brown, weathered greywacke, in small fragments.																			Moist			
	37	39.5	Weathered Bedrock - Greywacke	Dry, reddish brown weathered greywacke. Fine to medium fragments. Some whiteish vein material.								X											Dry			
	39.5	42	Weathered Bedrock - Greywacke, Shale	Dry, gray, fine to medium angular fragments of roughly equal parts weathered greywacke and hard shale.																			Dry			
	42	44.5	Bedrock - Argillite, Shale	Dry, dark gray argillite/shale with trace white vein material.								X											Dry			
	44.5	47	Bedrock - Greywacke	Dry, light gray, greywacke. Some with orangish brown staining along fractures.											X								Dry			37.5 - 57.5
	47	49.5	Bedrock - Shale	Moist, dark gray, small subangular shale fragments. Friable.																			Moist			
	49.5	52	Bedrock - Argillite, Shale	Moist, dark gray argillite with few shale and some white vein material.								X											Moist			
	52	54.5	Bedrock - Siltstone	Wet, dark gray, siltstone with some white vein material.								X											Wet			
	54.5	57	Bedrock - Greywacke, Shale	Moist, dark gray, medium sized fragments of greywacke with small fragments of shale.																			Moist			
	57	59.5	Bedrock - Shale, Argillte	Moist, dark gray, mostly shale with some argillite and some vein material.								X											Moist			
	0	1	Silt	0.0 - 0.3 ft.: Wet dark brown organic material (tundra). 0.3 - 1.0 ft.: Medium brown, wet, medium stiff Silt, with trace fine rounded gravel.													<LOD	10	3	2	<LOD	4	Wet			
	1	2	Silt	Medium brown, wet, Silt, with trace coarse angular gravel. Stiffness increases with depth.													<LOD	9	3	2	<LOD	3	Wet			
	2	3	Silt	Medium brown to gray, wet to moist, medium stiff Silt, with few fine angular gravel.													<LOD	11	11	3	<LOD	4	Wet			
SM86	3	4	No Recovery	No recovery.																			No Recovery		MW58	
	4	5	No Recovery	No recovery.																			No Recovery			
	5	6	silty Gravel	Moist, brown to gray silty Gravel with sand. Mostly angular gravel, fine to coarse. Some silt, few sand, fine. Gravel consists of friable sandstone and shale.													<LOD	14	23	3	<LOD	6	Moist			
	6	7	silty Gravel	As above.													<LOD	13	20	4	<LOD	6	Moist			
	7	8	silty Gravel	As above.													<LOD	13	17	3	<LOD	5	Moist			

Table 2-5 Field Data Summary, 2017 Groundwater Monitoring Well Installation

Soil Boring ID	Sample Depth Interval (feet bgs) Top	Bottom	Llithology	Lithological Description	Red Porous Rock	Vitrious "Slag"	Stibnite	Elem-ental Mercury	Cinnabar	Realgar	Orpiment	Vein Material	Red Rind	Sulfides	Iron Stain	Odor	XRF Antimony Conc. (ppm)	XRF Antimony Error	XRF Arsenic Conc. (ppm)	XRF Arsenic Error	XRF Mercury Conc. (ppm)	XRF Mercury Error	Groundwater Observations: Moisture Observed in Soil Sample or Drill Cuttings	Static Water Level in Completed Well, 9/26/17 (feet bgs)	Monitoring Well ID	Monitoring Well Screened Interval (feet bgs)
SM86	8	9	silty Gravel	As above.													<LOD	12	24	3	<LOD	5	Moist			
	9	10	No Recovery	No recovery.																			No Recovery		MW58	
	10	12.5	Bedrock - Shale, Siltstone	Dry, dark gray to brown, mostly weak small friable shale cuttings with significant shale (pulverized to clay) and few larger siltstone cuttings, some iron staining.											X								Dry			
	12.5	15	Bedrock - Greywacke	Dry, dark gray to brown, fine grained micaceous greywacke.																			Dry			
	15	17.5	Bedrock - Siltstone, Shale	Dry, dark grayish brown, mostly angular Siltstone in small cuttings with iron staining. Trace shale pulverized to clay.											X								Dry			
	17.5	20	Bedrock - Shale, Greywacke	Dry, dark grayish brown, weak friable shale, mostly pulverized to clay. Few larger pieces with iron staining. Trace greywacke.											X								Dry			
	20	22.5	Weathered Bedrock - Greywacke, Argillite	Dry, dark reddish gray, mostly fine to medium grained greywacke weathered to brown, with trace argillite.																			Dry			
	22.5	25	Bedrock - Siltstone, Argillite	Dry, gray, siltstone with few iron staining and argillite.											X								Dry			
	25	27.5	Bedrock - Shale	Dry, dark grayish brown, weak friable shale, mostly pulverized to clay.																			Dry	25.96		
	27.5	30	Bedrock - Siltstone, Argillite	Dry, grayish brown, mostly siltstone with few iron staining. Few argillite cuttings.											X								Dry			
	30	32.5	Weathered Bedrock - Greywacke, Argillite	Dry, dark grayish brown, mostly fine grained, micaceous greywacke weathered to brown. Trace argillite.																			Dry			
	32.5	35	Weathered Bedrock - Argillite, Greywacke	Dry, dark gray to brown, mostly argillite, with some fine grained, greywacke weathered to brown.																			Dry			
	35	37.5	Bedrock - Argillite, Greywacke	Dry, dark gray to brown, as above, but with less greywacke.																			Dry			
	37.5	40	Weathered Bedrock - Greywacke	Dry, gray to brown, fine to medium grained greywacke with few fragments weathered to brown. Trace quartz veins, difficult drilling, larger cuttings.								X											Dry			36.6 - 56.6
	40	42.5	Weathered Bedrock - Greywacke	Dry, gray to brown, as above, but with more weathering to brown and smaller cuttings size.								X											Dry			
	42.5	45	Weathered Bedrock - Greywacke	Moist, gray, as above, with less weathering to brown and quartz veins. Greywacke is coarser, mostly medium grained.								X											Moist			
	45	47.5	Bedrock - Siltstone, Shale	Dry, gray, large cuttings of siltstone with some quartz veins, subangular, with trace shale as pulverized clay.								X											Dry			
	47.5	50	Bedrock - Greywacke, Shale	Moist, gray, mostly micaceous, medium grained greywacke with quartz veins. Small cuttings. Evidence of shale pulverized to clay (clumps).								X											Moist			
	50	52.5	Bedrock - Siltstone	Wet, dark gray siltstone with trace quartz veins.								X											Wet			
	52.5	55	Bedrock - Siltstone	Wet, dark gray, as above, but with larger cuttings and more quartz veins.								X											Wet			
	55	58	Bedrock - Siltstone, Argillite	Wet, dark gray, mostly subangular siltstone with quartz as veins and individual pieces up to 3 cm. Trace argillite.								X											Wet			
SM87	0	2	Silt	Moist, grayish brown, mostly Silt with few greywacke gravel fragments and trace sand.																			Moist		MW59	
	2	4	Silt	Moist, grayish brown, medium stiff Silt (loess).																			Moist			
	4	5	No Recovery	No recovery.																			No Recovery			
	5	7	Silt	Same as above. Medium stiff Silt.																			Moist			
	7	8.5	Silt	Moist to wet, grayish brown, mostly soft. Silt with few very fine sand.																			Moist to wet			
	8.5	10	No Recovery	No recovery.																			No Recovery			
	10	12	Gravel Weathered Bedrock - Shale, Greywacke	10.0 - 10.4 ft.: As above. Moist, dark brown. 10.4 - 12.0 ft.: Weathered bedrock consisting mostly of gravel, coarse, angular (shale and greywacke) and some silt.																			Moist			
	12	14	Weathered Bedrock - Shale, Greywacke	Moist, dark brown weathered bedrock consisting mostly of gravel, coarse, angular shale and greywacke, and some silt.																			Moist			
	14	15	No Recovery	No recovery.																			No Recovery			
	15	17	Weathered Bedrock - Greywacke	Moist, reddish brown, weathered greywacke. Mostly silt in cuttings, some to few greywacke fragments.																			Moist			
	17	19.5	Weathered Bedrock - Shale, Argillite	Dry, very dark grayish brown, mostly silt, few fragments of friable shale and weathered argillite.																			Dry			
	19.5	22	Bedrock - Greywacke	Moist, grayish brown. Mostly light gray medium stiff silt/clay with medium to fine sand embedded. Trace fine grained greywacke fragments.																			Moist			

Table 2-5 Field Data Summary, 2017 Groundwater Monitoring Well Installation

Soil Boring ID	Sample Depth Interval (feet bgs)		Llithology	Lithological Description	Mineralogical/Lithological Observations												XRF Antimony		XRF Arsenic		XRF Mercury		Groundwater Observations		Monitoring Well Installation	
	Top	Bottom			Red Porous Rock	Vitrious "Slag"	Stibnite	Elem-ental Mercury	Cinnabar	Realgar	Orpiment	Vein Material	Red Rind	Sulfides	Iron Stain	Odor	Conc. (ppm)	Error	Conc. (ppm)	Error	Conc. (ppm)	Error	Moisture Observed in Soil Sample or Drill Cuttings	Static Water Level in Completed Well, 9/26/17 (feet bgs)	Monitoring Well ID	Monitoring Well Screened Interval (feet bgs)
SM87	22	24.5	Weathered Bedrock - Greywacke	Moist, light reddish brown, mostly fine grained greywacke with greenish orange staining along fractures. Slightly weathered.											X								Moist		MW59	
	24.5	27	Bedrock - Greywacke, Silstone	Dry, light brownish gray. Mostly orangish gray, very fine grained greywacke. Few to trace siltstone. Greywacke had orangish staining along fractures.											X								Dry			
	27	29.5	Weathered Bedrock - Greywacke, Argillite	Mostly slightly weathered greywacke, few weathered argillite. Greywacke has orangish staining along fractures.											X								Dry			
	29.5	32	Bedrock - Greywacke	Dry, reddish brown, very fine grained greywacke with orangish staining along fractures.											X								Dry			
	32	34.5	Weathered Bedrock - Greywacke, Argillite	Moist, reddish brown weathered greywacke with trace white vein material. Argillite had orangish staining along fractures.								X			X								Moist			
	34.5	37	Bedrock - Greywacke, Argillite	Moist, reddish brown, as above, with no white vein material observed.											X								Moist			
	37	39.5	Bedrock - Greywacke	Moist, reddish brown, as above. Greywacke. No vein material.											X								Moist			
	39.5	42	Weathered Bedrock - Argillite	Moist, dark gray, weathered friable argillite.																			Moist			
	42	44.5	Bedrock - Greywacke, Argillite	Moist, dark reddish gray, mostly greywacke with orangish staining along fractures, and few friable argillite fragments.											X								Moist			
	44.5	47	Bedrock - Argillite	Moist, dark gray, somewhat friable argillite with some orangish staining along fractures.											X								Moist			
	47	49.5	Bedrock - Argillite	Moist, dark gray, as above. Friable argillite.											X								Moist			
	49.5	52	Bedrock - Argillite, Greywacke	Moist, dark gray, mostly friable argillite with few greywacke. Some argillite is micaceous. Greywacke has orangish staining along fractures.											X								Moist			
	52	54.5	Bedrock - Greywacke	Moist, reddish brown, greywacke with orangish staining along fractures.											X								Moist			
	54.5	57	Bedrock - Greywacke, Argillite, Shale	Moist, grayish brown, mostly greywacke with few friable argillite and trace shale. Some of the greywacke had organgish staining along fractures, some was a light gray color.											X								Moist			
	57	59.5	Bedrock - Argillite, Greywacke	Dry, dark gray, mostly argillite with few greywacke. Argillite friable with some orangish staining along fractures.											X								Dry			
	59.5	62	Bedrock - Greywacke	Moist, gray greywacke with trace white vein material and trace orangish staining along fractures.								X			X								Moist			
	62	64.5	Bedrock - Greywacke	Moist, gray greywacke with some orangish staining along fractures.											X								Moist			
	64.5	67	Bedrock - Greywacke	Moist, dark reddish brown greywacke with orangish staining along fractures and trace white vein material.								X			X								Moist			
	67	69.5	Bedrock - Argillite	Moist, dark reddish brown argillite with orangish staining along fractures and trace white vein material.								X			X								Moist			
	69.5	72	Bedrock - Argillte, Greywacke	Dry, dark reddish brown argillite and greywacke with orangish staining along fractures and trace white vein material.								X			X								Dry			
	72	74.5	Bedrock - Argillite	Dry, dark gray, somewhat friable argillite.																			Dry			
	74.5	77	Bedrock - Greywacke	Dry, dark reddish brown greywacke with some orangish staining along fractures.											X								Dry			
	77	79.5	Bedrock - Argillite	Dry, dark gray argillite.																			Dry			
	79.5	82	Bedrock - Argillite	Dry, dark gray argillite.																			Dry			
	82	84.5	Bedrock - Greywacke	Dry, dark gray greywacke. Few orangish staining along fractures.											X								Dry			
	84.5	87	Bedrock - Argillite, Shale	Dry, dark gray, mostly argillite with some shale.																			Dry			
	87	89.5	Bedrock - Greywacke	Dry, dark gray greywacke with trace white vein material and trace orangish staining along fractures.								X			X								Dry			
	89.5	92	Bedrock - Greywacke	Dry, gray greywacke with trace orangish staining along fracture.											X								Dry			
	92	94.5	Bedrock - Argillte, Shale	Dry, dark gray, mostly argillite with few shale and few white to yellowish vein material.								X											Dry			
	94.5	97	Bedrock - Argillite, Greywacke	Dry, dark gray argillite with trace greywacke.																			Dry			
	97	99.5	Bedrock - Argillite	Dry, dark gray argillite.																			Dry			
	99.5	102	Bedrock - Argillite	Dry, dark gray argillite with trace white vein material.								X											Dry			
	102	104.5	Bedrock - Argillite, Shale	Moist, dark gray, mostly argillite with few to some shale.																			Moist			
	105	107	Bedrock - Argillite	Dry, dark gray, argillite with few to some white vein material.								X											Dry			
	107	109.5	Bedrock - Greywacke	Dry, dark gray greywacke with trace white vein material.								X											Dry			
	110	112	Bedrock - Argillite, Greywacke	Dry, dark gray, mostly argillite with few greywacke.																			Dry			
	112	114.5	Bedrock - Argillite, Greywacke	Dry, dark gray mostly argillite with few greywacke and few white vein material.								X			_								Dry			

Table 2-5 Field Data Summary, 2017 Groundwater Monitoring Well Installation

Soil Boring ID	Sample Depth Interval (feet bgs)		Llithology	Lithological Description	Mineralogical/Lithological Observations												XRF Antimony		XRF Arsenic		XRF Mercury		Groundwater Observations		Monitoring Well Installation	
	Top	Bottom			Red Porous Rock	Vitrious "Slag"	Stibnite	Elem-ental Mercury	Cinnabar	Realgar	Orpiment	Vein Material	Red Rind	Sulfides	Iron Stain	Odor	Conc. (ppm)	Error	Conc. (ppm)	Error	Conc. (ppm)	Error	Moisture Observed in Soil Sample or Drill Cuttings	Static Water Level in Completed Well, 9/26/17 (feet bgs)	Monitoring Well ID	Monitoring Well Screened Interval (feet bgs)
	115	117	Bedrock - Argillite, Shale	Dry, dark gray, mostly argillite with some shale.																			Dry			
	117	119.5	Bedrock - Argillite	Dry, dark gray argillite.																			Dry			
	120	122	Bedrock - Argillite	Dry, dark gray argillite.																			Dry			
	122	124.5	Bedrock - Argillite	Dry, dark gray argillite with trace white vein material.								X											Dry			
	125	127	Bedrock - Argillite	Dry, dark gray argillite with trace white vein material.								X											Dry			
	127	129.5	Bedrock - Greywacke	Dry, dark gray greywacke. No vein material, no staining.																			Dry			
	130	132	Bedrock - Greywacke	Dry, dark gray greywacke with trace white vein material.								X											Dry			
	132	134.5	Bedrock - Greywacke	Dry, dark gray, fine to very fine grained greywacke with trace white vein material.								X											Dry			
	135	137	Bedrock - Greywacke, Argillite	Dry, dark gray, mostly greywacke with some argillite and trace white vein material.								X											Dry	134.92		
	137	139.5	Bedrock - Argillite	Dry, dark gray argillite with trace to few white vein material.								X											Dry			
SM87	140	140	No Recovery	No recovery.																			Dry		MW59	
	140	142	Bedrock - Argillite	Dry, dark gray argillite with some vein material.								X											Dry			
	142	144.5	Bedrock - Greywacke	Dry, dark gray greywacke with trace vein material.								X											Dry			
	145	147	Bedrock - Argillite	Dry, dark gray argillite.																			Dry			
	147	149.5	Bedrock - Greywacke, Argillite	Dry, dark gray, mostly greywacke with few argillite and few vein material.								X											Dry			
	150	152	Bedrock - Greywacke	Dry, dark gray greywacke with trace vein material.								X											Dry			
	152	154.5	Bedrock - Greywacke	Wet, dark gray, as above.								X											Wet			140 - 160
	155	157	Bedrock - Greywacke	Wet, dark gray, as above, slightly smaller fragment size.								X											Wet			
	157	159.5	Bedrock - Greywacke	Dry, dark gray, as above.								X											Dry			
	160	161	NR	NR																			No Record			

Key
<LOD = Less than level of detection for XRF
bgs = below ground surface
cm = centimeters
Conc. = Concentration
Fe = iron
ft. = feet
Hg = mercury
ID = identifier
mm = millimeters
NR = not reported
ppm = parts per million
XRF = X-ray fluoresence spectroscopy

Table 2-6 2017 Surface Mined Area Laboratory Soil Sample Results

Soil Boring ID	Sample ID	Sample Depth Interval (feet bgs)		Total Inorganic Elements (mg/kg)																							Total Organic Carbon
				Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc	
		Top	Bottom	SW846 6010B	SW846 6020A	SW846 6020A	SW846 6020A	SW846 6020A	SW846 6020A	SW846 6010B	SW846 6020A	SW846 6020A	SW846 6020A	SW846 6010B	SW846 6020A	SW846 6010B	SW846 6020A	SW846 7471A	SW846 6020A	SW846 6010B	SW846 6020A	SW846 6020A	SW846 6010B	SW846 6020A	SW846 6020A	SW846 6020A	SW846 9060
SM78	17SM78SB09	0	9	15000 J	5	17 J	160 J +	0.42	0.21	2200 J +	25 J +	9	26 J	20000	7.6 J	4500 J +	270	3 J	26	590 J +	0.7 J +	0.086	92 J	0.089 J	40 J +	61 J	4500
	17SM78SB17	9	17.6	14000 J	2.9	36 J	160 J +	0.53	0.2	1500 J +	25 J +	12	29 J	28000	7.8 J	3900 J +	550	0.65	27	560 J +	0.78 J +	0.092	77 J	0.083	46 J +	61 J	9400
SM79	17SM79SB05	0	5	16000 J	0.79	10 J	120 J +	0.43	0.19	1900 J +	25 J +	10	24 J	25000	7.2 J	4900 J +	410	0.08	26	570 J +	0.71 J +	0.073	85 J	0.093 J	41 J +	58 J	5100
	17SM79SB11	5	11	14000 J	0.89	12 J	160 J +	0.4	0.2	2600 J +	24 J +	9.8	23 J	23000	6.7 J	4600 J +	390	0.11	24	570 J +	0.75 J +	0.075	120	0.084 J	40 J +	53 J	2000
SM81	17SM81SB03	0	3	15000 J	1.1	11 J	160 J +	0.42	0.16	1900 J +	24 J +	9.2	22 J	25000	7.6 J	4400 J +	350	0.094	23	510 J +	0.65 J +	0.089	82 J	0.086 J	42 J +	54 J	8300
	17SM81SB07	3	7.2	12000 J	0.98	13 J	160 J +	0.43	0.29	2600 J +	26 J +	11	31 J	28000	8.1 J	4000 J +	610	0.33	28	690 J +	0.86 J +	0.1	110 J	0.082 J	43 J +	65 J	3300
SM82	17SM82SB06	0	5.5	15000 J	1.2	12 J	140 J +	0.38	0.19	1800 J +	26 J +	8.3	24 J	22000	7.2 J	4600 J +	350	0.31	24	570 J +	0.84 J +	0.074	78 J	0.088 J	41 J +	56 J	9800
	17SM82SB09	5.5	8.5	5300 J	5	110 J	120 J +	0.85	0.55	1500 J +	15 J +	14	73 J	33000	16 J	1100 J +	630	5.4	52	870 J +	1.2 J +	0.17	37 J	0.09 J	31 J +	110 J	4000
SM86	17SM86SB03	0	3	15000 J	1.3	16 J	120 J +	0.45	0.24	840 J +	23 J +	12	28 J	27000	9.7 J	3300 J +	720	0.53	28	560 J +	0.85 J +	0.12	49 J	0.1 J	42 J +	69 J	15000

Key

bgs = below ground surface

ID = identifier

J = The analyte was detected. The associated result is estimated.

J+ = The analyte was detected. The value is estimated with a high bias.

Table 2-7 2017 Geotechnical Laboratory Test Results

Geotechnical Tests — Direct Push Soil Core (Disturbed)

Soil Boring ID	Sample ID	Sample Depth Interval (ft bgs)	USCS Soil Type (ASTM 2487)	Moisture Content (ASTM D2216)	Specific Gravity of Soil Solids (ASTM D854/C127)	Grain Size Distribution with Hydrometer (ASTM D422): Gravel [#4 (4.75mm) to 3-inch] (%)	Grain Size Distribution with Hydrometer (ASTM D422): Sand [#200 (0.075mm) to #4] (%)	Grain Size Distribution with Hydrometer (ASTM D422): Silt [0.005mm to 0.075mm] (%)	Grain Size Distribution with Hydrometer (ASTM D422): Clay/ Colloids [<0.005mm] (%)	Liquid Limit, Plastic Limit, and Plasticity Index of Soils (ASTM D4318): Liquid Limit	Liquid Limit, Plastic Limit, and Plasticity Index of Soils (ASTM D4318): Plastic Limit	Liquid Limit, Plastic Limit, and Plasticity Index of Soils (ASTM D4318): Plascicity Index	Compaction Characteristics of Soil Using Standard Effort (Standard Proctor) (ASTM D698): Maximum Dry Density (pcf)	Compaction Characteristics of Soil Using Standard Effort (Standard Proctor) (ASTM D698): Optimum Moisture Content (%)	Initial Dry Bulk Density - Sample Remolded to 90% Compaction at Optimal Moisture Content (ASTM D7263) (pcf)	Porosity of Sample Remolded to 90% Compaction at Optimal Moisture Content Caltulated Using Results of Bulk Density (ASTM D7263) and Grain Density (ASTM D854)	Hydraulic Conductivity Using Flexible Wall Permeameter (ASTM D5084) - Sample Remolded to 90% Compaction at Optimal Moisture Content (m/s)
SM78	17SM78SB09	0-9	Silt (ML)	21.0	2.71	5	9	72	14	NP	NP	--	109.5	16.0	98.6	0.417	8.2E-08
SM78	17SM78SB17	10-17											102.4	19.4	92.2	0.455	6.2E-07
SM79	17SM79SB05	0-5	Silt (ML)	24.9	2.72	0	4	86	9				101.2	19.4	91.0	0.464	2.5E-06
SM79	17SM79SB11	5-11											103.7	18.0	93.3	0.450	1.8E-06
SM81	17SM81SB03	0-3	Silt (ML)	26.2	2.70	0	6	79	14	NP	NP	--	105.2	18.0	94.7	0.438	2.7E-08
SM81	17SM81SB07	3-7											109.0	16.8	98.1	0.422	2.1E-07
SM82	17SM82SB06	0-6	Silt (ML)	28.5	2.70	2	8	77	13				102.0	19.2	91.9	0.455	2.5E-07
SM82	17SM82SB09	6-9											115.2	15.0	103.7	0.393	3.9E-08
SM86	17SM86SB1.5	0-1.5	Silt with Sand (ML)	50.5	2.54	7	14	69	9	NP	NP	--	78.9 (corrected for 7.2% oversize particles)	34.0 (corrected for 7.2% oversize particles)	68.6	0.567	2.3E-07

Geotechnical Tests — Shelby Tube (Undisturbed)

Soil Boring ID	Sample ID	Sample Depth Interval (ft bgs)	USCS Soil Type	Bulk Density (ASTM D7263) - Undisturbed Sample: Total (Moist) Density (g/cm³)	Bulk Density (ASTM D7263) - Undisturbed Sample: Dry Density (g/cm³)	Bulk Density (ASTM D7263) - Undisturbed Sample: Dry Density (pcf)	Porosity of Undis-turbed Sample Calculated Using Results of Bulk Density (ASTM D7263) and Grain Density (ASTM D854)	Hydraulic Conductivity Using Flexible Wall Permeameter (ASTM D5084) - Undisturbed Sample	Moisture Content (ASTM D2216)	Specific Gravity of Soil Solids (ASTM D854/ C127)	Grain Size Distribution with Hydrometer (ASTM D422): Gravel [#4 (4.75mm) to 3-inch] (%)	Grain Size Distribution with Hydrometer (ASTM D422): Sand [#200 (0.075mm) to #4] (%)	Grain Size Distribution with Hydrometer (ASTM D422): Silt [0.005mm to 0.075mm] (%)	Grain Size Distribution with Hydrometer (ASTM D422): Clay/ Colloids [<0.005mm] (%)	Liquid Limit, Plastic Limit, and Plasticity Index of Soils (ASTM D4318): Liquid Limit	Liquid Limit, Plastic Limit, and Plasticity Index of Soils (ASTM D4318): Plastic Limit	Liquid Limit, Plastic Limit, and Plasticity Index of Soils (ASTM D4318): Plascicity Index
SM78	17SM78SB12	9-12	Silt (ML)	1.649	1.288	80.38	0.525	1.1E-07	28.0	2.71	0	8	72	20	NP	NP	--
SM79	17SM79SB08	5-8	Silt (ML)	1.607	1.356	84.65	0.501	8.2E-07	18.5	2.72	0	7	86	7	NP	NP	--
SM81	17SM81SB06	3-6	Silt (ML)	1.895	1.535	95.80	0.436	2.1E-08	23.5	2.72	1	7	77	15	NP	NP	--
SM82	17SM82SB8.5	5.5-8.5	Lean Clay with Sand (CL)	2.081	1.752	109.37	0.360	2.4E-09	18.8	2.74	4	15	51	30	31	21	10
SM86	17SM86SB04	1-4		1.782	1.315	82.07	0.516	2.4E-07	35.5	2.72	19	14	55	12	NP	NP	--

Key
ASTM = ASTM International (formerly American Society of Testing and Materials)
-- = not tested or not applicable
% = percent
bgs = below ground surface
ft. = feet
g/cm^3 = grams per cubic centimeter
ID = identifier
m/s = meters per second
mm = millimeters
NP = non plastic
pcf = pounds per cubic foot
USCS = Unified Soil Classification System

Ecology & Environment, Inc. GIS Department Project:
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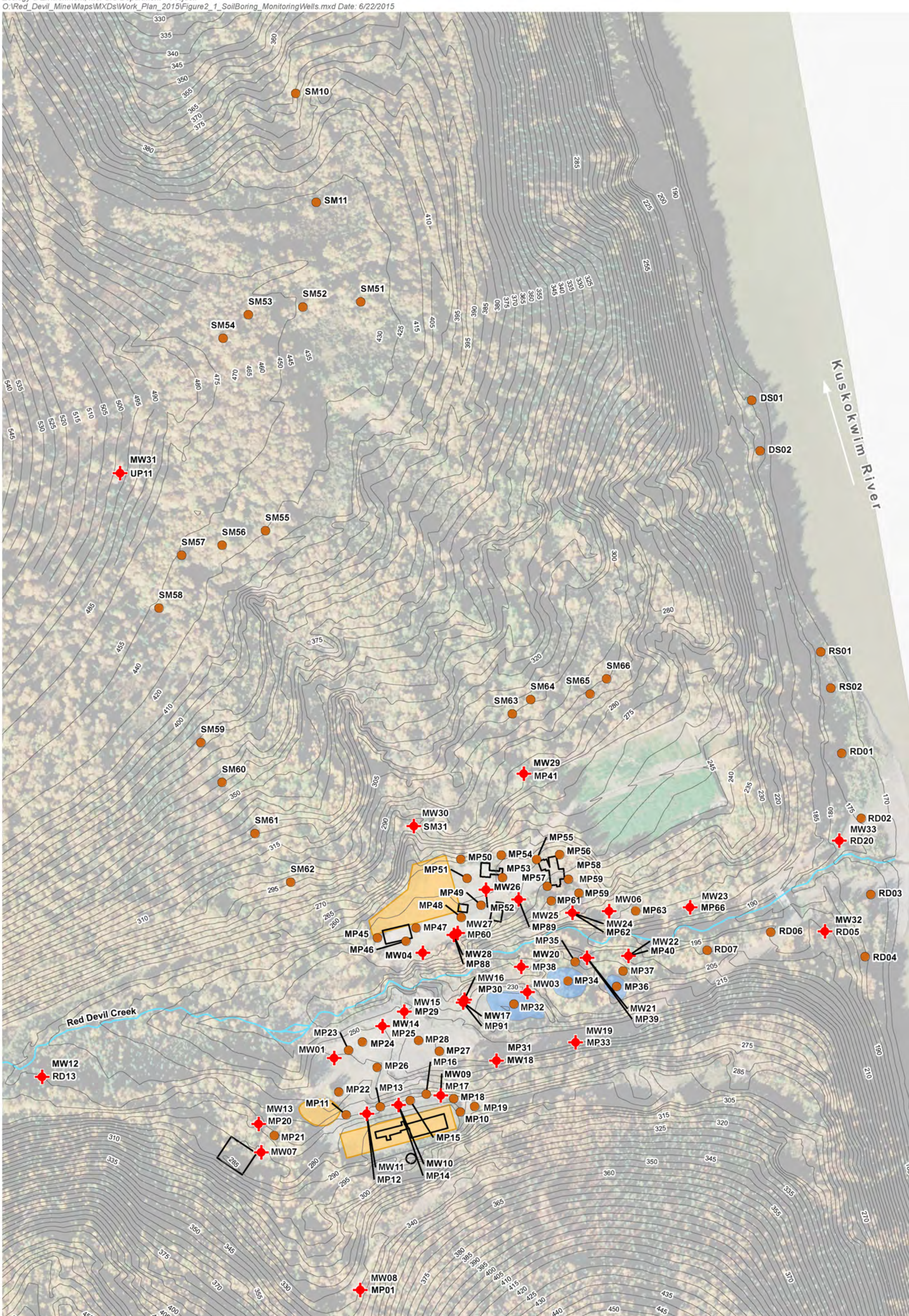

RI Monitoring Well ID
Soil Boring ID

RI Soil Boring

2010 5-foot Contour

Red Devil Creek

Settling Pond

Monofill

Historical Structure

RED DEVIL MINE

Red Devil, Alaska

Figure 2-1
RI Soil Boring and Monitoring Well Locations

0 50 100 200 300 400
Feet

0 12.5 25 50 75 100 125
Meters

Scale 1:2,500

Digital aerial orthophotograph taken on September 21, 2010 (AeroMetric 2010)

Digital 2010 5-foot topographic contours based on the aerial orthophotograph taken on September 21, 2010 (AeroMetric 2012)

Ecology & Environment, Inc. GIS Department Project:
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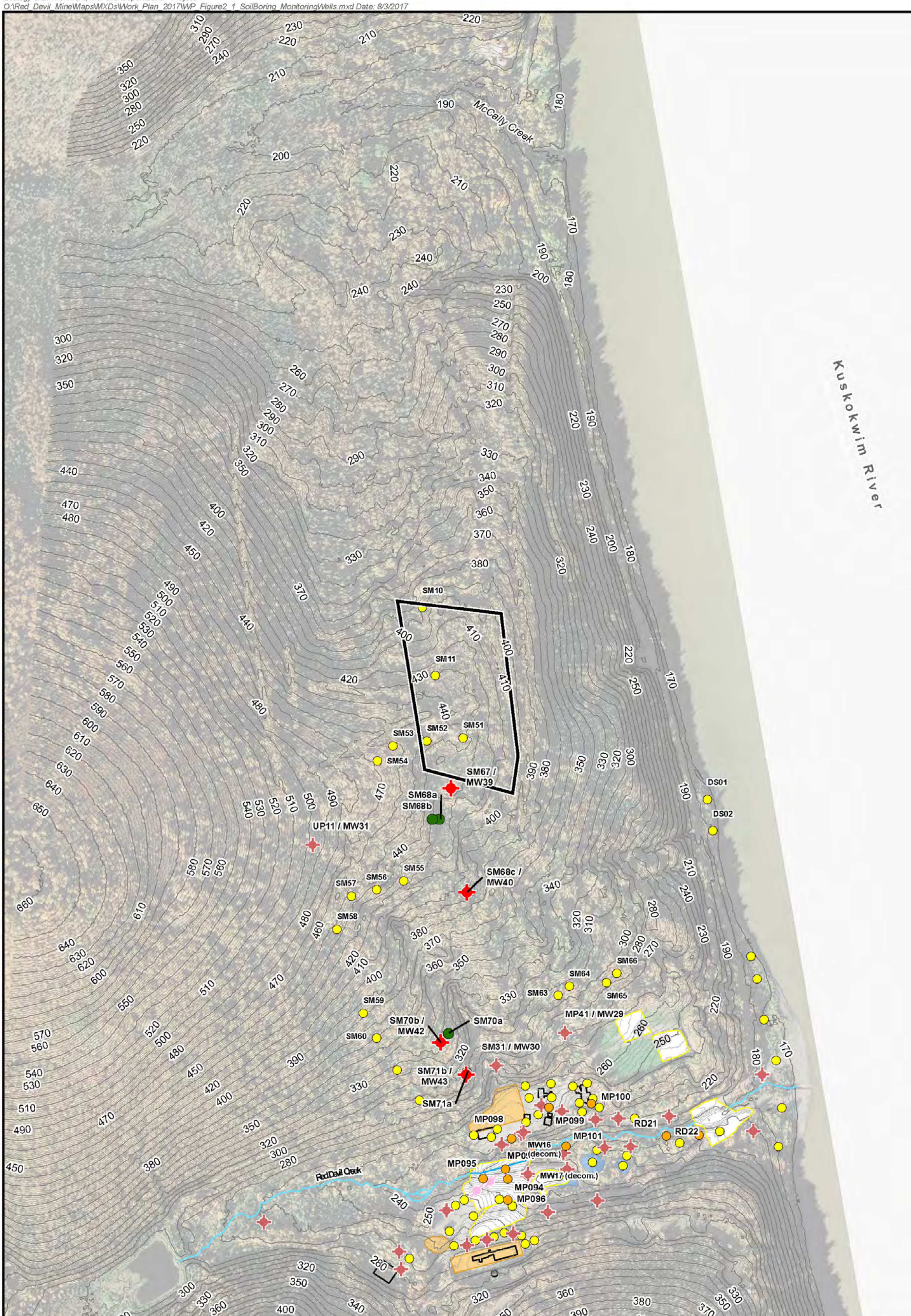


RI Supplement Soil Boring	2015 2-foot Contour	Settling Pond	
RI Supplement Soil Boring/Monitoring Well Location – Abandoned	2015 10-foot Contour	Monofill	
RI Supplement Soil Boring / Monitoring Well	Area of 2014 NTCRA Re-grading	Historical Structure	
RI Monitoring Well	Post-NTCRA Stream Alignment	Approximate Location of Proposed Repository Footprint	
Decommissioned RI Monitoring Well	Red Devil Creek	Seep Location	
RI Soil Boring			

RED DEVIL MINE

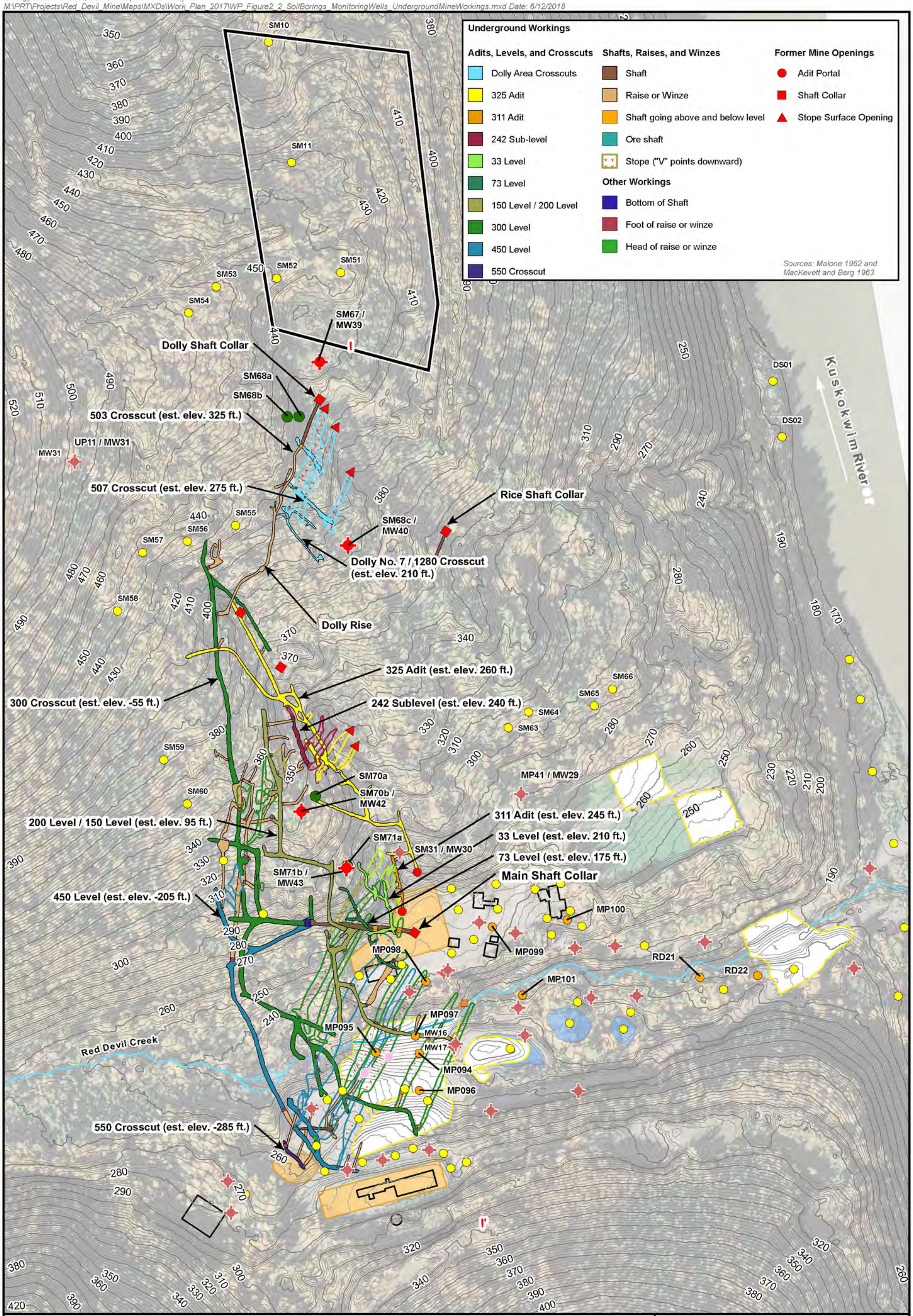
Red Devil, Alaska

Figure 2-2
RI and RI Supplement Soil Borings and Monitoring Wells

0 75 150 300 450 600
Feet
0 20 40 80 120 160 200
Meters
Scale 1:4,000

Digital 2015 10-foot and 2-foot topographic contours based on October 10, 2015 LiDAR Survey (QSI 2015).

Ecology & Environment, Inc. GIS Department Project:
M:\PRT\Projects\Red_Devil_Mine\Maps\MXDs\Work_Plan_2017\WP_Figure2_2_SoilBorings_MonitoringWells_UndergroundMineWorkings.mxd Date: 6/12/2018



RI Supplement Soil Boring	2015 2-foot Contour	Settling Pond
RI Supplement Soil Boring/Monitoring Well Location – Abandoned	2015 10-foot Contour	Monofill
RI Supplement Soil Boring / Monitoring Well	Area of 2014 NTCRA Re-grading	Historical Structure
RI Monitoring Well	Post-NTCRA Stream Alignment	Approximate Location of Proposed Repository Footprint
Decommissioned RI Monitoring Well	Red Devil Creek	Seep Location
RI Soil Boring	Line of Geologic Cross Section I-I'	

Digital 2015 5-foot topographic contours based on Octobr 10, 2015 LiDAR Survey (Quantum Spatial 2015).

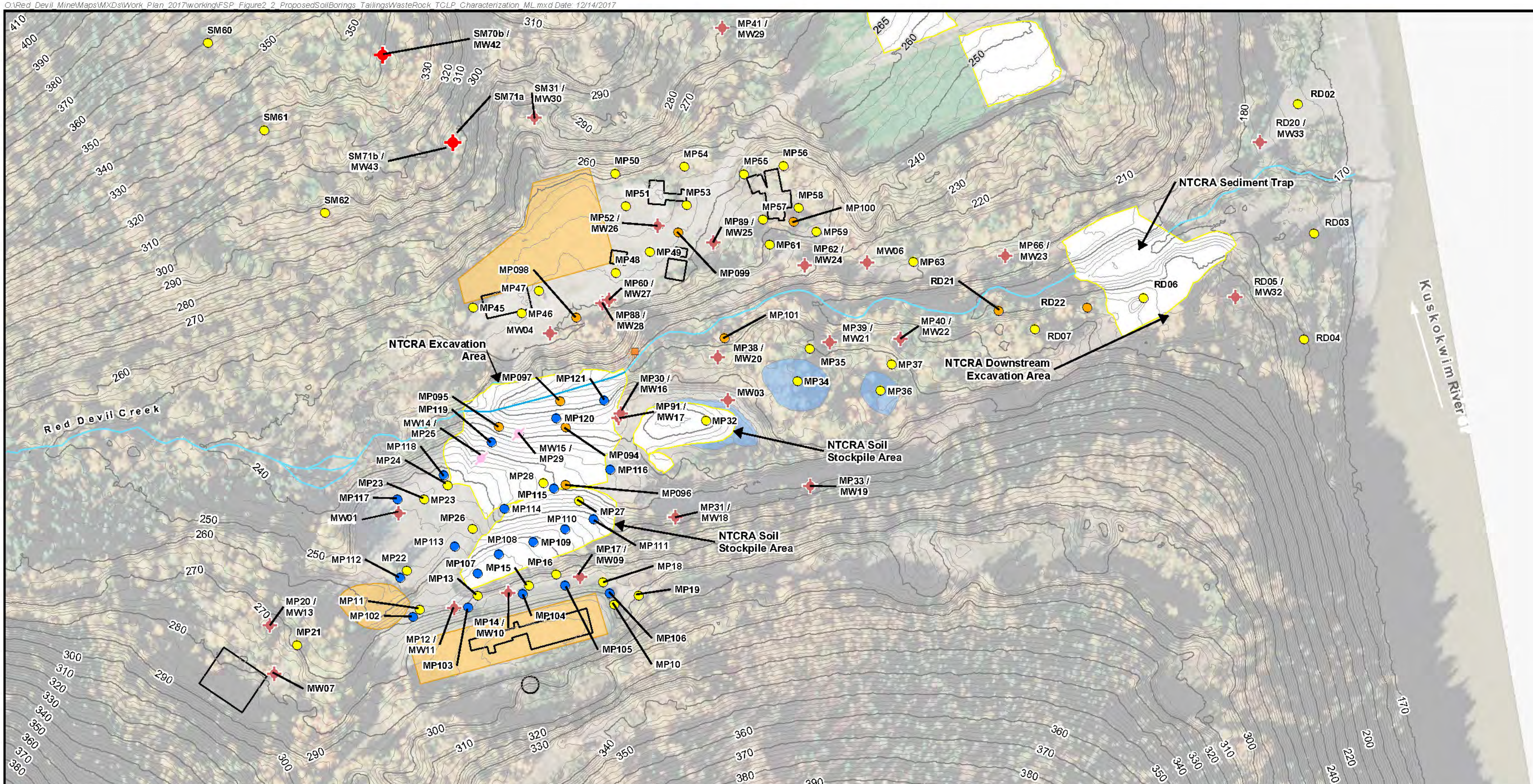
RED DEVIL MINE

Red Devil, Alaska

Figure 2-3
RI and RI Supplement Soil Boring and Monitoring Well Locations and Underground Mine Workings

0 37.5 75 150 225 300
Feet
0 10 20 40 60 80 100
Meters
Scale 1:2,500

Ecology & Environment, Inc. GIS Department Project: O:\Red_Devil_Mine\Maps\MXDs\Work_Plan_2017\working\FSP_Figure2_2_ProposedSoilBorings_TailingsWasteRock_TCLP_Characterization_ML.mxd Date: 12/14/2017



- 2017 Soil Boring Location
- RI Supplement Soil Boring
- RI Soil Boring / Monitoring Well
- Decommissioned RI Monitoring Well
- RI Soil Boring
- 2015 2-foot Contour
- 2015 10-foot Contour
- Area of 2014 NTCRA Re-grading
- Post-NTCRA Stream Alignment
- Red Devil Creek
- Settling Pond
- Monofill
- Historical Structure
- Approximate Location of Proposed Repository Footprint
- Seep Location

RED DEVIL MINE

Red Devil, Alaska

Figure 2-4

Soil Boring Locations 2017 Tailings / Waste Rock TCLP Characterization

0 25 50 100 150 200 Feet

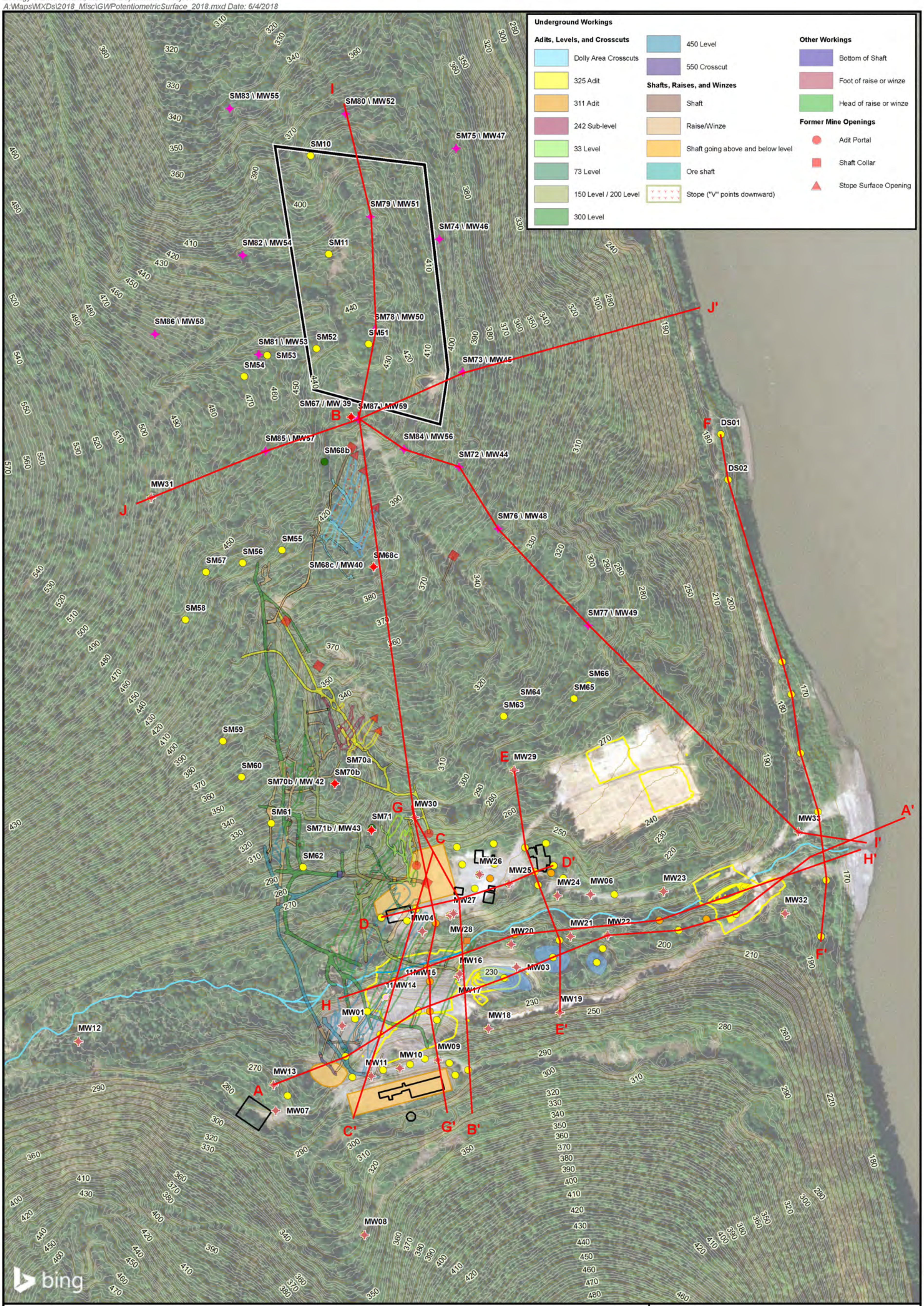
0 7.5 15 30 45 60 75 Meters

Scale 1:1,500

Digital 2015 5-foot topographic contours based on Octobr 10, 2015 LiDAR Survey (Quantum Spatial 2015).

Ecology & Environment, Inc. GIS Department Project:
R:\ACTIVE\Red Devil Mine\GIS - Seattle mirror\Work Products\Figure A-3 MW locations_JR.mxd Date: 1/2/2018

Ecology & Environment, Inc. GIS Department Project: A:\Maps\MXDs\2018_Misc\GWPotentiometricSurface_2018.mxd Date: 6/4/2018



2017 Monitoring Well
RI Supplement Monitoring Well
RI Monitoring Well
Abandoned RI Monitoring Well
RI Soil Boring
RI Supplement Soil Boring
RI Supplement Borehole / Monitoring Well Location - Abandoned
Seep Location
2015 2-foot Contour
2015 10-foot Contour
Post-NTCRA Stream Alignment
Red Devil Creek
Area of 2014 NTCRA Re-grading
Settling Pond
Monofill
Historical Structure
Approximate Location of Proposed Repository Footprint
Line of Geologic Cross Section

RED DEVIL MINE

Red Devil, Alaska

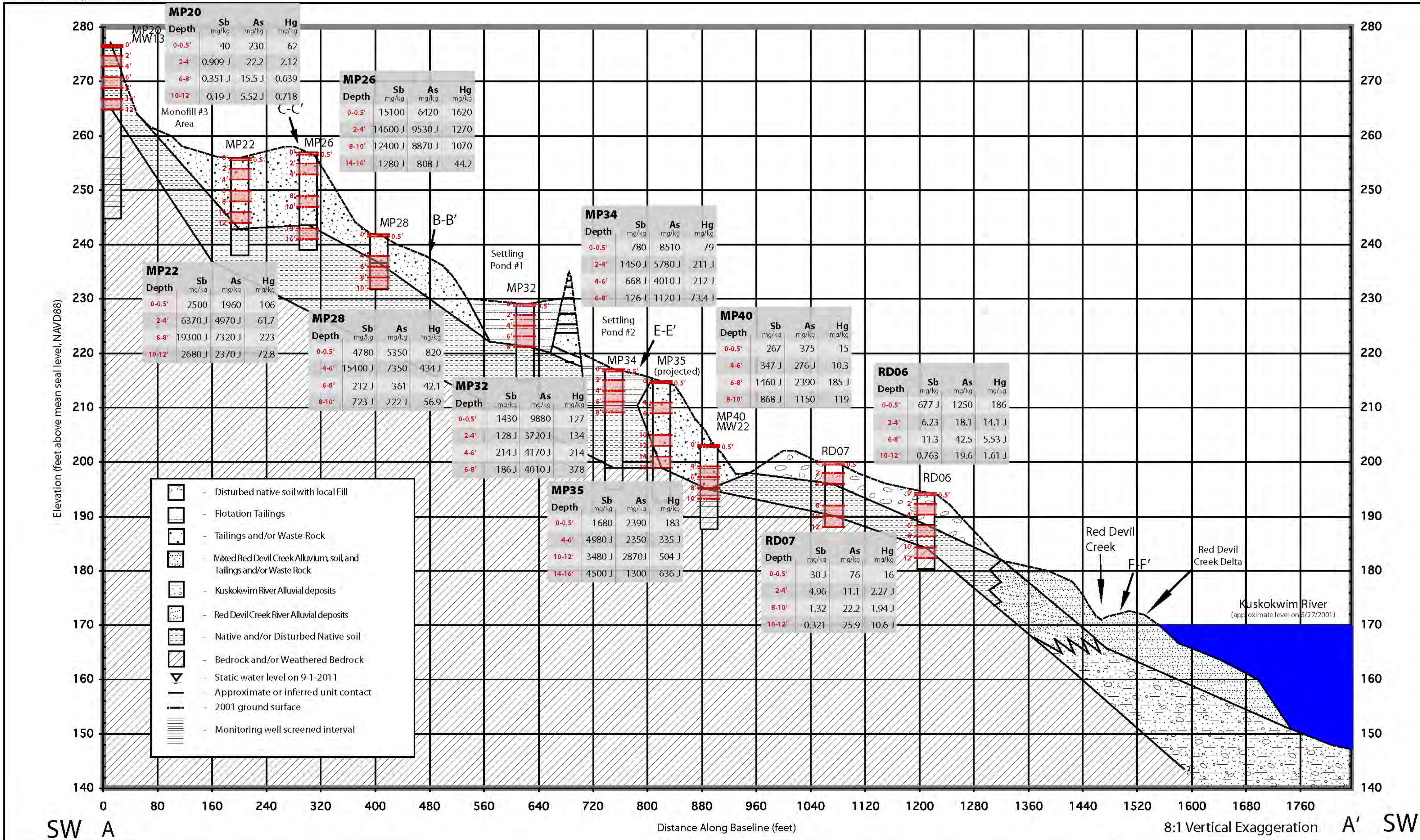
Figure 2-6

Lines of Geologic Cross Sections

0 50 100 200 300 400
Feet
0 12.5 25 50 75 100
Meters
Scale 1:2,000

Source: Malone 1962 and MacKevett and Berg 1963

02:EE-001096-0070-08\Figure 4-17 A-A'ai-01/02/13-GRA



MP20

Depth	Sb mg/kg	As mg/kg	Hg mg/kg
0-0.5′	40	230	62
2-4′	0.909 J	22.2	2.12
6-8′	0.351 J	15.5 J	0.639
10-12′	0.19 J	5.52 J	0.718

MP26

Depth	Sb mg/kg	As mg/kg	Hg mg/kg
0-0.5′	15100	6420	1620
2-4′	14600 J	9530 J	1270
8-10′	12400 J	8870 J	1070
14-16′	1280 J	808 J	44.2

MP22

Depth	Sb mg/kg	As mg/kg	Hg mg/kg
0-0.5′	2500	1960	106
2-4′	6370 J	4970 J	61.7
6-8′	19300 J	7320 J	223
10-12′	2680 J	2370 J	72.8

MP28

Depth	Sb mg/kg	As mg/kg	Hg mg/kg
0-0.5′	4780	5350	820
4-6′	15400 J	7350	434 J
6-8′	212 J	361	42.1
8-10′	723 J	222 J	56.9

MP32

Depth	Sb mg/kg	As mg/kg	Hg mg/kg
0-0.5′	1430	9880	127
2-4′	128 J	3720 J	134
4-6′	214 J	4170 J	214
6-8′	186 J	4010 J	378

MP34

Depth	Sb mg/kg	As mg/kg	Hg mg/kg
0-0.5′	780	8510	79
2-4′	1450 J	5780 J	211 J
4-6′	668 J	4010 J	212 J
6-8′	126 J	1120 J	73.4 J

MP35

Depth	Sb mg/kg	As mg/kg	Hg mg/kg
0-0.5′	1680	2390	183
4-6′	4980 J	2350	335 J
10-12′	3480 J	2870 J	504 J
14-16′	4500 J	1300	636 J

MP40

Depth	Sb mg/kg	As mg/kg	Hg mg/kg
0-0.5′	267	375	15
4-6′	347 J	276 J	10.3
6-8′	1460 J	2390	185 J
8-10′	868 J	1150	119

RD06

Depth	Sb mg/kg	As mg/kg	Hg mg/kg
0-0.5′	677 J	1250	186
2-4′	6.23	18.1	14.1 J
6-8′	11.3	42.5	5.53 J
10-12′	0.763	19.6	1.61 J

RD07

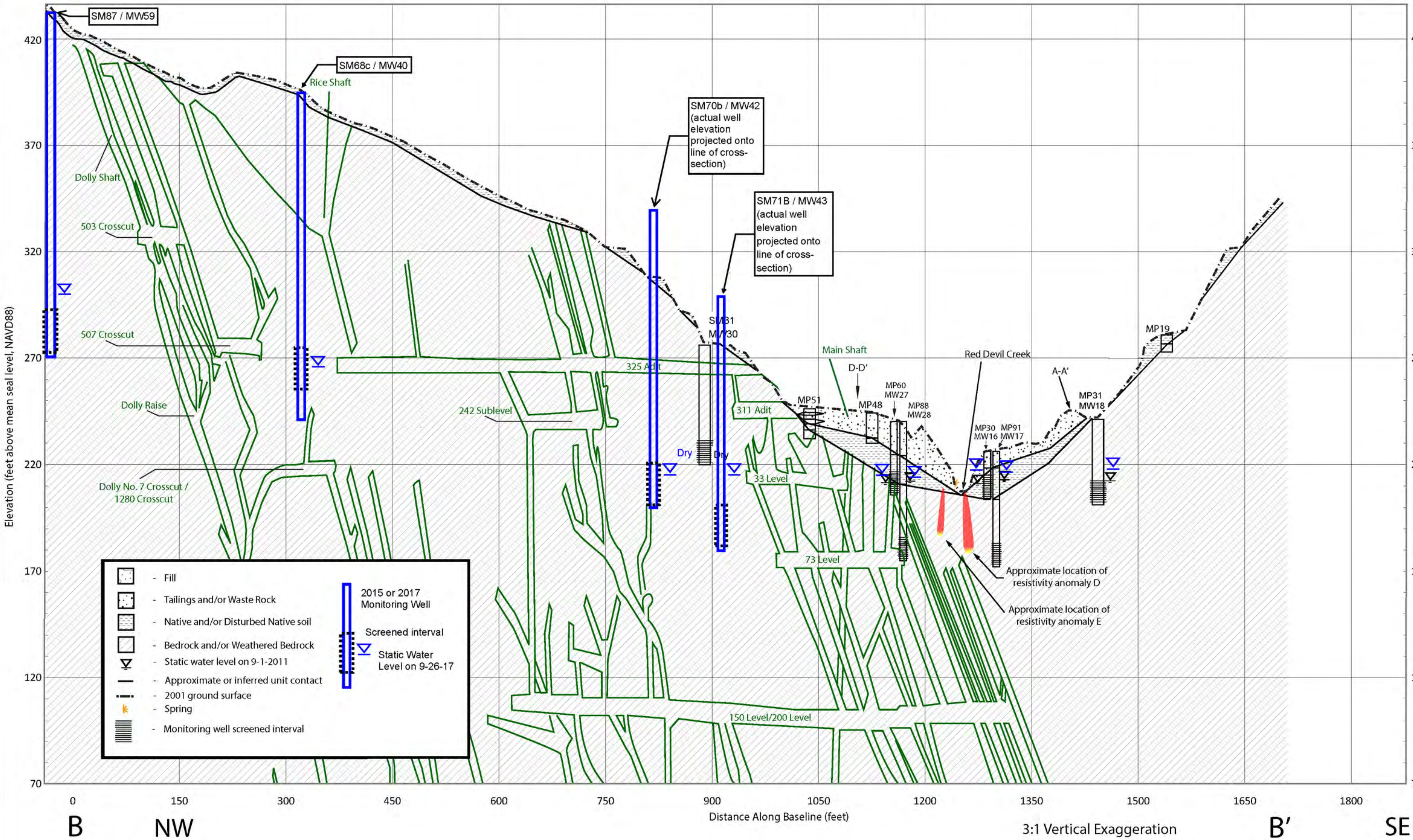
Depth	Sb mg/kg	As mg/kg	Hg mg/kg
0-0.5′	30 J	76	16
2-4′	4.96	11.1	2.27 J
8-10′	1.32	22.2	1.94 J
10-12′	0.321	25.9	10.6 J

Note:
1. Surface topography and Kuskokwim River Level based on 5/27/2001 aerial photograph and topographic map (Aero-Metric, Inc. 2010)
2. Subsurface sample depth intervals in feet below ground surface
3. Total Antimony (Sb), total Arsenic (As), and total Mercury (Hg) concentrations in mg/kg

RED DEVIL MINE

Red Devil, Alaska

Figure 2-7
Geologic Cross Section A-A′



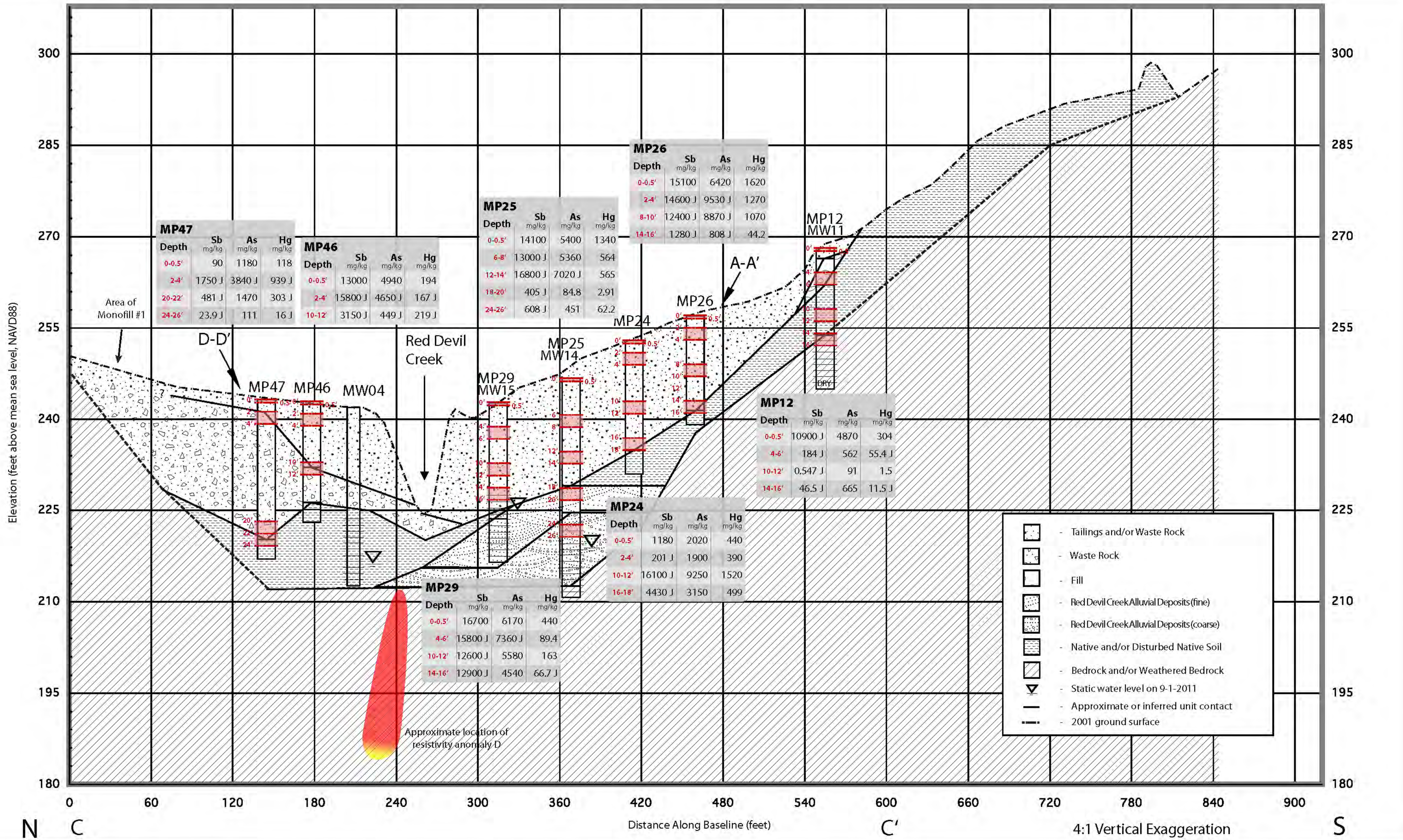
Notes: 1) Surface topography based on 5/27/2001 aerial photograph and topographic map (Aero-Metric, Inc. 2010)
2) Mine workings projected onto geological cross section based on March 1962 longitudinal projection (Alaska Mines and Minerals, Inc. and Decoursey Mountain Mining Co., Inc., 1962)
3) Approximate resistivity anomaly locations based on USGS (2011)

RED DEVIL MINE

Red Devil, Alaska

Figure 2-8
Geologic Cross Section B-B' and Underground Mine Workings

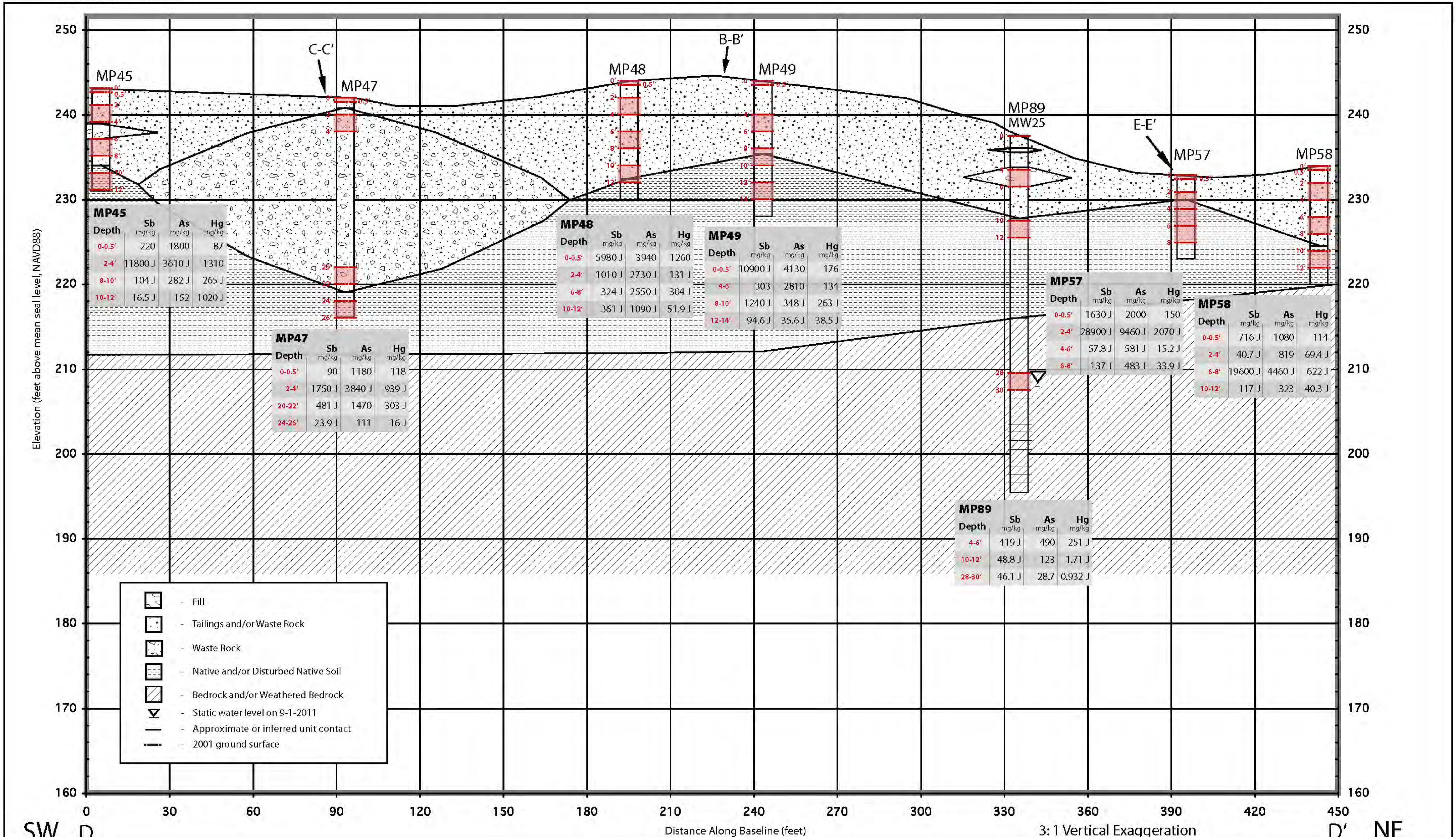
02:001095.0002.01



Notes:
1. Surface topography based on 5/27/2001 aerial photograph and topographic map (Aero-Metric, Inc. 2010)
2. Approximate resistivity anomaly locations based on USGS (2011)
2. Subsurface sample depth intervals in feet below ground surface
4. Total Antimony (Sb), total Arsenic (As), and total Mercury (Hg) concentrations in mg/kg

RED DEVIL MINE
Red Devil, Alaska

Figure 2-9
Geologic Cross Section C-C'



MP45

Depth	Sb mg/kg	As mg/kg	Hg mg/kg
0-0.5'	220	1800	87
2-4'	11800 J	3610 J	1310
8-10'	104 J	282 J	265 J
10-12'	16.5 J	152	1020 J

MP47

Depth	Sb mg/kg	As mg/kg	Hg mg/kg
0-0.5'	90	1180	118
2-4'	1750 J	3840 J	939 J
20-22'	481 J	1470	303 J
24-26'	23.9 J	111	16 J

MP48

Depth	Sb mg/kg	As mg/kg	Hg mg/kg
0-0.5'	5980 J	3940	1260
2-4'	1010 J	2730 J	131 J
6-8'	324 J	2550 J	304 J
10-12'	361 J	1090 J	51.9 J

MP49

Depth	Sb mg/kg	As mg/kg	Hg mg/kg
0-0.5'	10900 J	4130	176
4-6'	303	2810	134
8-10'	1240 J	348 J	263 J
12-14'	94.6 J	35.6 J	38.5 J

MP57

Depth	Sb mg/kg	As mg/kg	Hg mg/kg
0-0.5'	1630 J	2000	150
2-4'	28900 J	9460 J	2070 J
4-6'	57.8 J	581 J	15.2 J
6-8'	137 J	483 J	33.9 J

MP58

Depth	Sb mg/kg	As mg/kg	Hg mg/kg
0-0.5'	716 J	1080	114
2-4'	40.7 J	819	69.4 J
6-8'	19600 J	4460 J	622 J
10-12'	117 J	323	40.3 J

MP89

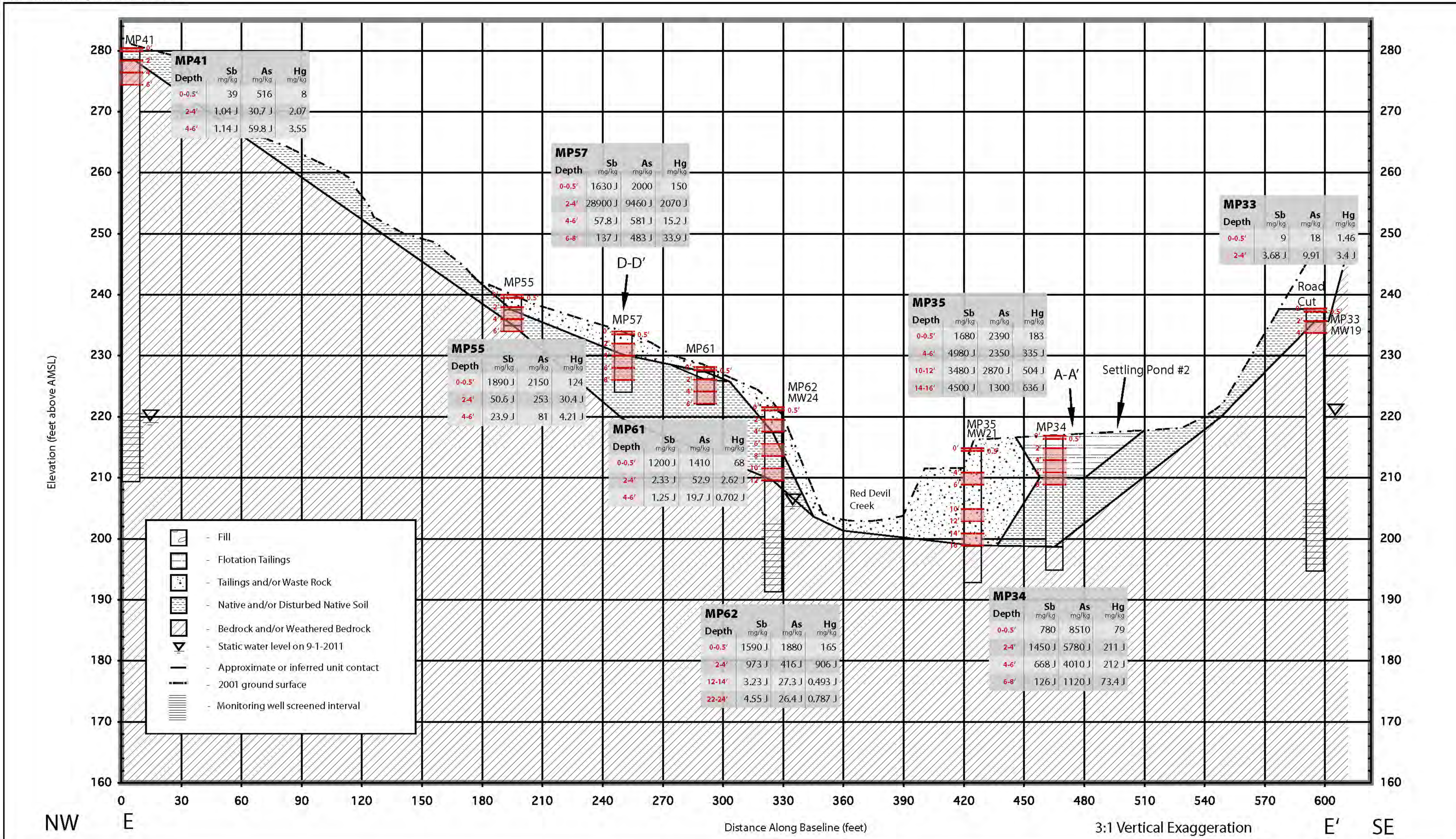
Depth	Sb mg/kg	As mg/kg	Hg mg/kg
4-6'	419 J	490	251 J
10-12'	48.8 J	123	1.71 J
28-30'	46.1 J	28.7	0.932 J

Notes:
1. Surface topography based on 5/27/2001 aerial photograph and topographic map (Aero-Metric, Inc. 2010)
2. Subsurface sample depth intervals in feet below ground surface
3. Total Antimony (Sb), total Arsenic (As), and total Mercury (Hg) concentrations in mg/kg

RED DEVIL MINE
Red Devil, Alaska

Figure 2-10
Geologic Cross Section D-D'

02:EE-001096-0070-08\Figure 4-21 E-E'.ai-12/26/12-GRA

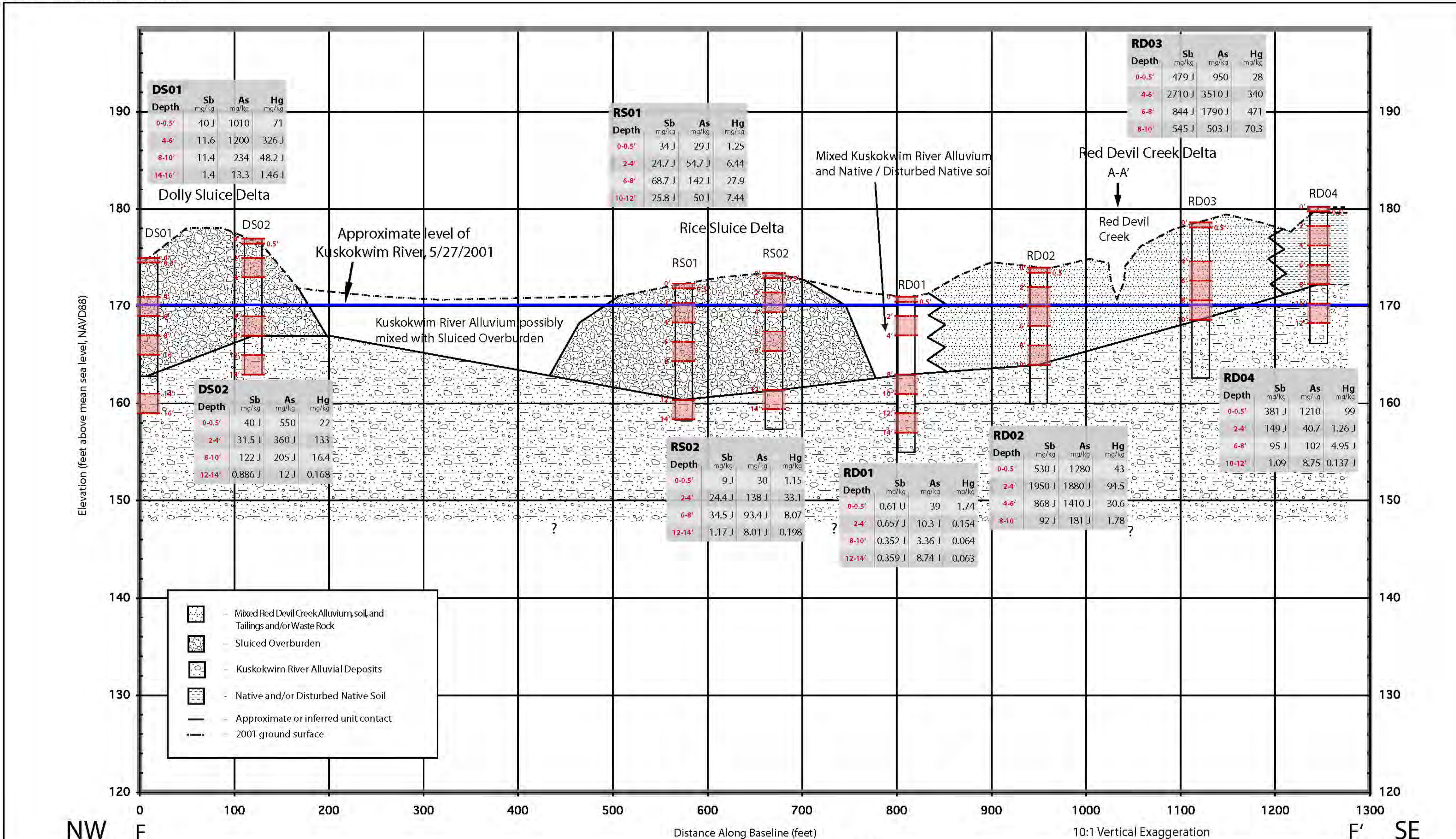


Notes:
1. Surface topography based on 5/27/2001 aerial photograph and topographic map (Aero-Metric, Inc. 2010)
2. Subsurface sample depth intervals in feet below ground surface
3. Total Antimony (Sb), total Arsenic (As), and total Mercury (Hg) concentrations in mg/kg

RED DEVIL MINE
Red Devil, Alaska

Figure 2-11
Geologic Cross Section E-E′

02:EE-001096-0070-08\Figure 4-22 F-F'.ai-12/26/12-GRA

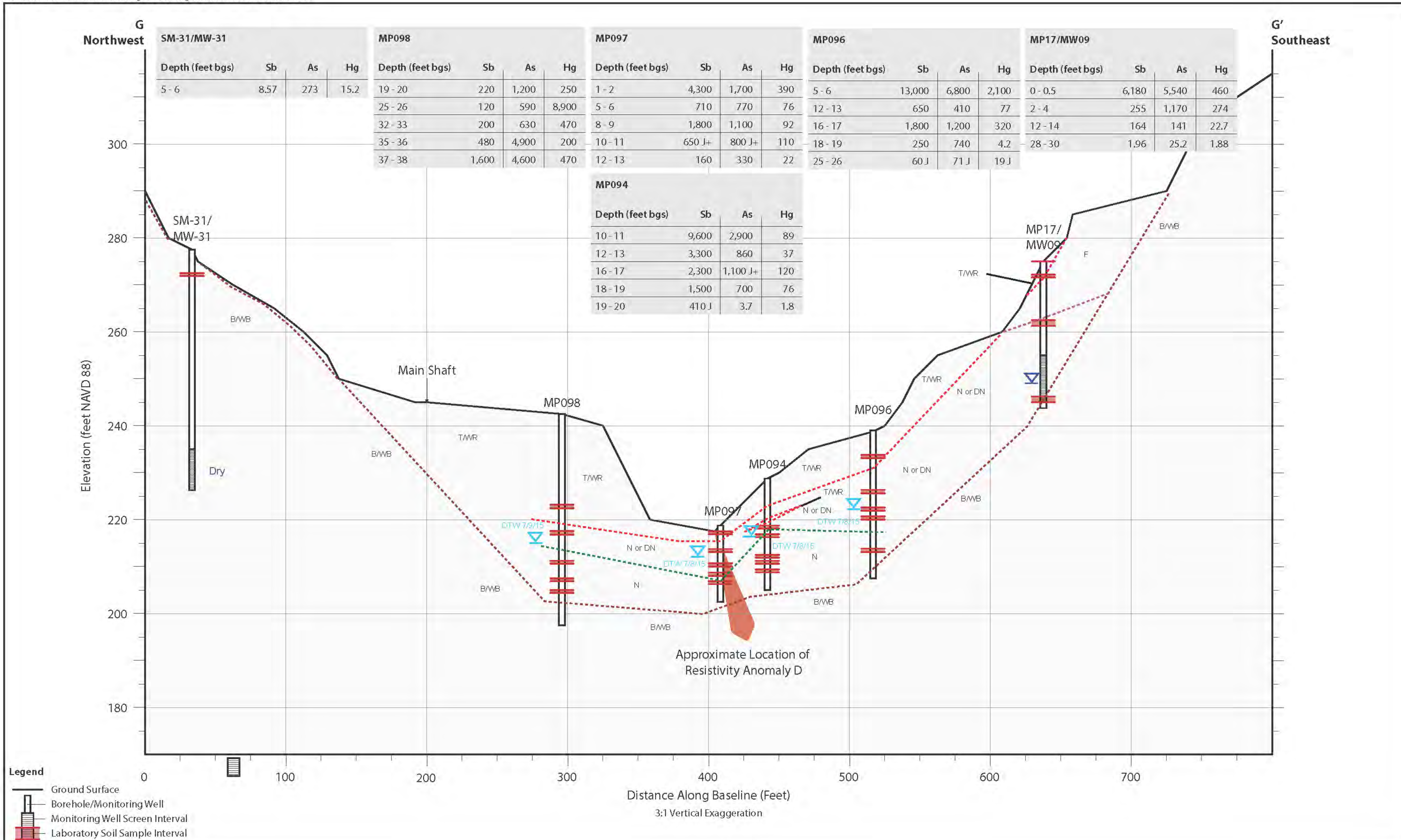


Notes:

1. Surface topography and Kuskokwim River level based on 5/27/2001 aerial photograph and topographic map (Aero-Metric, Inc. 2010)
2. Subsurface sample depth intervals in feet below ground surface
3. Total Antimony (Sb), total Arsenic (As), and total Mercury (Hg) concentrations in mg/kg

RED DEVIL MINE
Red Devil, Alaska

Figure 2-12
Geologic Cross Section F-F'



SM-31/MW-31

Depth (feet bgs)	Sb	As	Hg
5 - 6	8.57	273	15.2

MP098

Depth (feet bgs)	Sb	As	Hg
19 - 20	220	1,200	250
25 - 26	120	590	8,900
32 - 33	200	630	470
35 - 36	480	4,900	200
37 - 38	1,600	4,600	470

MP097

Depth (feet bgs)	Sb	As	Hg
1 - 2	4,300	1,700	390
5 - 6	710	770	76
8 - 9	1,800	1,100	92
10 - 11	650 J+	800 J+	110
12 - 13	160	330	22

MP094

Depth (feet bgs)	Sb	As	Hg
10 - 11	9,600	2,900	89
12 - 13	3,300	860	37
16 - 17	2,300	1,100 J+	120
18 - 19	1,500	700	76
19 - 20	410 J	3.7	1.8

MP096

Depth (feet bgs)	Sb	As	Hg
5 - 6	13,000	6,800	2,100
12 - 13	650	410	77
16 - 17	1,800	1,200	320
18 - 19	250	740	4.2
25 - 26	60 J	71 J	19 J

MP17/MW09

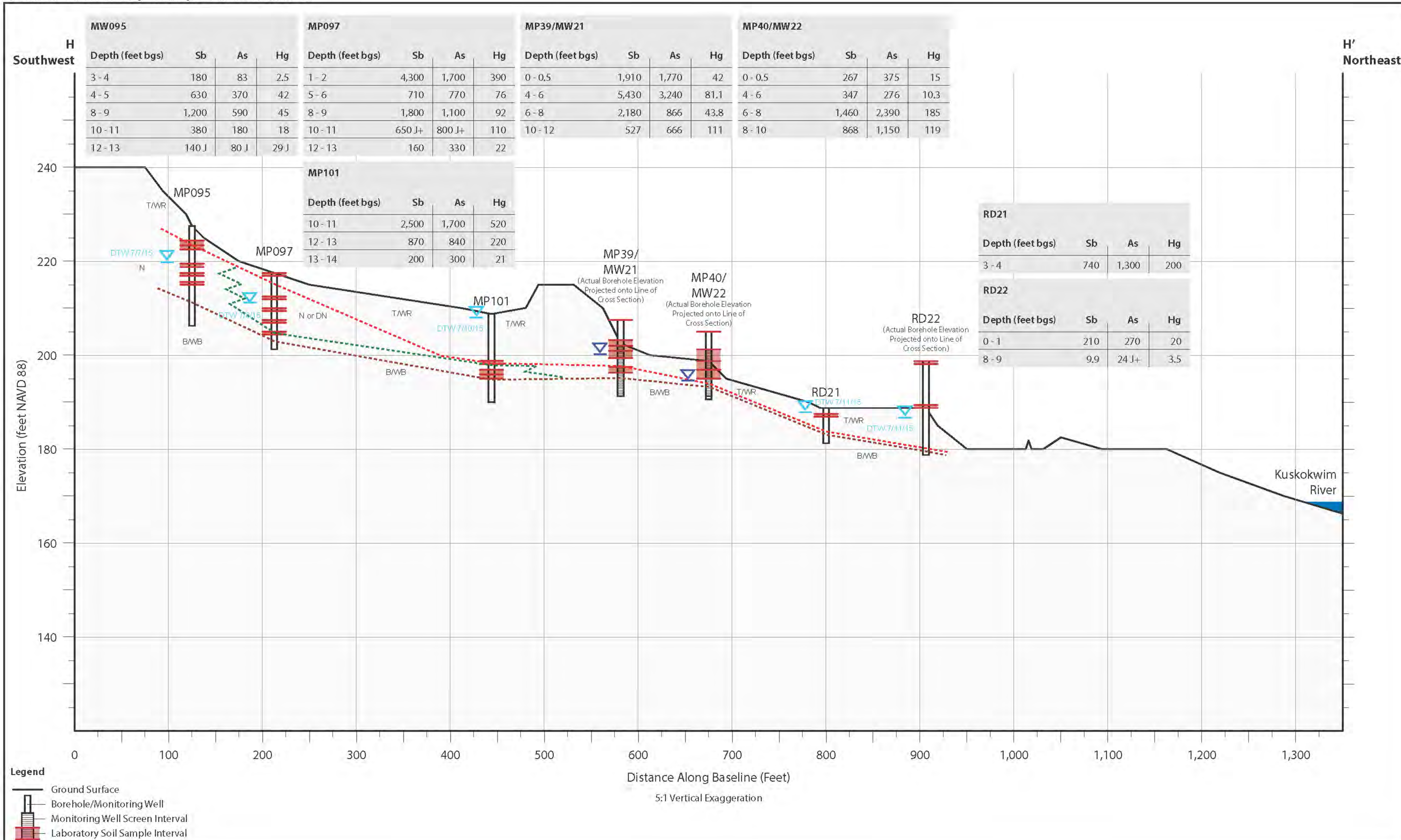
Depth (feet bgs)	Sb	As	Hg
0 - 0.5	6,180	5,540	460
2 - 4	255	1,170	274
12 - 14	164	141	22.7
28 - 30	1.96	25.2	1.88

Notes:

1. Surface topography is based on: 1) digital 2010 5-foot topographic contours based on the aerial orthograph taken on September 21, 2010 (Aerometric 2012); and 2) digital 2014 5-foot and 1-foot topographic contours based on Marsh Creek (2014).
2. Approximate resistivity anomaly locations based on USGS (2011).
3. Tabulated sample results are for laboratory total antimony (Sb), arsenic (As), and mercury (Hg) in soil in milligrams per kilogram.

Figure 2-13
Geologic Cross Section G-G'
Red Devil Mine
Red Devil, Alaska

1001095.0014.05 -RDM Cross Sections\Figure 2-5 Geologic Cross Section H-H'.ai-08/02/17-GRA



MW095

Depth (feet bgs)	Sb	As	Hg
3 - 4	180	83	2.5
4 - 5	630	370	42
8 - 9	1,200	590	45
10 - 11	380	180	18
12 - 13	140 J	80 J	29 J

MP097

Depth (feet bgs)	Sb	As	Hg
1 - 2	4,300	1,700	390
5 - 6	710	770	76
8 - 9	1,800	1,100	92
10 - 11	650 J+	800 J+	110
12 - 13	160	330	22

MP39/MW21

Depth (feet bgs)	Sb	As	Hg
0 - 0.5	1,910	1,770	42
4 - 6	5,430	3,240	81.1
6 - 8	2,180	866	43.8
10 - 12	527	666	111

MP40/MW22

Depth (feet bgs)	Sb	As	Hg
0 - 0.5	267	375	15
4 - 6	347	276	10.3
6 - 8	1,460	2,390	185
8 - 10	868	1,150	119

MP101

Depth (feet bgs)	Sb	As	Hg
10 - 11	2,500	1,700	520
12 - 13	870	840	220
13 - 14	200	300	21

RD21

Depth (feet bgs)	Sb	As	Hg
3 - 4	740	1,300	200

RD22

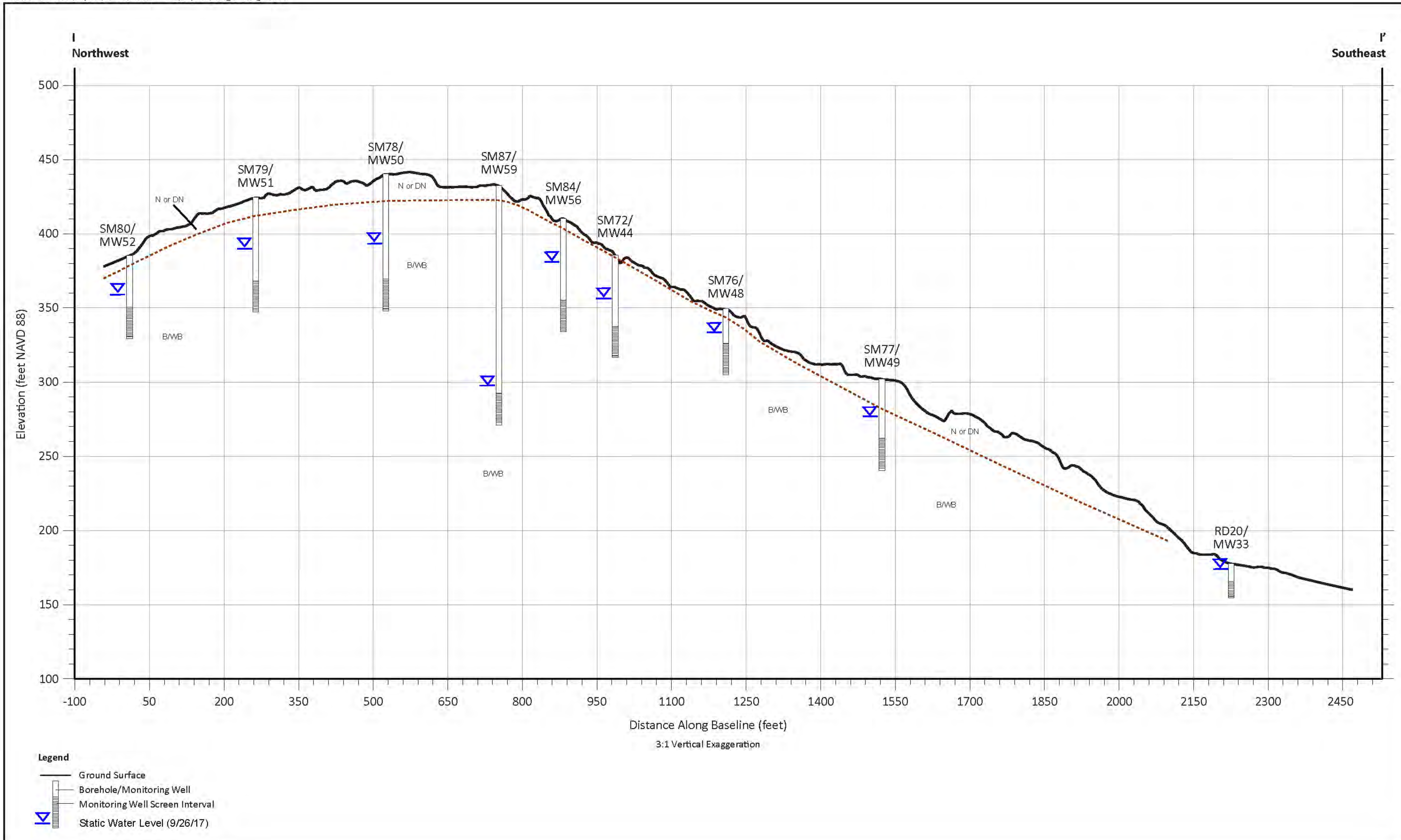
Depth (feet bgs)	Sb	As	Hg
0 - 1	210	270	20
8 - 9	9.9	24 J+	3.5

Notes:

1. Surface topography is based on: 1) digital 2010 5-foot topographic contours based on the aerial orthograph taken on September 21, 2010 (Aerometric 2012); and 2) digital 2014 5-foot and 1-foot topographic contours based on Marsh Creek (2014).
2. Tabulated sample results are for laboratory total antimony (Sb), arsenic (As), and mercury (Hg) in soil in milligrams per kilogram.

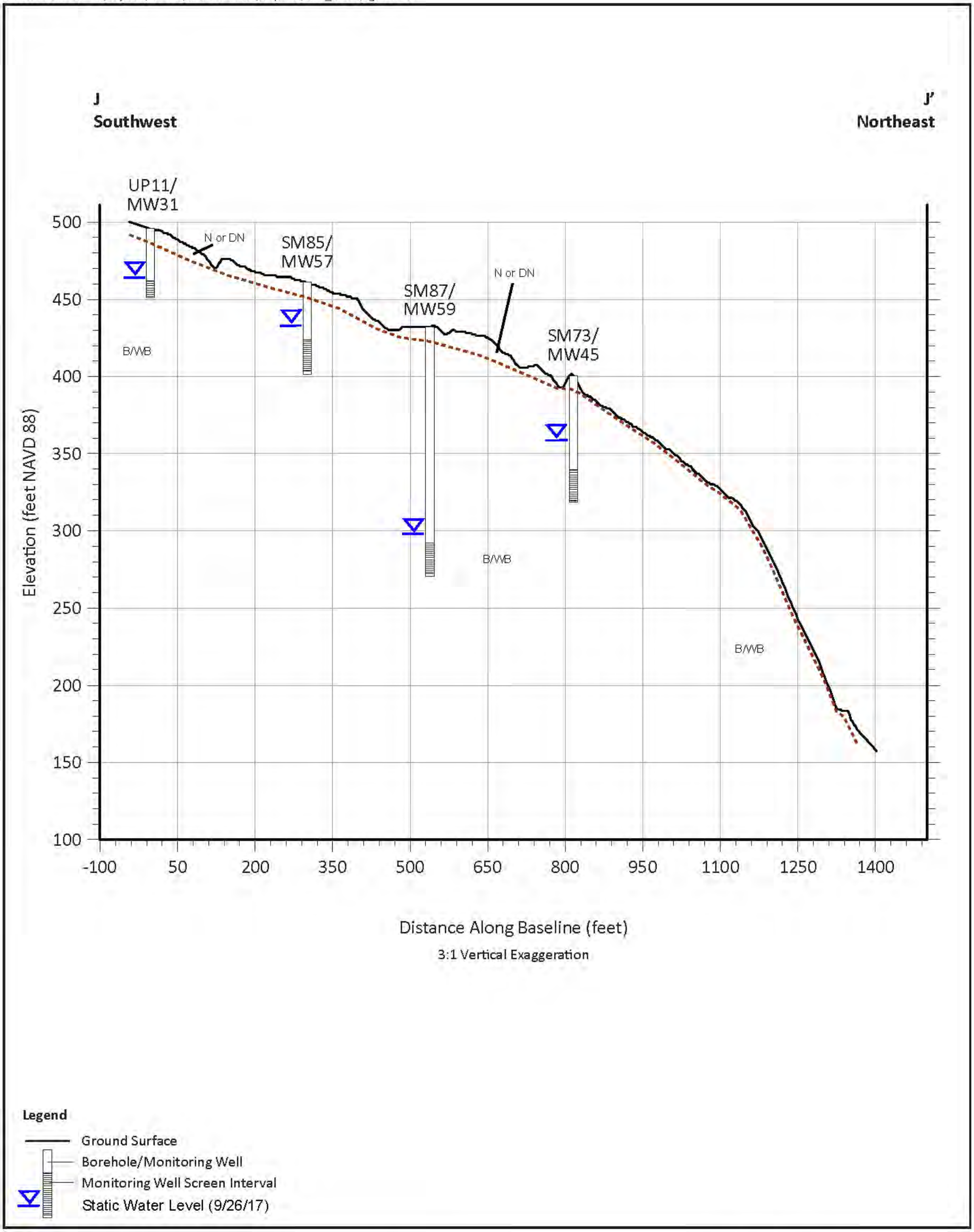
Figure 2-14
Geologic Cross Section H-H'
Red Devil Mine
Red Devil, Alaska

1001095.0015.01 - L:\Projects\ACTIVE\Red Devil Mine\Graphics\2018_05-24\Figure 2-15



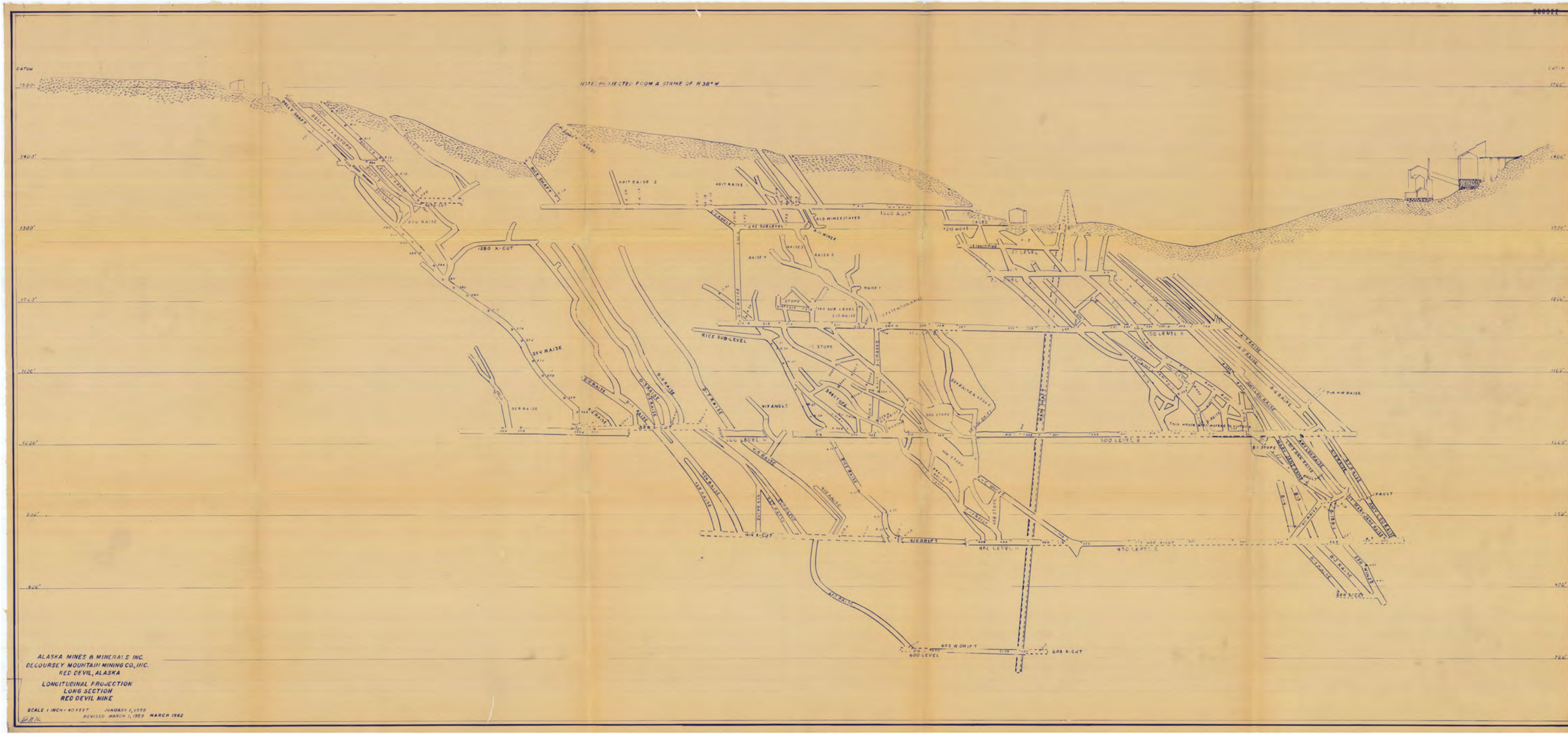
Notes:
1. Ground surface topography is based on October 10, 2015 LIDAR Survey (Quantum Spatial 2015).

Figure 2-15
Geologic Cross Section I-I'
Red Devil Mine
Red Devil, Alaska



Notes:
1. Ground surface topography is based on October 10, 2015 LIDAR Survey (Quantum Spatial 2015).

Figure 2-16
Geologic Cross Section J-J'
Red Devil Mine
Red Devil, Alaska



RED DEVIL MINE

Red Devil, Alaska

Figure 2-17
1962 Cross Sectional Profile of Mine Workings, Red Devil Mine

Image Source: Alaska Mines and Minerals, Inc. and Decoursey Mountain Mining Co., Inc. 1962. Longitudinal Projection, Long Section, Red Devil Mine, Revised March 1962.

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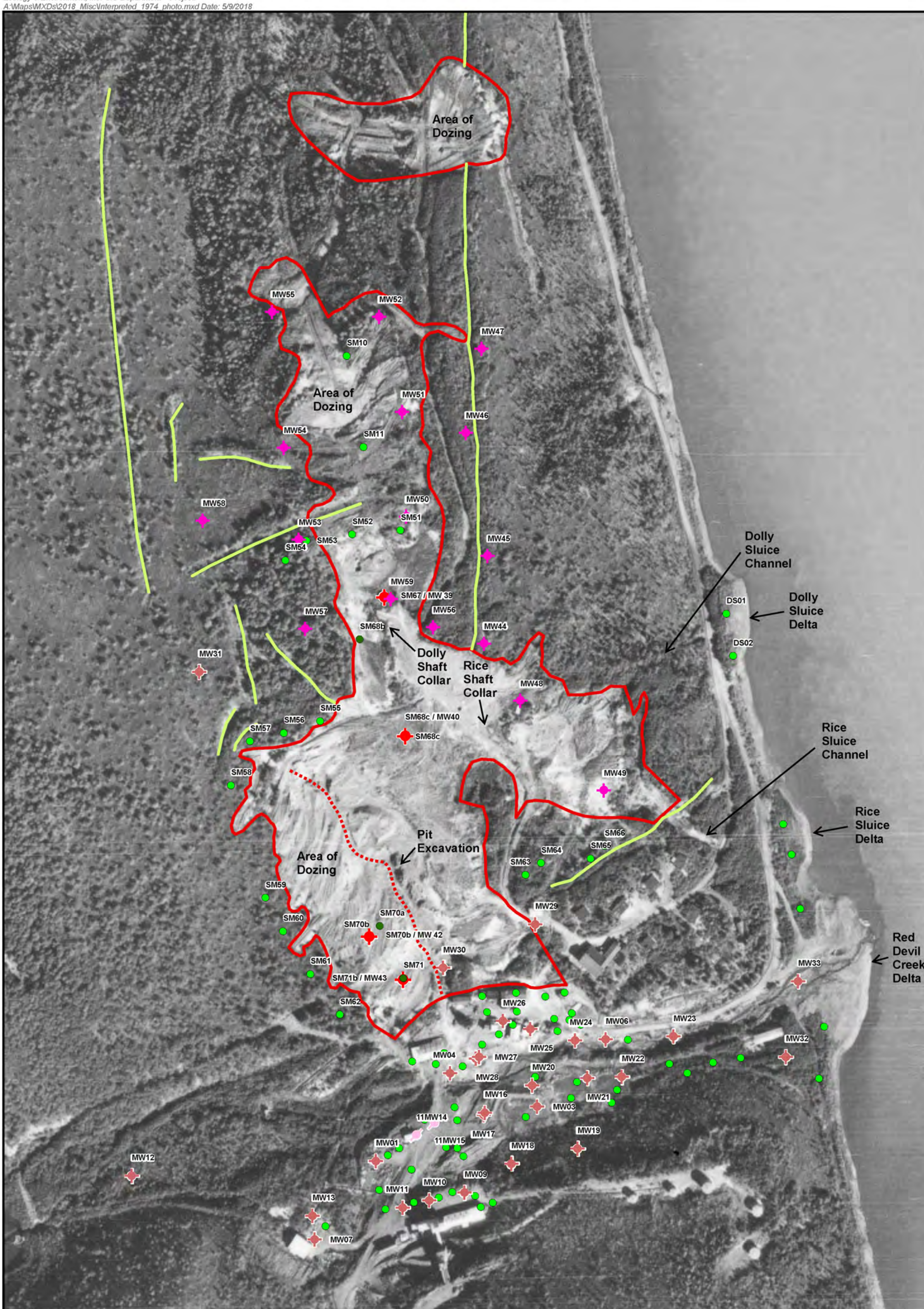


2017 Monitoring Well	RI and RI Supplement Boreholes	
RI Supplement Monitoring Well	Abandoned RI Supplement Borehole / Monitoring Well	
RI Monitoring Well	Overall Area of Extensive Surface Mining Disturbance	
Abandoned RI Monitoring Well	Centerline of Open Pit	
	Trench	

RED DEVIL MINE

Red Devil, Alaska

Figure 2-18

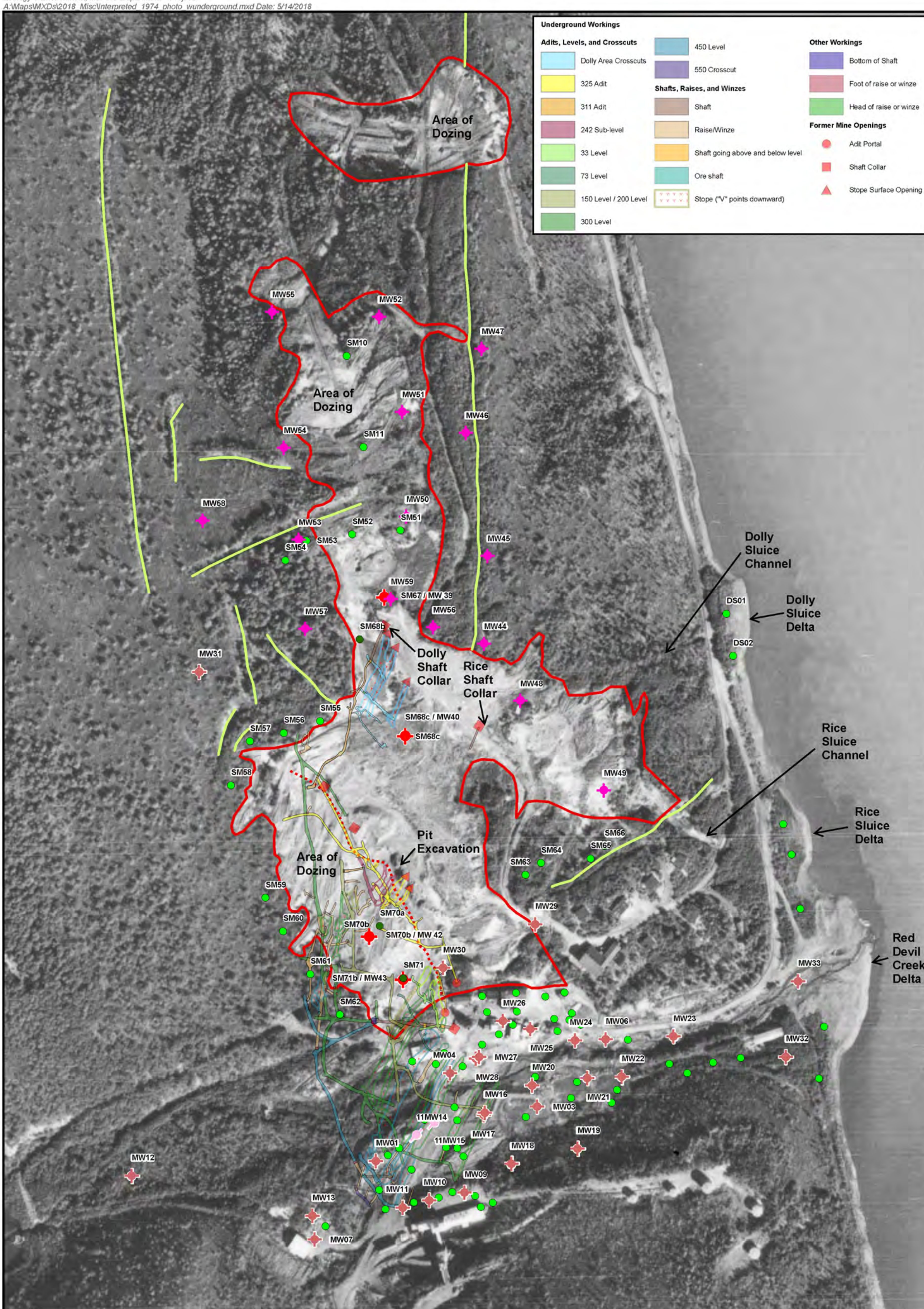
Interpreted 1974 Aerial Photograph

0 50 100 200 300 400
Feet

0 12.5 25 50 75 100
Meters

Scale 1:2,000

Ecology & Environment, Inc. GIS Department Project:
A:\Maps\MXDs\2018_Misc\Interpreted_1974_photo_wunderground.mxd Date: 5/14/2018



2017 Monitoring Well
RI Supplement Monitoring Well
RI Monitoring Well
Abandoned RI Monitoring Well
RI and RI Supplement Boreholes
Abandoned RI Supplement Borehole / Monitoring Well
Overall Area of Extensive Surface Mining Disturbance
Centerline of Open Pit
Trench

RED DEVIL MINE

Red Devil, Alaska

Figure 2-19

Interpreted 1974 Aerial Photograph and Underground Mine Workings

0 50 100 200 300 400
Feet
0 12.5 25 50 75 100
Meters
Scale 1:2,000

Ecology & Environment, Inc. GIS Department Project:
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2017 Monitoring Well	Red Devil Creek	Mappend extent of loess as of 1963 (MacKevett and Berg 1963)	
RI Supplement Monitoring Well	Settling Pond	Overall Area of Extensive Surface Mining Disturbance	
RI Monitoring Well	Monofill	Centerline of Open Pit	
Abandoned RI Monitoring Well	Historical Structure	Trench	
2015 2-foot Contour	Approximate Location of Proposed Repository Footprint	RI and RI Supplement Boreholes	
2015 10-foot Contour	Area of 2014 NTCRA Re-grading	Abandoned RI Supplement Borehole / Monitoring Well	
Post-NTCRA Stream Alignment	Seep Location		

RED DEVIL MINE

Red Devil, Alaska

Figure 2-20

Soil Boring and Monitoring Well Locations and Extent of Loess as of 1963

0 50 100 200 300 400 Feet

0 10 20 40 60 80 100 Meters

Scale 1:3,000

Digital 2015 topographic contours based on October 10, 2015 LiDAR Survey (Quantum Spatial 2015).

Aerial photograph taken on 9/21/2010 (AeroMetric 2012)

3 Groundwater

Groundwater conditions at the RDM have been characterized as part of the RI and RI Supplement. Additional characterization of groundwater in the area of the proposed repository was performed in 2017. Baseline groundwater monitoring activities have been performed at the RDM in 2012, 2015, and between 2016 and 2018. Methods and results of the RI and RI Supplement groundwater characterization and the baseline monitoring performed in 2012 and 2015 were presented in the RI and RI Supplement reports and are briefly summarized in Sections 3.1.1 and 3.2.1. Methods of the 2016 to 2018 baseline monitoring and 2017 additional groundwater characterization are presented in Sections 3.1.2 and 3.1.3, and results are presented in Section 3.2.2 and 3.2.3. Key findings of groundwater characterization and baseline monitoring performed to date are synthesized in Sections 3.3 through 3.6 of this report. Analysis of background groundwater conditions, hydraulic conductivity, and groundwater discharge and contaminant flux into the Kuskokwim River are presented in Sections 3.7 through 3.9.

3.1 Groundwater Characterization and Monitoring Activities

3.1.1 RI and RI Supplement

Groundwater at the RDM was characterized as part of the RI and RI Supplement. Groundwater characterization activities and methods are presented in Chapter 2 of the RI report and Chapter 3 of the RI Supplement report. RI and RI Supplement groundwater monitoring locations are shown in Figures 3-1 and 3-2, respectively. Selected RI and RI Supplement groundwater characterization results are included in this report.

3.1.2 Baseline Groundwater Monitoring

The BLM initiated baseline groundwater and surface water monitoring in 2012 to augment the RI results to characterize pre-remedial action conditions and identify seasonal and annual trends in flow, contaminant concentrations, and loading. Baseline groundwater monitoring activities are discussed in the sections below.

3.1.2.1 2012 Baseline Monitoring

The 2012 baseline monitoring was performed following the 2012 Baseline Monitoring Work Plan (E & E 2012) and methods consistent with those used for the RI and RI Supplement. The 2012 groundwater baseline monitoring was performed at the monitoring wells installed during the RI; locations are shown in Figure 3-3. The 2012 baseline data were presented in Appendix A of the RI report.

3.1.2.2 2015 Baseline Monitoring

A second round of baseline monitoring of groundwater and surface water was performed in the spring and fall 2015. The 2015 baseline monitoring was performed in conjunction with additional groundwater characterization conducted as part of the RI Supplement, and was performed following the RI Supplement Work Plan (E & E 2015). Groundwater monitoring locations are shown in Figure 3-2.

3.1.2.3 2016 to 2018 Baseline Monitoring

The BLM continued baseline monitoring in the fall of 2016, spring and fall of 2017, and spring of 2018. This additional baseline monitoring was conducted following the final 2016 Baseline Monitoring Work Plan (E & E 2016b). Groundwater monitoring locations for the 2016 through 2018 baseline monitoring consist of the monitoring wells installed during the RI and RI Supplement and are shown in Figure 3-4.

Specific objectives of the 2016 to 2018 baseline monitoring are to:

- Characterize the seasonal variability in groundwater and surface water hydrology and chemistry;
- Characterize the long-term (multiple year) variability in groundwater and surface water hydrology and chemistry; and
- Characterize trends in groundwater and surface water hydrology and chemistry.

Groundwater sample collection is summarized in Tables 3-1 through 3-4. The baseline monitoring performed in the fall of 2017 was done in conjunction with the additional groundwater characterization of the Surface Mined Area performed in 2017 (see Section 3.1.3). Table 3-3 presents the sample collection for both the fall 2017 baseline groundwater monitoring and the groundwater sampling performed as part of the additional characterization activities.

All groundwater samples were collected for field water quality parameters (pH, specific conductance, oxidation reduction potential, turbidity, dissolved oxygen, and temperature). Groundwater samples were submitted to TestAmerica, Seattle, Washington and Brooks Applied Labs, Bothell, Washington, under subcontract to E & E, for the following laboratory analyses:

- Total TAL metals (EPA 6010/6020/7470);
- Total low-level mercury (EPA 1631);
- Dissolved low-level mercury (EPA 1631);
- Inorganic ions (chloride, fluoride, and sulfate; EPA 300.0);

- Total Suspended Solids (SM2540D)
- Nitrate-nitrite as N (EPA 353.2);
- Alkalinity as carbonate/bicarbonate (EPA 310.1/SM2320B);
- Semivolatile organic compounds (SVOCs; EPA 8021B/8270C);
- Benzene, toluene, ethylbenzene, and xylenes (BTEX; EPA 8260C)
- Gasoline range organics (AK101); and
- Diesel range organics (AK102).

Analytical data were validated by an E & E chemist. The results of laboratory analytical data validation are summarized in Data Review Memoranda for each laboratory data deliverable and are presented in Appendix A. Results of the baseline monitoring performed from 2016 to 2018 are presented in Section 3.2.2.

3.1.3 2017 Groundwater Monitoring Well Installation

The BLM is conducting additional characterization of groundwater in the vicinity of the proposed repository (see FS Alternatives 3a and 3c). The additional characterization is designed to generate additional information that may be useful for a more detailed hydrologic analysis of the proposed repository. The additional characterization also is intended to generate data necessary to establish a detection groundwater monitoring network for the repository proposed under FS Alternatives 3a and 3c. The additional characterization was performed to gather the types of additional information identified in Section 3.3.1 of the 2017 Groundwater and Tailings Characterization Work Plan (E & E 2017).

3.1.3.1 Monitoring Well Installation

Additional groundwater characterization included installation of new monitoring wells and measurement of water levels and collection of groundwater samples from the new wells. A total of 16 new monitoring wells were installed at locations upgradient of, near, and downgradient of the proposed repository and/or the potentially extended repository footprint area during the summer of 2017. Actual well locations were refined from the locations proposed in the 2017 Groundwater and Tailings Characterization Work Plan (E & E 2017) during the investigation based on actual conditions encountered in the field. Locations of new monitoring wells are illustrated in Figures 2-5 and 3-5. Drilling activities are described in Section 2.1.3.1. Field procedures and laboratory analyses were performed following the 2017 Groundwater and Tailings Characterization Work Plan (E & E 2017), except as noted below. Well construction information is provided in Tables 2-5 and 3-5. A brief description of field sampling and other procedures pertinent to the groundwater characterization is provided below.

At most drilling locations, occurrence of groundwater and saturated conditions was readily identifiable in the unconsolidated materials based on moisture content of the recovered soil in the core samplers. Groundwater in the Kuskokwim Group bedrock occurs primarily in fractures. While drilling through comparatively less productive saturated zones using the air rotary/down-the-hole hammer method, the drilling returns may not provide a clear indication of saturated conditions because little or none of the water encountered may be present or observable in the returns at the surface. While drilling in bedrock using the air rotary/down-the-hole hammer method, care was taken to observe and record drilling-related information pertinent to identification of water-bearing intervals, including rate of penetration, occurrence of water returns, and borehole caving or sloughing. In addition, drilling was discontinued for short breaks at frequent intervals and after any potential indications of water to allow any groundwater, if present, to flow into the borehole. Each monitoring well was constructed with a 20-foot screen interval that straddles the depth of first observed occurrence of groundwater.

Following well completion, horizontal coordinates and elevations of all newly installed monitoring wells were surveyed by a subcontracted, Alaska-registered land surveyor.

3.1.3.2 Well Development

Following well installation, each new monitoring well was developed following procedures described in the 2017 Groundwater and Tailings Characterization Work Plan (E & E 2017). Wells were developed by a combination of bailing, mechanical surging, and pumping with a submersible pump. Fines were removed from the well periodically using a bailer to minimize the re-entry of fines into the formation during surging. The final phase of development entailed pumping with a submersible pump and monitoring depth to water and field water quality parameters (pH, temperature, specific conductance, and turbidity). The final pumping was performed until the water quality parameters stabilized. Information regarding the final pumping period for each well, including start and end times and durations of final pumping periods, water levels and drawdown, volumes pumped, and average pumping rates, is summarized in Table 3-6.

3.1.3.3 Development and Post-Development Water Level Monitoring

The final pumping period of well development typically was performed for several hours at each well and resulted in drawdown of water in the well and aquifer (see Table 3-6). Water levels were monitored every several minutes during the final pumping period. The resulting drawdown data are used to evaluate bedrock hydraulic conductivity, discussed in Section 3.8.2.

Immediately following completion of development pumping, the pump was removed from the well and subsequently a Solinst 3001 Levelogger Edge® pressure transducer was temporarily installed in the well to monitor water level recovery. The time at which the transducer was lowered into the well is noted in Table 3-6. The period of time between removal of the pump and installation of the transducer was typically several minutes. Because the pump used for well development was not equipped with a check valve, some water (approximately 0.8 gallon for well MW59 and 0.4 gallon or less for all other wells) contained within the pump tubing drained back into the well after the pump was turned off. These amounts of water are small relative to the amounts of water removed from the well during the final pumping period (see Table 3-6). Water levels measured with the transducer were recorded during the recovery at 30-second intervals in each well for a period of 24 or more hours. Water level recovery data collected by the transducers is used to evaluate K, discussed in Section 3.8.2.

3.1.3.4 Well Survey

The horizontal and vertical coordinates of new monitoring wells were surveyed by a subcontracted, Alaska-registered land surveyor. Vertical coordinates were surveyed to within the nearest 0.1 foot. Elevation survey data are provided in Table 3-5.

3.1.3.5 Static Water Level Measurement

Static water levels were measured in the new monitoring wells several times over the course of the 2017 field event. A round of static water level measurements in the 2017 wells was performed in conjunction with water level measurement in the RI and RI Supplement wells performed as part of the baseline groundwater monitoring. Water level measurement was performed following procedures described in the 2017 Groundwater and Tailings Characterization Work Plan (E & E 2017) and 2016 Baseline Monitoring Work Plan (E & E 2016b). Results are presented in Sections 3.3 and 3.4.

3.1.3.6 Continuous Water Level Measurement

Following sampling and static water level measurements in the new monitoring wells in the fall of 2017, a Solinst 3001 Levelogger Edge® pressure transducer was installed to monitor water levels continuously in seven wells—MW46, MW48, MW50, MW51, MW53, MW56, and MW59—from the fall of 2017 to the spring of 2018. The transducers were programmed to measure total pressure (water pressure plus atmospheric pressure) and water temperature hourly. One Solinst 3001 Barrologger® was deployed to measure atmospheric pressure.

The Levelogger® transducers and Barrologger® were retrieved from each of the wells during the spring 2018 baseline monitoring event. Data were recovered from each of the data loggers except for the unit from well MW53, in which no data were recorded. Following recovery of the available data, the transducers were reinstalled in all seven wells. Results of the continuous water level measurement are presented in Section 3.3.3.

3.1.3.7 Groundwater Sampling

Additional groundwater characterization included groundwater characterization at new monitoring wells. Additional groundwater characterization was performed using a combination of field data collection and the results of laboratory analysis for selected analytical parameters. Groundwater samples were collected from the 2017 wells in conjunction with sampling of RI and RI supplement wells performed as part of the baseline groundwater monitoring. Groundwater sample collection is summarized in Table 3-3. The additional groundwater characterization was performed in conjunction with the baseline monitoring performed in the fall of 2017 (see Section 3.1.2.3). Table 3-3 summarizes sample collection for both the additional characterization activities and the fall 2017 baseline groundwater monitoring.

All groundwater samples were collected for field water quality parameters (pH, specific conductance, oxidation reduction potential, turbidity, dissolved oxygen, and temperature). Groundwater samples were submitted to TestAmerica, Seattle, Washington, and Brooks Applied Labs, Bothell, Washington, under subcontract to E & E, for laboratory the following laboratory analyses:

- Total TAL metals (EPA 6010/6020/7470);
- Total low-level mercury (EPA 1631);
- Dissolved low-level mercury (EPA 1631);
- Inorganic ions (chloride, fluoride, and sulfate; EPA 300.0);
- Nitrate-nitrite as N (EPA 353.2); and
- Alkalinity as carbonate/bicarbonate (EPA 310.1/SM2320B).

Analytical data were validated by an E & E chemist. The results of laboratory analytical data validation are summarized in Data Review Memoranda for each laboratory data deliverable and are presented in Appendix A. Results of the 2017 groundwater sampling are presented in Section 3.2.3.

3.2 Groundwater Characterization and Monitoring Results

Groundwater at the RDM has been characterized and monitored over the course of the RI, RI Supplement, baseline monitoring, and the 2017 groundwater characterization. Results are summarized below.

3.2.1 RI and RI Supplement

The results of groundwater characterization performed during the RI are detailed in Chapters 3, 4, and 5 of the RI report. The RI Supplement characterization results are detailed in Chapter 3 of the RI Supplement report.

3.2.2 Baseline Groundwater Monitoring

3.2.2.1 2012 Baseline Monitoring

Results of the 2012 baseline monitoring are presented in Appendix A of the RI report.

3.2.2.2 2015 Baseline Monitoring

Results of the 2015 baseline monitoring are presented in the RI Supplement report.

3.2.2.3 2016 to 2018 Baseline Monitoring

Groundwater sample results for the 2016 to 2018 baseline monitoring are presented in Tables 3-7 to 3-11. The baseline monitoring performed in the fall of 2017 was performed in conjunction with the additional groundwater characterization of the Surface Mined Area performed in 2017 (see Section 3.1.3).

Table 3-9 presents the groundwater sample results for both the fall 2017 baseline groundwater monitoring and the groundwater sampling performed as part of the additional characterization activities. Groundwater sample results are discussed in Section 3.5. Results of baseline groundwater level measurement are presented in Sections 3.3 and 3.4.

3.2.3 2017 Groundwater Characterization

Information on soil moisture and occurrence of groundwater in the 2017 boreholes is presented in Table 2-5. Results of groundwater samples collected from the 2017 monitoring wells are presented in Table 3-9. The additional groundwater characterization was performed in conjunction with the baseline monitoring performed in the fall of 2017 (see Section 3.1.3). Table 3-9 presents groundwater sample results for both the additional characterization activities and the fall 2017 baseline groundwater monitoring. Groundwater sample results are discussed in Section 3.5. Results of groundwater level measurement are presented in Section 3.3 and 3.4.

3.3 Occurrence and Depths to Groundwater

3.3.1 Occurrence of Groundwater

An objective of the RI, RI Supplement, and 2017 additional characterization efforts was to identify saturated zones and depths to groundwater. This information has been used to evaluate the nature and extent and fate and transport of COCs at the RDM. Over the course of the RI, RI Supplement, and 2017 additional characterization activities, groundwater has been observed during drilling in unconsolidated materials consisting of mine waste (tailings/waste rock), native soils, and bedrock. Observations of soil moisture content, occurrence of groundwater during drilling, and saturated zones are presented in Sections 3.2 and 5.4 of the final RI report, Section 2.2.6 and Chapter 3 of the RI Supplement report, and Section 2.2.2 and 2.2.3 of this report. Overall results are discussed below.

Unconsolidated overburden and bedrock saturated zones appear to be in hydraulic communication on a large scale at the RDM, although some hydraulic segregation exists locally, as discussed below.

Thin, localized perched groundwater zones above apparently low permeability unconsolidated zones were identified during drilling at several locations in the Main Processing Area:

- Boring MP01 / Well MW08;
- Boring MP17 / Well MW09;
- Boring MP29 / Well MW15;
- Boring MP32; and
- Boring MP56.

Weathered bedrock locally exhibits clay and silt filling fractures. Where this occurs, the top of weathered bedrock may comprise a low permeability zone locally. For example, a thin saturated zone associated with such fracture filling was observed during drilling at the contact between unconsolidated materials and underlying weathered bedrock at soil boring MP14 / well MW10. Well MW10 was screened within a deeper saturated interval in bedrock. A similar situation was observed during drilling boring MP30 / well MW16, in which the fractures within the upper 4 feet of weathered bedrock (23 to 27 feet bgs) were filled with silt and clay. This zone appeared to segregate the overlying saturated interval within native/disturbed native soil from the underlying weathered bedrock interval. Well MW16 was screened at the top of the weathered bedrock surface. Nearby deeper well MW17 was screened in deeper bedrock.

During the 2017 additional characterization activities, localized thin perched groundwater was observed in soil overlying weathered bedrock at the following drilling locations (see Table 2-5):

- Boring SM78 / well MW50;
- Boring SM79 / well MW51;
- Boring SM81 / well MW53;
- Boring SM82 / well MW54; and
- Boring SM83 / well MW55.

At each of the locations listed above, the Kuskokwim Group bedrock lithology consisted of shale or shale and siltstone.

Groundwater within the Kuskokwim Group bedrock unit appears to occur primarily within bedrock fractures. Based on detailed geologic information gathered during mining operations (see Section 2.2.4.4), fractures include bedding-parallel fractures; faults (see Section 2.2.4.5); and NNE-striking, SE-dipping joints and ENE-striking, NW-dipping joints (see Section 2.2.4.4). No information regarding joint or fracture apertures or sealing of the various faults is available. As noted in Section 2.2.4.5, individual faults of the Red Devil fault zone and wrench faults are particularly well developed in the argillaceous rocks and follow shaley bedding planes.

Typically, during drilling through Kuskokwim Group bedrock during the RI Supplement (see RI Supplement report Appendix B) and 2017 additional characterization (see Table 2-5), little or no groundwater was observed until a transmissive fracture below the water table was penetrated. As a consequence, the static water levels in the completed wells, constructed with screens that straddle the depth of first occurrence of groundwater, are typically well above the depth of the first occurrence of groundwater observed during drilling. The first occurrence of groundwater was typically observed while drilling in graywacke or, to a lesser extent, in siltstone. This is consistent with observations noted by MacKevett and Berg (1963) that joints are best developed in the thicker graywacke beds.

3.3.2 Static Water Levels

Static groundwater depth and elevation data gathered over the course of the RI, RI Supplement, baseline monitoring, and 2017 additional groundwater characterization is summarized in Table 3-5. Based on static water elevations and stream elevations along Red Devil Creek during the RI, RI Supplement, baseline monitoring, and 2017 additional groundwater characterization events, groundwater potentiometric surface maps were generated and presented in Figures 3-6 through 3-14. Static water levels measured over time in selected RI, RI Supplement, and 2017 wells are presented graphically in Figure 3-15a through 3-15f.

During the RI, RI Supplement, baseline, and 2017 groundwater characterization and monitoring events, groundwater at the site generally flowed toward Red Devil Creek, with groundwater elevations generally mimicking topography over much of the site. Of notable exception is the groundwater in the Surface Mined Area. As noted in Section 3.2.1 of the RI report and Section 3.2.2 of the RI Supplement report, the presence of underground mine workings exerts a draining effect where the mine workings lie below the water table within the host bedrock but above the nearby base level, which is the level of Red Devil Creek. This includes a part of the Surface Mined Area. During the RI Supplement and subsequent groundwater monitoring events, the depths to groundwater in Surface Mined Area wells whose lateral positions and screened intervals are in close proximity to the mine workings—MW40, MW42, MW43, MW56, and MW59—were substantially lower than in other nearby Surface Mined Area wells installed in bedrock further away from the mine workings (e.g., MW31, MW57, MW53, MW50, MW45, MW44, MW48, and MW49). The positions of these wells relative to the mine workings are illustrated in Figures 2-5, 2-8, and 3-10 through 3-14. The groundwater levels in these wells are deeper than would be expected in the bedrock for this area and appear to be depressed due to the presence of the nearby underground mine workings. These observations support the conclusion that the mine workings network provides a highly transmissive hydraulic connection between the area of the wells and much of the underground mine workings network, including deeper portions of the mine extending below Red Devil Creek and the Main Processing Area (see Figures 2-3, 2-8, and 2-17).

As indicated by the groundwater elevation contours in Figures 3-10 through 3-14, the mine workings efficiently drain a large part of the Surface Mined Area with a locally very steep groundwater gradient toward the mine workings. Based on a comparison of the positions of the well screened intervals to the mine workings, and the groundwater potentiometric surface in the vicinity of the mine workings, it appears that the screened interval of each of these wells is positioned hydraulically upgradient of the nearby underground mine workings features.

As further indicated by the groundwater elevation contours in Figures 3-10 through 3-14, much of the groundwater in the Surface Mined Area flows toward the Red Devil Creek valley. Much of this groundwater likely flows via the preferential flow pathways of the interconnected underground mine workings to shallow depths below Red Devil Creek (see Figures 2-8 and 2-17). However, as noted above, the interconnected flow pathways of the underground workings also extend to deeper bedrock below the Main Processing Area and Red Devil Creek.

Based on the groundwater elevations and stream elevations in Red Devil Creek (see Figures 3-10 through 3-14), much of the groundwater within the Red Devil Creek valley, including groundwater in the Main Processing Area and the area downstream of the Main Processing Area, emerges into Red Devil Creek and enters the Kuskokwim River as surface water rather than as groundwater. However, some groundwater in deeper bedrock as well as unconsolidated materials likely does not discharge to Red Devil Creek, but instead migrates via the groundwater pathway down Red Devil Creek valley and discharges through the river bed to the Kuskokwim River (see Section 3.9).

3.3.3 Continuous Water Level Measurement

Static water level measurements are augmented with the continuous water level measurements collected using pressure transducers between the fall 2017 and early spring of 2018, as described in Section 3.1.3.6. Continuous water levels measured in wells MW46, MW48, MW50, MW51, MW56, and MW59 from September 2017 to May 2018 are illustrated in Figure 3-16. Meteorological factors affecting water levels exhibited in the transducer data are discussed in Section 3.3.4.

3.3.4 Meteorology

It is expected that groundwater levels generally are tied to rates of precipitation, snowmelt, and other meteorological and hydrologic factors. No site-specific meteorological data for the RDM are available to allow detailed evaluation of the correlation between groundwater levels and these factors. To inform a general understanding of precipitation and temperature in the region around the RDM, available meteorological data from nearby locations was evaluated. Available daily total precipitation and minimum, maximum, and average temperatures measured at the Western Regional Climate Center at Stoney River, Alaska station (WRCC 2018) are presented graphically in Figure 3-17.

A period of relatively heavy rain recorded at Stoney River in early to mid-October 2017 (Figure 3-17) appears to coincide with the rapid increase in water levels at that time observed in the transducer data presented in Figure 3-16. The transducer data also show steadily decreasing water levels over the winter, consistent with precipitation primarily in the form of snow. The rapid increase in water levels beginning in late April is consistent with observed increases in temperature above freezing, resulting in snowmelt, and precipitation recorded at Stoney River.

3.4 Groundwater Gradients and Flow Paths

3.4.1 Lateral Gradients

Lateral groundwater gradient varies with location and aquifer properties across the site. The gradients in the Red Devil Creek valley range from approximately 0.07 in parts of the Main Processing Area to 0.04 between the Main Processing Area and the Kuskokwim River.

Gradients in undisturbed (i.e., unmined) bedrock are commonly steeper and generally follow topography. Gradients between the eastern edge of the area of the proposed repository and the Kuskokwim River are approximately 0.35.

As described in Section 3.3.2, the network of underground mine workings that underlies part of the Surface Mined Area provides a highly transmissive hydraulic connection that efficiently drains the part of the Surface Mined Area in close proximity to the workings that lie below the water table. A steep hydraulic gradient exists between the areas near the mine workings and the areas without underground workings. Near the northern end of the underground mine workings (near the Dolly Shaft collar), the gradient is locally as high as approximately 1.

The generally high hydraulic gradients in bedrock suggest a generally fairly low hydraulic conductivity in Kuskokwim Group bedrock not in close proximity to the mine workings. Hydraulic conductivity of Kuskokwim Group bedrock is discussed further in Section 3.8.2.

3.4.2 Vertical Gradients

During each RI, RI Supplement, and baseline groundwater monitoring event there was an upward gradient in the MW27 (shallow)/MW28 (deep) well pair. The upward gradient has ranged from 0.011 to 0.127. An upward gradient in the vicinity of wells MW27 and MW28 is consistent with the interpretation that groundwater in that part of the Main Processing Area emerges into Red Devil Creek (e.g., see Section 3.2 of the RI report and Section 3.2.2 of the RI Supplement report).

During each RI, RI Supplement, and baseline groundwater monitoring event except the September 1, 2011, event there was an apparent downward gradient in the MW16 (shallow)/MW17 (deep) well pair. The apparent downward gradient has ranged from 0.020 to 0.149. The apparent downward gradient observed during most of the monitoring events in the MW16/MW17 well pair may be a result of the hydraulic segregation of the shallow saturated interval within unconsolidated materials from the underlying fractured bedrock by a low permeability zone within the upper 4 feet of weathered bedrock in which the fractures are filled by silt and clay (see Section 3.3.1). The apparent downward gradient in the MW16/MW17 well pair could also possibly be due to losing conditions in that area, such as those interpreted along Red Devil Creek in part of the Main Processing Area during the RI and 2012 baseline monitoring events prior to the

2014 NTCRA (see Section 3.2.2 of the RI report). Such losing conditions would result in a localized generally downward flow of surface water into the subsurface.

As illustrated in Figures 3-6 through 3-14, at times Red Devil Creek exhibits losing conditions at the Red Devil Creek delta. Under such conditions, the groundwater gradient would be downward.

3.5 Groundwater Quality

3.5.1 Groundwater Sample Results

Groundwater sampling at the RDM has been conducted over the course of the RI, RI Supplement, baseline monitoring, and the 2017 groundwater characterization. The RI groundwater sample results are detailed in Section 4.4 of the RI Report. The RI Supplement groundwater sampling results are detailed in Section 3.2.3 of the RI Supplement report. Groundwater sample results of the baseline groundwater monitoring are presented in Tables 3-7 through 3-11 of this report. Groundwater sample results for the primary COCs—antimony, arsenic, and mercury—for the RI, RI Supplement, baseline monitoring, and the 2017 groundwater characterization are summarized in Table 3-11. Groundwater COC concentrations and elevations over time in selected RI, RI Supplement, and 2017 wells are presented graphically in Figure 3-15a through 3-15f.

3.6 Factors Influencing Groundwater Quality

Factors affecting transport of inorganic elements in groundwater are discussed in Chapter 5 of the RI report. RI report Section 5.4.1 presents a general discussion of factors that may affect release and transport of metals in groundwater, as summarized below. Transport and concentrations of contaminants in groundwater are governed by the processes of advection, hydrodynamic dispersion (including mechanical dispersion and molecular diffusion), adsorption/desorption, precipitation and dissolution, and recharge. Release and migration of inorganics in sulfide minerals are controlled by presence and flux of water and oxygen; ferric iron; bacteria that catalyze the oxidation reactions; heat generated from the exothermic oxidation reactions; mineralogy of the sulfides and the materials in which the oxidation is occurring; and acid neutralization reactions. In general, many trace inorganics are strongly adsorbed onto surfaces of minerals and organic compounds in soils and sediments, limiting their mobility in the environment. The strong adsorptive capabilities of secondary clay minerals, hydrous iron, aluminum and manganese oxides and humic material have been well demonstrated and may be responsible for retardation of transport of trace metals in groundwater.

The groundwater flow pathways determine the chemical, physical, and biological environments in which leaching and mobilization of inorganic elements may occur. The groundwater flow pathways at the RDM are complex and include flow through fractured bedrock, overlying unconsolidated materials comprising mixed mine wastes and native soils and stream and river sediments, and a network of underground mine workings. Groundwater flow pathways at the RDM are discussed in Section 5.4.2 of the RI report. Sources of inorganic elements in groundwater at the RDM, including mine wastes, bedrock, and native soils, are discussed in Section 5.4.3 of the RI report.

As discussed in Section 5.4.3.1 of the RI report, groundwater at the RDM is locally impacted by contaminants in mine waste consisting of tailings/waste rock, flotation tailings, and contaminated soils, as evidenced by detection of contaminants in monitoring wells installed within and hydraulically downgradient of areas containing these contaminant sources. The primary source of inorganics in groundwater at the RDM is leaching from tailings/waste rock in the Main Processing Area. The highest concentrations of COCs in groundwater are observed in wells screened within or downgradient of saturated tailings/waste rock, as exemplified in wells MW15, MW20, MW21, MW22, MW14, MW16, and MW03.

Groundwater at the RDM also is locally impacted by inorganic elements present in naturally mineralized bedrock (see RI Section 5.4.3.2) and native soils (see RI Section 5.4.3.3).

As noted in Section 5.4.3 of the RI report, underground mine workings are developed within naturally mineralized bedrock. The mine workings followed rich ore bodies formed in association with fractures and faults. Associated with the ore bodies are zone(s) of sub-ore grade natural mineralization with deposits of cinnabar as well as antimony and arsenic minerals (see Section 2.2.6.2). The mine workings form a network of conduits that may facilitate rapid groundwater flow (e.g., see RI report Sections 3.2.6 and 5.4.2). In addition, the mine workings also provide a conduit exposing the mineralized bedrock and groundwater to oxygen (in air) and other possible surface influences on groundwater geochemistry. RI report Section 5.4.3.2 further notes that groundwater impacts exhibited in bedrock wells could be attributable to the bedrock itself, natural weathering of the bedrock, disturbance of the bedrock by underground mining, and/or migration of contaminants from surficial or near-surface sources downward into bedrock.

Multiple factors in addition to natural mineralization in bedrock may affect groundwater quality at the RDM. As was noted in RI report Section 5.4.3.2, distinguishing between groundwater impacts attributable to natural mineralization and contamination resulting from mining-related impacts is complicated. Subsequent to the RI, additional empirical data were gathered as part of the RI Supplement to attempt to assess impacts of natural mineralization on groundwater quality in the Surface Mined Area. Results of that effort are summarized in Section 3.6.1. Following the RI Supplement, additional soil, bedrock, and groundwater characterization was conducted as part of the 2017 groundwater characterization. Although the wells installed in 2017 in the vicinity of the repository are intended primarily to inform the development of the detailed hydrologic analysis and establishment of a detection monitoring network for the proposed repository, the resulting data also are useful for assessing the potential influence of natural mineralization and underground mine workings on groundwater conditions in the Surface Mined Area. Results of that effort are summarized in Section 3.6.2.

3.6.1 RI Supplement Wells

A primary objective of the RI Supplement was to assess groundwater occurrence, depth, and quality in the Surface Mined Area to better understand impacts of naturally mineralized bedrock and underground mine workings on groundwater flow paths and inorganic element concentrations. A total of eight soil borings were installed in the Surface Mined Area in 2015 as part of an effort to install monitoring wells. A total of four new monitoring wells were installed. A summary of the soil boring and monitoring well installation are presented in Tables 2-1 and 3-1 of the RI Supplement report, respectively. Well construction details are provided in Table 3-1 of the RI Supplement report. Information regarding bedrock mineralized zones and the occurrence of groundwater is presented in Table 2-2 and Appendix B of the RI Supplement report and discussed below.

RI Supplement wells MW39, MW40, MW42, and MW43 were installed to better understand impacts of the underground mine workings on groundwater depths, gradient, and flow paths. The wells also were installed to better understand the impacts of naturally mineralized bedrock on inorganic element concentrations in groundwater. The screened interval of each of these wells is positioned in competent bedrock close to, but apparently hydraulically upgradient of, the nearest underground mine workings. The mine workings features located nearest to each well are identified in Table 3-1 of the RI Supplement report. The map locations of the monitoring wells and mine workings features are illustrated in Figure 2-3. The elevations of the generally horizontal features of the mine workings (adits, levels/sublevels, and crosscuts) are indicated on Figures 2-3 and 2-8. The vertical positions of the generally horizontal mine features and the sub-vertical mine workings features that interconnect the generally horizontal mine workings (shafts, raises, winzes, and stopes), as projected horizontally onto the line of geologic cross section B-B’ (see Figure 2-8). Observations made during drilling indicate that, despite their proximity, none of the wells intercept any of the underground mine workings.

Observations regarding soil and bedrock conditions and the occurrence of groundwater for the RI Supplement monitoring wells are detailed in Table 2-2 and Appendix B of the RI Supplement report and described below:

- **Well MW39** was installed in borehole SM67 near its originally planned location NW of the Dolly Shaft and assumed downgradient of the proposed repository location (see Figures 2-3 and 2-8). Shallow soil at this location consists of disturbed native soil comprising loess mixed with Kuskokwim Group derived soil from 0 to 2 feet bgs. The shallow disturbed soil is underlain by undisturbed loess from 2 to 9 feet bgs, which is underlain by Kuskokwim Group bedrock. The minimal surface disturbance observed in soil samples is consistent with the apparently low degree of surface disturbance visible in the 1974 aerial photograph in the immediate area of the borehole/well (see Figures 2-18 and 2-19) and the mapped extent of loess as of 1963 (see Figure 2-20). Little visual or XRF field screening evidence of mineralization was observed in the soil or Kuskokwim Group bedrock. During bedrock drilling, evidence for groundwater was observed at several intervals as shallow as 63 feet bgs. As noted above, groundwater in the Kuskokwim Group bedrock occurs primarily in fractures, and while drilling in bedrock using the air rotary/down-the-hole hammer method, identification of saturated conditions was locally difficult. Such conditions appear to have been experienced during drilling of borehole SM67. Moisture mixed with the clayey cuttings resulted in a clayey coating of the borehole wall, which was suspected to have obscured and possibly limited flow of water into the borehole. Based on the interpretation of available information made during drilling, a well was installed with a screen interval of 63 to 83 feet bgs. The well has been dry during subsequent attempts to monitor groundwater in the well.

- **Well MW40** was installed in borehole SM68c, the third borehole drilled in the attempt to install the well. SM68c/MW40 is located approximately 250 feet SE of boreholes SM68a and SM68b, the first two boreholes drilled in the attempt to install the well (see Figure 2-3). Borehole SM68c/well MW40 was installed near the 507 Crosscut and Dolly No. 7 / 1280 Crosscut (see Figures 2-3 and 2-8). Soil and bedrock in the upper 50 feet of borehole SM68c was not logged. Based on review of the 1974 aerial photograph (see Figures 2-18 and 2-19), the area of SM68c/MW40 appears to have been disturbed less than other areas of the Surface Mined Area along the surface trends of the ore zones. Well MW40 was installed at a location with loess as mapped in 1963 (see Figure 2-20). In borehole SM68c, realgar and orpiment were visually identified in drill cuttings from 102.5 to 107.5 feet bgs, near the water table, and white vein material was identified in multiple intervals. The XRF arsenic concentration for the 105- to 107.5-foot interval is 4,608 ppm. The well was with a screen interval of 119 to 139 feet bgs that straddled the water table and is just below the highly mineralized zone from 102 to 107.5 feet bgs.

- **Well MW42** was installed in borehole SM70b, the second borehole drilled in the attempt to install the well. Borehole SM70b is located approximately 40 feet S of borehole SM70a, the first borehole drilled in the attempt to install the well (see Figure 2-3). The well was installed near raises/winzes/stopes extending upward from the 150 Level / 200 Level (see Figures 2-3 and 2-8). Shallow soil at this location consists of disturbed native soil comprising loess mixed with Kuskokwim Group derived soil mixed with loess from 0 to 3 feet bgs. The shallow disturbed soil is underlain by apparently undisturbed loess from 3 to 12 feet bgs, which is underlain by Kuskokwim Group bedrock. Well MW42 was installed at a location just outside of the mapped extent of loess as of 1963 (see Figure 2-20). The presence of loess and the soil disturbance observed in the 0- to 3-foot interval is consistent with the interpreted surface disturbance—dozing of loess and other soil away from the ore zone to expose the zone for surface excavation—apparent in the 1974 aerial photograph (see Figures 2-18 and 2-19). Clasts of Kuskokwim Group derived soils in the 0- to 3-foot interval exhibited some mineralization consisting of visible realgar and XRF arsenic concentrations up to 467 ppm (see RI Supplement report Table 2-2 and Appendix B). XRF arsenic concentrations in the underlying undisturbed loess (3- to 12-foot interval) were generally low, with a maximum of 35 ppm. The Kuskokwim Group bedrock in boreholes SM70a and SM70b exhibited abundant visual evidence of mineralization, including cinnabar, stibnite, realgar, orpiment (see Photograph 5, Section 2.2.6.2), and white vein material in cuttings. Borehole SM70a exhibited XRF field screening concentrations for arsenic up to 3,831 ppm and for mercury up to 1,531 ppm. Borehole SM70b exhibited XRF arsenic field screening concentrations up to 3,458 ppm in a zone ranging from approximately 120 to 140 feet bgs, coincident with the water table, which was observed at a depth of approximately 127 feet bgs on September 10, 2015. The well was installed with a screen interval of 119 to 139 feet bgs, straddling the water table and coinciding with a strongly mineralized zone in borehole SB70b described above.

- **Well MW43** was installed in borehole SM71b, the second borehole drilled in the attempt to install the well. Borehole SM71b is located a short distance from borehole SM71a, the first borehole drilled in the attempt to install the well (see Figure 2-3). Well MW43 was installed near the 33 Level and 73 Level and raises/winzes/stopes extending between the levels and upward from the 33 Level (see Figures 2-3 and 2-8). Soil overlying the Kuskokwim Group bedrock in borehole SM71a consists of disturbed loess and loess mixed with Kuskokwim Group derived soil from 0 to 12 feet bgs. Well MW43 was installed at a location just outside of the mapped extent of loess as of 1963 (see Figure 2-20). The presence of disturbed loess mixed with some Kuskokwim Group derived soil is consistent with the interpreted surface disturbance—dozing of loess and other soil away from the ore zone to expose the zone for surface excavation—apparent in the 1974 aerial photograph (see Figures 2-18 and 2-19). Clasts of Kuskokwim Group derived soils in the upper 3 feet exhibited some mineralization consisting of visible realgar and XRF arsenic concentrations up to 253 ppm in the 1- to 2-foot interval and 208 ppm in the 2- to 3-foot interval. XRF arsenic concentrations in the soils from 3- to 9-foot interval were lower, ranging from 11 to 62 ppm. XRF arsenic concentrations in the soils from 9 to 12 feet range up to 164 ppm.

> The Kuskokwim Group bedrock in boreholes SM71a and SM71b exhibit indications of some mineralization, including visual observation of realgar and XRF arsenic concentrations up to 400 ppm (40 to 41 feet bgs) in multiple intervals above the water table. The observed degree of mineralization was greatest below the water table, which was approximately 88 feet bgs on September 10, 2015. Stibnite was observed in SM71b in intervals of 114 to 116 feet and 119 to 120 feet, and white vein material was observed in most of the intervals between 105 and 120 feet bgs. XRF arsenic concentrations range up to 6,954 ppm in SM71b within this zone. Installation of a well in borehole SM71a was attempted, but the well was damaged in the process. A well was successfully installed in borehole SM71b, with a screen interval of 98 to 118 feet bgs, coinciding with the strongly mineralized zone described above.

The wells are screened within or near bedrock intervals that exhibit natural sub-ore grade mineralization peripheral to the ore zones that were targeted by the mining. Although the wells were installed at locations with surface disturbance that resulted from surface mining, the potential impacts on COC concentrations in groundwater resulting from this surface disturbance and associated COC migration through the vadose zone to the saturated zone appear to be less important than the impacts resulting from flow through bedrock where the bedrock is heavily mineralized such as was observed adjacent to or near the screen intervals of the 2015 wells. Concentrations of COCs in groundwater samples collected from the wells from 2015 to 2017 are summarized in Table 3-11. Additional data collected from new wells in 2017 supports this result (see Section 3.6.2).

3.6.2 2017 Wells

Although the wells installed in 2017 in the vicinity of the repository are intended primarily to inform the development of the detailed hydrologic analysis and establishment of a detection monitoring network for the proposed repository, the resulting data also are useful for assessing the potential influence of natural mineralization and underground mine workings on groundwater conditions in the Surface Mined Area. A total of 16 new monitoring wells were installed in 2017 at locations upgradient of, near, and downgradient of the proposed repository and/or the potentially extended repository footprint area. The locations of new monitoring wells are illustrated in Figures 2-5 and 3-5. The wells are located hydraulically upgradient of or outside of the hydraulic influence of the underground mine workings (see Figures 3-13 and 3-14). Information on lithology and mineralogy, occurrence of groundwater, and concentrations of inorganic elements in soil and bedrock, and geotechnical properties is presented in Section 2.2.3 and summarized in Tables 2-5 through 2-7.

Observations regarding soil and bedrock conditions and the occurrence of groundwater for the RI Supplement monitoring wells are described below.

- **Well MW44** was installed in borehole SM72, located generally E of the proposed repository, to characterize aquifer conditions potentially downgradient (Red Devil Creek or Kuskokwim River drainage) of the proposed repository. The well was drilled at a location that does not appear to have been disturbed by surface mining activities (see Figures 2-18 and 2-19). The well was installed at a location just within of the mapped extent of loess as of 1963 (see Figure 2-20). Soil overlying the Kuskokwim Group bedrock consists of loess from 0 to 1 foot bgs and soil derived from Kuskokwim Group bedrock from 1 to 2.2 feet bgs. No visual indications of mineralization were observed in the soil or Kuskokwim Group bedrock. Monitoring well MW44 was installed with a screen interval in Kuskokwim Group bedrock.

- **Well MW45** was installed in borehole SM73, located generally E of the proposed repository, to characterize aquifer conditions in the area potentially downgradient (Kuskokwim River drainage) of the proposed repository. The well was drilled at a location near an exploratory trench (see Figures 2-18 and 2-19). The well was installed at a location outside of the mapped extent of loess as of 1963 (see Figure 2-20). Soil overlying the Kuskokwim Group bedrock consists of loess, peat, and Kuskokwim Group bedrock derived soil from 0 to 8.4 feet bgs. No visual indications of mineralization were observed in the soil. Visual indications of mineralization in Kuskokwim Group bedrock include realgar and white vein material. XRF arsenic concentrations up to 85 ppm were observed.

- **Well MW46** was installed in borehole SM74, located generally NE of the proposed repository, to characterize aquifer conditions in the area potentially downgradient (Kuskokwim River drainage) of the proposed repository. The well was drilled at a location near an exploratory trench (see Figures 2-18 and 2-19). The well was installed at a location outside of the mapped extent of loess as of 1963 (see Figure 2-20). Soil overlying the Kuskokwim Group bedrock consists of Kuskokwim Group bedrock derived soil from 0 to 1.6 feet bgs. No visual indications of mineralization were observed in the soil. Visual indications of mineralization in Kuskokwim Group bedrock include white vein material. XRF arsenic concentrations up to 119 ppm were observed.

- **Well MW47** was installed in borehole SM75, located generally N of the proposed repository, to characterize aquifer conditions in the area potentially downgradient (Kuskokwim River drainage) of the proposed repository. The well was drilled at a location near an exploratory trench (see Figures 2-18 and 2-19). The well was installed at a location outside of the mapped extent of loess as of 1963 (see Figure 2-20). Soil overlying the Kuskokwim Group bedrock consists of Kuskokwim Group bedrock derived soil and loess from 0 to 2.6 feet bgs. No visual indications of mineralization were observed in the soil. Visual indications of mineralization in Kuskokwim Group bedrock include white vein material. No XRF data are available.

- **Well MW48** was installed in borehole SM76, located generally SE of the proposed repository, to characterize aquifer conditions in the area potentially downgradient (Red Devil Creek or Kuskokwim River drainage) of the proposed repository. The well was drilled at a location outside of the mapped extent of loess as of 1963 (see Figure 2-20). Soil overlying the Kuskokwim Group bedrock consists of Kuskokwim Group bedrock derived soil from 0 to feet bgs. No visual indications of mineralization were observed in the soil. Visual indications of mineralization in Kuskokwim Group bedrock include some white vein material. XRF arsenic concentrations up to 217 ppm in soil and 78 ppm in bedrock were observed.

- **Well MW49** was installed in borehole SM77, located generally SE of the proposed repository, to characterize aquifer conditions in the area potentially downgradient (Red Devil Creek or Kuskokwim River drainage) of the proposed repository. The well was drilled at a location within the mapped extent of loess as of 1963 (see Figure 2-20). Soil overlying the Kuskokwim Group bedrock consists of loess from 0 to 5.5 feet bgs and Kuskokwim Group bedrock derived soil from 5.5 to 20 feet bgs. No visual indications of mineralization were observed in the soil. Visual indications of mineralization in Kuskokwim Group bedrock include stibnite, cinnabar, and white vein material at depths below the water table. XRF arsenic concentrations up to 142 ppm in soil and 64 ppm in bedrock were observed.

- **Well MW50** was installed in borehole SM78, located within the footprint of the proposed repository, to characterize vadose zone and aquifer conditions within the proposed repository footprint. The well was drilled at a location within the mapped extent of loess as of 1963 (see Figure 2-20). Soil overlying the Kuskokwim Group bedrock consists of loess with some Kuskokwim Group derived soil from 0 to 2 feet bgs and loess from 2 to 17.6 feet bgs. The relatively thick layer of loess and apparent minimal disturbance, reflected in the mixing of loess and Kuskokwim Group derived soil being limited to only the upper 2 feet of soil, is consistent with the apparently low degree of surface disturbance visible in the 1974 aerial photograph in the immediate area of the borehole/well (see Figures 2-18 and 2-19) and its location near the middle of the mapped extent of loess as of 1963 (see Figure 2-20). No visual indications of mineralization were observed in the soil. Visual indications of mineralization in Kuskokwim Group bedrock include red mineral grains, suspected to be realgar, contained within the argillite in the 42.5- to 45-foot interval and 72.5- to 75-foot interval (see Photograph 6, Section 2.2.6.2.5). XRF data are available for the upper 25 feet of the borehole. Elevated arsenic XRF concentrations were observed in the weathered bedrock, ranging up to up to 1,040 ppm in the 22- to 23-foot interval.

- **Well MW51** was installed in borehole SM79, located within the footprint of the proposed repository, to characterize vadose zone and aquifer conditions within the proposed repository footprint. The well was drilled at a location near the edge of the mapped extent of loess as of 1963 (see Figure 2-20). Soil overlying the Kuskokwim Group bedrock consists of loess from 0 to 11.3 feet bgs. The relatively thick layer of loess is consistent with the relatively low degree of surface disturbance apparent in the 1974 aerial photograph in the immediate area of the borehole/well (see Figures 2-18 and 2-19). No visual indications of mineralization were observed in the soil or bedrock. Arsenic XRF concentrations up to in shallow bedrock (13 to 14 feet bgs) above the water table up to 128 ppm below the water table were observed.

- **Well MW52** was installed in borehole SM80, located generally NW of the proposed repository, to characterize aquifer conditions in the area potentially downgradient (McCally Creek drainage) of the proposed repository. The well was drilled at a location outside of the mapped extent of loess as of 1963 (see Figure 2-20) and within the area of surface disturbance from mining (see Figures 2-18 and 2-19). Soil overlying the Kuskokwim Group bedrock consists of silt interpreted to be loess from 0 to 5.2 feet bgs. The presence of loess is likely due to dozing (see Figures 2-18 and 2-19). No visual indications of mineralization were observed in the soil. Visual indications of mineralization in Kuskokwim Group bedrock include white vein material at depths below the water table (45 to 56 feet bgs). No XRF data are available.

- **Well MW53** was installed in borehole SM81, located generally SW of the proposed repository, characterize aquifer conditions in the area potentially upgradient of proposed repository, and vadose zone (soil and bedrock) and aquifer conditions near the potentially extended footprint of proposed repository. The well was drilled at a location within the mapped extent of loess as of 1963 (see Figure 2-20) and outside of the area of surface disturbance from mining (see Figures 2-18 and 2-19). Soil overlying the Kuskokwim Group bedrock consists of silt interpreted to be loess from 0 to 6 feet bgs and Kuskokwim Group bedrock derived soil from 6 to 7.3 feet bgs. No visual indications of mineralization were observed in the soil. Visual indications of mineralization in Kuskokwim Group bedrock include white vein material at depths above and below the water table. Arsenic XRF concentrations up to 410 ppm above the water table and up to 140 below the water table were observed.

- **Well MW54** was installed in borehole SM82 located generally W of the proposed repository, to characterize aquifer conditions in the area near the proposed repository, and vadose zone (soil and bedrock) and aquifer conditions in the area near the potentially extended footprint of proposed repository. The well was drilled at a location outside of the mapped extent of loess as of 1963 (see Figure 2-20) and the area of surface disturbance from mining (see Figures 2-18 and 2-19). Soil overlying the Kuskokwim Group bedrock consists of sand and silt likely to be loess and Kuskokwim Group derived soil from 0 to 7.3 feet bgs. No visual indications of mineralization were observed in the soil. Visual indications of mineralization in bedrock include the occurrence of an igneous dike from 42.5 to 50 feet. Other visual indications of mineralization include white vein material above the water table (11 to 20 feet bgs), and white vein material (32.5 to 50 feet bgs), stibnite (45 to 47.5 feet bgs), and orpiment (47.5 to 50 feet bgs) below the water table. Arsenic XRF concentrations up to 563 ppm below the water table and 551 ppm just above the water table were observed. Antimony concentrations up to 347 ppm above the water table also were observed.

- **Well MW55** was installed in borehole SM83, located generally NW of the proposed repository, to characterize aquifer conditions in the area potentially downgradient of the proposed repository, and vadose zone (soil and bedrock) and aquifer conditions in the area near and potentially downgradient (McCally Creek drainage) of the potentially extended footprint of proposed repository. The well was drilled at a location outside of the mapped extent of loess as of 1963 (see Figure 2-20) and near the edge of the area of surface disturbance from mining (see Figures 2-18 and 2-19). Soil overlying the Kuskokwim Group bedrock consists of silt with some gravel, interpreted to be mixed loess and Kuskokwim Group bedrock derived soil, from 0 to 16 feet bgs. Visual indications of mineralization observed in the soil include clasts of Kuskokwim Group gravel with cinnabar and white vein material. Visual indications of bedrock mineralization below water table include white vein material (20 to 27 feet bgs) and orpiment (25 to 27 feet bgs). XRF data are available only for antimony. Antimony XRF concentrations up to 24,484 ppm in soil and 2,183 ppm in bedrock below the water table were observed.

- **Well MW56** was installed in borehole SM84, located generally SE of the proposed repository, to characterize aquifer conditions in the area near and potentially downgradient (Red Devil Creek drainage) of the proposed repository and within the anticipated area of hydraulic influence of the underground mine workings. The well was drilled at a location within the mapped extent of loess as of 1963 (see Figure 2-20) and near the edge of the area of surface disturbance from mining and a trench (see Figures 2-18 and 2-19). Soil overlying the Kuskokwim Group bedrock consists of mixed loess and Kuskokwim Group bedrock derived soil, from 0 to 6.6 feet bgs. No visual indications of mineralization were observed in the soil. Visual indications of bedrock mineralization include stibnite (17 to 22 feet bgs) and white vein material above the water table, and stibnite (32 to 34.5 and 39.5 to 42 feet bgs) and white vein material below the water table. XRF arsenic concentrations up to 527 ppm above the water table and 1,733 ppm below the water table were observed.

- **Well MW57** was installed in borehole SM85, located generally S of the proposed repository, to characterize aquifer conditions in the area near and potentially downgradient (Red Devil Creek drainage) of the proposed repository and the potentially extended repository footprint, and within the anticipated area of hydraulic influence of the underground mine workings. The well was drilled at a location near the edge of the mapped extent of loess as of 1963 (see Figure 2-20) and outside of the area of surface disturbance from mining (see Figures 2-18 and 2-19). Soil overlying the Kuskokwim Group bedrock consists of mixed loess and Kuskokwim Group bedrock derived soil, from 0 to 12 feet bgs. No visual indications of mineralization were observed in the soil. Visual indications of bedrock mineralization include white vein material above and below the water table. No XRF data are available.

- **Well MW58** was installed in borehole SM86, located generally SW of the proposed repository, to characterize vadose zone (soil and bedrock) and aquifer conditions in the area near the proposed repository and the potentially extended repository footprint. The well was drilled at a location outside of the mapped extent of loess as of 1963 (see Figure 2-20) and outside of the area of surface disturbance from mining (see Figures 2-18 and 2-19). Soil overlying the Kuskokwim Group bedrock consists of Kuskokwim Group bedrock derived soil from 0 to 10 feet bgs. No visual indications of mineralization were observed in the soil. Visual indications of bedrock mineralization include white vein material below the water table. No XRF data are available.

- **Well MW59** was installed in borehole SM87, located near existing well MW39 (dry), generally SE of the proposed repository, to replace well MW39 and characterize aquifer conditions in the area near and potentially downgradient (Red Devil Creek drainage) of the proposed repository and within the anticipated area of hydraulic influence of the underground mine workings. The well was drilled at a location within the mapped extent of loess as of 1963 (see Figure 2-20) and the area of surface disturbance from mining (see Figures 2-18 and 2-19). Soil overlying the Kuskokwim Group bedrock consists of mixed loess and Kuskokwim Group derived soil (0 to 2 feet bgs) and loess (2 to 10.4 feet bgs). No visual indications of mineralization were observed in the soil. Visual indications of bedrock mineralization include white vein material above and below the water table. No XRF data are available.

As with RI Supplement wells, although some of the 2017 wells were installed at locations with surface disturbance that resulted from surface mining, the potential impacts on COC concentrations in groundwater resulting from this surface disturbance and associated COC migration through the vadose zone to the saturated zone appear to be less important than the impacts resulting from groundwater flow through the bedrock if such bedrock is significantly mineralized. This is supported by results for well MW50, which was installed at a location in the Surface Mined Area with minimal surface disturbance and with a relatively thick layer of loess exhibiting no indications of mineralization or elevated COC concentrations. Indications of mineralization in Kuskokwim Group bedrock include suspected realgar (arsenic sulfide) and elevated arsenic XRF concentrations. The well is located hydraulically upgradient of the underground mine workings (see Figure 3-13) and is not hydraulically downgradient of any known contaminant sources. Groundwater sampled in MW50 contained relatively elevated concentrations of total antimony at 7.3 micrograms per liter (µg/L), total arsenic at 490 µg/L, dissolved mercury at 14.8 nanograms per liter (ng/L), and total mercury at 1,130 ng/L. Results of groundwater samples collected from well MW50 are presented Tables 3-9 and 3-11 of this report.

Collectively, 2017 characterization results and RI Supplement results provide additional information useful for assessing the impacts on groundwater quality of the natural mineralization present in bedrock close to, but apparently hydraulically upgradient of, the mine workings. It should be noted that, at such locations, once groundwater flows through the naturally mineralized bedrock peripheral to the mine workings it enters the mine workings and may subsequently be further impacted by the mine workings themselves. No data presently exist to directly assess such impacts of the mine workings themselves on groundwater COC concentrations.

3.7 Groundwater Background Levels

3.7.1 Rationale for Groundwater Background Level Development

Previously, as part of the RI, background groundwater concentrations were proposed based on results of samples collected from two wells—MW12, screened in alluvium located within the Red Devil Creek upstream alluvial area, and MW31, screened in bedrock within the upland area west of the Surface Mined Area. These wells were proposed for background groundwater characterization during the RI based on their location outside of and upgradient of any likely mining-related influence on groundwater COC concentrations. These wells also are located outside of the area of any natural mineralization in bedrock such as described in Section 2.2.6.2.

Remedial Alternatives 3 and 4 presented in the 2016 FS include excavation of tailings/waste rock and soil with COC concentrations exceeding one or more soil remedial goals (RGs). It is anticipated that such excavation would extend to the top of bedrock throughout much of the Main Processing Area and Red Devil

Creek downstream alluvial area. Where such excavation would extend to the top of bedrock, any groundwater contained within the excavated materials also would be removed. Following such excavation, only small, laterally discontinuous areas of residual uncontaminated soil (i.e., with concentrations of COCs below soil RGs) would remain in place in the Main Processing Area and the downstream Red Devil Creek valley. Some of this residual soil may contain groundwater. Such groundwater would be expected to occur in thin, discontinuous zones within the soil. Some of this groundwater could potentially include residual groundwater contaminated by leaching of COCs from the tailings/waste rock and contaminated soil prior to their removal. To evaluate such potentially contaminated groundwater in the FS Supplement, groundwater RGs need to be developed. One or more groundwater RGs may be based on background conditions. For the purposes of the FS RGs, background groundwater is defined as the groundwater that would flow into the Main Processing Area and Red Devil Creek downstream alluvial valley following excavation. Due to complexities in groundwater flow and contaminant transport at the site, it is not possible to reliably predict what the COC concentrations in such background groundwater would be prior to such excavation and subsequent re-establishment of equilibrium groundwater conditions.

Much of the groundwater presently flowing into and through the Main Processing Area and Red Devil Creek downstream alluvial area originates in the Surface Mined Area northwest of Red Devil Creek and the upland area on the southeast side of Red Devil Creek. It is generally expected that groundwater from these areas would continue to flow into and through the Main Processing Area and Red Devil Creek downstream alluvial area following excavation.

As discussed in Section 3.6, some of the groundwater presently flowing into the Main Processing Area and Red Devil Creek downstream alluvial area is impacted by naturally mineralized bedrock. As described in Section 2.2.6.2, as a result of localized hydrothermal mineralization, concentrations of COCs in the Kuskokwim Group bedrock are locally significantly higher than in unmineralized zones of the bedrock unit. Groundwater flowing through these mineralized zones contains COC concentrations significantly higher than groundwater in Kuskokwim Group bedrock that has not undergone the mineralization.

Previously, as part of the RI, background groundwater concentrations were proposed based on results of samples collected from two wells—MW12, screened in alluvium located within the Red Devil Creek upstream alluvial area, and MW31, screened in bedrock within the upland area west of the Surface Mined Area. These wells were proposed for background groundwater characterization during the RI based on their location outside of and upgradient of any likely mining-related influence on groundwater COC concentrations. These wells also are located outside of the area of any natural mineralization in bedrock such as described in Section 2.2.6.2.

In order to develop appropriate RGs to address the potentially contaminated groundwater that would be present in the Main Processing Area and Red Devil Creek Valley following excavation such as described in FS Alternatives 3 and 4, it is necessary to account for the influence of natural mineralization on the groundwater COC concentrations. As discussed in Section 3.6, some of the wells installed in the Surface Mined Area reflect impacts of natural bedrock mineralization on COC groundwater concentrations. As such, groundwater data from these wells provide an opportunity to estimate COC concentrations impacted by natural mineralization using presently available empirical data.

In coordination with the Alaska Department of Environmental Conservation and EPA, an approach was developed to estimate such background groundwater levels to inform development of groundwater RGs for the FS Supplement. The approach is presented in Section 3.7.2.

3.7.2 Development of Groundwater Background Threshold Values

The approach and results of the groundwater background threshold value (BTV) analysis are summarized below.

3.7.2.1 Well Selection

The observations used in the derivation of the groundwater BTVs were collected from monitoring wells believed to represent groundwater conditions in bedrock upgradient of the Main Processing Area and Red Devil Creek downstream alluvial area. Wells were selected for the groundwater BTV analysis if they met all of the following criteria:

1) The well is screened in Kuskokwim Group bedrock;
2) The well screen is in a position demonstrably hydraulically upgradient of groundwater that flows into the Main Processing Area or Red Devil Creek downstream alluvial area; and
3) The well has been sampled more than one time (through May 2018).

Eight wells meet all three criteria. These wells were installed during the RI, the RI Supplement, and the 2017 additional groundwater characterization activities (see Table 3-12). Groundwater samples were collected from the wells between August 2011 and May 2018. Table 3-13 shows the sampling events by well.

As discussed in Section 3.7.1, concentrations of COCs in the Kuskokwim Group bedrock are locally significantly higher than in unmineralized zones of the bedrock unit, and concentrations of COCs in groundwater flowing through these mineralized zones contains significantly higher COC concentrations than groundwater in the bedrock that has not undergone the mineralization. Three of the selected wells—MW40, MW42, and MW43—are installed in zones of mineralized bedrock, and groundwater COC concentrations in these wells are accordingly higher than in other the other five wells. Observations of natural mineralization and elevated COC concentrations in groundwater in other wells not included in the list of wells used in the BTV analysis (e.g., MW50) are consistent with this relationship.

It should be noted that several other wells installed in 2017 in the Surface Mined Area meet selection criteria 1 and 2, but as of the date of the BTV analysis presented in this report, the wells had been sampled only once and were therefore not selected for the BTV analysis. The rationale for selection criterion 3 stems from the observation that some wells that have been sampled multiple times exhibit significant variability in concentrations of COCs, particularly mercury. Such variability is especially evident in some bedrock wells installed relatively high in the watershed. Possible explanations for such variability include factors and processes described in the RI report, Section 5.4. For the wells installed in 2017, which are limited to one sampling event for all wells except MW59, evaluation of such variability in COC concentrations is therefore not possible using existing data.

3.7.2.2 Derivation of Background Threshold Values

As indicated in Table 3-13, the numbers of samples collected from each of the selected wells vary based on their date of installation. To maintain equal weighting of COC concentrations among the wells, the average of all sample results for a given well was calculated and used in the BTV analysis. For averaging purposes, non-detect observations were replaced by one-half of the sample detection limit. If any of the values contributing to an average concentration was a detected value, the average value also was considered detected.

The data were evaluated and BTVs derived using EPA’s ProUCL software version 5.1.002 (EPA 2017). The data were first arranged in the format required for input into ProUCL. The ProUCL input format uses two fields to describe each input value, the first being a numerical concentration value and the second a flag indicating whether the numerical value was a detected (1) or non-detected (0) value.

The analytical parameters evaluated are:

- Antimony, total;
- Arsenic, total; and
- Mercury, dissolved and total by Method 1631 and total by Method 7470.

Concentrations of dissolved antimony and arsenic were also measured in four of the wells included in the background well data set. However, for these analyses, there are too few observations to support reliable statistics, so these parameters were not included in the BTV calculations.

3.7.2.3 Outlier Analysis

Based on the analysis presented in Section 3.6, groundwater samples results from each of the wells selected for the BTV analysis are considered reasonably representative of naturally occurring conditions upgradient of the Main Processing Area and Red Devil Creek downstream alluvial area. This list of wells includes wells installed in bedrock exhibiting significant natural bedrock mineralization (MW40, MW42, and MW43) and other wells installed in bedrock with no obvious or reported mineralization. As would be expected, the groundwater COC concentrations varied widely as a result of the wide range in mineralization conditions. Nonetheless, an outlier analysis was performed, as described below.

The data sets having sufficient observations were examined for potential outliers by examining quantile-quantile (Q-Q) plots and performing Dixon's Outlier test for both the original and log transformed observations. Datasets that are gamma or lognormally distributed can appear to include high outliers when the high values may actually be from the upper tail of the gamma or lognormal distribution rather than being true outliers. The results of the outlier tests are summarized in Table 3-14.

Subsequent BTV calculations for all of the datasets were performed with and without the high statistical outlier values identified as described. Both the original and trimmed (minus the high outliers) data sets, the Q-Q plots, and the Dixon's Outlier test results are included the BTV calculation analysis and the ProUCL files provided in Appendix B.

3.7.2.4 BTV Calculations

BTV calculations were performed for all of the possible statistical distributions included in ProUCL—normal, gamma, lognormal, and nonparametric. ProUCL automatically performs goodness-of-fit tests for each of the parametric distributions and indicates whether the data appear to fit each of the distributions. The candidate BTVs considered for use depended on the outcome of the various goodness-of-fit tests. Sometimes a dataset may appear to fit more than one distribution; in such cases, the distribution used was selected based on the following hierarchy: normal > gamma > lognormal. For each distribution, ProUCL calculates the following upper limit values: the 90th, 95th, and 99th percentile values and the 95% Upper Prediction Limits (UPLs), 95/95% Upper Tolerance Limits (UTLs), and 95% Upper Simultaneous Limits (USLs). The detailed results of the BTV calculations provided by ProUCL are included in the ProUCL files provided in Appendix B. A summary of the ProUCL results is presented in Table 3-15.

Section 3.1.1 of the ProUCL Technical Guide (EPA 2015a) provides a description and interpretation of upper limits and their use to estimate BTVs, as briefly summarized below:

- Upper Percentile, $\underline{x_{0.95}}$: It is expected that an observation coming from the background population (or comparable to the background population) will be $\leq x_{0.95}$ with probability 0.95.

- UPL: a 95% UPL represents that statistic such that an independently collected observation (e.g., new/future) from the target population (e.g., background, comparable to background) will be less than or equal to the UPL95 with CC of 0.95. We are 95% sure that a *single future value (k=1)* from the background population will be less than the UPL95 with CC= 0.95.
- UTL: a UTL95-95 represents that statistic such that 95% of observations (current and future) from the target population (background, comparable to background) will be less than or equal to the UTL95-95 with CC of 0.95. A UTL95-95 represents a 95% Upper Confidence Limit of the 95th percentile of the data distribution (population). A UTL95-95 is designed to simultaneously provide coverage for 95% of all potential observations (current and future) from the background population (or comparable to background) with a CC of 0.95. A UTL95-95 can be used when many (unknown) current or future onsite observations need to be compared with a BTV.
- USL: a USL95 represents that statistic such that all observations from the "established" background data set are less than or equal to the USL95 with a CC of 0.95. Since USL represents an upper limit on the largest value in the sample, that largest value should come from the same background population. A parametric USL takes the data variability into account. It is expected that *all* current or future observations coming from the background population (comparable to background population, unimpacted site locations) will be less than or equal to the USL95 with CC, 0.95. The use of a USL as a BTV estimate is suggested when a large number of onsite observations (current or future) need to be compared with a BTV.

Based on these considerations, parametric USL values appear to be the most appropriate choice of BTVs for groundwater from the set of wells selected for the BTV analysis. The recommended groundwater BTVs are identified in Table 3-15.

3.7.3 Uncertainty

As noted in Section 3.7.2.1, it is not possible to reliably predict what the COC concentrations in background groundwater would be prior to excavation and subsequent re-establishment of equilibrium groundwater conditions. Sources of uncertainty include the variability in COC concentrations in bedrock wells described in Section 3.7.2.1. It is expected that the eight wells selected for the BTV analysis presented in Section 3.7.2 will be sampled as part of ongoing monitoring at the site. It is expected that other wells, including the wells installed in the Surface Mined Area in 2017, also will be sampled as part of ongoing monitoring. Results of such future monitoring should provide additional information regarding variability of COC concentrations within a given well as well as spatial variability.

3.8 Hydraulic Conductivity

3.8.1 Hydraulic Conductivity of Soil in the Vicinity of the Proposed Repository

As part of the 2017 groundwater characterization activities, undisturbed soil samples were collected with Shelby tubes for laboratory analysis to assess native soil conditions expected to locally exist in the area of the proposed repository and the potentially extended footprint. Undisturbed samples were analyzed for laboratory geotechnical tests, including K using a flexible wall permeameter (ASTM D5084). Disturbed samples remolded to 90 percent compaction at optimal moisture content also were tested for K using a flexible wall permeameter (ASTM D5084). Hydraulic conductivity results for the undisturbed samples range from 2.4E-09 to 8.2E-07 meters per second, or 7.9E-09 to 2.7E-06 feet per second (ft/second). The average K value is 2.4E-07 meters per second, or 7.8E-07 ft/second. Results of K tests and other geotechnical tests are presented in Table 2-7.

3.8.2 Estimated Hydraulic Conductivity of Bedrock in the Vicinity of the Proposed Repository

To evaluate fate and transport in groundwater at the RDM, it is important to have an understanding of the hydraulic characteristics of the Kuskokwim Group bedrock, including hydraulic conductivity. Information on pertinent lithologic, stratigraphic, and structural characteristics of the bedrock is provided in Section 2.2.4.

As described in Section 3.3.1, groundwater in Kuskokwim Group bedrock appears to occur primarily in fractures, particularly those occurring within the relatively competent graywacke and siltstone beds. Such fractures include the intersecting NNE-striking, SE-dipping joints and ENE-striking, NW-dipping joints described to occur throughout the area of the Red Devil Mine (Malone 1962; MacKevett and Berg 1963).

As described in Section 3.4.1, steep hydraulic gradients in Kuskokwim Group bedrock in the Surface Mined Area, as high as approximately 1, suggest a generally fairly low hydraulic conductivity in Kuskokwim Group bedrock not in close proximity to the mine workings.

No long-duration or multi-well pumping tests have been performed to evaluate hydraulic conductivity at the RDM. However, as described in Section 3.1.3.3, water levels were monitored and recorded every several minutes during the final pumping period of well development. The resulting drawdown data for some of the wells are useful for evaluating near-wellbore K of the Kuskokwim Group bedrock unit in the Surface Mined Area away from mapped underground mine workings. As also described in Section 3.1.3.3, immediately following the final pumping period of development of each new well installed in 2017, a pressure transducer was temporarily installed in the well to monitor the recovery of the drawdown induced by the final pumping. Water level recovery for some of the wells also is useful for evaluating near-wellbore bedrock K of the Kuskokwim Group bedrock unit in the Surface Mined Area away from mapped underground mine workings. The use of drawdown and recovery data to evaluate K is described in Sections 3.8.2.1 and 3.8.2.2 below.

3.8.2.1 Drawdown Testing

Well drawdown (pumping) data collected during the final pumping period of well development were reviewed to assess whether the data may be useful for evaluating K. The drawdown data were formatted for input into AQTESOLV Pro®, an aquifer testing software package. Plotted drawdown data for each well were evaluated for overall quality and assessment of usability for further evaluation. Data from six of the wells—MW49, MW50, MW51, MW53, MW54, and MW56—appeared to be of adequate quality to use to evaluate K properties of the aquifer. Data from the other wells was not usable for one or more reasons, including insufficient overall duration of pumping, interruptions during pumping, and insufficient drawdown. Graphs illustrating the drawdown and cumulative amount of water pumped during the final pumping for the wells with usable drawdown data are provided in Appendix C.

The drawdown data were evaluated (using AQTESOLV Pro®) using the Cooper-Jacob solution for confined aquifers (Cooper and Jacob 1946). This solution, sometimes called Jacob's modified nonequilibrium method, is a late-time approximation derived from the Theis type-curve method (Theis 1935). Analysis with the Cooper-Jacob method involves matching a straight line to drawdown data plotted as a function of the logarithm of time since pumping began.

A derivative analysis (e.g., Bourdet et al. 1989) was performed in conjunction with analysis of the Cooper-Jacob plot to assist with the identification of wells that appeared to exhibit infinite-acting radial flow conditions during at least a portion of the drawdown, and for identifying the period of time in which such conditions appear to have occurred. In a plot of the derivative versus time, the period of apparent radial flow is indicated by a flattening of the curve to a horizontal slope. Based on the derivative curve shapes, drawdown data for wells MW49, MW50, MW51, MW53, MW54, and MW56 appeared to exhibit such flow conditions for part of the drawdown period, typically near the end of the pumping. For the periods of time in which these wells appeared to exhibit infinite-acting radial flow conditions, the Cooper-Jacob (1946) solution was used to estimate hydraulic transmissivity (T) of the fractured bedrock in the near-wellbore zones for the wells.

Cooper-Jacob and derivative curve matching reports generated using AQTESOLV Pro® for each well analyzed are provided in Appendix C. The resulting estimated near-wellbore T values are summarized in Table 3-16.

3.8.2.2 Recovery Testing

After the final pumping period of development, a pressure transducer was installed in the wells to monitor the recovery of the drawdown induced by the final pumping. Field log book entries and water temperature data recorded by the transducers/data loggers were used to determine when the transducer was established in a static position in the well. Transducer water level data collected during transducer placement and removal were excluded from the recovery data set.

The recorded water level data were formatted for input into AQTESOLV Pro®. This formatting included arranging the data to display as time elapsed since the beginning of the final pumping period of well development versus drawdown. The pump rate information is also input to the program. The pumping rate information was obtained from well development data recorded in the field (see Table 3-6). For each well evaluated, the pumping rates were fairly constant for the duration of the final pumping period, so the average pumping rate for each well was used.

Plotted recovery data for each well were evaluated for overall quality and assessment of usability for further evaluation. Data from seven of the wells—MW50, MW51, MW52, MW53, MW54, MW56, and MW58—appeared to be of adequate quality to use to evaluate K properties of the aquifer. Data from the other wells was not usable for one or more reasons, including insufficient duration or consistency of pumping during drawdown, insufficient amount of drawdown, or irregularities in the recovery curves. Graphs illustrating the drawdown and cumulative amount of water pumped during the final pumping for the wells used for recovery evaluation are provided in Appendix C.

The usable data were analyzed for T using AQTESOLV Pro®, which offers multiple solutions for various aquifer types and testing scenarios, including recovery tests. The Theis (1935) residual drawdown method was selected as the most appropriate method for the recovery data based on the observation that time versus drawdown curves for the wells exhibited a Theis type curve shape. The Theis method is one of the most commonly utilized pump test analyses that can be applied for transient flow conditions. Theis analysis of the residual drawdown data was performed for those wells for which the well development pumping was fairly consistent and resulted in at least several feet of drawdown (see Table 3-6), and whose recovery curves appear to exhibit generally infinite-acting radial flow conditions during at least a portion (typically near the end) of the recovery.

The Theis recovery method analyzes the recovery portion of a pumping test by solving for the residual drawdown ($s\^{\prime}$) using time since pumping began (t) and time since pumping ceased ($t\^{\prime}$). The method estimates the T of the aquifer and S/ $S\^{\prime}$, the ratio of storativity during pumping (S) to storativity during recovery ($S\^{\prime}$). Storativity is defined as the volume of water released per unit drop in hydraulic head. S/ $S^{\prime}$ will be close to one for an unbounded aquifer. The Theis residual drawdown method estimates T and S/ $S^{\prime}$ using the following equation:

$$s^{\prime} = (2.303Q[\log(t/t^{\prime}) - \log(S/S^{\prime})])/4\pi T$$

Where:

- Q = pumping rate (ft^3/second);
- $s^{\prime}$ = residual drawdown (feet);
- S = storativity during pumping (dimensionless);
- $S^{\prime}$ = storativity during recovery (dimensionless);
- t = elapsed time since start of pumping (seconds);
- $t^{\prime}$ = elapsed time since pumping stopped (seconds); and
- T = transmissivity (ft^2/second).

The procedure involves fitting a straight line on a plot of residual drawdown ($s^{\prime}$) versus the ratio of time since pumping began to time since pumping stopped (t/ $t^{\prime}$), plotted on semi-logarithmic axes. The fitted line favors data from the end of the recovery period, which plot closer to the origin of the graph (i.e., as t/ $t^{\prime}$ approaches 1). Using the slope of this straight line, T can be calculated using the following equation:

$$T = 2.303Q/(4\pi\Delta s^{\prime})$$

Where:

- Q = pumping rate (ft^3/second);
- T = transmissivity (ft^2/second); and
- $s^{\prime}$ = slope of the matched line, defined as the change in residual drawdown per log cycle equivalent time.

S/ $S^{\prime}$ is found from the intersection of the fitted line with the log(t/ $t^{\prime}$) axis of the plot. In the absence of boundary effects, S/S′ should be close to one. An S/ $S^{\prime}$ value greater than 1 suggests recharge during the test, whereas an S/ $S^{\prime}$ value less than 1 may indicate existence of a no-flow boundary.

The Theis residual recovery method is designed for confined aquifers. However, the subject wells are considered to be in an unconfined bedrock unit. For such situations, the following correction factor (Kruseman and de Ridder 1994) can be applied to the drawdown data for analyzing unconfined aquifers.

$$s_c = s - s^2/2b$$

Where:

s_c = corrected drawdown for unconfined aquifers (feet);
s = observed drawdown (feet); and
b = saturated thickness of the aquifer (vertical distance from z-boundary to potentiometric surface; feet).

The 2017 data were analyzed using recovery data both with and without the correction factor. Curve matching reports generated using AQTESOLV Pro® for each well analyzed using the correction factor are provided in Appendix C. The resulting estimated near-wellbore T values are summarized in Table 3-16.

In addition to performing the Theis (1935) analysis, the recovery data also were evaluated after an Agarwal data transformation on the data was performed to attempt to analyze the recovery data using fractured bedrock solutions. The attempts to match the Agarwal-transformed data to various fractured bedrock solutions were not successful. This may be because the durations of the pumping were too short for fracture flow regime patterns to be established or identified.

3.8.2.3 Hydraulic Conductivity Estimation

T is defined as the K over a cross sectional plane. In order to calculate K, the T value is divided by the aquifer thickness (b). In general, there is no consistent standard approach for determining aquifer thickness for wells completed in unconfined bedrock or unconsolidated aquifers for the purposes of calculating K values from T estimates. An approach that may be taken to estimate K from T values for wells completed in unconsolidated aquifers is to assume an aquifer thickness equal to the well's screen length. An approach that may be taken for bedrock aquifers is to divide the T value by the thickness of saturated bedrock penetrated by the tested wells. For unconfined aquifers, the saturated thickness (i.e., that part of the aquifer thickness that is saturated and able to transmit water) decreases during the test as the water level is drawn down.

All the wells evaluated have a screen length of 20 feet. For simplicity, the aquifer thickness was assumed to be equal to the 20-foot screen length. As shown in Table 3-6, the water columns in the wells (essentially equal to the thickness of saturated bedrock penetrated by the well) at the start of the drawdown period for each well ranged from 19.88 feet to 45.18 feet. At the end of the drawdown periods, water columns ranged as high as 33.08 feet but were less than 20 feet in four of the wells. Assuming a saturated thickness of 20 feet may underestimate K for wells with an actual saturated thickness of less than 20 feet for significant portions of the testing period. Assuming a saturated thickness of 20 feet may overestimate K for wells with an actual saturated thickness of greater than 20 feet for significant portions of the testing period. The near-wellbore K values estimated assuming a consistent saturated thickness of 20 feet are presented in Table 3-16.

3.8.2.4 Limitations and Potential Sources of Error

There are a number of limitations and sources of error that should be considered in evaluating the level of confidence in the results generated through the hydraulic evaluation presented Sections 3.8.2.1 through 3.8.2.3 above. Such limitations and sources of error are described below.

Some of the basic assumptions of the test methods are not met. For example, both the Theis and Cooper-Jacob methods are based on the following assumptions that are not met by some or all of the subject wells or tests: the aquifer is homogeneous, horizontal, has a uniform thickness, and an infinite extent; the potentiometric surface is horizontal within the effective radius of the well prior to pumping; the well fully penetrates the aquifer; the aquifer is ideal, confined, and non-leaky; and water from the well discharges at a constant rate during pumping.

It is noted that the durations of the pumping (drawdown) and recovery used to develop the T and K estimates presented above are shorter than would be the case for full-scale pumping tests.

As described in Section 3.8.3, uncertainty in the approach used to estimate aquifer thickness values results in uncertainty in the estimation of K values from T estimates.

Despite these potential sources of error, the results of the analysis of the available data appear to provide an adequate first order approximation T and K values for bedrock in the near-wellbore zones of the subject wells. The estimated T and K values are consistent with available information regarding the lithology, stratigraphy, and structure of the Kuskokwim Group bedrock at the RDM (see Section 2.2.4) and observations regarding the occurrence of groundwater (see Section 3.3.1) and hydraulic gradients in bedrock (see Section 3.4.1). The site-specific K estimates also are consistent with literature values developed using robust methodologies to evaluate K for bedrock with similar lithology, stratigraphy, and structure (e.g., Cilona et al. 2016; DesRoches et al. 2014).

3.9 Groundwater Discharge and Contaminant Flux to Kuskokwim River

As discussed in Section 3.3.2, much of the groundwater in the Surface Mined Area flows toward the Red Devil Creek valley. Much of this groundwater likely flows via the preferential flow pathways of the interconnected underground mine workings to shallow depths below Red Devil Creek (see Figures 2-8 and 2-17). Based on the groundwater elevations and stream elevations in Red Devil Creek (see Figures 3-10 through 3-14), some of the groundwater within the Red Devil Creek valley, including groundwater in the Main Processing Area and the area downstream of the Main Processing Area, emerges into Red Devil Creek and enters the Kuskokwim River as surface water rather than as groundwater. Some of the groundwater that originates in the Surface Mined Area and flows via the system of underground mine workings into the Main Processing Area does not discharge to Red Devil Creek, but instead migrates via groundwater down Red Devil Creek valley and discharges through the river bed to the Kuskokwim River.

To assess flow of such deep bedrock groundwater, a simple hydrogeological model was developed using Darcy's Law. Darcy's Law defines the rate of flow of groundwater through a cross sectional area perpendicular to groundwater flow as the product of K and the hydraulic gradient. Darcy's equation is presented below:

$$Q = KiA$$

Where:

Q = groundwater flow rate through cross sectional area A perpendicular to the groundwater flow direction (ft^3/second);
K = hydraulic conductivity;
i = hydraulic gradient;
A = cross sectional area perpendicular to the direction of groundwater flow (ft^2).

K values used include the site-specific estimated K values presented in Section 3.8.2, and literature values for bedrock with similar lithology, stratigraphy, and structure (Cilona et al. 2016). Based on the model results, the estimated bedrock groundwater discharge into the Kuskokwim River likely lies within the range of approximately 0.00003 to 16 cubic feet per second. Input data, assumptions, and results are presented in Table 3-17.

The groundwater discharge results presented above were used to develop an estimate of the flux of arsenic in deep bedrock groundwater into the Kuskokwim River. The arsenic flux estimates were used to estimate the amount of increase in arsenic concentrations in Kuskokwim River water following mixing. Input data, assumptions, and results are presented in Table 3-17.

Groundwater also discharges from Red Devil Creek alluvial materials directly into the Kuskokwim River at the delta. A similar approach to that described above for deep bedrock was taken to estimate the discharge of alluvial groundwater and groundwater arsenic flux into the river. Input data, assumptions, and results are presented in Table 3-18.

Table 3-1 Summary of Groundwater Samples, Fall 2016 Baseline Monitoring

Location ID	Sample Date	Sampling Method	Comment	Analyses								
				Total TAL Metals	Total Low Level Mercury	Dissolved Low Level Mercury	Inorganic Ions (Cl, F, SO_4)	Nitrate/ Nitrite	Carbonate, Bicarbonate	GRO/ BTEX	DRO	SVOCs
MW01	9/30/2016	Low flow (bladder pump)		X	X	X	X	X	X			
MW06	10/1/2016	Low flow (peristaltic pump)		X	X	X	X	X	X			
MW08	10/1/2016	Low flow (peristaltic pump)		X	X	X	X	X	X			
MW09	10/3/2016	bailer	Insufficient recharge for low flow sampling	X	X	X	X	X	X			
MW10	10/2/2016	Low flow (bladder pump)		X	X	X	X	X	X			
MW16	10/3/2016	Low flow (peristaltic pump)		X	X	X	X	X	X			
MW17	9/30/2016	Low flow (bladder pump)		X	X	X	X	X	X			
MW19	10/4/2016	Low flow (peristaltic pump)		X	X	X	X	X	X	X	X	X
MW22	10/5/2016	Low flow (peristaltic pump)		X	X	X	X	X	X	X	X	X
MW26	10/5/2016	Low flow (bladder pump)		X	X	X	X	X	X			
MW27	10/5/2016	Low flow (bladder pump)		X	X	X	X	X	X			
MW28	10/2/2016	Low flow (peristaltic pump)		X	X	X	X	X	X			
MW29	10/3/2016	Low flow (bladder pump)		X	X	X	X	X	X			
MW30		Not sampled	Dry									
MW31	10/1/2016	Low flow (bladder pump)		X	X	X	X	X	X			
MW32	9/29/2016	Low flow (peristaltic pump)		X	X	X	X	X	X			
MW33	10/2/2016	Low flow (peristaltic pump)		X	X	X	X	X	X			
MW39		Not sampled	Dry									
MW40	10/4/2016	Low flow (bladder pump)		X	X	X	X	X	X			
MW42	10/5/2016	Low flow (bladder pump)		X	X	X	X	X	X			
MW43	10/2/2016	Low flow (bladder pump)		X	X	X	X	X	X			

Key:

BTEX = benzene, toluene, ethylbenzene, and xylenes

Cl = chloride

DRO = diesel range organics

F = fluoride

GRO = gasoline range organics

ID = identifier

SO_4 = sulfate

SVOC = semivolatile organic compound

TAL = Target Analyte List

Table 3-2 Summary of Groundwater Samples, Spring 2017 Baseline Monitoring

Location ID	Sample Date	Sampling Method	Comment	Analyses									
				Total TAL Metals	Total Low Level Mercury	Dissolved Low Level Mercury	Inorganic Ions (Cl, F, SO_4)	Total Suspended Solids	Nitrate/ Nitrite	Carbonate, Bicarbonate	GRO/ BTEX	DRO	SVOCs
MW01	5/28/2017	Low flow (bladder pump)		X	X	X	X	X	X	X			
MW06	5/28/2017	Low flow (peristaltic pump)		X	X	X	X	X	X	X			
MW08	5/28/2017	Low flow (peristaltic pump)		X	X	X	X	X	X	X			
MW09	5/31/2017	bailer	Insufficient recharge for low flow sampling	X	X	X	X	X	X	X			
MW10	5/29/2017	Low flow (bladder pump)		X	X	X	X	X	X	X			
MW16	5/29/2017	Low flow (peristaltic pump)		X	X	X	X	X	X	X			
MW17	5/29/2017	Low flow (peristaltic pump)		X	X	X	X	X	X	X			
MW19	5/31/2017	Low flow (peristaltic pump)		X	X	X	X	X	X	X	X	X	X
MW22	5/31/2017	Low flow (peristaltic pump)		X	X	X	X	X	X	X	X	X	X
MW26	5/30/2017	Low flow (bladder pump)		X	X	X	X	X	X	X			
MW27	5/30/2017	Low flow (bladder pump)		X	X	X	X	X	X	X			
MW28	5/30/2017	Low flow (bladder pump)		X	X	X	X	X	X	X			
MW29	5/28/2017	Low flow (bladder pump)		X	X	X	X	X	X	X			
MW30		Not sampled	Dry										
MW31	6/1/2017	Low flow (bladder pump)		X	X	X	X	X	X	X			
MW32	6/1/2017	Low flow (peristaltic pump)		X	X	X	X	X	X	X			
MW33	5/29/2017	Low flow (peristaltic pump)		X	X	X	X	X	X	X			
MW39		Not sampled	Dry										
MW40	5/29/2017	Low flow (bladder pump)		X	X	X	X	X	X	X			
MW42	5/31/2017	Low flow (bladder pump)		X	X	X	X	X	X	X			
MW43	5/29/2017	Low flow (bladder pump)		X	X	X	X	X	X	X			

Key:

BTEX = benzene, toluene, ethylbenzene, and xylenes

Cl = chloride

DRO = diesel range organics

F = fluoride

GRO = gasoline range organics

ID = identifier

SO_4 = sulfate

SVOC = semivolatile organic compound

TAL = Target Analyte List

Table 3-3 Summary of Groundwater Samples, Fall 2017 Baseline Monitoring and 2017 Additional Groundwater Characterization

Location ID	Sample Date	Sampling Method	Comment	Analyses									
				Total TAL Metals	Total Low Level Mercury	Dissolved Low Level Mercury	Inorganic Ions (Cl, F, SO_4)	Total Suspended Solids	Nitrate/ Nitrite	Carbonate, Bicarbonate	GRO/ BTEX	DRO	SVOCs
Fall 2017 Baseline Monitoring													
MW01	9/16/2017	Low flow (peristaltic pump)		X	X	X	X	X	X	X			
MW06	9/19/2017	Low flow (peristaltic pump)		X	X	X	X	X	X	X			
MW08	9/18/2017	Low flow (peristaltic pump)		X	X	X	X	X	X	X			
MW09	9/25/2017	bailer	Insufficient recharge for low flow sampling	X	X	X	X	X	X	X			
MW10	9/19/2017	Low flow (bladder pump)		X	X	X	X	X	X	X			
MW16	9/18/2017	Low flow (peristaltic pump)		X	X	X	X	X	X	X			
MW17	9/18/2017	Low flow (peristaltic pump)		X	X	X	X	X	X	X			
MW19	9/25/2017	Low flow (peristaltic pump)		X	X	X	X	X	X	X	X	X	X
MW22	9/25/2017	Low flow (peristaltic pump)		X	X	X	X	X	X	X	X	X	X
MW26	9/24/2017	Low flow (bladder pump)		X	X	X	X	X	X	X			
MW27	9/19/2017	Low flow (bladder pump)		X	X	X	X	X	X	X			
MW28	9/24/2017	Low flow (bladder pump)		X	X	X	X	X	X	X			
MW29	9/18/2017	Low flow (bladder pump)		X	X	X	X	X	X	X			
MW30		Not sampled	Dry										
MW31	9/17/2017	Low flow (bladder pump)		X	X	X	X	X	X	X			
MW32	9/17/2017	Low flow (peristaltic pump)		X	X	X	X	X	X	X			
MW33	9/19/2017	Low flow (peristaltic pump)		X	X	X	X	X	X	X			
MW39		Not sampled											
MW40	9/19/2017	Low flow (bladder pump)		X	X	X	X	X	X	X	_	_	_
MW42	9/25/2017	Low flow (bladder pump)		X	X	X	X	X	X	X	_	_	_
MW43	9/18/2017	Low flow (bladder pump)		X	X	X	X	X	X	X			
2017 Additional Groundwater Characterization													
MW44	9/22/2017	Low flow (bladder pump)		X	X	X	X	_	X	X	_	_	_
MW45	9/20/2017	Low flow (bladder pump)		X	X	X	X	_	X	X	_	_	_
MW46	9/20/2017	Low flow (bladder pump)		X	X	X	X	_	X	X	_	_	_
MW47	9/21/2017	Low flow (bladder pump)		X	X	X	X	_	X	X	_	_	_
MW48	9/19/2017	Low flow (bladder pump)		X	X	X	X	_	X	X	_	_	_
MW49	9/20/2017	Low flow (bladder pump)		X	X	X	X	_	X	X	_	_	_
MW50	9/24/2017	Low flow (bladder pump)		X	X	X	X	_	X	X	_	_	_
MW51	9/22/2017	Low flow (bladder pump)		X	X	X	X	_	X	X	_	_	_
MW52	9/21/2017	Low flow (bladder pump)		X	X	X	X	_	X	X	_	_	_
MW53	9/22/2017	Low flow (bladder pump)		X	X	X	X	_	X	X	_	_	_
MW54	9/21/2017	Low flow (bladder pump)		X	X	X	X	_	X	X	_	_	_
MW55	9/20/2017	Low flow (peristaltic pump)		X	X	X	X	_	X	X	_	_	_
MW56	9/22/2017	Low flow (bladder pump)		X	X	X	X	_	X	X	_	_	_
MW57	9/22/2017	Low flow (bladder pump)		X	X	X	X	_	X	X	_	_	_
MW58	9/21/2017	Low flow (bladder pump)		X	X	X	X	_	X	X	_	_	_
MW59	9/22/2017	Low flow (bladder pump)		X	X	X	X		X	X			

Key:

BTEX = benzene, toluene, ethylbenzene, and xylenes

Cl = chloride

DRO = diesel range organics

F = fluoride

GRO = gasoline range organics

ID = identifier

SO_4 = sulfate

SVOC = semivolatile organic compound

TAL = Target Analyte List

Table 3-4 Summary of Groundwater Samples, Spring 2018 Baseline Monitoring

Location ID	Sample Date	Sampling Method	Comment	Analyses									
				Total TAL Metals	Total Low Level Mercury	Dissolved Low Level Mercury	Inorganic Ions (Cl, F, SO_4)	Total Suspended Solids	Nitrate/ Nitrite	Carbonate, Bicarbonate	GRO/ BTEX	DRO	SVOCs
MW01	5/18/2018	Low flow (peristaltic pump)		X	X	X	X	X	X	X			
MW06	5/20/2018	Low flow (peristaltic pump)		X	X	X	X	X	X	X			
MW08	5/19/2018	Low flow (peristaltic pump)		X	X	X	X	X	X	X			
MW09	5/22/2018	Low flow (bladder pump)		X	X	X	X	X	X	X			
MW10	5/22/2018	Low flow (bladder pump)		X	X	X	X	X	X	X			
MW16	5/21/2018	Low flow (peristaltic pump)		X	X	X	X	X	X	X			
MW17	5/20/2018	Low flow (peristaltic pump)		X	X	X	X	X	X	X			
MW19	5/21/2018	Low flow (peristaltic pump)		X	X	X	X	X	X	X	X	X	X
MW22	5/24/2018	Low flow (peristaltic pump)		X	X	X	X	X	X	X	X	X	X
MW26	5/23/2018	Low flow (bladder pump)		X	X	X	X	X	X	X			
MW27	5/23/2018	Low flow (bladder pump)		X	X	X	X	X	X	X			
MW28	5/23/2018	Low flow (bladder pump)		X	X	X	X	X	X	X			
MW29	5/20/2018	Low flow (bladder pump)		X	X	X	X	X	X	X			
MW30		Not sampled	Dry										
MW31	5/19/2018	Low flow (bladder pump)		X	X	X	X	X	X	X			
MW32	5/19/2018	Low flow (peristaltic pump)		X	X	X	X	X	X	X			
MW33	5/21/2018	Low flow (peristaltic pump)		X	X	X	X	X	X	X			
MW39		Not sampled	Dry										
MW59	5/20/2018	Low flow (bladder pump)	Sampled in place of MW39	X	X	X	X	X	X	X			
MW40	5/21/2018	Low flow (bladder pump)		X	X	X	X	X	X	X			
MW42	5/24/2018	Low flow (bladder pump)		X	X	X	X	X	X	X			
MW43	5/21/2018	Low flow (bladder pump)		X	X	X	X	X	X	X			

Key:

BTEX = benzene, toluene, ethylbenzene, and xylenes

Cl = chloride

DRO = diesel range organics

F = fluoride

GRO = gasoline range organics

ID = identifier

SO_4 = sulfate

SVOC = semivolatile organic compound

TAL = Target Analyte List

Table 3-5 Well Construction and Groundwater Depth Information

Monitoring Well ID	Soil Boring ID	Reported Well Total Depth As Constructed (ft. bgs)	Reported Screened Interval (ft. bgs)	Surveyed Ground Elevation (feet NAVD88)	Surveyed Top of Casing Elevation (feet NAVD88)	GW Observed During Drilling (feet bgs)	Measured Well Total Depth (feet below TOC)	Static Water Level			Ground Water Elevation (feet NAVD88)
								Depth (feet below TOC)	Date	Time	
MW01	B01	29.5	19.0 - 29.0	254.51	257.51	17.8 - TD		21.72	8/14/2000	NR	235.79
MW01	B01	29.5	19.0 - 29.0	254.51	257.51	17.8 - TD		19.87	9/5/2007	13:15	237.64
MW01	B01	29.5	19.0 - 29.0	254.51	257.51	17.8 - TD		22.16	9/18/2008	13:28	235.35
MW01	B01	29.5	19.0 - 29.0	254.51	257.51	17.8 - TD		19.62	6/19/2009	NR	237.89
MW01	B01	29.5	19.0 - 29.0	254.51	257.51	17.8 - TD		22.27	10/6/2009	17:30	235.24
MW01	B01	29.5	19.0 - 29.0	254.51	257.51	17.8 - TD		20.04	9/20/2010	18:18	237.47
MW01	B01	29.5	19.0 - 29.0	254.51	257.51	17.8 - TD		19.46	8/24/2011	16:38	238.05
MW01	B01	29.5	19.0 - 29.0	254.51	257.51	17.8 - TD		19.55	9/1/2011	16:03	237.96
MW01	B01	29.5	19.0 - 29.0	254.51	257.51	17.8 - TD		17.56	5/26/2012	14:32	239.95
MW01	B01	29.5	19.0 - 29.0	254.51	257.51	17.8 - TD		18.62	9/9/2012	17:05	238.89
MW01	B01	29.5	19.0 - 29.0	254.51	257.51	17.8 - TD		19.43	6/17/2015	13:03	238.08
MW01	B01	29.5	19.0 - 29.0	254.51	257.51	17.8 - TD		20.80	8/12/2015	12:15	236.71
MW01	B01	29.5	19.0 - 29.0	254.51	257.51	17.8 - TD		21.03	9/2/2015	9:50	236.48
MW01	B01	29.5	19.0 - 29.0	254.51	257.51	17.8 - TD	29.82	20.36	9/10/2015	NR	237.15
MW01	B01	29.5	19.0 - 29.1	254.51	257.51	17.8 - TD	29.80	18.26	9/28/2016	13:05	239.25
MW01	B01	29.5	19.0 - 29.1	254.51	257.51	17.8 - TD	29.76	19.46	5/26/2017	1202	238.05
MW01	B01	29.5	19.0 - 29.1	254.51	257.51	17.8 - TD	29.76	18.56	9/26/2017	1332	238.95
MW01	B01	29.5	19.0 - 29.1	254.51	257.51	17.8 - TD		17.65	5/18/2018	13:36	239.86
MW03	B03	25.5	15.0 - 25.0	228.37	230.77	19.0 - TD		22.28	8/14/2000	NR	208.49
MW03	B03	25.5	15.0 - 25.0	228.37	230.77	19.0 - TD		20.68	9/5/2007	14:40	210.09
MW03	B03	25.5	15.0 - 25.0	228.37	230.77	19.0 - TD		22.57	9/18/2008	14:11	208.20
MW03	B03	25.5	15.0 - 25.0	228.37	230.77	19.0 - TD		19.51	6/19/2009	NR	211.26
MW03	B03	25.5	15.0 - 25.0	228.37	230.77	19.0 - TD		23.01	10/7/2009	13:20	207.76
MW03	B03	25.5	15.0 - 25.0	228.37	230.77	19.0 - TD		20.95	9/20/2010	19:50	209.82
MW03	B03	25.5	15.0 - 25.0	228.37	230.77	19.0 - TD		19.44	8/26/2011	10:18	211.33
MW03	B03	25.5	15.0 - 25.0	228.37	230.77	19.0 - TD		19.96	9/1/2011	15:41	210.81
MW03	B03	25.5	15.0 - 25.0	228.37	230.77	19.0 - TD		15.47	5/26/2012	15:17	215.30
MW03	B03	25.5	15.0 - 25.0	228.37	230.77	19.0 - TD		17.24	9/9/2012	17:10	213.53
MW03	B03	25.5	15.0 - 25.0	228.37	230.77	19.0 - TD		19.74	6/17/2015	10:54	211.03
MW03	B03	25.5	15.0 - 25.0	228.37	230.77	19.0 - TD		21.83	8/12/2015	12:33	208.94
MW03	B03	25.5	15.0 - 25.0	228.37	230.77	19.0 - TD		22.20	9/2/2015	9:45	208.57
MW03	B03	25.5	15.0 - 25.0	228.37	230.77	19.0 - TD	27.98	21.92	9/10/2015	NR	208.85
MW03	B03	25.5	15.0 - 25.0	228.37	230.77	19.0 - TD	27.85	16.77	9/28/2016	13:10	214.00
MW03	B03	25.5	15.0 - 25.0	228.37	230.77	19.0 - TD	NR	22.6	5/26/2017	11:21	208.17
MW03	B03	25.5	15.0 - 25.0	228.37	230.77	19.0 - TD	27.75	18.96	9/26/2017	1255	211.81
MW03	B03	25.5	15.0 - 25.0	228.37	230.77	19.0 - TD		15.64	5/18/2018	13:51	215.13
MW04	B04	30.5	20.0 - 30.0	239.92	242.12	25.3 - TD		27.77	8/14/2000	NR	214.35
MW04	B04	30.5	20.0 - 30.0	239.92	242.12	25.3 - TD		26.78	9/5/2007	12:25	215.34
MW04	B04	30.5	20.0 - 30.0	239.92	242.12	25.3 - TD		26.82	9/18/2008	12:32	215.30
MW04	B04	30.5	20.0 - 30.0	239.92	242.12	25.3 - TD		25.43	6/19/2009	NR	216.69
MW04	B04	30.5	20.0 - 30.0	239.92	242.12	25.3 - TD		27.77	10/6/2009	18:55	214.35

Table 3-5 Well Construction and Groundwater Depth Information

Monitoring Well ID	Soil Boring ID	Reported Well Total Depth As Constructed (ft. bgs)	Reported Screened Interval (ft. bgs)	Surveyed Ground Elevation (feet NAVD88)	Surveyed Top of Casing Elevation (feet NAVD88)	GW Observed During Drilling (feet bgs)	Measured Well Total Depth (feet below TOC)	Static Water Level			Ground Water Elevation (feet NAVD88)
								Depth (feet below TOC)	Date	Time	
MW04	B04	30.5	20.0 - 30.0	239.92	242.12	25.3 - TD		26.79	9/20/2010	16:09	215.33
MW04	B04	30.5	20.0 - 30.0	239.92	242.12	25.3 - TD		25.24	8/22/2011	16:02	216.88
MW04	B04	30.5	20.0 - 30.0	239.92	242.12	25.3 - TD		25.99	9/1/2011	15:00	216.13
MW04	B04	30.5	20.0 - 30.0	239.92	242.12	25.3 - TD		21.72	5/26/2012	16:47	220.40
MW04	B04	30.5	20.0 - 30.0	239.92	242.12	25.3 - TD		23.72	9/10/2012	14:15	218.40
MW04	B04	30.5	20.0 - 30.0	239.92	242.12	25.3 - TD		26.95	6/17/2015	15:13	215.17
MW04	B04	30.5	20.0 - 30.0	239.92	242.12	25.3 - TD		NR	8/12/2015	NR	--
MW04	B04	30.5	20.0 - 30.0	239.92	242.12	25.3 - TD		28.61	9/2/2015	11:40	213.51
MW04	B04	30.5	20.0 - 30.0	239.92	242.12	25.3 - TD	33.11	28.32	9/10/2015	NR	213.80
MW04	B04	30.5	20.0 - 30.0	239.92	242.12	25.3 - TD	33.02	23.81	9/28/2016	12:42	218.31
MW04	B04	30.5	20.0 - 30.0	239.92	242.12	25.3 - TD	NR	28.26	5/26/2017	12:11	213.86
MW04	B04	30.5	20.0 - 30.0	239.92	242.12	25.3 - TD	32.83	24.86	9/26/2017	1729	217.26
MW04	B04	30.5	20.0 - 30.0	239.92	242.12	25.3 - TD		22.22	5/18/2018	12:59	219.90
MW06	B06	23.5	13.0 - 23.0	214.99	217.49	20.0 - TD		19.29	8/14/2000	NR	198.20
MW06	B06	23.5	13.0 - 23.0	214.99	217.49	20.0 - TD		18.63	9/5/2007	15:30	198.86
MW06	B06	23.5	13.0 - 23.0	214.99	217.49	20.0 - TD		19.08	9/18/2008	11:35	198.41
MW06	B06	23.5	13.0 - 23.0	214.99	217.49	20.0 - TD		17.90	6/19/2009	NR	199.59
MW06	B06	23.5	13.0 - 23.0	214.99	217.49	20.0 - TD		19.29	10/7/2009	17:25	198.20
MW06	B06	23.5	13.0 - 23.0	214.99	217.49	20.0 - TD		19.03	9/20/2010	13:22	198.46
MW06	B06	23.5	13.0 - 23.0	214.99	217.49	20.0 - TD		18.78	8/24/2011	14:56	198.71
MW06	B06	23.5	13.0 - 23.0	214.99	217.49	20.0 - TD		18.70	9/1/2011	15:09	198.79
MW06	B06	23.5	13.0 - 23.0	214.99	217.49	20.0 - TD		16.25	5/26/2012	16:02	201.24
MW06	B06	23.5	13.0 - 23.0	214.99	217.49	20.0 - TD		18.29	9/9/2012	11:45	199.20
MW06	B06	23.5	13.0 - 23.0	214.99	217.49	20.0 - TD		18.24	6/17/2015	14:25	199.25
MW06	B06	23.5	13.0 - 23.0	214.99	217.49	20.0 - TD		19.17	8/12/2015	11:03	198.32
MW06	B06	23.5	13.0 - 23.0	214.99	217.49	20.0 - TD		19.20	9/2/2015	11:15	198.29
MW06	B06	23.5	13.0 - 23.0	214.99	217.49	20.0 - TD	26.19	19.18	9/10/2015	NR	198.31
MW06	B06	23.5	13.0 - 23.0	214.99	217.49	20.0 - TD	26.19	17.64	9/28/2016	13:38	199.85
MW06	B06	23.5	13.0 - 23.0	214.99	217.49	20.0 - TD	26.12	19.05	5/26/2017	12:52	198.44
MW06	B06	23.5	13.0 - 23.0	214.99	217.49	20.0 - TD	26.12	18.16	9/26/2017	1644	199.33
MW06	B06	23.5	13.0 - 23.0	214.99	217.49	20.0 - TD		16.07	5/18/2018	13:21	201.42
MW07	B07	21.5	11.0 - 21.0	278.39	280.89	14.8 - TD		Dry	8/14/2000	NR	Dry (Water Elevation <257.4 ft bgs)
MW07	B07	21.5	11.0 - 21.0	278.39	280.89	14.8 - TD		20.42	9/5/2007	14:00	260.47
MW07	B07	21.5	11.0 - 21.0	278.39	280.89	14.8 - TD		Dry	9/18/2008	NR	Dry (Water Elevation <257.4 ft bgs)
MW07	B07	21.5	11.0 - 21.0	278.39	280.89	14.8 - TD		20.10	6/19/2009	NR	260.79
MW07	B07	21.5	11.0 - 21.0	278.39	280.89	14.8 - TD		Dry	10/7/2009	NR	Dry (Water Elevation <257.4 ft bgs)
MW07	B07	21.5	11.0 - 21.0	278.39	280.89	14.8 - TD		20.40	9/21/2010	10:20	260.49
MW07	B07	21.5	11.0 - 21.0	278.39	280.89	14.8 - TD		19.51	8/26/2011	9:12	261.38
MW07	B07	21.5	11.0 - 21.0	278.39	280.89	14.8 - TD		19.97	9/1/2011	16:14	260.92
MW07	B07	21.5	11.0 - 21.0	278.39	280.89	14.8 - TD		19.68	5/26/2012	13:36	261.21
MW07	B07	21.5	11.0 - 21.0	278.39	280.89	14.8 - TD		20.57	9/9/2012	16:45	260.32

Table 3-5 Well Construction and Groundwater Depth Information

Monitoring Well ID	Soil Boring ID	Reported Well Total Depth As Constructed (ft. bgs)	Reported Screened Interval (ft. bgs)	Surveyed Ground Elevation (feet NAVD88)	Surveyed Top of Casing Elevation (feet NAVD88)	GW Observed During Drilling (feet bgs)	Measured Well Total Depth (feet below TOC)	Static Water Level			Ground Water Elevation (feet NAVD88)
								Depth (feet below TOC)	Date	Time	
MW07	B07	21.5	11.0 - 21.0	278.39	280.89	14.8 - TD		21.10	6/17/2015	12:25	259.79
MW07	B07	21.5	11.0 - 21.0	278.39	280.89	14.8 - TD		21.97	8/12/2015	11:54	258.92
MW07	B07	21.5	11.0 - 21.0	278.39	280.89	14.8 - TD		22.36	9/2/2015	10:50	258.53
MW07	B07	21.5	11.0 - 21.0	278.39	280.89	14.8 - TD	23.67	22.41	9/10/2015	NR	258.48
MW07	B07	21.5	11.0 - 21.0	278.39	280.89	14.8 - TD	23.70	20.4	9/28/2016	12:40	260.49
MW07	B07	21.5	11.0 - 21.0	278.39	280.89	14.8 - TD	NR	23.17	5/26/2017	13:23	257.72
MW07	B07	21.5	11.0 - 21.0	278.39	280.89	14.8 - TD	23.47	20.13	9/26/2017	1444	260.76
MW07	B07	21.5	11.0 - 21.0	278.39	280.89	14.8 - TD		20.02	5/18/2018	13:51	260.87
MW08	11MP01SB	16.0	5.0 - 15.0	328.92	331.32	2.5 - 4.0, 10.5 - TD		13.70	8/30/2011	9:21	317.62
MW08	11MP01SB	16.0	5.0 - 15.0	328.92	331.32	2.5 - 4.0, 10.5 - TD		13.65	9/1/2011	16:28	317.67
MW08	11MP01SB	16.0	5.0 - 15.0	328.92	331.32	2.5 - 4.0, 10.5 - TD		11.64	5/26/2012	13:23	319.68
MW08	11MP01SB	16.0	5.0 - 15.0	328.92	331.32	2.5 - 4.0, 10.5 - TD		12.74	9/9/2012	16:10	318.58
MW08	11MP01SB	16.0	5.0 - 15.0	328.92	331.32	2.5 - 4.0, 10.5 - TD		13.54	6/17/2015	12:41	317.78
MW08	11MP01SB	16.0	5.0 - 15.0	328.92	331.32	2.5 - 4.0, 10.5 - TD		14.87	8/12/2015	11:58	316.45
MW08	11MP01SB	16.0	5.0 - 15.0	328.92	331.32	2.5 - 4.0, 10.5 - TD		15.04	9/2/2015	10:35	316.28
MW08	11MP01SB	16.0	5.0 - 15.0	328.92	331.32	2.5 - 4.0, 10.5 - TD	17.61	14.89	9/10/2015	NR	316.43
MW08	11MP01SB	16.0	5.0 - 15.0	328.92	331.32	2.5 - 4.0, 10.5 - TD	17.68	12.99	9/28/2016	14:32	318.33
MW08	11MP01SB	16.0	5.0 - 15.0	328.92	331.32	2.5 - 4.0, 10.5 - TD	17.63	13.89	5/26/2017	13:07	317.43
MW08	11MP01SB	16.0	5.0 - 15.0	328.92	331.32	2.5 - 4.0, 10.5 - TD	17.63	12.95	9/26/2017	1534	318.37
MW08	11MP01SB	16.0	5.0 - 15.0	328.92	331.32	2.5 - 4.0, 10.5 - TD		11.6	5/18/2018	12:56	319.72
MW09	11MP17SB	31.0	20.0 - 30.0	274.88	277.28	14.0 - 16.0, 31.0 - TD		>31.56	8/29/2011	18:21	--
MW09	11MP17SB	31.0	20.0 - 30.0	274.88	277.28	14.0 - 16.0, 31.0 - TD		28.11	9/1/2011	16:43	249.17
MW09	11MP17SB	31.0	20.0 - 30.0	274.88	277.28	14.0 - 16.0, 31.0 - TD		26.67	5/26/2012	14:04	250.61
MW09	11MP17SB	31.0	20.0 - 30.0	274.88	277.28	14.0 - 16.0, 31.0 - TD		27.88	9/9/2012	15:30	249.40
MW09	11MP17SB	31.0	20.0 - 30.0	274.88	277.28	14.0 - 16.0, 31.0 - TD		27.81	9/11/2012	11:20	249.47
MW09	11MP17SB	31.0	20.0 - 30.0	274.88	277.28	14.0 - 16.0, 31.0 - TD		27.60	6/17/2015	11:31	249.68
MW09	11MP17SB	31.0	20.0 - 30.0	274.88	277.28	14.0 - 16.0, 31.0 - TD		27.93	8/12/2015	12:04	249.35
MW09	11MP17SB	31.0	20.0 - 30.0	274.88	277.28	14.0 - 16.0, 31.0 - TD		28.30	9/2/2015	10:00	248.98
MW09	11MP17SB	31.0	20.0 - 30.0	274.88	277.28	14.0 - 16.0, 31.0 - TD	34.72	29.38	9/10/2015	NR	247.90
MW09	11MP17SB	31.0	20.0 - 30.0	274.88	277.28	14.0 - 16.0, 31.0 - TD	34.63	26.05	9/28/2016	NR	251.23
MW09	11MP17SB	31.0	20.0 - 30.0	274.88	277.28	14.0 - 16.0, 31.0 - TD	34.62	30.22	5/26/2017	12:40	247.06
MW09	11MP17SB	31.0	20.0 - 30.0	274.88	277.28	14.0 - 16.0, 31.0 - TD	34.62	26.9	9/26/2017	1356	250.38
MW09	11MP17SB	31.0	20.0 - 30.0	274.88	277.28	14.0 - 16.0, 31.0 - TD		22.2	5/18/2018	13:21	255.08
MW10	11MP14SB	61.0	50.0 - 60.0	274.31	276.21	48.0 - TD		30.60	8/29/2011	16:15	245.61
MW10	11MP14SB	61.0	50.0 - 60.0	274.31	276.21	48.0 - TD		29.17	9/1/2011	16:38	247.04
MW10	11MP14SB	61.0	50.0 - 60.0	274.31	276.21	48.0 - TD		25.62	5/26/2012	14:14	250.59
MW10	11MP14SB	61.0	50.0 - 60.0	274.31	276.21	48.0 - TD		26.39	9/9/2012	15:45	249.82
MW10	11MP14SB	61.0	50.0 - 60.0	274.31	276.21	48.0 - TD		26.88	9/10/2012	11:35	249.33
MW10	11MP14SB	61.0	50.0 - 60.0	274.31	276.21	48.0 - TD		28.98	6/17/2015	11:37	247.23
MW10	11MP14SB	61.0	50.0 - 60.0	274.31	276.21	48.0 - TD		32.90	8/12/2015	12:09	243.31
MW10	11MP14SB	61.0	50.0 - 60.0	274.31	276.21	48.0 - TD		33.52	9/2/2015	10:25	242.69

Table 3-5 Well Construction and Groundwater Depth Information

Monitoring Well ID	Soil Boring ID	Reported Well Total Depth As Constructed (ft. bgs)	Reported Screened Interval (ft. bgs)	Surveyed Ground Elevation (feet NAVD88)	Surveyed Top of Casing Elevation (feet NAVD88)	GW Observed During Drilling (feet bgs)	Measured Well Total Depth (feet below TOC)	Static Water Level			Ground Water Elevation (feet NAVD88)
								Depth (feet below TOC)	Date	Time	
MW10	11MP14SB	61.0	50.0 - 60.0	274.31	276.21	48.0 - TD	63.54	31.02	9/10/2015	NR	245.19
MW10	11MP14SB	61.0	50.0 - 60.0	274.31	276.21	48.0 - TD	63.97	25.92	9/28/2016	NR	250.29
MW10	11MP14SB	61.0	50.0 - 60.0	274.31	276.21	48.0 - TD	63.53	30.19	5/26/2017	12:46	246.02
MW10	11MP14SB	61.0	50.0 - 60.0	274.31	276.21	48.0 - TD	63.53	26.03	9/26/2017	1347	250.18
MW10	11MP14SB	61.0	50.0 - 60.0	274.31	276.21	48.0 - TD		24.46	5/18/2018	13:28	251.75
MW11	11MP12SB	23.0	12.0 - 22.0	268.70	271.30	dry		Dry	8/29/2011	12:00	Dry (Water Elevation <246.7 ft bgs)
MW11	11MP12SB	23.0	12.0 - 22.0	268.70	271.30	dry		Dry	9/1/2011	16:34	Dry (Water Elevation <246.7 ft bgs)
MW11	11MP12SB	23.0	12.0 - 22.0	268.70	271.30	dry		22.60	5/26/2012	14:24	248.70
MW11	11MP12SB	23.0	12.0 - 22.0	268.70	271.30	dry		24.24	9/9/2012	16:00	Suspected Dry (Water Elevation <246.7 ft bgs)
MW11	11MP12SB	23.0	12.0 - 22.0	268.70	271.30	dry		23.69	6/17/2015	15:52	Suspected Dry (Water Elevation <246.7 ft bgs)
MW11	11MP12SB	23.0	12.0 - 22.0	268.70	271.30	dry		24.08	8/12/2015	12:11	Suspected Dry (Water Elevation <246.7 ft bgs)
MW11	11MP12SB	23.0	12.0 - 22.0	268.70	271.30	dry		24.36	9/2/2015	10:30	Suspected Dry (Water Elevation <246.7 ft bgs)
MW11	11MP12SB	23.0	12.0 - 22.0	268.70	271.30	dry	25.70	24.16	9/10/2015	NR	Suspected Dry (Water Elevation <246.7 ft bgs)
MW11	11MP12SB	23.0	12.0 - 22.0	268.70	271.30	dry	25.63	21.60	9/28/2016	NR	249.70
MW11	11MP12SB	23.0	12.0 - 22.0	268.70	271.30	dry	NR	25.20	5/26/2017	12:56	246.10
MW11	11MP12SB	23.0	12.0 - 22.0	268.70	271.30	dry		19.12	5/18/2018	13:21	252.18
MW11	11MP12SB	23.0	12.0 - 22.0	268.70	271.30	dry	25.42	21.26	9/26/2017	13:41	250.04
MW12	11RD13SB	15.0	4.0 - 14.0	263.22	265.62	1.0 - TD		3.72	8/31/2011	13:34	261.90
MW12	11RD13SB	15.0	4.0 - 14.0	263.22	265.62	1.0 - TD		3.70	9/1/2011	16:20	261.92
MW12	11RD13SB	15.0	4.0 - 14.0	263.22	265.62	1.0 - TD		2.46	5/26/2012	11:04	263.16
MW12	11RD13SB	15.0	4.0 - 14.0	263.22	265.62	1.0 - TD		3.30	9/9/2012	16:39	262.32
MW12	11RD13SB	15.0	4.0 - 14.0	263.22	265.62	1.0 - TD		5.02	6/17/2015	13:18	260.60
MW12	11RD13SB	15.0	4.0 - 14.0	263.22	265.62	1.0 - TD		6.80	8/12/2015	11:46	258.82
MW12	11RD13SB	15.0	4.0 - 14.0	263.22	265.62	1.0 - TD		6.98	9/2/2015	11:00	258.64
MW12	11RD13SB	15.0	4.0 - 14.0	263.22	265.62	1.0 - TD	17.68	5.97	9/10/2015	NR	259.65
MW12	11RD13SB	15.0	4.0 - 14.0	263.22	265.62	1.0 - TD	17.60	4.49	9/28/2016	10:40	261.13
MW12	11RD13SB	15.0	4.0 - 14.0	263.22	265.62	1.0 - TD	NR	6.49	5/26/2017	13:29	259.13
MW12	11RD13SB	15.0	4.0 - 14.0	263.22	265.62	1.0 - TD	17.39	4.81	9/26/2017		260.81
MW12	11RD13SB	15.0	4.0 - 14.0	263.22	265.62	1.0 - TD		4.44	5/18/2018	12:26	261.18
MW13	11MP20SB	32.0	21.0 - 31.0	274.30	276.70	27.0 - TD		30.05	8/30/2011	18:04	246.65
MW13	11MP20SB	32.0	21.0 - 31.0	274.30	276.70	27.0 - TD		29.70	9/1/2011	16:09	247.00
MW13	11MP20SB	32.0	21.0 - 31.0	274.30	276.70	27.0 - TD		18.41	5/26/2012	13:45	258.29
MW13	11MP20SB	32.0	21.0 - 31.0	274.30	276.70	27.0 - TD		24.06	9/9/2012	16:50	252.64
MW13	11MP20SB	32.0	21.0 - 31.0	274.30	276.70	27.0 - TD		29.85	6/17/2015	12:13	246.85
MW13	11MP20SB	32.0	21.0 - 31.0	274.30	276.70	27.0 - TD		DRY	8/12/2015	11:51	Dry (Water Elevation <243.3 ft bgs)
MW13	11MP20SB	32.0	21.0 - 31.0	274.30	276.70	27.0 - TD		DRY	9/2/2015	10:45	Dry (Water Elevation <243.3 ft bgs)
MW13	11MP20SB	32.0	21.0 - 31.0	274.30	276.70	27.0 - TD	31.70	DRY	9/10/2015	NR	Dry (Water Elevation <243.3 ft bgs)
MW13	11MP20SB	32.0	21.0 - 31.0	274.30	276.70	27.0 - TD	31.65	24.35	9/28/2016	12:55	252.35
MW13	11MP20SB	32.0	21.0 - 31.0	274.30	276.70	27.0 - TD	31.65	DRY	5/26/2017	NR	Dry (Water Elevation <243.3 ft bgs)
MW13	11MP20SB	32.0	21.0 - 31.0	274.30	276.70	27.0 - TD	31.65	25.9	9/26/2017	1454	250.80
MW13	11MP20SB	32.0	21.0 - 31.0	274.30	276.70	27.0 - TD		19.14	5/18/2018	12:42	257.56

Table 3-5 Well Construction and Groundwater Depth Information

Monitoring Well ID	Soil Boring ID	Reported Well Total Depth As Constructed (ft. bgs)	Reported Screened Interval (ft. bgs)	Surveyed Ground Elevation (feet NAVD88)	Surveyed Top of Casing Elevation (feet NAVD88)	GW Observed During Drilling (feet bgs)	Measured Well Total Depth (feet below TOC)	Static Water Level			Ground Water Elevation (feet NAVD88)
								Depth (feet below TOC)	Date	Time	
MW14	11MP25SB	36.0	25.0 - 35.0	246.71	249.01	25.7 - TD		30.51	8/31/2011	10:05	218.50
MW14	11MP25SB	36.0	25.0 - 35.0	246.71	249.01	25.7 - TD		30.01	9/1/2011	16:00	219.00
MW14	11MP25SB	36.0	25.0 - 35.0	246.71	249.01	25.7 - TD		24.40	5/26/2012	14:45	224.61
MW14	11MP25SB	36.0	25.0 - 35.0	246.71	249.01	25.7 - TD		27.34	9/10/2012	17:35	221.67
MW14	11MP25SB	36.0	25.0 - 35.0	246.71	249.01	25.7 - TD		--	--	--	Decommissioned in 2014 NTCRA
MW15	11MP29SB	26.0	15.0 - 25.0	242.63	244.93	16.2 - TD		19.64	8/30/2011	10:35	225.29
MW15	11MP29SB	26.0	15.0 - 25.0	242.63	244.93	16.2 - TD		19.59	9/1/2011	15:56	225.34
MW15	11MP29SB	26.0	15.0 - 25.0	242.63	244.93	16.2 - TD		18.33	5/26/2012	14:56	226.60
MW15	11MP29SB	26.0	15.0 - 25.0	242.63	244.93	16.2 - TD		18.3	9/8/2012	13:00	226.63
MW15	11MP29SB	26.0	15.0 - 25.0	242.63	244.93	16.2 - TD		--	--	--	Decommissioned in 2014 NTCRA
MW16	11MP30SB	22.0	11.0 - 21.0	226.09	228.09	16.0 - TD		13.84	8/30/2011	11:35	214.25
MW16	11MP30SB	22.0	11.0 - 21.0	226.09	228.09	16.0 - TD		14.90	9/1/2011	15:50	213.19
MW16	11MP30SB	22.0	11.0 - 21.0	226.09	228.09	16.0 - TD		6.17	5/26/2012	15:08	221.92
MW16	11MP30SB	22.0	11.0 - 21.0	226.09	228.09	16.0 - TD		8.88	9/8/2012	14:30	219.21
MW16	11MP30SB	22.0	11.0 - 21.0	226.09	228.09	16.0 - TD		13.13	6/18/2015	19:52	214.96
MW16	11MP30SB	22.0	11.0 - 21.0	226.09	228.09	16.0 - TD		14.80	8/12/2015	12:19	213.29
MW16	11MP30SB	22.0	11.0 - 21.0	226.09	228.09	16.0 - TD		15.19	9/2/2015	9:35	212.90
MW16	11MP30SB	22.0	11.0 - 21.0	226.09	228.09	16.0 - TD	24.14	14.81	9/10/2015	NR	213.28
MW16	11MP30SB	22.0	11.0 - 21.0	226.09	228.09	16.0 - TD	24.10	8.58	9/28/2016	13:33	219.51
MW16	11MP30SB	22.0	11.0 - 21.0	226.09	228.09	16.0 - TD	24.08	15.09	5/26/2017	11:46	213.00
MW16	11MP30SB	22.0	11.0 - 21.0	226.09	228.09	16.0 - TD	24.08	10.32	9/26/2017	1314	217.77
MW16	11MP30SB	22.0	11.0 - 21.0	226.09	228.09	16.0 - TD		5.4	5/18/2018	13.44	222.69
MW17	11MP91SB	52.5	41.5 - 51.5	226.36	228.66	25.0 - 33.0, 33.0 - TD		15.00	8/30/2011	9:20	213.66
MW17	11MP91SB	52.5	41.5 - 51.5	226.36	228.66	25.0 - 33.0, 33.0 - TD		13.78	9/1/2011	15:52	214.88
MW17	11MP91SB	52.5	41.5 - 51.5	226.36	228.66	25.0 - 33.0, 33.0 - TD		8.20	5/26/2012	15:03	220.46
MW17	11MP91SB	52.5	41.5 - 51.5	226.36	228.66	25.0 - 33.0, 33.0 - TD		10.79	9/8/2012	16:20	217.87
MW17	11MP91SB	52.5	41.5 - 51.5	226.36	228.66	25.0 - 33.0, 33.0 - TD		15.03	6/18/2015	19:40	213.63
MW17	11MP91SB	52.5	41.5 - 51.5	226.36	228.66	25.0 - 33.0, 33.0 - TD		17.01	8/12/2015	12:18	211.65
MW17	11MP91SB	52.5	41.5 - 51.5	226.36	228.66	25.0 - 33.0, 33.0 - TD		17.28	9/2/2015	9:36	211.38
MW17	11MP91SB	52.5	41.5 - 51.5	226.36	228.66	25.0 - 33.0, 33.0 - TD	55.02	19.93	9/10/2015	NR	208.73
MW17	11MP91SB	52.5	41.5 - 51.5	226.36	228.66	25.0 - 33.0, 33.0 - TD	54.80	10.58	9/28/2016	13:22	218.08
MW17	11MP91SB	52.5	41.5 - 51.5	226.36	228.66	25.0 - 33.0, 33.0 - TD	54.77	17.19	5/26/2017	11:35	211.47
MW17	11MP91SB	52.5	41.5 - 51.5	226.36	228.66	25.0 - 33.0, 33.0 - TD	54.77	12.18	9/26/2017	1312	216.48
MW17	11MP91SB	52.5	41.5 - 51.5	226.36	228.66	25.0 - 33.0, 33.0 - TD		7.5	5/18/2018	13:41	221.16
MW18	11MP31SB	40.0	29.0 - 39.0	241.33	243.83	38.0 - TD		29.66	8/31/2011	15:47	214.17
MW18	11MP31SB	40.0	29.0 - 39.0	241.33	243.83	38.0 - TD		29.87	9/1/2011	15:37	213.96
MW18	11MP31SB	40.0	29.0 - 39.0	241.33	243.83	38.0 - TD		21.82	5/26/2012	13:10	222.01
MW18	11MP31SB	40.0	29.0 - 39.0	241.33	243.83	38.0 - TD		24.83	9/9/2012	17:20	219.00
MW18	11MP31SB	40.0	29.0 - 39.0	241.33	243.83	38.0 - TD		29.17	6/17/2015	10:46	214.66
MW18	11MP31SB	40.0	29.0 - 39.0	241.33	243.83	38.0 - TD		31.43	8/12/2015	12:31	212.40
MW18	11MP31SB	40.0	29.0 - 39.0	241.33	243.83	38.0 - TD		31.65	9/2/2015	9:30	212.18

Table 3-5 Well Construction and Groundwater Depth Information

Monitoring Well ID	Soil Boring ID	Reported Well Total Depth As Constructed (ft. bgs)	Reported Screened Interval (ft. bgs)	Surveyed Ground Elevation (feet NAVD88)	Surveyed Top of Casing Elevation (feet NAVD88)	GW Observed During Drilling (feet bgs)	Measured Well Total Depth (feet below TOC)	Static Water Level			Ground Water Elevation (feet NAVD88)
								Depth (feet below TOC)	Date	Time	
MW18	11MP31SB	40.0	29.0 - 39.0	241.33	243.83	38.0 - TD	41.57	31.20	9/10/2015	NR	212.63
MW18	11MP31SB	40.0	29.0 - 39.0	241.33	243.83	38.0 - TD	41.38	23.85	9/28/2016	13:55	219.98
MW18	11MP31SB	40.0	29.0 - 39.0	241.33	243.83	38.0 - TD	NR	30.85	5/26/2017	11:14	212.98
MW18	11MP31SB	40.0	29.0 - 39.0	241.33	243.83	38.0 - TD	41.14	25.66	9/26/2017	1246	218.17
MW18	11MP31SB	40.0	29.0 - 39.0	241.33	243.83	38.0 - TD		20.64	5/18/2018	11:51	223.19
MW19	11MP33SB	43.0	32.0 - 42.0	237.70	240.00	39.0 - TD		19.47	9/1/2011	15:32	220.53
MW19	11MP33SB	43.0	32.0 - 42.0	237.70	240.00	39.0 - TD		11.54	5/26/2012	12:59	228.46
MW19	11MP33SB	43.0	32.0 - 42.0	237.70	240.00	39.0 - TD		16.02	9/9/2012	17:25	223.98
MW19	11MP33SB	43.0	32.0 - 42.0	237.70	240.00	39.0 - TD		18.48	6/17/2015	10:31	221.52
MW19	11MP33SB	43.0	32.0 - 42.0	237.70	240.00	39.0 - TD		23.48	8/12/2015	12:33	216.52
MW19	11MP33SB	43.0	32.0 - 42.0	237.70	240.00	39.0 - TD		24.95	9/2/2015	9:20	215.05
MW19	11MP33SB	43.0	32.0 - 42.0	237.70	240.00	39.0 - TD	45.70	23.94	9/10/2015	NR	216.06
MW19	11MP33SB	43.0	32.0 - 42.0	237.70	240.00	39.0 - TD	45.50	14.67	9/28/2016	14:00	225.33
MW19	11MP33SB	43.0	32.0 - 42.0	237.70	240.00	39.0 - TD	45.50	27.02	5/26/2017	11:05	212.98
MW19	11MP33SB	43.0	32.0 - 42.0	237.70	240.00	39.0 - TD	45.50	15.9	9/26/2017	1238	224.10
MW19	11MP33SB	43.0	32.0 - 42.0	237.70	240.00	39.0 - TD		12.3	5/18/2018	13:57	227.70
MW20	11MP38SB	15.5	4.5 - 14.5	212.90	215.20	6.5 - TD		6.89	8/31/2011	8:53	208.31
MW20	11MP38SB	15.5	4.5 - 14.5	212.90	215.20	6.5 - TD		6.97	9/1/2011	15:43	208.23
MW20	11MP38SB	15.5	4.5 - 14.5	212.90	215.20	6.5 - TD		4.82	5/26/2012	15:26	210.38
MW20	11MP38SB	15.5	4.5 - 14.5	212.90	215.20	6.5 - TD		5.53	9/9/2012	10:10	209.67
MW20	11MP38SB	15.5	4.5 - 14.5	212.90	215.20	6.5 - TD		7.11	6/17/2015	10:18	208.09
MW20	11MP38SB	15.5	4.5 - 14.5	212.90	215.20	6.5 - TD		7.92	8/12/2015	12:39	207.28
MW20	11MP38SB	15.5	4.5 - 14.5	212.90	215.20	6.5 - TD		8.12	9/2/2015	9:10	207.08
MW20	11MP38SB	15.5	4.5 - 14.5	212.90	215.20	6.5 - TD	17.70	7.96	9/10/2015	NR	207.24
MW20	11MP38SB	15.5	4.5 - 14.5	212.90	215.20	6.5 - TD	17.70	5.35	9/28/2016	14:15	209.85
MW20	11MP38SB	15.5	4.5 - 14.5	212.90	215.20	6.5 - TD	NR	8.6	5/26/2017	10:50	206.60
MW20	11MP38SB	15.5	4.5 - 14.5	212.90	215.20	6.5 - TD	17.47	6.32	9/26/2017	1303	208.88
MW20	11MP38SB	15.5	4.5 - 14.5	212.90	215.20	6.5 - TD		5.69	5/18/2018	13:57	209.51
MW21	11MP39SB	17.5	6.5 - 16.5	208.23	210.13	7.0 - TD		8.80	8/31/2011	10:16	201.33
MW21	11MP39SB	17.5	6.5 - 16.5	208.23	210.13	7.0 - TD		8.82	9/1/2011	17:10	201.31
MW21	11MP39SB	17.5	6.5 - 16.5	208.23	210.13	7.0 - TD		7.91	5/26/2012	15:36	202.22
MW21	11MP39SB	17.5	6.5 - 16.5	208.23	210.13	7.0 - TD		8.29	9/8/2012	17:35	201.84
MW21	11MP39SB	17.5	6.5 - 16.5	208.23	210.13	7.0 - TD		8.55	6/17/2015	10:08	201.58
MW21	11MP39SB	17.5	6.5 - 16.5	208.23	210.13	7.0 - TD		9.10	8/12/2015	12:39	201.03
MW21	11MP39SB	17.5	6.5 - 16.5	208.23	210.13	7.0 - TD		9.45	9/2/2015	9:00	200.68
MW21	11MP39SB	17.5	6.5 - 16.5	208.23	210.13	7.0 - TD	10.67	9.14	9/10/2015	NR	200.99
MW21	11MP39SB	17.5	6.5 - 16.5	208.23	210.13	7.0 - TD	19.60	8.01	9/28/2016	14:30	202.12
MW21	11MP39SB	17.5	6.5 - 16.5	208.23	210.13	7.0 - TD	NR	8.91	5/26/2017	10:34	201.22
MW21	11MP39SB	17.5	6.5 - 16.5	208.23	210.13	7.0 - TD	19.39	8.13	9/26/2017	1229	202.00
MW21	11MP39SB	17.5	6.5 - 16.5	208.23	210.13	7.0 - TD		7.94	5/18/2018	13:50	202.19
MW22	11MP40SB	15.5	4.5 - 14.5	203.10	205.10	7.8 - TD		8.20	8/31/2011	11:08	196.90

Table 3-5 Well Construction and Groundwater Depth Information

Monitoring Well ID	Soil Boring ID	Reported Well Total Depth As Constructed (ft. bgs)	Reported Screened Interval (ft. bgs)	Surveyed Ground Elevation (feet NAVD88)	Surveyed Top of Casing Elevation (feet NAVD88)	GW Observed During Drilling (feet bgs)	Measured Well Total Depth (feet below TOC)	Static Water Level			Ground Water Elevation (feet NAVD88)
								Depth (feet below TOC)	Date	Time	
MW22	11MP40SB	15.5	4.5 - 14.5	203.10	205.10	7.8 - TD		8.48	9/1/2011	17:04	196.62
MW22	11MP40SB	15.5	4.5 - 14.5	203.10	205.10	7.8 - TD		5.55	5/26/2012	15:44	199.55
MW22	11MP40SB	15.5	4.5 - 14.5	203.10	205.10	7.8 - TD		7.77	9/9/2012	17:35	197.33
MW22	11MP40SB	15.5	4.5 - 14.5	203.10	205.10	7.8 - TD		8.47	6/17/2015	9:46	196.63
MW22	11MP40SB	15.5	4.5 - 14.5	203.10	205.10	7.8 - TD		10.01	8/12/2015	12:43	195.09
MW22	11MP40SB	15.5	4.5 - 14.5	203.10	205.10	7.8 - TD		10.33	9/2/2015	8:50	194.77
MW22	11MP40SB	15.5	4.5 - 14.5	203.10	205.10	7.8 - TD	17.74	10.19	9/10/2015	NR	194.91
MW22	11MP40SB	15.5	4.5 - 14.5	203.10	205.10	7.8 - TD	17.66	6.65	9/28/2016	14:40	198.45
MW22	11MP40SB	15.5	4.5 - 14.5	203.10	205.10	7.8 - TD	NR	10.45	5/26/2017	10:21	194.65
MW22	11MP40SB	15.5	4.5 - 14.5	203.10	205.10	7.8 - TD	17.50	7.23	9/26/2017	1220	197.87
MW22	11MP40SB	15.5	4.5 - 14.5	203.10	205.10	7.8 - TD		5.63	5/18/2018	13:44	199.47
MW23	11MP66SB	29.0	18.0 - 28.0	201.96	204.16	20.0 - TD		16.02	8/30/2011	16:31	188.14
MW23	11MP66SB	29.0	18.0 - 28.0	201.96	204.16	20.0 - TD		16.01	9/1/2011	15:14	188.15
MW23	11MP66SB	29.0	18.0 - 28.0	201.96	204.16	20.0 - TD		14.60	5/26/2012	15:56	189.56
MW23	11MP66SB	29.0	18.0 - 28.0	201.96	204.16	20.0 - TD		15.56	9/9/2012	17:47	188.60
MW23	11MP66SB	29.0	18.0 - 28.0	201.96	204.16	20.0 - TD		15.88	6/17/2015	14:15	188.28
MW23	11MP66SB	29.0	18.0 - 28.0	201.96	204.16	20.0 - TD		16.92	8/12/2015	11:06	187.24
MW23	11MP66SB	29.0	18.0 - 28.0	201.96	204.16	20.0 - TD		16.63	9/2/2015	11:10	187.53
MW23	11MP66SB	29.0	18.0 - 28.0	201.96	204.16	20.0 - TD	30.95	16.54	9/10/2015	NR	187.62
MW23	11MP66SB	29.0	18.0 - 28.0	201.96	204.16	20.0 - TD	28.86	15.53	9/28/2016	13:46	188.63
MW23	11MP66SB	29.0	18.0 - 28.0	201.96	204.16	20.0 - TD	NR	17.63	5/26/2017	13:00	186.53
MW23	11MP66SB	29.0	18.0 - 28.0	201.96	204.16	20.0 - TD	30.58	15.86	9/26/2017	1634	188.30
MW23	11MP66SB	29.0	18.0 - 28.0	201.96	204.16	20.0 - TD		14.08	5/18/2018	13:27	190.08
MW24	11MP62SB	30.0	19.0 - 29.0	221.41	223.51	20.0 - TD		17.70	8/30/2011	14:51	205.81
MW24	11MP62SB	30.0	19.0 - 29.0	221.41	223.51	20.0 - TD		17.61	9/1/2011	15:06	205.90
MW24	11MP62SB	30.0	19.0 - 29.0	221.41	223.51	20.0 - TD		14.59	5/26/2012	16:15	208.92
MW24	11MP62SB	30.0	19.0 - 29.0	221.41	223.51	20.0 - TD		16.45	9/9/2012	14:00	207.06
MW24	11MP62SB	30.0	19.0 - 29.0	221.41	223.51	20.0 - TD		16.89	6/17/2015	14:31	206.62
MW24	11MP62SB	30.0	19.0 - 29.0	221.41	223.51	20.0 - TD		17.88	8/12/2015	10:58	205.63
MW24	11MP62SB	30.0	19.0 - 29.0	221.41	223.51	20.0 - TD		19.02	9/2/2015	11:12	204.49
MW24	11MP62SB	30.0	19.0 - 29.0	221.41	223.51	20.0 - TD	32.30	17.88	9/10/2015	NR	205.63
MW24	11MP62SB	30.0	19.0 - 29.0	221.41	223.51	20.0 - TD	32.22	15.40	9/28/2016	13:26	208.11
MW24	11MP62SB	30.0	19.0 - 29.0	221.41	223.51	20.0 - TD	NR	18.21	5/26/2017	12:48	205.30
MW24	11MP62SB	30.0	19.0 - 29.0	221.41	223.51	20.0 - TD	31.97	15.96	9/26/2017	1651	207.55
MW24	11MP62SB	30.0	19.0 - 29.0	221.41	223.51	20.0 - TD		14.90	5/18/2018	13:15	208.61
MW25	11MP89SB	42.0	31.0 - 41.0	237.56	239.76	32.0 - TD		31.85	8/30/2011	18:02	207.91
MW25	11MP89SB	42.0	31.0 - 41.0	237.56	239.76	32.0 - TD		31.88	9/1/2011	14:50	207.88
MW25	11MP89SB	42.0	31.0 - 41.0	237.56	239.76	32.0 - TD		29.74	5/26/2012	16:22	210.02
MW25	11MP89SB	42.0	31.0 - 41.0	237.56	239.76	32.0 - TD		33.87	9/9/2012	10:30	205.89
MW25	11MP89SB	42.0	31.0 - 41.0	237.56	239.76	32.0 - TD		31.81	6/17/2015	14:40	207.95
MW25	11MP89SB	42.0	31.0 - 41.0	237.56	239.76	32.0 - TD		32.48	8/12/2015	10:56	207.28

Table 3-5 Well Construction and Groundwater Depth Information

Monitoring Well ID	Soil Boring ID	Reported Well Total Depth As Constructed (ft. bgs)	Reported Screened Interval (ft. bgs)	Surveyed Ground Elevation (feet NAVD88)	Surveyed Top of Casing Elevation (feet NAVD88)	GW Observed During Drilling (feet bgs)	Measured Well Total Depth (feet below TOC)	Static Water Level			Ground Water Elevation (feet NAVD88)
								Depth (feet below TOC)	Date	Time	
MW25	11MP89SB	42.0	31.0 - 41.0	237.56	239.76	32.0 - TD		32.60	9/2/2015	11:20	207.16
MW25	11MP89SB	42.0	31.0 - 41.0	237.56	239.76	32.0 - TD	44.43	32.45	9/10/2015	NR	207.31
MW25	11MP89SB	42.0	31.0 - 41.0	237.56	239.76	32.0 - TD	40.24	30.38	9/28/2016	13:22	209.38
MW25	11MP89SB	42.0	31.0 - 41.0	237.56	239.76	32.0 - TD	NR	32.73	5/26/2017	12:41	207.03
MW25	11MP89SB	42.0	31.0 - 41.0	237.56	239.76	32.0 - TD	44.44	30.99	9/26/2017	1705	208.77
MW25	11MP89SB	42.0	31.0 - 41.0	237.56	239.76	32.0 - TD		29.51	5/18/2018	13:08	210.25
MW26	11MP52SB	43.0	32.0 - 42.0	244.03	245.93	34.0 - TD		36.25	8/30/2011	11:35	209.68
MW26	11MP52SB	43.0	32.0 - 42.0	244.03	245.93	34.0 - TD		36.30	9/1/2011	14:47	209.63
MW26	11MP52SB	43.0	32.0 - 42.0	244.03	245.93	34.0 - TD		32.76	5/26/2012	16:30	213.17
MW26	11MP52SB	43.0	32.0 - 42.0	244.03	245.93	34.0 - TD		34.01	9/9/2012	17:55	211.92
MW26	11MP52SB	43.0	32.0 - 42.0	244.03	245.93	34.0 - TD		36.04	6/17/2015	14:48	209.89
MW26	11MP52SB	43.0	32.0 - 42.0	244.03	245.93	34.0 - TD		36.98	8/12/2015	10:50	208.95
MW26	11MP52SB	43.0	32.0 - 42.0	244.03	245.93	34.0 - TD		37.24	9/2/2015	11:25	208.69
MW26	11MP52SB	43.0	32.0 - 42.0	244.03	245.93	34.0 - TD	45.13	36.42	9/10/2015	NR	209.51
MW26	11MP52SB	43.0	32.0 - 42.0	244.03	245.93	34.0 - TD	45.05	33.09	9/28/2016	13:10	212.84
MW26	11MP52SB	43.0	32.0 - 42.0	244.03	245.93	34.0 - TD	45.01	35.53	5/26/2017	12:35	210.40
MW26	11MP52SB	43.0	32.0 - 42.0	244.03	245.93	34.0 - TD	45.01	33.20	9/26/2017	1710	212.73
MW26	11MP52SB	43.0	32.0 - 42.0	244.03	245.93	34.0 - TD		31.08	5/18/2018	13:04	214.85
MW27	11MP60SB	34.0	23.0 - 33.0	241.04	242.94	29.0 - TD		30.30	8/30/2011	16:50	212.64
MW27	11MP60SB	34.0	23.0 - 33.0	241.04	242.94	29.0 - TD		30.37	9/1/2011	14:58	212.57
MW27	11MP60SB	34.0	23.0 - 33.0	241.04	242.94	29.0 - TD		26.28	5/26/2012	16:38	216.66
MW27	11MP60SB	34.0	23.0 - 33.0	241.04	242.94	29.0 - TD		28.64	9/9/2012	12:50	214.30
MW27	11MP60SB	34.0	23.0 - 33.0	241.04	242.94	29.0 - TD		34.41	6/17/2015	14:58	Suspected Dry (Water Elevation <208.4 ft)
MW27	11MP60SB	34.0	23.0 - 33.0	241.04	242.94	29.0 - TD		NR	8/12/2015	NR	--
MW27	11MP60SB	34.0	23.0 - 33.0	241.04	242.94	29.0 - TD		31.42	9/2/2015	22:30	211.52
MW27	11MP60SB	34.0	23.0 - 33.0	241.04	242.94	29.0 - TD	35.77	31.24	9/10/2015	NR	211.52
MW27	11MP60SB	34.0	23.0 - 33.0	241.04	242.94	29.0 - TD	35.70	27.51	9/28/2016	12:46	215.43
MW27	11MP60SB	34.0	23.0 - 33.0	241.04	242.94	29.0 - TD	35.65	31.52	5/26/2017	12:30	211.42
MW27	11MP60SB	34.0	23.0 - 33.0	241.04	242.94	29.0 - TD	35.65	28.83	9/26/2017	1718	214.11
MW27	11MP60SB	34.0	23.0 - 33.0	241.04	242.94	29.0 - TD		24.86	5/18/2018	12:57	218.08
MW28	11MP88SB	64.0	53.0 - 63.0	239.94	241.94	49.0 - TD		25.50	8/30/2011	14:57	216.44
MW28	11MP88SB	64.0	53.0 - 63.0	239.94	241.94	49.0 - TD		28.61	9/1/2011	14:53	213.33
MW28	11MP88SB	64.0	53.0 - 63.0	239.94	241.94	49.0 - TD		24.19	5/26/2012	16:41	217.75
MW28	11MP88SB	64.0	53.0 - 63.0	239.94	241.94	49.0 - TD		27.01	9/10/2012	15:43	214.93
MW28	11MP88SB	64.0	53.0 - 63.0	239.94	241.94	49.0 - TD		28.90	6/17/2015	15:08	213.04
MW28	11MP88SB	64.0	53.0 - 63.0	239.94	241.94	49.0 - TD		29.88	8/12/2015	10:46	212.06
MW28	11MP88SB	64.0	53.0 - 63.0	239.94	241.94	49.0 - TD		30.10	9/2/2015	11:35	211.84
MW28	11MP88SB	64.0	53.0 - 63.0	239.94	241.94	49.0 - TD	65.87	29.95	9/10/2015	NR	211.99
MW28	11MP88SB	64.0	53.0 - 63.0	239.94	241.94	49.0 - TD	65.65	25.74	9/28/2016	13:00	216.20
MW28	11MP88SB	64.0	53.0 - 63.0	239.94	241.94	49.0 - TD	65.58	30.13	5/26/2017	12:25	211.81
MW28	11MP88SB	64.0	53.0 - 63.0	239.94	241.94	49.0 - TD	65.58	27.05	9/26/2017	1721	214.89

Table 3-5 Well Construction and Groundwater Depth Information

Monitoring Well ID	Soil Boring ID	Reported Well Total Depth As Constructed (ft. bgs)	Reported Screened Interval (ft. bgs)	Surveyed Ground Elevation (feet NAVD88)	Surveyed Top of Casing Elevation (feet NAVD88)	GW Observed During Drilling (feet bgs)	Measured Well Total Depth (feet below TOC)	Static Water Level			Ground Water Elevation (feet NAVD88)
								Depth (feet below TOC)	Date	Time	
MW28	11MP88SB	64.0	53.0 - 63.0	239.94	241.94	49.0 - TD		23.18	5/18/2018	15:53	218.76
MW29	11MP41SB	70.0	59.0 - 69.0	280.35	282.25	61.0 - TD		63.21	9/1/2011	13:20	219.04
MW29	11MP41SB	70.0	59.0 - 69.0	280.35	282.25	61.0 - TD		52.65	5/26/2012	17:09	229.60
MW29	11MP41SB	70.0	59.0 - 69.0	280.35	282.25	61.0 - TD		61.20	9/9/2012	16:22	221.05
MW29	11MP41SB	70.0	59.0 - 69.0	280.35	282.25	61.0 - TD		64.08	6/17/2015	15:41	218.17
MW29	11MP41SB	70.0	59.0 - 69.0	280.35	282.25	61.0 - TD		66.60	8/12/2015	11:12	215.65
MW29	11MP41SB	70.0	59.0 - 69.0	280.35	282.25	61.0 - TD		66.89	9/2/2015	12:11	215.36
MW29	11MP41SB	70.0	59.0 - 69.0	280.35	282.25	61.0 - TD	71.75	66.81	9/10/2015	NR	215.44
MW29	11MP41SB	70.0	59.0 - 69.0	280.35	282.25	61.0 - TD	71.59	55.01	9/28/2016	12:11	227.24
MW29	11MP41SB	70.0	59.0 - 69.0	280.35	282.25	61.0 - TD	71.52	55.68	5/26/2017	11:45	226.57
MW29	11MP41SB	70.0	59.0 - 69.0	280.35	282.25	61.0 - TD	71.52	58.36	9/26/2017	1818	223.89
MW29	11MP41SB	70.0	59.0 - 69.0	280.35	282.25	61.0 - TD		48.60	5/18/2018	12:19	233.65
MW30	11SM31SB	53.0	42.0 - 52.0	275.71	277.41	45.0 - TD		53.53	9/1/2011	14:35	Suspected Dry (Water Elevation <223.7 ft.)
MW30	11SM31SB	53.0	42.0 - 52.0	275.71	277.41	45.0 - TD		52.63	5/26/2012	16:58	Suspected Dry (Water Elevation <223.7 ft.)
MW30	11SM31SB	53.0	42.0 - 52.0	275.71	277.41	45.0 - TD		NR	9/9/2012	NR	Suspected Dry (Water Elevation <223.7 ft.)
MW30	11SM31SB	53.0	42.0 - 52.0	275.71	277.41	45.0 - TD		54.25	6/17/2015	19:33	Suspected Dry (Water Elevation <223.7 ft.)
MW30	11SM31SB	53.0	42.0 - 52.0	275.71	277.41	45.0 - TD		54.28	8/12/2015	11:19	Suspected Dry (Water Elevation <223.7 ft.)
MW30	11SM31SB	53.0	42.0 - 52.0	275.71	277.41	45.0 - TD		54.32	9/2/2015	12:15	Suspected Dry (Water Elevation <223.7 ft.)
MW30	11SM31SB	53.0	42.0 - 52.0	275.71	277.41	45.0 - TD	55.63	54.45	9/10/2015	NR	Suspected Dry (Water Elevation <223.7 ft.)
MW30	11SM31SB	53.0	42.0 - 52.0	275.71	277.41	45.0 - TD	55.40	54.22	9/28/2016	12:24	Suspected Dry (Water Elevation <223.7 ft.)
MW30	11SM31SB	53.0	42.0 - 52.0	275.71	277.41	45.0 - TD	55.35	54.23	5/26/2017	11:35	223.18
MW30	11SM31SB	53.0	42.0 - 52.0	275.71	277.41	45.0 - TD	55.35	54.27	9/26/2017		223.14
MW30	11SM31SB	53.0	42.0 - 52.0	275.71	277.41	45.0 - TD		52.8	5/18/2018	12:12	224.61
MW31	11UP11SB	44.8	33.8 - 43.8	495.79	497.99	34.0 - TD		37.75	8/29/2011	13:51	460.24
MW31	11UP11SB	44.8	33.8 - 43.8	495.79	497.99	34.0 - TD		37.51	9/1/2011	14:05	460.48
MW31	11UP11SB	44.8	33.8 - 43.8	495.79	497.99	34.0 - TD		34.12	5/26/2012	10:10	463.87
MW31	11UP11SB	44.8	33.8 - 43.8	495.79	497.99	34.0 - TD		36.29	9/9/2012	18:10	461.70
MW31	11UP11SB	44.8	33.8 - 43.8	495.79	497.99	34.0 - TD		39.31	6/22/2015	19:09	458.68
MW31	11UP11SB	44.8	33.8 - 43.8	495.79	497.99	34.0 - TD		42.25	8/12/2015	11:31	455.74
MW31	11UP11SB	44.8	33.8 - 43.8	495.79	497.99	34.0 - TD		43.07	9/2/2015	12:45	454.92
MW31	11UP11SB	44.8	33.8 - 43.8	495.79	497.99	34.0 - TD	47.10	41.75	9/10/2015	NR	456.24
MW31	11UP11SB	44.8	33.8 - 43.8	495.79	497.99	34.0 - TD	47.10	35.22	10/1/2016	11:15	462.77
MW31	11UP11SB	44.8	33.8 - 43.8	495.79	497.99	34.0 - TD	47.07	44.95	5/26/2017	NR	453.04
MW31	11UP11SB	44.8	33.8 - 43.8	495.79	497.99	34.0 - TD	47.07	35.22	9/26/2017		462.77
MW31	11UP11SB	44.8	33.8 - 43.8	495.79	497.99	34.0 - TD		33.98	5/15/2018		464.01
MW32	11RD05SB	25.0	14.0 - 24.0	194.38	196.58	16.5 - TD		18.90	8/31/2011	15:55	177.68
MW32	11RD05SB	25.0	14.0 - 24.0	194.38	196.58	16.5 - TD		18.86	9/1/2011	15:26	177.72
MW32	11RD05SB	25.0	14.0 - 24.0	194.38	196.58	16.5 - TD		16.71	5/26/2012	12:45	179.87
MW32	11RD05SB	25.0	14.0 - 24.0	194.38	196.58	16.5 - TD		17.21	9/8/2012	15:40	179.37
MW32	11RD05SB	25.0	14.0 - 24.0	194.38	196.58	16.5 - TD		19.03	6/17/2015	9:30	177.55
MW32	11RD05SB	25.0	14.0 - 24.0	194.38	196.58	16.5 - TD		19.49	8/12/2015	12:47	177.09

Table 3-5 Well Construction and Groundwater Depth Information

Monitoring Well ID	Soil Boring ID	Reported Well Total Depth As Constructed (ft. bgs)	Reported Screened Interval (ft. bgs)	Surveyed Ground Elevation (feet NAVD88)	Surveyed Top of Casing Elevation (feet NAVD88)	GW Observed During Drilling (feet bgs)	Measured Well Total Depth (feet below TOC)	Static Water Level			Ground Water Elevation (feet NAVD88)
								Depth (feet below TOC)	Date	Time	
MW32	11RD05SB	25.0	14.0 - 24.0	194.38	196.58	16.5 - TD		20.17	9/2/2015	12:45	176.41
MW32	11RD05SB	25.0	14.0 - 24.0	194.38	196.58	16.5 - TD	26.73	20.05	9/10/2015	NR	176.53
MW32	11RD05SB	25.0	14.0 - 24.0	194.38	196.58	16.5 - TD	26.43	18.35	9/28/2016	14:13	178.23
MW32	11RD05SB	25.0	14.0 - 24.0	194.38	196.58	16.5 - TD	26.70	21.33	5/26/2017	9:53	175.25
MW32	11RD05SB	25.0	14.0 - 24.0	194.38	196.58	16.5 - TD	26.70	18.00	9/26/2017	1212	178.58
MW32	11RD05SB	25.0	14.0 - 24.0	194.38	196.58	16.5 - TD		17.16	5/18/2018	13:38	179.42
MW33	11RD20SB	23.0	12.0 - 22.0	176.62	178.92	10.5 - TD		8.14	8/31/2011	17:57	170.78
MW33	11RD20SB	23.0	12.0 - 22.0	176.62	178.92	10.5 - TD		8.19	9/1/2011	15:20	170.73
MW33	11RD20SB	23.0	12.0 - 22.0	176.62	178.92	10.5 - TD		3.98	5/26/2012	12:33	174.94
MW33	11RD20SB	23.0	12.0 - 22.0	176.62	178.92	10.5 - TD		5.97	9/8/2012	12:30	172.95
MW33	11RD20SB	23.0	12.0 - 22.0	176.62	178.92	10.5 - TD		8.50	6/17/2015	14:04	170.42
MW33	11RD20SB	23.0	12.0 - 22.0	176.62	178.92	10.5 - TD		9.05	8/12/2015	11:09	169.87
MW33	11RD20SB	23.0	12.0 - 22.0	176.62	178.92	10.5 - TD		9.23	9/2/2015	8:40	169.69
MW33	11RD20SB	23.0	12.0 - 22.0	176.62	178.92	10.5 - TD	24.26	9.12	9/10/2015	NR	169.80
MW33	11RD20SB	23.0	12.0 - 22.0	176.62	178.92	10.5 - TD	24.38	4.49	9/28/2016	13:56	174.43
MW33	11RD20SB	23.0	12.0 - 22.0	176.62	178.92	10.5 - TD	24.40	8.96	5/26/2017	13:10	169.96
MW33	11RD20SB	23.0	12.0 - 22.0	176.62	178.92	10.5 - TD	24.40	6.67	9/26/2017	1158	172.25
MW33	11RD20SB	23.0	12.0 - 22.0	176.62	178.92	10.5 - TD		3.43	5/18/2018	13:43	175.49
MW34	AST5 MW1	NR	NR	290.95	294.25			15.57	9/1/2011	16:49	278.68
MW34	AST5 MW1	NR	NR	290.95	294.25			15.82	6/22/2015	11:54	278.43
MW34	AST5 MW1	NR	NR	290.95	294.25			17.11	9/2/2015	10:20	277.14
MW34	AST5 MW1	NR	NR	290.95	294.25		22.80	16.38	9/10/2015	NR	277.87
MW34	AST5 MW1	NR	NR	290.95	294.25		65.80	29.66	9/28/2016	NR	264.59
MW34	AST5 MW1	NR	NR	290.95	294.25		NR	49.88	5/26/2017	12:30	244.37
MW34	AST5 MW1	NR	NR	290.95	294.25		65.5	30.03	9/26/2017	1409	264.22
MW34	AST5 MW1	NR	NR	290.95	294.25			26.43	5/18/2018	13:06	267.82
MW35	AST5 MW2	NR	NR	285.76	289.26			41.97	9/1/2011	16:55	247.29
MW35	AST5 MW2	NR	NR	285.76	289.26			40.01	6/22/2015	11:58	249.25
MW35	AST5 MW2	NR	NR	285.76	289.26			44.94	9/2/2015	10:15	244.32
MW35	AST5 MW2	NR	NR	285.76	289.26		55.30	44.42	9/10/2015	NR	244.84
MW35	AST5 MW2	NR	NR	285.76	289.26		55.20	36.03	9/28/2016		253.23
MW35	AST5 MW2	NR	NR	285.76	289.26		NR	47.78	5/26/2017	12:13	241.48
MW35	AST5 MW2	NR	NR	285.76	289.26		54.95	36.34	9/26/2017	1417	252.92
MW35	AST5 MW2	NR	NR	285.76	289.26			33.06	5/18/2018		256.20
MW36	AST5 MW3	NR	NR	286.33	290.03			35.81	9/1/2011	16:57	254.22
MW36	AST5 MW3	NR	NR	286.33	290.03			33.16	6/22/2015	12:08	256.87
MW36	AST5 MW3	NR	NR	286.33	290.03			40.89	9/2/2015	10:10	249.14
MW36	AST5 MW3	NR	NR	286.33	290.03		65.38	39.39	9/10/2015	NR	250.64
MW36	AST5 MW3	NR	NR	286.33	290.03		22.73	15.30	9/28/2016		274.73
MW36	AST5 MW3	NR	NR	286.33	290.03		NR	15.63	5/26/2017	12:26	274.40
MW36	AST5 MW3	NR	NR	286.33	290.03		22.60	15.46	9/26/2017	1427	274.57

Table 3-5 Well Construction and Groundwater Depth Information

Monitoring Well ID	Soil Boring ID	Reported Well Total Depth As Constructed (ft. bgs)	Reported Screened Interval (ft. bgs)	Surveyed Ground Elevation (feet NAVD88)	Surveyed Top of Casing Elevation (feet NAVD88)	GW Observed During Drilling (feet bgs)	Measured Well Total Depth (feet below TOC)	Static Water Level			Ground Water Elevation (feet NAVD88)
								Depth (feet below TOC)	Date	Time	
MW36	AST5 MW3	NR	NR	286.33	290.03			15.01	5/18/2018	13:12	275.02
MW39	SM67	84.0	63 - 83	432.83	435.26			85.11	8/3/2015	9:00	Dry (Water Elevation <349.8 ft.)
MW39	SM67	84.0	63 - 83	432.83	435.26			Dry (>84)	8/12/2015	11:25	Dry (Water Elevation <349.8 ft.)
MW39	SM67	84.0	63 - 83	432.83	435.26			Dry (>84)	9/2/2015	12:35	Dry (Water Elevation <349.8 ft.)
MW39	SM67	84.0	63 - 83	432.83	435.26		86.02	Dry (>84)	9/10/2015	NR	Dry (Water Elevation <349.8 ft.)
MW39	SM67	84.0	63 - 83	432.83	435.26		85.95	85.82	9/28/2016	11:40	Dry (Water Elevation <349.8 ft.)
MW39	SM67	84.0	63 - 83	432.83	435.26		85.89	84.76	5/26/2017	10:59	350.50
MW39	SM67	84.0	63 - 83	432.83	435.26		85.89	84.90	9/26/2017		350.36
MW39	SM67	84.0	63 - 83	432.83	435.26			84.80	5/18/2018	14:24	350.46
MW40	SM68c	140.0	119 - 139	392.86	395.18	135		131.11	8/12/2015	11:37	264.07
MW40	SM68c	140.0	119 - 139	392.86	395.18	135		131.49	9/2/2015	12:25	263.69
MW40	SM68c	140.0	119 - 139	392.86	395.18	135	142.45	131.60	9/10/2015	NR	263.58
MW40	SM68c	140.0	119 - 139	392.86	395.18		143.38	127.64	9/28/2016	11:50	267.54
MW40	SM68c	140.0	119 - 139	392.86	395.18		142.35	132.03	5/26/2017	11:20	263.15
MW40	SM68c	140.0	119 - 139	392.86	395.18		142.35	128.72	9/26/2017		266.46
MW40	SM68c	140.0	119 - 139	392.86	395.18			126.79	5/18/2018	11:30	268.39
MW42	SM70b	140.0	119 - 139	339.85	342.34	99		NR	8/12/2015	NR	--
MW42	SM70b	140.0	119 - 139	339.85	342.34	99		129.10	9/2/2015	11:50	213.24
MW42	SM70b	140.0	119 - 139	339.85	342.34	99	142.97	129.01	9/10/2015	NR	213.33
MW42	SM70b	140.0	119 - 139	339.85	342.34			125.24	9/28/2016	9:57	217.10
MW42	SM70b	140.0	119 - 139	339.85	342.34		142.45	128.87	5/26/2017	NR	213.47
MW42	SM70b	140.0	119 - 139	339.85	342.34		142.45	126.60	9/26/2017	1750	215.74
MW42	SM70b	140.0	119 - 139	339.85	342.34			122.62	5/18/2018	12:30	219.72
MW43	SM71b	118.5	98 - 118	300.87	303.69	94		90.25	8/12/2015	10:33	213.44
MW43	SM71b	118.5	98 - 118	300.87	303.69	94		90.42	9/2/2015	12:00	213.27
MW43	SM71b	118.5	98 - 118	300.87	303.69	94	121.13	90.34	9/10/2015	NR	213.35
MW43	SM71b	118.5	98 - 118	300.87	303.69		121.85	86.53	9/28/2016	10:17	217.16
MW43	SM71b	118.5	98 - 118	300.87	303.69		120.78	90.26	5/26/2017	NR	213.43
MW43	SM71b	118.5	98 - 118	300.87	303.69		120.78	87.83	9/26/2017	1740	215.86
MW43	SM71b	118.5	98 - 118	300.87	303.69			83.95	5/18/2018	12:37	219.74
MW44	SM72	69	48-68	378.92	381.59	64, possibly 50.	71.73	32.51	9/26/2017	1900	349.08
MW44	SM72	69	48-68	378.92	381.59		71.17	31.15	5/18/2018	11:38	350.44
MW45	SM73	82	61-81	397.70	400.37	66	79.78	45.06	9/26/2017	1924	355.31
MW45	SM73	82	61-81	397.70	400.37		79.4	41.51	5/18/2018	10:31	358.86
MW46	SM74	57	36-56	399.62	402.50	41	60.04	31.81	9/26/2017	1934	370.69
MW46	SM74	57	36-56	399.62	402.50		59.71	30.62	5/18/2018	10:24	371.88
MW47	SM75	67	46-66	380.67	383.67	51	70.2	35.88	9/26/2017	1941	347.79
MW47	SM75	67	46-66	380.67	383.67		69.44	33.31	5/18/2018	10:21	350.36
MW48	SM76	44.5	23-43	348.87	351.51	28	46.76	19.23	9/26/2017	1850	332.28
MW48	SM76	44.5	23-43	348.87	351.51		46.6	18.57	5/18/2018	11:47	332.94
MW49	SM77	61.7	40-60	301.15	303.78	45	64.14	27.81	9/26/2017	1839	275.97

Table 3-5 Well Construction and Groundwater Depth Information

Monitoring Well ID	Soil Boring ID	Reported Well Total Depth As Constructed (ft. bgs)	Reported Screened Interval (ft. bgs)	Surveyed Ground Elevation (feet NAVD88)	Surveyed Top of Casing Elevation (feet NAVD88)	GW Observed During Drilling (feet bgs)	Measured Well Total Depth (feet below TOC)	Static Water Level			Ground Water Elevation (feet NAVD88)
								Depth (feet below TOC)	Date	Time	
MW49	SM77	61.7	40-60	301.15	303.78		63.75	26.40	5/18/2018	12:00	277.38
MW50	SM78	92	71-91	439.58	442.6501	estimated 75	96.71	50.47	9/26/2017	2037	392.18
MW50	SM78	92	71-91	439.58	442.6501		95.36	42.81	5/18/2018	11:28	399.84
MW51	SM79	77	56-76	422.38	425.05	61	80.4	38.69	9/26/2017	2056	386.36
MW51	SM79	77	56-76	422.38	425.05		79.5	35.89	5/18/2018	10:58	389.16
MW52	SM80	56	35-55	383.91	386.83	40	59.72	29.67	9/26/2017	1949	357.16
MW52	SM80	56	35-55	383.91	386.83		59.33	27.36	5/18/2018	10:05	359.47
MW53	SM81	62	41-61	460.82	463.7785	46	65.6	29.90	9/26/2017	2118	433.88
MW53	SM81	62	41-61	460.82	463.7785		65	27.12	5/18/2018	10:36	436.66
MW54	SM82	50	29-49	423.01	425.7406	34	53.5	29.80	9/26/2017		395.94
MW54	SM82	50	29-49	423.01	425.7406		53.1	27.26	5/18/2018	10:48	398.48
MW55	SM83	27	10-20	341.26	344.09	13	23.92	12.27	9/26/2017		331.82
MW55	SM83	27	10-20	341.26	344.09		22.57	10.85	5/18/2018	9:50	333.24
MW56	SM84	76	55-75	408.55	411.329	60	79.72	32.70	9/26/2017	1913	378.63
MW56	SM84	76	55-75	408.55	411.329		78.65	30.61	5/18/2018	10:42	380.72
MW57	SM85	60	37.5-57.5	461.00	463.8141	44	61.45	30.65	9/26/2017	2107	433.16
MW57	SM85	60	37.5-57.5	461.00	463.8141		60.9	28.81	5/18/2018	11:41	435.00
MW58	SM86	58	36.62-56.62	469.84	472.7246	42	60.63	28.84	9/26/2017	2128	443.88
MW58	SM86	58	36.62-56.62	469.84	472.7246		60.39	27.90	5/18/2018	10:15	444.82
MW59	SM87	161.5	140-160	432.63	435.4785	152	167.67	137.77	9/26/2017		297.71
MW59	SM87	161.5	140-160	432.63	435.4785		164.18	135.56	5/18/2018	10:54	299.92

Notes

Elevation datum: NAVD88 calculated using GEOID09.

Top of casing (TOC) refers to the top of PVC inner casing.

Key

NR = Not Recorded

TD = Total depth

TOC = Top of Casing

bgs = Below ground surface

Table 3-6 2017 Well Development - Final Pumping Period

Monitoring Well ID	Depth to Top of Screen (ft bgs)	Depth to Bottom of Screen (ft bgs)	Date Well Development Started	Date Well Development Completed	Start Time of Final Pumping Period	Stop Time of Final Pumping Period	Duration of Final Pumping Period (hours:minutes)	DTW at Start of Final Pumping Period (feet below top of casing)	DTW at End of Final Pumping Period (feet below top of casing)	Drawdown for Final Pumping Period (feet)	Water Column Height at Start of Final Pumping Period (feet above bottom of screen)	Water Column Height at End of Final Pumping Period (feet above bottom of screen)	Volume Pumped During Final Pumping Period (gallons)	Average Pumping Rate During Final Pumping Period (gallons/minute)	Date and Time Transducer Installed
MW44	48	68	9/13/17	9/13/17	11:15	13:47	2:32	32.69	37.65	4.96	37.98	33.02	145	0.95	9/13/2017 13:51
MW45	61	81	9/7/17	9/8/17	10:30	12:48	2:18	50.71	54.35	3.64	32.96	29.32	135	0.98	N/A
MW46	36	56	9/8/017	9/8/017	14:30	17:30	3:00	29.98	34.90	4.92	28.90	23.98	215	1.19	9/8/17 17:35
MW47	46	66	9/8/17	9/10/17	9:15	12:08	2:53	35.51	37.79	2.28	33.49	31.21	120	0.69	9/10/17 12:10
MW48	23	43	9/7/17	9/7/17	11:18	14:20	3:02	18.19	21.11	2.92	27.45	24.53	240	1.32	9/7/17 14:22
MW49	40	60	9/5/17	9/6/17	13:00	18:17	5:17	31.75	37.30	5.55	30.88	25.33	385	1.21	9/6/17 18:20
MW50	71	91	9/15/17	9/16/17	10:00	14:07	4:07	53.96	71.43	17.47	40.11	22.64	155	0.63	9/16/2017 14:15
MW51	56	76	9/16/17	9/16/17	15:25	18:55	3:30	38.89	45.59	6.70	39.78	33.08	185	0.88	9/16/2017 19:10
MW52	35	55	9/10/17	9/10/17	13:25	16:53	3:28	31.19	41.48	10.29	26.73	16.44	210	1.01	9/10/17 16:59
MW53	41	61	9/12/17	9/12/17	10:46	14:46	4:00	40.10	48.17	8.07	23.86	15.79	175	0.73	9/12/2017 14:49
MW54	29	49	9/11/17	9/11/17	11:28	13:31	2:03	31.85	36.75	4.90	19.88	14.98	150	1.22	9/11/17 13:36
MW55	10	20	9/16/17	9/16/17	19:35	22:02	2:27	12.10	15.41	3.31	10.73	7.42	100	0.68	9/16/2017 22:11
MW56	55	75	9/13/17	9/13/17	16:00	19:44	3:44	32.60	48.71	16.11	45.18	29.07	210	0.94	9/13/2017 19:49
MW57	37.5	57.5	9/12/17	9/12/17	16:16	19:25	3:09	32.50	41.57	9.07	27.81	18.74	215	1.14	9/12/2017 19:58
MW58	36.6	56.6	9/11/17	9/11/17	15:45	18:22	2:37	29.73	45.77	16.04	29.75	13.71	155	0.99	9/11/2017 18:33
MW59	140	160	9/14/17	9/15/17	12:30	13:20	0:50	142.00	143.49	1.49	20.85	19.36	18	0.36	N/A

Key

bgs = below ground surface

DTW = Depth to Water

ft = feet

Table 3-7 Groundwater Sample Results, Fall 2016

Analyte	Station ID		Units	MW01	MW08	MW09	MW10	MW16	MW17	MW19	MW22	MW26	MW27	MW28	MW06	MW32	MW33	MW40	MW42	MW43	MW29	MW31
	Geographic Area			Post-1955 MPA								Pre-1955 MPA		Pre-1955 MPA		Red Devil Creek Downstream Alluvial Area and Delta		Surface Mined Area				Upland Area West of Surface Mined Area
	Sample ID			0916MW01GW	1016MW08GW	1016MW09GW	1016MW10GW	1016MW16GW	0916MW17GW	1016MW19GW	1016MW22GW	1016MW26GW	1016MW27GW	1016MW28GW	1016MW06GW	0916MW32GW	1016MW33GW	1016MW40GW	1016MW42GW	1016MW43GW	1016MW29GW	1016MW31GW
	Method																					
Total Inorganic Elements																						
Aluminum	Metals (ICP)	SW846 6010B	µg/L	190 U	190 U	650 J	190 U	190 U	310 J	190 U	190 U	190 U	190 U	190 U	190 U	210 J	190 U	860 J	540 J	190 U	190 U	190 U
Antimony	Metals (ICP/MS)	SW846 6020A	µg/L	2.3	0.59 U	13	0.4 U	1100	75	0.56 U	400	66	8.1	5.3	7.6	3.8	450	8.5	260	4.2	1.2 U	0.4 U
Arsenic	Metals (ICP/MS)	SW846 6020A	µg/L	17	1.4 U	14	100	1500	21	3.0 J	190	1200	22	100	46	2.6 J	26	120	360	240	56	1.4 U
Barium	Metals (ICP/MS)	SW846 6020A	µg/L	76	36	500	88	86	42	46	41	450	43	46	95	17	37	110	110	120	220	4.3 J
Beryllium	Metals (ICP/MS)	SW846 6020A	µg/L	0.51 U	0.51 U	0.51 U	0.51 U	0.51 U	0.51 U	0.51 U	0.51 U	0.51 U	0.51 U	0.51 U	0.51 U	0.51 U	0.51 U	0.51 U	0.51 U	0.51 U	0.51 U	0.51 U
Cadmium	Metals (ICP/MS)	SW846 6020A	µg/L	0.14 U	0.14 U	0.15 J	0.14 U	0.42 J	0.14 U	0.14 U	0.14 U	0.14 U	0.14 U	0.14 U	0.14 U	0.14 U	0.14 U	0.14 U	0.14 U	0.14 U	0.14 U	0.14 U
Calcium	Metals (ICP)	SW846 6010B	µg/L	13000	8900	29000	20000	44000	21000	18000	12000	61000	79000	34000	30000	9400	19000	45000	34000	21000	48000	7300
Chromium	Metals (ICP/MS)	SW846 6020A	µg/L	0.73 J	0.74 J	1.5 J	0.71 U	0.71 U	0.83 J	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	1.0 J	0.71 U	1.0 J	1.6 J	0.71 U	0.71 U	1.1 J
Cobalt	Metals (ICP/MS)	SW846 6020A	µg/L	0.16 U	0.16 U	3.4	0.16 U	12	0.35 J	0.16 U	0.16 U	22	1.6 J	2.7	1.6 J	0.16 U	0.16 U	17	4.3	25	0.31 J	0.16 U
Copper	Metals (ICP/MS)	SW846 6020A	µg/L	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.1 J	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U
Iron	Metals (ICP)	SW846 6010B	µg/L	5900	180 U	1800	880	22000	310 J	180 U	180 U	43000	180 U	970	3100	310 J	180 U	750	850	2700	2200	180 U
Lead	Metals (ICP/MS)	SW846 6020A	µg/L	0.46 J	0.17 U	1.3 J	0.17 U	0.17 U	0.43 J	0.17 U	0.17 U	0.17 U	0.17 J	0.19 J	0.17 U	0.2 J	0.28 J	0.49 J	0.7 J	0.17 U	0.31 J	0.17 U
Magnesium	Metals (ICP)	SW846 6010B	µg/L	9500	6900	21000	30000	85000	16000	13000	10000	37000	50000	26000	29000	7800	13000	46000	26000	15000	48000	5200
Manganese	Metals (ICP/MS)	SW846 6020A	µg/L	17	1.8 U	5200	120	10000	14	16	1.8 U	6300	1100	810	690	6.2 J	21	290	630	3100	380	4.5 J
Mercury	Mercury (CVAA)	SW846 7470A	µg/L	0.041 U	0.041 U	0.68	0.041 U	0.51	1.7 J	0.041 U	0.041 U	1.1	0.1 J	0.058 J	0.041 U	0.091 J	0.041 U	0.047 J	0.81	0.041 U	0.059 J	0.041 U
Nickel	Metals (ICP/MS)	SW846 6020A	µg/L	2.0 U	2.0 U	5.1 J	2.0 U	7.1 J	2.0 U	2.0 U	2.0 U	27	31	6.3 J	3 J	3.5 J	2.0 U	69	21	72	2.0 U	2.0 U
Potassium	Metals (ICP)	SW846 6010B	µg/L	440 J	420 J	710 J	900 J	2700 J	420 J	260 J	430 J	3200 J	1300 J	740 J	750 J	390 J	680 J	1000 J	940 J	490 J	870 J	230 J
Selenium	Metals (ICP/MS)	SW846 6020A	µg/L	2.2 J	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 J	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U
Silver	Metals (ICP/MS)	SW846 6020A	µg/L	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.18 J	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.18 J	0.15 U	0.15 U	0.15 U
Sodium	Metals (ICP)	SW846 6010B	µg/L	1800 J	1200 J	2500	3000	6600	2600	2300	2000	4800	15000	9300	3900	1300 J	4600	2400	2800	3700	2200	1400 J
Thallium	Metals (ICP/MS)	SW846 6020A	µg/L	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U
Vanadium	Metals (ICP/MS)	SW846 6020A	µg/L	5.8 J	5.1 J	5.5 J	4.9 U	4.9 U	4.9 U	4.9 U	4.9 U	4.9 U	4.9 U	4.9 U	4.9 U	5.9 J	4.9 U	5.1 J	4.9 U	4.9 U	4.9 U	4.9 U
Zinc	Metals (ICP/MS)	SW846 6020A	µg/L	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U	16 J	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U
Total Low Level Mercury																						
Mercury	Total Mercury by EPA 1631	EPA 1631	ng/L	93.2	5.54	561	21.6	1390	2590	3.32	200	2020	336	384	24.8	221	171	286	2520	6.77 U	125	15.3
Dissolved Low Level Mercury																						
Mercury	Dissolved Mercury by EPA 1631	EPA 1631	ng/L	6.47	4.26	37.8	1.26	1230	1100	0.61 UJ	79.8	432	203	59.9	0.30 J	20.0	6.16	1.53	205	0.56	18.7	1.02
Semivolatile Organic Compounds																						
Butyl benzyl phthalate	Semivolatile Organic Compounds (GC/MS)	SW846 8270D	µg/L							0.19 U	0.19 U											
Di-n-butyl phthalate	Semivolatile Organic Compounds (GC/MS)	SW846 8270D	µg/L							0.12 U	0.12 U											
2-Fluorobiphenyl	Semivolatile Organic Compounds (GC/MS)	SW846 8270D	µg/L							81	80											
Benzene, Toluene, Ethylbenzene, and Xylenes																						
Benzene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L							0.025 U	0.025 U											
Toluene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L							0.64 J	0.55 J+											
Ethylbenzene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L							0.03 U	0.03 U											
m-Xylene & p-Xylene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L							0.05 U	0.05 U											
o-Xylene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L							0.06 U	0.06 U											
Gasoline Range Organics and Diesel Range Organics																						
Gasoline Range Organics (GRO)-C6-C10	Alaska - Gasoline Range Organics (GC)	ADEC AK102	mg/L							0.015 U	0.015 U											
DRO (nC10-<nC25)	Alaska - Diesel Range Organics & Residual Range Organics (GC)	ADEC AK102 & 103	mg/L							0.045 J	0.038 U											

Table 3-7 Groundwater Sample Results, Fall 2016

Analyte	Station ID		Units	MW01	MW08	MW09	MW10	MW16	MW17	MW19	MW22	MW26	MW27	MW28	MW06	MW32	MW33	MW40	MW42	MW43	MW29	MW31
	Geographic Area			Post-1955 MPA								Pre-1955 MPA		Pre-1955 MPA		Red Devil Creek Downstream Alluvial Area and Delta		Surface Mined Area				Upland Area West of Surface Mined Area
	Sample ID			0916MW01GW	1016MW08GW	1016MW09GW	1016MW10GW	1016MW16GW	0916MW17GW	1016MW19GW	1016MW22GW	1016MW26GW	1016MW27GW	1016MW28GW	1016MW06GW	0916MW32GW	1016MW33GW	1016MW40GW	1016MW42GW	1016MW43GW	1016MW29GW	1016MW31GW
	Method																					
General Chemistry																						
Total Suspended Solids	Solids, Total Suspended (TSS)	SM 2540D	mg/L																			
Chloride	Anions, Ion Chromatography	MCAWW 300.0	mg/L	**1.1**	**1.1**	**1.2**	**1.2**	**1.2**	**1.1**	**0.93**	**1**	**0.58 J**	**1.6**	**1.3**	**1.4**	**0.85 J**	**1.5**	**1.4**	**1.2**	**1.3**	**0.66 J**	**0.92**
Fluoride	Anions, Ion Chromatography	MCAWW 300.1	mg/L	0.03 U	**0.07 J**	**0.07 J**	**0.09 J**	**0.16 J**	**0.06 J**	**0.07 J**	**0.06 J**	**0.08 J**	**0.08 J**	**0.12 J**	**0.07 J**	0.03 U	0.03 U	**0.19 J**	**0.12 J**	**0.16 J**	**0.06 J**	0.03 U
Sulfate	Anions, Ion Chromatography	MCAWW 300.2	mg/L	**13**	**3.9**	**14**	**9**	**350**	**7.2**	**5.8**	**5.6**	**93**	**190**	**39**	**34**	**11**	**18**	**17**	**18**	**9.8**	**34**	1.5 U
Carbonate Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Bicarbonate Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L	**59**	**48**	**150**	**160**	**120**	**100**	**82**	**66**	**260**	**230**	**180**	**170**	**44**	**82**	**270**	**210**	**120**	**270**	**38**
Hydroxide Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Alkalinity	Alkalinity	SM 2320B	mg/L	**59**	**48**	**150**	**160**	**120**	**100**	**82**	**66**	**260**	**230**	**180**	**170**	**44**	**82**	**270**	**210**	**120**	**270**	**38**
Nitrate Nitrite as N	Nitrogen, Nitrate-Nitrite	MCAWW 353.2	mg/L	**0.23 J-**	**0.49**	0.026 U	0.024 U	0.025 U	0.074 U	**0.12 J**	0.074 U	0.061 U	**0.71**	0.022 U	0.032 U	**0.91**	**0.63**	0.025 U	0.023 U	0.03 U	0.025 U	0.063 U
Field Water Quality Parameters																						
Temperature	Field Measurement		Deg C	7.2	5.34	7.28	7.46	6.59	5.46	3.93	5.04	4.5	6.56	9.28	5.9	5.97	6.4	4.9	5.07	5.37	4.34	3.55
pH	Field Measurement		pH Units	6.20	5.74	6.48	8.50	7.10	6.51	8.05	7.47	7.28	7.05	6.69	7.54	5.64	6.19	8.76	8.65	7.47	6.46	6.58
Conductivity	Field Measurement		mS/cm	0.153	0.114	0.422	0.356	0.981	0.218	0.215	0.175	0.791	0.873	0.431	0.418	0.137	0.229	0.581	0.409	0.271	0.568	0.087
Turbidity	Field Measurement		NTU	6.8	0	0	0	9.9	0	0	0	8.4	0	1.1	0	0	6.5	8.2	34.8	0	9.1	0.5
Dissolved Oxygen	Field Measurement		mg/L	1.63	4.42	0	0	0	4.97	2.27	3.25	0	0	0	0	3.37	3.83	5.92	10.36	0	0	5.95
Oxidation-Reduction Potential	Field Measurement		mV	171	281	-10	-49	17	214	138	185	-29	191	-11	37	314	145	17	164	32	-1	227

Key
µg/L = Micrograms per liter
ADEC = Alaska Department of Environmental Conservation
Bold = Detected
Deg C = Degrees Celsius.
EPA = United States Environmental Protection Agency
GC/MS = Gas Chromatography/Mass Spectrometry
ICP/ MS = Inductively coupled plasma/mass spectrometry
J = The analyte was detected. The associated result is estimated.
mg/L = milligrams per liter
mS/cm = Millisiemens per centimeter
mV = Millivolts
ng/L = Nanograms per liter
NTU = Nephelometric turbidity units
U = The analyte was analyzed for but not detected. The value provided is the method detection limit.
UJ+ = The analyte was analyzed for but not detected. The associated reporting limit is estimated with a high bias.
UJ- = The analyte was analyzed for but not detected. The associated reporting limit is estimated with a low bias.
UJ = The analyte was analyzed for but not detected. The associated reporting limit is estimated.

Table 3-8 Groundwater Sample Results, Spring 2017

Analyte	Station ID		Units	MW01	MW08	MW09	MW10	MW16	MW17	MW19	MW22	MW06	MW26	MW27	MW28	MW32	MW33	MW29	MW40	MW42	MW43	MW31
	Geographic Area			Post-1955 MPA								Pre-1955 MPA				Red Devil Creek Downstream Alluvial Area and Delta		Surface Mined Area				Upland Area West of Surface Mined Area
	Sample ID			0517MW01GW	0517MW08GW	0517MW09GW	0517MW10GW	0517MW16GW	0517MW17GW	0517MW19GW	0517MW22GW	0517MW06GW	0517MW26GW	0517MW27GW	0517MW28GW	0617MW32GW	0517MW33GW	0517MW29GW	0517MW40GW	0517MW42GW	0517MW43GW	0617MW31GW
	Method																					
Total Inorganic Elements																						
Aluminum	Metals (ICP)	SW846 6010B	µg/L	110 U	120 J	540 J	110 U	110 U	110 U	110 U	110 U	110 U	110 U	110 U	590 J	200 J	110 U	110 U	110 U	110 U	110 U	2500
Antimony	Metals (ICP/MS)	SW846 6020A	µg/L	2.1	1.1 J	8.8	1.7 J	420	12	0.55 U	1000	6.4	170	7.6	9.5	5.2	380	0.9 J	5.1	240	7	1.3 J
Arsenic	Metals (ICP/MS)	SW846 6020A	µg/L	14	1.4 U	6.9	110	1400	6.7	1.4 U	51	39	1400	32	110	1.4 U	24	69	160	310	230	2.8 J
Barium	Metals (ICP/MS)	SW846 6020A	µg/L	79	43	470	92	55	44	140	49	85	480	43	54	19	30	240	120	100	100	57
Beryllium	Metals (ICP/MS)	SW846 6020A	µg/L	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U
Cadmium	Metals (ICP/MS)	SW846 6020A	µg/L	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Calcium	Metals (ICP)	SW846 6010B	µg/L	14000	12000	30000	22000	32000	28000	18000	18000	30000	64000	91000	44000	12000	21000	58000	46000	35000	24000	5200
Chromium	Metals (ICP/MS)	SW846 6020A	µg/L	0.98 J	0.71 U	1.5 J	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	1.7 J	0.81 J	0.71 U	1 J	0.71 U	0.71 U	0.71 U	5.7
Cobalt	Metals (ICP/MS)	SW846 6020A	µg/L	0.16 U	0.16 U	2.3	0.16 U	11	0.16 U	2.2	0.16 U	1.3 J	27	2.8	3.1	0.16 U	0.16 U	0.64 J	24	3.2	31	1.6 J
Copper	Metals (ICP/MS)	SW846 6020A	µg/L	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	4.9 J
Iron	Metals (ICP)	SW846 6010B	µg/L	5900	120 U	990	1400	18000	120 U	120 U	120 U	2500	48000	120 J	1900	240 J	120 U	3100	610	1100	2800	3000
Lead	Metals (ICP/MS)	SW846 6020A	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1.6 J
Magnesium	Metals (ICP)	SW846 6010B	µg/L	9900	8600	20000	30000	53000	18000	16000	15000	30000	34000	53000	31000	9300	14000	54000	44000	25000	16000	4000
Manganese	Metals (ICP/MS)	SW846 6020A	µg/L	31	2.3 U	4900	150	7700	11	470	2.3 U	610	6300	2500	870	9.9 J	3.7 J	450	280	840	2600	74
Mercury	Mercury (CVAA)	SW846 7470A	µg/L	0.15 U	0.15 U	0.15 U	0.15 U	0.82	0.15 U	0.15 U	0.4	0.15 U	1.1	0.26 J	1	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.17 J
Nickel	Metals (ICP/MS)	SW846 6020A	µg/L	1.6 J	0.99 J	4.4 J	0.54 U	3.5 J	0.54 U	5.4 J	1 J	2.4 J	25	56	7.7 J	6.2 J	1.1 J	2.3 J	90	14 J	94	5.4 J
Potassium	Metals (ICP)	SW846 6010B	µg/L	410 U	410 J	660 J	1000 J	1900 J	410 U	410 U	410 U	730 J	3100 J	1200 J	1100 J	410 U	610 J	1000 J	760 J	500 J	490 J	1200 J
Selenium	Metals (ICP/MS)	SW846 6020A	µg/L	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Silver	Metals (ICP/MS)	SW846 6020A	µg/L	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U
Sodium	Metals (ICP)	SW846 6010B	µg/L	1500 J	1300 J	2700	3300	5000	3200	1900 J	2100	3800	4700	17000	12000	1200 J	4300	2400	1700 J	1500 J	3700	840 J
Thallium	Metals (ICP/MS)	SW846 6020A	µg/L	0.33 U	0.41 J	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
Vanadium	Metals (ICP/MS)	SW846 6020A	µg/L	2.7 J	2.3 U	3.1 J	2.3 U	2.3 U	2.3 U	2.3 U	2.3 U	2.3 U	2.3 U	2.3 U	2.6 J	2.3 U	2.3 U	2.3 U	2.3 U	2.3 U	2.3 U	9.6 J
Zinc	Metals (ICP/MS)	SW846 6020A	µg/L	9.5 U	9.5 U	11 J	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U	22 J	9.5 U	11 J	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U	11 J
Total Low Level Mercury																						
Mercury	Total Mercury by EPA 1631	EPA 1631	ng/L	6.06	8.92	172	133	881	161	12.3	423	23.7	1160	410	1080	108	48.1	26.1	4.3	28.4	5.77	150
Dissolved Low Level Mercury																						
Mercury	Dissolved Mercury by EPA 1631	EPA 1631	ng/L	2.34	3.49	167	0.28 J	896	7.32	5.14	262	7.53	158	407	43.3	20	3.12	0.71	0.1 U	0.78	0.3 J	1.58
Semivolatile Organic Compounds																						
Butyl benzyl phthalate	Semivolatile Organic Compounds (GC/MS)	SW846 8270D	µg/L							0.73 U	0.74 U											
Di-n-butyl phthalate	Semivolatile Organic Compounds (GC/MS)	SW846 8270D	µg/L							0.54 U	0.55 U											
2-Fluorobiphenyl	Semivolatile Organic Compounds (GC/MS)	SW846 8270D	µg/L							82	79											
Benzene, Toluene, Ethylbenzene, and Xylenes																						
Benzene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L							0.025 U	0.025 U											
Toluene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L							0.025 U	0.025 U											
Ethylbenzene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L							0.03 U	0.03 U											
m-Xylene & p-Xylene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L							0.05 U	0.05 U											
o-Xylene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L							0.06 U	0.06 U											
Gasoline Range Organics and Diesel Range Organics																						
Gasoline Range Organics (GRO)-C6-C10	Alaska - Gasoline Range Organics (GC)	ADEC AK102	mg/L							0.33 U	0.33 U		0.33 U									
DRO (nC10-<nC25)	Alaska - Diesel Range Organics & Residual Range Organics (GC)	ADEC AK102 & 103	mg/L							0.072 U	0.036 J											

Table 3-8 Groundwater Sample Results, Spring 2017

Analyte	Station ID		Units	MW01	MW08	MW09	MW10	MW16	MW17	MW19	MW22	MW06	MW26	MW27	MW28	MW32	MW33	MW29	MW40	MW42	MW43	MW31
	Geographic Area			Post-1955 MPA								Pre-1955 MPA				Red Devil Creek Downstream Alluvial Area and Delta		Surface Mined Area				Upland Area West of Surface Mined Area
	Sample ID / Method			0517MW01GW	0517MW08GW	0517MW09GW	0517MW10GW	0517MW16GW	0517MW17GW	0517MW19GW	0517MW22GW	0517MW06GW	0517MW26GW	0517MW27GW	0517MW28GW	0617MW32GW	0517MW33GW	0517MW29GW	0517MW40GW	0517MW42GW	0517MW43GW	0617MW31GW
General Chemistry																						
Total Suspended Solids	Solids, Total Suspended (TSS)	SM 2540D	mg/L	**17 J**	2 UJ	16	3.8 UJ	2 UJ	2 UJ	2 U	2 U	6.8 UJ	**50**	2 U	**15**	2 U	2 UJ	6.6 UJ	2 UJ	2 U	2 UJ	**91**
Chloride	Anions, Ion Chromatography	MCAWW 300.0	mg/L	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	0.91 U	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U
Fluoride	Anions, Ion Chromatography	MCAWW 300.1	mg/L	0.2 U	0.2 U	0.2 U	0.23 U	0.31 U	0.23 U	0.23 U	0.2 U	0.2 U	0.2 U	0.28 U	0.23 U	0.2 U	0.2 U	0.2 U	0.26 U	0.2 U	0.3 U	0.2 U
Sulfate	Anions, Ion Chromatography	MCAWW 300.2	mg/L	**14**	**4.2**	**6.4**	**9.4**	**200**	**8.7**	**4.5**	**12**	**23**	**100**	**190**	**45**	**11**	**17**	**31**	**10**	**14**	**11**	**18**
Carbonate Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Bicarbonate Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L	57	54	140	**160**	**100**	**120**	**100**	**84**	**170**	**190**	**240**	**200**	**41**	**88**	**290**	**260**	**170**	**110**	**11**
Hydroxide Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Alkalinity	Alkalinity	SM 2320B	mg/L	**57**	**54**	**140**	**160**	**100**	**120**	**100**	**84**	**170**	**190**	**240**	**200**	**41**	**88**	**290**	**260**	**170**	**110**	**11**
Nitrate Nitrite as N	Nitrogen, Nitrate-Nitrite	MCAWW 353.2	mg/L	**0.23 J**	**0.71 J**	**0.15 J**	0.15 UJ	**0.067 J**	**0.091 J**	**0.1 J**	**0.27 J**	0.15 UJ	0.066 J	0.15 J	**0.15 J**	**3.6 J**	**0.2 J**	0.15 UJ	0.15 UJ	0.15 UJ	0.15 UJ	0.077 J
Field Water Quality Parameters																						
Temperature	Field Measurement		Deg C	10.95	2.75		6.37	4.98	4.45	4.62	3.98	7.29	12.06	5.14	6.64	20.4	4.71	5.39	6.27	12.53	2.99	14.30
pH	Field Measurement		pH Units	6.27	6.48		7.30	6.61	7.26	7.24	6.19	6.94	6.57	6.28	6.95	5.61	6.60	6.71	7.08	6.77	6.29	6.45
Conductivity	Field Measurement		mS/cm	0.152	0.138		0.341	0.700	0.293	0.241	0.209	0.408	0.662	0.866	0.468	0.156	0.228	0.635	0.51	0.358	0.264	0.063
Turbidity	Field Measurement		NTU	6.8	0.0		0.0	0.0	0.0	5.4	4.7	0.0	3.6	0.0	2.2	0.0	0.0	7.8	1.0	0.0	0.0	92.8
Dissolved Oxygen	Field Measurement		mg/L	3.36	7.73		2.82	0.00	4.39	2.73	5.32	0.00	0.41	0.00	7.68	4.06	2.08	0.46	5.75	2.57	2.48	9.93
Oxidation-Reduction Potential	Field Measurement		mV	121	188		-99	-41	167	-5	200	-45	-73	158	-10	213	106	13	15	8	5	232

Key
µg/L = Micrograms per liter
ADEC = Alaska Department of Environmental Conservation
Bold = Detected
Deg C = Degrees Celsius.
EPA = United States Environmental Protection Agency
GC/MS = Gas Chromatography/Mass Spectrometry
ICP/ MS = Inductively coupled plasma/mass spectrometry
J = The analyte was detected. The associated result is estimated.
mg/L = milligrams per liter
mS/cm = Millisiemens per centimeter
mV = Millivolts
ng/L = Nanograms per liter
NTU = Nephelometric turbidity units
U = The analyte was analyzed for but not detected. The value provided is the method detection limit.
UJ+ = The analyte was analyzed for but not detected. The associated reporting limit is estimated with a high bias.
UJ- = The analyte was analyzed for but not detected. The associated reporting limit is estimated with a low bias.
UJ = The analyte was analyzed for but not detected. The associated reporting limit is estimated.

Table 3-9 Groundwater Sample Results, Fall 2017

Analyte	Station ID / Geographic Area / Sample ID / Method		Units	MW01	MW08	MW09	MW10	MW16	MW17	MW19	MW22	MW06	MW26	MW27	MW28	MW32	MW33	MW29	MW40	MW42	MW43	MW31
	Geographic Area			Post-1955 MPA								Pre-1955 MPA				Red Devil Creek Downstream Alluvial Area and Delta		Surface Mined Area				Upland Area West of Surface Mined Area
	Sample ID			0917MW01GW	0917MW08GW	0917MW09GW	0917MW10GW	0917MW16GW	0917MW17GW	0917MW19GW	0917MW22GW	0917MW06GW	0917MW26GW	0917MW27GW	0917MW28GW	0917MW32GW	0917MW33GW	0917MW29GW	0917MW40GW	0917MW42GW	0917MW43GW	0917MW31GW
	Method																					
Total Inorganic Elements																						
Aluminum	Metals (ICP)	SW846 6010B	µg/L	1500 U	1500 U	1500 U	1500 U	1500 U	1500 U	1500 U	1500 U	1500 U	1500 U	1500 U	**240 J**	1500 U	1500 U	1500 U	1500 U	140 J	130 J	1500 U
Antimony	Metals (ICP/MS)	SW846 6020A	µg/L	**1.7 J**	2 U	**12**	2 U	**2600**	**30**	2	**510**	**7.6**	**59**	**7.6**	**7.1**	**2.7**	**450**	0.62 J	**10**	**170**	**8**	2 U
Arsenic	Metals (ICP/MS)	SW846 6020A	µg/L	**1.8 J**	5 U	**11**	**100**	**2500**	**14**	5 U	**130**	**42**	**1100**	**32**	**75**	5 U	**24**	**60**	**220**	**480**	**270**	5 U
Barium	Metals (ICP/MS)	SW846 6020A	µg/L	**67**	**36**	**550**	**95**	**68**	**39**	**58**	**41**	**93**	**490**	**40**	**50**	**18**	**29**	**270**	**130**	**110**	**100**	**3.9 J**
Beryllium	Metals (ICP/MS)	SW846 6020A	µg/L	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	0.25 J	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Cadmium	Metals (ICP/MS)	SW846 6020A	µg/L	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Calcium	Metals (ICP)	SW846 6010B	µg/L	**14000**	**8700**	**27000**	**20000**	**40000**	**19000**	**18000**	**12000**	**31000**	**62000**	**81000**	**37000**	**12000**	**17000**	**57000**	**49000**	**35000**	**20000**	**6900**
Chromium	Metals (ICP/MS)	SW846 6020A	µg/L	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	**0.79 J**	2 U	2 U	2 U	2 U	2 U	2 U	**0.91 J**
Cobalt	Metals (ICP/MS)	SW846 6020A	µg/L	2 U	2 U	**1.6 J**	2 U	**6.5**	2 U	**0.18 J**	2 U	**1.7 J**	**30**	**1.8 J**	**2.6**	2 U	2 U	**1.1 J**	**30**	**5**	**26**	2 U
Copper	Metals (ICP/MS)	SW846 6020A	µg/L	10 U	10 U	10 U	10 U	5.5 J	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Iron	Metals (ICP)	SW846 6010B	µg/L	**760**	500 U	**950**	**930**	**14000**	500 U	500 U	500 U	**2700**	**44000**	**200 J**	**1100**	500 U	500 U	**2300**	**560**	**1200**	**2800**	500 U
Lead	Metals (ICP/MS)	SW846 6020A	µg/L	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U
Magnesium	Metals (ICP)	SW846 6010B	µg/L	**9700**	**6200**	**18000**	**28000**	**89000**	**13000**	**12000**	**9700**	**28000**	**34000**	**47000**	**27000**	**8700**	**11000**	**53000**	**48000**	**25000**	**13000**	**4200**
Manganese	Metals (ICP/MS)	SW846 6020A	µg/L	**16**	10 U	**4900**	**150**	**4700**	**8.9 J**	**45**	10 U	**630**	**6500**	**1200**	**830**	**3.3 J**	**7.7 J**	**440**	**320**	**630**	**2300**	**2.3 J**
Mercury	Mercury (CVAA)	SW846 7470A	µg/L	0.3 U	0.3 U	0.3 U	0.3 U	**0.16 J**	0.26 J	0.3 U	0.3 U	0.3 U	**0.37**	**0.24 J**	**0.48**	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.16 J	0.3 U
Nickel	Metals (ICP/MS)	SW846 6020A	µg/L	**1.1 J**	**0.93 J**	**2.8 J**	15 U	**7.8 J**	15 U	15 U	**1.4 J**	**2.7 J**	**27**	**29**	**6.3 J**	**4.9 J**	**0.93 J**	**3.1 J**	**120**	**19**	**77**	**0.56 J**
Potassium	Metals (ICP)	SW846 6010B	µg/L	480 J	3300 U	**480 J**	**940 J**	**3700**	3300 U	3300 U	3300 U	**800**	**3200**	**1200 J**	**950 J**	3300 U	**640 J**	**1000 J**	**890 J**	**720 J**	**600 J**	3300 U
Selenium	Metals (ICP/MS)	SW846 6020A	µg/L	40 U	40 U	40 U	40 U	40 U	40 U	40 U	40 U	40 U	40 U	40 U	40 U	40 U	40 U	40 U	40 U	40 U	40 U	40 U
Silver	Metals (ICP/MS)	SW846 6020A	µg/L	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Sodium	Metals (ICP)	SW846 6010B	µg/L	**2000**	**1300 J**	**2600**	**3400**	**8200**	**2600**	**2600**	**2300**	**4400**	**5500**	**16000**	**11000**	**1800**	**4600**	**2700**	**2200**	2100	**13000**	**1800**
Thallium	Metals (ICP/MS)	SW846 6020A	µg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Vanadium	Metals (ICP/MS)	SW846 6020A	µg/L	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Zinc	Metals (ICP/MS)	SW846 6020A	µg/L	35 U	35 U	35 U	35 U	35 U	35 U	35 U	35 U	35 U	35 U	**19 J**	35 U	35 U	35 U	35 U	35 U	35 U	35 U	35 U
Total Low Level Mercury																						
Mercury	Total Mercury by EPA 1631	EPA 1631	ng/L	**65.8**	7.31 U	**511**	16.3 U	**315**	**1340**	**4.4**	**214**	**45.7**	**534**	**367**	**542**	30.9 U	**40.1**	24.9 U	25.9 U	93.8 U	50 U	4.87 U
Dissolved Low Level Mercury																						
Mercury	Dissolved Mercury by EPA 1631	EPA 1631	ng/L	**2.38**	3.93 U	**56.9**	0.25 U	**171**	**234**	1.07 U	**103**	**0.72 J**	**242**	**207**	**80.7**	1.86 U	8.91 U	1.05 U	0.31 U	**16.9**	4.04 U	0.42 U
Semivolatile Organic Compounds																						
Butyl benzyl phthalate	Semivolatile Organic Compounds (GC/MS)	SW846 8270D	µg/L							9.5 U	9.6 U											
Di-n-butyl phthalate	Semivolatile Organic Compounds (GC/MS)	SW846 8270D	µg/L							2.8 U	2.9 U											
2-Fluorobiphenyl	Semivolatile Organic Compounds (GC/MS)	SW846 8270D	µg/L							**81**	**79**											
Benzene, Toluene, Ethylbenzene, and Xylenes																						
Benzene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L							0.2 U	0.2 U											
Toluene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L							0.2 U	0.2 U											
Ethylbenzene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L							0.2 U	0.2 U											
m-Xylene & p-Xylene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L							0.5 U	0.5 U											
o-Xylene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L							0.5 U	0.5 U											
Gasoline Range Organics and Diesel Range Organics																						
Gasoline Range Organics (GRO)-C6-C10	Alaska - Gasoline Range Organics (GC)	ADEC AK102	mg/L							1 U	1 U											
DRO (nC10-<nC25)	Alaska - Diesel Range Organics & Residual Range Organics (GC)	ADEC AK102 & 103	mg/L							0.1 U	0.1 U											

Table 3-9 Groundwater Sample Results, Fall 2017

Analyte	Station ID		Units	MW01	MW08	MW09	MW10	MW16	MW17	MW19	MW22	MW06	MW26	MW27	MW28	MW32	MW33	MW29	MW40	MW42	MW43	MW31
	Geographic Area			Post-1955 MPA								Pre-1955 MPA				Red Devil Creek Downstream Alluvial Area and Delta		Surface Mined Area				Upland Area West of Surface Mined Area
	Sample ID			0917MW01GW	0917MW08GW	0917MW09GW	0917MW10GW	0917MW16GW	0917MW17GW	0917MW19GW	0917MW22GW	0917MW06GW	0917MW26GW	0917MW27GW	0917MW28GW	0917MW32GW	0917MW33GW	0917MW29GW	0917MW40GW	0917MW42GW	0917MW43GW	0917MW31GW
	Method																					
General Chemistry																						
Total Suspended Solids	Solids, Total Suspended (TSS)	SM 2540D	mg/L	**2.6 J**	2 UJ	63	**2.2 J**	**6.2 J**	2 UJ	2 U	2 U	**11 J**	**70 J**	2 J	**8.4 J**	2 UJ	2 UJ	**4 J**	**5.8 J**	7	**7 J**	2 UJ
Chloride	Anions, Ion Chromatography	MCAWW 300.0	mg/L	**0.52 J+**	**0.55 J**	**0.53 J**	**0.51 J**	**0.54 J**	**0.47 J**	**0.35 J**	**0.39 J**	**0.54 J**	**0.39 J**	**1**	**0.92**	**0.68 J**	**0.86 J**	**0.78 J**	**0.85 J**	**0.75 J**	**0.89 J**	**0.81 J**
Fluoride	Anions, Ion Chromatography	MCAWW 300.1	mg/L	**0.13 J+**	**0.047 J**	0.2 U	**0.1 J**	**0.4**	**0.15 J**	**0.17 J**	**0.12 J**	**0.094 J**	**0.17 J**	0.2 U	**0.15 J**	0.2 U	0.2 U	**0.11 J**	**0.041 J**	0.2 U	**0.26**	0.2 U
Sulfate	Anions, Ion Chromatography	MCAWW 300.2	mg/L	**14**	**3.5**	**12**	**9.4**	**360**	**6.5**	**6.2**	**5.5**	**27**	**93**	**200**	**41**	**10**	**18**	**37**	**23**	**14**	**13**	1.2 U
Carbonate Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L	5 UJ	5 UJ	5 U	5 U	5 UJ	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 UJ
Bicarbonate Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L	70 J	44 J	140	**150**	**140 J**	**96 J**	**92**	**68**	**170**	**230**	**220**	**180**	**49 J**	**75**	**260**	**290**	**180**	**110**	**36 J**
Hydroxide Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L	5 UJ	5 UJ	5 U	5 U	5 UJ	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 UJ
Alkalinity	Alkalinity	SM 2320B	mg/L	**70 J**	**44 J**	**140**	**150**	**140 J**	**96 J**	**92**	**68**	**170**	**230**	**220**	**180**	**49 J**	**75**	**260**	**290**	**180**	**110**	**36 J**
Nitrate Nitrite as N	Nitrogen, Nitrate-Nitrite	MCAWW 353.2	mg/L	**0.33**	**0.4**	0.15 U	0.15 U	**0.12 J-**	**0.082 J**	**0.12 J**	**0.062 J**	0.15 U	0.15 U	0.091 J	0.15 U	**1.5**	**0.21**	0.15 U	0.15 U	0.15 U	0.15 U	0.068 J
Field Water Quality Parameters																						
Temperature	Field Measurement		Deg C	11.40	6.2	6.54	4.79	8.86	8.68	3.51	10.44	3.84	5.81	4.72	6.65	7.66	5.05	4.44	3.18	5.23	3.99	6.49
pH	Field Measurement		pH Units	6.66	7.08	7.22	7.7	6.73	7.8	7.35	7.25	7.46	6.98	6.44	7.51	6.24	7.2	6.93	7.24	7.35	6.77	6.63
Conductivity	Field Measurement		mS/cm	0.130	0.085	0.366	0.298	0.728	0.173	0.175	0.114	0.345	0.62	0.71	0.364	0.188	0.173	0.525	0.53	0.19	0.238	0.064
Turbidity	Field Measurement		NTU	7.4	2	0.6	1.5	22.7	1	3.9	0	5.9	4.4	21.4	18.3	3.3	0	8.7	9.2	8.9	28	0
Dissolved Oxygen	Field Measurement		mg/L	1.90	8.74	5.13	0	0.98	7.3	3.3	2	0.75	4.74	0.79	0	7.44	5.47	0	2.6	0	0.94	10.44
Oxidation-Reduction Potential	Field Measurement		mV	246	277	-1	-103	77	257	164	218	47	-71	103	51	296	236	-11	4	60	7	212

Key
μg/L = Micrograms per liter
ADEC = Alaska Department of Environmental Conservation
Bold = Detected
Deg C = Degrees Celsius.
EPA = United States Environmental Protection Agency
GC/MS = Gas Chromatography/Mass Spectrometry
ICP/ MS = Inductively coupled plasma/mass spectrometry
J = The analyte was detected. The associated result is estimated.
mg/L = milligrams per liter
mS/cm = Millisiemens per centimeter
mV = Millivolts
ng/L = Nanograms per liter
NTU = Nephelometric turbidity units
U = The analyte was analyzed for but not detected. The value provided is the method detection limit.
UJ+ = The analyte was analyzed for but not detected. The associated reporting limit is estimated with a high bias.
UJ- = The analyte was analyzed for but not detected. The associated reporting limit is estimated with a low bias.
UJ = The analyte was analyzed for but not detected. The associated reporting limit is estimated.

Table 3-9 Groundwater Sample Results, Fall 2017

Analyte	Station ID		Units	MW44	MW45	MW46	MW47	MW48	MW49	MW50	MW51	MW52	MW53	MW54	MW55	MW56	MW57	MW58	MW59
	Geographic Area			Vicinity of the Proposed Repository															
	Sample ID			0917MW44GW	0917MW45GW	0917MW46GW	0917MW47GW	0917MW48GW	0917MW49GW	0917MW50GW	0917MW51GW	0917MW52GW	0917MW53GW	0917MW54GW	0917MW55GW	0917MW56GW	0917MW57GW	0917MW58GW	0917MW59GW
	Method																		
Total Inorganic Elements																			
Aluminum	Metals (ICP)	SW846 6010B	µg/L	130 J	1500 U	560 J	690 J	1500 U	1100 J	690 J	160 J	1500 U	360 J	800 J	140 J	1500 U	950 J	1500 U	970 J
Antimony	Metals (ICP/MS)	SW846 6020A	µg/L	0.4 U	0.4 U	**0.21 J**	**0.11 J**	**0.75**	**0.48**	**7.3**	0.4 U	**0.34 J**	**0.29 J**	**2.2**	**6.5**	**0.13 J**	**0.15 J**	**0.56**	**8.9**
Arsenic	Metals (ICP/MS)	SW846 6020A	µg/L	**0.64 J**	**1.4**	**0.73 J**	**0.77 J**	**0.47 J**	**3.3**	**490**	**2.2**	**5.5**	**2.6**	**34**	**14**	**2.3**	**2.5**	**3**	**78**
Barium	Metals (ICP/MS)	SW846 6020A	µg/L	**22**	**1.4**	**7.9**	**19**	**29**	**17**	**270**	**35**	**30**	**140**	**110**	**63**	**64**	**12**	**78**	**330**
Beryllium	Metals (ICP/MS)	SW846 6020A	µg/L	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.063 J	0.4 U	0.4 U	0.4 U	0.043 J	0.043 J	0.4 U	0.4 U	0.4 U	0.067 J
Cadmium	Metals (ICP/MS)	SW846 6020A	µg/L	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Calcium	Metals (ICP)	SW846 6010B	µg/L	**36000 J**	**21000**	**11000 J**	**14000 J**	**14000 J**	**12000**	**64000 J**	**22000 J**	**13000 J**	**20000 J**	**39000 J**	**24000 J**	**45000 J**	**7000 J**	**29000**	**61000 J**
Chromium	Metals (ICP/MS)	SW846 6020A	µg/L	0.37 U	0.66 U	1	1.5	1.1	2.1	1.2	0.53 U	0.49 U	0.79 U	2.7	0.94	0.27 U	1.7	0.23 J	2.7
Cobalt	Metals (ICP/MS)	SW846 6020A	µg/L	**2.8**	**0.22 J**	**0.16 J**	**0.77**	**0.065 J**	**0.96**	**2.1**	**1.3**	**0.43**	**0.98**	**1.4**	**19**	**2.4**	**0.44**	**0.65**	**6.2**
Copper	Metals (ICP/MS)	SW846 6020A	µg/L	4 U	4.1 U	4.2 U	4.9 U	3.3 U	4.2 U	6.3 U	4.3 U	3.2 U	3.4 U	4.3 U	5.4	4.3 U	3.9 U	3.5 U	5.9 U
Iron	Metals (ICP)	SW846 6010B	µg/L	**870**	500 U	**220 J**	**970**	500 U	**610**	**1100**	**230 J**	500 U	**340**	**2300**	**28000**	500 U	**400 J**	**850**	**1300**
Lead	Metals (ICP/MS)	SW846 6020A	µg/L	0.8 U	0.8 U	0.8 U	0.35 J	0.8 U	0.23 J	0.26 J	0.8 U	0.8 U	0.8 U	0.23 J	0.8 U	0.8 U	0.8 U	0.8 U	0.28 J
Magnesium	Metals (ICP)	SW846 6010B	µg/L	**29000 J**	**17000**	**12000 J**	**16000 J**	**12000 J**	**7700 J**	**49000**	**17000 J**	**8100 J**	**10000 J**	**35000 J**	**15000 J**	**38000 J**	**3400 J**	**21000 J**	**55000 J**
Manganese	Metals (ICP/MS)	SW846 6020A	µg/L	**640**	**21**	**25**	**160**	**5**	**100**	**870**	**230**	**120**	**50**	**310**	**2300**	**780**	**22**	**100**	**520**
Mercury	Mercury (CVAA)	SW846 7470A	µg/L	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.25 J	0.57	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
Nickel	Metals (ICP/MS)	SW846 6020A	µg/L	**2.9 J**	**1.3 J**	**0.96 J**	**2.3 J**	**1 J**	**5.1**	**5.7**	**2.6 J**	**1.7 J**	**3.1**	**6.1**	**25**	**6.7**	**2.8 J**	**2.6 J**	**19**
Potassium	Metals (ICP)	SW846 6010B	µg/L	**570 J**	**470 J**	**560 J**	**630 J**	**490 J**	**740**	**880 J**	**490 J**	3300 U	3300 U	**970 J**	**870 J**	**660 J**	**440 J**	**520 J**	**1400 J**
Selenium	Metals (ICP/MS)	SW846 6020A	µg/L	8 U	8 U	8 U	8 U	8 U	8 U	8 U	8 U	8 U	8 U	8 U	8 U	8 U	8 U	8 U	8 U
Silver	Metals (ICP/MS)	SW846 6020A	µg/L	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Sodium	Metals (ICP)	SW846 6010B	µg/L	**3600**	**1300 J**	**1400 J**	**2100**	**2400**	**2000**	**2200**	**3300**	**2600**	**2000**	**2000**	**11000**	**1600 J**	**3400**	**1700 J**	**3100**
Thallium	Metals (ICP/MS)	SW846 6020A	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Vanadium	Metals (ICP/MS)	SW846 6020A	µg/L	1.1 U	1 U	2.4 U	3.2 U	0.79 U	4.1 U	2.3 U	1.4 U	1.3 U	1.9 U	3.1 U	1.9 J	0.82 U	2.7 U	0.95 U	3.4 U
Zinc	Metals (ICP/MS)	SW846 6020A	µg/L	2.3 J	7 U	7 U	3.5 J	3.3 J	5.5 J	3.8 J	2.7 J	2 J	2.9 J	2.6 J	11	6.6 J	4.8 J	2.1 J	3.6 J
Total Low Level Mercury																			
Mercury	Total Mercury by EPA 1631	EPA 1631	ng/L	6.02 U	**34.1**	**38.8**	**47.4**	**21.6**	**198**	**1130**	27.2 U	23.9 U	**186**	**381**	**321**	26.3 U	**119**	8.78 U	**312**
Dissolved Low Level Mercury																			
Mercury	Dissolved Mercury by EPA 1631	EPA 1631	ng/L	0.25 U	10.1 U	2.63 U	9.59 U	4.3 U	**12.3**	**14.8**	0.89 U	2.38 U	**18.4**	1.48 U	**39**	0.7 U	**13.6**	0.43 U	7.43 U
Semivolatile Organic Compounds																			
Butyl benzyl phthalate	Semivolatile Organic Compounds (GC/MS)	SW846 8270D	µg/L																
Di-n-butyl phthalate	Semivolatile Organic Compounds (GC/MS)	SW846 8270D	µg/L																
2-Fluorobiphenyl	Semivolatile Organic Compounds (GC/MS)	SW846 8270D	µg/L																
Benzene, Toluene, Ethylbenzene, and Xylenes																			
Benzene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L																
Toluene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L																
Ethylbenzene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L																
m-Xylene & p-Xylene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L																
o-Xylene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L																
Gasoline Range Organics and Diesel Range Organics																			
Gasoline Range Organics (GRO)-C6-C10	Alaska - Gasoline Range Organics (GC)	ADEC AK102	mg/L																
DRO (nC10-<nC25)	Alaska - Diesel Range Organics & Residual Range Organics (GC)	ADEC AK102 & 103	mg/L																

Table 3-9 Groundwater Sample Results, Fall 2017

Analyte	Station ID		Units	MW44	MW45	MW46	MW47	MW48	MW49	MW50	MW51	MW52	MW53	MW54	MW55	MW56	MW57	MW58	MW59
	Geographic Area			Vicinity of the Proposed Repository															
	Sample ID			0917MW44GW	0917MW45GW	0917MW46GW	0917MW47GW	0917MW48GW	0917MW49GW	0917MW50GW	0917MW51GW	0917MW52GW	0917MW53GW	0917MW54GW	0917MW55GW	0917MW56GW	0917MW57GW	0917MW58GW	0917MW59GW
	Method																		
General Chemistry																			
Total Suspended Solids	Solids, Total Suspended (TSS)	SM 2540D	mg/L																
Chloride	Anions, Ion Chromatography	MCAWW 300.0	mg/L	1.3 U	0.95 U	0.76 U	0.99 U	0.9 U	0.72 U	0.91 U	0.79 U	0.65 U	1.1 U	0.92 U	1.6 U	0.96 U	1.1 U	0.75 U	1.4 U
Fluoride	Anions, Ion Chromatography	MCAWW 300.1	mg/L	**0.22**	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	**0.24**	**0.09 J**	**0.03 J**	0.2 U	**0.13 J**	**0.16 J**
Sulfate	Anions, Ion Chromatography	MCAWW 300.2	mg/L	**7.7**	**4.9**	**2.4**	**4.4**	**4.5**	**3.1**	**7.7**	**3**	**2.2**	**3.4**	**10**	**17**	**3.8**	**4.3**	**10**	**5.7**
Carbonate Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Bicarbonate Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L	**200**	**120**	**75**	**99**	**75**	**52**	**360**	**120**	**70**	**95**	**230**	5 U	**270**	**32**	**140**	**370**
Hydroxide Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Alkalinity	Alkalinity	SM 2320B	mg/L	**200**	**120**	**75**	**99**	**75**	**52**	**360**	**120**	**70**	**95**	**230**	5 U	**270**	**32**	**140**	**370**
Nitrate Nitrite as N	Nitrogen, Nitrate-Nitrite	MCAWW 353.2	mg/L	0.15 U	0.22	0.37	0.28	1.8	2.9	0.15 U	0.062 J	0.78	0.12 J	0.15 U	0.35	0.32	0.14 J	0.15 U	0.15 U
Field Water Quality Parameters																			
Temperature	Field Measurement		Deg C	6.55	4.21	2.77	3.24	5.2	4.66	6.75	3.64	4.53	5.85	4.97	7.11	4.75	3.19	3.97	5.55
pH	Field Measurement		pH Units	7.66	7.2	6.69	7.07	7.05	5.87	7.18	6.58	6.77	7.12	7.45	6.97	6.94	6.11	7.39	7.42
Conductivity	Field Measurement		mS/cm	0.32	0.2	0.138	0.184	0.153	0.123	0.561	0.204	0.12	0.163	0.366	0.337	0.423	0.07	0.272	0.557
Turbidity	Field Measurement		NTU	6.7	3.5	11.6	47	2	43	35.1	22.3	6.9	4.9	45.4	24.8	0	6.2	0	47.4
Dissolved Oxygen	Field Measurement		mg/L	0	6	7.04	11.32	5.58	5.79	0	3.49	8.78	6.91	0.69	1.52	1.01	8.97	0.11	0
Oxidation-Reduction Potential	Field Measurement		mV	36	233	227	208	261	225	84	150	275	247	42	42	144	261	-56	43

Key
µg/L = Micrograms per liter
ADEC = Alaska Department of Environmental Conservation
Bold = Detected
Deg C = Degrees Celsius.
EPA = United States Environmental Protection Agency
GC/MS = Gas Chromatography/Mass Spectrometry
ICP/ MS = Inductively coupled plasma/mass spectrometry
J = The analyte was detected. The associated result is estimated.
mg/L = milligrams per liter
mS/cm = Millisiemens per centimeter
mV = Millivolts
ng/L = Nanograms per liter
NTU = Nephelometric turbidity units
U = The analyte was analyzed for but not detected. The value provided is the method detection limit.
UJ+ = The analyte was analyzed for but not detected. The associated reporting limit is estimated with a high bias.
UJ- = The analyte was analyzed for but not detected. The associated reporting limit is estimated with a low bias.
UJ = The analyte was analyzed for but not detected. The associated reporting limit is estimated.

Table 3-10 Groundwater Sample Results, Spring 2018

Analyte	Station ID / Geographic Area / Sample ID / Method		Units	MW01	MW08	MW09	MW10	MW16	MW17	MW19	MW22	MW06	MW26	MW27	MW28	MW32	MW33
	Geographic Area			Post-1955 MPA								Pre-1955 MPA				Red Devil Creek Downstream Alluvial Area and Delta	
	Sample ID			0518MW01GW	0518MW08GW	0518MW09GW	0518MW10GW	0518MW16GW	0518MW17GW	0518MW19GW	0518MW22GW	0518MW06GW	0518MW26GW	0518MW27GW	0518MW28GW	0518MW32GW	0518MW33GW
	Method																
Total Inorganic Elements																	
Aluminum	Metals (ICP)	SW846 6010B	µg/L	1000 U	**88 J**	1000 U	1000 U	**160 J**	1000 U	1000 U	1.7 U	1000 U	1000 U	1000 U	**150 J**	**70 J**	1000 U
Antimony	Metals (ICP/MS)	SW846 6020A	µg/L	**1.1**	**0.52**	**2.1**	**1.3**	**1700**	**21**	**0.62**	**1.1**	**6.6**	**40**	**9.5**	**8**	**2.3**	**370**
Arsenic	Metals (ICP/MS)	SW846 6020A	µg/L	**2**	1 U	**28**	**110**	**600**	**4.9**	**0.5 J**	**0.15**	**40**	**1100**	**22**	**84**	**0.61 J**	**24**
Barium	Metals (ICP/MS)	SW846 6020A	µg/L	**62**	**27**	**440**	**91**	**16**	**33**	**43**	**0.033**	**82**	**400**	**40**	**51**	**13**	**32**
Beryllium	Metals (ICP/MS)	SW846 6020A	µg/L	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.0004 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Cadmium	Metals (ICP/MS)	SW846 6020A	µg/L	0.4 U	0.4 U	**0.33 J**	0.4 U	0.4 U	0.4 U	0.4 U	0.0004 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Calcium	Metals (ICP)	SW846 6010B	µg/L	**14000**	**7600**	**27000**	**20000**	**11000**	**17000**	**18000**	**11**	**31000**	**47000**	**82000**	**37000**	**10000**	**20000**
Chromium	Metals (ICP/MS)	SW846 6020A	µg/L	**0.19 J**	**0.73**	**1.3**	0.4 U	**0.48**	**0.39 J**	**0.24 J**	**0.00037 J**	0.4 U	**0.36 J**	0.4 U	**1.2**	**0.54**	**0.77**
Cobalt	Metals (ICP/MS)	SW846 6020A	µg/L	0.4 U	0.4 U	**2.8**	**0.085 J**	**0.53**	0.4 U	**0.16 J**	**0.000042 J**	**1.8**	**22**	**1.3**	**2.8**	**0.056 J**	**0.039 J**
Copper	Metals (ICP/MS)	SW846 6020A	µg/L	2 U	**0.71 J**	**7.1**	2 U	**4.5**	2 U	2 U	**0.0015 J**	2 U	**1.1 J**	**2.4**	**1 J**	**0.64 J**	**0.74 J**
Iron	Metals (ICP)	SW846 6010B	µg/L	**670 J**	2000 U	**2800**	**1100 J**	**820 J**	2000 U	2000 U	3.3 U	**3900**	**39000**	2000 U	**1000 J**	2000 U	2000 U
Lead	Metals (ICP/MS)	SW846 6020A	µg/L	0.8 U	0.8 U	**1.3**	**0.4 J**	0.8 U	0.8 U	0.8 U	**0.00021 J**	0.8 U	0.8 U	**0.42 J**	**0.3 J**	0.8 U	0.8 U
Magnesium	Metals (ICP)	SW846 6010B	µg/L	**9500**	**5600**	**18000**	**29000**	**31000**	**12000**	**12000**	**9**	**28000**	**27000**	**49000**	**27000**	**8000**	**15000**
Manganese	Metals (ICP/MS)	SW846 6020A	µg/L	**4.7**	**1.1 J**	**5300**	**140**	**200**	**1.4 J**	**29**	**0.0014 J**	**630**	**5500**	**700**	**790**	**2.5**	**2.2**
Mercury	Mercury (CVAA)	SW846 7470A	µg/L	0.3 U	0.3 U	0.3 U	0.3 U	**0.25 J**	**0.41**	0.3 U	0.0003 U	0.3 U	**0.52**	0.3 U	**0.97**	0.3 U	0.3 U
Nickel	Metals (ICP/MS)	SW846 6020A	µg/L	**0.97 J**	**0.82 J**	**4.5**	**0.31 J**	**3.5**	**0.13 J**	**0.44 J**	**0.0013 J**	**2.8 J**	**19**	**17**	**6.8**	**3.4**	**1.3 J**
Potassium	Metals (ICP)	SW846 6010B	µg/L	**390 J**	**280 J**	**370 J**	**900**	**2100**	**350 J**	**290 J**	**0.5 J**	**720**	**2800**	**1400**	**860**	**290 J**	**630**
Selenium	Metals (ICP/MS)	SW846 6020A	µg/L	8 U	8 U	8 U	8 U	8 U	8 U	8 U	0.008 U	8 U	8 U	8 U	8 U	8 U	8 U
Silver	Metals (ICP/MS)	SW846 6020A	µg/L	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.0004 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Sodium	Metals (ICP)	SW846 6010B	µg/L	**1700**	**1100**	**2400**	**3200**	**3400**	**2200**	**2300**	**2.1**	**4200**	**3800**	**18000**	**10000**	**1400**	**4600**
Thallium	Metals (ICP/MS)	SW846 6020A	µg/L	1 U	1 U	**0.095 J**	1 U	1 U	1 U	1 U	0.001 U	1 U	1 U	1 U	1 U	1 U	1 U
Vanadium	Metals (ICP/MS)	SW846 6020A	µg/L	4 U	4 U	**0.52 J**	4 U	**1.5 J**	4 U	4 U	**0.00062 J**	4 U	4 U	4 U	**1.3 J**	4 U	4 U
Zinc	Metals (ICP/MS)	SW846 6020A	µg/L	**2.1 J**	7 U	**21**	7 U	**3 J**	7 U	**2.9 J**	**0.0019 J**	**2.7 J**	**4.6 J**	**12**	**3.2 J**	**4.8 J**	**2.7 J**
Total Low Level Mercury																	
Mercury	Total Mercury by EPA 1631	EPA 1631	ng/L	**9.97**	**7.97**	**31.9**	**141**	**410**	**411**	**1.97**	**279**	**2.65**	**889**	**313**	**1460**	**33.7**	**62.7**
Dissolved Low Level Mercury																	
Mercury	Dissolved Mercury by EPA 1631	EPA 1631	ng/L	**1.37**	**1.87**	**4.12**	0.66 U	**73**	**19.5**	0.63 U	**137**	**1.62**	**71.7**	**199**	**82.8**	**12.2**	**3.2**
Semivolatile Organic Compounds																	
Butyl benzyl phthalate	Semivolatile Organic Compounds (GC/MS)	SW846 8270D	µg/L							9.7 U	9.5 U						
Di-n-butyl phthalate	Semivolatile Organic Compounds (GC/MS)	SW846 8270D	µg/L							2.9 U	2.9 U						
2-Fluorobiphenyl	Semivolatile Organic Compounds (GC/MS)	SW846 8270D	µg/L							**66**	**64**						
Benzene, Toluene, Ethylbenzene, and Xylenes																	
Benzene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L							3 U	3 U						
Toluene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L							2 U	2 U						
Ethylbenzene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L							3 U	3 U						
m-Xylene & p-Xylene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L							3 U	3 U						
o-Xylene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L							2 U	2 U						

Table 3-10 Groundwater Sample Results, Spring 2018

Analyte	Station ID		Units	MW01	MW08	MW09	MW10	MW16	MW17	MW19	MW22	MW06	MW26	MW27	MW28	MW32	MW33
	Geographic Area			Post-1955 MPA								Pre-1955 MPA				Red Devil Creek Downstream Alluvial Area and Delta	
	Sample ID			0518MW01GW	0518MW08GW	0518MW09GW	0518MW10GW	0518MW16GW	0518MW17GW	0518MW19GW	0518MW22GW	0518MW06GW	0518MW26GW	0518MW27GW	0518MW28GW	0518MW32GW	0518MW33GW
	Method																
Gasoline Range Organics and Diesel Range Organics																	
Gasoline Range Organics (GRO)-C6-C10	Alaska - Gasoline Range Organics (GC)	ADEC AK102	mg/L							0.25 U	0.25 U						
DRO (nC10-<nC25)	Alaska - Diesel Range Organics & Residual Range Organics (GC)	ADEC AK102 & 103	mg/L							0.11 U	0.11 U						
General Chemistry																	
Total Suspended Solids	Solids, Total Suspended (TSS)	SM 2540D	mg/L	**3 J**	2 U	**3.8**	2 U	**2.6**	2 U	2 U	2 U	**7**	**67**	2 U	**18**	2 U	2 U
Chloride	Anions, Ion Chromatography	MCAWW 300.0	mg/L	**1**	**0.99**	**1.3**	**1.2**	**1.1**	**1.1**	**0.87 J**	**0.81 J+**	**1.4**	**1.3**	**1.8**	**1.3**	**0.87 J**	**1.5**
Fluoride	Anions, Ion Chromatography	MCAWW 300.1	mg/L	**0.13 J**	**0.14 J**	**0.12 J**	**0.12 J**	**0.13 J**	**0.077 J**	**0.17 J**	**0.052 J+**	**0.2**	**0.15 J**	**0.1 J**	**0.21**	**0.15 J**	0.2 U
Sulfate	Anions, Ion Chromatography	MCAWW 300.2	mg/L	**16**	**3.8**	**6**	**10**	**83**	**6.4**	**6.9**	**7.3 J+**	**33**	**73**	**220**	**43**	**8.4**	**22**
Carbonate Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Bicarbonate Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L	**61**	**35**	**160**	**160**	**75**	**88**	**86**	**55**	**160**	**140**	**210**	**170**	**38**	**81**
Hydroxide Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Alkalinity	Alkalinity	SM 2320B	mg/L	**61**	**35**	**160**	**160**	**75**	**88**	**86**	**55**	**160**	**140**	**210**	**170**	**38**	**81**
Nitrate Nitrite as N	Nitrogen, Nitrate-Nitrite	MCAWW 353.2	mg/L	**0.27 J-**	**0.49 J-**	0.15 U	0.15 U	**0.15 J-**	**0.1 J-**	**0.13 J-**	**0.11 J-**	0.15 U	0.15 U	**1.2 J-**	0.15 U	**2.2 J-**	**1.7 J-**
Field Water Quality Parameters																	
Temperature	Field Measurement		Deg C	5.42	4.16	9.66	6.95	8.57	7.47	5.53	5.62	5.34	9.38	8.46	7.84	4.29	6.82
pH	Field Measurement		pH Units	6.08	6.7	7.16	7.72	6.4	7.06	7.29	5.66	7.03	6.65	6.16	6.97	6.11	6.54
Conductivity	Field Measurement		mS/cm	0.120	0.63	0.248	0.231	0.245	0.143	0.138	0.92	0.287	0.475	0.643	0.332	0.920	0.173
Turbidity	Field Measurement		NTU	8.3	2.3	0	0.22	15.49	1.99	1.44	1.92	4.25	8.78	0.67	22.65	3.8	1.48
Dissolved Oxygen	Field Measurement		mg/L	1.97	11.2	1.3	0.79	2.13	9.83	6.02	3.95	1.15	0.8	1.91	1.06	9.40	9.85
Oxidation-Reduction Potential	Field Measurement		mV	222	81.8	2.5	-23	149.7	163.8	118.8	161.7	8	-39.6	212.3	19.7	155.5	312.3

Key
µg/L = Micrograms per liter
ADEC = Alaska Department of Environmental Conservation
Bold = Detected
Deg C = Degrees Celsius.
EPA = United States Environmental Protection Agency
GC/MS = Gas Chromatography/Mass Spectrometry
ICP/ MS = Inductively coupled plasma/mass spectrometry
mg/L = milligrams per liter
mS/cm = Millisiemens per centimeter
mV = Millivolts
ng/L = Nanograms per liter
NTU = Nephelometric turbidity units
U = The analyte was analyzed for but not detected. The value provided is the method detection limit.
J = The analyte was detected. The associated result is estimated.
+ = The associated reporting limit is estimated with a high bias.
- = The associated reporting limit is estimated with a low bias.

Table 3-10 Groundwater Sample Results, Spring 2018

Analyte	Station ID		Units	MW29	MW40	MW42	MW43	MW59	MW31
	Geographic Area			Surface Mined Area					Upland Area West of Surface Mined Area
	Sample ID			0518MW29GW	0518MW40GW	0518MW42GW	0518MW43GW	0917MW59GW	0518MW31GW
	Method								
Total Inorganic Elements									
Aluminum	Metals (ICP)	SW846 6010B	µg/L	1000 U	1000 U	**510 J**	1000 U	1000 U	**94 J**
Antimony	Metals (ICP/MS)	SW846 6020A	µg/L	**0.29 J**	**14**	**160**	**1.3**	0.4 U	0.4 U
Arsenic	Metals (ICP/MS)	SW846 6020A	µg/L	**34**	**260**	**560**	**300**	**67**	**0.27 J**
Barium	Metals (ICP/MS)	SW846 6020A	µg/L	**180**	**130**	**140**	**120**	**350**	**7.7 J**
Beryllium	Metals (ICP/MS)	SW846 6020A	µg/L	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Cadmium	Metals (ICP/MS)	SW846 6020A	µg/L	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Calcium	Metals (ICP)	SW846 6010B	µg/L	**44000**	**52000**	**37000**	**22000**	**61000**	**6700**
Chromium	Metals (ICP/MS)	SW846 6020A	µg/L	**0.21 J**	0.4 U	**1.7**	0.4 U	0.4 U	**1.5**
Cobalt	Metals (ICP/MS)	SW846 6020A	µg/L	**0.25 J**	**31**	**3.6**	**23**	**1.5**	**0.24 J**
Copper	Metals (ICP/MS)	SW846 6020A	µg/L	2 U	2 U	**2.3**	2 U	2 U	**1.4 J**
Iron	Metals (ICP)	SW846 6010B	µg/L	**1700 J**	**550 J**	**1800 J**	**3500**	**1100 J**	**74 J**
Lead	Metals (ICP/MS)	SW846 6020A	µg/L	**0.79 J**	0.8 U	**0.45 J**	**0.27 J**	**0.43 J**	**0.38 J**
Magnesium	Metals (ICP)	SW846 6010B	µg/L	**42000**	**54000**	**29000**	**16000**	**57000**	**4400**
Manganese	Metals (ICP/MS)	SW846 6020A	µg/L	**310**	**330**	**540**	**2700**	**480**	**16**
Mercury	Mercury (CVAA)	SW846 7470A	µg/L	0.3 U	0.3 U	**0.69**	0.3 U	0.3 U	0.3 U
Nickel	Metals (ICP/MS)	SW846 6020A	µg/L	**0.96 J**	**120**	**14**	**61**	**4.5**	**0.79 J**
Potassium	Metals (ICP)	SW846 6010B	µg/L	**840**	**900**	**920**	**580**	**790**	**210 J**
Selenium	Metals (ICP/MS)	SW846 6020A	µg/L	8 U	8 U	8 U	8 U	8 U	8 U
Silver	Metals (ICP/MS)	SW846 6020A	µg/L	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Sodium	Metals (ICP)	SW846 6010B	µg/L	**2100**	**2000**	**3600**	**3600**	**2000**	**1500**
Thallium	Metals (ICP/MS)	SW846 6020A	µg/L	1 U	1 U	1 U	1 U	1 U	1 U
Vanadium	Metals (ICP/MS)	SW846 6020A	µg/L	4 U	4 U	**2.5 J**	4 U	4 U	**0.79 J**
Zinc	Metals (ICP/MS)	SW846 6020A	µg/L	7 U	**4 J**	**7.3**	**3.2 J**	**4.2 J**	**3.3 J**
Total Low Level Mercury									
Mercury	Total Mercury by EPA 1631	EPA 1631	ng/L	8.4 U	5.08 U	**909**	15.8 U	10.5 U	15.7 U
Dissolved Low Level Mercury									
Mercury	Dissolved Mercury by EPA 1631	EPA 1631	ng/L	0.61 U	0.79 U	**4.87**	1.97 U	0.4 U	0.8 U
Semivolatile Organic Compounds									
Butyl benzyl phthalate	Semivolatile Organic Compounds (GC/MS)	SW846 8270D	µg/L						
Di-n-butyl phthalate	Semivolatile Organic Compounds (GC/MS)	SW846 8270D	µg/L						
2-Fluorobiphenyl	Semivolatile Organic Compounds (GC/MS)	SW846 8270D	µg/L						
Benzene, Toluene, Ethylbenzene, and Xylenes									
Benzene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L						
Toluene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L						
Ethylbenzene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L						
m-Xylene & p-Xylene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L						
o-Xylene	Volatile Organic Compounds (GC/MS)	SW846 8260C	µg/L						

Table 3-10 Groundwater Sample Results, Spring 2018

Analyte	Station ID		Units	MW29	MW40	MW42	MW43	MW59	MW31
	Geographic Area			Surface Mined Area					Upland Area West of Surface Mined Area
	Sample ID			0518MW29GW	0518MW40GW	0518MW42GW	0518MW43GW	0917MW59GW	0518MW31GW
	Method								
Gasoline Range Organics and Diesel Range Organics									
Gasoline Range Organics (GRO)-C6-C10	Alaska - Gasoline Range Organics (GC)	ADEC AK102	mg/L						
DRO (nC10-<nC25)	Alaska - Diesel Range Organics & Residual Range Organics (GC)	ADEC AK102 & 103	mg/L						
General Chemistry									
Total Suspended Solids	Solids, Total Suspended (TSS)	SM 2540D	mg/L	**4.4**	2 U	**22**	**5.6**		**10**
Chloride	Anions, Ion Chromatography	MCAWW 300.0	mg/L	**1.4**	**1.5**	**1.3**	**1.2**	**1.9**	**0.86 J**
Fluoride	Anions, Ion Chromatography	MCAWW 300.1	mg/L	**0.15 J**	**0.22**	**0.12 J+**	**0.26**	**0.23**	**0.061 J**
Sulfate	Anions, Ion Chromatography	MCAWW 300.2	mg/L	**35**	**22**	**17**	**10**	**6.1**	**1.5**
Carbonate Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L	5 U	5 U	5 U	5 U	5 U	5 U
Bicarbonate Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L	**240**	**300**	**190**	**110**	**340**	**34**
Hydroxide Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L	5 U	5 U	5 U	5 U	5 U	5 U
Alkalinity	Alkalinity	SM 2320B	mg/L	**240**	**300**	**190**	**110**	**340**	**34**
Nitrate Nitrite as N	Nitrogen, Nitrate-Nitrite	MCAWW 353.2	mg/L	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	**0.081 J-**
Field Water Quality Parameters									
Temperature	Field Measurement		Deg C	6.15	6.35	6.43	6.16	4.99	5.95
pH	Field Measurement		pH Units	5.23	4.79	6.87	4.63	5.28	6.57
Conductivity	Field Measurement		mS/cm	0.385	0.457	0.291	0.183	0.477	0.052
Turbidity	Field Measurement		NTU	2.57	0	23.54	2.78	2.37	9.79
Dissolved Oxygen	Field Measurement		mg/L	0.74	0.79	1.37	0.7	0.9	9.96
Oxidation-Reduction Potential	Field Measurement		mV	36.2	59.5	12.6	33.3	27.5	201.8

Key
µg/L = Micrograms per liter
ADEC = Alaska Department of Environmental Conservation
Bold = Detected
Deg C = Degrees Celsius.
EPA = United States Environmental Protection Agency
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mS/cm = Millisiemens per centimeter
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NTU = Nephelometric turbidity units
U = The analyte was analyzed for but not detected. The value provided is the method detection limit.
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+ = The associated reporting limit is estimated with a high bias.
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Table 3-11 Groundwater Antimony, Arsenic, and Mercury Concentrations, 2010-2018

Well ID	Sample Collection Date (Month-Year)	Units	Total Antimony	Dissolved Antimony	Total Arsenic	Dissolved Arsenic	Total Mercury (7470)	Total Low Level Mercury (1631E)	Dissolved Low Level Mercury (1631E)
MW01	September-10	µg/L	1.8	1.4	10.6	9		0.0167	0.0085
MW01	August-11	µg/L	1.9	1.64	3.3	3		0.0254	0.00619
MW01	May-12	µg/L	5.46	1.6	39	2 U		0.271	0.005
MW01	June-15	µg/L	11		130			0.532	0.00452
MW01	September-15	µg/L	1.8 U		6.8 U			0.0169 U	0.0538
MW01	September-16	µg/L	2.3		17			0.0932	0.00647
MW01	May-17	µg/L	2.1		14			0.00606	0.00234
MW01	September-17	µg/L	1.7 J		1.8 J			0.0658	0.00238
MW01	May-18	µg/L	1.1		2			0.00997	0.00137
MW03	September-10	µg/L	748	724	57.8	55.8		0.0165	0.00647
MW03	August-11	µg/L	917	861	58.9	56		0.0477	0.00909
MW04	September-10	µg/L	29.1	30	8.8	8.8		0.15	0.149
MW04	August-11	µg/L	27.9	27.2	8	7.8		0.155	0.0838
MW04	May-12	µg/L	51.3	32.1	12	7		0.211	0.057
MW04	September-12	µg/L	32.7		10			0.197 J	0.05 J
MW06	September-10	µg/L	5.4	5.2	28.1	26.3		0.00185	0.00015 U
MW06	August-11	µg/L	5.51	5.3	25.8	24.8		0.00725	0.0009 J
MW06	May-12	µg/L	9.87		53			0.016	0.007
MW06	September-12	µg/L	6.19		34			0.001 UJ	0.001 UJ
MW06	June-15	µg/L	6.1		34			0.004	0.00051
MW06	September-15	µg/L	7.3		48			0.0129	0.00019
MW06	October-16	µg/L	7.6		46			0.0248	0.0003 J
MW06	May-17	µg/L	6.4		39			0.0237	0.00753
MW06	September-17	µg/L	7.6		42			0.0457	0.00072 J
MW06	May-18	µg/L	6.6		40			0.00265	0.00162
MW07	September-10	µg/L		4.9		0.4		0	0.0121
MW08	August-11	µg/L	1.59	1.58	0.6	0.5 J		0.0215	0.001
MW08	May-12	µg/L	0.68		2 U			0.009	0.003
MW08	June-15	µg/L	0.24 J		0.27 J			0.00235	0.00148
MW08	September-15	µg/L	0.44		0.39 J			0.00849	0.00045 U
MW08	October-16	µg/L	0.59 U		1.4 U			0.00554	0.00426
MW08	May-17	µg/L	1.1 J		1.4 U			0.00892	0.00349
MW08	September-17	µg/L	2 U		5 U			0.00731 U	0.00393 U
MW08	May-18	µg/L	0.52		1 U			0.00797	0.00187
MW09	September-12	µg/L	11.7		13			0.172 J	0.011 J
MW09	September-15	µg/L	7.8		7.6 U			1.02	0.00546
MW09	October-16	µg/L	13		14			0.561	0.0378
MW09	May-17	µg/L	8.8		6.9			0.172	0.167
MW09	September-17	µg/L	12		11			0.511	0.0569
MW09	May-18	µg/L	2.1		28			0.0319	0.00412
MW10	August-11	µg/L	6.49	0.5	96.9	92.1		0.532	0.00062 J
MW10	May-12	µg/L	1.23		148			0.032	0.001 UJ
MW10	September-12	µg/L	2.65		110			0.001 UJ	0.001 UJ
MW10	June-15	µg/L	0.21 J		95			0.00795	0.00232
MW10	September-15	µg/L	0.56 U		100 J			0.0261 U	0.0323 J
MW10	October-16	µg/L	0.4 U		100			0.0216	0.00126
MW10	May-17	µg/L	1.7 J		110			0.133	0.00028 J
MW10	September-17	µg/L	2 U		100			0.0163 U	0.00025 U
MW10	May-18	µg/L	1.3		110			0.141	0.00066 U
MW12	August-11	µg/L	0.505 J	0.522 J	13.5	13.9		0.0541	0.00114
MW12	May-12	µg/L	0.56		21			0.008	0.001
MW13	May-12	µg/L	924	1.6	396	2 U		0.051	0.007
MW14	August-11	µg/L	79.5 J	53.8 J	6650	6660		0.759	0.141
MW14	May-12	µg/L	103	26	7030	6340			
MW14	September-12	µg/L	74.8		9710			0	0.254 J*
MW15	August-11	µg/L	13100	13100	5620	5590		2.91	2.2
MW15	May-12	µg/L	6440		4570				
MW15	September-12	µg/L	8430		5370				2 J*
MW16	August-11	µg/L	678	658	1020	1010		1.21	0.285
MW16	May-12	µg/L	2.2		2 U			1.33	0.077
MW16	September-12	µg/L	757		830				0.285 J*
MW16	September-15	µg/L	570		1700			1.54	0.702
MW16	October-16	µg/L	1100		1500			1.39	1.23
MW16	May-17	µg/L	420		1400			0.881	0.896
MW16	September-17	µg/L	2600		2500			0.315	0.171
MW16	May-18	µg/L	1700		600			0.41	0.073
MW17	August-11	µg/L	53.9	9.16	28.5	4.9		6.07	0.00949
MW17	May-12	µg/L	10.7		3			0.035	0.007

Table 3-11 Groundwater Antimony, Arsenic, and Mercury Concentrations, 2010-2018

Well ID	Sample Collection Date (Month-Year)	Units	Total Antimony	Dissolved Antimony	Total Arsenic	Dissolved Arsenic	Total Mercury (7470)	Total Low Level Mercury (1631E)	Dissolved Low Level Mercury (1631E)
MW17	September-12	µg/L	6.44		3			0.01 J	0.001 U
MW17	September-15	µg/L	9.3		5.3 U			0.361 J	0.00798
MW17	September-16	µg/L	75		21			2.59	1.1
MW17	May-17	µg/L	12		6.7			0.161	0.00732
MW17	September-17	µg/L	30		14			1.34	0.234
MW17	May-18	µg/L	21		4.9			0.411	0.0195
MW18	August-11	µg/L	1.04 J	0.654 J	1.3	0.7		0.0504	0.0027
MW19	August-11	µg/L	0.6 J	0.317 J	5.6	2.9		0.413	0.00054 J
MW19	May-12	µg/L	0.49		2 U			0.002	0.001
MW19	June-15	µg/L	0.21 J		0.55 J			0.00201 U	0.00091
MW19	September-15	µg/L	0.33 J		0.62 J			0.00329	0.00115 U
MW19	October-16	µg/L	0.56 U		3 J			0.00332	0.00061 UJ
MW19	May-17	µg/L	0.55 U		1.4 U			0.0123	0.00514
MW19	September-17	µg/L	2		5 U			0.0044	0.00107 U
MW19	May-18	µg/L	0.62		0.5 J			0.00197	0.00063 U
MW20	August-11	µg/L	566 J	616 J	161	173		1.61	0.277
MW20	May-12	µg/L	985		662				
MW20	September-12	µg/L	871		221				0.85 J*
MW21	August-11	µg/L	5860	5950	1760	1770		0.141	0.0802
MW21	May-12	µg/L	9100		2540				
MW21	September-12	µg/L	9490		2510				0.131 J*
MW22	August-11	µg/L	297	294	80.4	77.3		0.981	0.527
MW22	June-15	µg/L	340		59			0.246	0.108
MW22	September-15	µg/L	280		61			0.401	0.323
MW22	October-16	µg/L	400		190			0.2	0.0798
MW22	May-17	µg/L	1000		51			0.423	0.262
MW22	September-17	µg/L	510		130			0.214	0.103
MW22	May-18	µg/L	1100		150			0.279	0.137
MW23	August-11	µg/L	2.4 J	1.87 J	9.2	8		0.261	0.00239
MW24	August-11	µg/L	101 J	79.9 J	7.4	5.1		56.5	0.00611
MW24	May-12	µg/L	99		4			10.6	0.008
MW24	September-12	µg/L	108		5			0.035 J	0.001 UJ
MW25	August-11	µg/L	5.86 J	3.71 J	6.2	3.6		0.452	0.0447
MW25	May-12	µg/L	7.97		7				
MW25	September-12	µg/L	69.6		1160			0	0.138 J*
MW26	August-11	µg/L	26.2	32.3	78	68.3		0.237	0.0338
MW26	June-15	µg/L	37		1300			0.483	0.0324
MW26	September-15	µg/L	28		490			0.216	0.0347
MW26	October-16	µg/L	66		1200			2.02	0.432
MW26	May-17	µg/L	170		1400			1.16	0.158
MW26	September-17	µg/L	59		1100			0.534	0.242
MW26	May-18	µg/L	40		1100			0.889	0.0717
MW27	August-11	µg/L	9.16 J	8.48 J	22.6	22.1		0.411	0.277
MW27	May-12	µg/L	12.7		37				
MW27	September-12	µg/L	12.9		31			0.112 J	0.06 J
MW27	June-15	µg/L	11		29			0.663	0.131
MW27	September-15	µg/L	8.3		27			0.401	0.253
MW27	October-16	µg/L	8.1		22			0.336	0.203
MW27	May-17	µg/L	7.6		32			0.41	0.407
MW27	September-17	µg/L	7.6		32			0.367	0.207
MW27	May-18	µg/L	9.5		22			0.313	0.199
MW28	August-11	µg/L	19.3 J	9.18 J	32.8	8.4		4	0.0109
MW28	May-12	µg/L	13.2	3.3	73	39		1.34	0.038
MW28	September-12	µg/L	17.4		68				0.026 J
MW28	June-15	µg/L	7		75			1.89	0.0275
MW28	September-15	µg/L	16		130			1.32 J	0.294
MW28	October-16	µg/L	5.3		100			0.384	0.0599
MW28	May-17	µg/L	9.5		110			1.08	0.0433
MW28	September-17	µg/L	7.1		75			0.542	0.0807
MW28	May-18	µg/L	8		84			1.46	0.0828
MW29	August-11	µg/L	1.21	0.837	36.9	31.1		0.247	0.00071 J
MW29	May-12	µg/L	6.52	2.3	102	20		0.006	0.001
MW29	September-12	µg/L	1.34		44			0.008 J	0.007 J
MW29	June-15	µg/L	0.75 J		75			0.215	0.00145
MW29	September-15	µg/L	0.23 U		35			0.0117 U	0.00569
MW29	October-16	µg/L	1.2 U		56			0.125	0.0187
MW29	May-17	µg/L	0.9 J		69			0.0261	0.00071
MW29	September-17	µg/L	0.62 J		60			0.0249 U	0.00105 U

Table 3-11 Groundwater Antimony, Arsenic, and Mercury Concentrations, 2010-2018

Well ID	Sample Collection Date (Month-Year)	Units	Total Antimony	Dissolved Antimony	Total Arsenic	Dissolved Arsenic	Total Mercury (7470)	Total Low Level Mercury (1631E)	Dissolved Low Level Mercury (1631E)
MW29	May-18	µg/L	0.29 J		34			0.0084 U	0.00061 U
MW31	August-11	µg/L	0.098	0.027 J	0.1 U	0.1 U		0.0584	0.0007 J
MW31	June-15	µg/L	0.36 J		4.1		0.34	0.376	0.0145
MW31	September-15	µg/L	0.14 U		0.82 U		0.041 U	0.0355 U	0.00112 U
MW31	October-16	µg/L	0.4 U		1.4 U		0.041 U	0.0153	0.00102
MW31	May-17	µg/L	1.3 J		2.8 J		0.17 J	0.15	0.00158
MW31	September-17	µg/L	2 U		5 U		0.3 U	0.00487 U	0.00042 U
MW31	May-18	µg/L	0.4 U		0.27 J		0.3 U	0.0157 U	0.0008 U
MW32	August-11	µg/L	2.15 J	1.74 J	7.3	6.3		0.306	0.00365
MW32	May-12	µg/L	4.35		2			0.151	0.031
MW32	September-12	µg/L	6.35		3			0.19 J	0.028 UJ
MW32	June-15	µg/L	1.2		0.65 J			0.0479	0.0185
MW32	September-15	µg/L	1.9		1			0.114	0.0359
MW32	September-16	µg/L	3.8		2.6 J			0.221	0.02
MW32	May-17	µg/L	5.2		1.4 U			0.108	0.02
MW32	September-17	µg/L	2.7		5 U			0.0309 U	0.00186 U
MW32	May-18	µg/L	2.3		0.61 J			0.0337	0.0122
MW33	August-11	µg/L	427 J	420 J	15.2	14.4		0.115	0.00458
MW33	May-12	µg/L	391		31			0.21	0.007
MW33	September-12	µg/L	417		29			0.01 J	0.003 J
MW33	June-15	µg/L	430		23			0.745	0.00584
MW33	September-15	µg/L	460		25			0.00821	0.00302
MW33	October-16	µg/L	450		26			0.171	0.00616
MW33	May-17	µg/L	380		24			0.0481	0.00312
MW33	September-17	µg/L	450		24			0.0401	0.00891 U
MW33	May-18	µg/L	370		24			0.0627	0.0032
MW40	September-15	µg/L	6.2		85		0.041 U	0.0309 U	0.00187 U
MW40	October-16	µg/L	8.5		120		0.047 J	0.286	0.00153
MW40	May-17	µg/L	5.1		160		0.15 U	0.0043	0.0001 U
MW40	September-17	µg/L	10		220		0.3 U	0.0259 U	0.00031 U
MW40	May-18	µg/L	14		260		0.3 U	0.00508 U	0.00079 U
MW42	September-15	µg/L	250		610		0.041 U	0.259 U	0.0482
MW42	October-16	µg/L	260		360		0.81	2.52	0.205
MW42	May-17	µg/L	240		310		0.15 U	0.0284	0.00078
MW42	September-17	µg/L	170		480		0.3 U	0.0938 U	0.0169
MW42	May-18	µg/L	160		560		0.69	0.909	0.00487
MW43	September-15	µg/L	9.2		38		0.041 U	0.0743 U	0.00755 J
MW43	October-16	µg/L	4.2		240		0.041 U	0.00677 U	0.00056
MW43	May-17	µg/L	7		230		0.15 U	0.00577	0.0003 J
MW43	September-17	µg/L	8		270		0.16 J	0.05 U	0.00404 U
MW43	May-18	µg/L	1.3		300		0.3 U	0.0158 U	0.00197 U
MW44	September-17	µg/L	0.4 U		0.64 J		0.3 U	0.00602 U	0.00025 U
MW45	September-17	µg/L	0.4 U		1.4		0.3 U	0.0341	0.0101 U
MW46	September-17	µg/L	0.21 J		0.73 J		0.3 U	0.0388	0.00263 U
MW47	September-17	µg/L	0.11 J		0.77 J		0.3 U	0.0474	0.00959 U
MW48	September-17	µg/L	0.75		0.47 J		0.3 U	0.0216	0.0043 U
MW49	September-17	µg/L	0.48		3.3		0.25 J	0.198	0.0123
MW50	September-17	µg/L	7.3		490		0.57	1.13	0.0148
MW51	September-17	µg/L	0.4 U		2.2		0.3 U	0.0272 U	0.00089 U
MW52	September-17	µg/L	0.34 J		5.5		0.3 U	0.0239 U	0.00238 U
MW53	September-17	µg/L	0.29 J		2.6		0.3 U	0.186	0.0184
MW54	September-17	µg/L	2.2		34		0.3 U	0.381	0.00148 U
MW55	September-17	µg/L	6.5		14		0.3 U	0.321	0.039
MW56	September-17	µg/L	0.13 J		2.3		0.3 U	0.0263 U	0.0007 U
MW57	September-17	µg/L	0.15 J		2.5		0.3 U	0.119	0.0136
MW58	September-17	µg/L	0.56		3		0.3 U	0.00878 U	0.00043 U
MW59	September-17	µg/L	8.9		78		0.3 U	0.312	0.00743 U
MW59	May-18	µg/L	0.4 U		67		0.3 U	0.0105	0.0004 U

Key

J = The analyte was analyzed for but not detected. The value provided is the method detection limit.

µg/L = Micrograms per liter

U = The analyte was analyzed for but not detected. The value provided is the method detection limit.

UJ = The analyte was analyzed for but not detected. The associated reporting limit is estimated.

Table 3-12 Monitoring Well Selection for Groundwater Background Evaluation

Well ID	Year Installed
MW19	2011
MW28	2011
MW29	2011
MW31	2011
MW40	2015
MW42	2015
MW43	2015
MW59	2017

Table 3-13 Sampling Events by Well

Well ID	Sampling Event							
	Summer 2011	Spring 2012	Fall 2012	Spring 2015	Fall 2015	Fall 2016	Spring 2017	Fall 2017	Spring 2018
MW19	X	X		X	X	X	X	X	X
MW28	X	X	X	X	X	X	X	X	X
MW29	X	X	X	X	X	X	X	X	X
MW31	X			X	X	X	X	X	X
MW40					X	X	X	X	X
MW42					X	X	X	X	X
MW43					X	X	X	X	X
MW59								X	X

Table 3-14 Summary of Dixon's Outlier Test Results

Parameter	Value (µg/L)	Significant High Outlier?*		Significant Low Outlier?*	
		Original	Log Transformed	Original	Log Transformed
Total Antimony	216	Yes (p<0.01)	No (0.1>p>0.05)		
	11.42	No (p>0.1)	No (p>0.1)		
	0.461			No (p>0.1)	No (p>0.1)
Total Arsenic	464	No (0.1>p>0.05)	No (p>0.1)		
	215.6	No (p>0.1)	No (p>0.1)		
	1.547			No (p>0.1)	No (p>0.1)
Dissolved Mercury (1631)	0.074	Yes (p<0.01)	No (p>0.1)		
	0.05515	Yes (p<0.01)	No (p>0.1)		
	0.000613			No (p>0.1)	No (p>0.1)
Total Mercury (1631)	1.502	No (0.1>p>0.05)	No (p>0.1)		
	0.727	Yes (p>0.01)	No (p>0.1)		
	0.016			No (p>0.1)	No (p>0.1)
Total Mercury (7470)	0.3491	Yes (0.05>p>0.01)	No (0.1>p>0.05)		
	0.15	No (p>0.1)	No (p>0.1)		
	0.0852			No (p>0.1)	No (p>0.1)

* The table present the probabilities that the tested values are part of the main body of the data set.

A probability (p value) of less than 0.05 ($p < 0.05$) indicates a statistically significant outlier with 95% confidence.

The Dixon's Outlier Test only tests for one high and one low outlier at a time. If one statistically significant ($p < 0.05$) outlier was found by the Dixon's test, that value was removed from the data set and the reduced data set was retested to see if the next highest value was also a significant outlier. Based on the Q-Q plots, there did not appear to be more than two potential high outliers in any of the data sets; therefore, only two iterations of the Dixon's test were performed. No statistically significant Low Outliers were found in any of the original data sets.

Table 3-15 Statistical Summaries and Upper Limit Values for Groundwater

Parameter	Complete/ Trimmed	Number of Observations	Number of Detections	Mean (detects)	SD (detects)	Max (detects)	Apparent Distribution	95th Percentile	99th Percentile	95% UPL k=1	95% UTL	95% USL
Antimony, Total (µg/L)	Complete	8	8	31.14	74.8	216	Lognormal	118	450.1	241.5	2442	252.3
	Trimmed -1	7	7	4.729	4.264	11.42	Normal	11.74	14.65	13.59	19.22	**12.99**
Arsenic, Total (µg/L)	Complete	8	8	133.1	153.1	464	Normal	384.9	489.3	440.7	621	**444.1**
	Trimmed -1	7	7	85.77	80.56	215.6	Normal	218.3	273.2	253.1	359.6	241.9
Mercury, Dissolved (µg/L)	Complete	8	7	0.0177	0.0293	0.0737	Lognormal (KM)	0.066	--	0.123	0.923	0.128
	Trimmed -1	7	6	0.011	0.0217	0.0552	Lognormal (KM)	0.0259	--	0.0474	0.3	0.039
	Trimmed -2	6	5	0.00216	0.00133	0.00401	Normal	0.00391	0.00472	0.00454	0.00637	**0.00412**
Mercury, Total (1631) (µg/L)	Complete	8	8	0.336	0.525	1.502	Gamma (WH)	1.313	2.291	1.601	3.56	**1.628**
	Trimmed -1	7	7	0.169	0.25	0.727	Gamma (WH)	0.604	1.006	0.737	1.621	0.669
	Trimmed -2	6	6	0.076	0.0474	0.159	Normal	0.154	0.186	0.179	0.252	0.162
Mercury, Total (7470) (µg/L)	Complete	5	4	0.166	0.125	0.349	Normal (KM)	0.319	0.387	0.388	0.575	**0.322***
	Trimmed -1	4	3	0.105	0.0318	0.142	Normal (KM)	0.148	0.166	0.173	0.239	0.143*

Statistical methods used: KM = Kaplan-Meier - appropriate for data sets including non-detect observations; **WH** = Wilson Hilferty methodology used.

Values recommended for use as BTVs are indicated in bold font in the table above and described below:

Antimony, Total: Q-Q Plots and Outlier tests provide strong indications of the presence of a high outlier in the complete dataset. The Trimmed data set is recommended.

Arsenic, Total and Mercury, Total (1631): Q-Q plots suggest two possible high outliers in each of these data sets; however, the outlier tests found no significant high outliers (p>0.05) in the complete data sets. The complete data sets are recommended.

Mercury, Dissolved (1631): Q-Q Plots and Outlier tests indicate that the original data set includes 2 high statistical outliers; however, the outlier tests for the log transformed data found no statistically significant outliers suggesting that the original data sets may be gamma or lognormally distributed and that the apparent outliers may be values drawn from the upper tails of gamma or lognormal distributions. Nevertheless, the trimmed data set is recommended.

*** Mercury, Total (7470):** The Q-Q Plots and outlier tests indicate a single significant (0.05>p>0.01) high outlier in the complete data set. However the trimmed data set has only 3 detected values which is not enough to compute meaningful or reliable statistics and estimates. The upper limit estimates shown for the trimmed data set are for the 3 detected values only and should not be used. Therefore the complete data set is recommended despite the presence of a marginally significant high outlier.

Regarding the use of the USL statistic as the BTV, the ProUCL output files advise:

The use of USL tends to provide a balance between false positives and false negatives provided the data represents a background data set and when many onsite observations need to be compared with the BTV.

Table 3-16 2017 Well Development Hydraulic Testing Results

Well	Transmissivity (T) (ft^2/sec)		Hydraulic Conductivity (K) (ft/sec)		
	Estimated Transmissivity (T) Cooper-Jacob Method Development Drawdown (ft^2/sec)	Estimated Transmissivity (T) Theis Method - Unconfined Corrected Post-Development Residual Drawdown (ft^2/sec)	Assumed Saturated Thickness (set equal to 20 foot screened interval length)	Estimated Hydraulic Conductivity (K) Cooper-Jacob Method Development Drawdown (ft/sec)	Estimated Hydraulic Conductivity (K) Theis Method - Unconfined Corrected Post-Development Residual Drawdown (ft/sec)
MW49	1.E-04	Data not usable	20	5.E-06	Data not usable
MW50	4.E-05	3.E-05	20	2.E-06	1.E-06
MW51	9.E-05	2.E-04	20	4.E-06	9.E-06
MW52	Data not usable	2.E-04	20	Data not usable	8.E-06
MW53	5.E-05	1.E-05	20	2.E-06	7.E-07
MW54	1.E-04	4.E-05	20	5.E-06	2.E-06
MW56	2.E-04	3.E-05	20	1.E-05	1.E-06
MW58	Data not usable	4.E-05	20	Data not usable	2.E-06
Minimum	***1.E-05***			***7.E-07***	
Maximum	***2.E-04***			***1.E-05***	
Average	***8.E-05***			***4.E-06***	

Table 3-17 Estimated Bedrock Groundwater Discharge and Arsenic Flux to Kuskokwim River

Bedrock Groundwater Discharge to Kuskokwim River											Bedrock Groundwater Arsenic Flux to Kuskokwim River				
Hydraulic Conductivity (K) of Kuskokwim Group Bedrock				Bedrock Hydraulic Gradient (i) - Average Gradient between Kuskokwim River and Selected Wells Screened in Bedrock in Main Processing Area (MW17, MW21, MW22, and MW28)			Area of Groundwater Discharge (A) to Bed of Kuskokwim River		Estimated Bedrock Groundwater Discharge to Kuskokwim River Q = KiA (ft^3/second)		Assumed Arsenic Groundwater Concentration (µg/L)[2]	Estimated Bedrock Groundwater Arsenic Loading to Kuskokwim River (kg/day)		Estimated Increase in Kuskokwim River Arsenic Concentration (µg/L) After Mixing (Assuming Arsenic Groundwater Concentration = 1,000 µg/L and River Discharge = 30,000 ft^3/second	
Hydraulic Conductivity (K) (ft/second)			Notes	Hydraulic Gradient (i)		Notes	Area of Discharge (A) (ft^2)	Notes[1]	Discharge (Q) (ft^3/second)						
Site-Specific Estimated K Values	*Min:*	7.E-07	See Table 3-16	*Min:*	0.046	Low groundwater level (9/10/2015)	640,000	Based on assumed 800 foot wide area extending from bank of Kuskokwim River 800 feet to mid-channel.[1]	*Min:*	0.02	1,000	*Min:*	0.05	*Min:*	0.0006
	Max:	1.E-05	See Table 3-16	*Max:*	0.049	High groundwater level (5/26/2012)			*Max:*	0.3		*Max:*	0.8	*Max:*	0.01
	Ave.	4.E-06	See Table 3-16	*Ave.*	0.047	Average of high and low levels			*Ave.*	0.1		*Ave.*	0.3	*Ave.*	0.004
Literature K Values for Similar Geologic Units	*Min:*	1.0E-09	Source: Cilona et al. (2016); Canyon, Woolsey, and Happy Valley members	*Min:*	0.046	Low groundwater level (9/10/2015)			*Min:*	0.00003		*Min:*	0.00007	*Min:*	0.000001
	Max:	5.0E-04	Source: Cilona et al. (2016); Sage member with Bravo Line beds	*Max:*	0.049	High groundwater level (5/26/2012)			*Max:*	16		*Max:*	39	*Max:*	0.5

Key

A = Area of groundwater discharge

ft = Feet

ft^2 = Square feet

ft^3 = Cubic feet

i = Hydraulic gradient

K = Hydraulic conductivity

Q = Discharge

Notes

1 The selection of a cross sectional area measuring 800 ft by 800 ft in the Kuskokwim River bed through which the groundwater would flow from deep bedrock into the Kuskokwim River is based on the following assumptions:
1) Deeper groundwater flow such as that which would occur in the deep bedrock at the RDM would be expected to follow flow patterns typical of regional groundwater flow. Such flow would emerge from the subsurface into the river through an area of the river bed that extends from the bank out to approximately the middle of the river. At the RDM, the distance from the bank to the middle of the river is approximately 800 feet.
2) The assumed 800-foot width of the cross-sectional area is based on the approximate width of the zone of deeper mine workings underlying the Main Processing Area that could potentially cause deeper bedrock groundwater to be impacted.

2 No empirical data are available to directly measure the combined impacts of natural mineralization and mine workings on concentrations of arsenic or other RDM COCs in groundwater. For the purpose of the present flux estimation, the arsenic groundwater concentration is assumed to be 1,000 µg/L, similar to concentrations observed in seep samples collected at surface water sampling location RD05.

Literature Source

Cilona, Antonino, Atilla Aydin, Jermais Likerman, Beth Parker, and John Cherry. 2016. Structural and statistical characterization of joints and multi-scale faults in an alternating sandstone and shale turbidite sequence at the Santa Susana Field Laboratory: Implications for their effects on groundwater flow and contaminant transport. Journal of Structural Geology 85. 95-114.

Table 3-18 Estimated Alluvial Groundwater Discharge and Arsenic Flux to Kuskokwim River

Alluvial Groundwater Discharge to Kuskokwim River									Alluvial Groundwater Arsenic Flux to Kuskokwim River				
Hydraulic Conductivity (K) of Red Devil Creek Alluvial Valley Materials[1]		Hydraulic Gradient (i) in Middle of Red Devil Creek Valley in Vicinity of Monitoring Wells MW32 and MW33			Cross Sectional Area of Saturated Red Devil Creek Valley Alluvial Materials (A) in Vicinity of Monitoring Wells MW32 and MW33		Estimated Alluvial Groundwater Discharge to Kuskokwim River Q = KiA (ft^3/second)		Assumed Arsenic Groundwater Concentration (µg/L)[2]	Estimated Alluvial Groundwater Arsenic Loading to Kuskokwim River (kg/day)		Estimated Increase in Kuskokwim River Arsenic Concentration (µg/L) After Mixing (Assuming Arsenic Groundwater Concentration = 100 µg/L and River Discharge = 30,000 ft^3/second	
Hydraulic Conductivity (K) (ft/second)		Hydraulic Gradient (i)		Notes	Area of Discharge (A) (ft^2)	Notes							
Min:	3.E-03	*Min:*	0.043	Low groundwater level (9/10/2015)	72	Low groundwater level (9/10/2015)	*Min:*	0.01	100	*Min:*	0.002	*Min:*	0.00003
Max:	3.E+00	*Max:*	0.046	High groundwater level (5/26/2012)	99	High groundwater level (5/26/2012)	*Max:*	15.0		*Max:*	3.7	*Max:*	0.05

Key

A = Area of groundwater discharge

ft = Feet

ft^2 = Square feet

ft^3 = Cubic feet

i = Hydraulic gradient

K = Hydraulic conductivity

Q = Discharge

Notes

1 Based on available soil boring data, the alluvial soils consist of a mix of gravel with varying amounts of sand and fines. The estimated K values are conservatively based on literature values (Freeze and Cherry 1979) for gravel.

2 No empirical data are available to directly measure the concentrations of arsenic or other RDM COCs in groundwater discharging directly from Red Devil Creek alluvial materials into the Kuskokwim River. For the purpose of the present flux estimation, the arsenic groundwater concentration is assumed to be 100 µg/L.

RI Monitoring Well Location
RI Background Monitoring Well Location
Settling Pond
Monofill
Historical Structure

RED DEVIL MINE

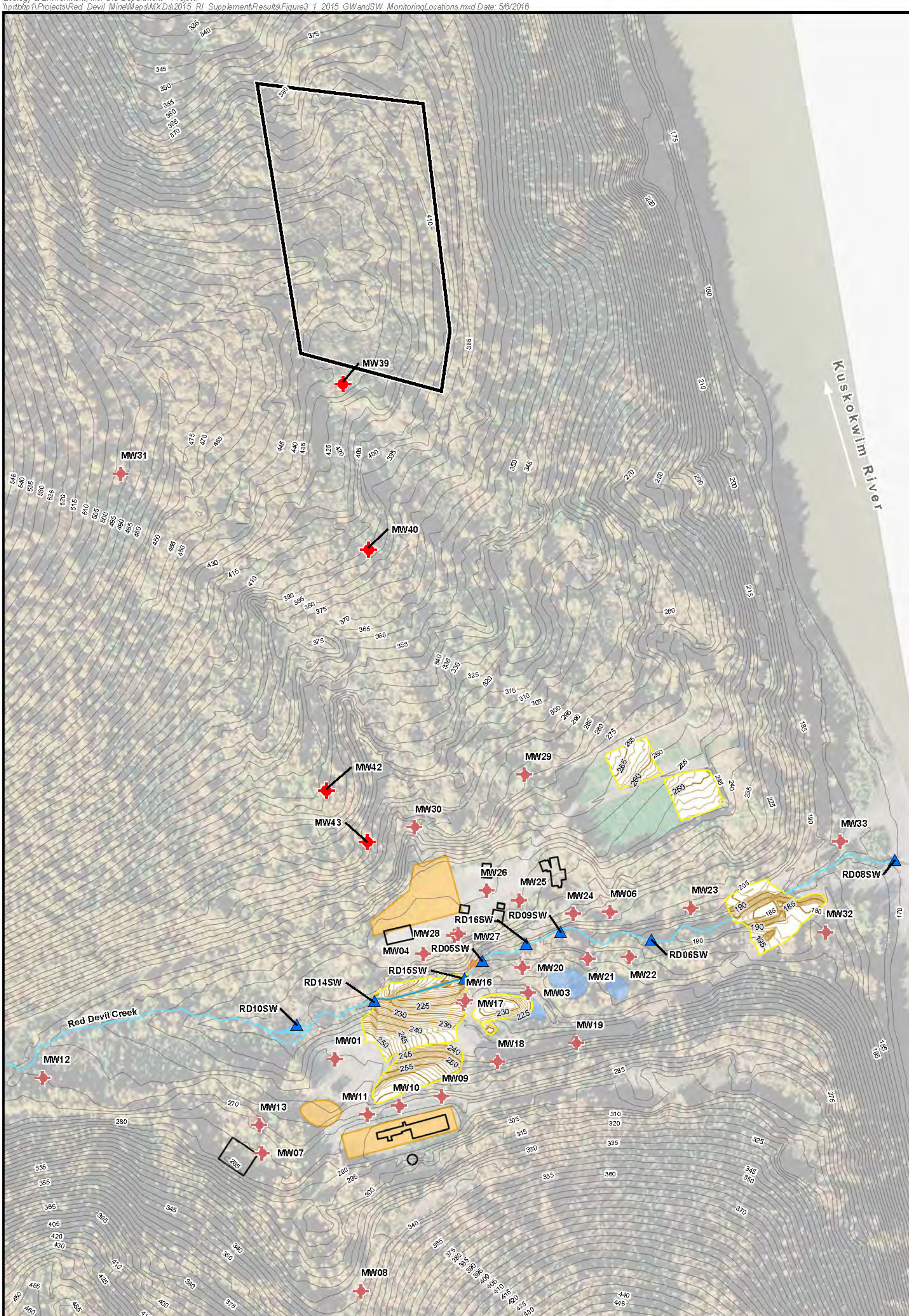
Red Devil, Alaska

Figure 3-1

RI Monitoring Well Locations

0 50 100 200 300 400 Feet
0 12.5 25 50 75 100 125 Meters
Scale 1:2,500

Image Source: Aero-Metric, Inc. 2010a



RI Supplement Monitoring Well
RI Monitoring Well
Surface Water

2014 5-foot Contour
2014 1-foot Contour
Area of 2014 NTCRA Re-grading
2010 5-foot Contour
Post-NTCRA Stream Alignment
Red Devil Creek

Settling Pond
Monofill
Historical Structure
Approximate Location of Proposed Repository Footprint
Seep Location

RED DEVIL MINE

Red Devil, Alaska

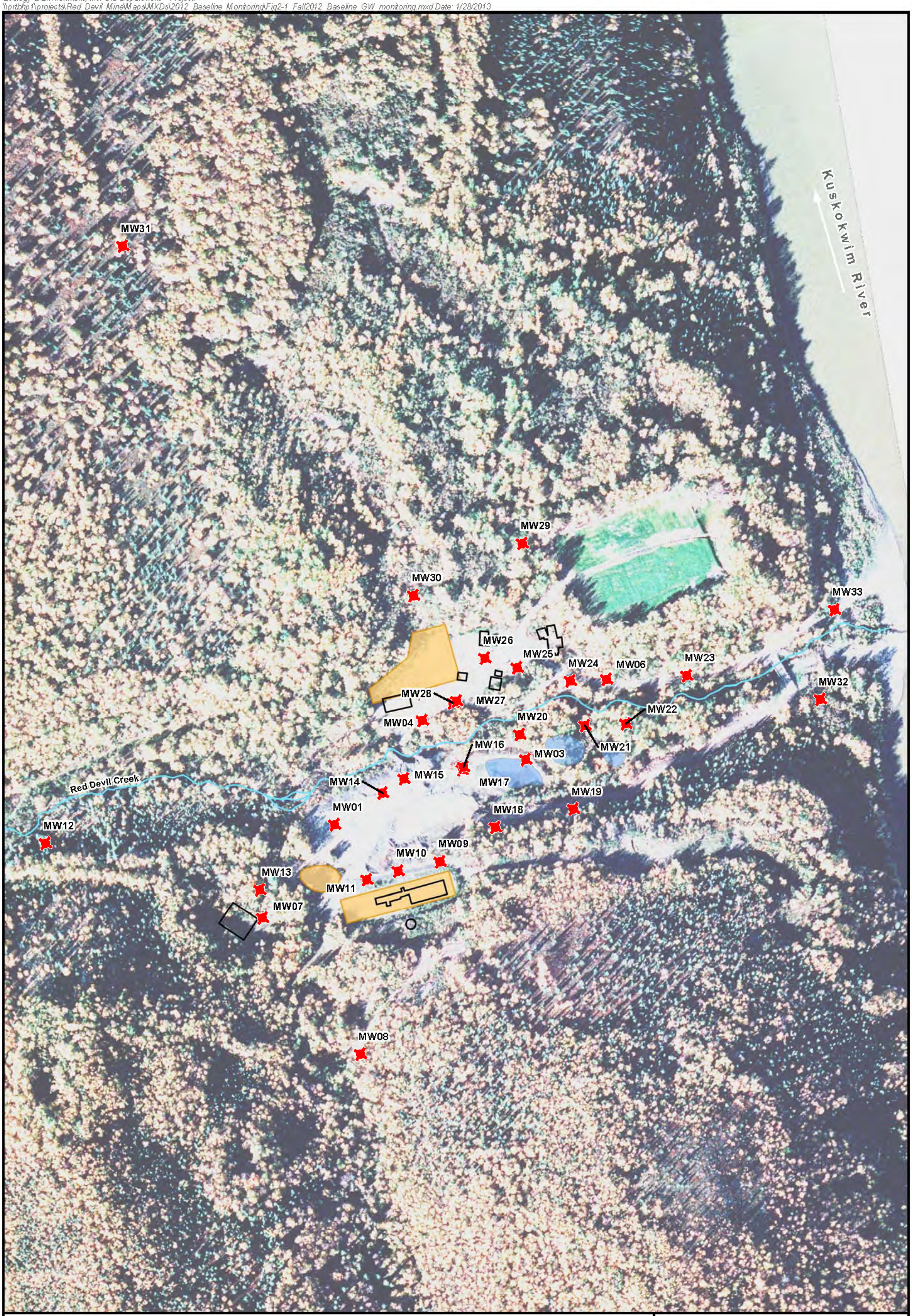
Figure 3-2
RI and RI Supplement Groundwater and Surface Water Monitoring Locations

0 50 100 200 300 400
Feet
0 12.5 25 50 75 100 125
Meters
Scale 1:2,500

Digital 2010 5-foot topographic contours based on the aerial orthophotograph taken on September 21, 2010 (AeroMetric 2012)

Digital 2014 5-foot and 1-foot topographic contours based on Marsh Creek (2014)

Ecology & Environment, Inc. GIS Department Project:
\\prtbhp1\projects\Red_Devil_Mine\Maps\MXDs\2012_Baseline_Monitoring\Fig2-1_Fall2012_Baseline_GW_monitoring.mxd Date: 1/28/2013



RI Monitoring Well
Settling Pond
Monofill
Historical Structure

RED DEVIL MINE

Red Devil, Alaska

Figure 3-3
Groundwater Baseline Monitoring Locations Spring and Fall 2012

0 50 100 200 300 400
Feet
0 12.5 25 50 75 100 125
Meters
Scale 1:2,500

Image Source: Aero-Metric, Inc. 2010a

Ecology & Environment, Inc. GIS Department Project:
\\prtbhp1\Projects\Red_Devil_Mine\Maps\MXDs\Work_Plan_2016\Figure2_2_GW_SW_BaselineMonitoring_Locations.mxd Date: 3/18/2016

Baseline Monitoring Locations

- RI Supplement Monitoring Well
- RI Monitoring Well
- Surface Water
- 2014 5-foot Contour
- 2014 1-foot Contour
- Area of 2014 NTCRA Re-grading
- 2010 5-foot Contour
- Post-NTCRA Stream Alignment
- Red Devil Creek
- Settling Pond
- Monofill
- Historical Structure
- Approximate Location of Proposed Repository Footprint
- Seep Location

Digital 2010 5-foot topographic contours based on the aerial orthophotograph taken on September 21, 2010 (AeroMetric 2012)

Digital 2014 5-foot and 1-foot topographic contours based on Marsh Creek (2014)

RED DEVIL MINE

Red Devil, Alaska

Figure 3-4
Groundwater and Surface Water Baseline Monitoring Locations
2016 - 2018

0 50 100 200 300 400 Feet

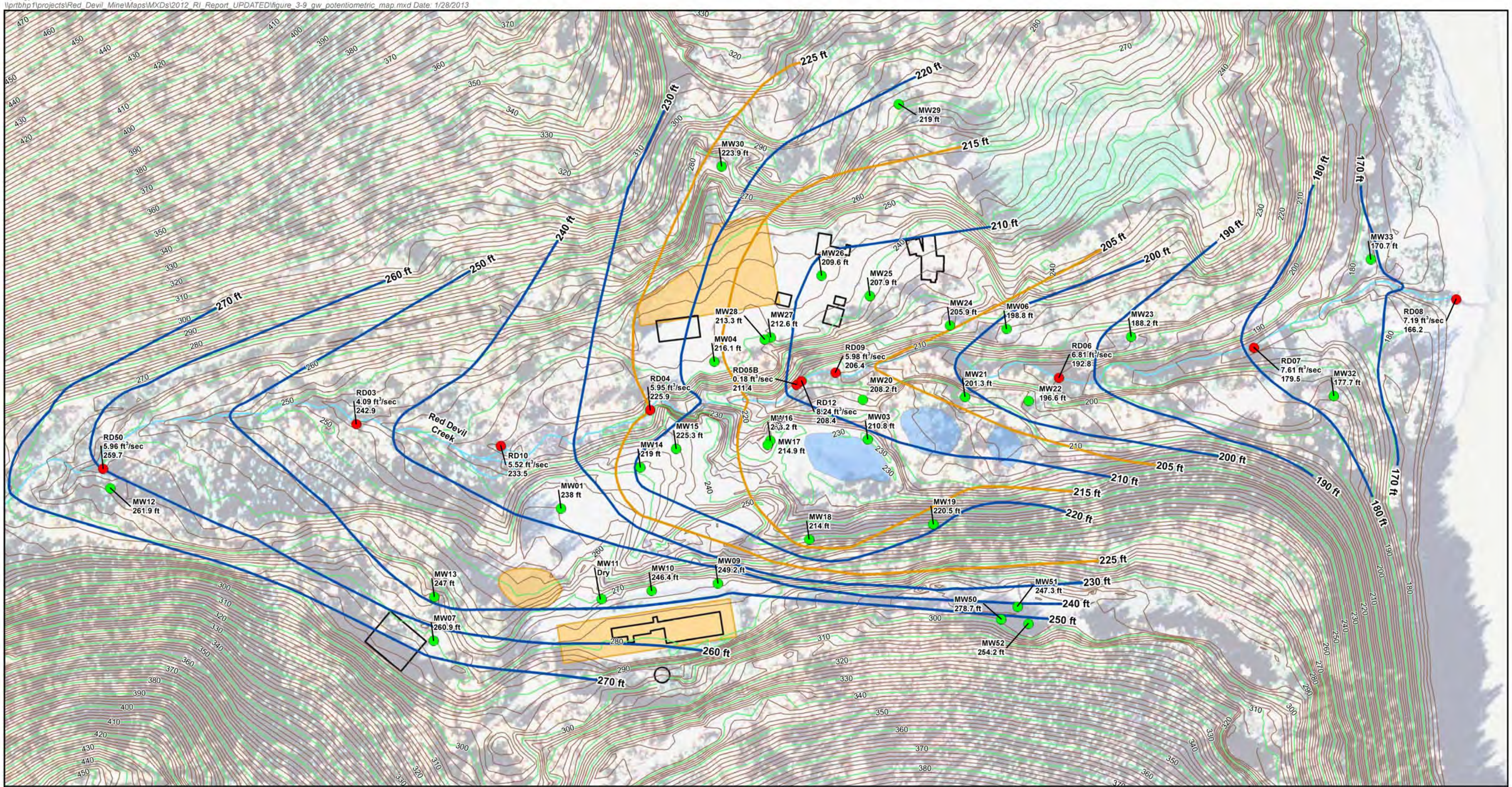
0 12.5 25 50 75 100 125 Meters

Scale 1:2,500

Ecology & Environment, Inc. GIS Department Project:
R:\ACTIVE\Red Devil Mine\GIS - Seattle mirror\Work Products\Figure A-3 MW locations_JR.mxd Date: 1/2/2018

Figure 3-5

2017 Monitoring Well Locations



Red Devil Creek Estimated Flow and Elevation
Monitoring Well Groundwater Elevation
Groundwater Contour (10 ft. interval)
Groundwater Contour (5 ft. interval)
Topographic Contour (2 ft. interval)
Topographic Contour (10 ft. interval)
Settling Pond
Monofill
Historical Structure

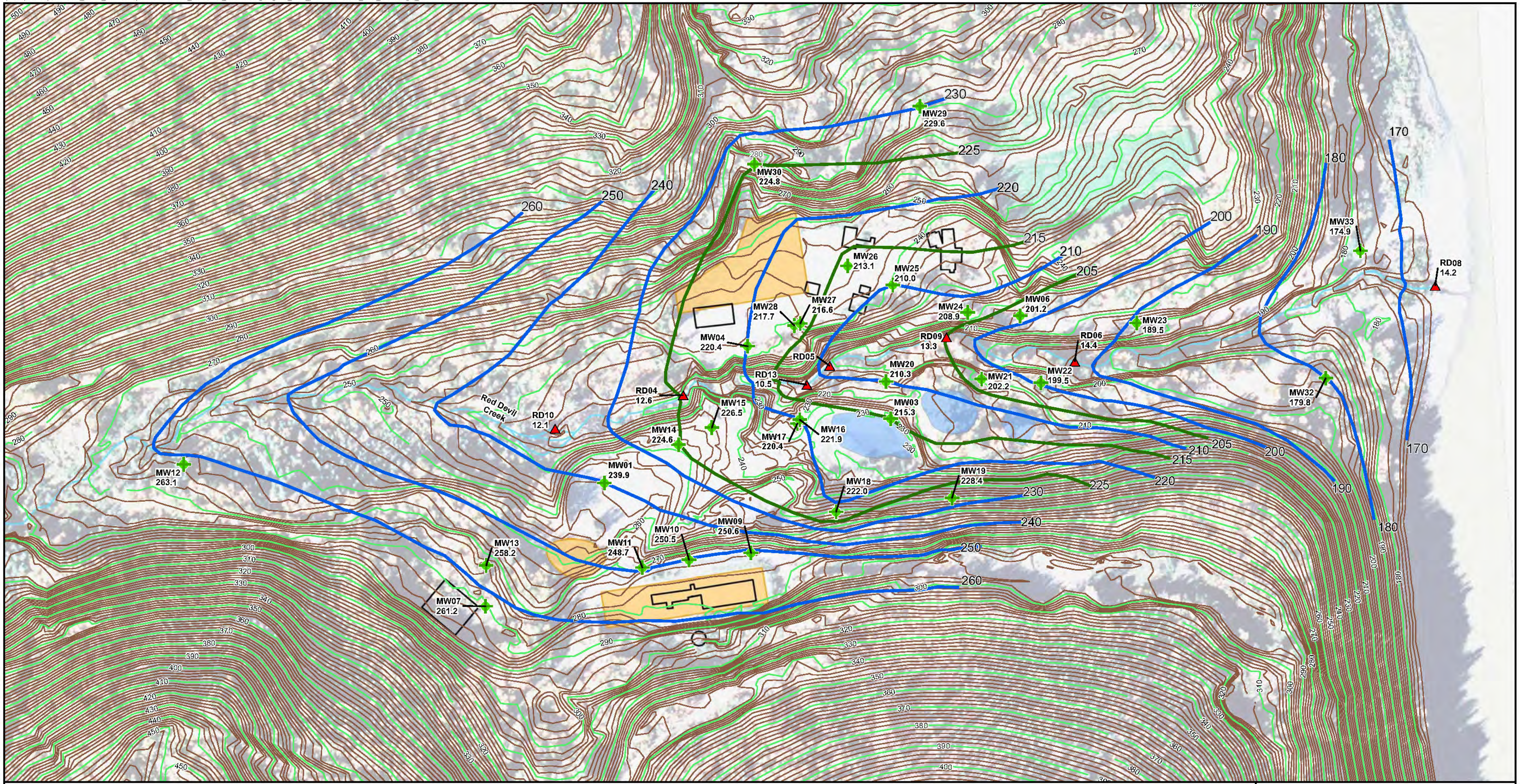
RED DEVIL MINE

Red Devil, Alaska

Figure 3-6
Groundwater Potentiometric Surface and Surface Water Discharge
Fall 2011

Feet
0 12.5 25 50 75
Meters

Image Source: Aero-Metric, Inc. 2010a
Topographic elevation contours source: Aero-Metric, Inc. 2010b, based on Aero-Metric, Inc. aerial photograph dated 5/29/2001



- Groundwater Contour (10 ft. interval)
- Groundwater Contour (5 ft. interval)
- Topographic Contour (2 ft. interval)
- Topographic Contour (10 ft. interval)
- May 26, 2012 Groundwater Elevation
- May 26, 2012 Estimated Surface Water Discharge (cu ft/second)
- Settling Pond
- Monofill
- Historical Structure

RED DEVIL MINE

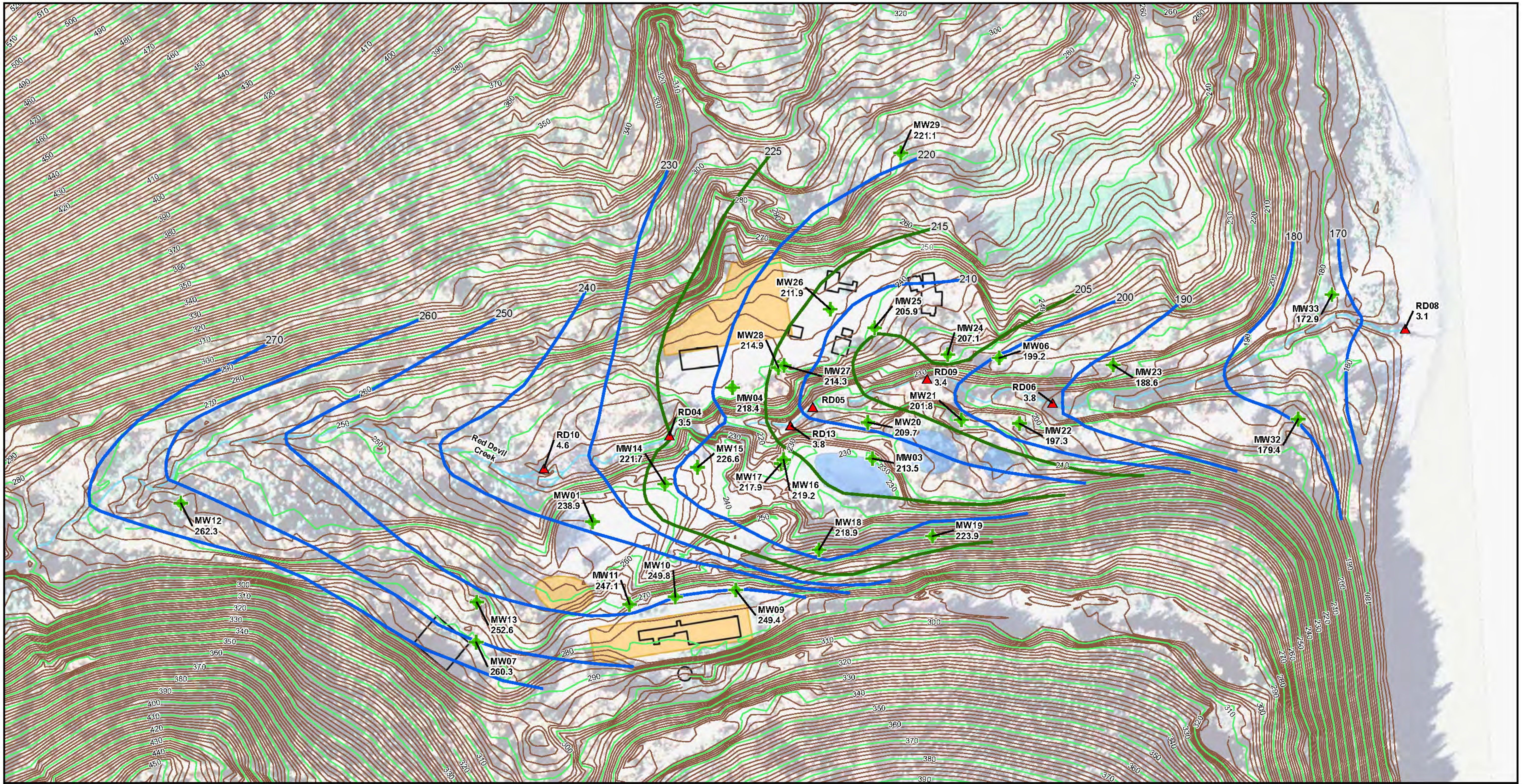
Red Devil, Alaska

Figure 3-7
Groundwater Potentiometric Surface and Surface Water Discharge
Spring 2012

0 50 100 200 300
Feet
0 12.5 25 50 75
Meters

Image Source: Aero-Metric, Inc. 2010a
Topographic elevation contours source: Aero-Metric, Inc. 2010b, based on Aero-Metric, Inc. aerial photograph dated 5/29/2001

Ecology & Environment, Inc. GIS Department Project:
\\prtbhp1\projects\Red_Devil_Mine\Maps\MXDs\2012_Baseline_Monitoring\Fig3-2_GW_potentiometric_SW_discharge_Fall2012.mxd Date: 1/28/2013



Groundwater Contour (10ft interval)
Groundwater Contour (5ft interval)
Topographic Contour (2 ft. interval)
Topographic Contour (10 ft. interval)
September 2012 Groundwater Elevation
September 2012 Estimated Surface Water Discharge (cu ft/second)
Settling Pond
Monofill
Historical Structure

RED DEVIL MINE

Red Devil, Alaska

Figure 3-8
Groundwater Potentiometric Surface and Surface Water Discharge
Fall 2012

0 50 100 200 300
Feet
0 12.5 25 50 75
Meters

Image Source: Aero-Metric, Inc. 2010a
Topographic elevation contours source: Aero-Metric, Inc. 2010b, based on Aero-Metric, Inc. aerial photograph dated 5/29/2001

Ecology & Environment, Inc. GIS Department Project:
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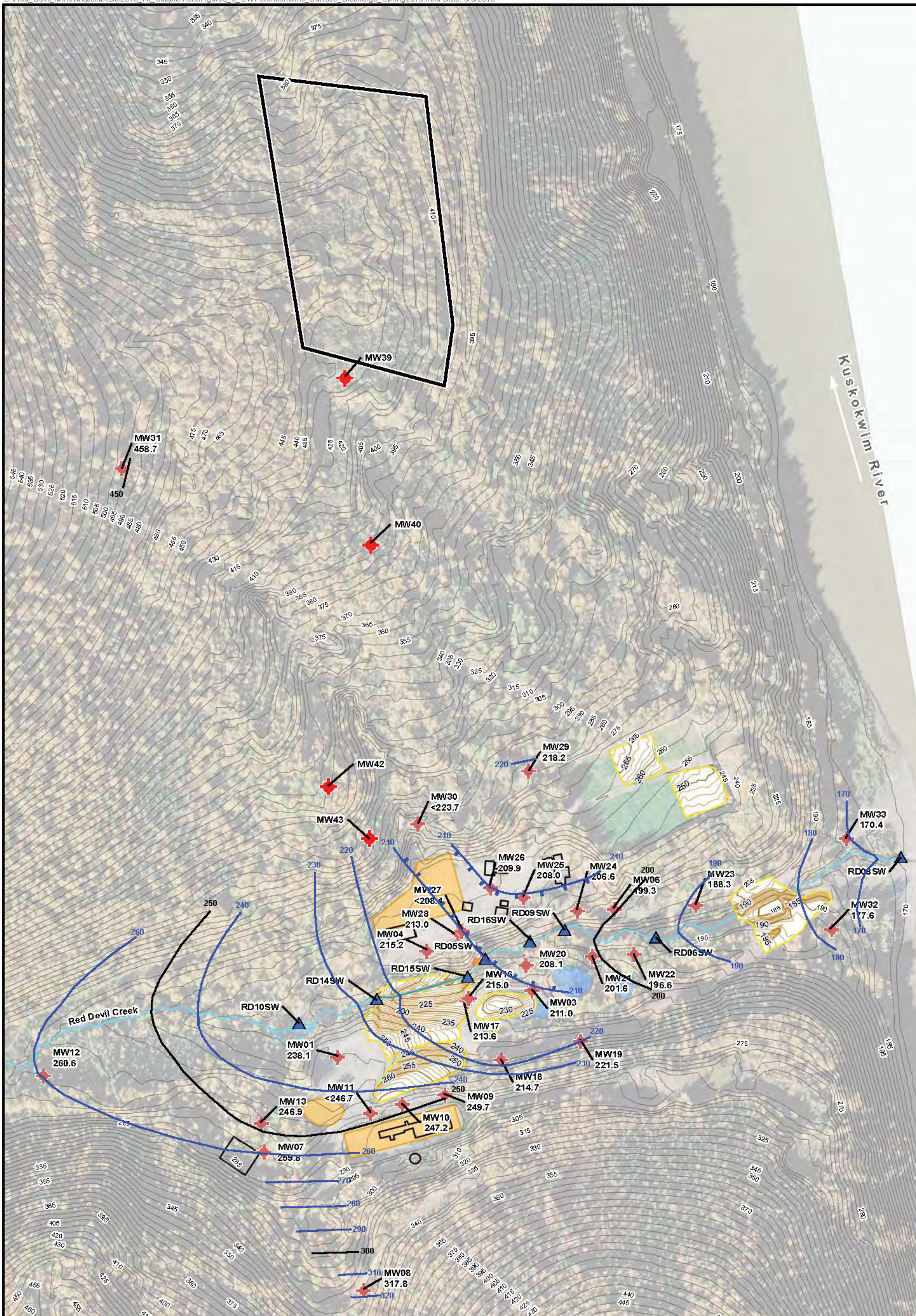


RI Supplement Monitoring Well	2014 5-foot Contour	Settling Pond	**RED DEVIL MINE**
RI Monitoring Well Groundwater Elevation	2014 1-foot Contour	Monofill	Red Devil, Alaska
Surface Water	Area of 2014 NTCRA Re-grading	Historical Structure	
210 Groundwater Potentiometric Surface Elevation Contour (hatch mark on downgradient side)	2010 5-foot Contour	Approximate Location of Proposed Repository Footprint	
	Post-NTCRA Stream Alignment	Seep Location	
	Red Devil Creek		

Digital 2010 5-foot topographic contours based on the aerial orthophotograph taken on September 21, 2010 (AeroMetric 2012)

Digital 2014 5-foot and 1-foot topographic contours based on Marsh Creek (2014)

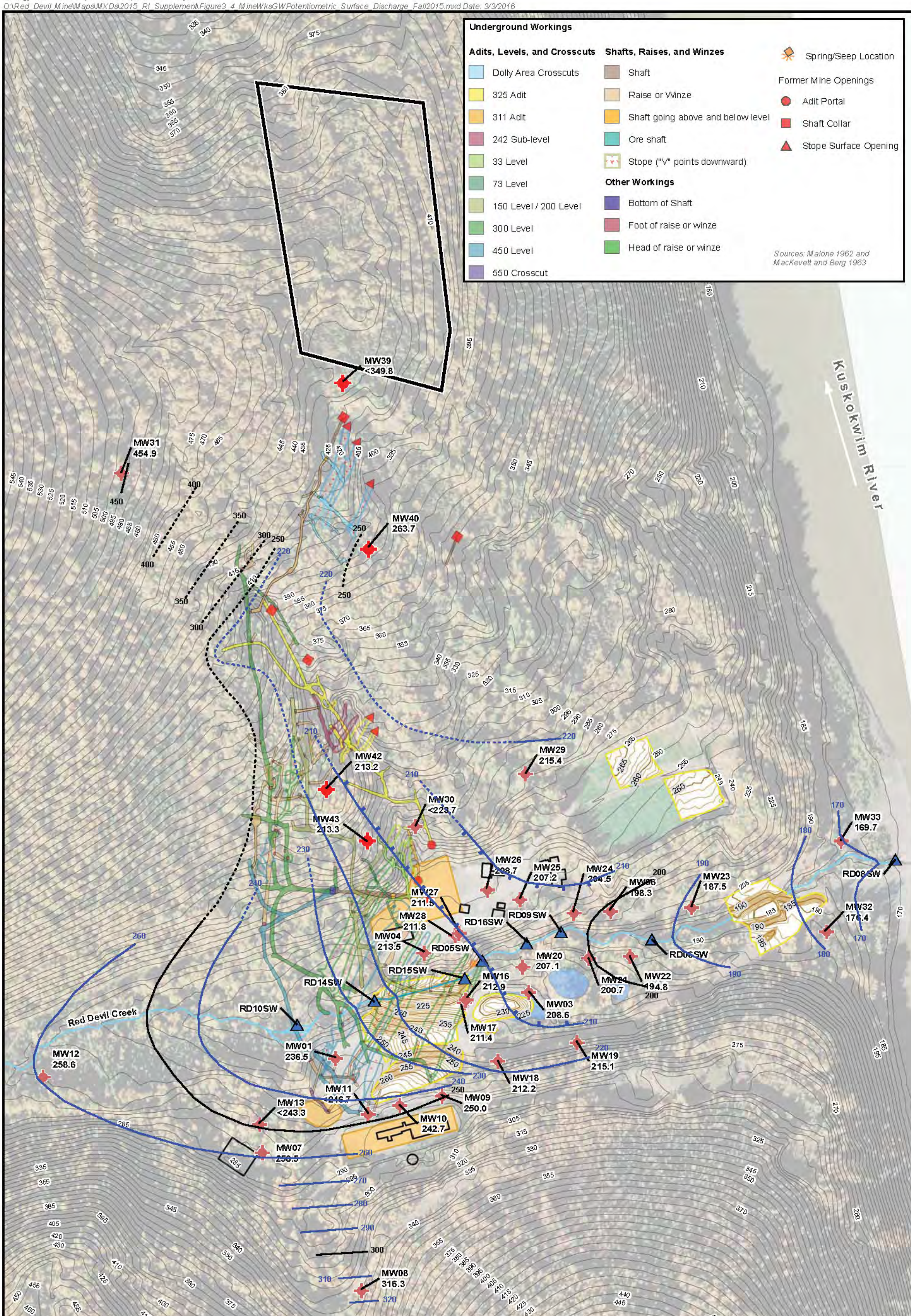
Figure 3-9
Groundwater Potentiometric Surface, Spring 2015

0 50 100 200 300 400 Feet

0 12.5 25 50 75 100 125 Meters

Scale 1:2,500

Ecology & Environment, Inc. GIS Department Project:
O:\Red_Devil_Mine\Maps\MXDs\2015_RI_Supplement\Figure3_4_MineWksGWPotentiometric_Surface_Discharge_Fall2015.mxd Date: 3/3/2016



RI Supplement Monitoring Well Groundwater Elevation
RI Monitoring Well Groundwater Elevation
Surface Water
Groundwater Potentiometric Surface Elevation Contour (dashed where inferred based on configuration of mine workings; hatch mark on downgradient side)
2014 5-foot Contour
2014 1-foot Contour
Area of 2014 NTCRA Re-grading
2010 5-foot Contour
Post-NTCRA Stream Alignment
Red Devil Creek
Settling Pond
Monofill
Historical Structure
Approximate Location of Proposed Repository Footprint
Seep Location

Digital 2010 5-foot topographic contours based on the aerial orthophotograph taken on September 21, 2010 (AeroMetric 2012)

Digital 2014 5-foot and 1-foot topographic contours based on Marsh Creek (2014)

RED DEVIL MINE

Red Devil, Alaska

Figure 3-10
Groundwater Potentiometric Surface, Fall 2015

0 50 100 200 300 400 Feet
0 12.5 25 50 75 100 125 Meters
Scale 1:2,500

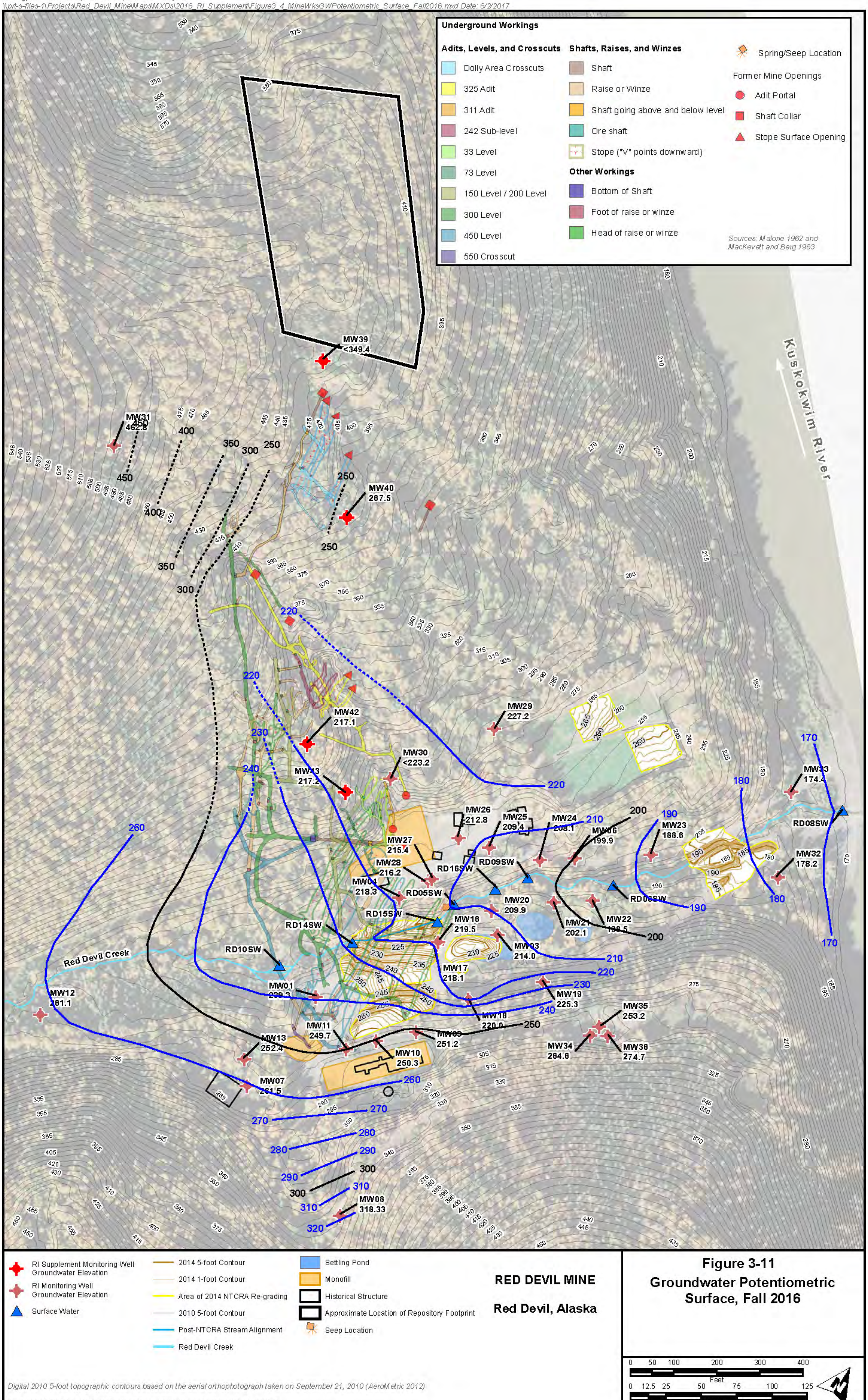


Figure 3-11
Groundwater Potentiometric Surface, Fall 2016

Ecology & Environment, Inc. GIS Department Project:
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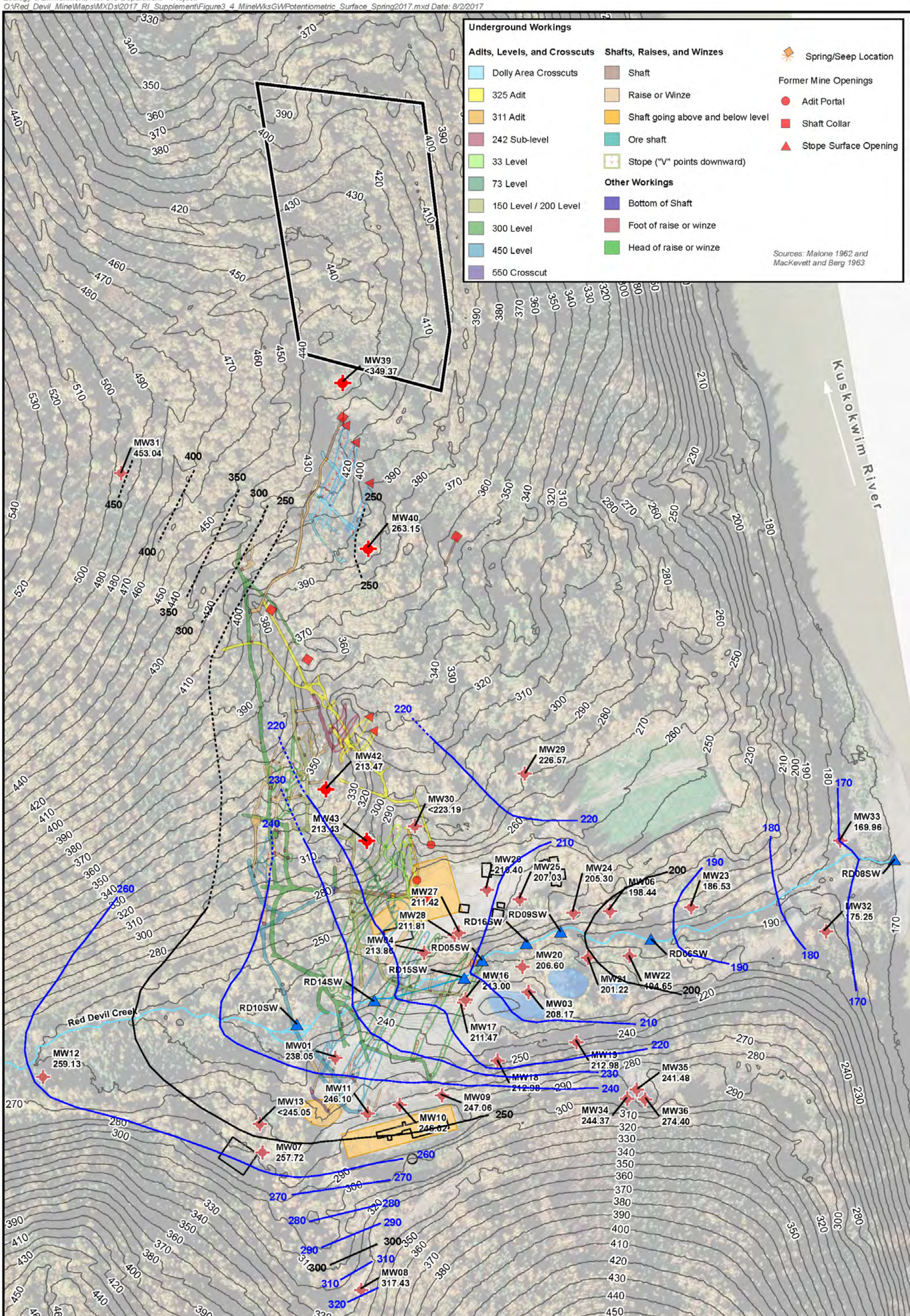


RI Supplement Monitoring Well Groundwater Elevation	2015 2-foot Contour	Settling Pond	
RI Monitoring Well Groundwater Elevation	2015 10-foot Contour	Monofill	
Surface Water	Post-NTCRA Stream Alignment	Historical Structure	
	Red Devil Creek	Approximate Location of Repository Footprint	
		Seep Location	

RED DEVIL MINE

Red Devil, Alaska

Figure 3-12
Groundwater Potentiometric Surface, Spring 2017

0 50 100 200 300 400 Feet
0 12.5 25 50 75 100 125 Meters
Scale 1:2,500

Digital 2015 5-foot topographic contours based on October 10, 2015 LiDAR Survey (Quantum Spatial 2015).

- 2017 Monitoring Well
- RI Supplement Monitoring Well
- RI Monitoring Well
- Abandoned RI Monitoring Well
- 2015 2-foot Contour
- 2015 10-foot Contour
- Post-NTCRA Stream Alignment
- Red Devil Creek
- Settling Pond
- Monofill
- Historical Structure
- Approximate Location of Proposed Repository Footprint
- Area of 2014 NTCRA Re-grading
- Seep Location
- 10-foot groundwater contour
- 50-foot groundwater contour

RED DEVIL MINE

Red Devil, Alaska

Figure 3-13

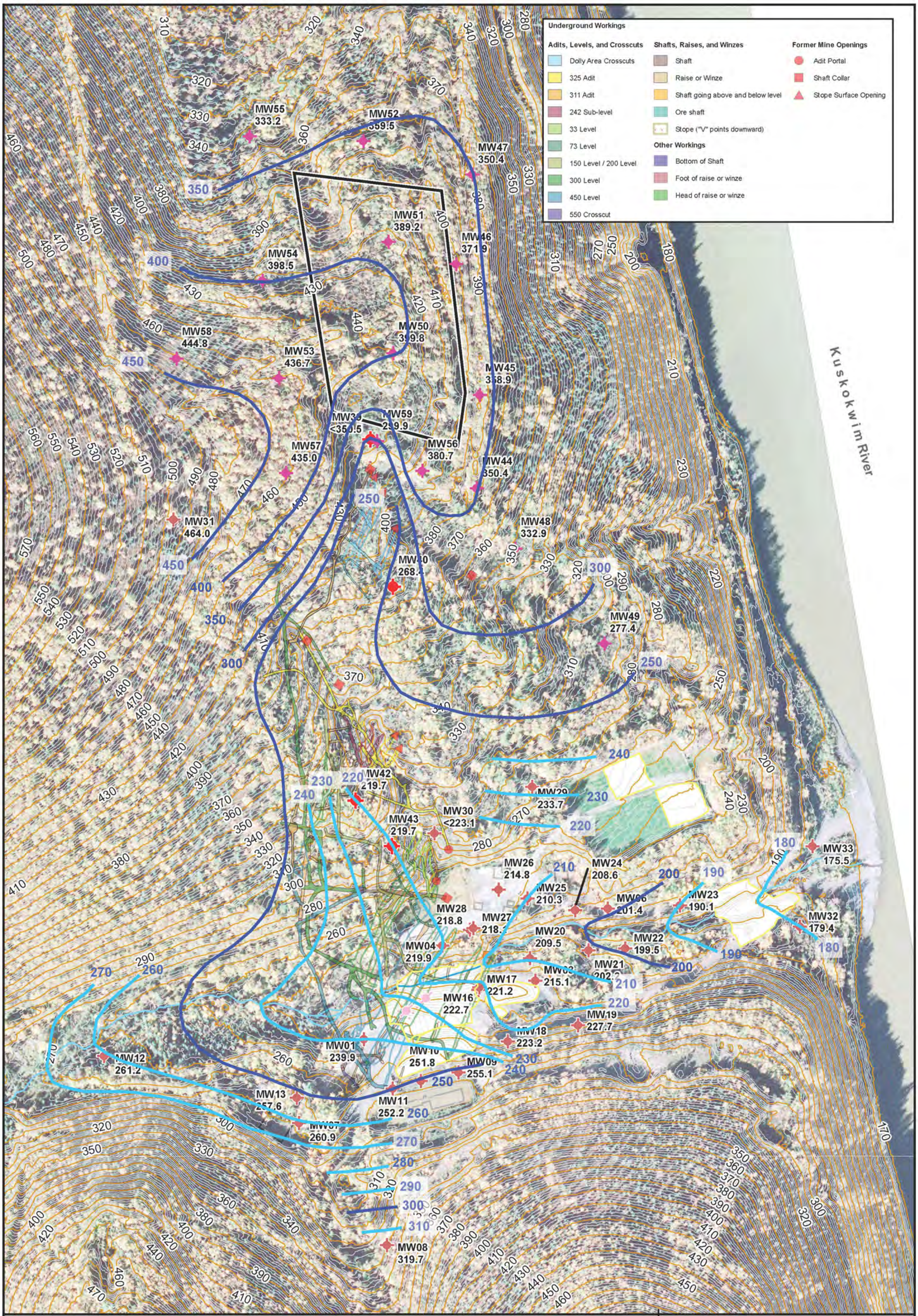
Groundwater Potentiometric Surface, Fall 2017

0 50 100 200 300 400
Feet
0 10 20 40 60 80 100
Meters
Scale 1:3,000

Digital 2015 topographic contours based on October 10, 2015 LiDAR Survey (Quantum Spatial 2015).

Aerial photograph taken on 9/21/2010 (AeroMetric 2012)

Ecology & Environment, Inc. GIS Department Project:
R:\ACTIVE\Red Devil Mine\GIS - Seattle mirror\Work Products\Maps\2018 Potentiometric Surface.mxd Date: 6/11/2018



2017 Monitoring Well	Red Devil Creek
RI Supplement Monitoring Well	Settling Pond
RI Monitoring Well	Monofill
Abandoned RI Monitoring Well	Historical Structure
2015 2-foot Contour	Approximate Location of Proposed Repository Footprint
2015 10-foot Contour	Area of 2014 NTCRA Re-grading
Post-NTCRA Stream Alignment	Seep Location

Digital 2015 topographic contours based on October 10, 2015 LiDAR Survey (Quantum Spatial 2015)
Aerial photograph taken on 9/21/2010 (AeroMetric 2012)

RED DEVIL MINE

Red Devil, Alaska

Figure 3-14

Groundwater Potentiometric Surface, Spring 2018

0 50 100 200 300 400 Feet
0 10 20 40 60 80 100 Meters
Scale 1:3,000

Figure 3-15a. Groundwater Concentrations and Elevation - Upstream Alluvial Area

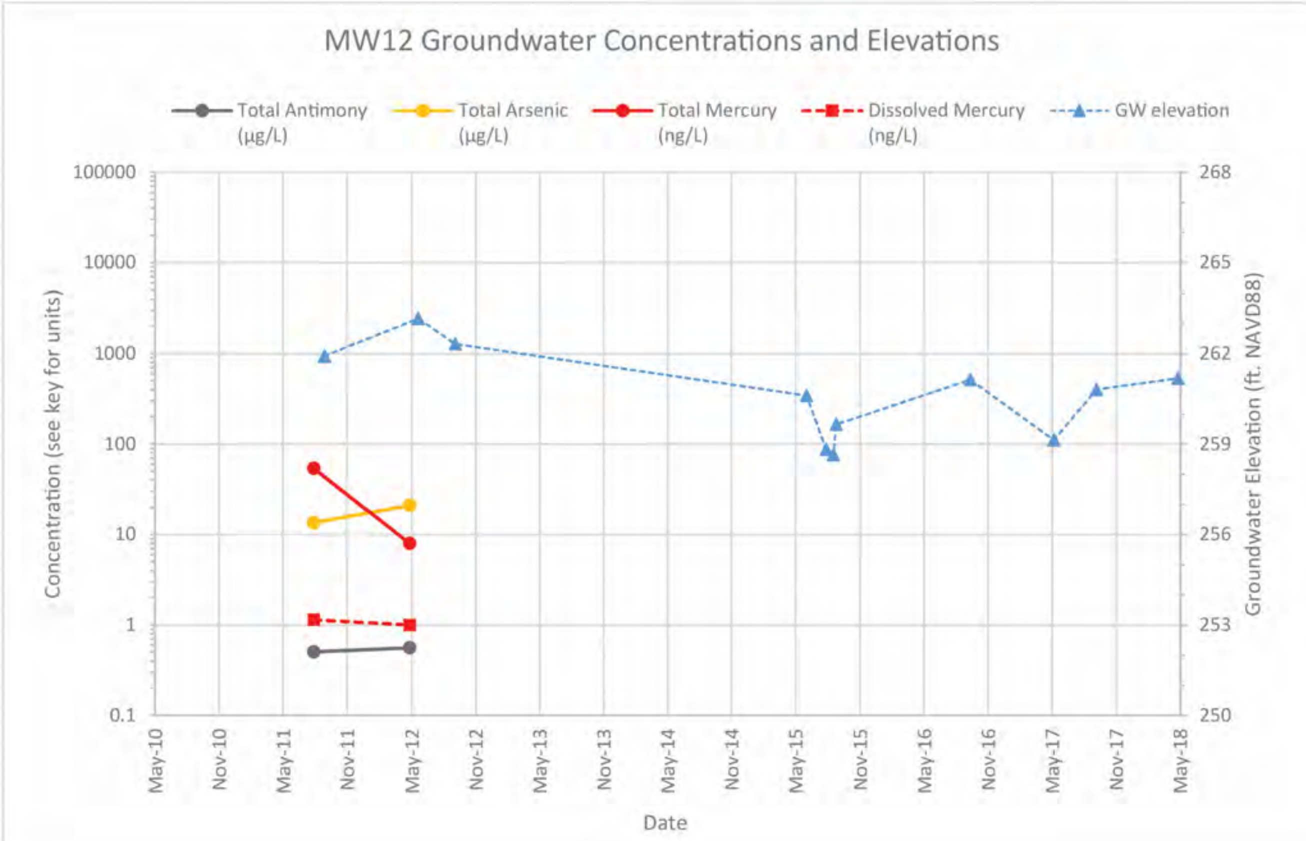


Figure 3-15b. Groundwater Concentrations and Elevation - Upland Area

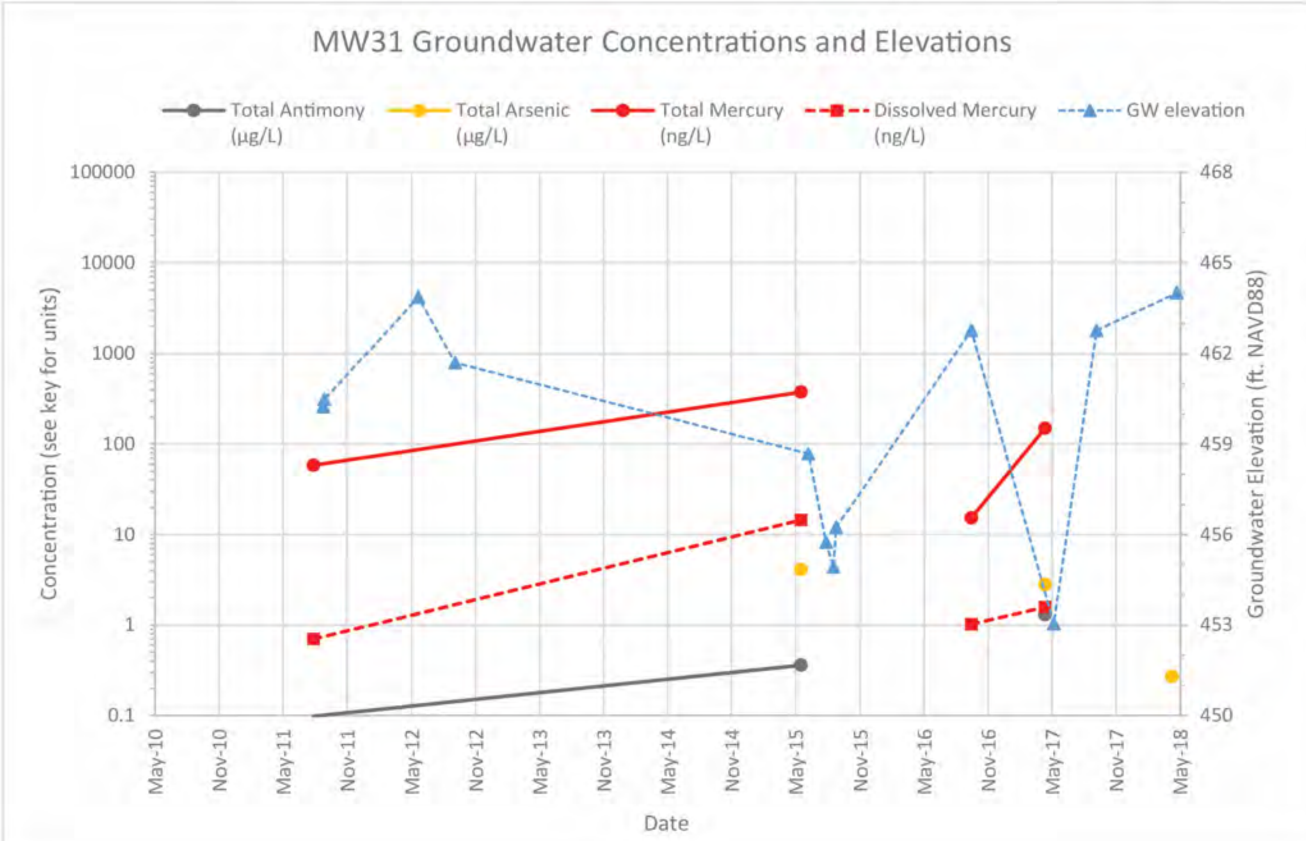
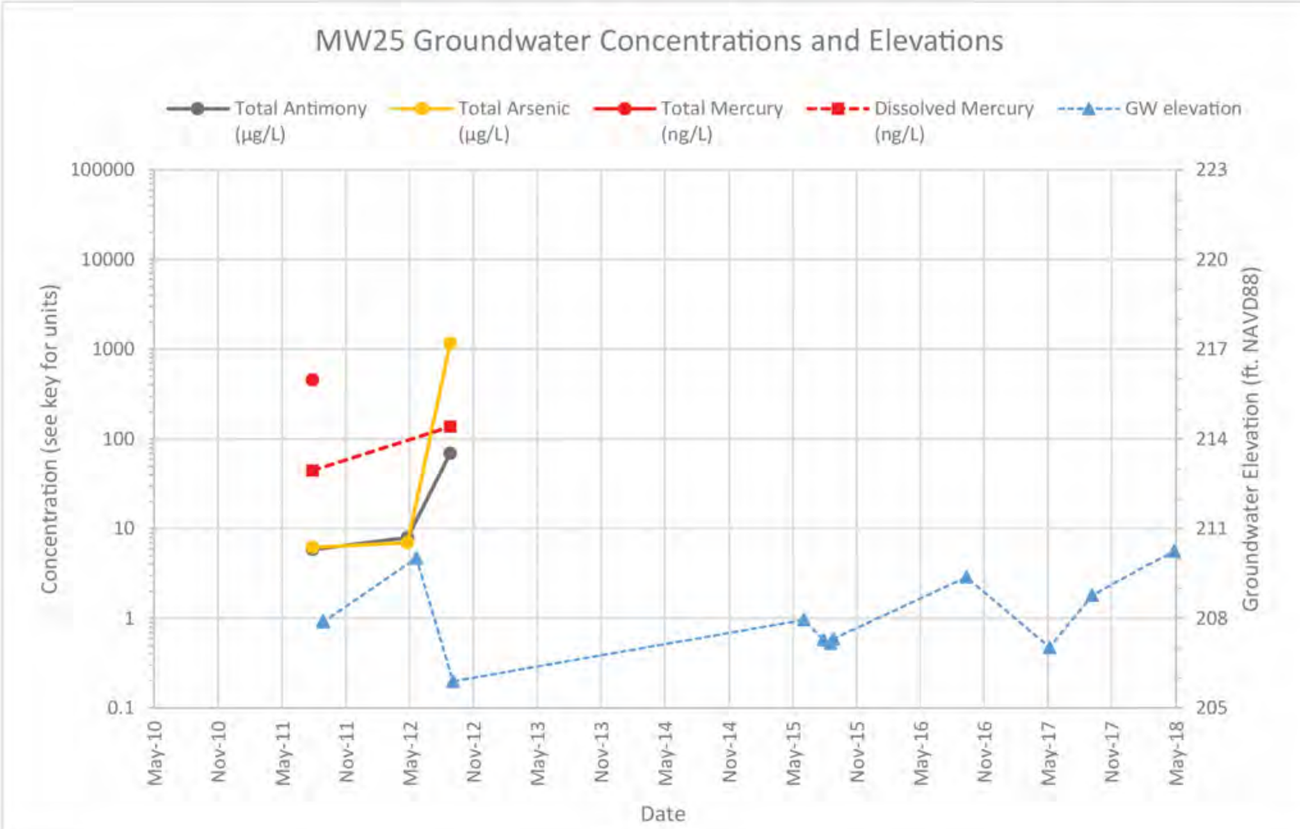
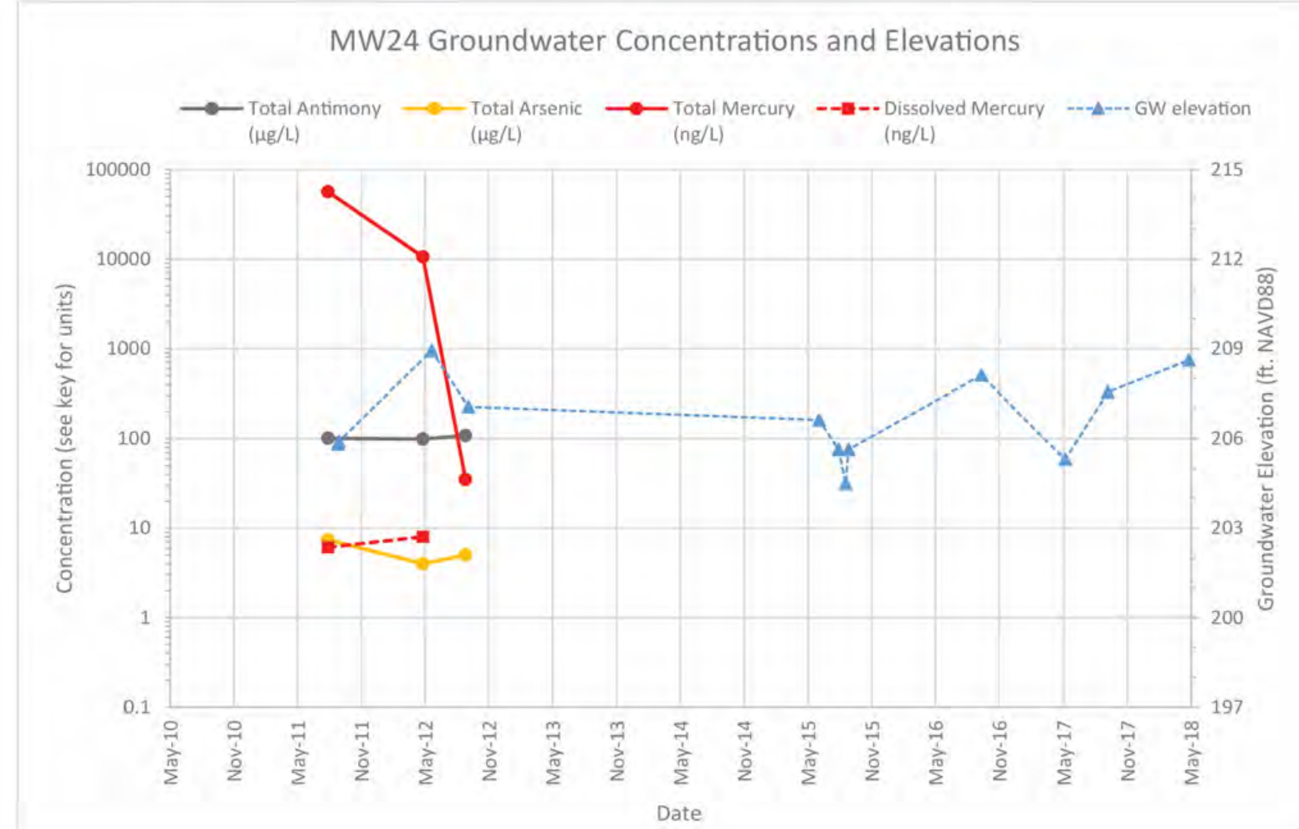


Figure 3-15c. Groundwater Concentrations and Elevation - Surface Mined Area

Figure 3-15d. Groundwater Concentrations and Elevation - Pre-1955 Main Processing Area

Figure 3-15d. Groundwater Concentrations and Elevation - Pre-1955 Main Processing Area





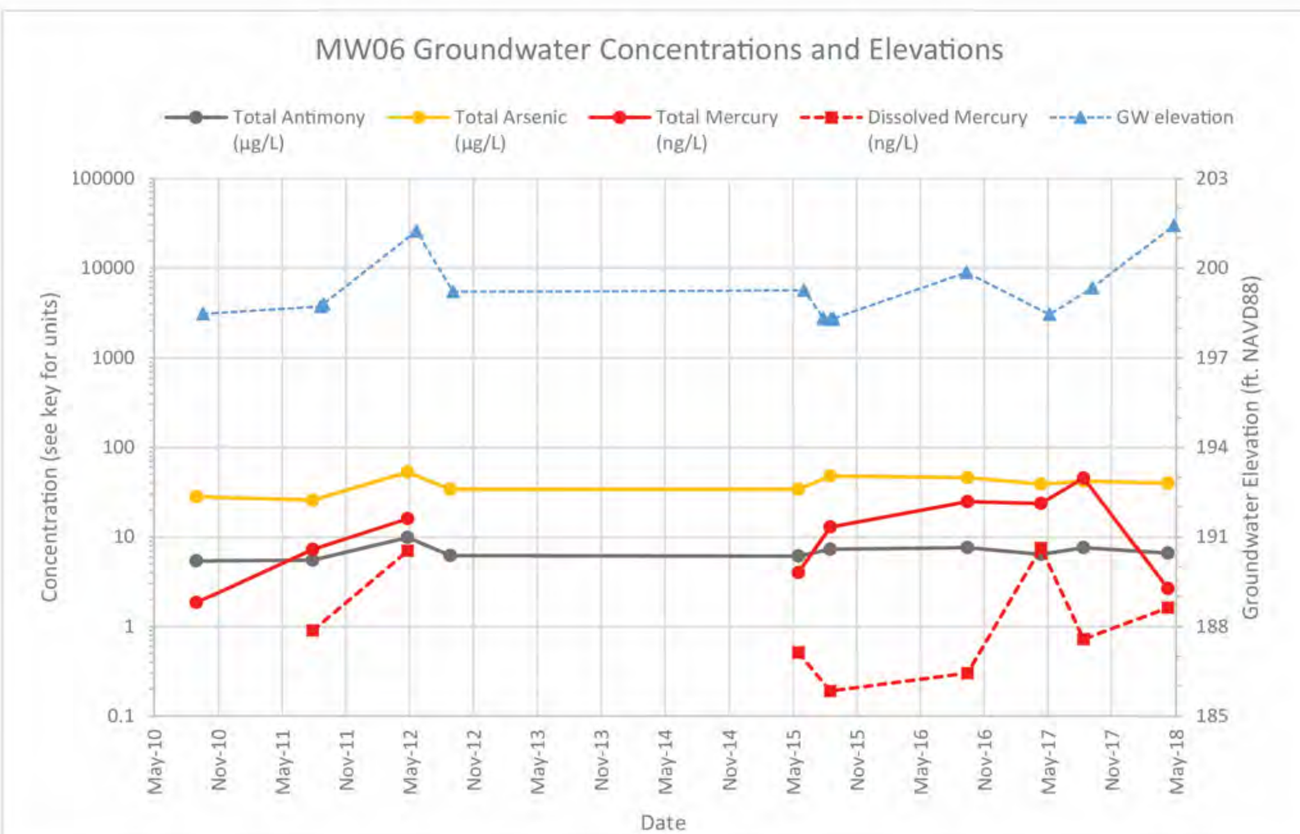
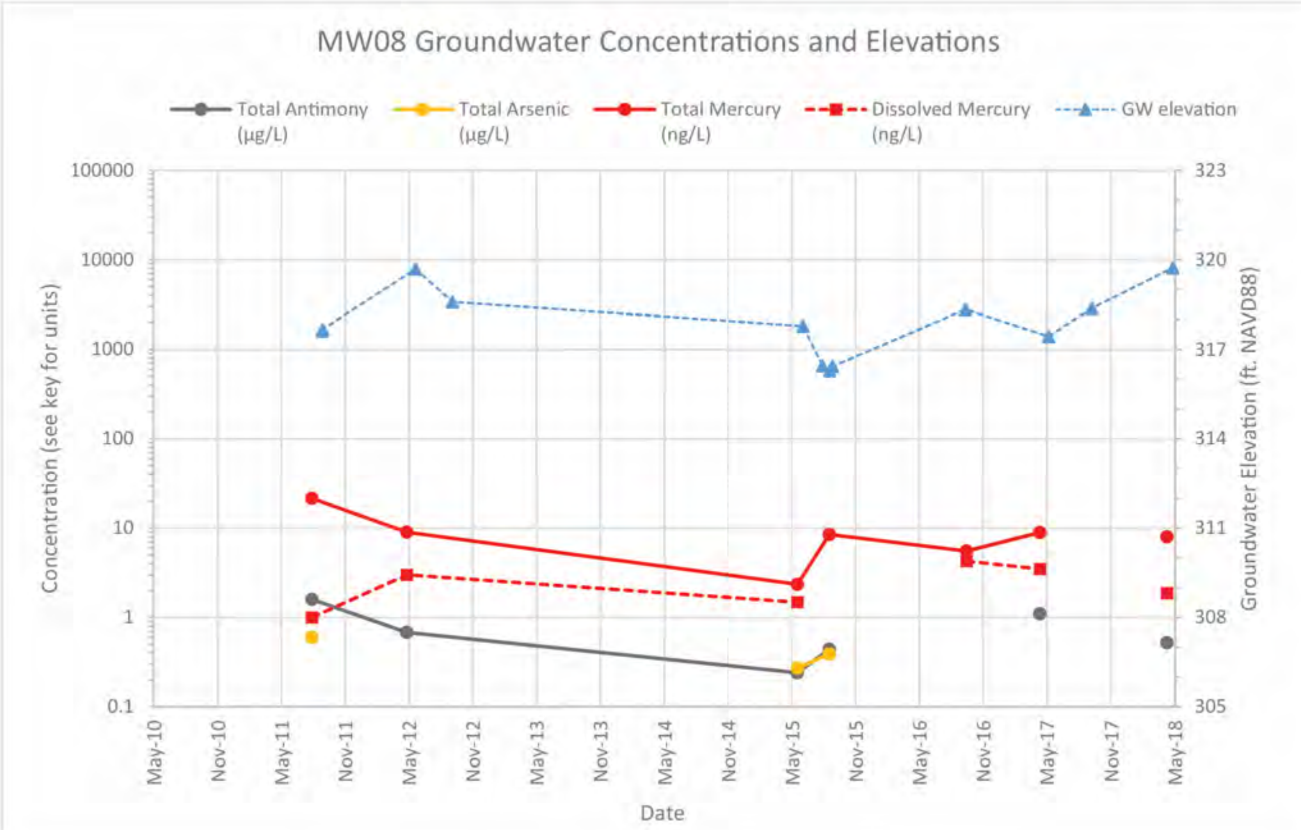
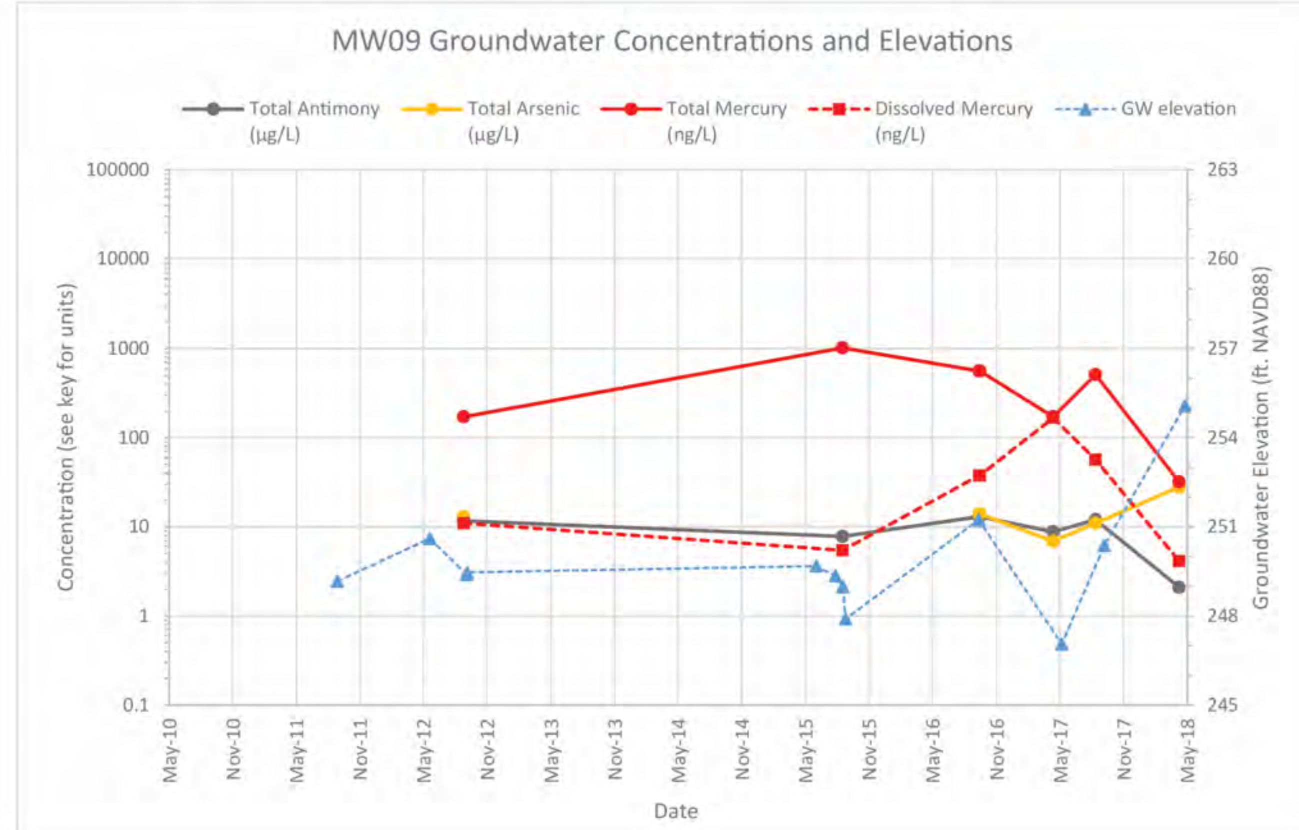
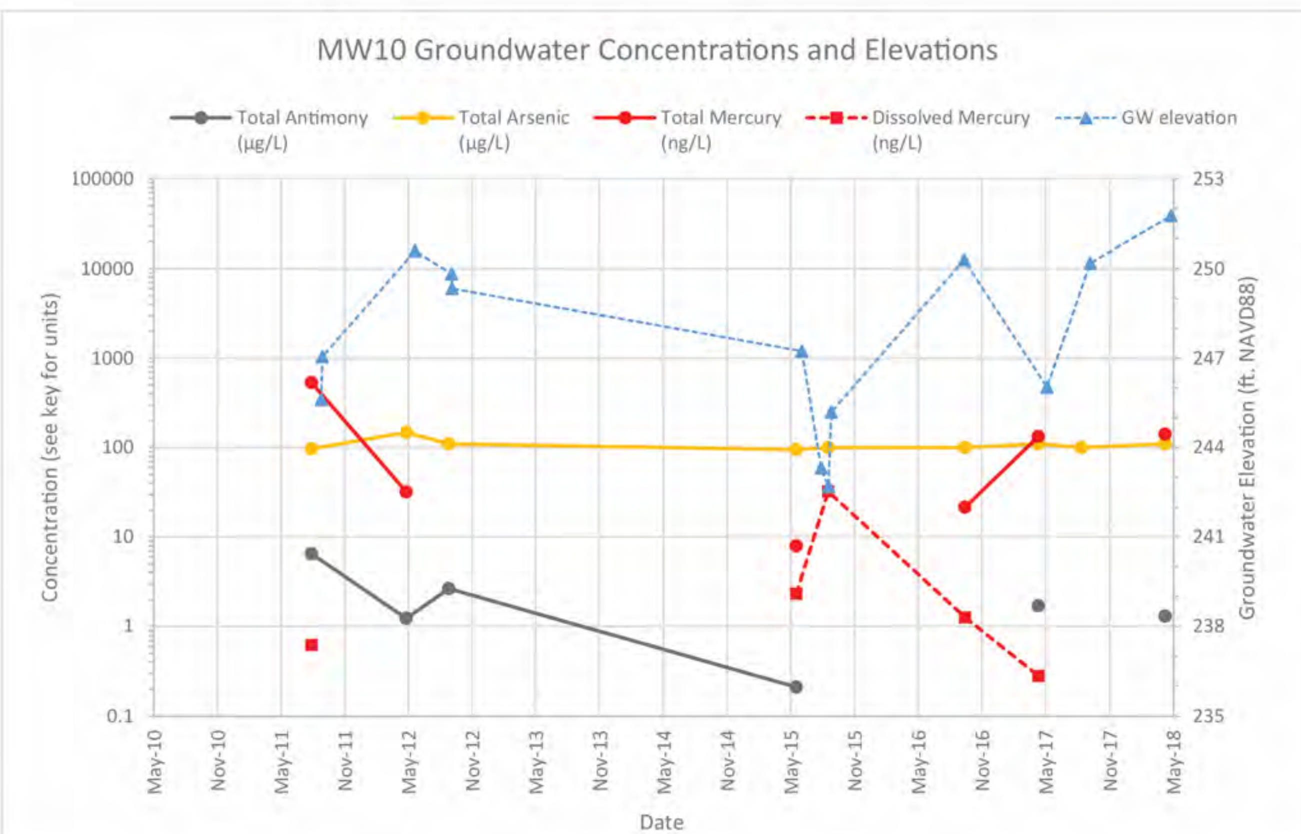


Figure 3-15e. Groundwater Concentrations and Elevation - Post-1955 Main Processing Area







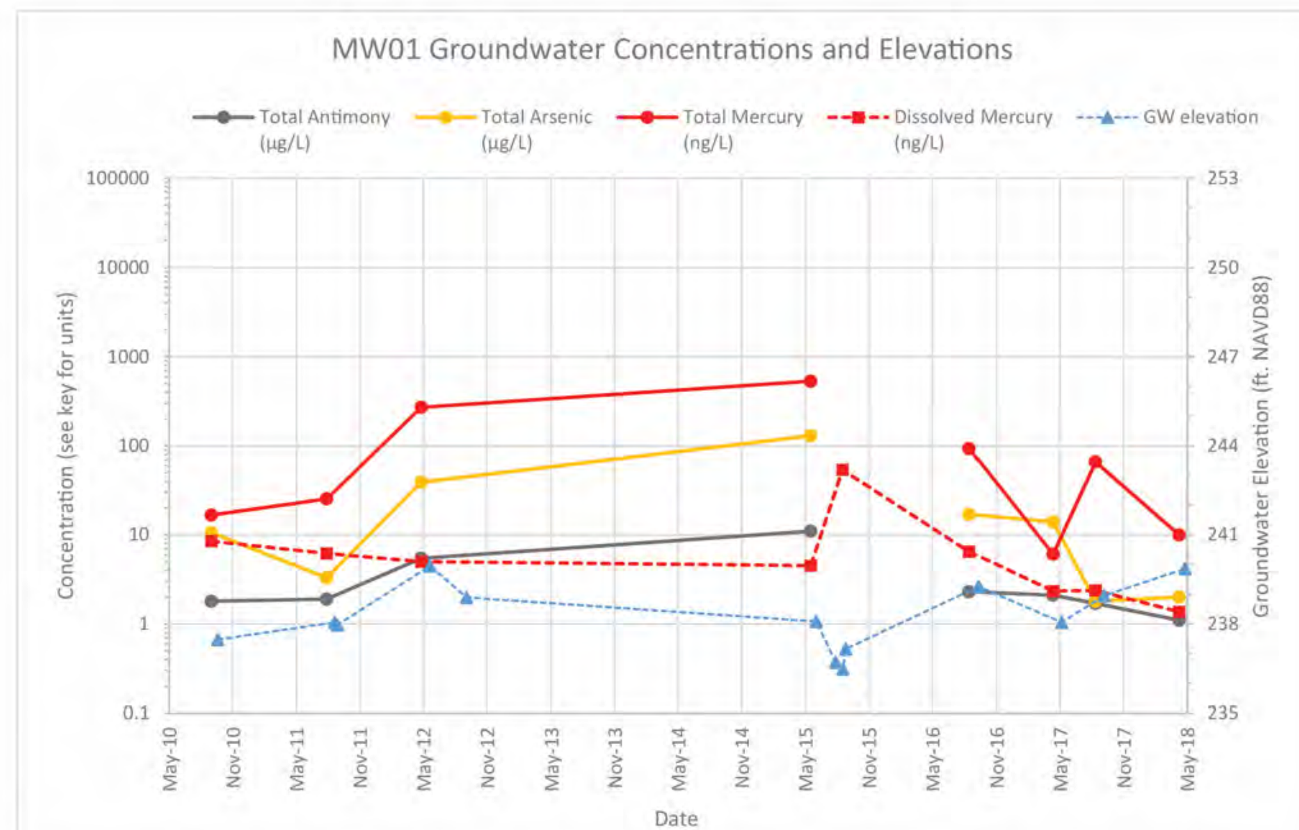
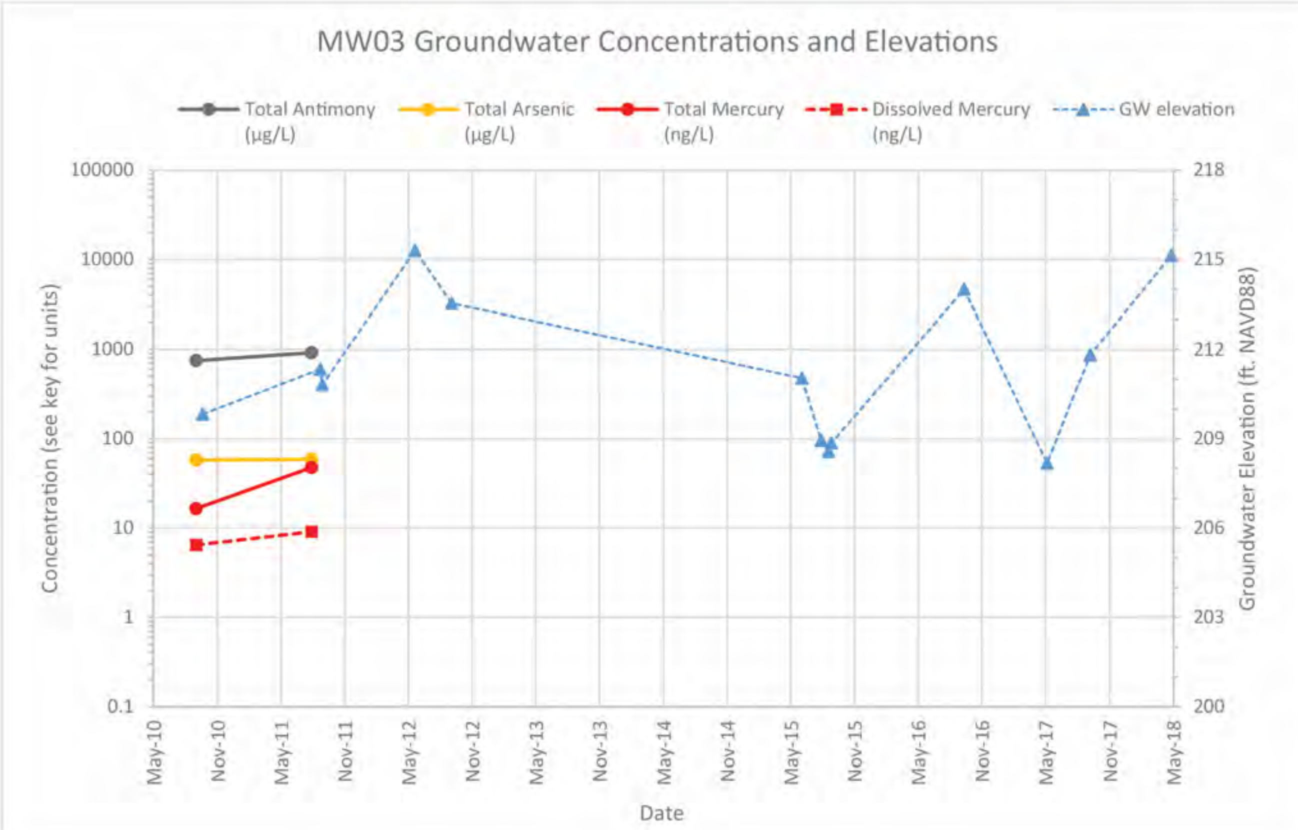
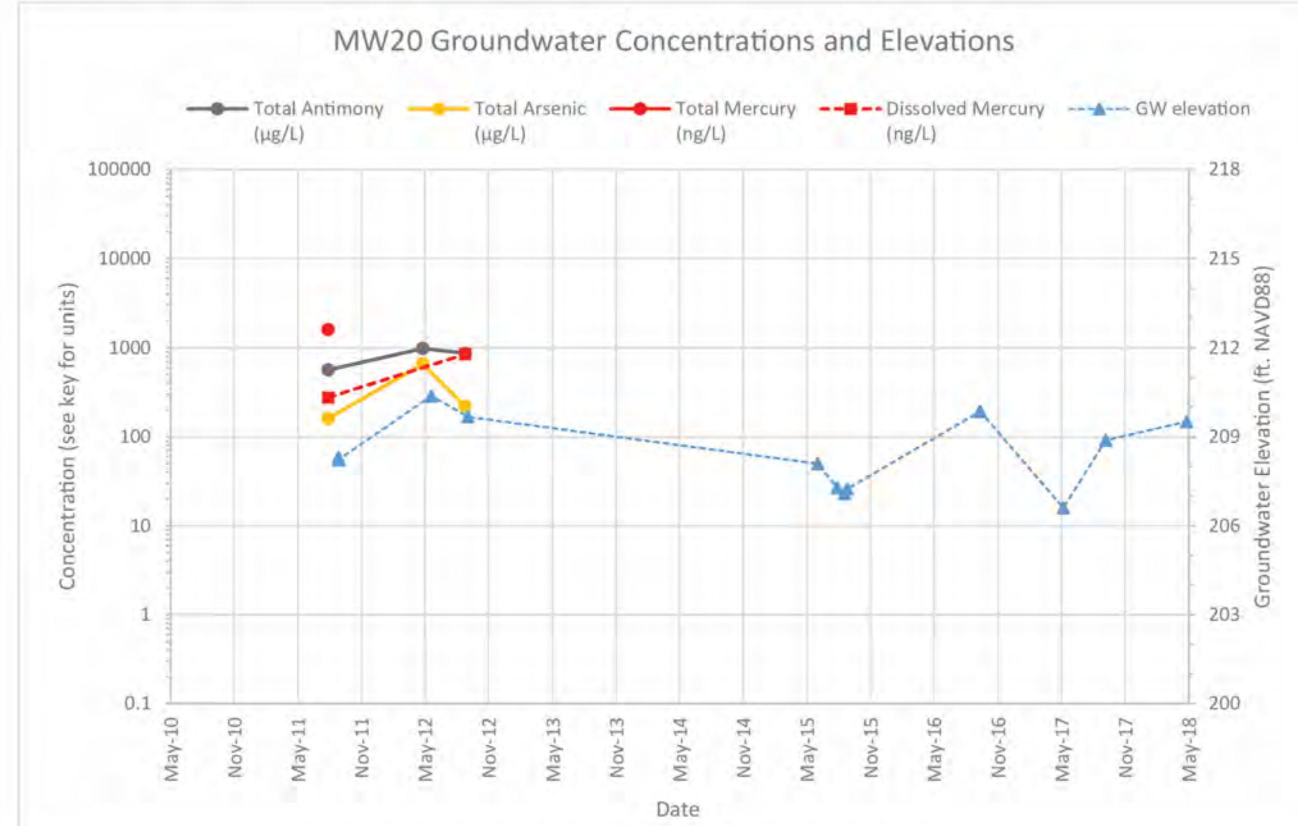
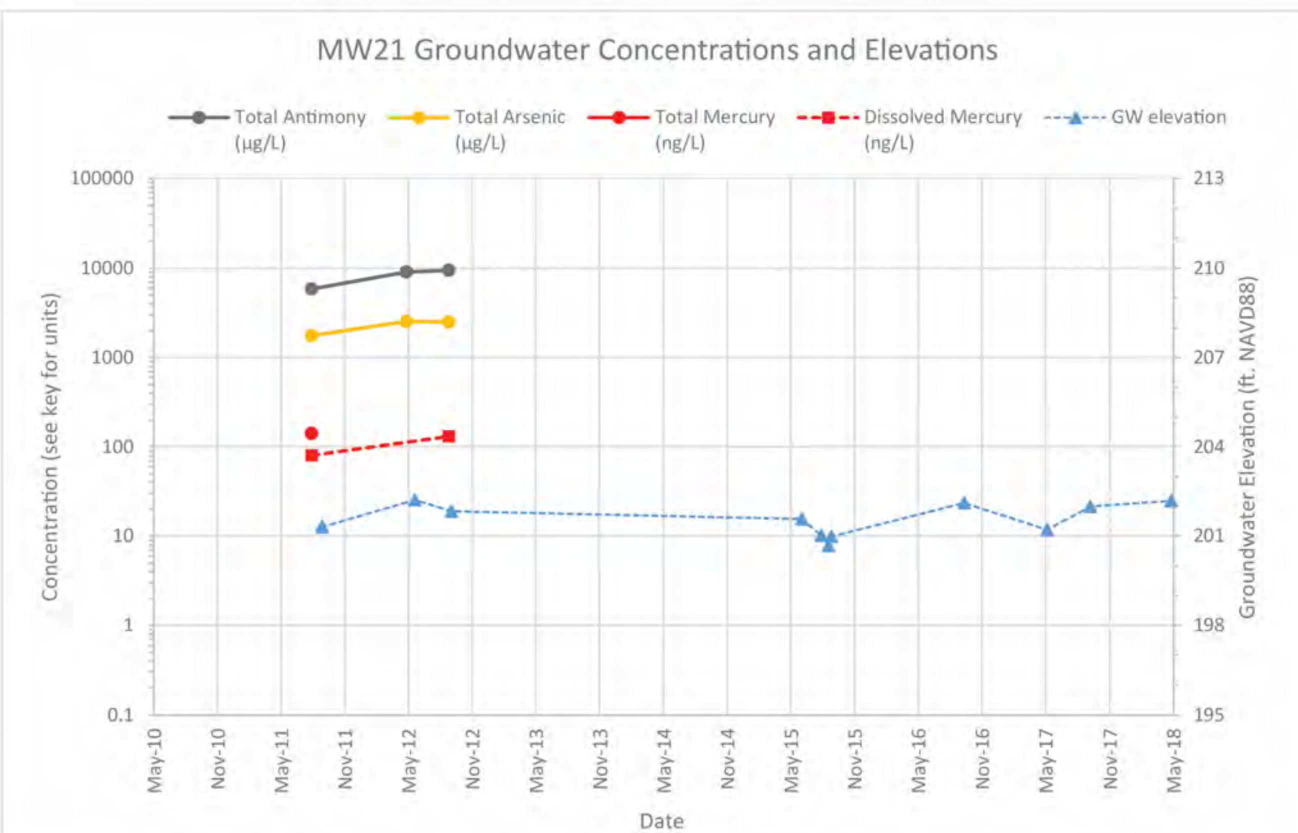


Figure 3-15e. Groundwater Concentrations and Elevation - Post-1955 Main Processing Area

Figure 3-15e. Groundwater Concentrations and Elevation - Post-1955 Main Processing Area







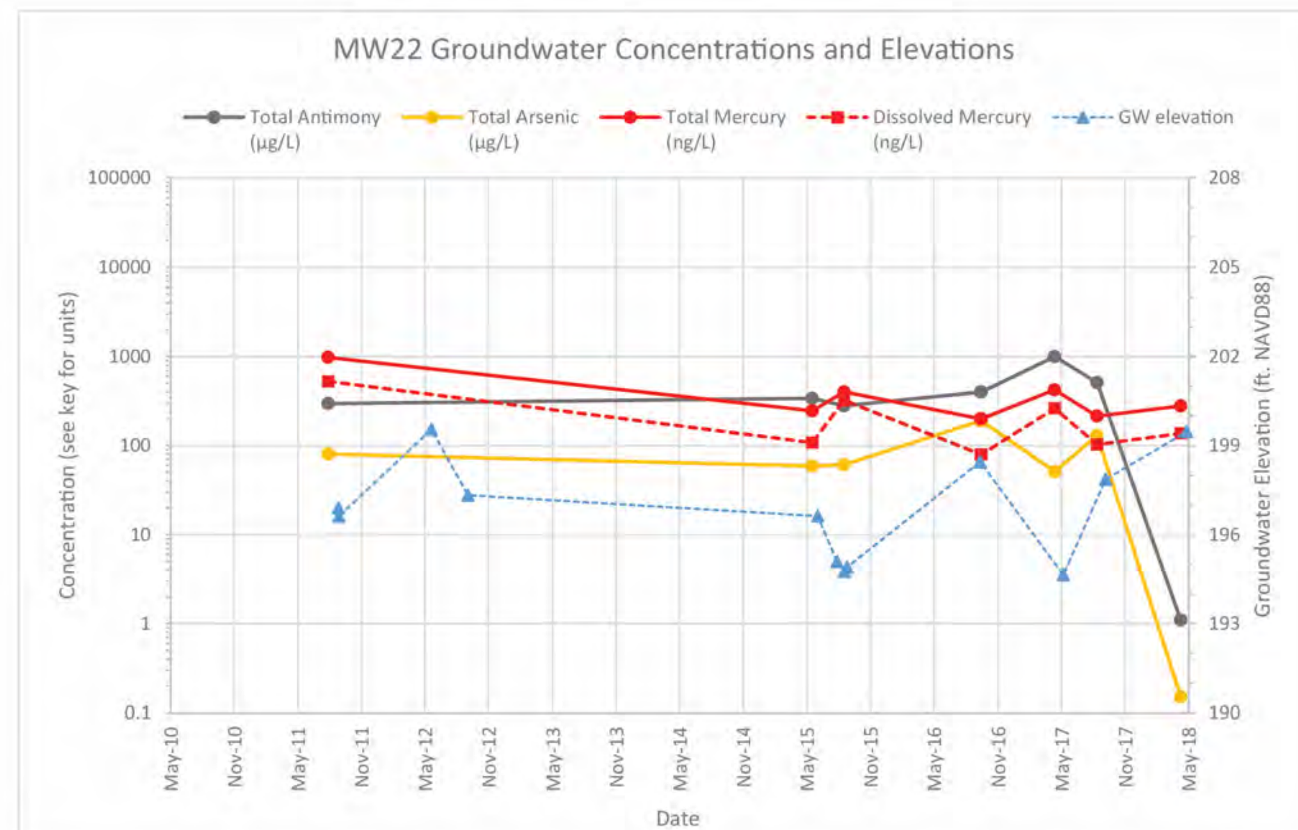


Figure 3-15e. Groundwater Concentrations and Elevation - Post-1955 Main Processing Area

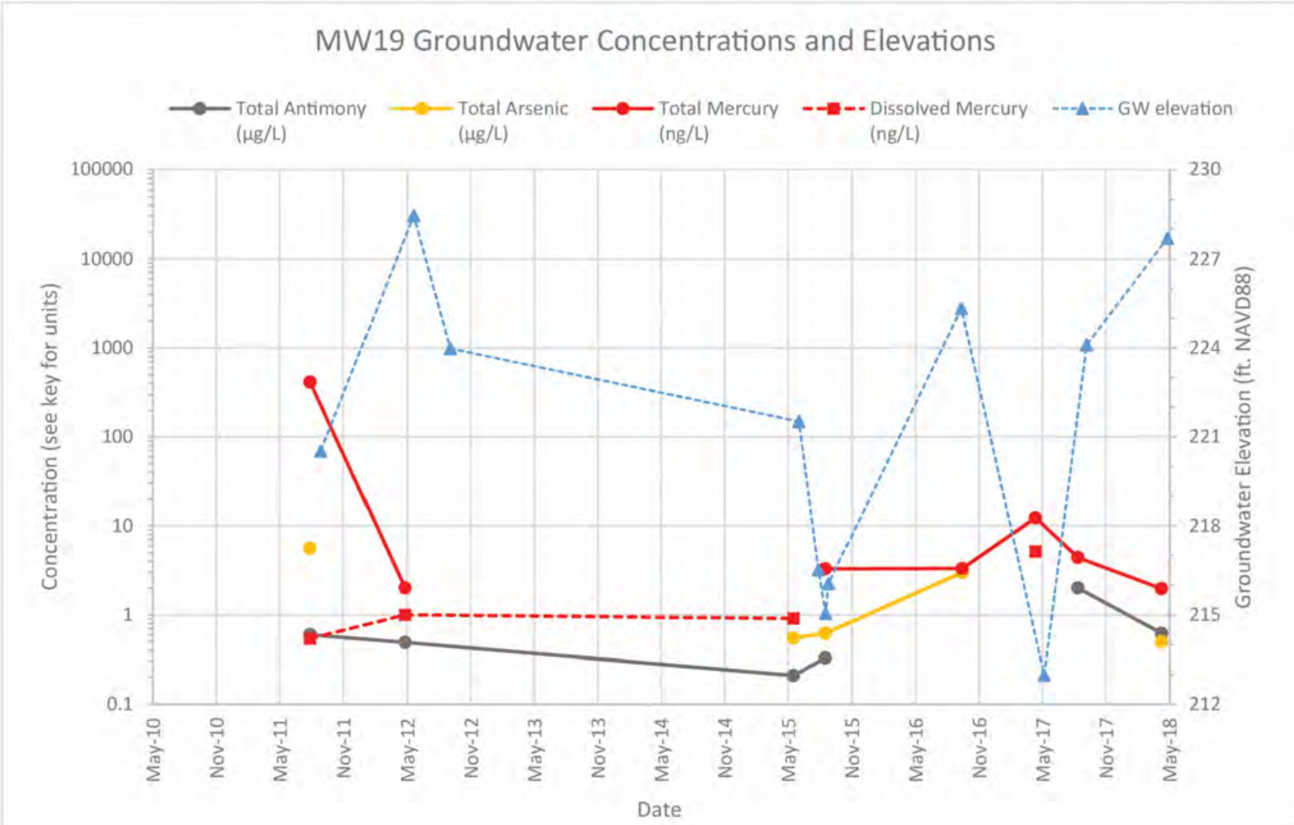
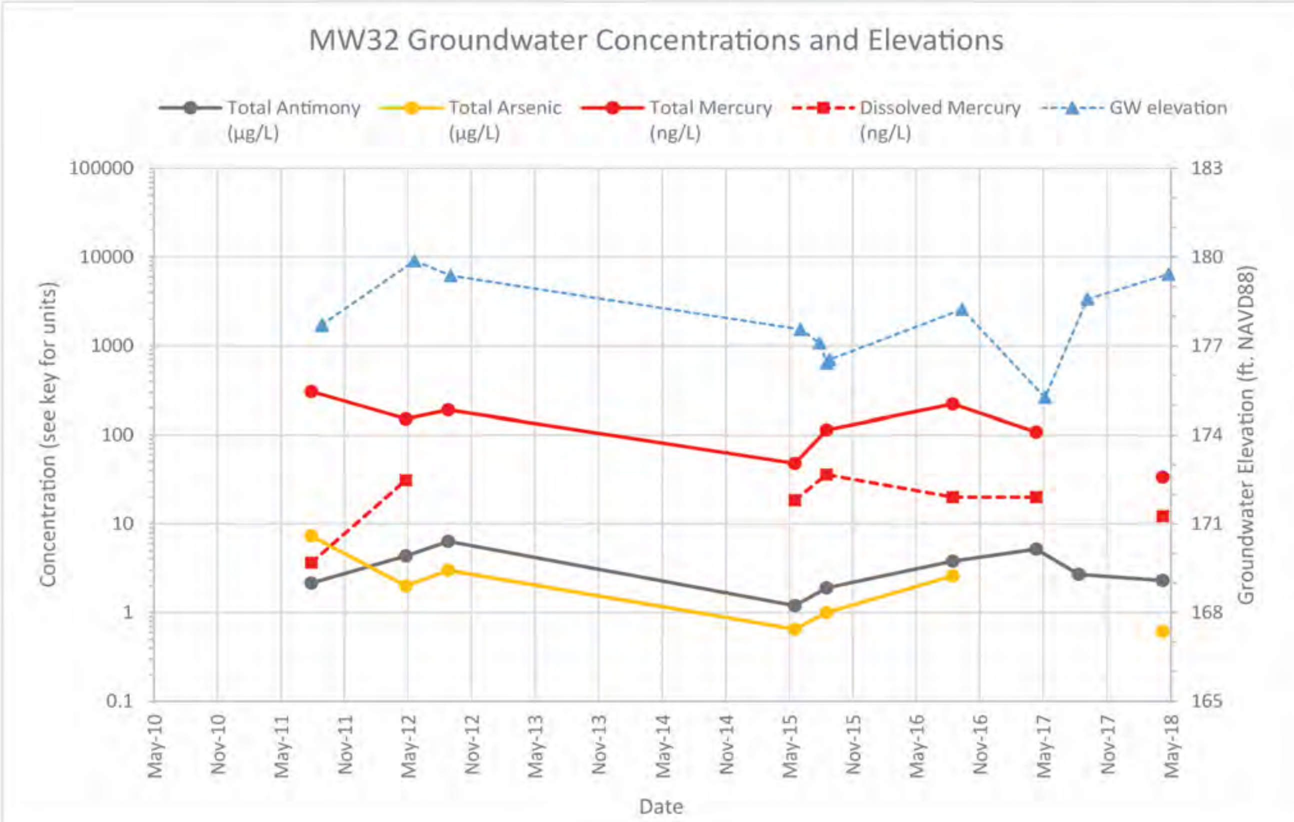


Figure 3-15f. Groundwater Concentrations and Elevation - Downstream Alluvial Area



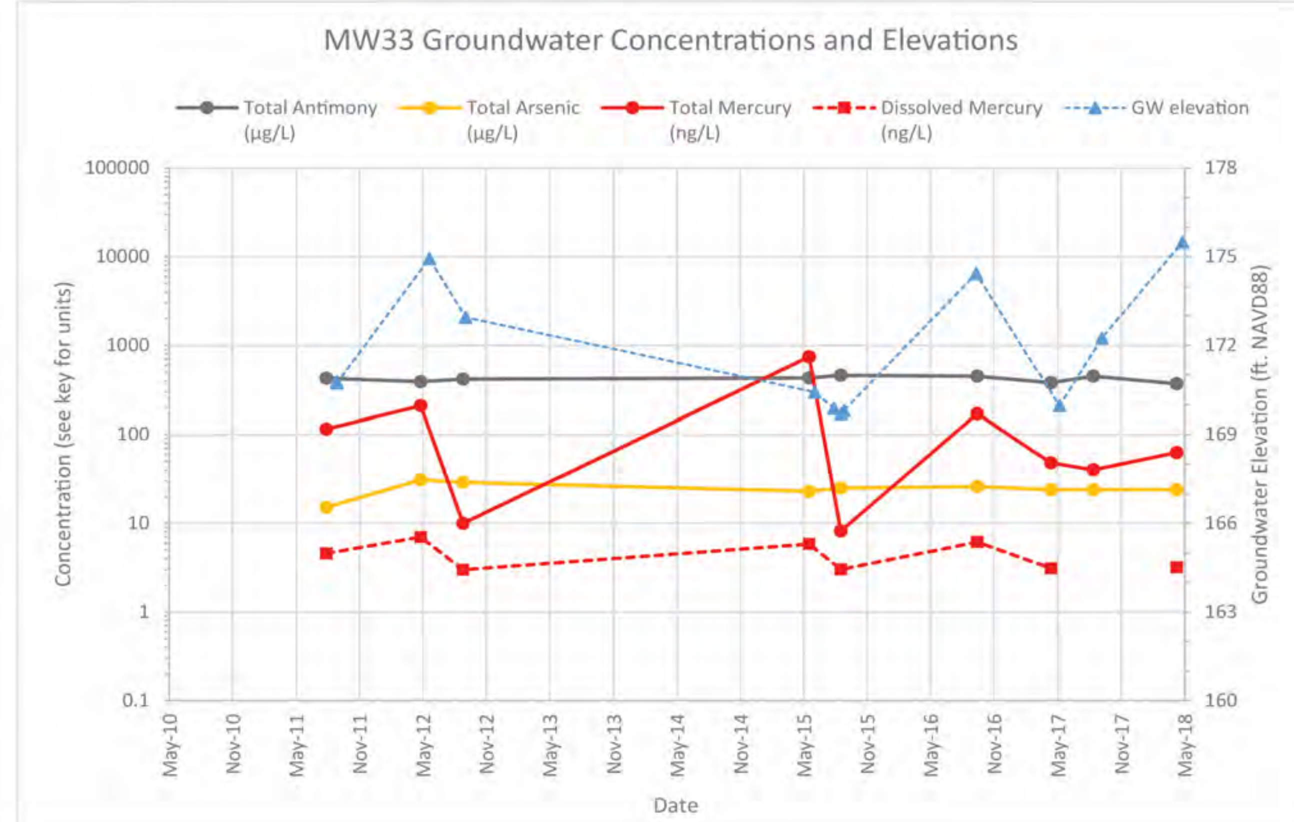


Figure 3-16 Continuous Groundwater Levels in Selected Wells – Fall 2017 to Spring 2018

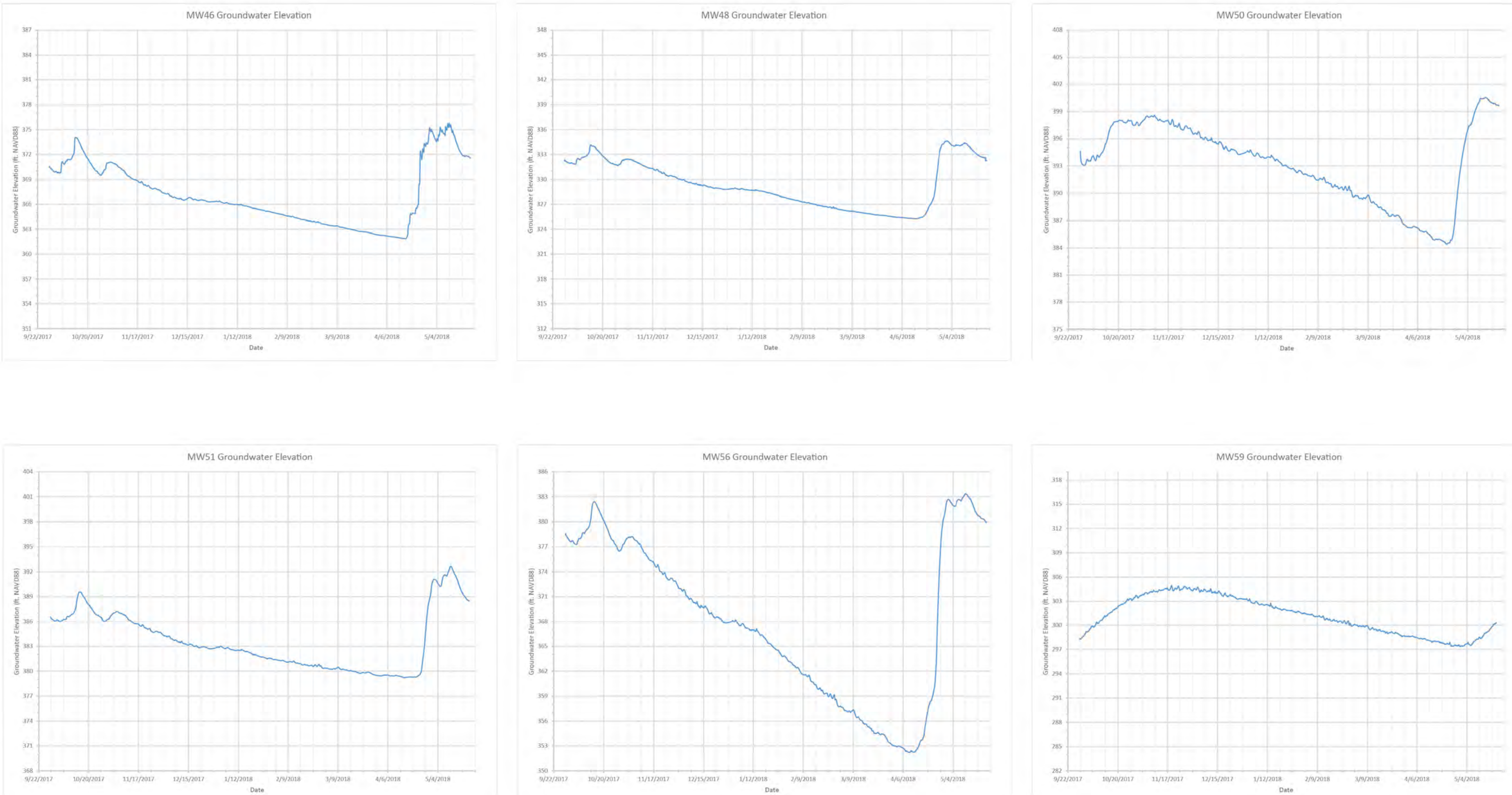
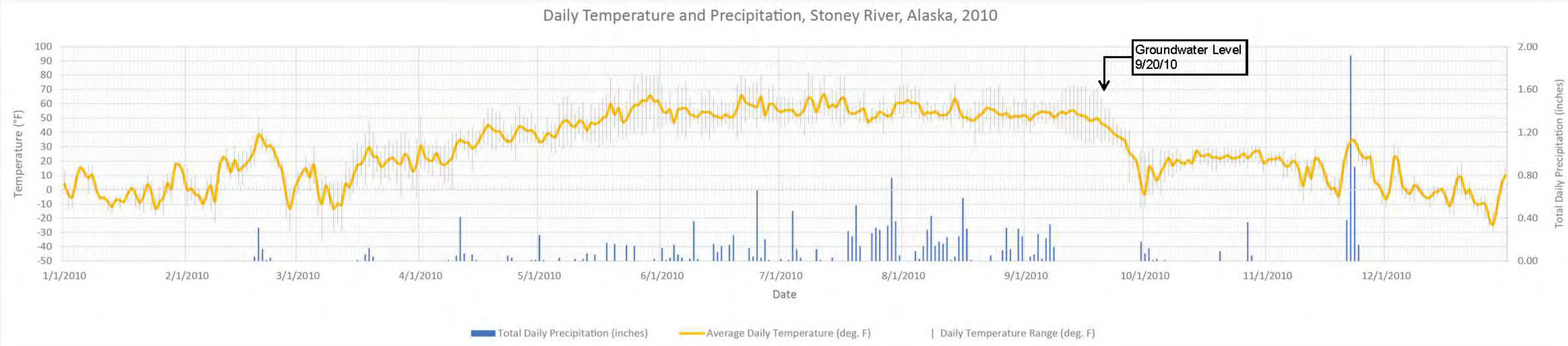


Figure 3-17 Daily Precipitation and Temperature, Stoney River, Alaska, 2010-2018



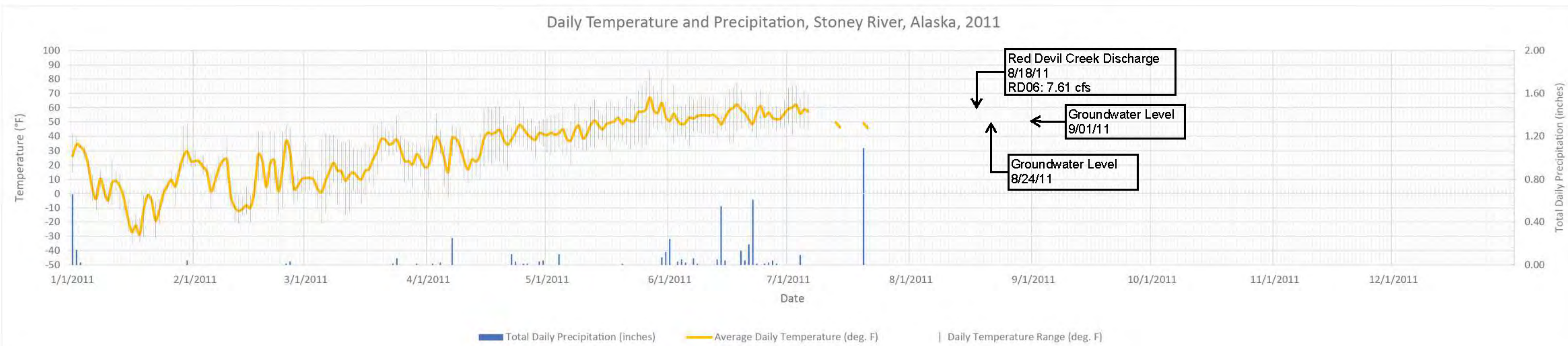
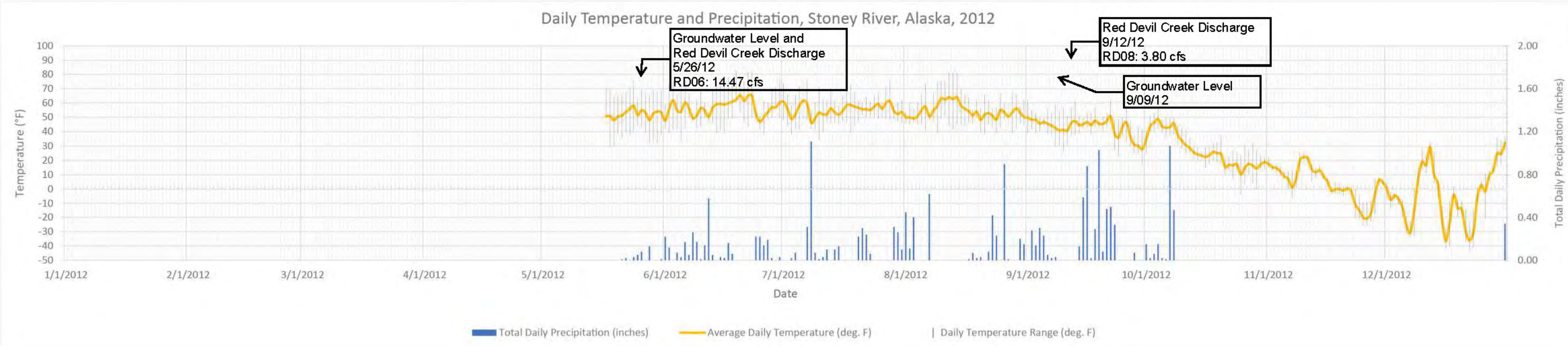


Figure 3-17 Daily Precipitation and Temperature, Stoney River, Alaska, 2010-2018



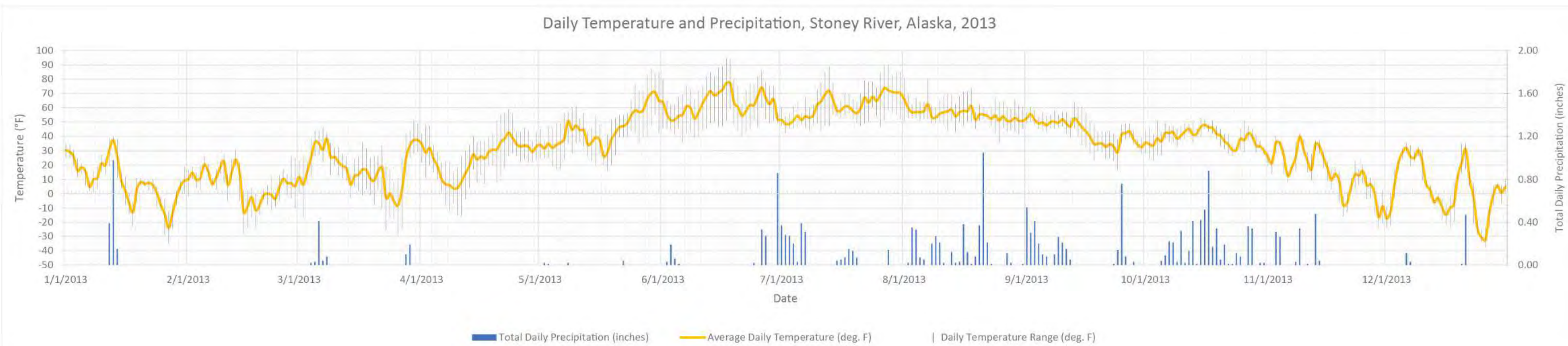
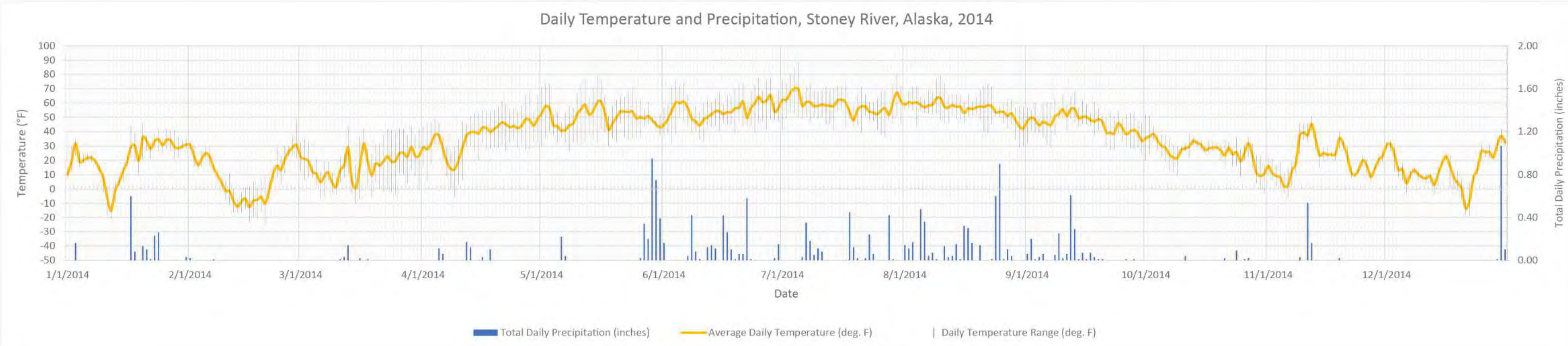


Figure 3-17 Daily Precipitation and Temperature, Stoney River, Alaska, 2010-2018



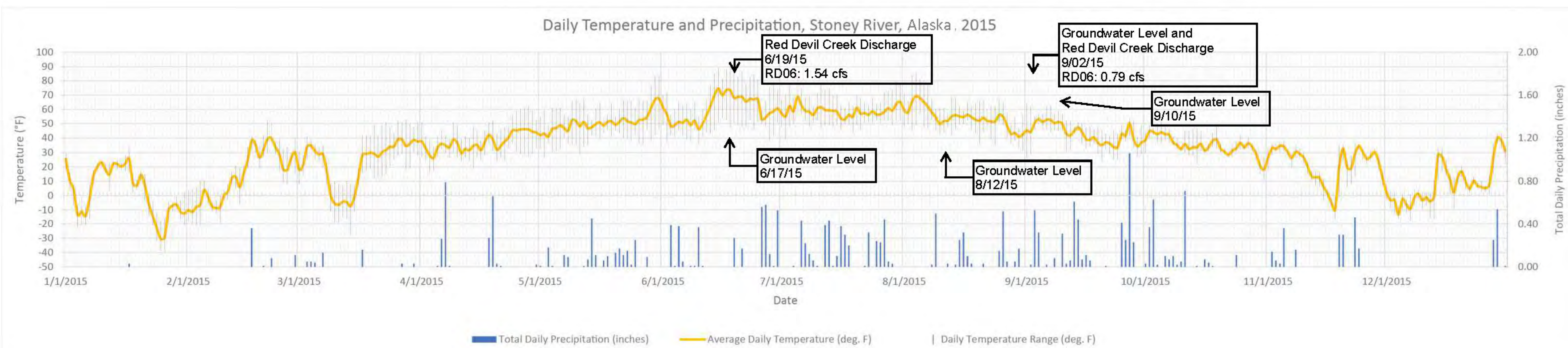
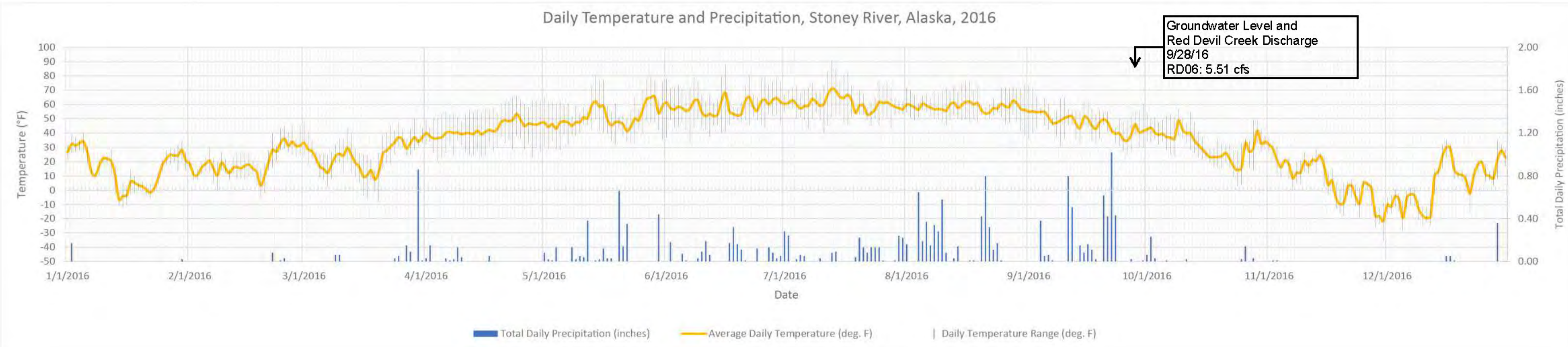


Figure 3-17 Daily Precipitation and Temperature, Stoney River, Alaska, 2010-2018



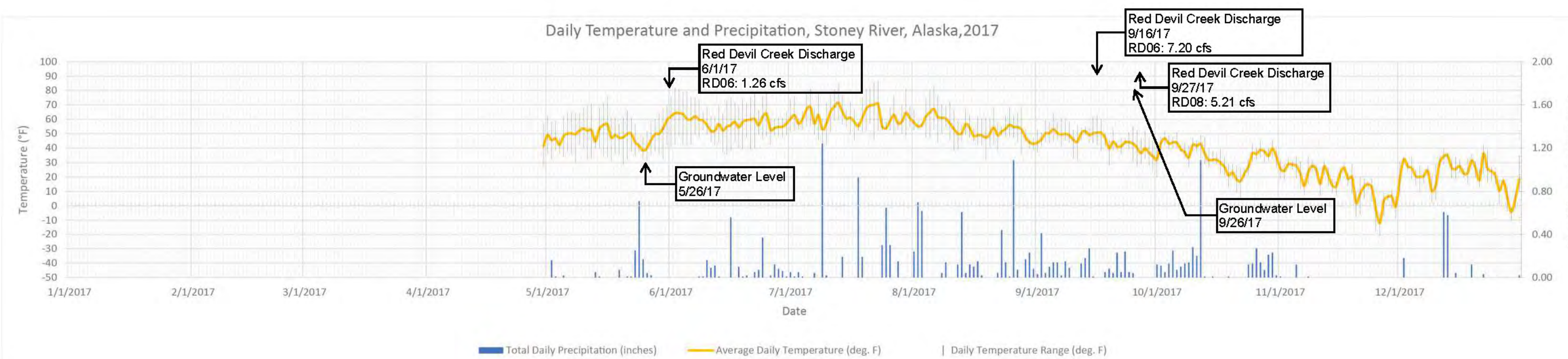
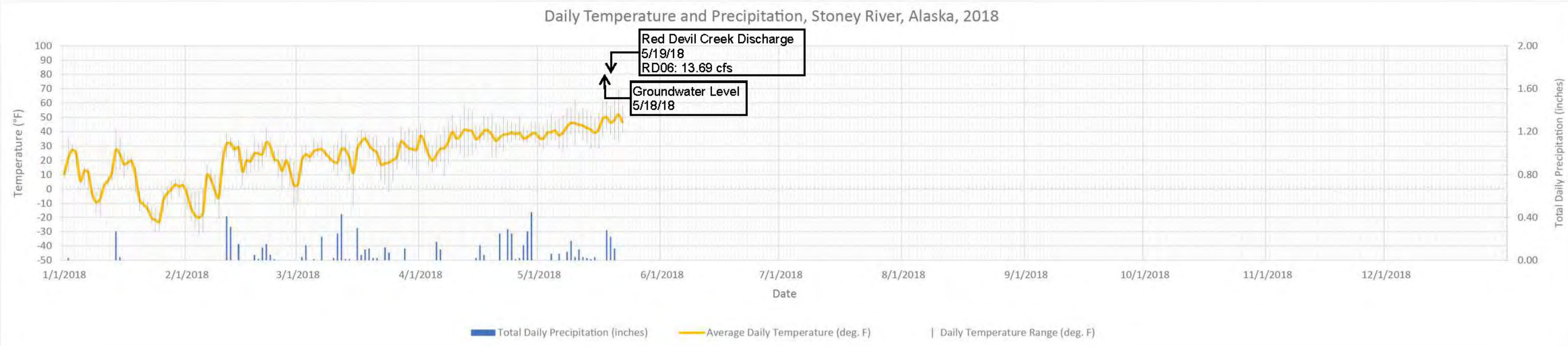


Figure 3-17 Daily Precipitation and Temperature, Stoney River, Alaska, 2010-2018



4 Surface Water

Surface water conditions at the RDM have been characterized as part of the RI and RI Supplement. Baseline surface water monitoring activities have been performed at the RDM in 2012, 2015, and between 2016 and 2018. Methods of the RI and RI Supplement surface water characterization and the baseline monitoring performed in 2012 and 2015 were presented in the RI and RI Supplement reports and are briefly summarized in Section 4.1.1 below. Methods of the 2016 to 2018 baseline monitoring are presented in Section 4.1.2. Results of the RI and RI Supplement surface water characterization and the baseline monitoring performed in 2012 and 2015 were presented in the RI and RI Supplement reports. Results of the 2016 to 2018 baseline monitoring are presented in Section 4.2. Key findings of surface water characterization and baseline monitoring performed to date are synthesized in Section 4.2.

4.1 Surface Water Characterization and Monitoring Activities

4.1.1 RI and RI Supplement

Surface water is present at the RDM in Red Devil Creek, a seep located on the left bank of Red Devil Creek in the Main Processing Area, and the Kuskokwim River. Surface water in Red Devil Creek and the seep was characterized as part of the RI and RI Supplement. RI and RI Supplement surface water monitoring locations are shown in Figures 4-1 and 4-2, respectively. Characterization activities and methods are presented in Chapter 2 of the RI report and Chapter 4 of the RI Supplement report.

4.1.2 Baseline Surface Water Monitoring

The BLM initiated baseline groundwater and surface water monitoring in 2012 to augment the RI results to characterize pre-remedial action conditions and identify seasonal and annual trends in flow, contaminant concentrations, and loading. The 2012 baseline monitoring was performed following the 2012 Baseline Monitoring Work Plan (E & E 2012). The 2012 baseline surface water monitoring locations are shown in Figure 4-3. The 2012 baseline activities and methods are presented in Appendix A of the RI report.

A second round of baseline monitoring of groundwater and surface water was performed in the spring and fall 2015. The 2015 baseline monitoring was performed in conjunction with additional surface water characterization conducted as part of the RI Supplement, described above. Surface water monitoring locations are shown in Figure 3-2.

Baseline surface water monitoring was continued in the fall of 2016, spring and fall of 2017, and spring of 2018 following methods defined in the 2016 Baseline Monitoring Work Plan (E & E 2016b). Surface water monitoring locations are shown in Figure 4-4. Surface water sample collection is summarized in Tables 4-1 through 4-4. Results of the baseline monitoring performed from 2016 to 2018 are presented in Section 4.2. Analytical data were validated by an E & E chemist. The results of laboratory analytical data validation are summarized in Data Review Memoranda for each laboratory data deliverable and are presented in Appendix A.

4.2 Surface Water Characterization and Monitoring Results

Surface water at the RDM has been characterized and monitored over the course of the RI, RI Supplement, and baseline monitoring. The RI results are detailed in Chapters 3, 4, and 5 of the RI report. The RI Supplement results are detailed in Chapter 4 of the RI Supplement report. Results of the baseline groundwater monitoring are combined with RI and RI Supplement results and presented below.

Significant modification was made to Red Devil Creek in 2014 as part of the NTCRA to address migration of tailings/waste rock into the Kuskokwim River. Several of the surface water monitoring stations established during the RI were destroyed as part of the NTCRA. New monitoring stations were established as part of 2015 baseline monitoring. The new stations were established at locations that allowed continuous assessment of surface water flow and quality throughout the entire monitoring period.

4.2.1 Stream Discharge

Estimated surface water discharge calculations for Red Devil Creek surface water stations monitored during the RI, RI Supplement, and baseline monitoring are presented in Table 4-5. Estimated discharge values also are presented graphically for each monitoring event in Figure 4-5. In each of the charts in Figure 4-5, the locations of Red Devil Creek monitoring stations are arrayed from upstream (left) to downstream (right), with the seep positioned on the charts at the locations where the seep drains into the Red Devil Creek channel. During each monitoring event, the stream discharge commonly increased slightly from upstream to downstream, consistent with observations of elevations of the stream bed relative to groundwater elevations in nearby monitoring wells, indicating generally gaining conditions and the conclusion that groundwater in the Main Processing Area and part of the Surface Mines Area emerges as surface water in the creek.

The amount of increase of stream discharge between location RD10, located near the upstream end of the Main Processing Area, and downstream locations RD06 and RD08 is generally consistent with the respective increases in the drainage areas contributing to stream flow at those locations. The total Red Devil Creek drainage area contributing to flow at location RD08 is approximately 1.080 square miles, and the drainage area contributing to flow at location RD10 is approximately 0.921 square mile. The difference between the drainage areas contributing to flow at RD10 and RD08—approximately 0.159 square mile—is equal to approximately 15 percent of the total drainage area at location RD08.

4.2.2 Surface Water Quality

At the selected surface water monitoring locations along Red Devil Creek and the seep, surface water was sampled for field and laboratory water quality parameters. Laboratory results and field water quality measurements of RI surface water samples are detailed in Chapters 4 and 5 of the RI report. Results for RI Supplement samples are detailed in Chapter 4 of the RI Supplement report. Surface water sample results for the 2016 to 2018 baseline monitoring are presented in Tables 4-6 through 4-9.

Results for primary COCs—total and dissolved antimony, total and dissolved arsenic, and total and dissolved mercury—and sulfate and discharge measurement are presented graphically in Figure 4-5. In each of the charts in Figure 4-5, the locations of Red Devil Creek monitoring stations are arrayed from upstream (left) to downstream (right), with the seep positioned on the charts at the locations where the seep drains into the Red Devil Creek channel. RI, RI Supplement, and baseline surface water results consistently indicate a significant increase in total and dissolved antimony, arsenic, and mercury concentrations between stations RD03 and RD09. Downstream of RD09, concentrations typically remain relatively constant or increase slightly (see Figure 4-5).

Although there is some variability in the magnitude of concentrations between sampling events, the overall trend is reasonably consistent over time. This trend suggests that COC concentrations are directly and primarily influenced by emerging groundwater for most sampling events. The May 2018 baseline surface water sampling was conducted a short period of time after a flood event occurred as a result of a breach of the beaver dam at the upstream reservoir. The flood resulted in damage to the stream control structures constructed in the 2014 NTCRA. As a result of the flood damage, the Red Devil Creek surface water was turbid at the time of sampling. The total mercury concentrations observed in the May 2018 samples are notably higher than those observed in previous sampling events, likely attributable to the elevated turbidity resulting from the flood damage noted above.

4.2.3 Surface Water Contaminant Loading and Transport

The RI, RI Supplement, baseline monitoring, and 2017 characterization results show that transport of contaminants in surface water is occurring presently at the RDM. Contaminant loading (e.g., antimony, arsenic, mercury, and methylmercury) along Red Devil Creek as it flows through the Main Processing Area is attributable to groundwater migration into the stream along gaining reaches and erosion and entrainment of particulates. Groundwater emerges to surface water as Red Devil Creek baseflow and possibly the seep located adjacent to the creek in the Main Processing Area.

The primary source of inorganics in groundwater in the Main Processing Area is leaching from tailings/waste rock. The highest concentrations of COCs in groundwater are observed in wells screened within or downgradient of saturated tailings/waste rock. Another source includes naturally mineralized bedrock and native soils. Based on results of the groundwater characterization (see Chapter 3), groundwater flow in portions of the Surface Mined Area is controlled by the system of interconnected underground mine workings. The mine workings provide a preferential flow pathway of groundwater in areas drained by the mine workings from the Surface Mined Area the Red Devil Creek valley. Some of this groundwater discharges to Red Devil Creek in the Main Processing Area and downstream Red Devil Creek alluvial area and enters the Kuskokwim River as surface water, and some of the groundwater discharges directly to the Kuskokwim River groundwater flow (see Section 3.9). The groundwater investigation results demonstrate that the groundwater that flows into the underground mine workings network is impacted by the natural sub-ore grade mineralization associated with the Red Devil Mine ore zones and the mine workings, and that much of this groundwater emerges into Red Devil Creek within the Main Processing Area and is a source of impacts to Red Devil Creek.

Total concentrations of antimony and arsenic are typically only slightly higher than the dissolved concentrations at each sample location throughout most of Red Devil Creek. This was interpreted in the final RI report to indicate that transport of antimony and arsenic in Red Devil Creek surface water was dominated by dissolved phase transport at the times of monitoring. This is further evidenced by field measurements of turbidity and laboratory analysis of total suspended solids that indicate low turbidity and total suspended solids concentrations at the times of sampling. Such dissolved phase transport also is concluded to be the dominant transport mechanism at the times of sampling prior to the May 2018 baseline monitoring event. The May 2018 baseline surface water sampling was conducted a short period of time after a flood event occurred as a result of a breach of the beaver dam at the upstream reservoir. The flood resulted in damage to the stream control structures constructed in the 2014 NTCRA. As a result of the flood damage, the Red Devil Creek surface water was turbid at the time of sampling.

In contrast to antimony and arsenic concentrations, mercury transport in surface water in Red Devil Creek includes substantial transport by particulate phases that are larger than 0.45 micrometers (the pore size of the filters used to collect the dissolved phase aliquots) at the times of sampling. Total concentrations of mercury in surface water were substantially higher (up to more than an order of magnitude) than the dissolved mercury concentrations at each surface water sample location within and downstream of the Main Processing Area for all sampling events. The total mercury concentrations observed in the May 2018 samples are notably higher than those observed in previous sampling events, likely attributable to the elevated turbidity resulting from the flood damage noted above.

Table 4-1 Summary of Surface Water Samples, Fall 2016 Baseline Monitoring

Location ID	Sample Date	Analyses									
		Total TAL Metals	Dissolved TAL Metals	Total Low-Level Mercury	Dissolved Low-Level Mercury	Inorganic Ions (Cl, F, SO_4)	Total Dissolved Solids	Total Suspended Solids	Nitrate/ Nitrite	Carbonate, Bicarbonate	Total Organic Carbon
RD05	9/29/2016	X	X	X	X	X	X	X	X	X	X
RD06	9/28/2016	X	X	X	X	X	X	X	X	X	X
RD08	9/28/2016	X	X	X	X	X	X	X	X	X	X
RD09	9/29/2016	X	X	X	X	X	X	X	X	X	X
RD10	9/29/2016	X	X	X	X	X	X	X	X	X	X
RD14	9/29/2016	X	X	X	X	X	X	X	X	X	X
RD15	9/29/2016	X	X	X	X	X	X	X	X	X	X

Key:

Cl = chloride

F = fluoride

SO_4 = sulfate

TAL = Target Analyte List

Table 4-2 Summary of Surface Water Samples, Spring 2017 Baseline Monitoring

Location ID	Sample Date	Analyses									
		Total TAL Metals	Dissolved TAL Metals	Total Low-Level Mercury	Dissolved Low-Level Mercury	Inorganic Ions (Cl, F, SO_4)	Total Dissolved Solids	Total Suspended Solids	Nitrate/ Nitrite	Carbonate, Bicarbonate	Total Organic Carbon
RD05	5/26/2017	X	X	X	X	X	X	X	X	X	X
RD06	5/26/2017	X	X	X	X	X	X	X	X	X	X
RD08	5/26/2017	X	X	X	X	X	X	X	X	X	X
RD09	5/26/2017	X	X	X	X	X	X	X	X	X	X
RD10	5/26/2017	X	X	X	X	X	X	X	X	X	X
RD14	5/26/2017	X	X	X	X	X	X	X	X	X	X
RD15	5/26/2017	X	X	X	X	X	X	X	X	X	X

Key:

Cl = chloride

F = fluoride

SO_4 = sulfate

TAL = Target Analyte List

Table 4-3 Summary of Surface Water Samples, Fall 2017 Baseline Monitoring

Location ID	Sample Date	Analyses									
		Total TAL Metals	Dissolved TAL Metals	Total Low-Level Mercury	Dissolved Low-Level Mercury	Inorganic Ions (Cl, F, SO_4)	Total Dissolved Solids	Total Suspended Solids	Nitrate/ Nitrite	Carbonate, Bicarbonate	Total Organic Carbon
RD05	9/15/2017	X	X	X	X	X	X	X	X	X	X
RD06	9/15/2017	X	X	X	X	X	X	X	X	X	X
RD08	9/15/2017	X	X	X	X	X	X	X	X	X	X
RD09	9/15/2017	X	X	X	X	X	X	X	X	X	X
RD10	9/15/2017	X	X	X	X	X	X	X	X	X	X
RD14	9/15/2017	X	X	X	X	X	X	X	X	X	X
RD15	9/15/2017	X	X	X	X	X	X	X	X	X	X

Key:

Cl = chloride

F = fluoride

SO_4 = sulfate

TAL = Target Analyte List

Table 4-4 Summary of Surface Water Samples, Spring 2018 Baseline Monitoring

Location ID	Sample Date	Analyses									
		Total TAL Metals	Dissolved TAL Metals	Total Low-Level Mercury	Dissolved Low-Level Mercury	Inorganic Ions (Cl, F, SO_4)	Total Dissolved Solids	Total Suspended Solids	Nitrate/ Nitrite	Carbonate, Bicarbonate	Total Organic Carbon
RD05	5/19/2018	X	X	X	X	X	X	X	X	X	X
RD06	5/19/2018	X	X	X	X	X	X	X	X	X	X
RD08	5/19/2018	X	X	X	X	X	X	X	X	X	X
RD09	5/19/2018	X	X	X	X	X	X	X	X	X	X
RD10	5/19/2018	X	X	X	X	X	X	X	X	X	X
RD14	5/19/2018	X	X	X	X	X	X	X	X	X	X
RD15	5/19/2018	X	X	X	X	X	X	X	X	X	X

Key:

Cl = chloride

F = fluoride

SO_4 = sulfate

TAL = Target Analyte List

Table 4-5 Red Devil Creek and Seep Discharge

Monitoring Location[1]	Estimated Discharge (cfs)									
	August 18, 2011	May 26, 2012	September 12, 2012	June 19, 2015	September 2, 2015	September 28 & 29, 2016	June 1, 2017[2]	September 16, 2017	September 27, 2017	May 19, 2018
RD02	5.96	Station not monitored	Station not monitored	Station not monitored	Station not monitored	Station not monitored	Station not monitored	Station not monitored	Station not monitored	Station not monitored
RD03	4.09	Station not monitored	Station not monitored	Station not monitored	Station not monitored	Station not monitored	Station not monitored	Station not monitored	Station not monitored	Station not monitored
RD10	5.52	9.03	4.48	1.25	0.48	2.45	1.20	5.19	Station not monitored	11.60
RD11	Station not established	12.18	4.64	Station not monitored	Station not monitored	Station not monitored	Station not monitored	Station not monitored	Station not monitored	Station not monitored
RD14	Station not established	Station not established	Station not established	1.41	0.54	3.01	1.54	6.35	Station not monitored	10.84
RD04	5.95	12.67	3.45	Station not monitored	Station not monitored	Station not monitored	Station not monitored	Station not monitored	Station not monitored	Station not monitored
RD12	8.24	10.53	3.79	Station not monitored	Station not monitored	Station not monitored	Station not monitored	Station not monitored	Station not monitored	Station not monitored
RD13	Station not established	Station not monitored	Station not monitored	Station not monitored	Station not monitored	Station not monitored	Station not monitored	Station not monitored	Station not monitored	Station not monitored
RD15	Station not established	Station not established	Station not established	1.40	0.67	3.53	1.91	6.85	Station not monitored	15.80
RD05 (seep)	0.18	Station not monitored	0.16	0.23	0.19	0.35	0.01	0.05	Station not monitored	0.33
RD16	Station not established	Station not established	Station not established	1.61	0.60	Station not monitored	Station not monitored	Station not monitored	Station not monitored	Station not monitored
RD09	5.98	13.36	3.40	1.40	0.80	2.43	1.55	6.23	Station not monitored	14.87
RD06	6.81	14.47	3.80	1.54	0.79	5.51	1.26	7.08	Station not monitored	13.69
RD07	7.61	Not monitored	3.61	Station not monitored	Station not monitored	Station not monitored	Station not monitored	Station not monitored	Station not monitored	Station not monitored
RD08	7.19	14.20	3.09	1.90	0.81	Station Inaccessible	2.15	7.38	5.21	10.41

Notes:

[1] Locations are organized from upstream to downstream along Red Devil Creek

[2] Flow at RD05 measured using 'bucket method.' Water was collected in a 5-liter volumetric container for 10 seconds. This process was repeated 5 times to generate an average volume per time.

Key:

cfs Cubic feet per second

Table 4-6 Surface Water Sample Results, Fall 2016

Analyte	Station ID		Units	Water Quality Comparison Criteria					RD10	RD14	RD15	RD05	RD09	RD06	RD08
	Geographic Area			Hardness-Dependent Aquatic Life Water Quality Criterion	National Recommended Water Quality Criteria; Fresh Water; Aquatic Life Criteria; CMC - Acute (1)	National Recommended Water Quality Criteria; Fresh Water; Aquatic Life Criteria; CCC - Chronic (2)	Alaska Water Quality Criteria for Toxics and Other Deleterious Substances; Aquatic Life for Fresh Water; Acute - CMC (3)	Alaska Water Quality Criteria for Toxics and Other Deleterious Substances; Aquatic Life for Fresh Water; Chronic - CCC (4)	Red Devil Creek	Red Devil Creek	Red Devil Creek	Seep	Red Devil Creek	Red Devil Creek	Red Devil Creek
	Sample ID								0916RD10SW	0916RD14SW	0916RD15SW	0916RD05SW	0916RD09SW	0916RD06SW	0916RD08SW
	Method														
Total Inorganic Elements															
Aluminum	Metals (ICP)	SW846 6010B	µg/L						190 U	190 U	190 U	190 U	190 U	190 U	190 U
Antimony	Metals (ICP/MS)	SW846 6020A	µg/L						**1.7 J**	**31 J**	**90**	**260**	**220**	**26**	**290**
Arsenic	Metals (ICP/MS)	SW846 6020A	µg/L						**1.7 J**	**18 J**	**35**	**100**	**92**	**930**	**110**
Barium	Metals (ICP/MS)	SW846 6020A	µg/L						**21**	**23**	**23**	**28**	**26**	**110**	**28**
Beryllium	Metals (ICP/MS)	SW846 6020A	µg/L						0.51 U	0.51 U	0.51 U	0.51 U	0.51 U	0.51 U	0.51 U
Cadmium	Metals (ICP/MS)	SW846 6020A	µg/L						0.14 U	0.14 U	0.14 U	0.14 U	0.14 U	0.14 U	0.14 U
Calcium	Metals (ICP)	SW846 6010B	µg/L						**16000**	**14000**	**15000**	**16000**	**15000**	**39000**	**16000**
Chromium	Metals (ICP/MS)	SW846 6020A	µg/L						0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U
Cobalt	Metals (ICP/MS)	SW846 6020A	µg/L						0.16 U	0.16 U	0.16 U	**0.22 J**	**0.21 J**	**4.5**	**0.18 J**
Copper	Metals (ICP/MS)	SW846 6020A	µg/L						3 U	3 U	3 U	3 U	3 U	3 U	3 U
Iron	Metals (ICP)	SW846 6010B	µg/L						**180 J**	180 U	180 U	**220 J**	**200 J**	**2400**	180 U
Lead	Metals (ICP/MS)	SW846 6020A	µg/L						0.27 U	0.17 U	0.17 U	0.17 U	0.17 U	0.17 U	0.17 U
Magnesium	Metals (ICP)	SW846 6010B	µg/L						**8400**	**8100**	**8300**	**9900**	**9600**	**40000**	**10000**
Manganese	Metals (ICP/MS)	SW846 6020A	µg/L						**15 J**	**14**	**19 J**	**37**	**35**	**400**	**36**
Mercury	Mercury (CVAA)	SW846 7470A	µg/L						0.041 U	0.041 U	0.041 U	0.041 U	**0.081 J**	0.041 U	**0.18 J**
Nickel	Metals (ICP/MS)	SW846 6020A	µg/L						2 U	2 U	2 U	2 U	2 U	**17**	2 U
Potassium	Metals (ICP)	SW846 6010B	µg/L						**310 J**	**290 J**	**250 J**	**310 J**	**320 J**	**1100 J**	**330 J**
Selenium	Metals (ICP/MS)	SW846 6020A	µg/L						1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U
Silver	Metals (ICP/MS)	SW846 6020A	µg/L						0.23 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U
Sodium	Metals (ICP)	SW846 6010B	µg/L						**1500 J**	**1700 J**	**1600 J**	**1800 J**	**1900 J**	**9900**	**2200**
Thallium	Metals (ICP/MS)	SW846 6020A	µg/L						0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U
Vanadium	Metals (ICP/MS)	SW846 6020A	µg/L						4.9 U	4.9 U	4.9 U	4.9 U	4.9 U	4.9 U	4.9 U
Zinc	Metals (ICP/MS)	SW846 6020A	µg/L						9.5 U	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U
Total Low Level Mercury															
Mercury	Total Mercury by EPA 1631	EPA 1631	ng/L						**5.62**	**28.9**	**78.4**	**35.6**	**117**	**130**	**228 J**

Table 4-6 Surface Water Sample Results, Fall 2016

Analyte	Station ID		Units	Water Quality Comparison Criteria					RD10	RD14	RD15	RD05	RD09	RD06	RD08
	Geographic Area			Hardness-Dependent Aquatic Life Water Quality Criterion	National Recommended Water Quality Criteria; Fresh Water; Aquatic Life Criteria; CMC - Acute (1)	National Recommended Water Quality Criteria; Fresh Water; Aquatic Life Criteria; CCC - Chronic (2)	Alaska Water Quality Criteria for Toxics and Other Deleterious Substances; Aquatic Life for Fresh Water; Acute - CMC (3)	Alaska Water Quality Criteria for Toxics and Other Deleterious Substances; Aquatic Life for Fresh Water; Chronic - CCC (4)	Red Devil Creek	Red Devil Creek	Red Devil Creek	Seep	Red Devil Creek	Red Devil Creek	Red Devil Creek
	Sample ID								0916RD10SW	0916RD14SW	0916RD15SW	0916RD05SW	0916RD09SW	0916RD06SW	0916RD08SW
	Method														
Dissolved Inorganic Elements															
Aluminum	Metals (ICP) (DISSOLVED)	SW846 6010B	µg/L		750	87	750	87	190 U	190 U	190 U	190 U	190 U	190 U	190 U
Antimony	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						**1.7 J**	**35 J**	**110**	**8.7**	**220**	**260**	**300**
Arsenic	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L		340	150	340	150	1.4 U	**20**	**41**	**810**	**90**	**100**	**100**
Barium	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						**23**	**22**	**23**	**110**	**26**	**27**	**29**
Beryllium	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						0.51 U	0.51 U	0.51 U	0.51 U	0.51 U	0.51 U	0.51 U
Cadmium	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L	H (5)(6)	1.3	0.57	1.5	0.20	**0.14 U**	**0.14 U**	**0.14 U**	**0.14 U**	**0.14 U**	**0.14 U**	**0.14 U**
Calcium	Metals (ICP) (DISSOLVED)	SW846 6010B	µg/L						**14000**	**14000**	**15000**	**38000**	**15000**	**16000**	**15000**
Chromium	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L	H (5)(6)	442	58	442	58	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U
Cobalt	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						0.16 U	0.16 U	0.16 U	**4.1**	**0.17 J**	**0.18 J**	**0.16 J**
Copper	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L	H (5)(6)(7)	--	--	10	6.9	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Iron	Metals (ICP) (DISSOLVED)	SW846 6010B	µg/L		--	1000	--	1000	180 U	180 U	180 U	**1900**	180 U	180 U	180 U
Lead	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L	H (5)(6)	46	1.8	46	1.8	0.17 U	0.17 U	0.17 U	**0.2 J**	0.17 U	0.17 U	0.17 U
Magnesium	Metals (ICP) (DISSOLVED)	SW846 6010B	µg/L						**7600**	**8000**	**8300**	**40000**	**9500**	**9800**	**9700**
Manganese	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						**7.9 J**	**9.7 J**	**19 J**	**390**	**28**	**31**	**30**
Mercury	Mercury (CVAA) (DISSOLVED)	SW846 7470A	µg/L		1.4	0.77	1.4	0.77	0.041 U	0.041 U	0.041 U	0.041 U	0.041 U	0.041 U	0.041 U
Nickel	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L	H (5)(6)	360	40	360	40	2 U	2 U	2 U	**14 J**	2 U	2 U	2 U
Potassium	Metals (ICP) (DISSOLVED)	SW846 6010B	µg/L						**280 J**	**310 J**	**280 J**	**1200 J**	**370 J**	**380 J**	**400 J**
Selenium	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U
Silver	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L	H (5)	1.9	--	1.9	—	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U
Sodium	Metals (ICP) (DISSOLVED)	SW846 6010B	µg/L						**1400 J**	**1500 J**	**1500 J**	**9300**	**1800 J**	**1900 J**	**1900 J**
Thallium	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U
Vanadium	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						4.9 U	4.9 U	4.9 U	4.9 U	4.9 U	4.9 U	4.9 U
Zinc	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L	H (5)(6)	90	91	90	91	**11 J**	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U
Dissolved Low Level Mercury															
Mercury	Dissolved Mercury by EPA 1631	EPA 1631	ng/L		1400	770	1400	770	**3.22**	**14.6**	**15.9**	**2.10**	**12.9**	**16.0**	**654 J**

Table 4-6 Surface Water Sample Results, Fall 2016

Analyte	Station ID		Units	Water Quality Comparison Criteria					RD10	RD14	RD15	RD05	RD09	RD06	RD08
	Geographic Area			Hardness-Dependent Aquatic Life Water Quality Criterion	National Recommended Water Quality Criteria; Fresh Water; Aquatic Life Criteria; CMC - Acute (1)	National Recommended Water Quality Criteria; Fresh Water; Aquatic Life Criteria; CCC - Chronic (2)	Alaska Water Quality Criteria for Toxics and Other Deleterious Substances; Aquatic Life for Fresh Water; Acute - CMC (3)	Alaska Water Quality Criteria for Toxics and Other Deleterious Substances; Aquatic Life for Fresh Water; Chronic - CCC (4)	Red Devil Creek	Red Devil Creek	Red Devil Creek	Seep	Red Devil Creek	Red Devil Creek	Red Devil Creek
	Sample ID								0916RD10SW	0916RD14SW	0916RD15SW	0916RD05SW	0916RD09SW	0916RD06SW	0916RD08SW
	Method														
General Chemistry															
Total Organic Carbon	Organic Carbon, Total (TOC)	SW846 9060	mg/L						**2.5**	**2.5**	**2.5**	**1.2**	**2.5**	**2.4**	**2.6**
Total Dissolved Solids	Solids, Total Dissolved (TDS)	SM 2540C	mg/L						**73 J**	**65 J**	**67 J**	**260 J**	**83 J**	**80 J**	**78 J**
Total Suspended Solids	Solids, Total Suspended (TSS)	SM 2540D	mg/L						2 U	2 U	2 U	**3.8 J**	2 U	2 U	2 U
Chloride	Anions, Ion Chromatography	MCAWW 300.0	mg/L		860	230	860	230	**0.97 J+**	**1.1**	**0.98**	**0.7 J**	**1**	**0.96**	**1.1**
Fluoride	Anions, Ion Chromatography	MCAWW 300.0	mg/L						0.03 U	0.03 U	0.03 U	**0.07 J**	0.03 U	0.03 U	0.03 U
Sulfate	Anions, Ion Chromatography	MCAWW 300.0	mg/L						**7.1 J+**	**7.2**	**8.1**	**38**	**10**	**10**	**11**
Carbonate Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L						5 U	5 U	5 U	5 U	5 U	5 U	5 U
Bicarbonate Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L						**66**	**69**	**64**	**250**	**69**	**70**	**68**
Hydroxide Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L						5 U	5 U	5 U	5 U	5 U	5 U	5 U
Alkalinity	Alkalinity	SM 2320B	mg/L		--	20	--	20	**66**	**69**	**64**	**250**	**69**	**70**	**68**
Nitrate Nitrite as N	Nitrogen, Nitrate-Nitrite	MCAWW 353.2	mg/L						**0.21 J-**	**0.21 J**	**0.21 J**	0.026 U	**0.19 J**	**0.2 J**	**0.2 J**
Hardness	Hardness as CaCO3	Calculated	mg/L						**66**	**68**	**72**	**260**	**77**	**80**	**77**
Field Water Quality Parameters															
Temperature	Field Measurement		Deg C						4.72	4.55	4.43	3.52	4.32	5.16	6.62
pH	Field Measurement		pH Units			6.5 - 9.0		6.5 - 8.5	7.18	6.5	6.46	5.93	6.03	5.82	6.92
Conductivity	Field Measurement		mS/cm						0.143	0.143	0.147	0.52	0.166	0.154	0.208
Turbidity	Field Measurement		NTU						3.1	2.7	16.2	4.9	3.2	2	0
Dissolved Oxygen	Field Measurement		mg/L					≥ 4	9.09	9.79	9.38	4.18	9.82	11.14	10.3
Oxidation-Reduction Potential	Field Measurement		mV						113	133	90	109	207	240	204

Key

µg/L = Micrograms per liter

ADEC = Alaska Department of Environmental Conservation

Bold = Detected

CCC = Criteria Continuous Concentration

CMC = Criteria Maximum Concentration

Deg C = Degrees Celsius.

EPA = United States Environmental Protection Agency

GC/MS = Gas Chromatography/Mass Spectrometry

H = Hardness-dependent water quality criterion for aquatic life.

ICP/ MS = Inductively coupled plasma/mass spectrometry

J = The analyte was detected. The associated result is estimated. "+" indicates high bias and "-" indicates low bias.

mg/L = milligrams per liter

mS/cm = Millisiemens per centimeter

mV = Millivolts

ng/L = Nanograms per liter

NTU = Nephelometric turbidity units

U = The analyte was analyzed for but not detected. The value provided is the method detection limit.

UJ = The analyte was analyzed for but not detected. The associated reporting limit is estimated.

Shading = Sample concentration exceeds one or more WQC value.

Notes

(1) USEPA. 2016. National Recommended Water Quality Criteria - Aquatic Life Criteria. Accessed on May 9, 2017 at: https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table#table

(2) USEPA. 2016. National Recommended Water Quality Criteria - Aquatic Life Criteria. Accessed on May 9, 2017 at: https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table#table

(3) ADEC. 2008. Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances (as amended through December 12, 2008). ADEC, Anchorage, Alaska

(4) ADEC. 2008. Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances (as amended through December 12, 2008). ADEC, Anchorage, Alaska

(5) Calculated total hardness as CaCO3 = Calcium Hardness (mg/L as CaCO3) + Magnesium Hardness (mg/L as CaCO3)

(6) Hardness-adjusted criterion value was calculated following EPA 2016 and ADEC 2008. A total hardness value of **73.4** mg/L as CaCO3, based on the average value for Red Devil Creek surface water samples, is assumed.

(7) As of 2017 the USEPA no longer considers copper to be hardness-dependent.

Table 4-7 Surface Water Sample Results, Spring 2017

Analyte	Station ID		Units	Water Quality Comparison Criteria					RD10	RD14	RD15	RD05	RD09	RD06	RD08
	Geographic Area			Hardness-Dependent Aquatic Life Water Quality Criterion	National Recommended Water Quality Criteria; Fresh Water; Aquatic Life Criteria; CMC - Acute (1)	National Recommended Water Quality Criteria; Fresh Water; Aquatic Life Criteria; CCC - Chronic (2)	Alaska Water Quality Criteria for Toxics and Other Deleterious Substances; Aquatic Life for Fresh Water; Acute - CMC (3)	Alaska Water Quality Criteria for Toxics and Other Deleterious Substances; Aquatic Life for Fresh Water; Chronic - CCC (4)	Red Devil Creek	Red Devil Creek	Red Devil Creek	Seep	Red Devil Creek	Red Devil Creek	Red Devil Creek
	Sample ID								0517RD10SW	0517RD14SW	0517RD15SW	0517RD05SW	0517RD09SW	0517RD06SW	0517RD08SW
	Method														
Total Inorganic Elements															
Aluminum	Metals (ICP)	SW846 6010B	µg/L						110 U	**320 J**	**140 J**	110 U	110 U	110 U	110 U
Antimony	Metals (ICP/MS)	SW846 6020A	µg/L						**2.2**	**18**	**40**	**17**	**95**	**130**	**170**
Arsenic	Metals (ICP/MS)	SW846 6020A	µg/L						**1.4 J**	**8.2**	**12**	**1300**	**61**	**73**	**79**
Barium	Metals (ICP/MS)	SW846 6020A	µg/L						**24**	**31**	**26**	**100**	**29**	**29**	**29**
Beryllium	Metals (ICP/MS)	SW846 6020A	µg/L						0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U
Cadmium	Metals (ICP/MS)	SW846 6020A	µg/L						0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Calcium	Metals (ICP)	SW846 6010B	µg/L						**13000**	**13000**	**13000**	**36000**	**14000**	**15000**	**14000**
Chromium	Metals (ICP/MS)	SW846 6020A	µg/L						0.71 U	**0.75 J**	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U
Cobalt	Metals (ICP/MS)	SW846 6020A	µg/L						0.16 U	**0.29 J**	0.16 U	**5**	**0.25 J**	**0.25 J**	**0.17 J**
Copper	Metals (ICP/MS)	SW846 6020A	µg/L						3 U	3 U	3 U	3 U	3 U	3 U	3 U
Iron	Metals (ICP)	SW846 6010B	µg/L						**260 J**	**800**	**330 J**	**2700**	**320 J**	**390 J**	**290 J**
Lead	Metals (ICP/MS)	SW846 6020A	µg/L						1 U	1 U	1 U	1 U	1 U	1 U	1 U
Magnesium	Metals (ICP)	SW846 6010B	µg/L						**7600**	**7600**	**7500**	**38000**	**9000**	**9400**	**9300**
Manganese	Metals (ICP/MS)	SW846 6020A	µg/L						**16**	**54**	**31**	**400**	**47**	**45**	**35**
Mercury	Mercury (CVAA)	SW846 7470A	µg/L						0.15 U	0.15 U	**0.15 J**	0.15 U	**0.19 J**	**0.26 J**	**0.24 J**
Nickel	Metals (ICP/MS)	SW846 6020A	µg/L						0.54 U	**0.92 J**	**0.66 J**	**17**	**1.3 J**	**1.2 J**	**1.1 J**
Potassium	Metals (ICP)	SW846 6010B	µg/L						**530 J**	**540 J**	**500 J**	**1100 J**	**530 J**	**550 J**	**540 J**
Selenium	Metals (ICP/MS)	SW846 6020A	µg/L						10 U	10 U	10 U	10 U	10 U	10 U	10 U
Silver	Metals (ICP/MS)	SW846 6020A	µg/L						0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U
Sodium	Metals (ICP)	SW846 6010B	µg/L						**1200 J**	**1200 J**	**1200 J**	**11000**	**1500 J**	**1700 J**	**1700 J**
Thallium	Metals (ICP/MS)	SW846 6020A	µg/L						**0.42 J**	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
Vanadium	Metals (ICP/MS)	SW846 6020A	µg/L						2.3 U	2.3 U	2.3 U	2.3 U	2.3 U	2.3 U	2.3 U
Zinc	Metals (ICP/MS)	SW846 6020A	µg/L						9.5 U	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U
Total Low Level Mercury															
Mercury	Total Mercury by EPA 1631	EPA 1631	ng/L						**19.7**	**202**	**169**	**34.2**	**269**	**403**	**349**

Table 4-7 Surface Water Sample Results, Spring 2017

Analyte	Station ID / Geographic Area / Sample ID / Method		Units	Water Quality Comparison Criteria: Hardness-Dependent Aquatic Life Water Quality Criterion	National Recommended Water Quality Criteria; Fresh Water; Aquatic Life Criteria; CMC - Acute (1)	National Recommended Water Quality Criteria; Fresh Water; Aquatic Life Criteria; CCC - Chronic (2)	Alaska Water Quality Criteria for Toxics and Other Deleterious Substances; Aquatic Life for Fresh Water; Acute - CMC (3)	Alaska Water Quality Criteria for Toxics and Other Deleterious Substances; Aquatic Life for Fresh Water; Chronic - CCC (4)	RD10 Red Devil Creek 0517RD10SW	RD14 Red Devil Creek 0517RD14SW	RD15 Red Devil Creek 0517RD15SW	RD05 Seep 0517RD05SW	RD09 Red Devil Creek 0517RD09SW	RD06 Red Devil Creek 0517RD06SW	RD08 Red Devil Creek 0517RD08SW
Dissolved Inorganic Elements															
Aluminum	Metals (ICP) (DISSOLVED)	SW846 6010B	µg/L		750	87	750	87	110 U	110 U	110 U	110 U	110 U	110 U	110 U
Antimony	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						**2.2**	**21**	**40**	**3.3**	**88**	**130**	**170**
Arsenic	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L		340	150	340	150	**1.5 J**	**8.2**	**11**	**1200**	**53**	**64**	**72**
Barium	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						**22**	**23**	**25**	**100**	**26**	**27**	**29**
Beryllium	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U
Cadmium	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L	H (5)(6)	1.3	0.54	1.4	0.19	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Calcium	Metals (ICP) (DISSOLVED)	SW846 6010B	µg/L						**14000**	**13000**	**13000**	**38000**	**14000**	**14000**	**15000**
Chromium	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L	H (5)(6)	418	54	418	54	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U
Cobalt	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						0.16 U	0.16 U	0.16 U	**4.1**	0.16 U	0.17 J	0.16 U
Copper	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L	H (5)(6)(7)	--	--	9	6.5	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Iron	Metals (ICP) (DISSOLVED)	SW846 6010B	µg/L		--	1000	--	1000	**160 J**	**170 J**	**140 J**	**2800**	**120 J**	**180 J**	120 U
Lead	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L	H (5)(6)	43	1.7	43	1.7	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Magnesium	Metals (ICP) (DISSOLVED)	SW846 6010B	µg/L						**7600**	**7700**	**7600**	**40000**	**8600**	**8800**	**9200**
Manganese	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						**11**	**19**	**25**	**380**	**38**	**40**	**27**
Mercury	Mercury (CVAA) (DISSOLVED)	SW846 7470A	µg/L		1.4	0.77	1.4	0.77	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U
Nickel	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L	H (5)(6)	340	38	340	38	0.54 U	0.54 U	0.54 U	**11 J**	**0.84 J**	**0.87 J**	**0.89 J**
Potassium	Metals (ICP) (DISSOLVED)	SW846 6010B	µg/L						**500 J**	**510 J**	**510 J**	**1200 J**	**500 J**	**500 J**	**500 J**
Selenium	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						10 U	10 U	10 U	10 U	10 U	10 U	10 U
Silver	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L	H (5)	1.7	--	1.7	—	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U
Sodium	Metals (ICP) (DISSOLVED)	SW846 6010B	µg/L						**1300 J**	**1200 J**	**1200 J**	**11000**	**1500 J**	**1700 J**	**1700 J**
Thallium	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						**0.46 J**	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
Vanadium	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						2.3 U	2.3 U	2.3 U	2.3 U	2.3 U	2.3 U	2.3 U
Zinc	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L	H (5)(6)	85	86	85	86	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U
Dissolved Low Level Mercury															
Mercury	Dissolved Mercury by EPA 1631	EPA 1631	ng/L		1400	770	1400	770	**7.22**	**11.2**	**27**	**7.27**	**17.4**	**18.7**	**21.5**

Table 4-7 Surface Water Sample Results, Spring 2017

Analyte			Units	Water Quality Comparison Criteria											
Station ID									RD10	RD14	RD15	RD05	RD09	RD06	RD08
Geographic Area				Hardness-Dependent Aquatic Life Water Quality Criterion	National Recommended Water Quality Criteria; Fresh Water; Aquatic Life Criteria; CMC - Acute (1)	National Recommended Water Quality Criteria; Fresh Water; Aquatic Life Criteria; CCC - Chronic (2)	Alaska Water Quality Criteria for Toxics and Other Deleterious Substances; Aquatic Life for Fresh Water; Acute - CMC (3)	Alaska Water Quality Criteria for Toxics and Other Deleterious Substances; Aquatic Life for Fresh Water; Chronic - CCC (4)	Red Devil Creek	Red Devil Creek	Red Devil Creek	Seep	Red Devil Creek	Red Devil Creek	Red Devil Creek
Sample ID									0517RD10SW	0517RD14SW	0517RD15SW	0517RD05SW	0517RD09SW	0517RD06SW	0517RD08SW
Method															
General Chemistry															
Total Organic Carbon	Organic Carbon, Total (TOC)	SW846 9060	mg/L						**4.83**	**4.7**	**4.6**	**1.6**	**4.4**	**4.4**	**4.2**
Total Dissolved Solids	Solids, Total Dissolved (TDS)	SM 2540C	mg/L						NR	**74 J**	**87 J**	**270 J**	**87 J**	**85 J**	**90 J**
Total Suspended Solids	Solids, Total Suspended (TSS)	SM 2540D	mg/L						2 UJ	**13 J**	2 UJ	6 UJ	2 UJ	3.6 UJ	2 UJ
Chloride	Anions, Ion Chromatography	MCAWW 300.0	mg/L		860	230	860	230	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U
Fluoride	Anions, Ion Chromatography	MCAWW 300.0	mg/L						0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Sulfate	Anions, Ion Chromatography	MCAWW 300.0	mg/L						**8**	**7.8**	**8.7**	**27**	**11**	**11**	**11**
Carbonate Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L						5 U	5 U	5 U	5 U	5 U	5 U	5 U
Bicarbonate Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L						**51**	**51**	**52**	**240**	**61**	**64**	**64**
Hydroxide Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L						5 U	5 U	5 U	5 U	5 U	5 U	5 U
Alkalinity	Alkalinity	SM 2320B	mg/L		--	20	--	20	**51**	**51**	**52**	**240**	**61**	**64**	**64**
Nitrate Nitrite as N	Nitrogen, Nitrate-Nitrite	MCAWW 353.2	mg/L						**0.25 J**	**0.24 J**	**0.24 J**	0.15 UJ	**0.23 J**	**0.23 J**	**0.23 J**
Hardness	Hardness as CaCO3	Calculated	mg/L						**66**	**64**	**64**	**260**	**70**	**71**	**75**
Field Water Quality Parameters															
Temperature	Field Measurement		Deg C						4.11	3.91	4.3	2.9	4.73	4.54	4.66
pH	Field Measurement		pH Units			6.5 - 9.0		6.5 - 8.5	7.34	7.29	7.46	6.97	7.39	7.24	7.41
Conductivity	Field Measurement		mS/cm						0.142	0.143	0.145	0.534	0.163	0.163	0.171
Turbidity	Field Measurement		NTU						0.0	64.0	0.0	0.0	0.0	0.0	0.0
Dissolved Oxygen	Field Measurement		mg/L					≥ 4	10.61	10.46	11.01	2.47	10.99	11.18	11.64
Oxidation-Reduction Potential	Field Measurement		mV						94	61	26	-35	46	86	193

Key

µg/L = Micrograms per liter
ADEC = Alaska Department of Environmental Conservation
Bold = Detected
CCC = Criteria Continuous Concentration
CMC = Criteria Maximum Concentration
Deg C = Degrees Celsius.
EPA = United States Environmental Protection Agency
GC/MS = Gas Chromatography/Mass Spectrometry
H = Hardness-dependent water quality criterion for aquatic life.
ICP/ MS = Inductively coupled plasma/mass spectrometry
J = The analyte was detected. The associated result is estimated. "+" indicates high bias and "-" indicates low bias.
mg/L = milligrams per liter
mS/cm = Millisiemens per centimeter
mV = Millivolts
ng/L = Nanograms per liter
NTU = Nephelometric turbidity units
U = The analyte was analyzed for but not detected. The value provided is the method detection limit.
UJ = The analyte was analyzed for but not detected. The associated reporting limit is estimated.
Shading = Sample concentration exceeds one or more WQC value.
NR = No Result

Notes

(1) USEPA. 2016. National Recommended Water Quality Criteria - Aquatic Life Criteria. Accessed on May 9, 2017 at: https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table#table
(2) USEPA. 2016. National Recommended Water Quality Criteria - Aquatic Life Criteria. Accessed on May 9, 2017 at: https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table#table
(3) ADEC. 2008. Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances (as amended through December 12, 2008). ADEC, Anchorage, Alaska
(4) ADEC. 2008. Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances (as amended through December 12, 2008). ADEC, Anchorage, Alaska
(5) Calculated total hardness as CaCO3 = Calcium Hardness (mg/L as CaCO3) + Magnesium Hardness (mg/L as CaCO3)
(6) Hardness-adjusted criterion value was calculated following EPA 2016 and ADEC 2008. A total hardness value of **73.4** mg/L as CaCO3, based on the average value for Red Devil Creek surface water samples, is assumed.
(7) As of 2017 the USEPA no longer considers copper to be hardness-dependent.

Table 4-8 Surface Water Sample Results, Fall 2017

Analyte	Station ID		Units	Water Quality Comparison Criteria					RD10	RD14	RD15	RD05	RD09	RD06	RD08
	Geographic Area			Hardness-Dependent Aquatic Life Water Quality Criterion	National Recommended Water Quality Criteria; Fresh Water; Aquatic Life Criteria; CMC - Acute (1)	National Recommended Water Quality Criteria; Fresh Water; Aquatic Life Criteria; CCC - Chronic (2)	Alaska Water Quality Criteria for Toxics and Other Deleterious Substances; Aquatic Life for Fresh Water; Acute - CMC (3)	Alaska Water Quality Criteria for Toxics and Other Deleterious Substances; Aquatic Life for Fresh Water; Chronic - CCC (4)	Red Devil Creek	Red Devil Creek	Red Devil Creek	Seep	Red Devil Creek	Red Devil Creek	Red Devil Creek
	Sample ID								0917RD10SW	0917RD14SW	0917RD15SW	0917RD05SW	0917RD09SW	0917RD06SW	0917RD08SW
	Method														
Total Inorganic Elements															
Aluminum	Metals (ICP)	SW846 6010B	µg/L						1500 U	1500 U	1500 U	1500 U	1500 U	1500 U	1500 U
Antimony	Metals (ICP/MS)	SW846 6020A	µg/L						**2.9**	**4.6**	**92**	**14**	**200**	**230**	**250**
Arsenic	Metals (ICP/MS)	SW846 6020A	µg/L						5 U	**2.7 J**	**33**	**1000**	**82**	**85**	**86**
Barium	Metals (ICP/MS)	SW846 6020A	µg/L						**22**	**23**	**22**	**110**	**26**	**26**	**26**
Beryllium	Metals (ICP/MS)	SW846 6020A	µg/L						2 U	2 U	2 U	2 U	2 U	2 U	0.22 J
Cadmium	Metals (ICP/MS)	SW846 6020A	µg/L						2 U	2 U	2 U	2 U	2 U	2 U	2 U
Calcium	Metals (ICP)	SW846 6010B	µg/L						**15000**	**14000**	**15000**	**37000**	**15000**	**15000**	**15000**
Chromium	Metals (ICP/MS)	SW846 6020A	µg/L						2 U	**2.1**	2 U	2 U	2 U	2 U	2 U
Cobalt	Metals (ICP/MS)	SW846 6020A	µg/L						2 U	2 U	2 U	**4.6**	**0.17 J**	2 U	**0.16 J**
Copper	Metals (ICP/MS)	SW846 6020A	µg/L						10 U	10 U	10 U	10 U	10 U	10 U	10 U
Iron	Metals (ICP)	SW846 6010B	µg/L						500 U	500 U	**140 J**	**2400**	**200**	500 U	**160 J**
Lead	Metals (ICP/MS)	SW846 6020A	µg/L						4 U	4 U	4 U	4 U	4 U	4 U	4 U
Magnesium	Metals (ICP)	SW846 6010B	µg/L						**7800**	**7500**	**7900**	**38000**	**8900**	**9000**	**8900**
Manganese	Metals (ICP/MS)	SW846 6020A	µg/L						**12**	**11**	**14**	**350**	**24**	**19**	**23**
Mercury	Mercury (CVAA)	SW846 7470A	µg/L						0.3 U	0.3 U	0.3 U	0.3 U	**0.19 J**	0.3 U	**0.39**
Nickel	Metals (ICP/MS)	SW846 6020A	µg/L						15 U	**1.2 J**	15 U	**16**	**0.86 J**	**1.1 J**	**1.1 J**
Potassium	Metals (ICP)	SW846 6010B	µg/L						3300 U	3300 U	3300 U	**1200 J**	3300 U	3300 U	3300 U
Selenium	Metals (ICP/MS)	SW846 6020A	µg/L						40 U	40 U	40 U	40 U	40 U	40 U	40 U
Silver	Metals (ICP/MS)	SW846 6020A	µg/L						2 U	2 U	2 U	2 U	2 U	2 U	2 U
Sodium	Metals (ICP)	SW846 6010B	µg/L						**1600 J**	**1600**	**1600**	**13000**	**1900 J**	**1900**	**1900 J**
Thallium	Metals (ICP/MS)	SW846 6020A	µg/L						5 U	5 U	5 U	5 U	5 U	5 U	5 U
Vanadium	Metals (ICP/MS)	SW846 6020A	µg/L						20 U	20 U	20 U	20 U	20 U	20 U	20 U
Zinc	Metals (ICP/MS)	SW846 6020A	µg/L						35 U	35 U	35 U	35 U	35 U	35 U	35 U
Total Low Level Mercury															
Mercury	Total Mercury by EPA 1631	EPA 1631	ng/L						**40.2 J**	**11.2**	**124**	**40.4**	**443**	**349**	**512**

Table 4-8 Surface Water Sample Results, Fall 2017

Analyte	Station ID / Geographic Area / Sample ID / Method		Units	Water Quality Comparison Criteria: Hardness-Dependent Aquatic Life Water Quality Criterion	National Recommended Water Quality Criteria; Fresh Water; Aquatic Life Criteria; CMC - Acute (1)	National Recommended Water Quality Criteria; Fresh Water; Aquatic Life Criteria; CCC - Chronic (2)	Alaska Water Quality Criteria for Toxics and Other Deleterious Substances; Aquatic Life for Fresh Water; Acute - CMC (3)	Alaska Water Quality Criteria for Toxics and Other Deleterious Substances; Aquatic Life for Fresh Water; Chronic - CCC (4)	RD10 Red Devil Creek 0917RD10SW	RD14 Red Devil Creek 0917RD14SW	RD15 Red Devil Creek 0917RD15SW	RD05 Seep 0917RD05SW	RD09 Red Devil Creek 0917RD09SW	RD06 Red Devil Creek 0917RD06SW	RD08 Red Devil Creek 0917RD08SW
Dissolved Inorganic Elements															
Aluminum	Metals (ICP) (DISSOLVED)	SW846 6010B	µg/L		750	87	750	87	1500 U	1500 U	1500 U	1500 U	1500 U	1500 U	1500 U
Antimony	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						**2.4**	**4.7**	**96**	**1.8 J**	**190**	**220**	**240**
Arsenic	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L		340	150	340	150	5 U	**2.3 J**	**32**	**880**	**77**	**86**	**80**
Barium	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						**18**	**21**	**21**	**100**	**25**	**26**	**24**
Beryllium	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						2 U	2 U	2 U	2 U	2 U	2 U	2 U
Cadmium	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L	H (5)(6)	1.3	0.55	1.4	0.19	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Calcium	Metals (ICP) (DISSOLVED)	SW846 6010B	µg/L						**14000**	**14000**	**15000**	**38000**	**15000**	**15000**	**15000**
Chromium	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L	H (5)(6)	429	56	429	56	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Cobalt	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						2 U	0.21 J	2 U	**4.1**	2 U	2 U	2 U
Copper	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L	H (5)(6)(7)	--	--	10	6.7	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Iron	Metals (ICP) (DISSOLVED)	SW846 6010B	µg/L		--	1000	--	1000	500 U	**120 J**	500 U	**2100**	500 U	**200 J**	500 U
Lead	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L	H (5)(6)	44	1.7	44	1.7	4 U	4 U	4 U	4 U	4 U	4 U	4 U
Magnesium	Metals (ICP) (DISSOLVED)	SW846 6010B	µg/L						**7400**	**7300**	**8100**	**37000**	**8800**	**9000**	**9000**
Manganese	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						**4.5 J**	**5.6 J**	**8.9 J**	**340**	**19**	**26**	**18**
Mercury	Mercury (CVAA) (DISSOLVED)	SW846 7470A	µg/L		1.4	0.77	1.4	0.77	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
Nickel	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L	H (5)(6)	349	39	349	39	15 U	15 U	15 U	**11 J**	**0.74 J**	**0.87 J**	**0.66 J**
Potassium	Metals (ICP) (DISSOLVED)	SW846 6010B	µg/L						3300 U	3300 U	3300 U	**1200 J**	3300 U	3300 U	3300 U
Selenium	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						40 U	40 U	40 U	40 U	40 U	40 U	40 U
Silver	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L	H (5)	1.8	--	1.8	—	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Sodium	Metals (ICP) (DISSOLVED)	SW846 6010B	µg/L						**1500 J**	**1400 J**	**1500 J**	**12000**	**1800 J**	**1900 J**	**1900 J**
Thallium	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						5 U	0.7 J	5 U	5 U	5 U	5 U	5 U
Vanadium	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						20 U	20 U	20 U	20 U	20 U	20 U	20 U
Zinc	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L	H (5)(6)	87.4	88.1	87.4	88.1	35 U	35 U	35 U	35 U	35 U	35 U	35 U
Dissolved Low Level Mercury															
Mercury	Dissolved Mercury by EPA 1631	EPA 1631	ng/L		1400	770	1400	770	**3.87**	**5.15**	**16**	**1.76**	**76.5**	**20.3**	**15.3**

Table 4-8 Surface Water Sample Results, Fall 2017

Analyte	Station ID / Geographic Area / Sample ID / Method		Units	Water Quality Comparison Criteria: Hardness-Dependent Aquatic Life Water Quality Criterion	National Recommended Water Quality Criteria; Fresh Water; Aquatic Life Criteria; CMC - Acute (1)	National Recommended Water Quality Criteria; Fresh Water; Aquatic Life Criteria; CCC - Chronic (2)	Alaska Water Quality Criteria for Toxics and Other Deleterious Substances; Aquatic Life for Fresh Water; Acute - CMC (3)	Alaska Water Quality Criteria for Toxics and Other Deleterious Substances; Aquatic Life for Fresh Water; Chronic - CCC (4)	RD10	RD14	RD15	RD05	RD09	RD06	RD08
	Geographic Area								Red Devil Creek	Red Devil Creek	Red Devil Creek	Seep	Red Devil Creek	Red Devil Creek	Red Devil Creek
	Sample ID								0917RD10SW	0917RD14SW	0917RD15SW	0917RD05SW	0917RD09SW	0917RD06SW	0917RD08SW
General Chemistry															
Total Organic Carbon	Organic Carbon, Total (TOC)	SW846 9060	mg/L						**3.5**	**3.2**	**3.7**	**1.2**	**3.3**	**3**	**3.3**
Total Dissolved Solids	Solids, Total Dissolved (TDS)	SM 2540C	mg/L						85 J	**95 J**	**94 J**	**280 J**	**110 J**	**97 J**	**100 J**
Total Suspended Solids	Solids, Total Suspended (TSS)	SM 2540D	mg/L						**2 J**	2 UJ	2 UJ	**2.2 J**	2 UJ	2 UJ	2 UJ
Chloride	Anions, Ion Chromatography	MCAWW 300.0	mg/L		860	230	860	230	**0.81 J**	**0.45 J**	**0.81 J**	**0.86 J**	**0.82 J**	**0.82 J**	**0.81 J**
Fluoride	Anions, Ion Chromatography	MCAWW 300.0	mg/L						0.2 U	0.2 U	0.2 U	**0.11 J**	0.2 U	0.2 U	0.2 U
Sulfate	Anions, Ion Chromatography	MCAWW 300.0	mg/L						**7**	**7.4**	**8.5**	**31**	**9.9**	**10**	**10**
Carbonate Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L						5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ
Bicarbonate Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L						**62 J**	**52 J**	**52 J**	**240 J**	**64 J**	**66 J**	**67 J**
Hydroxide Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L						5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ
Alkalinity	Alkalinity	SM 2320B	mg/L		--	20	--	20	**62 J**	**52 J**	**52 J**	**240 J**	**64 J**	**66 J**	**67 J**
Nitrate Nitrite as N	Nitrogen, Nitrate-Nitrite	MCAWW 353.2	mg/L						**0.21**	**0.2**	**0.2**	0.15 U	**0.2**	**0.19**	**0.19**
Hardness	Hardness as CaCO3	Calculated	mg/L						**65.49**	**65.08**	**70.87**	**247.44**	**73.76**	**74.58**	**74.58**
Field Water Quality Parameters															
Temperature	Field Measurement		Deg C						4.66	4.74	4.96	2.70	4.82	4.89	4.99
pH	Field Measurement		pH Units			6.5 - 9.0		6.5 - 8.5	7.41	7.28	7.36	6.74	6.85	6.91	6.58
Conductivity	Field Measurement		mS/cm						0.117	0.118	0.121	0.435	0.135	0.33	0.135
Turbidity	Field Measurement		NTU						0.0	0.0	1.0	0.0	0.0	0.0	0.8
Dissolved Oxygen	Field Measurement		mg/L					≥ 4	14.75	15.28	16.03	16.19	15.24	15.57	15.42
Oxidation-Reduction Potential	Field Measurement		mV						115	76	40	-48	41	83	193

Key

µg/L = Micrograms per liter
ADEC = Alaska Department of Environmental Conservation
Bold = Detected
CCC = Criteria Continuous Concentration
CMC = Criteria Maximum Concentration
Deg C = Degrees Celsius.
EPA = United States Environmental Protection Agency
GC/MS = Gas Chromatography/Mass Spectrometry
H = Hardness-dependent water quality criterion for aquatic life.
ICP/ MS = Inductively coupled plasma/mass spectrometry
J = The analyte was detected. The associated result is estimated. "+" indicates high bias and "-" indicates low bias.
mg/L = milligrams per liter
mS/cm = Millisiemens per centimeter
mV = Millivolts
ng/L = Nanograms per liter
NTU = Nephelometric turbidity units
U = The analyte was analyzed for but not detected. The value provided is the method detection limit.
UJ = The analyte was analyzed for but not detected. The associated reporting limit is estimated.
Shading = Sample concentration exceeds one or more WQC value.

Notes

(1) USEPA. 2016. National Recommended Water Quality Criteria - Aquatic Life Criteria. Accessed on May 9, 2017 at: https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table#table
(2) USEPA. 2016. National Recommended Water Quality Criteria - Aquatic Life Criteria. Accessed on May 9, 2017 at: https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table#table
(3) ADEC. 2008. Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances (as amended through December 12, 2008). ADEC, Anchorage, Alaska
(4) ADEC. 2008. Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances (as amended through December 12, 2008). ADEC, Anchorage, Alaska
(5) Calculated total hardness as CaCO3 = Calcium Hardness (mg/L as CaCO3) + Magnesium Hardness (mg/L as CaCO3)
(6) Hardness-adjusted criterion value was calculated following EPA 2016 and ADEC 2008. A total hardness value of **73.4** mg/L as CaCO3, based on the average value for Red Devil Creek surface water samples, is assumed.
(7) As of 2017 the USEPA no longer considers copper to be hardness-dependent.

Table 4-9 - Surface Water Sample Results, Spring 2018

Analyte	Station ID / Geographic Area / Sample ID / Method		Units	Water Quality Comparison Criteria: Hardness-Dependent Aquatic Life Water Quality Criterion	National Recommended Water Quality Criteria; Fresh Water; Aquatic Life Criteria; CMC - Acute (1)	National Recommended Water Quality Criteria; Fresh Water; Aquatic Life Criteria; CCC - Chronic (2)	Alaska Water Quality Criteria for Toxics and Other Deleterious Substances; Aquatic Life for Fresh Water; Acute - CMC (3)	Alaska Water Quality Criteria for Toxics and Other Deleterious Substances; Aquatic Life for Fresh Water; Chronic - CCC (4)	RD10	RD14	RD15	RD05	RD09	RD06	RD08
	Geographic Area								Red Devil Creek	Red Devil Creek	Red Devil Creek	Seep	Red Devil Creek	Red Devil Creek	Red Devil Creek
	Sample ID								0518RD10SW	0518RD14SW	0518RD15SW	0518RD05SW	0518RD09SW	0518RD06SW	0518RD08SW
	Method														
Total Inorganic Elements															
Aluminum	Metals (ICP)	SW846 6010B	µg/L						**830 J**	**1600**	**2400**	1000 U	**6400**	**3100**	**3100**
Antimony	Metals (ICP/MS)	SW846 6020A	µg/L						**1.4**	**15**	**57**	**180**	**140**	**170**	**220**
Arsenic	Metals (ICP/MS)	SW846 6020A	µg/L						**1.6**	**9.7**	**34**	**910**	**99**	**75**	**95**
Barium	Metals (ICP/MS)	SW846 6020A	µg/L						**22**	**45**	**57**	**94**	**130**	**73**	**72**
Beryllium	Metals (ICP/MS)	SW846 6020A	µg/L						0.4 U	0.4 U	**0.076 J**	0.4 U	**0.24 J**	**0.089 J**	**0.095 J**
Cadmium	Metals (ICP/MS)	SW846 6020A	µg/L						0.4 U	0.4 U	0.4 U	0.4 U	**0.11 J**	0.4 U	0.4 U
Calcium	Metals (ICP)	SW846 6010B	µg/L						**11000**	**11000**	**11000**	**40000**	**12000**	**12000**	**12000**
Chromium	Metals (ICP/MS)	SW846 6020A	µg/L						**0.96**	**2.6 J**	**3.5**	**0.23 J**	**11**	**5.7**	**5.4**
Cobalt	Metals (ICP/MS)	SW846 6020A	µg/L						**0.32 J**	**1.2**	**1.7**	**5.2**	**5.6**	**2.2**	**2.4**
Copper	Metals (ICP/MS)	SW846 6020A	µg/L						**0.96 J**	**2.7**	**3.9**	2 U	**11**	**5.3**	**5.9**
Iron	Metals (ICP)	SW846 6010B	µg/L						**1100 J**	**2300**	**3900**	**1800 J**	**11000**	**4700**	**4800**
Lead	Metals (ICP/MS)	SW846 6020A	µg/L						**0.28 J**	**1**	**1.5**	0.8 U	**4.3**	**1.8**	**2**
Magnesium	Metals (ICP)	SW846 6010B	µg/L						**6300**	**6300**	**6700**	**40000**	**9100**	**8000**	**8300**
Manganese	Metals (ICP/MS)	SW846 6020A	µg/L						**27**	**59**	**91**	**300**	**230**	**110**	**130**
Mercury	Mercury (CVAA)	SW846 7470A	µg/L						0.3 U	**0.39**	**3.2**	0.3 U	**5.2**	**3.3**	**6**
Nickel	Metals (ICP/MS)	SW846 6020A	µg/L						**0.82 J**	**2.8 J**	**3.9**	**21**	**14**	**6.3**	**6.7**
Potassium	Metals (ICP)	SW846 6010B	µg/L						**340 J**	**510**	**660**	**1300**	**1100**	**790**	**870**
Selenium	Metals (ICP/MS)	SW846 6020A	µg/L						8 U	8 U	8 U	8 U	**2.3 J**	8 U	8 U
Silver	Metals (ICP/MS)	SW846 6020A	µg/L						0.4 U	0.4 U	0.4 U	0.4 U	**0.062 J**	0.4 U	0.4 U
Sodium	Metals (ICP)	SW846 6010B	µg/L						**1200 J**	**1300**	**1300**	**12000**	**1500**	**1500**	**1600**
Thallium	Metals (ICP/MS)	SW846 6020A	µg/L						1 U	1 U	1 U	1 U	1 U	1 U	1 U
Vanadium	Metals (ICP/MS)	SW846 6020A	µg/L						**1.6 J**	**4.9 J**	**6.3**	4 U	**21**	**9.7**	**8.9**
Zinc	Metals (ICP/MS)	SW846 6020A	µg/L						**2.7 J**	**7.6 J**	**11**	**6.2 J**	**36**	**15**	**16**
Total Low Level Mercury															
Mercury	Total Mercury by EPA 1631	EPA 1631	ng/L						**20**	**760**	**3840**	**211**	**16700**	**9890**	**10100**
Dissolved Inorganic Elements															
Aluminum	Metals (ICP) (DISSOLVED)	SW846 6010B	µg/L		750	87	750	87	1700 U	1000 U	**110 J**	1000 U	1000 U	1000 U	1000 U
Antimony	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						**1.3**	**13**	**35**	**180**	**120**	**150**	**180**
Arsenic	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L		340	150	340	150	**0.88 J**	**5.6**	**12**	**930**	**37**	**43**	**46**
Barium	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						**16**	**17**	**19**	**95**	**19**	**20**	**21**
Beryllium	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Cadmium	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L	H (5)(6)	1.0	0.44	1.1	0.15	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Calcium	Metals (ICP) (DISSOLVED)	SW846 6010B	µg/L						**7100**	**11000**	**11000**	**37000**	**11000**	**11000**	**11000**
Chromium	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L	H (5)(6)	330	43	330	43	**0.3 J**	**0.25 J**	**0.37 J**	**0.52**	**0.21 J**	**0.22 J**	**0.2 J**
Cobalt	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						**0.062 J**	**0.096 J**	**0.19 J**	**5.4**	**0.2 J**	**0.21 J**	**0.23 J**
Copper	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L	H (5)(6)(7)	--	--	7	5.1	2 U	2 U	2 U	**1.8 J**	2 U	2 U	2 U
Iron	Metals (ICP) (DISSOLVED)	SW846 6010B	µg/L		--	1000	--	1000	3300 U	**130 J**	**310 J**	**1000 J**	**190 J**	**210 J**	**230 J**
Lead	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L	H (5)(6)	31	1.2	31	1.2	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
Magnesium	Metals (ICP) (DISSOLVED)	SW846 6010B	µg/L						**4100**	**6000**	**6300**	**39000**	**6900**	**6900**	**6900**
Manganese	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						**9.6**	**21**	**36**	**300**	**46**	**49**	**54**
Mercury	Mercury (CVAA) (DISSOLVED)	SW846 7470A	µg/L		1.4	0.77	1.4	0.77	0.3 U	0.3 U	**0.19 J**	0.3 U	0.3 U	0.3 U	0.3 U
Nickel	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L	H (5)(6)	266	30	266	30	**0.23 J**	**0.29 J**	**0.47 J**	**22**	**0.54 J**	**0.62 J**	**0.7**
Potassium	Metals (ICP) (DISSOLVED)	SW846 6010B	µg/L						830 U	**200 J**	**250 J**	**1200**	**280 J**	**300 J**	**310 J**
Selenium	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						8 U	8 U	8 U	8 U	8 U	8 U	8 U
Silver	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L	H (5)	1.0	--	1.0		0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Sodium	Metals (ICP) (DISSOLVED)	SW846 6010B	µg/L						**740 J**	**1200**	**1200**	**11000**	**1400**	**1400**	**1400**
Thallium	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						1 U	1 U	1 U	1 U	1 U	1 U	1 U
Vanadium	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L						4 U	4 U	**0.54 J**	4 U	4 U	**0.5 J**	**0.49 J**
Zinc	Metals (ICP/MS) (DISSOLVED)	SW846 6020A	µg/L	H (5)(6)	66.6	67.2	66.6	67.2	**2 J**	7 U	7 U	**5.4 J**	7 U	7 U	7 U

Table 4-9 - Surface Water Sample Results, Spring 2018

Analyte	Station ID		Units	Water Quality Comparison Criteria					RD10	RD14	RD15	RD05	RD09	RD06	RD08
	Geographic Area			Hardness-Dependent Aquatic Life Water Quality Criterion	National Recommended Water Quality Criteria; Fresh Water; Aquatic Life Criteria; CMC - Acute (1)	National Recommended Water Quality Criteria; Fresh Water; Aquatic Life Criteria; CCC - Chronic (2)	Alaska Water Quality Criteria for Toxics and Other Deleterious Substances; Aquatic Life for Fresh Water; Acute - CMC (3)	Alaska Water Quality Criteria for Toxics and Other Deleterious Substances; Aquatic Life for Fresh Water; Chronic - CCC (4)	Red Devil Creek	Red Devil Creek	Red Devil Creek	Seep	Red Devil Creek	Red Devil Creek	Red Devil Creek
	Sample ID								0518RD10SW	0518RD14SW	0518RD15SW	0518RD05SW	0518RD09SW	0518RD06SW	0518RD08SW
	Method														
Dissolved Low Level Mercury															
Mercury	Dissolved Mercury by EPA 1631	EPA 1631	ng/L		1400	770	1400	770	**3.32**	**7**	**134**	**5.64**	**10**	**11.4**	**95.3**
General Chemistry															
Total Organic Carbon	Organic Carbon, Total (TOC)	SW846 9060	mg/L						**2.9**	**3.2**	**3.3**	**2.1**	**4.2**	**3.3**	**3.4**
Total Dissolved Solids	Solids, Total Dissolved (TDS)	SM 2540C	mg/L						**48 J**	**10 J**	**42 J**	**220 J**	**19 J**	**29 J**	**45 J**
Total Suspended Solids	Solids, Total Suspended (TSS)	SM 2540D	mg/L						**19**	**62 J**	**120**	**3.2**	**240**	2 U	2 U
Chloride	Anions, Ion Chromatography	MCAWW 300.0	mg/L		860	230	860	230	**0.76 J**	**0.71 J**	**0.68 J**	**1.5**	**0.81 J**	**0.75 J**	**0.8 J**
Fluoride	Anions, Ion Chromatography	MCAWW 300.0	mg/L						**0.041 J**	**0.11 J**	0.2 U	**0.089 J**	0.2 U	0.2 U	0.2 U
Sulfate	Anions, Ion Chromatography	MCAWW 300.0	mg/L						**6.4**	**6.4**	**6.6**	**38**	**8.9**	**8.4**	**8.4**
Carbonate Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L						5 U	5 U	5 U	5 U	5 U	5 U	5 U
Bicarbonate Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L						**44**	**44**	**43**	**230**	**47**	**48**	**46**
Hydroxide Alkalinity as CaCO3	Alkalinity	SM 2320B	mg/L						5 U	5 U	5 U	5 U	5 U	5 U	5 U
Alkalinity	Alkalinity	SM 2320B	mg/L		--	20	--	20	**44**	**44**	**43**	**230**	**47**	**48**	**46**
Nitrate Nitrite as N	Nitrogen, Nitrate-Nitrite	MCAWW 353.2	mg/L						**0.32 J-**	**0.26 J-**	**0.25 J-**	0.15 U	**0.23 J-**	**0.25 J-**	**0.24 J-**
Hardness	Hardness as CaCO3	Calculated	mg/L						**34.64**	**52.22**	**53.46**	**253.18**	**55.93**	**55.93**	**55.93**
Field Water Quality Parameters															
Temperature	Field Measurement		Deg C						3.28	3.41	3.57	3.42	3.78	3.82	3.89
pH	Field Measurement		pH Units			6.5 - 9.0		6.5 - 8.5	6.59	7.38	7.06	6.81	6.8	6.55	4.3
Conductivity	Field Measurement		mS/cm						0.064	0.069	0.069	0.322	0.073	0.083	0.078
Turbidity	Field Measurement		NTU						55.5	15.9	34.0	9.6	46.3	59.0	53.7
Dissolved Oxygen	Field Measurement		mg/L					≥ 4	14.66	12.88	11.34	7.15	20.65	11.09	13.9
Oxidation-Reduction Potential	Field Measurement		mV						269.6	65.9	63.6	48.6	65.9	79.8	223.1

Key

µg/L = Micrograms per liter
ADEC = Alaska Department of Environmental Conservation
Bold = Detected
CCC = Criteria Continuous Concentration
CMC = Criteria Maximum Concentration
Deg C = Degrees Celsius.
EPA = United States Environmental Protection Agency
GC/MS = Gas Chromatography/Mass Spectrometry
H = Hardness-dependent water quality criterion for aquatic life.
ICP/ MS = Inductively coupled plasma/mass spectrometry
J = The analyte was detected. The associated result is estimated. "+" indicates high bias and "-" indicates low bias.
mg/L = milligrams per liter
mS/cm = Millisiemens per centimeter
mV = Millivolts
ng/L = Nanograms per liter
NTU = Nephelometric turbidity units
U = The analyte was analyzed for but not detected. The value provided is the method detection limit.
UJ = The analyte was analyzed for but not detected. The associated reporting limit is estimated.
Shading = Sample concentration exceeds one or more WQC value.

Notes

(1) USEPA. 2016. National Recommended Water Quality Criteria - Aquatic Life Criteria. Accessed on September 10th, 2018 at: https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table#table
(2) USEPA. 2016. National Recommended Water Quality Criteria - Aquatic Life Criteria. Accessed on September 10th, 2018 at: https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table#table
(3) ADEC. 2008. Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances (as amended through December 12, 2008). ADEC, Anchorage, Alaska
(4) ADEC. 2008. Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances (as amended through December 12, 2008). ADEC, Anchorage, Alaska
(5) Calculated total hardness as CaCO3 = Calcium Hardness (mg/L as CaCO3) + Magnesium Hardness (mg/L as CaCO3)
(6) Hardness-adjusted criterion value was calculated following EPA 2016 and ADEC 2008. A total hardness value of **73.4** mg/L as CaCO3, based on the average value for Red Devil Creek surface water samples, is assumed.
(7) As of 2017 the USEPA no longer considers copper to be hardness-dependent.

Ecology & Environment, Inc. GIS Department Project:
\\prtbhpf\Projects\Red_Devil_Mine\Maps\MXDs\2012_RI_Report_UPDATED\2013_RI_Revisions\figure_2-8_surface_water_sample_locations.mxd Date: 10/11/2013

Surface Water Sample Location
Background Location
Settling Pond
Monofill
Historical Structure

RED DEVIL MINE

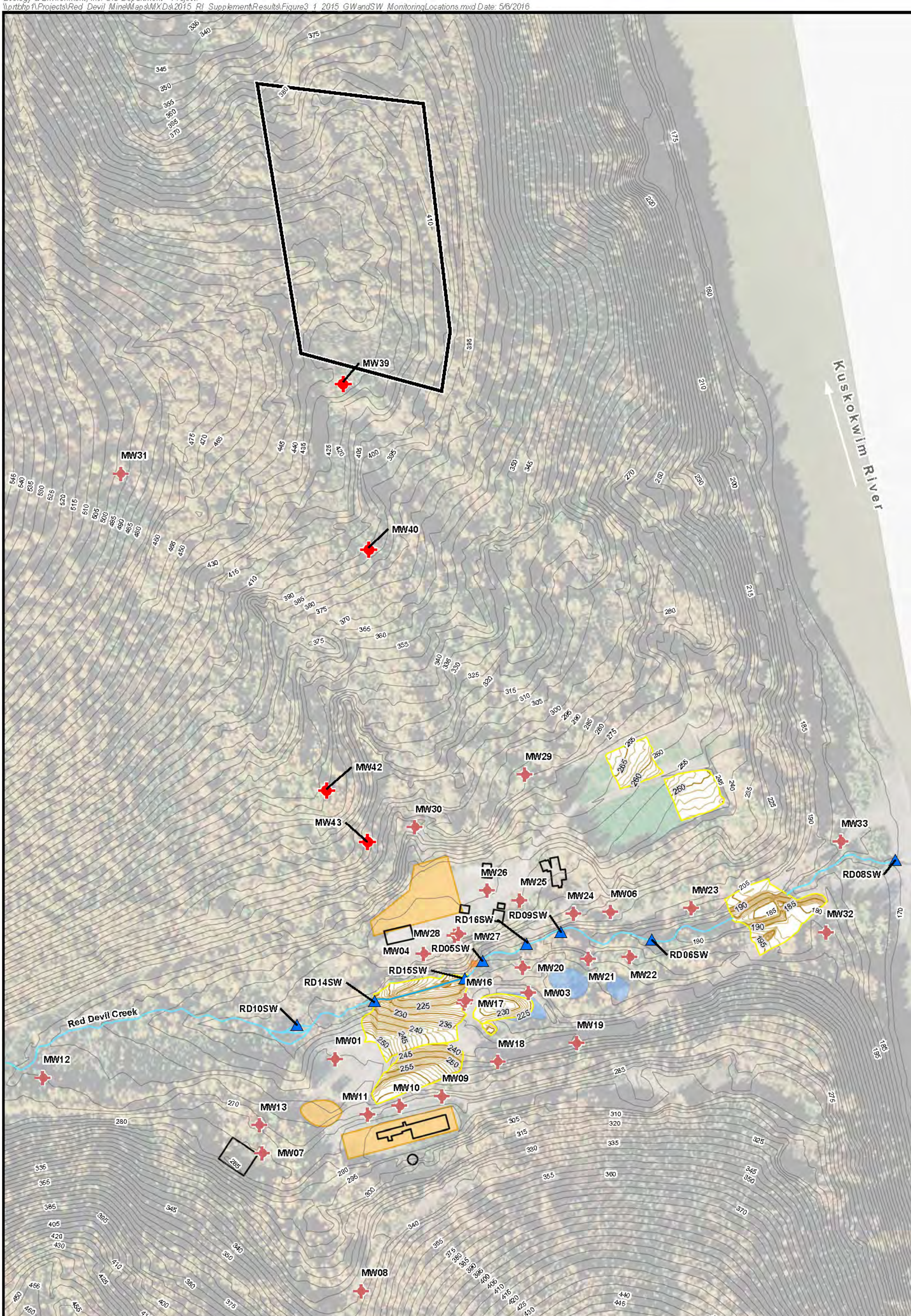
Red Devil, Alaska

Figure 4-1
RI Surface Water Sample Locations

0 25 50 100 150 200 250 300 350
Feet
0 12.5 25 50 75 100
Meters

Image Source: Aero-Metric, Inc. 2010a

Ecology & Environment, Inc. GIS Department Project:
\\prtbhp1\Projects\Red_Devil_Mine\Maps\MXDs\2015_RI_Supplement\Results\Figure3_1_2015_GWandSW_MonitoringLocations.mxd Date: 5/6/2016



RI Supplement Monitoring Well
RI Monitoring Well
Surface Water
2014 5-foot Contour
2014 1-foot Contour
Area of 2014 NTCRA Re-grading
2010 5-foot Contour
Post-NTCRA Stream Alignment
Red Devil Creek
Settling Pond
Monofill
Historical Structure
Approximate Location of Proposed Repository Footprint
Seep Location

Digital 2010 5-foot topographic contours based on the aerial orthophotograph taken on September 21, 2010 (AeroMetric 2012)

Digital 2014 5-foot and 1-foot topographic contours based on Marsh Creek (2014)

RED DEVIL MINE

Red Devil, Alaska

Figure 4-2
RI Supplement
Groundwater and Surface Water Monitoring Locations

0 50 100 200 300 400
Feet
0 12.5 25 50 75 100 125
Meters
Scale 1:2,500

Ecology & Environment, Inc. GIS Department Project:
\\prtbhp1\projects\Red_Devil_Mine\Maps\MXDs\2012_Baseline_Monitoring\Fig2-2_Fall2012_Baseline_SW_monitoring.mxd Date: 1/28/2013

- 2012 Baseline Surface Water Monitoring Location
- RI Surface Water Sample Location, not Sampled in 2012
- Settling Pond
- Monofill
- Historical Structure

RED DEVIL MINE

Red Devil, Alaska

Figure 4-3
Surface Water
Baseline Monitoring Locations
Spring and Fall 2012

0 25 50 100 150 200 250 300 350
Feet
0 12.5 25 50 75 100
Meters

Image Source: Aero-Metric, Inc. 2010a

Ecology & Environment, Inc. GIS Department Project:
\\prtbhp1\Projects\Red Devil Mine\Maps\MXDs\Work Plan 2016\Figure2_2_GW_SW_BaselineMonitoring_Locations.mxd Date: 3/18/2016

Baseline Monitoring Locations

- RI Supplement Monitoring Well
- RI Monitoring Well
- Surface Water
- 2014 5-foot Contour
- 2014 1-foot Contour
- Area of 2014 NTCRA Re-grading
- 2010 5-foot Contour
- Post-NTCRA Stream Alignment
- Red Devil Creek
- Settling Pond
- Monofill
- Historical Structure
- Approximate Location of Proposed Repository Footprint
- Seep Location

RED DEVIL MINE

Red Devil, Alaska

Figure 4-4
Groundwater and Surface Water Baseline Monitoring Locations
2016 - 2018

0 50 100 200 300 400 Feet
0 12.5 25 50 75 100 125 Meters
Scale 1:2,500

Digital 2010 5-foot topographic contours based on the aerial orthophotograph taken on September 21, 2010 (AeroMetric 2012)

Digital 2014 5-foot and 1-foot topographic contours based on Marsh Creek (2014)

Figure 4-5 Red Devil Creek and Seep Surface Water Concentrations and Discharge

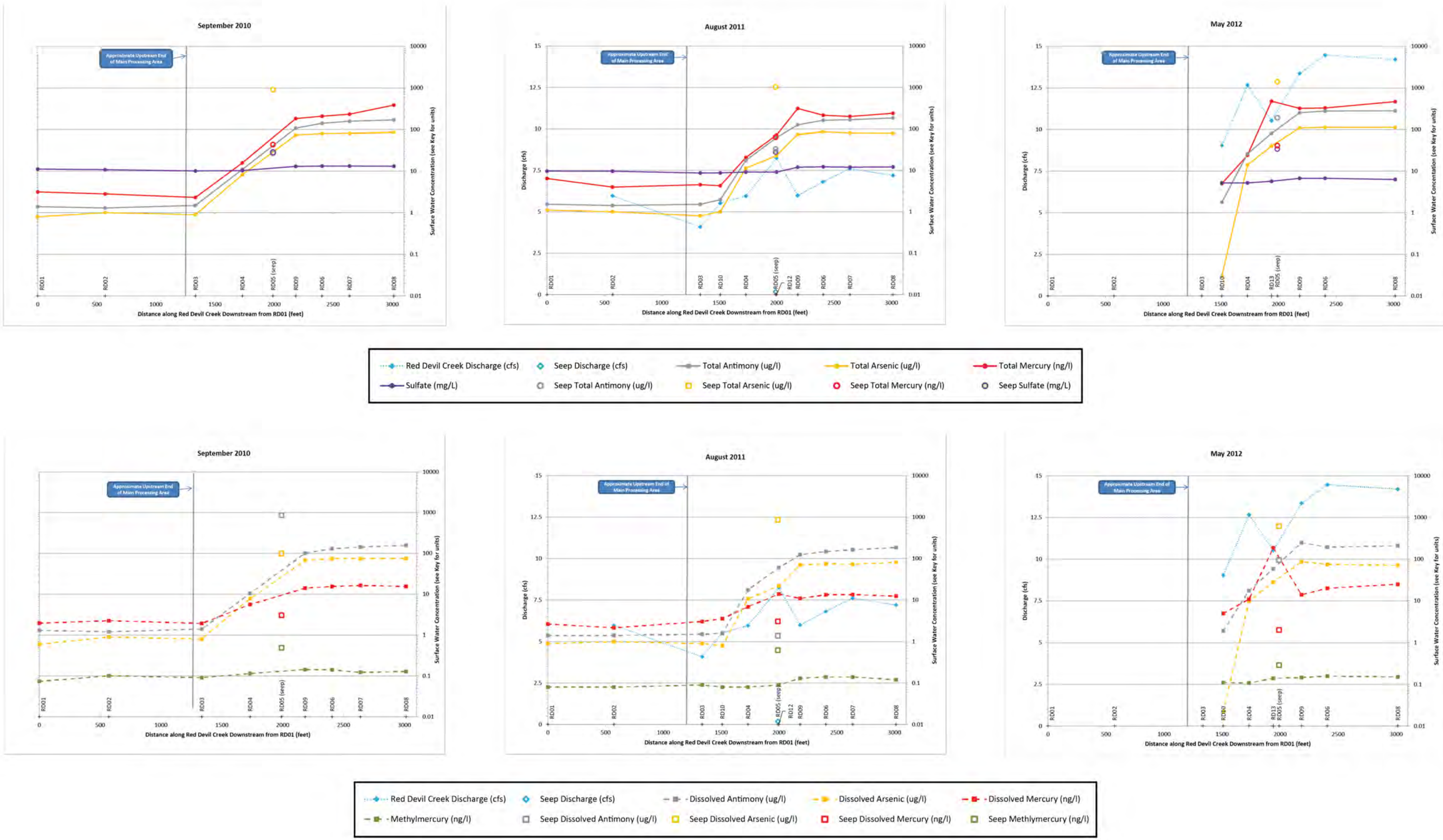


Figure 4-5 Red Devil Creek and Seep Surface Water Concentrations and Discharge

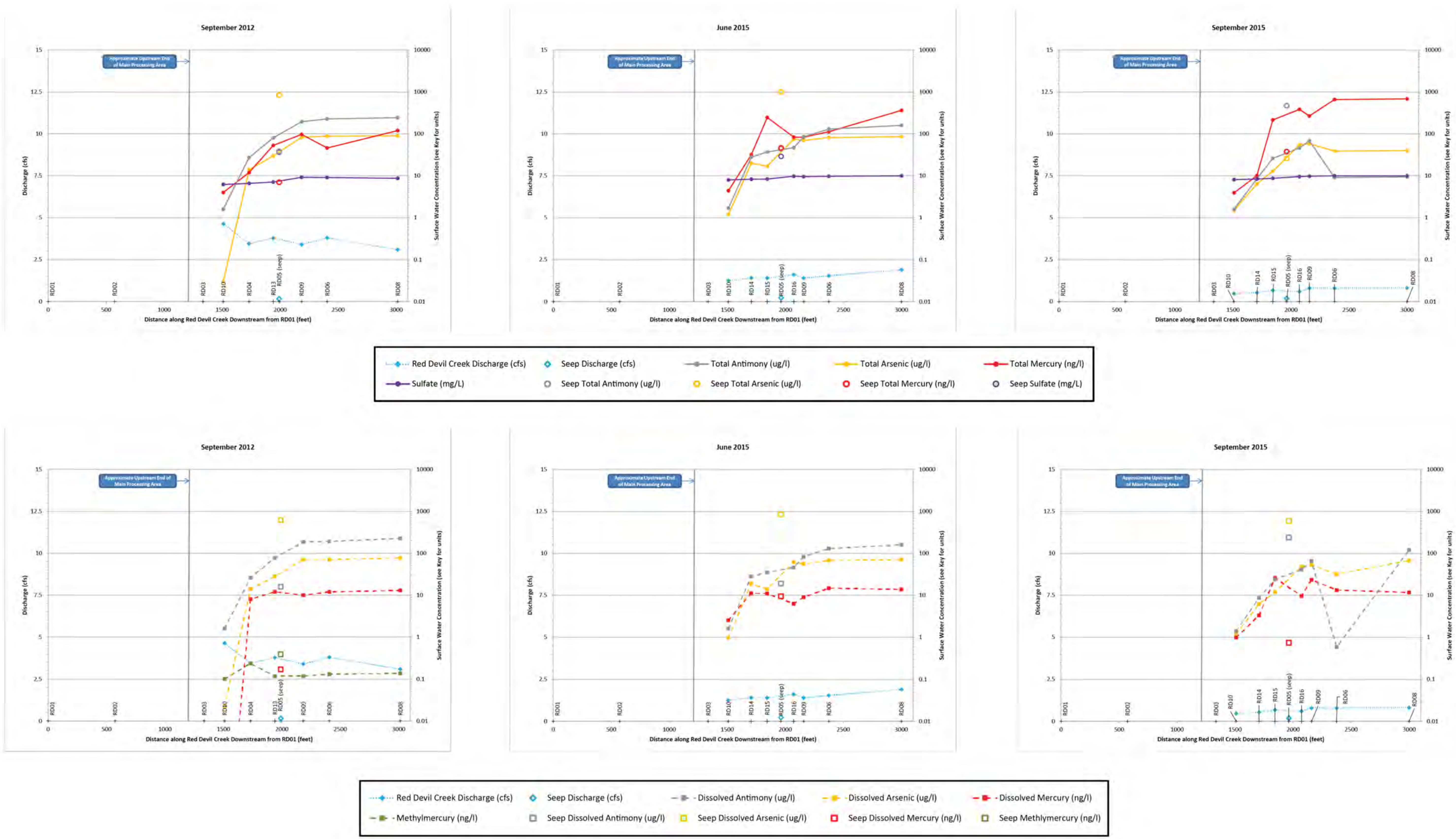


Figure 4-5 Red Devil Creek and Seep Surface Water Concentrations and Discharge

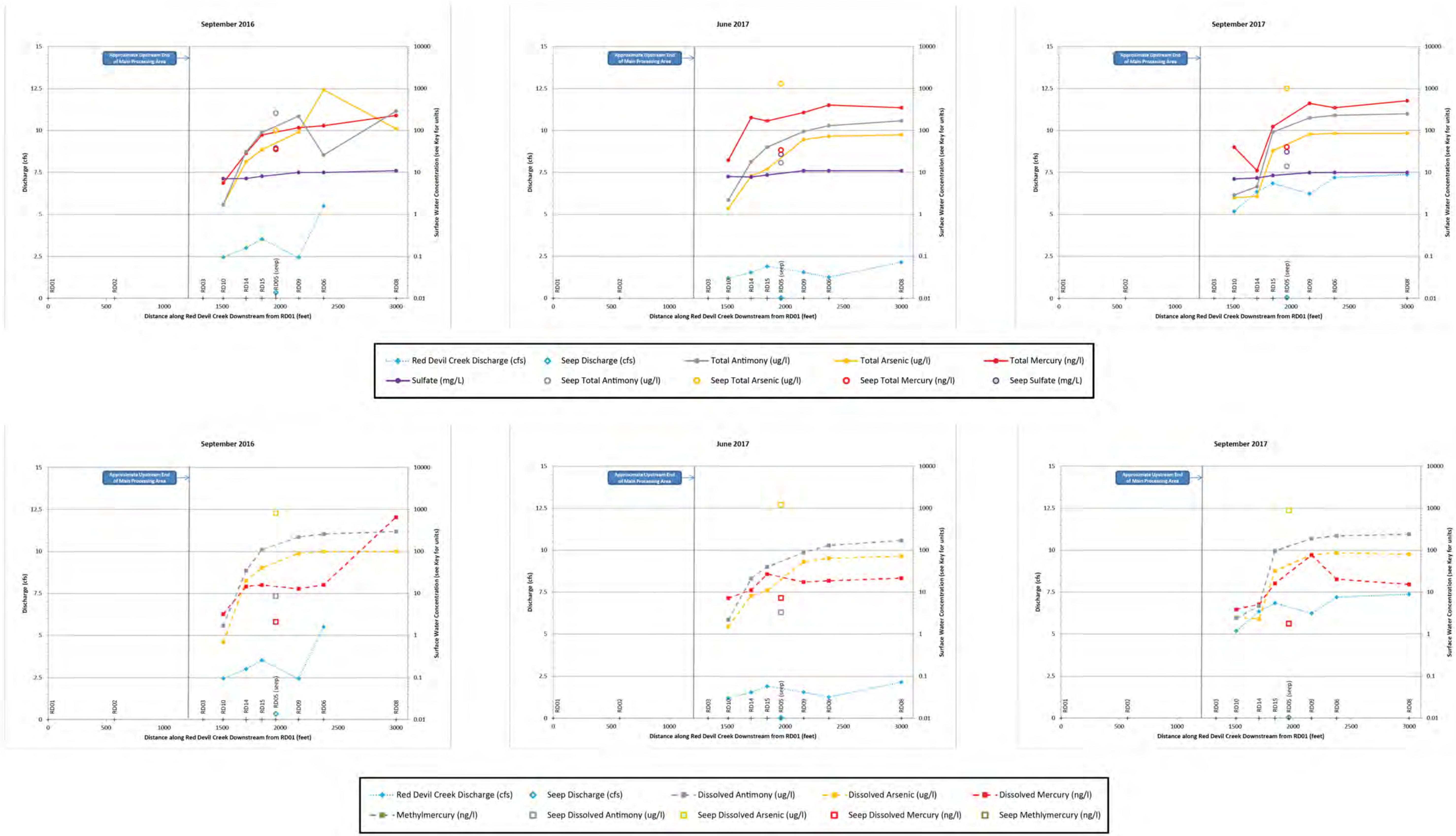
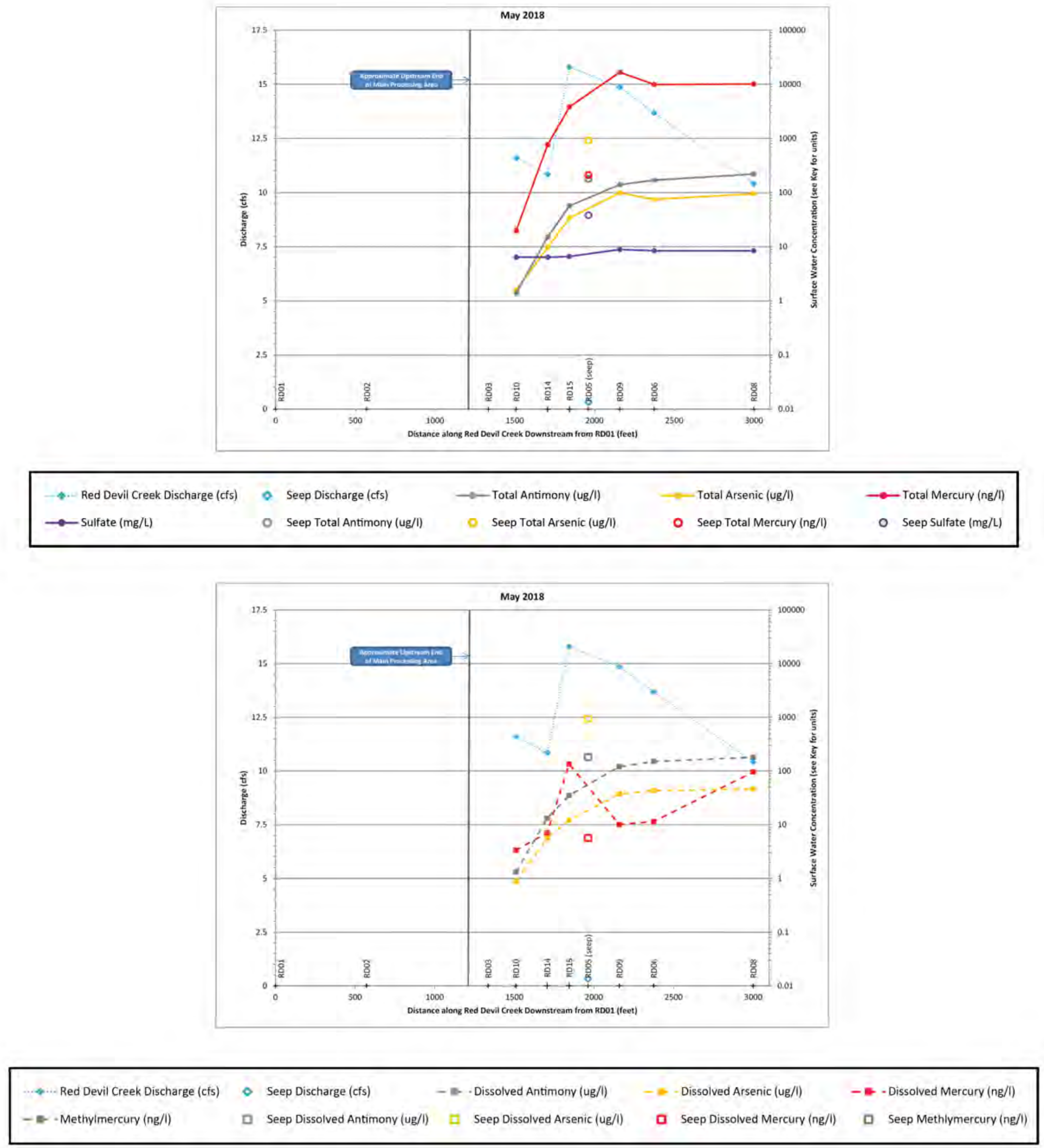


Figure 4-5 Red Devil Creek and Seep Surface Water Concentrations and Discharge



5 Summary and Conclusions

5.1 Groundwater

Groundwater at the RDM was characterized as part of the RI, RI Supplement, and 2017 additional characterization activities. Baseline groundwater monitoring has been performed to characterize pre-remedial action conditions and identify seasonal and annual trends in flow, contaminant concentrations, and loading.

Groundwater occurs at the RDM in bedrock and unconsolidated materials consisting of mine waste (tailings/waste rock) and native soils. Groundwater within the Kuskokwim Group bedrock unit appears to occur primarily within fractures, including intersecting faults and joints. Hydraulic conductivity estimates of the bedrock are consistent with estimates for other aquifers in fractured turbidite sequences. Unconsolidated overburden and bedrock saturated zones appear to be in hydraulic communication on a large scale at the RDM, although some hydrologic segregation exists locally, particularly at the top of weathered bedrock in parts of the site.

Groundwater at the site generally flows toward Red Devil Creek, with groundwater elevations generally mimicking topography over much of the site. Overall, the spatial and temporal variation in water table elevation, estimates of bedrock and soil K, and Red Devil Creek discharge data are reflective of a fractured bedrock and alluvial aquifer in a small watershed anchored by a predominantly gaining stream. Of notable exception is the portion of the Surface Mined Area where the system of underground mine workings exerts a draining effect where the mine workings lie below the water table within the host bedrock but above the nearby base level, which is the level of Red Devil Creek. The underground workings impart a strong hydraulic gradient toward the workings where they lie below the water table within the host bedrock but above the nearby base level. The mine workings also provide a highly transmissive hydraulic connection between the affected portion of the Surface Mined Area and the Red Devil Creek valley.

The distribution and arrangement of soils and mine and ore processing wastes at the site play an important role in determining the nature and extent of contamination and fate and transport of contaminants at the RDM. The primary source of the primary COCs—antimony, arsenic, and mercury—in groundwater at the RDM is tailings/waste rock located in the Main Processing Area. Tailings/waste rock also are located in parts of the Red Devil Creek valley downstream of the Main Processing Area. In general, the highest COC concentrations in groundwater are found where tailings/waste rock lie below the water table. No tailings/waste rock are observed in the Surface Mined Area.

Groundwater at the RDM also is locally impacted by inorganic elements present in naturally mineralized bedrock and native soils. Bedrock is naturally mineralized throughout portions of the Surface Mined Area and Main Processing Area, including the sub-ore grade zones that are peripheral to the ore zones that were targeted by mining. These peripheral mineralized zones currently envelop the present-day system of underground mine workings. Because the underground mine workings impart a strong hydraulic gradient toward the workings where the workings lie below the water table within the host bedrock but above the nearby base level, groundwater in much of the Surface Mined Area flows through these zones of peripheral mineralization. Concentrations of COCs in groundwater are locally elevated as a consequence of interaction with this naturally mineralized bedrock.

Much of the groundwater flowing into and through the Main Processing Area and Red Devil Creek valley originates in the Surface Mined Area. Much of this groundwater is impacted by naturally mineralized bedrock, as described above. As such, the quality of groundwater that would emerge from bedrock in the Main Processing Area and Red Devil Creek valley is expected to be impacted by this natural mineralization. Results of the evaluation of such impacts are used to develop of groundwater BTVs that may be used to inform development of groundwater RGs for the FS Supplement. Once groundwater enters into the system of underground mine workings, it may be further impacted by the mine workings themselves. The magnitude of the impacts attributable to natural mineralization versus flow through the mine workings and/or tailings/waste rock cannot be estimated quantitatively.

5.2 Surface Water

As part of the RI and RI Supplement, surface water in Red Devil Creek and a seep located on the left bank of the creek were characterized to evaluate the nature and extent of contamination and fate and transport of contaminants. Baseline groundwater monitoring has been performed to characterize pre-remedial action conditions and identify seasonal and annual trends in flow, contaminant concentrations, and loading.

Groundwater emerges to surface water as Red Devil Creek baseflow and via the seep located adjacent to the creek in the Main Processing Area. Red Devil Creek is impacted primarily by emergence of groundwater into the stream along gaining reaches in the Main Processing Area. The primary source of groundwater impacts, and therefore surface water impacts, is leaching of tailings/waste rock in the Main Processing Area. Other sources of impacts to Red Devil Creek are flow through naturally mineralized bedrock, native soils, and mine workings. As noted above, some of the groundwater flowing into and through the Main Processing Area and Red Devil Creek valley originates in the Surface Mined Area, and much of that groundwater is impacted by naturally mineralized bedrock. Some of this groundwater discharges to Red Devil Creek, and thus contributes to contaminant loading in Red Devil Creek surface water. The magnitude of the influences due to natural mineralization versus tailings/waste rock and mine workings cannot be estimated quantitatively.

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A Data Validation Memoranda

DATA REVIEW MEMORANDUM

DATE: November 21, 2016

TO: Jonathan Reeve, Project Manager, E & E, Seattle, WA

FROM: Howard Edwards, E & E, San Francisco, CA

SUBJ: Data Review: Red Devil Mine Fall 2016

REFERENCE:

Project ID	Lab Work Order	Lab
1001095.0009.02	580-63069-1	Test America – Seattle

Validated data is attached to the end of this memorandum.

1. SAMPLE IDENTIFICATION

For the sampling activities at the Red Devil Mine site, Ecology and Environment, Inc. (E & E) collected the samples listed in Table 1. Project-specific matrix spike/matrix spike duplicates (MS/MSD) were designated in the field. All samples were sent to Test America's labs in Tacoma, Washington, for select analyses. This report addresses only Test America-generated data.

The analytical report was issued by Test America on October 27, 2016. The data in the analytical report were reviewed for field and laboratory precision, accuracy, and completeness in accordance with procedures and quality control (QC) limits, the current laboratory Quality Assurance Manual (QAM), and current standard operating procedures (SOPs). Laboratory data qualifiers for identified analytes and analyte quantitation were accepted. Any additional data review qualifiers added are noted below and listed on the tables at the end of this memorandum. Definitions of all data qualifiers are given in the report.

Work Orders, Tests, and Number of Samples Included in this Data Review Memo

Work Orders/ Job Number	Matrix	Test Method	Method Name	Number of Samples
580-63069-1	Surface Water	EPA 7470A	Mercury (CVAA)	8
580-63069-1	Surface Water	EPA 6010B/6020A	Total TAL Metals by ICP	8
580-63069-1	Surface Water	EPA 7470A	Dissolved Mercury (CVAA)	8
580-63069-1	Surface Water	EPA 6010B/6020A	Dissolved TAL Metals by ICP	8
580-63069-1	Surface Water	EPA 9060	TOC	8
580-63069-1	Surface Water	SM2540D	TSS	8
580-63069-1	Surface Water	SM2540C	TDS	8
580-63069-1	Surface Water	EPA 300.0	Inorganic Ions (Cl, F, SO4)	8
580-63069-1	Surface Water	EPA 353.2	Nitrate-Nitrite as N	8
580-63069-1	Surface Water	SM2320B	Alkalinity as CO3/HCO3	8
580-63069-1	Ground Water	EPA 6010B/6020A	Total TAL Metals by ICP	21
580-63069-1	Ground Water	EPA 7470A	Mercury (CVAA)	21
580-63069-1	Ground Water	EPA 300.0	Inorganic Ions (Cl, F, SO4)	21
580-63069-1	Ground Water	EPA 353.2	Nitrate-Nitrite as N	21
580-63069-1	Ground Water	SM2320B	Alkalinity as CO3/HCO3	21
580-63069-1	Ground Water	EPA 8270D	SVOCs	3
580-63069-1	Ground Water	AK102/103	DRO	3
580-63069-1	Ground Water	EPA 8260C	BTEX	3
580-63069-1	Ground Water	AK101	GRO	3
580-63069-1	Rinse Blank	EPA 7470A	Mercury (CVAA)	1
580-63069-1	Rinse Blank	EPA 6010B/6020A	Total TAL Metals by ICP	1
580-63069-1	Rinse Blank	EPA 7470A	Dissolved Mercury (CVAA)	1
580-63069-1	Rinse Blank	EPA 6010B/6020A	Dissolved TAL Metals by ICP	1
580-63069-1	Rinse Blank	SM2540C	TDS	1
580-63069-1	Rinse Blank	EPA 353.2	Nitrate-Nitrite as N	1
580-63069-1	Rinse Blank	SM2320B	Alkalinity as CO3/HCO3	1
580-63069-1	Field Blank	EPA 8260C	BTEX	1
580-63069-1	Field Blank	AK101	GRO	1

2. SAMPLE PROCEDURES

All samples were collected as specified in the work plan and as documented on the chain-of-custody (COC) and in field notebooks. Samples were analyzed as specified on the COC. Samples were packaged, shipped, and received as specified in the work plan. All samples must be received cold (4 ±2 degrees Celsius [^{o}C]) and in good condition as documented on the Cooler Receipt Form.

REVIEW RESULTS

All sample procedures were followed and the sample coolers were received at -0.2 to 2.5 ^{o}C. No problems with the condition of the samples upon receipt are documented.

3. LABORATORY DATA

3.1 HOLDING TIMES

Holding times are established and monitored to ensure analytical results accurately represent analyte concentrations in a sample at the time of collection. These results are presented in Table 2 (if applicable). Exceeding the holding time for a sample generally results in a loss of the analyte due to a variety of mechanisms, such as deposition on the sample container walls or precipitation.

REVIEW RESULTS

Samples requiring the determination of total dissolved solids (TDS) and total suspended solids (TSS) were received by the laboratory three days after the method specified holding time of 7 days had passed. TDS and TSS were determined approximately three days after sample receipt and 13 days after the date of sample collection. All associated TSS and TDS data was J qualified as estimated. All other samples were analyzed within the project and method specified holding times for all analytes (see Table 2).

3.2 BLANKS

Laboratory and field blank samples are analyzed and evaluated to determine the existence and magnitude of possible contamination during the sampling and analysis process. These results are presented in Table 3 (if applicable). If the analyte is present in the sample at similar trace levels (less than 5 times the blank concentration), then the analyte is likely a common background contaminant from some phase of the sampling, extraction, or analytical procedure and associated low-level sample concentrations are not considered to be site related. Sample results in these cases are qualified as not detected, “U”.

REVIEW RESULTS

All laboratory blanks were performed at the required frequency. As noted in Table 3a, analyte concentrations in the blanks were below the practical quantitation limit (PQL). All associated reported concentration of lead, silver, Nitrate-Nitrite as Nitrogen (N), and

DRO that were less than 5 times the concentration found in the preparation blank/ method blank (MB) were U-qualified as not detected. A number of Nitrate-Nitrite as N samples were “J” qualified as estimated due to the analyte concentration being less than 10 times the blank concentration. Butyl benzyl phthalate, which was found in the MB, was not found in any associated sample, therefore no qualification was necessary. A summary of qualified data due to method blank contamination is presented in Table 3b.

One equipment rinsate blank was collected, with several EPA Method 6010, 6020, and 300.0 analytes detected in at concentrations less than the PQL. All associated sample results that were detected at levels less than 5 times the blank were U-qualified as not detected. Associated samples with detection greater than 5 times the blank were not qualified. A summary of qualified data due to equipment rinsate blank contamination is presented in Table 3c.

3.3 SURROGATE SPIKE RECOVERY

Laboratory performance for individual samples analyzed for organic compounds is established by means of surrogate spiking activities. Samples are spiked with surrogate compounds prior to preparation and analysis. Unusually low or high surrogate recovery values may indicate some deficiency in the analytical system or that some matrix effects exist, resulting in low or high sample results for target compounds. Sample surrogate recoveries outside QC limits (if applicable) are presented in Table 4.

REVIEW RESULTS

All surrogates were run at the required frequency with no exceptions noted.

3.4 MATRIX SPIKE AND MATRIX SPIKE DUPLICATE ANALYSIS

The MS/MSD analyses are intended to provide information about the effects that the sample matrix exerts on the digestion / extraction and measurement methodology. MS recovery values that do not meet laboratory QC criteria may indicate that sample analyte results are being attenuated in the analysis procedure. The potential sample bias may be estimated by noting the degree to which the MS concentration was elevated or lowered in the spike analysis. However, this estimated bias should serve only as an approximation; sample-specific problems may be the cause of the discrepancy, particularly in soil samples.

Recoveries of a post-digestion spike or a laboratory control sample (LCS) are used to verify that the analytical methodology is acceptable and that MS recoveries are due to matrix effects. An MSD analysis is performed to evaluate the precision of the sample results. Precision is measured as the relative percent difference (RPD) between analytical results for duplicate samples. The laboratory's failure to produce similar results for MSD samples may indicate that the samples were non-homogeneous (particularly in soil samples), or that method defects may exist in the laboratory's techniques.

Recovery calculations are not required if the spiking concentration added is less than 25% of the sample background concentration.

REVIEW RESULTS

The MS/MSD sample analyses were performed on three samples: 1016MW22GW, 0916RD10SW, and10916MW01GW, at the required frequency. MS/MSD recoveries were within the control limits generated by the laboratory with the following exceptions:

- For sample 1016MW22GW, the EPA Methods 8260C, EPA 8272D, EPA 300.0, EPA 353.2 and AK102/103 had MS and/or MSD recoveries for benzene, toluene, Bis(2-ethyhexyl) Phthalate, fluoride, DRO and Nitrate-Nitrite as N that were above laboratory control limits. The sample result for benzene, Bis(2-ethyhexyl) Phthalate, and fluoride were not detected in associated sample and required no qualification. The results for DRO and Nitrate-Nitrite as N in the parent sample have been qualified as estimated with a high bias, “J-“. The results for toluene in the parent sample have been qualified as estimated with a high bias, “J+“.
- For sample 0916RD10SW, the EPA Methods EPA 300.0, EPA 353.2 had MS and/or MSD recoveries of fluoride and Nitrate-Nitrite as N that were above laboratory control limits. The sample result for fluoride were not detected in associated sample and required no qualification. The results for Nitrate-Nitrite as N in the parent sample have been qualified as estimated with a high bias, “J-“.
- For sample 10916MW01GW, the EPA Methods EPA 353.2 had MS and/or MSD recoveries of Nitrate-Nitrite as N that were above laboratory control limits. The results for Nitrate-Nitrite as N in the parent sample have been qualified as estimated with a high bias, “J-“.

The accuracy of MS/MSD recoveries were within the control limits generated by the laboratory with the following exceptions:

- For sample 1016MW22GW, the EPA Methods EPA 8270D and AK102/103 had MS and/or MSD RPDs for Bis(2-ethyhexyl) Phthalate, 3,3- Dichlorobenzidine, and DRO that were above laboratory control limits. The sample result for 3,3-Dichlorobenzidine and Bis(2-ethyhexyl) Phthalate was not detected in associated samples and required no qualification. The results for DRO in all three associated sample have been qualified as estimated with a "J".
- For sample 0916RD10SW, the EPA Methods EPA 6010C had MS and/or MSD RPDs for potassium that were above laboratory control limits. The results for potassium in the parent sample have been qualified as estimated with a "J".
- For sample 10916MW01GW, the EPA Methods EPA 6020A had MS and/or MSD RPDs for selenium that were above laboratory control limits. Selenium was not detected in associated samples and required no qualification.

A summary of sample data qualified due to MS/MSD precision and accuracy are presented in Tables 5a and 5b.

3.5 LABORATORY CONTROL SAMPLE ANALYSIS

The LCS is analyzed to monitor the efficiency of the digestion/extraction procedure and analytical instrument operation. The ability of the laboratory to successfully analyze an LCS demonstrates that there are no analytical problems related to the digestion/sample preparation procedures and/or instrument operations. The LCS results outside QC limits are presented in Table 6 (if applicable). Sporadic and marginal QC failures for multiple component methods do not indicate an analytical concern. If recoveries are high and the compounds are not detected in the samples, then no data qualification is required. All recoveries should be above 10% or the non-detect results flagged "UR" as rejected.

REVIEW RESULTS

All LCS analyses were within control limits and performed at the required frequency for all method with the exception of EPA 8270D. Most out of control analytes had high and not present in the samples and thus required no qualification. The compound 4-Chloroaniline had recoveries below 10% and the associated non-detection in three samples were qualified as rejected with a “UR”.

3.6 COMPOUND IDENTIFICATION AND QUANTITATION

Compound identities are assigned by comparing sample compound retention times to retention times from known (standard) compounds and identification of an acceptable mass spectrum. Compounds detected below the PQL in samples should be considered estimated and are qualified "J." The samples with compounds above the linear range were all re-analyzed at a higher dilution factor.

REVIEW RESULTS

All compound identification and quantitation criteria were achieved. As noted in Table 7, no samples were reported as reanalyzed.

4. FIELD DUPLICATE SAMPLE RESULTS

Field duplicate samples were collected and analyzed as an indication of overall precision for both field and laboratory. Field duplicate results are summarized in Table 8 (if applicable). The results are expected to have more variability than laboratory duplicates, which measure only laboratory precision. It is expected also that soil field duplicates will exhibit greater variance than water field duplicates due to the difficulties associated with collecting identical field samples. The QC criteria used to assess field duplicate samples for this project was limits of 70% RPD for soils and 40% RPD for waters, or twice the general laboratory duplicate criteria. If a given compound in both the regular sample and associated field duplicate sample was below the laboratory PQL, or the compound was not detected in one of the samples, then the compound is generally not qualified due to field duplicate precision. There are no guidelines regarding data qualification based on poor field duplicate precision. Professional judgment was used to determine whether or not to qualify results.

REVIEW RESULTS

Three field duplicates analyses were performed on this SDG. The RPD ratings are listed on Tables 8a through 8c as “Good” if the RPD is less than field duplicate QC criteria of 40% and as “Poor” if the RPD exceeded the field duplicate QC criteria.

All the results show good precision in the sample pair with the exceptions noted on Tables 8a through 8c. Qualifiers were only added to the field duplicate sample pair results as noted.

5. OVERALL ASSESSMENT OF DATA

All data were reviewed and considered usable with qualification as noted in this report.

Table 1 - Sample Listing

Work Order	Matrix	Sample ID	Lab ID	Sample Date	QA/QC	Analysis
580-63069-1	SW	0916RD05SW	580-63069-25	9/28/2016		6010B, 6020A, 7471A, 9060, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-63069-1	SW	0916RD06SW	580-63069-26	9/28/2016		6010B, 6020A, 7471A, 9060, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-63069-1	SW	0916RD08SW	580-63069-27	9/28/2016		6010B, 6020A, 7471A, 9060, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-63069-1	SW	0916RD09SW	580-63069-28	9/29/2016		6010B, 6020A, 7471A, 9060, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-63069-1	SW	0916RD10SW	580-63069-29	9/29/2016	MS/MSD	6010B, 6020A, 7471A, 9060, 300.0’ 353.2, SM2320B, SM2540C, SM2540D
580-63069-1	SW	0916RD14SW	580-63069-30	9/29/2016	FD1	6010B, 6020A, 7471A, 9060, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-63069-1	SW	0916RD15SW	580-63069-31	9/29/2016		6010B, 6020A, 7471A, 9060, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-63069-1	SW	0916RD50SW	580-63069-32	9/29/2016	FD1 of 0916RD14 SW	6010B, 6020A, 7471A, 9060, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-63069-1	GW	0916MW01GW	580-63069-1	9/30/2016	MS/MSD	6010B, 6020A, 7471A, 300.0, 353.2, SM2320B
580-63069-1	GW	0916MW17GW	580-63069-7	9/30/2016	FD2	6010B, 6020A, 7471A, 300.0, 353.2, SM2320B
580-63069-1	GW	0916MW32GW	580-63069-15	9/29/2016		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B
580-63069-1	GW	0916MW50GW	580-63069-20	9/30/2016	FD2 of 0916MW1 7GW	6010B, 6020A, 7471A, 300.0, 353.2, SM2320B
580-63069-1	GW	1016MW06GW	580-63069-2	10/1/2016		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B
580-63069-1	GW	1016MW08GW	580-63069-3	10/1/2016		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B
580-63069-1	GW	1016MW09GW	580-63069-4	10/3/2016		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B
580-63069-1	GW	1016MW10GW	580-63069-5	10/2/2016		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B
580-63069-1	GW	1016MW16GW	580-63069-6	10/3/2016		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B
580-63069-1	GW	1016MW19GW	580-63069-8	10/4/2016	FD3	6010B, 6020A, 7471A, 300.0, 353.2, SM2320B
580-63069-1	GW	1016MW22GW	580-63069-9	10/5/2016	MS/MSD	6010B, 6020A, 7471A, 300.0,AK102/103, AK101,8260C,8270D,353.2, SM2320B
580-63069-1	GW	1016MW26GW	580-63069-10	10/5/2016		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B
580-63069-1	GW	1016MW27GW	580-63069-11	10/5/2016		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B
580-63069-1	GW	1016MW28GW	580-63069-12	10/2/2016		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B
580-63069-1	GW	1016MW29GW	580-63069-13	10/3/2016		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B

Table 1 - Sample Listing

Work Order	Matrix	Sample ID	Lab ID	Sample Date	QA/QC	Analysis
580-63069-1	GW	1016MW31GW	580-63069-14	10/1/2016		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B
580-63069-1	GW	1016MW33GW	580-63069-16	10/2/2016		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B
580-63069-1	GW	1016MW40GW	580-63069-17	10/4/2016		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B
580-63069-1	GW	1016MW42GW	580-63069-18	10/5/2016		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B
580-63069-1	GW	1016MW43GW	580-63069-19	10/2/2016		6010B, 6020A, 7471A, 300.0,AK102/103, AK101,8260C,8270D,353.2, SM2320B
580-63069-1	GW	1016MW55GW	580-63069-21	10/4/2016	FD3 of 1016MW19GW	6010B, 6020A, 7471A, 300.0,AK102/103, AK101,8260C,8270D,353.2, SM2320B
580-63069-1	GW	1016RB01	580-63069-23	10/6/2016	EB	6010B, 6020A, 7471A, 353.2, SM2540D
580-63069-1	GW	1016EB01	580-63069-24	10/6/2016	EB	6020A, 7471A, SM2540C
580-63069-1	GW	0916TB01	580-63069-22	9/22/2016	TB	8260C, AK101

Table 2 - List of Samples Qualified for Holding Time Exceedance

Method	Analyte	Sample IDs	HT	Sampling Date	Analysis Date	Qual
SM2540 C & D	TSS and TDS	0916RD05SW	7 day	9/28/2016	10/11/2016	J
SM2540 C & D	TSS and TDS	0916RD06SW	7 day	9/28/2016	10/11/2016	J
SM2540 C & D	TSS and TDS	0916RD08SW	7 day	9/28/2016	10/11/2016	J
SM2540 C & D	TSS and TDS	0916RD09SW	7 day	9/29/2016	10/11/2016	J
SM2540 C & D	TSS and TDS	0916RD10SW	7 day	9/29/2016	10/11/2016	J
SM2540 C & D	TSS and TDS	0916RD14SW	7 day	9/29/2016	10/11/2016	J
SM2540 C & D	TSS and TDS	0916RD15SW	7 day	9/28/2016	10/11/2016	J
SM2540 C & D	TSS and TDS	0916RD50SW	7 day	9/28/2016	10/11/2016	J

Table 3a - List of Positive Results for Blank Samples

Method	Sample ID	Sample Type	Analyte	Result	Analysis Type	Units	PQL
EPA 6020A	MB 580-229926/15A	AQ	Lead	0.000289J	MB	mg/L	0.0020
EPA 6020A	MB 580-229926/15A	AQ	Silver	0.000241J	MB	mg/L	0.0020
EPA 353.2	MB 580-230140/14	AQ	Nitrate-Nitrite as Nitrogen	0.0210J	MB	mg/L	0.050
EPA 353.2	MB 580-230140/48	AQ	Nitrate-Nitrite as Nitrogen	0.0220J	MB	mg/L	0.050
AK10/103	MB 580-230089/1-A	AQ	DRO	0.0350J	MB	mg/L	0.10
EPA 8270D	MB 580-229524/1-A	AQ	Butyl benzyl phthalate	0.206J	MB	ug/L	0.60
EPA 353.2	1016RB01	AQ	Nitrate-Nitrite as Nitrogen	0.024J	RB	mg/L	0.050
EPA 300.0	1016RB01	AQ	Sulfate	0.44J	RB	mg/L	1.2
EPA 6020A	1016RB01	AQ	Antimony	0.00062J	RB	mg/L	0.0020
EPA 6020A	1016RB01	AQ	Barium	0.00033J	RB	mg/L	0.0060
EPA 6010B	1016RB01	AQ	Calcium	0.08J	RB	mg/L	1.1

Table 3b - List of Samples Qualified for Method Blank Contamination

Method	Sample ID	Analyte	Blank Result	Sample Result	Sample Qual	PQL
EPA 6020A	0916RD10SW	Lead	0.000289	0.00027	U	0.0020
EPA 6020A	0916RD10SW	Silver	0.000241	0.00023	U	0.0020
EPA 353.2	0916RD05SW	Nitrate-Nitrite as N	0.0220	0.026	J	0.05
EPA 353.2	0916RD06SW	Nitrate-Nitrite as N	0.0220	0.20	J	0.05
EPA 353.2	0916RD08SW	Nitrate-Nitrite as N	0.0220	0.20	J	0.05
EPA 353.2	0916RD09SW	Nitrate-Nitrite as N	0.0220	0.19	J	0.05
EPA 353.2	0916RD10SW	Nitrate-Nitrite as N	0.0220	0.21	J	0.05
EPA 353.2	0916RD14SW	Nitrate-Nitrite as N	0.0220	0.21	J	0.05
EPA 353.2	0916RD15SW	Nitrate-Nitrite as N	0.0220	0.21	J	0.05
EPA 353.2	0916RD50SW	Nitrate-Nitrite as N	0.0220	0.21	J	0.05
EPA 353.2	1016RB01	Nitrate-Nitrite as N	0.0220	0.024	U	0.05
EPA 353.2	0916MW50GW	Nitrate-Nitrite as N	0.0220	0.078	U	0.05
EPA 353.2	0916MW01GW	Nitrate-Nitrite as N	0.0220	0.23	J	0.05
EPA 353.2	0916MW17GW	Nitrate-Nitrite as N	0.0220	0.074	U	0.05
EPA 353.2	1016MW06GW	Nitrate-Nitrite as N	0.0220	0.032	U	0.05
EPA 353.2	1016MW09GW	Nitrate-Nitrite as N	0.0220	0.026	U	0.05
EPA 353.2	1016MW10GW	Nitrate-Nitrite as N	0.0220	0.024	U	0.05
EPA 353.2	1016MW16GW	Nitrate-Nitrite as N	0.0220	0.025	U	0.05
EPA 353.2	1016MW19GW	Nitrate-Nitrite as N	0.0220	0.12	J	0.05
EPA 353.2	1016MW22GW	Nitrate-Nitrite as N	0.0220	0.074	U	0.05
EPA 353.2	1016MW26GW	Nitrate-Nitrite as N	0.0220	0.061	U	0.05
EPA 353.2	1016MW28GW	Nitrate-Nitrite as N	0.0220	0.0220	U	0.05
EPA 353.2	1016MW29GW	Nitrate-Nitrite as N	0.0220	0.025	U	0.05
EPA 353.2	1016MW31GW	Nitrate-Nitrite as N	0.0220	0.063	U	0.05
EPA 353.2	1016MW40GW	Nitrate-Nitrite as N	0.0220	0.025	U	0.05
EPA 353.2	1016MW42GW	Nitrate-Nitrite as N	0.0220	0.023	U	0.05
EPA 353.2	1016MW43GW	Nitrate-Nitrite as N	0.0220	0.030	U	0.05
EPA 353.2	1016MW55GW	Nitrate-Nitrite as N	0.0220	0.12	J	0.05
AK102/103	1016MW22GW	DRO	0.0350	0.038	U	0.10

Table 3c - List of Samples Qualified for Equipment Rinsate Blank Contamination

Method	Sample ID	Analyte	Blank Result	Sample Result	Sample Qual	PQL
EPA 300.0	1016MW31GW	Sulfate	0.44	1.5	U	1.2
EPA 6020A	0916RD08SW	antimony	0.00062	0.00059	U	0.002
EPA 6020A	1016MW19GW	antimony	0.00062	0.00056	U	0.002
EPA 6020A	1016MW29GW	antimony	0.00062	0.0012	U	0.002
EPA 6020A	1016MW55GW	antimony	0.00062	0.0006	U	0.002

Table 4 - List of Samples with Surrogates outside Control Limits

Method	Sample ID	Sample Type	Analyte	Rec.	Low Limit	High Limit	Dil Fac	Sample Qual.
None.								

Table 5a - List of MS/MSD Recoveries outside Control Limits

Method	Sample ID	Sample Type	Analyte	Orig. Result	Spike Amount	Rec.	Dil Fac.	Low Limit	High Limit	Sample Qual
EPA 8260C	1016MW22GW	AQ	Benzene	0.2 U	4.32	129	1.0	73	120	None - ND
EPA 8260C	1016MW22GW	AQ	Toluene	0.55	4.3	134	1.0	70	126	J+
EPA 8270D	1016MW22GW	AQ	Bis(2-ethyhexyl) Phthalate	2.8 U	190	201	1.0	22	150	None- ND
EPA 300.0	1016MW22GW	AQ	Fluoride	0.2 U	5.0	112	1.0	90	110	None- ND
EPA 300.0	0916RD10SW	AQ	Fluoride	0.2 U	5.0	119	1.0	90	110	None- ND
EPA 300.0	0916RD10SW	AQ	Chloride	0.97	5.0	114	1.0	90	110	J+
EPA 300.0	0916RD10SW	AQ	Sulfate	7.1	5.0	121	1.0	90	110	J+
AK102/103	1016MW22GW	AQ	DRO	0.038	2.03	61	1.0	75	425	None- ND
EPA 353.2	0916MW01GW	AQ	Nitrate-Nitrite as N	0.23	0.5	65	1.0	90	110	J-
EPA 353.2	1016MW22GW	AQ	Nitrate-Nitrite as N	0.074	0.5	86	1.0	90	110	None- ND
EPA 353.2	0916RD10SW	AQ	Nitrate-Nitrite as N	0.21	0.5	88	1.0	90	110	J-

Table 5b - List of Lab and MS Duplicate RPDs outside Control Limits

Sample ID	Analyte	Method	RPD	RPD Limit	No. of Affected Samples	Samp Qual
1016MW22GW	Bis(2-ethyhexyl) Phthalate	EPA 8270D	69	35	0	*
1016MW22GW	3,3- Dichlorobenzidine	EPA 8270D	36	35	0	*
1016MW22GW	DRO	AK102/103	33	20	2	J
0916RD10SW	Potassium	EPA 6010C	21	20	1	J
0916MW01GW	Selenium	EPA 6020A	30	20	0	*

*Not detected in associated samples.

Table 6 - List of LCS Recoveries outside Control Limits

Method	Sample ID	Analyte	% Rec.	Low Limit	High Limit	No. of Affected Samples	Samp Qual
EPA 8270D	LCS 580-229524/2-A	4-Chloroaniline	5	20	110	3	UR
EPA 8270D	LCS 580-229524/2-A	Bis(chloroisopropyl) ether	128	44	123	0	*
EPA 8270D	LCS 580-229524/2-A	Dibenz(a,h)anthracene	127	56	124	0	*
EPA 8270D	LCS 580-229524/3-A	4-Chloroaniline	3	20	110	3	UR
EPA 8270D	LCS 580-229524/3-A	Dibenz(a,h)anthracene	131	56	124	0	*
EPA 8270D	LCS 580-229524/3-A	bis(chloroisopropyl) ether	127	44	123	0	*
EPA 8270D	LCS 580-229524/3-A	Di-n-octyl phthalate	153	55	150	0	*
EPA 8270D	LCS 580-229524/3-A	Bis(2-ethylhexyl) phthalate	200	22	150	0	*
EPA 8270D	LCS 580-229524/3-A	2-Nitroaniline	129	58	124	0	*

*= no qualification required

Table 7 - Samples that were Re-analyzed

Sample ID	Lab ID	Method	Sample Type	Action
None.				

Table 8a - Summary of Field Duplicate Results

Method	Analyte	Units	0916RD14SW	0916RD50SW	RPD	Rating	Sample Qualifier
EPA 9060	TOC	mg/L	2.5	2.5	0.0%	Good	None
EPA 300.0	Chloride	mg/L	0.98	0.98	0.0%	Good	None
EPA 300.0	Fluoride	mg/L	8.1	7.4	0.9%	Good	None
EPA 300.0	Sulfate	mg/L	0.21	0.21	0.0%	Good	None
EPA 353.2	Nitrate-Nitrite and N	mg/L	2.5	2.5	0.0%	Good	None
SM2320B	Alkalinity	mg/L	64	63	1.5%	Good	None
SM2320B	Bicarbonate Alkalinity	mg/L	64	63	1.5%	Good	None
SM2320C	TDS	mg/L	67	77	13.9%	Good	None
EPA 6010B	Dissolved Calcium	mg/L	15	14	6.9%	Good	None
EPA 6010B	Dissolved Magnesium	mg/L	8.3	7.9	4.9%	Good	None
EPA 6010B	Dissolved Potassium	mg/L	0.28	0.30	6.9%	Good	None
EPA 6010B	Dissolved Sodium	mg/L	1.5	1.5	0.0%	Good	None
EPA 6020A	Dissolved Antimony	mg/L	0.11	0.036	93%	Poor	J
EPA 6020A	Dissolved Arsenic	mg/L	0.041	0.020	69%	OK	J
EPA 6020A	Dissolved Barium	mg/L	0.023	0.023	0.0%	Good	None
EPA 6020A	Dissolved Manganese	mg/L	0.019	0.0094	42%	Poor	J
EPA 6010B	Calcium	mg/L	15	14	6.9%	Good	None
EPA 6010B	Magnesium	mg/L	8.3	8.1	2.4%	Good	None
EPA 6010B	Potassium	mg/L	0.25	0.20	22.2%	Good	None
EPA 6010B	Sodium	mg/L	1.6	1.5	6.5%	Good	None
EPA 6020A	Antimony	mg/L	0.090	0.031	100%	Poor	J
EPA 6020A	Arsenic	mg/L	0.035	0.018	59%	Poor	J
EPA 6020A	Barium	mg/L	0.023	0.022	4.4%	Good	None
EPA 6020A	Manganese	mg/L	0.019	0.014	30.3%	Good	None

Table 8b - Summary of Field Duplicate Results

Method	Analyte	Units	0916MW17GW	0916MW50GW	RPD	Rating	Sample Qualifier
EPA7471	Mercury	mg/L	0.0017	0.0032	60%	Poor	J
EPA 300.0	Chloride	mg/L	1.1	1.1	0.0%	Good	None
EPA 300.0	Fluoride	mg/L	0.060	0.060	0.0%	Good	None
EPA 300.0	Sulfate	mg/L	7.2	6.7	7%	Good	None
EPA 353.2	Nitrate-Nitrite as N	mg/L	0.074	0.078	5%	Good	None
SM2320B	Alkalinity	mg/L	100	120	9%	Good	None
ESM2320B	Bicarbonate Alkalinity	mg/L	100	120	9%	Good	None
EPA 6010B	Aluminum	mg/L	0.31	0.22	35%	Good	None
EPA 6010B	Calcium	mg/L	21	19	10%	Good	None
EPA 6010B	Iron	mg/L	0.31	0.42	33%	Good	None
EPA 6010B	Magnesium	mg/L	16	14	13%	Good	None
EPA 6010B	Potassium	mg/L	0.42	0.44	4.6%	Good	None
EPA 6010B	Sodium	mg/L	2.6	2.4	8%	Good	None
EPA 6020A	Antimony	mg/L	0.075	0.061	21%	Good	None
EPA 6020A	Arsenic	mg/L	0.021	0.019	10%	Good	None
EPA 6020A	Barium	mg/L	0.042	0.043	2%	Good	None
EPA 6020A	Chromium	mg/L	0.00083	0.00083	0.0%	Good	None
EPA 6020A	Cobalt	mg/L	0.00035	0.00036	3%	Good	None
EPA 6020A	Lead	mg/L	0.00043	0.00057	28%	Good	None
EPA 6020A	Manganese	mg/L	0.014	0.018	12.5%	Good	None
EPA 6020A	Silver	mg/L	0.002 U	0.00016 J	NA	Good	None

Table 8c - Summary of Field Duplicate Results

Method	Analyte	Units	1016MW19GW	1016MW55GW	RPD	Rating	Sample Qualifier
EPA 8260C	Toluene	ugL	0.64	0.41	44%	Poor	J
AK 101	GRO	mg/L	0.05 U	0.026	NA	Good	None
EPA 8270D	1-Methylnaphthalene	ugL	0.044	0.046	2.2%	Good	None
EPA 8270D	Benzoic acid	ugL	0.70	2.8 U	NA	Good	None
EPA 8270D	Bis(2-ethyhexyl) Phthalate	ugL	2.2	2.8 U	NA	Good	None
EPA 8270D	Phenol	ugL	0.15	0.57 U	NA	Good	None
AK102/103	DRO	mg/L	0.045	0.048	6.5%	Good	None
EPA 300.0	Chloride	mg/L	0.93	0.96	3.2%	Good	None
EPA 300.0	Fluoride	mg/L	0.070	0.080	13%	Good	None
EPA 300.0	Sulfate	mg/L	5.8	6.0	3.3%	Good	None
EPA 353.2	Nitrate-Nitrite as N	mg/L	0.12	0.12	0.0%	Good	None
SM2320B	Alkalinity	mg/L	82	82	0.0%	Good	None
ESM2320B	Bicarbonate Alkalinity	mg/L	82	82	0.0%	Good	None
EPA 6010B	Calcium	mg/L	18	18	0.0%	Good	None
EPA 6010B	Magnesium	mg/L	13	12	8.0%	Good	None
EPA 6010B	Potassium	mg/L	0.26	0.27	3.8%	Good	None
EPA 6010B	Sodium	mg/L	2.3	2.2	4.4%	Good	None
EPA 6010B	Antimony	mg/L	0.00056	0.00060	6.9%	Good	None
EPA 6010B	Arsenic	mg/L	0.0030	0.005 U	NA	Good	None
EPA 6020A	Barium	mg/L	0.046	0.044	4.4%	Good	None
EPA 6020A	Manganese	mg/L	0.016	0.0076	33%	Good	None
EPA 6020A	Selenium	mg/L	0.0015	0.005 U	NA	Good	None

DATA REVIEW MEMORANDUM

DATE: December 7, 2016 (Revised March 28, 2017)

TO: Jonathan Reeve, Project Manager, E & E, Seattle, WA

FROM: Howard Edwards, E & E, San Francisco, CA

SUBJ: Data Review: Red Devil Mine Fall 2016

REFERENCE:

Project ID	Lab Work Order	Lab
1001095.0009.02	EEI-SA1601	Brooks Applied Labs – Seattle

Validated data is attached to the end of this memorandum.

1. SAMPLE IDENTIFICATION

For the sampling activities at the Red Devil Mine site, Ecology and Environment, Inc. (E & E) collected the samples listed in Table 1. Project-specific matrix spike/matrix spike duplicates (MS/MSD) were designated in the field. All samples were sent to Brooks Applied Labs in Tacoma, Washington, for low-level analyses. This report addresses only Brooks Applied Labs-generated data.

The analytical report was issued by Brooks Applied Labs on November 25, 2016. The data in the analytical report were reviewed for field and laboratory precision, accuracy, and completeness in accordance with procedures and quality control (QC) limits, the current laboratory Quality Assurance Manual (QAM) and current standard operating procedures (SOPs). Any additional data review qualifiers added are noted below and listed on the tables at the end of this memorandum. Definitions of all data qualifiers are given in the report.

Work Orders, Tests, and Number of Samples Included in this Data Review Memo

Work Orders/ Job Number	Matrix	Test Method	Method Name	Number of Samples
EEI-SA1601	Surface Water	EPA 1631	Total Low-Level Mercury (CVAFS)	8
EEI-SA1601	Surface Water	EPA 1631	Dissolved Low-Level Mercury (CVAFS)	8
EEI-SA1601	Ground Water	EPA 1631	Total Low-Level Mercury (CVAFS)	21
EEI-SA1601	Ground Water	EPA 1631	Dissolved Low-Level Mercury (CVAFS)	21
EEI-SA1601	Rinse Blank	EPA 1631	Dissolved Low-Level Mercury (CVAFS)	1
EEI-SA1601	Trip Blank	EPA 1631	Dissolved Low-Level Mercury (CVAFS)	1
EEI-SA1601	Field Blank	EPA 1631	Dissolved Low-Level Mercury (CVAFS)	6

2. SAMPLE PROCEDURES

All samples were collected as specified in the work plan and documented on the chain-of-custody (COC) and in field notebooks. Samples were analyzed as specified on the COC. Samples were packaged, shipped, and received as specified in the work plan. All samples for organic analyses must be received cold (4 ± 2 degrees Celsius [^{o}C]) and in good condition as documented on the Cooler Receipt Form.

REVIEW RESULTS

All sample procedures were followed and the sample coolers were received by the laboratory at 6.0^{o}C and 11^{o}C. Since the samples were acidified in the field, the Field Sampling Plan requirement indicating 4 ±2 ^{o}C requirement, did not result in qualification. Since the temperature is not a method requirement.

3. LABORATORY DATA

3.1 HOLDING TIMES

Holding times are established and monitored to ensure analytical results accurately represent analyte concentrations in a sample at the time of collection. These qualified results based upon missed holding times are presented in Table 2 (if applicable). Exceeding the holding time for a sample generally results in a loss of the analyte due to a variety of mechanisms, such as deposition on the sample container walls or precipitation.

3.2 BLANKS

All laboratory blanks are integrated into the method and all results are corrected for blank values provided that the laboratory blank values are within method-set limits. When blanks are outside of the method limits, associated samples are re-analyzed. Method blanks are shown in Table 3a. No data was qualified due to laboratory method blanks (see Table 3b).

Field blank samples are analyzed and evaluated to determine the existence and magnitude of possible contamination during the sampling and analysis process. All field blank with reported results are also presented in Table 3a (if applicable). If the mercury is present in the sample at similar trace levels (less than 5 times the blank concentration), then the analyte is likely a common background contaminant from some phase of the sampling, extraction, or analytical procedure and associated low-level sample concentrations are not considered to be site related. Sample results in these cases are qualified as not detected, “U”.

REVIEW RESULTS

All laboratory blanks were performed at the required frequency. As noted in Table 3a, analyte concentrations in the method blanks were below the practical quantitation limit (PQL). Several field blanks were at a concentration above the detection limit. All associated reported concentration of mercury that were less than 5 times the concentration found in their associated field blank were U qualified as not detected. A summary of qualified data due to method blank contamination is presented in Table 3c.

Two equipment rinsate blank was collected. One rinsate blank was at a concentration above the method reporting limit. All associated sample results that were detected at levels less than 5 times the blank were U qualified as not detected. Associated samples with detection greater than 5 times the blank were not qualified. A summary of qualified data due to equipment rinsate blank contamination is also presented in Table 3c.

3.3 MATRIX SPIKE AND MATRIX SPIKE DUPLICATE ANALYSIS

The MS/MSD analyses are intended to provide information about the effects that the sample matrix exerts on the digestion / extraction and measurement methodology. MS recovery values that do not meet laboratory QC criteria may indicate that sample analyte results are being attenuated in the analysis procedure. The potential sample bias may be estimated by noting the degree to which the MS concentration was elevated or lowered in the spike analysis. However, this estimated bias should serve only as an approximation; sample-specific problems may be the cause of the discrepancy, particularly in soil samples.

Recovery calculations are not required if the spiking concentration added is less than 25% of the sample background concentration.

REVIEW RESULTS

The MS/MSD sample analyses were performed on five samples: 1016MW19GW, 1016MW16GW, 1016MW27GW, 10916MW22GW, and10916MW32GW, at the required frequency. All MS/MSD recoveries and accuracies were within the control limits

A summary of sample data qualified due to MS/MSD precision and accuracy are presented in Tables 5a and 5b (if applicable).

3.4 LABORATORY CONTROL SAMPLE ANALYSIS

The LCS or Certified Reference Material standard is analyzed to monitor the efficiency of the digestion/extraction procedure and analytical instrument operation. The ability of the laboratory to successfully analyze an LCS or Certified Reference Material standard demonstrates that there are no analytical problems related to the digestion/sample preparation procedures and/or instrument operations. The LCS or Certified Reference Material standard results outside QC limits are presented in Table 6 (if applicable). Sporadic and marginal QC failures for multiple component methods do not indicate an analytical concern. If recoveries are high and the compounds are not detected in the samples, then no data qualification is required. All recoveries should be above 10% or the non-detect results flagged “UR” as rejected.

REVIEW RESULTS

The analysis of the Certified Reference Material Sample was within control limits.

3.5 COMPOUND IDENTIFICATION AND QUANTITATION

Compound identities are assigned by comparing sample compound retention times to retention times from known (standard) compounds and identification of an acceptable mass spectrum. Compounds detected below the PQL in samples should be considered estimated and are qualified "J." The samples with compounds above the linear range were all re-analyzed at a higher dilution factor.

REVIEW RESULTS

All compound identification and quantitation criteria were achieved. As noted in Table 7, samples were reported as reanalyzed based upon laboratory blank concentrations in the batch. All reported concentrations were from batches with acceptable blanks.

Sample 0916RD08SW had a dissolved low-level lead concentration that was greater than the total low-level lead concentration. The data was “J” qualified, as this is an unrealistic scenario.

4. FIELD DUPLICATE SAMPLE RESULTS

Field duplicate samples were collected and analyzed as an indication of overall precision for both field and laboratory. Field duplicate results are summarized in Table 8 (if applicable). The results are expected to have more variability than laboratory duplicates, which measure only laboratory precision. The QC criteria used to assess field duplicate samples for this project was limits of 40% RPD for waters, or twice the general laboratory duplicate criteria. If a given compound in both the regular sample and associated field duplicate sample was below the laboratory PQL, or the compound was not detected in one of the samples, then the compound is generally not qualified due to field duplicate precision. There are no guidelines regarding data qualification based on poor field duplicate precision. Professional judgment was used to determine whether or not to qualify results.

REVIEW RESULTS

Three field duplicates analyses were performed on this SDG. The RPD ratings are listed on Tables 8a through 8c as “Good” if the RPD is less than field duplicate QC criteria of 40% and as “Poor” if the RPD exceeded the field duplicate QC criteria.

Two results show good precision in the sample pair for both total and dissolved mercury. One set of field duplicate samples had good precision for total mercury and poor precision for dissolved mercury. Results are noted on Tables 8a through 8c. Qualifiers were only added to the field duplicate results as noted.

5. OVERALL ASSESSMENT OF DATA

The data from several of the QA samples suggest the following:

- That there was a sample related problem at two locations. The lead concentrations in the filtered and unfiltered sample 1016MW55GW (duplicate of the MW19 sample) suggests that there was a filtering problem with that sample. The lead concentrations in the filtered and unfiltered sample 0916RD08 also suggest a filtering or labeling problem.
- That there was an equipment decontamination problem with the bladder pump that was used to collect some of the groundwater samples. The equipment rinsate blank indicates the potential of inadequate decontamination of the bladder pump. Since the rinsate blank sample was not field filtered, it is only associated with the total mercury concentration in unfiltered samples collected with a bladder pump. Future rinsate blanks sampling should include a filtered rinsate blanks.
- E & E notified the laboratory that the mercury (Hg) result associated with sample 1016MW19GW (1642012-54) was an outlier of what was expected. The laboratory re-analyzed the sample in duplicate and obtained a much lower result. The original Hg result was reported as 38.8 ng/L, and the re-analyses, performed in two separate sequences (analytical runs), were 3.32 ng/L and 3.38 ng/L. The result of 3.32 ng/L was reported. The value of 3.32 ng/L is consistent with the sample’s field duplicate value and with historic data for the location. The originally reported value of 38.8 ng/L was in error due to a unique instrument-related problem that was identified by the laboratory. According to the laboratory, the problem only affected that sample 1016MW19GW (1642012-54). The

laboratory has implemented a corrective action measures that will prevent the error in future analyses.

All data were reviewed and considered usable with qualification as noted in this report.

Table 1 - Sample Listing

Work Order	Matrix	Sample ID	Lab ID	Sample Date	QA/QC	Analysis
EE-IS-1601	F-GW	*0916MW32GW*	1642012-01	9/29/2016		EPA 1631
EE-IS-1601	F-GW	*1016MW09GW*	1642012-02	10/3/2016		EPA 1631
EE-IS-1601	F-GW	*1016MW55GW*	1642012-03	10/4/2016	FD of 1016MW19GW	EPA 1631
EE-IS-1601	F-GW	*1016MW40GW*	1642012-04	10/4/2016		EPA 1631
EE-IS-1601	F-GW	*1016MW19GW*	1642012-05	10/4/2016	FD of 1016MW55GW MS/MSD	EPA 1631
EE-IS-1601	F-GW	*1016MW28GW*	1642012-06	10/2/2016		EPA 1631
EE-IS-1601	F-GW	*1016MW06GW*	1642012-07	10/1/2016		EPA 1631
EE-IS-1601	F-GW	*1016MW08GW*	1642012-08	10/1/2016		EPA 1631
EE-IS-1601	F-GW	*1016MW42GW*	1642012-09	10/5/2016		EPA 1631
EE-IS-1601	F-GW	*0916MW01GW*	1642012-10	9/30/2016		EPA 1631
EE-IS-1601	F-GW	*1016MW33GW*	1642012-11	10/2/2016		EPA 1631
EE-IS-1601	F-DW	*0916RD05SW*	1642012-12	9/29/2016		EPA 1631
EE-IS-1601	F-DW	*0916RD06SW*	1642012-13	9/28/2016		EPA 1631
EE-IS-1601	F-DW	*0916RD08SW*	1642012-14	9/28/2016		EPA 1631
EE-IS-1601	F-DW	*0916RD09SW*	1642012-15	9/29/2016		EPA 1631
EE-IS-1601	F-DW	*0916RD10SW*	1642012-16	9/29/2016		EPA 1631
EE-IS-1601	F-DW	*0916RD14SW*	1642012-17	9/29/2016	FD of 0916RD50SW	EPA 1631
EE-IS-1601	F-DW	*0916RD15SW*	1642012-18	9/29/2016		EPA 1631
EE-IS-1601	F-DW	*0916RD50SW*	1642012-19	9/29/2016	FD of 0916RD14SW	EPA 1631
EE-IS-1601	F-GW	*0916MW50GW*	1642012-20	9/30/2016	FD of 0916MW17GW	EPA 1631
EE-IS-1601	F-GW	*1016MW16GW*	1642012-21	10/3/2016		EPA 1631
EE-IS-1601	F-GW	*1016MW43GW*	1642012-22	10/2/2016		EPA 1631
EE-IS-1601	F-GW	*1016MW10GW*	1642012-23	10/2/2016		EPA 1631
EE-IS-1601	F-GW	*1016MW27GW*	1642012-24	10/5/2016		EPA 1631
EE-IS-1601	F-GW	*0916MW17GW*	1642012-25	9/30/2016	FD of 0916MW50GW	EPA 1631
EE-IS-1601	F-GW	*1016MW31GW*	1642012-26	10/1/2016		EPA 1631
EE-IS-1601	F-GW	*1016MW26GW*	1642012-27	10/5/2016		EPA 1631
EE-IS-1601	F-GW	*1016MW29GW*	1642012-28	10/3/2016		EPA 1631
EE-IS-1601	F-GW	*1016MW22GW*	1642012-29	10/5/2016		EPA 1631
EE-IS-1601	GW	*1016MW16GW*	1642012-30	10/3/2016	MS/MSD	EPA 1631
EE-IS-1601	GW	*1016MW43GW*	1642012-31	10/2/2016		EPA 1631
EE-IS-1601	GW	*0916MW32GW*	1642012-32	9/29/2016	MS/MSD	EPA 1631
EE-IS-1601	Blank	*0916FB02*	1642012-33	9/29/2016	Field Blank	EPA 1631
EE-IS-1601	SW	*0916RD05SW*	1642012-34	9/29/2016		EPA 1631
EE-IS-1601	GW	*1016MW27GW*	1642012-35	10/5/2016	MS/MSD	EPA 1631
EE-IS-1601	SW	*0916RD06SW*	1642012-36	9/28/2016		EPA 1631
EE-IS-1601	SW	*0916RD09SW*	1642012-37	9/29/2016		EPA 1631
EE-IS-1601	SW	*0916RD08SW*	1642012-38	9/28/2016		EPA 1631
EE-IS-1601	SW	*0916RD15SW*	1642012-39	9/29/2016		EPA 1631
EE-IS-1601	GW	*0916MW01GW*	1642012-40	9/30/2016		EPA 1631
EE-IS-1601	SW	*0916RD50SW*	1642012-41	9/29/2016	FD of 0916RD14SW	EPA 1631
EE-IS-1601	Blank	1016RB01	1642012-42	10/6/2016	Rinse Blank	EPA 1631

Table 1 - Sample Listing

Work Order	Matrix	Sample ID	Lab ID	Sample Date	QA/QC	Analysis
EE-IS-1601	SW	0916RD10SW	1642012-43	9/29/2016		EPA 1631
EE-IS-1601	GW	1016MW26GW	1642012-44	10/5/2016		EPA 1631
EE-IS-1601	SW	0916RD14SW	1642012-45	9/29/2016	FD of 0916RD50SW	EPA 1631
EE-IS-1601	Blank	0916FB03	1642012-46	9/30/2016	Field Blank	EPA 1631
EE-IS-1601	Blank	0916TB02	1642012-47	9/22/2016	Trip Blank	EPA 1631
EE-IS-1601	GW	1016MW42GW	1642012-48	10/5/2016		EPA 1631
EE-IS-1601	GW	1016MW09GW	1642012-49	10/3/2016		EPA 1631
EE-IS-1601	GW	1016MW29GW	1642012-50	10/3/2016		EPA 1631
EE-IS-1601	GW	1016MW55GW	1642012-51	10/4/2016	FD of 1016MW19GW	EPA 1631
EE-IS-1601	GW	1016MW40GW	1642012-52	10/4/2016		EPA 1631
EE-IS-1601	GW	0916MW17GW	1642012-53	9/30/2016	FD of 0916MW17GW	EPA 1631
EE-IS-1601	GW	1016MW19GW	1642012-54	10/4/2016	FD of 1016MW55GW	EPA 1631
EE-IS-1601	Blank	1016FB08	1642012-55	10/5/2016	Field Blank	EPA 1631
EE-IS-1601	GW	0916MW50GW	1642012-56	9/30/2016	FD of 0916MW17GW	EPA 1631
EE-IS-1601	Blank	1016FB06	1642012-57	10/30/2016	Field Blank	EPA 1631
EE-IS-1601		1016MW33GW	1642012-58	10/2/2016		EPA 1631
EE-IS-1601	Blank	0916FB01	1642012-59	9/28/2016	Field Blank	EPA 1631
EE-IS-1601	GW	1016MW28GW	1642012-60	10/2/2016		EPA 1631
EE-IS-1601	GW	1016MW10GW	1642012-61	10/2/2016		EPA 1631
EE-IS-1601	GW	1016MW06GW	1642012-62	10/1/2016		EPA 1631
EE-IS-1601	GW	1016MW08GW	1642012-63	10/1/2016		EPA 1631
EE-IS-1601	Blank	1016FB05	1642012-64	10/2/2016	Field Blank	EPA 1631
EE-IS-1601	Blank	1016FB04	1642012-65	10/1/2016	Field Blank	EPA 1631
EE-IS-1601	GW	1016MW22GW	1642012-66	10/5/2016	MS/MSD	EPA 1631
EE-IS-1601	GW	1016MW31GW	1642012-67	10/1/2016		EPA 1631
EE-IS-1601	GW	1016FB07	1642012-68	10/4/2016	Field Blank	EPA 1631
EE-IS-1601		SGS Reagent Water Blank	1642012-69	10/4/2016		EPA 1631
EE-IS-1601	Blank	Filter Blank	1642012-70	10/4/2016	Rinse Blank	EPA 1631

F-SW = Filtered surface water
F-GW =Filtered ground water
FD = Field duplicate sample

SW = Surface water
GW = Ground water

Table 2 - List of Samples Qualified for Holding Time Exceedance

Method	Analyte	Sample IDs	HT	Sampling Date	Analysis Date	Qual
None						

Table 3a - List of Positive Results for Blank Samples

Method	Sample ID	Sample Type	Analyte	Result**	Analysis Type	Units	PQL
EPA1631	B162578-BLK1	AQ	Lead	0.07	MB	ng/L	0.40
EPA1631	B162578-BLK2	AQ	Lead	0.05	MB	ng/L	0.40
EPA1631	B162578-BLK3	AQ	Lead	0.10	MB	ng/L	0.40
EPA1631	B162578-BLK4	AQ	Lead	0.10	MB	ng/L	0.40
EPA1631	B162579-BLK5	AQ	Lead	0.23	MB	ng/L	0.40
EPA1631	B162579-BLK6	AQ	Lead	0.14	MB	ng/L	0.40
EPA1631	B162579-BLK7	AQ	Lead	0.15	MB	ng/L	0.40
EPA1631	B162579-BLK8	AQ	Lead	0.16	MB	ng/L	0.40
EPA1631	1016FB02	AQ	Lead	0.17	FB	ng/L	0.40
EPA1631	1016FB03	AQ	Lead	0.13	FB	ng/L	0.40
EPA1631	1016FB06	AQ	Lead	0.16	FB	ng/L	0.40
EPA1631	1016FB07	AQ	Lead	0.18	FB	ng/L	0.40
EPA1631	1016FB08	AQ	Lead	0.21	FB	ng/L	0.40
EPA1631	1016RB01	AQ	Lead	1.98	RB	ng/L	0.40

Table 3b - List of Samples Qualified for Method Blank Contamination

Method	Sample ID	Analyte	Blank Result	Sample Result	Sample Qual	PQL
None *						

*EPA 1631 method monitors laboratory blank concentration and uses blank concentration to correct reported sample data. Detected values less than the quantitation limit are normal.
** Field blanks (FB) and Rinsate blank (RB) value are laboratory blank corrected.

Table 3c - List of Samples Qualified for Field or Equipment Rinsate Blank Contamination

Method	Sample ID	Analyte	Blank Result ng/L	Sample Result ng/L	Sample Qual	PQL ng/L
EPA 1631	1016MW19GW	Dissolved Mercury	0.18	0.61	U	0.61*
EPA1631	1016MW43GW	Total Mercury	1.98	6.77	U	6.77*
* Adjusted from 0.5 ng/L						

Table 4 - List of Samples with Surrogates outside Control Limits

Method	Sample ID	Sample Type	Analyte	Rec.	Low Limit	High Limit	Dil Fac	Sample Qual.
None.								

Table 5a - List of MS/MSD Recoveries outside Control Limits

Method	Sample ID	Sample Type	Analyte	Orig. Result	Spike Amount	Rec.	Dil Fac.	Low Limit	High Limit	Sample Qual
None										

Table 5b - List of Lab and MS Duplicate RPDs outside Control Limits

Sample ID	Analyte	Method	RPD	RPD Limit	No. of Affected Samples	Samp Qual
None						

Table 6 - List of LCS Recoveries outside Control Limits

Method	Sample ID	Analyte	% Rec.	Low Limit	High Limit	No. of Affected Samples	Samp Qual
None							

Table 7 - Samples that were Re-analyzed

Sample ID	Lab ID	Method	Sample Type	Action
0916RD05SW	1642012-12	EPA1631	Filtered surface water	High blank with no Qualification
0916RD08SW	1642012-14	EPA1631	Filtered surface water	Confirmation with no Qualification High blank with no Qualification
0916RD09SW	1642012-15	EPA1631	Filtered surface water	High blank with no Qualification
0916RD10SW	1642012-16	EPA1631	Filtered surface water	High blank with no Qualification
0916MW50GW	1642012-20	EPA1631	Filtered ground water	High blank with no Qualification
1016MW16GW	1642012-21	EPA1631	Filtered ground water	High blank with no Qualification
1016MW43GW	1642012-22	EPA1631	Filtered ground water	High blank with no Qualification
1016MW10GW	1642012-23	EPA1631	Filtered ground water	High blank with no Qualification
1016MW31GW	1642012-26	EPA1631	Filtered ground water	High blank with no Qualification
1016MW29GW	1642012-28	EPA1631	Filtered ground water	High blank with no Qualification
1016MW22GW	1642012-29	EPA1631	Filtered ground water	High blank with no Qualification
1016MW43GW	1642012-31	EPA1631	ground water	High blank with no Qualification
0916RD06SW	1642012-36	EPA1631	Surface water	High blank with no Qualification
0916RD09SW	1642012-37	EPA1631	Surface water	High blank with no Qualification
0916RD08SW	1642012-38	EPA1631	Surface water	Confirmation with no Qualification High blank with no Qualification
1016RB01	1642012-42	EPA1631	Rinsate blank water	Per method with no Qualification
1016MW55GW	1642012-51	PA1631	ground water	Confirmation with no Qualification High blank with no Qualification
0916MW50GW	1642012-56	EPA1631	ground water	High blank with no Qualification
1016MW33GW	1642012-58	EPA1631	ground water	High blank with no Qualification
Filter Blank	1642012-70	EPA1631	Rinsate blank water	High blank with no Qualification

Table 8a - Summary of Field Duplicate Results

Method	Analyte	Units	0916RD14SW	0916RD50SW	RPD	Rating	Sample Qualifier
EPA 1631	Mercury	ng/L	28.9	27	6.8	Good	None
EPA 1631	Dissolved Mercury	ng/L	14.6	15.8	7.9	Good	None

Table 8b - Summary of Field Duplicate Results

Method	Analyte	Units	0916MW17GW	0916MW50GW	RPD	Rating	Sample Qualifier
EPA 1631	Mercury	ng/L	2,590	2,320	11.2	Good	None
EPA 1631	Dissolved Mercury	ng/L	1,100	990	10.5	Good	None

Table 8c - Summary of Field Duplicate Results

Method	Analyte	Units	1016MW19GW	1016MW55GW	RPD	Rating	Sample Qualifier
EPA 1631	Mercury	ng/L	3.32	3.94	17.0	Good	None
EPA 1631	Dissolved Mercury	ng/L	0.61	4.94	156	Poor	J

DATA REVIEW MEMORANDA

DATE: July 31, 2017
TO: Jonathan Reeve, Project Manager, Ecology and Environment, Inc., Seattle, WA
FROM: Brad Heusinkveld, Ecology and Environment, Inc., Seattle, WA
Valeriy Bizyayev, Ecology and Environment, Inc., Seattle WA

RE: Data Review, Red Devil Mine, Spring 2017

REFERENCE

PROJECT ID:	100195.0009.02
LAB WORK ORDER:	EEI-SA1601
LAB:	Brooks Applied Lab

Contents

1. Sample Identification

For the sampling activities at the Red Devil Mine site, Ecology and Environment, Inc. (E & E) collected the samples listed in Table 1. Project-specific matrix spike/matrix spike duplicates (MS/MSD) were designated in the field. All samples were sent to Brooks Applied Labs in Bothell, Washington, for low-level analyses. This report addresses only Brooks Applied Labs generated data.

The analytical report was issued by Brooks Applied Labs on June 26, 2017. The data in the analytical report were reviewed for field and laboratory precision, accuracy, and completeness in accordance with procedures and quality control (QC) limits, the current laboratory Quality Assurance Manual (QAM) and current standard operating procedures (SOPs). Any additional data review qualifiers added are noted below and listed on the tables at the end of this memorandum. Definitions of all data qualifiers are given in the report.

Work Orders and Samples Included in this Review Memo

Work Orders/ Job Number	Matrix	Test Method	Method Name	Number of Samples
EEI-SA1601	Surface Water	EPA 1631	Total Low-Level Mercury (CVAFS)	12
EEI-SA1601	Surface Water	EPA 1631	Dissolved Low-Level Mercury (CVAFS)	12
EEI-SA1601	Ground Water	EPA 1631	Total Low-Level Mercury (CVAFS)	19
EEI-SA1601	Ground Water	EPA 1631	Dissolved Low-Level Mercury (CVAFS)	19
EEI-SA1601	Rinse Blank	EPA 1631	Total Low-Level Mercury (CVAFS)	1
EEI-SA1601	Trip Blank	EPA 1631	Total Low-Level Mercury (CVAFS)	4
EEI-SA1601	Field Blank	EPA 1631	Total Low-Level Mercury (CVAFS)	7

2. Sample Procedures

All samples were collected as specified in the work plan and documented on the chain-of-custody (COC) and in field notebooks. Samples were analyzed as specified on the COC. Samples were packaged, shipped, and received as specified in the work plan. All samples for analyses must be received in good condition as documented on the Cooler Receipt Form.

Results

All samples were received by the laboratory in good condition with custody seals intact at 18 ^{o}C. Delivery temperature is not specified as a Method requirement. No qualification is given for sample procedures or delivery.

3. Laboratory Data

3.1 Holding Times

Holding times are established and monitored to ensure analytical results accurately represent analyte concentrations in a sample at the time of collection. Exceeding the holding time for a sample generally results in a loss of the analyte due to a variety of mechanisms, such as deposition on the sample container walls or precipitation.

Results

All field samples were taken between May 26 and June 2 of 2017, and received by the laboratory on June 5, 2017. All submitted Samples were analyzed between June 14 and June 17. No qualification is given for sample holding and analysis times.

3.2 Blanks

All laboratory blanks are integrated into the method and all results are corrected for blank values provided that the laboratory blank values are within method-set limits. When blanks are outside of the method limits, associated samples are re-analyzed. Method blanks are shown in Table 3a. No data was qualified due to laboratory method blanks (see Table 3b).

Field blank samples are analyzed and evaluated to determine the existence and magnitude of possible contamination during the sampling and analysis process. All field blank with reported results are also presented in Table 3a (if applicable). If the mercury is present in the sample at similar trace levels (less than 5 times the blank concentration), then the analyte is likely a common background contaminant from some phase of the sampling, extraction, or analytical procedure and associated low-level sample concentrations are not considered to be site related. Sample results in these cases are qualified as not detected, "U".

Results

Blank results with detectable Mercury are presented in Table 3a. No result exceeds the PQL limit of 0.4 ng/L nor method limit of 0.5 ng/L. No qualification is given for Method Blank Contamination.

Five Field Blanks were submitted for analysis. Samples 0517FB01, 0517FB04, 0517FB05, 0517FB06, were assessed below the Method Detection Limit of 0.10 ng/L and qualified with U. Sample 0517FB03 is reported at 0.20 ng/L and qualified with J.

The equipment rinsate blank 0617EQ01GW was qualified with U for results below the MDL. The rinsate blank 0617RS01GW was reported at 10.8 ng/L for total recoverable Mercury. Samples qualified due to equipment rinsate blank contamination are presented in Table 3c.

3.3 Matrix Spike and Matrix Duplicate Analysis

The MS/MSD analyses are intended to provide information about the effects that the sample matrix exerts on the digestion / extraction and measurement methodology. MS recovery values that do not meet laboratory QC criteria may indicate that sample analyte results are being attenuated in the analysis procedure. The potential sample bias may be estimated by noting the degree to which the MS concentration was elevated or lowered in the spike analysis. However, this estimated bias should serve only as an approximation; sample-specific problems may be the cause of the discrepancy, particularly in soil samples.

Recovery calculations are not required if the spiking concentration added is less than 25% of the sample background concentration.

Results

Seven pairs of MS/MSD samples were analyzed from the samples submitted. No samples were qualified due to MS/MSD analysis.

3.4 Laboratory Control Sample Analysis

The LCS or Certified Reference Material standard is analyzed to monitor the efficiency of the digestion/extraction procedure and analytical instrument operation. The ability of the laboratory to successfully analyze an LCS or Certified Reference Material standard demonstrates that there are no analytical problems related to the digestion/sample preparation procedures and/or instrument operations. The LCS or Certified Reference Material standard results outside QC limits are presented in Table 4 (if applicable). Sporadic and marginal QC failures for multiple component methods do not indicate an analytical concern. If recoveries are high and the compounds are not detected in the samples, then no data qualification is required. All recoveries should be above 10% or the non-detect results flagged “UR” as rejected.

Results

Two analyses of Certified Reference Material were performed. All results are within control limits.

3.5 Compound Identification and Qualification

Compound identities are assigned by comparing sample compound retention times to retention times from known (standard) compounds and identification of an acceptable mass spectrum. Compounds detected below the PQL in samples should be considered estimated and are qualified "J." The samples with compounds above the linear range were all re-analyzed at a higher dilution factor.

Results

All compound identification and quantitation criteria were achieved. As noted in Table 5, samples were reported as reanalyzed based upon laboratory blank concentrations in the batch. All reported concentrations were from batches with acceptable blanks.

4. Field Duplicate Sample Results

Field duplicate samples were collected and analyzed as an indication of overall precision for both field and laboratory. Field duplicate results are summarized in Table 5. The results are expected to have more variability than laboratory duplicates, which measure only laboratory precision. The QC criteria used to assess field duplicate samples for this project was limits of 40% RPD for waters, or twice the general laboratory duplicate criteria. If a given compound in both the regular sample and associated field duplicate sample was below the laboratory PQL, or the compound was not detected in one of the samples, then the compound is generally not qualified due to field duplicate precision. There are no guidelines regarding data qualification based on poor field duplicate precision. Professional judgment was used to determine whether to qualify results.

Results

Three field duplicates analyses were performed. The RPD ratings are listed on Table 5a through 5c as “Good” if the RPD is less than field duplicate QC criteria of 40% and as “Poor” if the RPD exceeded the field duplicate QC criteria.

Two results from Field Duplicate analysis fall within acceptable range for RPD comparison. One duplicate pair, 0571RD14SW and 0517RD50SW, qualified as “Good” for Dissolved Mercury and “Poor” for Total Mercury precision with and RPD of 112.7%. This sample was ascribed the qualifier J. Qualifiers were added to the field duplicate results only as noted.

5. Overall Assessment of Data

The data from several of the QA samples suggests the following:

- Equipment decontamination of the sampling bladder pump may be ineffective or inadequate. The rinsate sample 0517RS01GW returned a mercury designation of 10.8 ng/L. Examination of laboratory chromatograms in the same instrument run batch suggests that this value is indeed accurate. Previous positive mercury results from prior sampling events may suggest continuing or recurrent contamination of sampling equipment.

-Field Duplicate analysis of sample 0517RD14SW (Duplicate 0517RD50SW) yielded an Relative Percent Difference of 112.7% for Total Recoverable Mercury, well outside RPD control limits of 40%. Results from Sample 0517RD14SW are ascribed the qualifier J. Instrument results from these samples show no obvious errors that would indicate dramatically elevated or reduced results. No other sample results are given qualification.

Tables and Lists

Table 1 - Sample Listing

Work Order	Matrix	Sample ID	Lab ID	Sample Date	QA/QC	Analysis
EEI-SA1601	Blank	0517FB01	1723003-05	05/26/2017	Field Blank	EPA 1631
EEI-SA1601	Blank	0517FB03	1723003-22	05/28/2017	Field Blank	EPA 1631
EEI-SA1601	Blank	0517FB04	1723003-31	05/29/2017	Field Blank	EPA 1631
EEI-SA1601	Blank	0517FB05	1723003-46	05/30/2017	Field Blank	EPA 1631
EEI-SA1601	Blank	0517FB06	1723003-53	05/31/2017	Field Blank	EPA 1631
EEI-SA1601	GW	0517MW01GW	1723003-23	05/28/2017		EPA 1631
EEI-SA1601	GW	0517MW01GW	1723003-24	05/28/2017		EPA 1631
EEI-SA1601	GW	0517MW06GW	1723003-25	05/28/2017		EPA 1631
EEI-SA1601	GW	0517MW06GW	1723003-26	05/28/2017		EPA 1631
EEI-SA1601	GW	0517MW08GW	1723003-27	05/28/2017		EPA 1631
EEI-SA1601	GW	0517MW08GW	1723003-28	05/28/2017		EPA 1631
EEI-SA1601	GW	0517MW09GW	1723003-54	05/31/2017		EPA 1631
EEI-SA1601	GW	0517MW09GW	1723003-55	05/31/2017		EPA 1631
EEI-SA1601	GW	0517MW10GW	1723003-32	05/29/2017		EPA 1631
EEI-SA1601	GW	0517MW10GW	1723003-33	05/29/2017		EPA 1631
EEI-SA1601	GW	0517MW16GW	1723003-34	05/29/2017		EPA 1631
EEI-SA1601	GW	0517MW16GW	1723003-35	05/29/2017		EPA 1631
EEI-SA1601	GW	0517MW17GW	1723003-36	05/29/2017		EPA 1631
EEI-SA1601	GW	0517MW17GW	1723003-37	05/29/2017		EPA 1631
EEI-SA1601	GW	0517MW19GW	1723003-56	05/31/2017		EPA 1631
EEI-SA1601	GW	0517MW19GW	1723003-57	05/31/2017		EPA 1631
EEI-SA1601	GW	0517MW22GW	1723003-58	05/31/2017		EPA 1631
EEI-SA1601	GW	0517MW22GW	1723003-59	05/31/2017		EPA 1631
EEI-SA1601	GW	0517MW26GW	1723003-47	05/30/2017		EPA 1631
EEI-SA1601	GW	0517MW26GW	1723003-48	05/30/2017		EPA 1631
EEI-SA1601	GW	0517MW27GW	1723003-49	05/30/2017		EPA 1631
EEI-SA1601	GW	0517MW27GW	1723003-50	05/30/2017		EPA 1631
EEI-SA1601	GW	0517MW28GW	1723003-51	05/30/2017		EPA 1631
EEI-SA1601	GW	0517MW28GW	1723003-52	05/30/2017		EPA 1631
EEI-SA1601	GW	0517MW29GW	1723003-29	05/28/2017		EPA 1631
EEI-SA1601	GW	0517MW29GW	1723003-30	05/28/2017		EPA 1631
EEI-SA1601	GW	0517MW33GW	1723003-38	05/29/2017		EPA 1631
EEI-SA1601	GW	0517MW33GW	1723003-39	05/29/2017		EPA 1631
EEI-SA1601	GW	0517MW40GW	1723003-40	05/29/2017		EPA 1631
EEI-SA1601	GW	0517MW40GW	1723003-41	05/29/2017		EPA 1631
EEI-SA1601	GW	0517MW42GW	1723003-60	05/31/2017		EPA 1631

Table 1 - Sample Listing

Work Order	Matrix	Sample ID	Lab ID	Sample Date	QA/QC	Analysis
EEI-SA1601	GW	0517MW42GW	1723003-61	05/31/2017		EPA 1631
EEI-SA1601	GW	0517MW43GW	1723003-42	05/29/2017		EPA 1631
EEI-SA1601	GW	0517MW43GW	1723003-43	05/29/2017		EPA 1631
EEI-SA1601	GW	0517MW51GW	1723003-44	05/29/2017	FD of 0517MW43GW	EPA 1631
EEI-SA1601	GW	0517MW51GW	1723003-45	05/29/2017	FD of 0517MW43GW	EPA 1631
EEI-SA1601	GW	0517MW52GW	1723003-62	05/31/2017	FD of 0517MW22GW	EPA 1631
EEI-SA1601	GW	0517MW52GW	1723003-63	05/31/2017	FD of 0517MW22GW	EPA 1631
EEI-SA1601	SW	0517RD05SW	1723003-06	05/26/2017		EPA 1631
EEI-SA1601	SW	0517RD05SW	1723003-07	05/26/2017		EPA 1631
EEI-SA1601	SW	0517RD06SW	1723003-08	05/26/2017		EPA 1631
EEI-SA1601	SW	0517RD06SW	1723003-09	05/26/2017		EPA 1631
EEI-SA1601	SW	0517RD08SW	1723003-10	05/26/2017		EPA 1631
EEI-SA1601	SW	0517RD08SW	1723003-11	05/26/2017		EPA 1631
EEI-SA1601	SW	0517RD09SW	1723003-12	05/26/2017		EPA 1631
EEI-SA1601	SW	0517RD09SW	1723003-13	05/26/2017		EPA 1631
EEI-SA1601	SW	0517RD10SW	1723003-14	05/26/2017		EPA 1631
EEI-SA1601	SW	0517RD10SW	1723003-15	05/26/2017		EPA 1631
EEI-SA1601	SW	0517RD14SW	1723003-16	05/26/2017		EPA 1631
EEI-SA1601	SW	0517RD14SW	1723003-17	05/26/2017		EPA 1631
EEI-SA1601	SW	0517RD15SW	1723003-18	05/26/2017		EPA 1631
EEI-SA1601	SW	0517RD15SW	1723003-19	05/26/2017		EPA 1631
EEI-SA1601	SW	0517RD50SW	1723003-20	05/26/2017	FD of 0517RD14SW	EPA 1631
EEI-SA1601	SW	0517RD50SW	1723003-21	05/26/2017	FD of 0517RD14SW	EPA 1631
EEI-SA1601	Blank	0517TB03	1723003-01	05/09/2017	Trip Blank	EPA 1631
EEI-SA1601	Blank	0517TB04	1723003-02	05/09/2017	Trip Blank	EPA 1631
EEI-SA1601	Blank	0517TB05	1723003-03	05/09/2017	Trip Blank	EPA 1631
EEI-SA1601	Blank	0517TB06	1723003-04	05/09/2017	Trip Blank	EPA 1631
EEI-SA1601	Blank	0617EQ01GW	1723003-69	06/02/2017	Equip. Blank	EPA 1631
EEI-SA1601	Blank	0617FB07	1723003-64	06/01/2017	Field Blank	EPA 1631
EEI-SA1601	Blank	0617FB08	1723003-70	06/02/2017	Field Blank	EPA 1631
EEI-SA1601	GW	0617MW31GW	1723003-65	06/01/2017		EPA 1631
EEI-SA1601	GW	0617MW31GW	1723003-66	06/01/2017		EPA 1631
EEI-SA1601	GW	0617MW32GW	1723003-67	06/01/2017		EPA 1631

Table 1 - Sample Listing

Work Order	Matrix	Sample ID	Lab ID	Sample Date	QA/QC	Analysis
EEI-SA1601	GW	0617MW32GW	1723003-68	06/01/2017		EPA 1631
EEI-SA1601	GW	0617RS01GW	1723003-71	06/02/2017	Rinsate Blank	EPA 1631
EEI-SA1601	GW	0517MW08GW	B171380-MS1		MS/MSD	EPA 1631
EEI-SA1601	GW	0517MW08GW	B171380-MS2		MS/MSD	EPA 1631
EEI-SA1601	GW	0517MW08GW	B171380-MSD1		MS/MSD	EPA 1631
EEI-SA1601	GW	0517MW08GW	B171380-MSD2		MS/MSD	EPA 1631
EEI-SA1601	GW	0517MW09GW	B171380-MS4		MS/MSD	EPA 1631
EEI-SA1601	GW	0517MW09GW	B171380-MSD4		MS/MSD	EPA 1631
EEI-SA1601	GW	0517MW43GW	B171380-MS3		MS/MSD	EPA 1631
EEI-SA1601	GW	0517MW43GW	B171380-MSD3		MS/MSD	EPA 1631
EEI-SA1601	SW	0517RD10SW	B171379-MS4		MS/MSD	EPA 1631
EEI-SA1601	SW	0517RD10SW	B171379-MS5		MS/MSD	EPA 1631
EEI-SA1601	SW	0517RD10SW	B171379-MSD4		MS/MSD	EPA 1631
EEI-SA1601	SW	0517RD10SW	B171379-MSD5		MS/MSD	EPA 1631
EEI-SA1601	GW	0617MW31GW	B171380-MS6		MS/MSD	EPA 1631
EEI-SA1601	GW	0617MW31GW	B171380-MSD6		MS/MSD	EPA 1631

FD Field Duplicate
SW Surface Water
GW Ground Water
MS/MSD Matrix Spike/Matrix Spike Duplicate

Table 2 - Samples Qualified for Holding Time Exceedance

Method	Analyte	Sample IDs	HT	Sampling Date	Analysis Date	Qual
None						

Table 3a - Positive Results for Blank Samples

Method	Sample ID	Sample Type	Analyte	Result	Analysis Type	Units	PQL
EPA1631	B171379-BLK1	Water	Hg	0.11	MB	ng/L	0.4
EPA1631	B171379-BLK2	Water	Hg	0.06	MB	ng/L	0.4
EPA1631	B171379-BLK3	Water	Hg	0.04	MB	ng/L	0.4
EPA1631	B171379-BLK4	Water	Hg	0.02	MB	ng/L	0.4
EPA1631	B171380-BLK1	Water	Hg	0.20	MB	ng/L	0.4
EPA1631	B171380-BLK2	Water	Hg	0.23	MB	ng/L	0.4
EPA1631	B171380-BLK3	Water	Hg	0.28	MB	ng/L	0.4
EPA1631	B171380-BLK4	Water	Hg	0.19	MB	ng/L	0.4

Table 3b - Samples Qualified for Method Blank Contamination

Method	Sample ID	Analyte	Blank Result	Sample Result	Sample Qual	PQL
None *						

*EPA 1631 method monitors laboratory blank concentration and uses blank concentration to correct reported sample data. Detected values less than the quantitation limit are normal.

Table 3c - Samples Qualified for Field or Equipment Rinsate Blank Contamination

Table 4a - MS/MSD Recoveries outside Control Limits

Method	Sample ID	Sample Type	Analyte	Orig. Result	Spike Amount	Rec.	Dil Fac.	Low Limit	High Limit	Sample Qual.
None										

Table 4b - Lab and MS Duplicate PRDs outside Control Limits

Sample ID	Analyte	Method	RPD	RPD Limit	No. of Affected Samples	Samp Qual
None						

Table 5a - Samples with Surrogates outside Control Limits

Method	Sample ID	Sample Type	Analyte	Rec.	Low Limit	High Limit	Dil Fac	Sample Qual.
None.								

Table 5b - LCS Recoveries outside Control Limits

Method	Sample ID	Analyte	%Rec.	Low Limit	High Limit	No. of Affected Samples	Samp Qual
None							

Table 5c - Samples that were Re-analyzed

Sample ID	Lab ID	Method	Sample Type	Action
0517MW09GW	1723003-54	EPA 1631	Ground Water	High Blank with no Qualification
0517MW10GW	1723003-32	EPA 1631	Ground Water	High Blank with no Qualification
0517MW16GW	1723003-34	EPA 1631	Ground Water	High Blank with no Qualification
0517MW16GW	1723003-35	EPA 1631	Ground Water	High Blank with no Qualification
0517MW17GW	1723003-36	EPA 1631	Ground Water	High Blank with no Qualification
0517MW17GW	1723003-37	EPA 1631	Ground Water	Confirmation with no Qualification
0517MW22GW	1723003-58	EPA 1631	Ground Water	High Blank with no Qualification
0517MW22GW	1723003-59	EPA 1631	Ground Water	High Blank with no Qualification
0517MW26GW	1723003-47	EPA 1631	Ground Water	High Blank with no Qualification
0517MW26GW	1723003-48	EPA 1631	Ground Water	High Blank with no Qualification
0517MW27GW	1723003-49	EPA 1631	Ground Water	High Blank with no Qualification
0517MW27GW	1723003-50	EPA 1631	Ground Water	High Blank with no Qualification
0517MW28GW	1723003-51	EPA 1631	Ground Water	High Blank with no Qualification
0517MW29GW	1723003-29	EPA 1631	Ground Water	High Blank with no Qualification
0517MW29GW	1723003-30	EPA 1631	Ground Water	Confirmation with no Qualification
0517MW33GW	1723003-38	EPA 1631	Ground Water	High Blank with no Qualification
0517MW40GW	1723003-40	EPA 1631	Ground Water	High Blank with no Qualification
0517MW42GW	1723003-60	EPA 1631	Ground Water	High Blank with no Qualification
0517MW51GW	1723003-44	EPA 1631	Ground Water	Confirmation with no Qualification
0517MW51GW	1723003-45	EPA 1631	Ground Water	Confirmation with no Qualification
0517MW52GW	1723003-62	EPA 1631	Ground Water	High Blank with no Qualification
0517MW52GW	1723003-63	EPA 1631	Ground Water	High Blank with no Qualification
0517RD06SW	1723003-08	EPA 1631	Surface Water	High Blank with no Qualification
0517RD08SW	1723003-10	EPA 1631	Surface Water	High Blank with no Qualification
0617MW31GW	1723003-65	EPA 1631	Ground Water	Confirmation with no Qualification High Blank with no Qualification
0617MW32GW	1723003-67	EPA 1631	Ground Water	High Blank with no Qualification
0617RS01GW	1723003-71	EPA 1631	Ground Water	Per Method with no Qualification

Table 6a - Summary of Field Duplicate Results

Method	Analyte	Units	0517MW43GW	0517MW51GW	RPD	Rating	Sample Qualifier
EPA 1631	Mercury	ng/L	5.77	4.49	24.95	Good	None
EPA 1631	Dissolved Mercury	ng/L	0.30	0.30	0	Good	None

Table 6b - Summary of Field Duplicate Results

Method	Analyte	Units	0517RD14SW	0517RD50SW	RPD	Rating	Sample Qualifier
EPA 1631	Mercury	ng/L	202	56.4	112.7	Poor	J
EPA 1631	Dissolved Mercury	ng/L	11.20	11.50	2.64	Good	None

Table 6c - Summary of Field Duplicate Results

Method	Analyte	Units	0517MW22GW	0517MW52GW	RPD	Rating	Sample Qualifier
EPA 1631	Mercury	ng/L	423	420	0.71	Good	None
EPA 1631	Dissolved Mercury	ng/L	262.00	269.00	2.64	Good	None

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DATA REVIEW MEMORANDUM

DATE: October 5, 2017

TO: Jonathan Reeve, Project Manager, Ecology and Environment Inc., Seattle, WA

FROM: Valeriy Bizyayev, Ecology and Environment, Inc., Seattle, WA

SUBJ: Data Review: Red Devil Mine Spring 2017

REFERENCE:

Project ID	Lab Work Order	Lab
1001095.0009.03	580-68801-1	Test America – Seattle

Validated data is attached to the end of this memorandum.

1. SAMPLE IDENTIFICATION

For the sampling activities at the Red Devil Mine site, Ecology and Environment, Inc. (E & E) collected the samples listed in Table 1. Project-specific matrix spike/matrix spike duplicates (MS/MSD) were designated in the field. All samples were sent to Test America Laboratories. This report addresses only Test America-generated data for EPA methods 6010B, 6020A, and 7470A.

The analytical report was issued by Test America on June 28, 2017. The data in the analytical report were reviewed for field and laboratory precision, accuracy, and completeness in accordance with procedures and quality control (QC) limits, the current laboratory Quality Assurance Manual (QAM), and current standard operating procedures (SOPs). Laboratory data qualifiers for identified analytes and analyte quantitation were accepted. Any additional data review qualifiers added are noted below and listed on the tables at the end of this memorandum. Definitions of all data qualifiers are given in the report.

Work Orders, Tests, and Number of Samples Included in this Data Review Memo

Work Orders/ Job Number	Matrix	Test Method	Method Name	Number of Samples
580-68801-1	Surface Water	EPA 7470A	Mercury (CVAA)	8
580-68801-1	Surface Water	EPA 6010B/6020A	Total TAL Metals by ICP	8
580-68801-1	Surface Water	EPA 6010B/6020A	Dissolved TAL Metals by ICP	8
580-68801-1	Ground Water	EPA 6010B/6020A	Total TAL Metals by ICP	21
580-68801-1	Ground Water	EPA 7470A	Mercury (CVAA)	21
580-68801-1	Rinse Blank	EPA 7470A	Mercury (CVAA)	1
580-68801-1	Rinse Blank	EPA 6010B/6020A	Total TAL Metals by ICP	1
580-68801-1	Rinse Blank	EPA 6010B/6020A	Dissolved TAL Metals by ICP	1

2. SAMPLE PROCEDURES

All samples were collected as specified in the work plan and as documented on the chain-of-custody (COC) and in field notebooks. Samples were analyzed as specified on the COC. Samples were packaged, shipped, and received as specified in the work plan. Aqueous samples for total metals (EPA 6010B and 6020A) and mercury (EPA 7470A) must be preserved to pH≤2 with HNO_3.

REVIEW RESULTS

All sample procedures were followed and the sample coolers were received at 0.0-2.2^{o}C. Samples were hand delivered and then repackaged to be analyzed at a different laboratory location. Sample preservation was verified by the laboratory. No problems with the condition of the samples upon receipt are documented.

3. LABORATORY DATA

3.1 HOLDING TIMES

Holding times are established and monitored to ensure analytical results accurately represent analyte concentrations in a sample at the time of collection. These results are presented in Table 2 (if applicable). Exceeding the holding time for a sample generally results in a loss of the analyte due to a variety of mechanisms, such as deposition on the sample container walls or precipitation.

REVIEW RESULTS

All field samples were taken between May 28 and June 2 of 2017 and received by the laboratory on June 3, 2017. All submitted Samples were analyzed between June 7 and June 9. No qualification is given for sample holding and analysis times.

3.2 BLANKS

Laboratory and field blank samples are analyzed and evaluated to determine the existence and magnitude of possible contamination during the sampling and analysis process. These results are presented in Table 3 (if applicable). If the analyte is present in the sample at similar trace levels (less than 5 times the blank concentration), then the analyte is likely a common background contaminant from some phase of the sampling, extraction, or analytical procedure and associated low-level sample concentrations are not considered to be site related. Sample results in these cases are qualified as not detected, “U”.

REVIEW RESULTS

All laboratory blanks were performed at the required frequency. All laboratory blanks for EPA methods 6010B, 6020A, and 7470A had no detections. .

Two equipment rinsate blanks (field blanks) were collected, with EPA Method 6010B and 6020A analytes detected in at concentrations less than the PQL but greater than the MDL (Table 3). All associated sample results that were detected at levels less than 5 times the blank were U-qualified as not detected. Associated samples with detection greater than 5 times the blank were not qualified. A summary of qualified data due to equipment rinsate blank contamination is presented in Table 3.

3.4 MATRIX SPIKE AND MATRIX SPIKE DUPLICATE ANALYSIS

The MS/MSD analyses are intended to provide information about the effects that the sample matrix exerts on the digestion / extraction and measurement methodology. MS recovery values that do not meet laboratory QC criteria may indicate that sample analyte results are being attenuated in the analysis procedure. The potential sample bias may be estimated by noting the degree to which the MS concentration was elevated or lowered in the spike analysis. However, this estimated bias should serve only as an approximation; sample-specific problems may be the cause of the discrepancy, particularly in soil samples.

Recoveries of a post-digestion spike or a laboratory control sample (LCS) are used to verify that the analytical methodology is acceptable and that MS recoveries are due to matrix effects. An MSD analysis is performed to evaluate the precision of the sample results. Precision is measured as the relative percent difference (RPD) between analytical results for duplicate samples. The laboratory's failure to produce similar results for MSD samples may indicate that the samples were non-homogeneous (particularly in soil samples), or that method defects may exist in the laboratory's techniques.

Recovery calculations are not required if the spiking concentration added is less than 25% of the sample background concentration.

REVIEW RESULTS

The MS/MSD sample analyses were performed on two samples: 0517MW08GW and 0517RD10SW, at the required frequency. MS/MSD recoveries were within the control limits generated by the laboratory.

The accuracy of MS/MSD recoveries were within the control limits generated by the laboratory.

A summary of sample data qualified due to MS/MSD precision and accuracy are presented in Tables 4a and 4b.

3.5 LABORATORY CONTROL SAMPLE ANALYSIS

The LCS is analyzed to monitor the efficiency of the digestion/extraction procedure and analytical instrument operation. The ability of the laboratory to successfully analyze an LCS demonstrates that there are no analytical problems related to the digestion/sample preparation procedures and/or instrument operations. The LCS results outside QC limits are presented in Table 5 (if applicable). Sporadic and marginal QC failures for multiple component methods do not indicate an analytical concern. If recoveries are high and the compounds are not detected in the samples, then no data qualification is required. All recoveries should be above 10% or the non-detect (“U”) results flagged “R” as rejected.

REVIEW RESULTS

All LCS analyses were within control limits and performed at the required frequency for all methods.

3.6 COMPOUND IDENTIFICATION AND QUANTITATION

Compound identities are assigned by comparing sample compound retention times to retention times from known (standard) compounds and identification of an acceptable mass spectrum. Compounds detected below the PQL in samples should be considered estimated and are qualified "J." The samples with compounds above the linear range were all re-analyzed at a higher dilution factor.

REVIEW RESULTS

Compound identification and quantitation criteria were not noted for EPA methods 6010B, 6020A, and 7470A.

4. FIELD DUPLICATE SAMPLE RESULTS

Field duplicate samples were collected and analyzed as an indication of overall precision for both field and laboratory. Field duplicate results are summarized in Table 7 (if applicable). The results are expected to have more variability than laboratory duplicates, which measure only laboratory precision. It is expected also that soil field duplicates will exhibit greater variance than water field duplicates due to the difficulties associated with collecting identical field samples. The QC criteria used to assess field duplicate samples for this project was limits of 70% RPD for soils and 40% RPD for waters, or twice the general laboratory duplicate criteria. If a given compound in both the regular sample and associated field duplicate sample was below the laboratory PQL, or the compound was not detected in one of the samples, then the compound is generally not qualified due to field duplicate precision. There are no guidelines regarding data qualification based on poor field duplicate precision. Professional judgment was used to determine whether or not to qualify results.

REVIEW RESULTS

Three field duplicates analyses were performed on this SDG. The RPD ratings are listed on Tables 7a through 7c as "Good" if the RPD is less than field duplicate QC criteria of 40% and as "Poor" if the RPD exceeded the field duplicate QC criteria.

All the results show good precision in the sample pairs. No qualifiers were added to any sample results.

Serial Dilution

Serial dilution of samples were analyzed to determine whether significant physical or chemical interferences exist due to sample matrix. A serial dilution analysis shall be performed on a sample from each group of samples with a similar matrix type (e.g., water or soil) or for each Sample Delivery Group (SDG), whichever is more frequent. Samples identified as field blanks or Performance Evaluation (PE) samples cannot be used for serial dilution analysis. If the analyte concentration is sufficiently high [concentration in the original sample is > 50 times (50x) the Method Detection Limit (MDL)], the percent difference between the original determination and the serial dilution analysis (a five-fold dilution) after correction shall be less than 10. Interferences shall be analyzed and evaluated on professional judgement. If results have a percent difference greater than 10, results greater or equal to the MDL will qualified as an estimate (J) and qualify all non-detects as an estimate (UJ).

Review of Results:

Serial dilution analysis were conducted at the required frequency for EPA methods 6010B and 6020A, no qualifiers were assigned because of serial dilution issues. As exceedances do exist, none are present that imply an interference or need for qualifying any analytical data.

5. OVERALL ASSESSMENT OF DATA

All data were reviewed and considered usable with qualification as noted in this report.

Table 1 - Sample Listing

Work Order	Matrix	Sample ID	Lab ID	Sample Date	QA/QC	Analysis
580-68801-1	SW	0517RD05SW	580-66801-2	5/26/2017		6010B, 6020A, 7470A
580-68801-1	SW	0517RD06SW	580-66801-3	5/26/2017		6010B, 6020A, 7470A
580-68801-1	SW	0517RD08SW	580-66801-4	5/26/2017		6010B, 6020A, 7470A
580-68801-1	SW	0517RD09SW	580-66801-5	5/26/2017		6010B, 6020A, 7470A
580-68801-1	SW	0517RD10SW	580-66801-6	5/26/2017	MS/MSD	6010B, 6020A, 7470A
580-68801-1	SW	0517RD14SW	580-66801-7	5/26/2017		6010B, 6020A, 7470A
580-68801-1	SW	0517RD15SW	580-66801-8	5/26/2017		6010B, 6020A, 7470A
580-68801-1	SW	0517RD50SW	580-66801-9	5/26/2017	Field Duplicate	6010B, 6020A, 7470A
580-68801-1	GW	0517MW01GW	580-66801-10	5/28/2017		6010B, 6020A, 7470A
580-68801-1	GW	0517MW06GW	580-66801-11	5/28/2017		6010B, 6020A, 7470A
580-68801-1	GW	0517MW08GW	580-66801-12	5/28/2017	MS/MSD	6010B, 6020A, 7470A
580-68801-1	GW	0517MW09GW	580-68801-24	5/31/2017		6010B, 6020A, 7470A
580-68801-1	GW	0517MW10GW	580-66801-14	5/29/2017		6010B, 6020A, 7470A
580-68801-1	GW	0517MW16GW	580-66801-15	5/29/2017		6010B, 6020A, 7470A
580-68801-1	GW	0517MW17GW	580-66801-16	5/29/2017		6010B, 6020A, 7470A
580-68801-1	GW	0517MW19GW	580-68801-25	5/31/2017		6010B, 6020A, 7470A
580-68801-1	GW	0517MW22GW	580-68801-26	5/31/2017	Field Duplicate	6010B, 6020A, 7470A
580-68801-1	GW	0517MW26GW	580-66801-21	5/30/2017		6010B, 6020A, 7470A
580-68801-1	GW	0517MW27GW	580-66801-22	5/30/2017		6010B, 6020A, 7470A
580-68801-1	GW	0517MW28GW	580-66801-23	5/30/2017		6010B, 6020A, 7470A
580-68801-1	GW	0517MW29GW	580-66801-13	5/28/2017		6010B, 6020A, 7470A
580-68801-1	GW	0517MW33GW	580-66801-17	5/29/2017		6010B, 6020A, 7470A
580-68801-1	GW	0517MW40GW	580-66801-18	5/29/2017		6010B, 6020A, 7470A
580-68801-1	GW	0517MW42GW	580-66801-27	5/31/2017		6010B, 6020A, 7470A
580-68801-1	GW	0517MW43GW	580-66801-19	5/29/2017		6010B, 6020A, 7470A
580-68801-1	GW	0517MW51GW	580-66801-20	5/29/2017	Field Duplicate	6010B, 6020A, 7470A
580-68801-1	GW	0517MW52GW	580-66801-28	5/31/2017	Field Duplicate	6010B, 6020A, 7470A
580-68801-1	GW	0617MW31GW	580-66801-30	6/1/2017		6010B, 6020A, 7470A
580-68801-1	GW	0617MW32GW	580-66801-31	6/1/2017		6010B, 6020A, 7470A
580-68801-1	W	0617EQ01GW	580-68801-33	6/2/2017	Blank	6010B, 6020A, 7470A
580-68801-1	W	0617RS01GW	580-68801-34	6/2/2017	Blank	6010B, 6020A, 7470A

Table 2 - List of Samples Qualified for Holding Time Exceedance

Method	Analyte	Sample IDs	HT	Sampling Date	Analysis Date	Qual
None						

Table 3a - List of Positive Results for Blank Samples

Method	Sample ID	Sample Type	Analyte	Result	Analysis Type	Units	PQL
EPA 6020A	0617RS01GW	AQ	Barium	0.00062J	RB	mg/L	0.0060
EPA 6020A	0617RS01GW	AQ	Chromium	0.0010J	RB	mg/L	0.0020
EPA 6020A	0617RS01GW	AQ	Nickel	0.00055J	RB	mg/L	0.015

Table 3b - List of Samples Qualified for Method Blank Contamination

Method	Sample ID	Analyte	Blank Result	Sample Result	Sample Qual	PQL
None						

Table 3c - List of Samples Qualified for Equipment Rinsate Blank Contamination

Method	Sample ID	Analyte	Blank Result	Sample Result	Sample Qual	PQL
EPA 6020A	0517RD14SW	Chromium	0.0010	0.00075	U	0.002
EPA 6020A	0517RD50SW	Chromium	0.0010	0.00076	U	0.002
EPA 6020A	0517MW01GW	Chromium	0.0010	0.00098	U	0.002
EPA 6020A	0517MW29GW	Chromium	0.0010	0.0010	U	0.002
EPA 6020A	0617MW32GW	Chromium	0.0010	0.00081	U	0.002

Table 4a - List of MS/MSD Recoveries outside Control Limits

Method	Sample ID	Sample Type	Analyte	Orig. Result	Spike Amount	Rec.	Dil Fac.	Low Limit	High Limit	Sample Qual
None										

Table 4b - List of Lab and MS Duplicate RPDs outside Control Limits

Sample ID	Analyte	Method	RPD	RPD Limit	No. of Affected Samples	Samp Qual
None						

Table 5 - List of LCS Recoveries outside Control Limits

Method	Sample ID	Analyte	% Rec.	Low Limit	High Limit	No. of Affected Samples	Samp Qual
None							

Table 6 - Samples that were Re-analyzed

Sample ID	Lab ID	Method	Sample Type	Action
None				

Table 7a - Summary of Field Duplicate Results

Method	Analyte	Units	0517RD14SW	0517RD50SW	RPD	Rating	Sample Qualifier
EPA 6010B	Calcium (Dissolved)	mg/L	13	13	0%	Good	None
EPA 6010B	Iron (Dissolved)	mg/L	0.17	0.17	0%	Good	None
EPA 6010B	Magnesium (Dissolved)	mg/L	7.7	7.5	3%	Good	None
EPA 6010B	Potassium (Dissolved)	mg/L	0.51	0.51	0%	Good	None
EPA 6010B	Sodium (Dissolved)	mg/L	1.2	1.2	0%	Good	None
EPA 6020A	Antimony (Dissolved)	mg/L	0.021	0.022	5%	Good	None
EPA 6020A	Arsenic (Dissolved)	mg/L	0.0082	0.0083	1%	Good	None
EPA 6020A	Barium (Dissolved)	mg/L	0.023	0.023	0%	Good	None
EPA 6020A	Manganese (Dissolved)	mg/L	0.019	0.019	0%	Good	None
EPA 6010B	Aluminum	mg/L	0.32	0.35	9%	Good	None
EPA 6010B	Calcium	mg/L	13	14	7%	Good	None
EPA 6010B	Iron	mg/L	0.8	0.67	18%	Good	None
EPA 6010B	Magnesium	mg/L	7.6	7.7	1%	Good	None
EPA 6010B	Potassium	mg/L	0.54	0.55	2%	Good	None
EPA 6010B	Sodium	mg/L	1.2	1.2	0%	Good	None
EPA 6020A	Antimony	mg/L	0.018	0.018	0%	Good	None
EPA 6020A	Arsenic	mg/L	0.0082	0.0078	5%	Good	None
EPA 6020A	Barium	mg/L	0.031	0.031	0%	Good	None
EPA 6020A	Chromium	mg/L	0.00075	0.00076	1%	Good	None
EPA 6020A	Cobalt	mg/L	0.00029	0.00024	19%	Good	None
EPA 6020A	Manganese	mg/L	0.054	0.049	10%	Good	None
EPA 6020A	Nickel	mg/L	0.00092	0.00098	6%	Good	None

Table 7b - Summary of Field Duplicate Results

Method	Analyte	Units	0517MW43GW	0517MW51GW	RPD	Rating	Sample Qualifier
EPA 6010B	Calcium	mg/L	24	23	4%	Good	None
EPA 6010B	Iron	mg/L	2.8	2.7	4%	Good	None
EPA 6010B	Magnesium	mg/L	16	16	0%	Good	None
EPA 6010B	Potassium	mg/L	0.49	0.48	2%	Good	None
EPA 6010B	Sodium	mg/L	3.7	3.6	3%	Good	None
EPA 6020A	Antimony	mg/L	0.007	0.0068	3%	Good	None
EPA 6020A	Arsenic	mg/L	0.23	0.23	0%	Good	None
EPA 6020A	Barium	mg/L	0.1	0.1	0%	Good	None
EPA 6020A	Cobalt	mg/L	0.031	0.031	0%	Good	None
EPA 6020A	Manganese	mg/L	2.6	2.6	0%	Good	None
EPA 6020A	Nickel	mg/L	0.094	0.094	0%	Good	None

Table 7c - Summary of Field Duplicate Results

Method	Analyte	Units	1016MW19GW	1016MW55GW	RPD	Rating	Sample Qualifier
EPA 6010B	Calcium	mg/L	18	16	12%	Good	None
EPA 6010B	Magnesium	mg/L	15	14	7%	Good	None
EPA 6010B	Sodium	mg/L	2.1	1.9	10%	Good	None
EPA 6020A	Antimony	mg/L	1	0.93	7%	Good	None
EPA 6020A	Arsenic	mg/L	0.051	0.046	10%	Good	None
EPA 6020A	Barium	mg/L	0.049	0.047	4%	Good	None
EPA 6020A	Nickel	mg/L	0.001	0.001	0%	Good	None
EPA 7470A	Mercury	mg/L	0.0004	0.00036	11%	Good	None

DATA REVIEW MEMORANDUM

DATE: November 16, 2017

TO: Mark Longtine, Project Manager, E & E, Seattle, WA

FROM: Howard Edwards, E & E, San Francisco, CA

SUBJ: Data Review: Red Devil Mine 2017

Job Description: Red Devil Mine 2017 SMA GW
BAL Report: 1740001

REFERENCE:

Project ID	Lab Work Order	Lab
1001095.0015.01	EEI-SE1701	Brooks Applied Labs – Seattle

Validated data is attached to the end of this memorandum.

1. SAMPLE IDENTIFICATION

For the sampling activities at the Red Devil Mine site, Ecology and Environment, Inc. (E & E) collected the samples listed in Table 1. Project-specific matrix spike/matrix spike duplicates (MS/MSD) were designated in the field. All samples were sent to Brooks Applied Labs in Seattle, Washington, for all analyses. This report addresses only Brooks Applied Labs-generated data.

The analytical report was issued by Brooks Applied Labs on October 26, 2017. The data in the analytical report were reviewed for field and laboratory precision, accuracy, and completeness in accordance with procedures and quality control (QC) limits, the current laboratory Quality Assurance Manual (QAM) and current standard operating procedures (SOPs). Any additional data review qualifiers added are noted below and listed on the tables at the end of this memorandum. Definitions of all data qualifiers are given in the report.

Work Orders, Tests, and Number of Samples Included in this Data Review Memo

Work Orders/ Job Number	Matrix	Test Method	Method Name	Number of Samples
EEI-SE1701	Ground Water	EPA 1631	Total Low-Level Mercury (CVAFS)	13
EEI-SE1701	Ground Water	EPA 1631	Dissolved Low-Level Mercury (CVAFS)	13
EEI-SE1701	Rinse Blank	EPA 1631	Total Low-Level Mercury (CVAFS)	1
EEI-SE1701	Rinse Blank	EPA 1631	Dissolved Low-Level Mercury (CVAFS)	1
EEI-SE1701	Trip Blank	EPA 1631	Total Low-Level Mercury (CVAFS)	0
EEI-SE1701	Field Blank	EPA 1631	Total Low-Level Mercury (CVAFS)	4

2. SAMPLE PROCEDURES

All samples were collected as specified in the work plan and documented on the chain-of-custody (COC) and in field notebooks. Samples were analyzed as specified on the COC. Samples were packaged, shipped, and received as specified in the work plan. All samples for organic analyses must be received cold (4 ±2 degrees Celsius [^{o}C]) and in good condition as documented on the Cooler Receipt Form.

REVIEW RESULTS

All sampling procedures were followed and the sample coolers were received by the laboratory at 6.5^{o}C. Since the samples were acidified in the field, the Field Sampling Plan requirement indicating 4 ±2 ^{o}C requirement, did not result in qualification. Since the preservation temperature is not a method requirement.

3. LABORATORY DATA

3.1 HOLDING TIMES

Holding times are established and monitored to ensure analytical results accurately represent analyte concentrations in a sample at the time of collection. These qualified results based upon missed holding times are presented in Table 2 (if applicable). Exceeding the holding time for a sample generally results in a loss of the analyte due to a variety of mechanisms, such as deposition on the sample container walls or precipitation.

REVIEW RESULTS

All sample were analyzed within the method holding time.

3.2 BLANKS

All laboratory blanks are integrated into the method and all results are corrected for blank values provided that the laboratory blank values are within method-set limits. When blanks are outside of the method limits, associated samples are re-analyzed. Method blanks with positive results are shown in Table 3a. No data was qualified due to laboratory method blanks (see Table 3b).

Field blank and rinsate blank samples are analyzed and evaluated to determine the existence and magnitude of possible contamination during the sampling and analysis process. All field blank with reported results are also presented in Table 3a (if applicable). If the mercury is present in the sample at similar trace levels (less than 5 times the blank concentration), then the analyte is likely a common background contaminant from some phase of the sampling, extraction, or analytical procedure and associated low-level sample concentrations are not considered to be site related. Sample results in these cases are qualified as not detected, U.

REVIEW RESULTS

All laboratory (method) and field blanks were performed at the required frequencies. As noted in Table 3a, analyte concentrations in the method blanks were below the practical quantitation limit (PQL). Several field blanks were at a concentration above the detection limit. All associated reported concentration of mercury in samples that were less than 5 times the concentration found in their associated field blank were U qualified as not detected. No samples were qualified based on laboratory or field blanks. A summary of qualified data due to laboratory blank contamination is presented in Table 3b.

One set of equipment rinsate blanks (filtered and unfiltered) for the bladder pump was collected. The rinsate blank was found to contain both dissolved mercury and total mercury at a concentration above the method reporting limit. All associated sample results that were detected at levels less than 5 times the blank were U qualified as not detected. Associated samples with detection greater than 5 times the blank were not qualified. A summary of qualified data due to equipment rinsate blank contamination is also presented in Table 3c.

3.3 MATRIX SPIKE AND MATRIX SPIKE DUPLICATE ANALYSIS

The MS/MSD analyses are intended to provide information about the effects that the sample matrix exerts on the digestion / extraction and measurement methodology. MS recovery values that do not meet laboratory QC criteria may indicate that sample analyte results are being attenuated in the analysis procedure. The potential sample bias may be estimated by noting the degree to which the MS concentration was elevated or lowered in the spike analysis. However, this estimated bias should serve only as an approximation; sample-specific problems may be the cause of the discrepancy, particularly in soil samples.

Recovery calculations are not required if the spiking concentration added is less than 25% of the sample background concentration.

REVIEW RESULTS

The MS/MSD sample analyses were performed on two filter and two unfiltered samples 0917MW48GW (filtered and unfiltered) and 0917MW51GW (filtered and unfiltered), at the required frequency. All MS/MSD recoveries and accuracies were within the control limits

A summary of sample data qualified due to MS/MSD precision and accuracy are presented in Tables 5a and 5b (if applicable).

3.4 LABORATORY CONTROL SAMPLE ANALYSIS

The LCS or Certified Reference Material standard is analyzed to monitor the efficiency of the digestion/extraction procedure and analytical instrument operation. The ability of the laboratory to successfully analyze an LCS or Certified Reference Material standard demonstrates that there are no analytical problems related to the digestion/sample preparation procedures and/or instrument operations. The LCS or Certified Reference Material standard results outside QC limits are presented in Table 6 (if applicable). Sporadic and marginal QC failures for multiple component methods do not indicate an analytical concern. If recoveries are high and the compounds are not detected in the samples, then no data qualification is required. All recoveries should be above 10% or the non-detect results flagged “UR” as rejected.

REVIEW RESULTS

The analysis of the Certified Reference Material Sample was within control limits.

3.5 COMPOUND IDENTIFICATION AND QUANTITATION

Mercury identification is by cold-vapor atomic fluorescence spectrometer (CVAFS) at 253.7 nm for detection. The concentration of Hg based upon calibration curve done for each analysis batch. The method blank is used to correct the reported Mercury concentration detected below the PQL in samples should be considered estimated and are qualified "J." The samples with results above the linear range were all re-analyzed at a smaller aliquot.

REVIEW RESULTS

All compound identification and quantitation criteria were achieved and reported based upon the method. As noted in Table 7, three samples were reported as being reanalyzed due to the initial analysis concentration exceeding the calibration range. A smaller aliquot of all three samples were re-analyzed with the re-analysis confirming the initial analysis concentrations.

4. FIELD DUPLICATE SAMPLE RESULTS

Field duplicate samples were collected and analyzed as an indication of overall precision for both field and laboratory. Field duplicate results are summarized in Table 8 (if applicable). The results are expected to have more variability than laboratory duplicates, which measure only laboratory precision. It is expected also that soil field duplicates will exhibit greater variance than water field duplicates due to the difficulties associated with collecting identical field samples. The QC criteria used to assess field duplicate samples for this project was limits of 70% RPD for soils and 40% RPD for waters, or twice the general laboratory duplicate criteria. If a given compound in both the regular sample and associated field duplicate sample was below the laboratory PQL, or the compound was not detected in one of the samples, then the compound is generally not qualified due to field duplicate precision. There are no guidelines regarding data qualification based on poor field duplicate precision. Professional judgment was used to determine whether or not to qualify results.

REVIEW RESULTS

One field duplicates analyses were performed on this SDG. The RPD ratings are listed on Table 8 as “Good” if the RPD is less than field duplicate QC criteria of 40% and as “Poor” if the RPD exceeded the field duplicate QC criteria.

The result for dissolved mercury showed good precision in the sample. The result for total mercury showed poor precision in the sample. Results are presented in Table 8. A qualifier was only added to the field duplicate results as noted.

5. OVERALL ASSESSMENT OF DATA

The data from the QA samples suggest the following:

- That there was an equipment decontamination problem with the bladder pump that was used to collect most of the groundwater samples. The equipment rinsate blank indicates the potential of inadequate decontamination of the bladder pump.

All data were reviewed and considered usable with qualification as noted in this report. All non-detect results were reported as “U” qualified at the PQL except where noted based upon blank contamination. All reported data at concentration less than the PQL were J qualified as estimated.

Table 1 - Sample Listing

Work Order	Matrix	Sample ID	Lab ID	Sample Date	QA/QC	Analysis
EEI-SE1701	GW	*0917MW44GW*	1740001-05	9/22/2017		EPA 1631
EEI-SE1701	F-GW	*0917MW44GW*	1740001-06	9/22/2017		EPA 1631
EEI-SE1701	GW	*0917MW45GW*	1740001-07	9/20/2017		EPA 1631
EEI-SE1701	F-GW	*0917MW45GW*	1740001-08	9/20/2017		EPA 1631
EEI-SE1701	GW	*0917MW46GW*	1740001-09	9/20/2017		EPA 1631
EEI-SE1701	F-GW	*0917MW46GW*	1740001-10	9/20/2017		EPA 1631
EEI-SE1701	GW	*0917MW47GW*	1740001-11	9/21/2017		EPA 1631
EEI-SE1701	F-GW	*0917MW47GW*	1740001-12	9/21/2017		EPA 1631
EEI-SE1701	GW	*0917MW48GW*	1740001-13	9/19/2017	MS/MSD	EPA 1631
EEI-SE1701	F-GW	*0917MW48GW*	1740001-14	9/19/2017	MS/MSD	EPA 1631
EEI-SE1701	GW	*0917MW49GW*	1740001-15	9/20/2017		EPA 1631
EEI-SE1701	F-GW	*0917MW49GW*	1740001-16	9/20/2017		EPA 1631
EEI-SE1701	GW	*0917MW50GW*	1740001-17	9/24/2017		EPA 1631
EEI-SE1701	F-GW	*0917MW50GW*	1740001-18	9/24/2017		EPA 1631
EEI-SE1701	GW	*0917MW51GW*	1740001-19	9/22/2017	MS/MSD	EPA 1631
EEI-SE1701	F-GW	*0917MW51GW*	1740001-20	9/22/2017	MS/MSD	EPA 1631
EEI-SE1701	GW	*0917MW52GW*	1740001-21	9/21/2017	Duplicate of 0917MW52GW	EPA 1631
EEI-SE1701	F-GW	*0917MW52GW*	1740001-22	9/21/2017	Duplicate of 0917MW52GW	EPA 1631
EEI-SE1701	GW	*0917MW53GW*	1740001-23	9/22/2017		EPA 1631
EEI-SE1701	F-GW	*0917MW53GW*	1740001-24	9/22/2017		EPA 1631
EEI-SE1701	GW	*0917MW54GW*	1740001-25	9/21/2017		EPA 1631
EEI-SE1701	F-GW	*0917MW54GW*	1740001-26	9/21/2017		EPA 1631
EEI-SE1701	GW	*0917MW55GW*	1740001-27	9/20/2017		EPA 1631
EEI-SE1701	F-GW	*0917MW55GW*	1740001-28	9/20/2017		EPA 1631
EEI-SE1701	GW	*0917MW56GW*	1740001-29	9/22/2017		EPA 1631
EEI-SE1701	F-GW	*0917MW56GW*	1740001-30	9/22/2017		EPA 1631
EEI-SE1701	GW	*0917MW57GW*	1740001-31	9/22/2017		EPA 1631
EEI-SE1701	F-GW	*0917MW57GW*	1740001-23	9/22/2017		EPA 1631
EEI-SE1701	GW	*0917MW58GW*	1740001-33	9/21/2017		EPA 1631
EEI-SE1701	F-GW	*0917MW58GW*	1740001-34	9/21/2017		EPA 1631
EEI-SE1701	GW	*0917MW59GW*	1740001-35	9/22/2017		EPA 1631
EEI-SE1701	F-GW	*0917MW59GW*	1740001-36	9/22/2017		EPA 1631
EEI-SE1701	GW	*0917MW92GW*	1740001-37	9/21/2017	Duplicate of 0917MW52GW	EPA 1631
EEI-SE1701	F-GW	*0917MW92GW*	1740001-38	9/21/2017	Duplicate of 0917MW52GW	EPA 1631
EEI-SE1701	Blank	*0917MW08GW*	1740001-39	9/24/2017	Rinsate Blank	EPA 1631
EEI-SE1701	F- Blk	*0917MW08GW*	1740001-40	9/24/2017	Rinsate Blank	EPA 1631
EEI-SE1701	Blank	0917FB04	1740001-01	9/19/2017	Field Blank	EPA 1631
EEI-SE1701	Blank	0917FB05	1740001-02	9/20/2017	Field Blank	EPA 1631
EEI-SE1701	Blank	0917FB06	1740001-03	9/21/2017	Field Blank	EPA 1631
EEI-SE1701	Blank	0917FB07	1740001-04	9/22/2017	Field Blank	EPA 1631

F-GW =Filtered ground water — F-blk = Filtered Blank
FD = Field duplicate sample — GW = Ground water

Table 2 - List of Samples Qualified for Holding Time Exceedance

Method	Analyte	Sample IDs	HT	Sampling Date	Analysis Date	Qual
None						

Table 3a - List of Positive Results for Blank Samples

Method	Sample ID	Sample Type	Analyte	Result**	Analysis Type	Units	PQL
EPA1631	B172645-BLK1	AQ	Total Mercury	0.07	MB	ng/L	0.40
EPA1631	B172645-BLK2	AQ	Total Mercury	0.09	MB	ng/L	0.40
EPA1631	B172645-BLK3	AQ	Total Mercury	0.07	MB	ng/L	0.40
EPA1631	B172645-BLK4	AQ	Total Mercury	0.08	MB	ng/L	0.40
EPA1631	0917FB04	AQ	Total Mercury	≤ 0.10	FB	ng/L	0.40
EPA1631	0917FB05	AQ	Total Mercury	0.18	FB	ng/L	0.40
EPA1631	0917FB06	AQ	Total Mercury	≤ 0.10	FB	ng/L	0.40
EPA1631	0917FB07	AQ	Total Mercury	≤ 0.10	FB	ng/L	0.40
EPA1631	0917RS08GW	AQ	Total Mercury	2.16	RB	ng/L	0.40
EPA1631	0917RS08GW	AQ	Dissolved Mercury	5.93	RB	ng/L	0.40

Table 3b - List of Samples Qualified for Method Blank Contamination

Method	Sample ID	Analyte	Blank Result	Sample Result	Sample Qual	PQL
None *						

*EPA 1631 method monitors laboratory blank concentration and uses blank concentration to correct reported sample data. Detected values less than the quantitation limit are normal.
** Field blanks (FB) values are laboratory blank corrected.

Table 3c - List of Samples Qualified for Field Blank or Rinsate Blank Contamination

Method	Sample ID	Analyte	Blank Result ng/L	Sample Result ng/L	Sample Qual	PQL ng/L
EPA 1631	0917MW44GW	Total Mercury	5.93	6.02	U	0.4
EPA1631	0917MW44GW	Dissolved Mercury	2.16	0.25	U	0.4
EPA 1631	0917MW45GW	Dissolved Mercury	2.16	10.1	U	0.4
EPA1631	0917MW46GW	Dissolved Mercury	2.16	2.63	U	0.4
EPA 1631	0917MW47GW	Dissolved Mercury	2.16	9.59	U	0.4
EPA1631	0917MW48GW	Dissolved Mercury	2.16	4.30	U	0.4
EPA1631	0917MW51GW	Total Mercury	5.93	27.2	U	0.4
EPA 1631	0917MW51GW	Dissolved Mercury	2.16	0.89	U	0.4
EPA1631	0917MW56GW	Total Mercury	5.93	23.9	U	0.4
EPA1631	0917MW52GW	Dissolved Mercury	2.16	2.38	U	0.4
EPA 1631	0917MW54GW	Dissolved Mercury	2.16	1.48	U	0.4

Table 3c - List of Samples Qualified for Field Blank or Rinsate Blank Contamination

Method	Sample ID	Analyte	Blank Result ng/L	Sample Result ng/L	Sample Qual	PQL ng/L
EPA1631	0917MW56GW	Total Mercury	5.93	26.3	U	0.4
EPA1631	0917MW56GW	Dissolved Mercury	2.16	0.70	U	0.4
EPA1631	0917MW58GW	Total Mercury	5.93	8.78	U	0.4
EPA1631	0917MW58GW	Dissolved Mercury	2.16	0.43	U	0.4
EPA1631	0917MW59GW	Dissolved Mercury	2.16	7.43	U	0.4
EPA1631	0917MW92GW	Dissolved Mercury	2.16	2.51	U	0.4

Table 4 - List of Samples with Surrogates outside Control Limits

There are no surrogates used by this method.

Method	Sample ID	Sample Type	Analyte	Rec.	Low Limit	High Limit	Dil Fac	Sample Qual.
None.								

Table 5a - List of MS/MSD Recoveries outside Control Limits

Method	Sample ID	Sample Type	Analyte	Orig. Result	Spike Amount	Rec.	Dil Fac.	Low Limit	High Limit	Sample Qual
None										

Table 5b - List of Lab and MS Duplicate RPDs outside Control Limits

Sample ID	Analyte	Method	RPD	RPD Limit	No. of Affected Samples	Samp Qual
None						

Table 6 - List of LCS Recoveries outside Control Limits

Method	Sample ID	Analyte	% Rec.	Low Limit	High Limit	No. of Affected Samples	Samp Qual
None							

Table 7 - Samples that Were Re-analyzed

Sample ID	Lab ID	Method	Sample Type	Action
0917MW50GW	1740001-17	EPA1631	ground water	Re-analyzed due to elevated result above calibration range. Analyzed at a lower aliquot Confirmation with no Qualification
0917MW50GW	1740001-18	EPA1631	Filtered ground water	Analyzed at a lower aliquot Confirmation with no Qualification
0917MW51GW	1740001-19	EPA1631	ground water	Analyzed at a lower aliquot Confirmation with no Qualification

Table 8 - Summary of Field Duplicate Results

Method	Analyte	Units	0917MW52GW	0917MW92GW	RPD	Rating	Sample Qualifier
EPA 1631	Mercury	ng/L	23.9 U	51.7 J	> 100	Poor	J
EPA 1631	Dissolved Mercury	ng/L	2.38 U	2.51 U	NA	Good	None

DATA REVIEW MEMORANDUM

DATE: November 29, 2017

TO: Jonathan Reeve, Project Manager, E & E, Seattle, WA

FROM: Howard Edwards, E & E, San Francisco, CA

SUBJ: Data Review: Red Devil Mine 2017 Fall

Job Description: Red Devil Mine 2017 FALL SW/GW

BAL Report: 1740002

REFERENCE:

Project ID	Lab Work Order	Lab
1001095.0009.05	EEI-SE1601	Brooks Applied Labs – Seattle

Validated data is attached to the end of this memorandum.

1. SAMPLE IDENTIFICATION

For the sampling activities at the Red Devil Mine site, Ecology and Environment, Inc. (E & E) collected the samples listed in Table 1. Project-specific matrix spike/matrix spike duplicates (MS/MSD) were designated in the field. All samples were sent to Brooks Applied Labs in Seattle, Washington, for all analyses. This report addresses only Brooks Applied Labs-generated data.

The analytical report was issued by Brooks Applied Labs on October 26, 2017. The data in the analytical report were reviewed for field and laboratory precision, accuracy, and completeness in accordance with procedures and quality control (QC) limits, the current laboratory Quality Assurance Manual (QAM) and current standard operating procedures (SOPs). Any additional data review qualifiers added are noted below and listed on the tables at the end of this memorandum. Definitions of all data qualifiers are given in the report.

Work Orders, Tests, and Number of Samples Included in this Data Review Memo

Work Orders/ Job Number	Matrix	Test Method	Method Name	Number of Samples
EEI-SA1601	Surface Water	EPA 1631	Total Low-Level Mercury (CVAFS)	8
EEI-SA1601	Surface Water	EPA 1631	Dissolved Low-Level Mercury (CVAFS)	8
EEI-SE1601	Ground Water	EPA 1631	Total Low-Level Mercury (CVAFS)	22
EEI-SE1601	Ground Water	EPA 1631	Dissolved Low-Level Mercury (CVAFS)	22
EEI-SE1601	Rinse Blank	EPA 1631	Total Low-Level Mercury (CVAFS)	2
EEI-SE1601	Rinse Blank	EPA 1631	Dissolved Low-Level Mercury (CVAFS)	2
EEI-SE1601	Trip Blank	EPA 1631	Total Low-Level Mercury (CVAFS)	0
EEI-SE1601	Field Blank	EPA 1631	Total Low-Level Mercury (CVAFS)	4

2. SAMPLE PROCEDURES

All samples were collected as specified in the work plan and documented on the chain-of-custody (COC) and in field notebooks. Samples were analyzed as specified on the COC. Samples were packaged, shipped, and received as specified in the work plan. All samples for organic analyses must be received cold (4 ±2 degrees Celsius [°C]) and in good condition as documented on the Cooler Receipt Form.

REVIEW RESULTS

All sampling procedures were followed and the sample coolers were received by the laboratory at 6.5°C and 15 °C. Since the samples were acidified in the field, the Field Sampling Plan requirement indicating 4 ±2 °C requirement, did not result in qualification. Since the preservation, temperature is not a method requirement.

3. LABORATORY DATA

3.1 HOLDING TIMES

Holding times are established and monitored to ensure analytical results accurately represent analyte concentrations in a sample at the time of collection. These qualified results based upon missed holding times are presented in Table 2 (if applicable). Exceeding the holding time for a sample generally results in a loss of the analyte due to a variety of mechanisms, such as deposition on the sample container walls or precipitation.

REVIEW RESULTS

All sample were analyzed within the method holding time.

3.2 BLANKS

All laboratory blanks are integrated into the method and all results are corrected for blank values provided that the laboratory blank values are within method-set limits. When blanks are outside of the method limits, associated samples are re-analyzed. Method blanks with positive results are shown in Table 3a. No data was qualified due to laboratory method blanks (see Table 3b).

Field blank and rinsate blank samples are analyzed and evaluated to determine the existence and magnitude of possible contamination during the sampling and analysis process. All field blank with reported results are also presented in Table 3a (if applicable). If the mercury is present in the sample at similar trace levels (less than 5 times the blank concentration), then the analyte is likely a common background contaminant from some phase of the sampling, extraction, or analytical procedure and associated low-level sample concentrations are not considered to be site related. Sample results in these cases are qualified as not detected, U.

REVIEW RESULTS

All laboratory (method) were performed at the required frequencies. As noted in Table 3a, analyte concentrations in the method blanks were below the practical quantitation limit (PQL). No samples were qualified based on laboratory blanks. Field blanks were performed at the required frequency with one exception; there was no analysis for a field blank analyzed on September 19, 2017. All field blanks were reported at a concentration above the detection limit. All associated reported concentration of mercury in samples that were less than 5 times the concentration found in their associated field blank were U qualified as not detected. A total of18 samples were U qualified based on the field blanks. A summary of qualified data due to laboratory blank contamination is presented in Table 3b.

One set of equipment rinsate blanks (filtered and unfiltered) for the bladder pump was collected. The rinsate blank was found to contain both dissolved mercury (2.06 ng/L) and total mercury (40.4 ng/L) at a concentration above the method reporting limit. All associated sample results that were detected at levels less than 5 times the blank were U qualified as not detected. At total of 13 samples were U qualified as not detected. All but two of the 13 samples qualified by the rinsate blank were also qualified by the field blank detections. One set of equipment blanks (filtered and unfiltered) for the bailer was collected. The equipment blank was found to contain both dissolved mercury (1.02 ng/L) and total mercury (7.45 ng/L) at a concentration above the method reporting limit. There were no sample results that were detected at levels less than 5 times this equipment blank, thus, they were no associated qualifications.

Associated samples with detection greater than 5 times the blank were not qualified. A summary of qualified data due to equipment rinsate blank contamination is also presented in Table 3c.

3.3 MATRIX SPIKE AND MATRIX SPIKE DUPLICATE ANALYSIS

The MS/MSD analyses are intended to provide information about the effects that the sample matrix exerts on the digestion / extraction and measurement methodology. MS recovery values that do not meet laboratory QC criteria may indicate that sample analyte results are being attenuated in the analysis procedure. The potential sample bias may be estimated by noting the degree to which the MS concentration was elevated or lowered in the spike analysis. However, this estimated bias should serve only as an approximation; sample-specific problems may be the cause of the discrepancy, particularly in soil samples.

Recovery calculations are not required if the spiking concentration added is less than 25% of the sample background concentration.

REVIEW RESULTS

The MS/MSD sample analyses were performed at the required frequency on four unfiltered groundwater samples, two unfiltered surface water samples, and one filter surface water sample. All MS/MSD recoveries and accuracies were within the control limits.

A summary of sample data qualified due to MS/MSD precision and accuracy are presented in Tables 5a and 5b (if applicable).

3.4 LABORATORY CONTROL SAMPLE ANALYSIS

The LCS or Certified Reference Material standard is analyzed to monitor the efficiency of the digestion/extraction procedure and analytical instrument operation. The ability of the laboratory to successfully analyze an LCS or Certified Reference Material standard demonstrates that there are no analytical problems related to the digestion/sample preparation procedures and/or instrument operations. The LCS or Certified Reference Material standard results outside QC limits are presented in Table 6 (if applicable). Sporadic and marginal QC failures for multiple component methods do not indicate an analytical concern. If recoveries are high and the compounds are not detected in the samples, then no data qualification is required. All recoveries should be above 10% or the non-detect results flagged “UR” as rejected.

REVIEW RESULTS

The analysis of the Certified Reference Material Sample was within control limits.

3.5 COMPOUND IDENTIFICATION AND QUANTITATION

Mercury identification is by cold-vapor atomic fluorescence spectrometer (CVAFS) at 253.7 nanometers for detection. The concentration of Hg in each sample is based upon calibration curve done for each analysis batch. The method blank is used to correct the reported Mercury concentration detected below the PQL in samples should be considered estimated and are qualified "J." The samples with results above the linear range were all re-analyzed as a smaller aliquot.

REVIEW RESULTS

All compound identification and quantitation criteria were achieved and reported based upon the method. As noted in Table 7, three filtered samples were reported as being reanalyzed due to the initial analysis result being below the reporting limit. A larger aliquot of all three samples was re-analyzed with the re-analysis and reported. Also as noted in Table 7, two unfiltered samples were reported as being reanalyzed due to the initial analysis concentration exceeding the calibration range. A smaller aliquot of all three samples were re-analyzed with the re-analysis confirming the initial analysis concentrations.

The four field blank samples were reported as being reanalyzed due to the initial analysis results that yielded detectable concentration of mercury. The re-analysis confirm the initial results.

4. FIELD DUPLICATE SAMPLE RESULTS

Field duplicate samples were collected and analyzed as an indication of overall precision for both field and laboratory. Field duplicate results are summarized in Table 8 (if applicable). The results are expected to have more variability than laboratory duplicates, which measure only laboratory precision. It is expected also that soil field duplicates will exhibit greater variance than water field duplicates due to the difficulties associated with collecting identical field samples. The QC criteria used to assess field duplicate samples for this project was limits of 70% RPD for soils and 40% RPD for waters, or twice the general laboratory duplicate criteria. If a given compound in both the regular sample and associated field duplicate sample was below the laboratory PQL, or the compound was not detected in one of the samples, then the compound is generally not qualified due to field duplicate precision. There are no guidelines regarding data qualification based on poor field duplicate precision. Professional judgment was used to determine whether or not to qualify results.

REVIEW RESULTS

Four field duplicates analyses were performed on this SDG. The RPD ratings are listed on Table 8a through 8d as “Good” if the RPD is less than field duplicate QC criteria of 40% and as “Poor” if the RPD exceeded the field duplicate QC criteria.

The result for total mercury and dissolved mercury showed good precision in the three groundwater sample sets. The result for dissolved mercury showed good precision in the surface water sample. The result for total mercury showed poor precision in the surface water sample. Results are presented in Tables 8a through 8d. Qualifiers were only added to the field duplicate sample pair results as noted.

5. OVERALL ASSESSMENT OF DATA

The data from the QA samples suggest the following:

- That there was elevated contamination in the field blank collected on September 17, 2017. The field blank indicates the potential that airborne mercury may be contaminating samples. The elevated field blank may also indicate that a portion of the laboratory supplied blank water was contaminated. Nineteen samples were qualified U as being not detected based upon the field blank.

- That there was an equipment decontamination problem with the bladder pump that was used to collect most of the groundwater samples. The equipment rinsate blank indicates the potential of inadequate decontamination of the bladder pump. The problem did not cause any additional qualification.

- That there was an equipment decontamination problem with the bailer that was used to collect one of the groundwater samples. The equipment rinsate blank indicates the potential of inadequate decontamination of the bailer. The equipment blank may also indicate the potential that airborne mercury may be contaminating samples. No samples were qualified.

All data were reviewed and considered usable with qualification as noted in this report. All non-detect results were reported as "U" qualified at the PQL except where noted based upon blank contamination. All reported data at concentration less than the PQL were J qualified as estimated.

Table 1 - Sample Listing

Work Order	Matrix	Sample ID	Lab ID	Sample Date	QA/QC	Analysis
EEI-SE1601	GW	*0917MW01GW*	1740002-08	9/16/2017	MS/MSD	EPA 1631
EEI-SE1601	F-GW	*0917MW01GW*	1740002-09	9/16/2017		EPA 1631
EEI-SE1601	GW	*0917MW06GW*	1740002-10	9/19/2017	field duplicate of 0917MW90GW	EPA 1631
EEI-SE1601	F-GW	*0917MW06GW*	1740002-11	9/19/2017	field duplicate of 0917MW90GW	EPA 1631
EEI-SE1601	GW	*0917MW08GW*	1740002-12	9/18/2017		EPA 1631
EEI-SE1601	F-GW	*0917MW08GW*	1740002-13	9/18/2017		EPA 1631
EEI-SE1601	GW	*0917MW09GW*	1740002-14	9/25/2017		EPA 1631
EEI-SE1601	F-GW	*0917MW09GW*	1740002-15	9/25/2017		EPA 1631
EEI-SE1601	GW	*0917MW10GW*	1740002-16	9/19/2017	MS/MSD	EPA 1631
EEI-SE1601	F-GW	*0917MW10GW*	1740002-17	9/19/2017		EPA 1631
EEI-SE1601	GW	*0917MW16GW*	1740002-18	9/18/2017		EPA 1631
EEI-SE1601	F-GW	*0917MW16GW*	1740002-19	9/18/2017		EPA 1631
EEI-SE1601	GW	*0917MW17GW*	1740002-20	9/18/2017		EPA 1631
EEI-SE1601	F-GW	*0917MW17GW*	1740002-21	9/18/2017		EPA 1631
EEI-SE1601	GW	*0917MW19GW*	1740002-22	9/25/2017		EPA 1631
EEI-SE1601	F-GW	*0917MW19GW*	1740002-23	9/25/2017		EPA 1631
EEI-SE1601	GW	*0917MW22GW*	1740002-24	9/25/2017	Duplicate of 0917MW93GW	EPA 1631
EEI-SE1601	F-GW	*0917MW22GW*	1740002-25	9/25/2017	Duplicate of 0917MW93GW	EPA 1631
EEI-SE1601	GW	*0917MW26GW*	1740002-26	9/24/2017		EPA 1631
EEI-SE1601	F-GW	*0917MW26GW*	1740002-27	9/24/2017		EPA 1631
EEI-SE1601	GW	*0917MW27GW*	1740002-28	9/19/2017		EPA 1631
EEI-SE1601	F-GW	*0917MW27GW*	1740002-29	9/19/2017		EPA 1631
EEI-SE1601	GW	*0917MW28GW*	1740002-30	9/24/2017		EPA 1631
EEI-SE1601	F-GW	*0917MW28GW*	1740002-31	9/24/2017		EPA 1631
EEI-SE1601	GW	*0917MW29GW*	1740002-32	9/18/2017		EPA 1631
EEI-SE1601	F-GW	*0917MW29GW*	1740002-33	9/18/2017		EPA 1631
EEI-SE1601	GW	*0917MW31GW*	1740002-34	9/17/2017		EPA 1631
EEI-SE1601	F-GW	*0917MW31GW*	1740002-35	9/17/2017		EPA 1631
EEI-SE1601	GW	*0917MW32GW*	1740002-36	9/17/2017	MS/MSD	EPA 1631
EEI-SE1601	F-GW	*0917MW32GW*	1740002-37	9/17/2017		EPA 1631
EEI-SE1601	GW	*0917MW33GW*	1740002-38	9/19/2017		EPA 1631
EEI-SE1601	F-GW	*0917MW33GW*	1740002-39	9/19/2017		EPA 1631
EEI-SE1601	GW	*0917MW40GW*	1740002-40	9/19/2017	Duplicate of 0917MW91GW	EPA 1631
EEI-SE1601	F-GW	*0917MW40GW*	1740002-41	9/19/2017	Duplicate of 0917MW91GW	EPA 1631
EEI-SE1601	GW	*0917MW42GW*	1740002-42	9/25/2017		EPA 1631
EEI-SE1601	F-GW	*0917MW42GW*	1740002-43	9/25/2017		EPA 1631
EEI-SE1601	GW	*0917MW43GW*	1740002-44	9/18/2017		EPA 1631
EEI-SE1601	F-GW	*0917MW43GW*	1740002-45	9/18/2017		EPA 1631
EEI-SE1601	GW	*0917MW90GW*	1740002-46	9/19/2017	field duplicate of 0917MW06GW	EPA 1631
EEI-SE1601	F-GW	*0917MW90GW*	1740002-47	9/19/2017	field duplicate of 0917MW06GW	EPA 1631

Table 1 - Sample Listing

Work Order	Matrix	Sample ID	Lab ID	Sample Date	QA/QC	Analysis
EEI-SE1601	GW	*0917MW91GW*	1740002-48	9/19/2017	field duplicate of 0917MW40GW MS/MSD	EPA 1631
EEI-SE1601	F-GW	*0917MW91GW*	1740002-49	9/19/2017	field duplicate of 0917MW40GW	EPA 1631
EEI-SE1601	GW	*0917MW93GW*	1740002-50	9/25/2017	field duplicate of 0917MW22GW	EPA 1631
EEI-SE1601	F-GW	*0917MW93GW*	1740002-51	9/25/2017	field duplicate of 0917MW22GW	EPA 1631
EEI-SE1601	SW	*0917RD05SW*	1740002-52	9/15/2017	MS/MSD	EPA 1631
EEI-SE1601	F-SW	*0917RD05SW*	1740002-53	9/15/2017		EPA 1631
EEI-SE1601	SW	*0917RD06SW*	1740002-54	9/15/2017		EPA 1631
EEI-SE1601	F-SW	*0917RD06SW*	1740002-55	9/15/2017		EPA 1631
EEI-SE1601	SW	*0917RD08SW*	1740002-56	9/15/2017		EPA 1631
EEI-SE1601	F-SW	*0917RD08SW*	1740002-57	9/15/2017		EPA 1631
EEI-SE1601	SW	*0917RD09SW*	1740002-58	9/15/2017		EPA 1631
EEI-SE1601	F-SW	*0917RD09SW*	1740002-59	9/15/2017		EPA 1631
EEI-SE1601	SW	*0917RD10SW*	1740002-60	9/15/2017	field duplicate of 0917RD50SW	EPA 1631
EEI-SE1601	F-SW	*0917RD10SW*	1740002-61	9/15/2017	field duplicate of 0917RD50SW	EPA 1631
EEI-SE1601	SW	*0917RD14SW*	1740002-62	9/15/2017	MS/MSD	EPA 1631
EEI-SE1601	F-SW	*0917RD14SW*	1740002-63	9/15/2017	MS/MSD	EPA 1631
EEI-SE1601	SW	*0917RD15SW*	1740002-64	9/15/2017		EPA 1631
EEI-SE1601	F-SW	*0917RD15SW*	1740002-65	9/15/2017		EPA 1631
EEI-SE1601	SW	*0917RD50SW*	1740002-66	9/15/2017	field duplicate of 0917RD10SW	EPA 1631
EEI-SE1601	F-SW	*0917RS50SW*	1740002-67	9/15/2017	field duplicate of 0917RD10SW	EPA 1631
EEI-SE1601	Blank	*0917RS09SW*	1740002-68	9/25/2017	Rinsate Blank (pump)	EPA 1631
EEI-SE1601	F- Blk	*0917RS09SW*	1740002-69	9/25/2017	Rinsate Blank (pump)	EPA 1631
EEI-SE1601	Blank	*0917EB03GW*	1740002-01	9/25/2017	Equipment Blank (bailer)	EPA 1631
EEI-SE1601	F- Blk	*0917EB03GW*	1740002-02	9/25/2017	Equipment Blank (bailer)	EPA 1631
EEI-SE1601	Blank	0917FB01	1740002-03	9/15/2017	Field Blank	EPA 1631
EEI-SE1601	Blank	0917FB02	1740002-04	9/17/2017	Field Blank	EPA 1631
EEI-SE1601	Blank	0917FB08	1740002-06	9/24/2017	Field Blank	EPA 1631
EEI-SE1601	Blank	0917FB09	1740002-07	9/25/2017	Field Blank	EPA 1631

F-GW =Filtered ground water F-blk = Filtered Blank
FD = Field duplicate sample GW = Ground water

Table 2 - List of Samples Qualified for Holding Time Exceedance

Method	Analyte	Sample IDs	HT	Sampling Date	Analysis Date	Qual
None						

Table 3a - List of Positive Results for Blank Samples

Method	Sample ID	Sample Type	Analyte	Result**	Analysis Type	Units	PQL
EPA1631	0917RS09SW	AQ	Total Mercury	40.3	RB	ng/L	0.40
EPA1631	0917RS09SW	AQ	Dissolved Mercury	2.06	RB	ng/L	0.40
EPA1631	0917EB03GW	AQ	Total Mercury	7.45	EB	ng/L	0.40
EPA1631	0917EB03GW	AQ	Dissolved Mercury	1.03	EB	ng/L	0.40
EPA1631	0917FB01	AQ	Total Mercury	0.3 J	FB	ng/L	0.40
EPA1631	0917FB02	AQ	Total Mercury	6.69	FB	ng/L	0.40
EPA1631	0917FB08	AQ	Total Mercury	0.17	FB	ng/L	0.40
EPA1631	0917FB09	AQ	Total Mercury	0.73	FB	ng/L	0.40

Table 3b - List of Samples Qualified for Method Blank Contamination

Method	Sample ID	Analyte	Blank Result	Sample Result	Sample Qual	PQL
None *						

*EPA 1631 method monitors laboratory blank concentration and uses blank concentration to correct reported sample data. Detected values less than the quantitation limit are normal.
** Field blanks (FB) values are laboratory blank corrected.

Table 3c - List of Samples Qualified for Field Blank or Rinsate Blank Contamination

Method	Sample ID	Analyte	Blank Result ng/L	Sample Result ng/L	Sample Qual	PQL ng/L
EPA 1631	0917MW08GW	Total Mercury	6.69	7.31	U	0.4
EPA1631	0917MW08GW	Dissolved Mercury	6.69	3.93	U	0.4
EPA 1631	0917MW10GW	Total Mercury	40.3	16.3	U	0.4
EPA1631	0917MW10GW	Dissolved Mercury	2.06	0.25 J	U	0.4
EPA 1631	0917MW19GW	Dissolved Mercury	0.73	1.07	U	0.4
EPA1631	0917MW29GW	Total Mercury	40.3	24.9	U	0.4
EPA1631	0917MW29GW	Dissolved Mercury	2.06	1.05	U	0.4
EPA 1631	0917MW31GW	Total Mercury	40.3	4.87	U	0.4
EPA1631	0917MW31GW	Dissolved Mercury	2.06	0.42	U	0.4
EPA1631	0917MW32GW	Total Mercury	6.69	30.9	U	0.4
EPA 1631	0917MW32GW	Dissolved Mercury	6.69	1.86	U	0.4
EPA1631	0917MW33GW	Dissolved Mercury	6.69	8.91	U	0.4
EPA1631	0917MW40GW	Total Mercury	40.3	25.9	U	0.4
EPA1631	0917MW40GW	Dissolved Mercury	2.06	0.31	U	0.4
EPA1631	0917MW42GW	Total Mercury	40.3	93.8	U	0.4
EPA1631	0917MW43GW	Total Mercury	40.3	50	U	0.4
EPA1631	0917MW43GW	Dissolved Mercury	2.06	4.04	U	0.4
EPA1631	0917MW90GW	Dissolved Mercury	1.17	0.90	U	0.4
EPA1631	0917MW91GW	Total Mercury	40.3	27.9	U	0.4
EPA1631	0917MW91GW	Dissolved Mercury	2.06	0.41	U	0.4

Table 4 - List of Samples with Surrogates outside Control Limits

There are no surrogates used by this method.

Method	Sample ID	Sample Type	Analyte	Rec.	Low Limit	High Limit	Dil Fac	Sample Qual.
None.								

Table 5a - List of MS/MSD Recoveries outside Control Limits

Method	Sample ID	Sample Type	Analyte	Orig. Result	Spike Amount	Rec.	Dil Fac.	Low Limit	High Limit	Sample Qual
None										

Table 5b - List of Lab and MS Duplicate RPDs outside Control Limits

Sample ID	Analyte	Method	RPD	RPD Limit	No. of Affected Samples	Samp Qual
None						

Table 6 - List of LCS Recoveries outside Control Limits

Method	Sample ID	Analyte	% Rec.	Low Limit	High Limit	No. of Affected Samples	Samp Qual
None							

Table 7 - Samples that were Re-analyzed

Sample ID	Lab ID	Method	Sample Type	Action
0917MW10GW	1740002-16	EPA1631	Unfiltered groundwater	Analyzed at a lower aliquot Confirmation with no Qualification
0917MW90GW	1740002-47	EPA1631	Filtered groundwater	Re-analyzed due to result below reporting limit. Analyzed at a larger aliquot Confirmation with no additional qualification
0917MW90GW	1740002-48	EPA1631	Unfiltered groundwater	Analyzed at a lower aliquot Confirmation with no Qualification
0917MW91GW	1740002-49	EPA1631	Filtered groundwater	Re-analyzed due to result below reporting limit. Analyzed at a larger aliquot Confirmation with no additional qualification
0917MW09GW	1740002-69	EPA1631	Filtered groundwater	Re-analyzed due to result below reporting limit. Analyzed at a larger aliquot Confirmation with no additional qualification
0917FB01	1740002-03	EPA1631	Field Blank	Re-analyzed due to result above detection limit. Re –analysis confirmed initial analysis result.
0917FB02	1740002-04	EPA1631	Field Blank	Re-analyzed due to result above detection limit. Re –analysis confirmed initial analysis result.
0917FB08	1740002-06	EPA1631	Field Blank	Re-analyzed due to result above detection limit. Re –analysis confirmed initial analysis result.
0917FB09	1740002-07	EPA1631	Field Blank	Re-analyzed due to result above detection limit. Re –analysis confirmed initial analysis result.

Table 8a - Summary of Field Duplicate Results

Method	Analyte	Units	0917MW06GW	0917MW90GW	RPD	Rating	Sample Qualifier
EPA 1631	Mercury	ng/L	45.7	53.7	16	Good	None
EPA 1631	Dissolved Mercury	ng/L	0.72	0.90 U	Not Applicable	Good	None

Table 8b – Summary of Field Duplicate Results

Method	Analyte	Units	0917MW22GW	0917MW93GW	RPD	Rating	Sample Qualifier
EPA 1631	Mercury	ng/L	214	223	4	Good	None
EPA 1631	Dissolved Mercury	ng/L	103	114	10	Good	None

Table 8c – Summary of Field Duplicate Results

Method	Analyte	Units	0917MW40GW	0917MW91GW	RPD	Rating	Sample Qualifier
EPA 1631	Mercury	ng/L	25.9 U	27.9 U	4	Good	None
EPA 1631	Dissolved Mercury	ng/L	0.31 U	0.41 U	10	Good	None

Table 8d – Summary of Field Duplicate Results

Method	Analyte	Units	0917RD10SW	0917RD50SW	RPD	Rating	Sample Qualifier
EPA 1631	Mercury	ng/L	40.2	7.21	> 100	Poor	J
EPA 1631	Dissolved Mercury	ng/L	3.87	4.15	6	Good	None

DATA REVIEW MEMORANDUM

DATE: November 29, 2017

TO: Jonathan Reeve, Project Manager, E & E, Seattle, WA

FROM: Howard Edwards, E & E, San Francisco, CA

SUBJ: Data Review: Red Devil Mine Fall 2017

REFERENCE:

Project ID	Lab Work Order	Lab
1001095.0009.05	580-71716-1	Test America – Seattle

1. SAMPLE IDENTIFICATION

For the sampling activities at the Red Devil Mine site, Ecology and Environment, Inc. (E & E) collected the samples listed in Table 1. Project-specific matrix spike/matrix spike duplicates (MS/MSD) were designated in the field, except where noted. All samples were sent to Test America's lab in Seattle, Washington, for all listed analyses. This report addresses only Test America-generated data.

The analytical report was issued by Test America on October 17, 2017. The data in the analytical report were reviewed for field and laboratory precision, accuracy, and completeness in accordance with procedures and quality control (QC) limits, the current laboratory Quality Assurance Manual (QAM) and current standard operating procedures (SOPs). Laboratory data qualifiers for identified analytes and analyte quantitation were accepted. Any additional data review qualifiers added are noted below and listed on the tables at the end of this memorandum. Definitions of all data qualifiers are given in the report.

Work Orders, Tests, and Number of Samples Included in this Data Review Memo

Work Orders/ Job Number	Matrix	Test Method	Method Name	Number of Samples
580-71706-1	Surface Water	EPA 7470A	Mercury (CVAA)	8
580-71706-1	Surface Water	EPA 6010B/6020A	Total TAL Metals by ICP	8
580-71706-1	Surface Water	EPA 7470A	Dissolved Mercury (CVAA)	8
580-71706-1	Surface Water	EPA 6010B/6020A	Dissolved TAL Metals by ICP	8
580-71706-1	Surface Water	EPA 9060	TOC	8
580-71706-1	Surface Water	SM2540D	TSS	8
580-71706-1	Surface Water	SM2540C	TDS	8
580-71706-1	Surface Water	EPA 300.0	Inorganic Ions (Cl, F, SO4)	8
580-71706-1	Surface Water	EPA 353.2	Nitrate-Nitrite as N	8
580-71706-1	Surface Water	SM2320B	Alkalinity as CO3/HCO3	8
580-71706-1	Ground Water	EPA 6010B/6020A	Total TAL Metals by ICP	22
580-71706-1	Ground Water	EPA 7470A	Mercury (CVAA)	22
580-71706-1	Ground Water	EPA 300.0	Inorganic Ions (Cl, F, SO4)	22
580-71706-1	Ground Water	EPA 353.2	Nitrate-Nitrite as N	22
580-71706-1	Ground Water	SM2320B	Alkalinity as CO3/HCO3	22
580-71706-1	Ground Water	EPA 8270D	SVOCs	3
580-71706-1	Ground Water	AK102/103	DRO	3
580-71706-1	Ground Water	EPA 8260C	BTEX	3
580-71706-1	Ground Water	AK101	GRO	3
580-71706-1	Ground Water	SM2540D	TSS	22
580-71706-1	Ground Water	SM2540C	TDS	22
580-71706-1	Rinsate Blank	EPA 7470A	Mercury (CVAA)	1
580-71706-1	Rinsate Blank	EPA 6010B/6020A	Total TAL Metals by ICP	1
580-71706-1	Rinsate Blank	EPA 7470A	Dissolved Mercury (CVAA)	1
580-71706-1	Rinsate Blank	EPA 6010B/6020A	Dissolved TAL Metals by ICP	1
580-71706-1	Rinsate Blank	SM2540C	TDS	1
580-71706-1	Rinsate Blank	EPA 353.2	Nitrate-Nitrite as N	1
580-71706-1	Rinsate Blank	SM2320B	Alkalinity as CO3/HCO3	1
580-71706-1	Equipment Blank	EPA 7470A	Mercury (CVAA)	1
580-71706-1	Equipment Blank	EPA 6010B/6020A	Total TAL Metals by ICP	1
580-71706-1	Equipment Blank	EPA 7470A	Dissolved Mercury (CVAA)	1
580-71706-1	Equipment Blank	EPA 6010B/6020A	Dissolved TAL Metals by ICP	1
580-71706-1	Equipment Blank	SM2540C	TDS	1
580-71706-1	Equipment Blank	EPA 353.2	Nitrate-Nitrite as N	1
580-71706-1	Equipment Blank	SM2320B	Alkalinity as CO3/HCO3	1
580-71706-1	Trip Blank	EPA 8260C	BTEX	1
580-71706-1	Trip Blank	AK101	GRO	1

2. SAMPLE PROCEDURES

All samples were collected as specified in the work plan and documented on the chain-of-custody (COC) and in field notebooks. Samples were analyzed as specified on the COC. Samples were packaged, shipped, and received as specified in the work plan. All samples must be received cold (4 ±2 degrees Celsius [^{o}C]) and in good condition as documented on the Cooler Receipt Form.

REVIEW RESULTS

All sample procedures were followed and the sample coolers were received at temperatures between 0.1 and 2.4 ^{o}C. No problems with the condition of the samples upon receipt were documented.

3. LABORATORY DATA

3.1 HOLDING TIMES

Holding times are established and monitored to ensure analytical results accurately represent analyte concentrations in a sample at the time of collection. These results are presented in Table 2 (if applicable). Exceeding the holding time for a sample generally results in a loss of the analyte due to a variety of mechanisms, such as deposition on the sample container walls or precipitation.

REVIEW RESULTS

Most samples requiring the determination of total suspended solids (TSS) and all samples requiring the determination of total dissolved solids (TDS) were received by the laboratory after the holding time had expired. The method and project specified holding time is 7 days. All associated TSS and TDS data was J qualified as estimated. Fifteen samples requiring the determination for alkalinity were received by the laboratory with less than two days of holding time and were analyzed past the holding time. The method and project specified holding time is 14 days. All other samples were analyzed within the project and method specified holding times for all analytes (see Table 2).

3.2 BLANKS

Laboratory and field blank samples are analyzed and evaluated to determine the existence and magnitude of possible contamination during the sampling and analysis process. These results are presented in Table 3 (if applicable). If the analyte is present in the sample at similar trace levels(less than 5 times the blank concentration), then the analyte is likely a common background contaminant from some phase of the sampling, extraction, or analytical procedure and associated low-level sample concentrations are not considered to be site related. Sample results in these cases are qualified as not detected, U.

REVIEW RESULTS

All laboratory method blanks were performed at the required frequency. As noted in Table 3a, analyte concentrations in the method blanks detected for phenol, DRO, chloride, sulfate, and TOC. All method blank analytes were found at concentrations below the practical quantitation limit (PQL). All associated reported concentration of phenol, DRO, chloride, sulfate and TOC that were less than 5 times the concentration found in the preparation blank/ method blank (MB) were U qualified as not detected.

Phenol and DRO, which was found in the MB, was detected in three associated sample at a similar concentrations was U qualified as not detected. Sulfate was detected in two associated samples at less than 5 times the concentration found in the preparation blank/ method blank (MB). Chloride was U qualified in one associated sample. A summary of qualified data due to method blank contamination is presented in Table 3b.

One equipment and one rinsate blank were collected, with several EPA Method 6010, 6020, and 300.0 analytes detected in at concentrations less than the PQL. All associated sample results that were detected at levels less than 5 times the blank were U qualified as not detected. Associated samples with detection greater than 5 times the blank were not qualified. A summary of qualified data due to equipment rinsate blank contamination is presented in Table 3c.

One trip blank were submitted for analysis by EPA 8260C and AK101. Toluene by EPA 8260C was detected at 0.038 J ug/L in the trip blank. All associated sample results were detected at levels less than 5 times the blank and were U qualified as not detected.

3.3 SURROGATE SPIKE RECOVERY

Laboratory performance for individual samples analyzed for organic compounds is established by means of surrogate spiking activities. Samples are spiked with surrogate compounds prior to preparation and analysis. Unusually low or high surrogate recovery values may indicate some deficiency in the analytical system or that some matrix effects exist, resulting in low or high sample results for target compounds. Sample surrogate recoveries outside QC limits (if applicable) are presented in Table 4.

REVIEW RESULTS

All method which use surrogates were analyzed at the required frequency with no high or low surrogate recoveries noted.

3.4 MATRIX SPIKE AND MATRIX SPIKE DUPLICATE ANALYSIS

The MS/MSD analyses are intended to provide information about the effects that the sample matrix exerts on the digestion / extraction and measurement methodology. MS recovery values that do not meet laboratory QC criteria may indicate that sample analyte results are being attenuated in the analysis procedure. The potential sample bias may be estimated by noting the degree to which the MS concentration was elevated or lowered in the spike analysis. However, this estimated bias should serve only as an approximation; sample-specific problems may be the cause of the discrepancy, particularly in soil samples.

Recoveries of a post-digestion spike or a laboratory control sample (LCS) are used to verify that the analytical methodology is acceptable and that MS recoveries are due to matrix effects. An MSD analysis is performed to evaluate the precision of the sample results. Precision is measured as the relative percent difference (RPD) between analytical results for duplicate samples. The laboratory's failure to produce similar results for MSD samples may indicate that the samples were non-homogeneous (particularly in soil samples), or that method defects may exist in the laboratory's techniques.

Recovery calculations are not required if the spiking concentration added is less than 25% of the sample background concentration.

REVIEW RESULTS

The MS/MSD sample analyses were performed on three samples 0917MW01GW, 0917MW042GW, and 0917RD14SW, at the required frequency. The MS/MSD sample analyses were performed on 0917MW19GW for organic analyses. MS/MSD were performed on additional samples for EPA Method 353.2 and EPA 9060. MS/MSD recoveries were within the control limits generated by the laboratory with the following exceptions:

- For sample 0917MW19GW, the MS and MSD recoveries for DRO by AK102/103 were above laboratory control limits. The results for DRO in associated samples was previously qualified as none detect, based on blank contamination, and required no qualification.
- For sample 0917MW01GW, the EPA Methods EPA 300.0 had MS and/or MSD recoveries for chloride and fluoride that were above laboratory control limits. The detected results for chloride and fluoride in the parent sample have been qualified as estimated with a high bias, “J+“.
- For EPA method 353.2, samples 00917MW10GW, 00917MW16GW, and 00917MW16GW had low Nitrate Nitrite as N recovery. The detected results for Nitrate Nitrite as N in the parent sample have been qualified as estimated with a low bias, “J-“.

The accuracy of MS/MSD recoveries were within the control limits generated by the laboratory with the following exceptions:

- For sample 0917MW19GW, the EPA Methods EPA 8270D had MS and/or MSD RPDs for, 4,6 Dinitro-2-methylphenol, and Bis(2-ethyhexyl) Phthalate that were above laboratory control limits. 4,6 Dinitro-2-methylphenol was not detected in associated sample and required no qualification. The detected results for Bis(2-ethyhexyl) Phthalate in the parent sample have been qualified as estimated “J“.

A summary of sample data qualified due to MS/MSD precision and accuracy are presented in Tables 5a and 5b.

3.5 LABORATORY CONTROL SAMPLE ANALYSIS

The LCS is analyzed to monitor the efficiency of the digestion/extraction procedure and analytical instrument operation. The ability of the laboratory to successfully analyze an

LCS demonstrates that there are no analytical problems related to the digestion/sample preparation procedures and/or instrument operations. The LCS results outside QC limits are presented in Table 6 (if applicable). Sporadic and marginal QC failures for multiple component methods do not indicate an analytical concern. If recoveries are high and the compounds are not detected in the samples, then no data qualification is required. All recoveries should be above 10% or the non-detect results flagged "UR" as rejected.

REVIEW RESULTS

- All LCS analyses were within control limits and performed at the required frequency for all method with the exception of EPA 8270D. Most out of control analytes had high and not present in the samples and thus required no qualification. The Bis(2-ethylhexyl) phthalate had 166% recoveries of above the control limit of 150%. The results for bis(2-ethylhexyl) phthalate in the associated samples have been qualified as estimated with a high bias, "J+".

3.6 COMPOUND IDENTIFICATION AND QUANTITATION

Compound identities are assigned by comparing sample compound retention times to retention times from known (standard) compounds and identification of an acceptable mass spectrum. Compounds detected below the PQL in samples should be considered estimated and are qualified "J." The samples with compounds above the linear range were all re-analyzed at a higher dilution factor.

REVIEW RESULTS

All compound identification and quantitation criteria were achieved. As noted in Table 7, no samples were reported as reanalyzed.

4. FIELD DUPLICATE SAMPLE RESULTS

Field duplicate samples were collected and analyzed as an indication of overall precision for both field and laboratory. Field duplicate results are summarized in Table 8 (if applicable). The results are expected to have more variability than laboratory duplicates, which measure only laboratory precision. It is expected also that soil field duplicates will exhibit greater variance than water field duplicates due to the difficulties associated with collecting identical field samples. The QC criteria used to assess field duplicate samples for this project was limits of 70% RPD for soils and 40% RPD for waters, or twice the general laboratory duplicate criteria. If a given compound in both the regular sample and associated field duplicate sample was below the laboratory PQL, or the compound was not detected in one of the samples, then the compound is generally not qualified due to field duplicate precision. There are no guidelines regarding data qualification based on poor field duplicate precision. Professional judgment was used to determine whether or not to qualify results.

REVIEW RESULTS

Four field duplicates analyses were performed on this SDG. The RPD ratings are listed on Tables 8a through 8d as “Good” if the RPD is less than field duplicate QC criteria of 40% and as “Poor” if the RPD exceeded the field duplicate QC criteria.

All the results show good precision in the sample pair with the exceptions noted on Tables 8a through 8d. Qualifiers were only added to the field duplicate sample pair results as noted.

5. OVERALL ASSESSMENT OF DATA

All data were reviewed and considered usable with qualification as noted in this report. All non-detect results were reported as “U” qualified at the PQL except where noted based upon blank contamination. All reported data at concentration less than the PQL were J qualified as estimated.

Table 1 - Sample Listing

Work Order	Matrix	Sample ID	Lab ID	Sample Date	QA/QC	Analysis
580-71706-1	SW	0917RD05SW	580-71706-24	9/28/2016		6010B, 6020A, 7471A, 9060, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-71706-1	SW	0917RD06SW	580-71706-25	9/28/2016		6010B, 6020A, 7471A, 9060, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-71706-1	SW	0917RD08SW	580-71706-26	9/28/2016		6010B, 6020A, 7471A, 9060, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-71706-1	SW	0917RD09SW	580-71706-27	9/29/2016		6010B, 6020A, 7471A, 9060, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-71706-1	SW	0917RD10SW	580-71706-28	9/29/2016	FD of 0916RD50SW	6010B, 6020A, 7471A, 9060, 300.0’ 353.2, SM2320B, SM2540C, SM2540D
580-71706-1	SW	0917RD14SW	580-71706-29	9/29/2016	MS/MSD	6010B, 6020A, 7471A, 9060, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-71706-1	SW	0917RD15SW	580-71706-30	9/29/2016		6010B, 6020A, 7471A, 9060, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-71706-1	SW	0917RD50SW	580-71706-31	9/29/2016	FD of 0916RD10SW	6010B, 6020A, 7471A, 9060, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-71706-1	GW	0917MW01GW	580-71706-2	9/30/2016	MS/MSD	6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-71706-1	GW	0917MW17GW	580-71706-8	9/30/2016		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-71706-1	GW	0917MW32GW	580-71706-16	9/29/2016		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-71706-1	GW	0917MW06GW	580-71706-3	10/1/2016	FD of 0917MW90GW	6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-71706-1	GW	0917MW08GW	580-71706-4	10/1/2016		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-71706-1	GW	0917MW09GW	580-71706-5	10/3/2016		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-71706-1	GW	0917MW10GW	580-71706-6	10/2/2016		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-71706-1	GW	0917MW16GW	580-71706-7	10/3/2016		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-71706-1	GW	0917MW19GW	580-71706-9	10/4/2016	MS/MSD	6010B, 6020A, 7471A, 300.0,AK102/103, AK101,8260C,8270D,353.2, SM2320B, SM2540C, SM2540D

Table 1 - Sample Listing

Work Order	Matrix	Sample ID	Lab ID	Sample Date	QA/QC	Analysis
580-71706-1	GW	0917MW22GW	580-71706-10	10/5/2016	FD of 0917MW92GW	6010B, 6020A, 7471A, 300.0,AK102/103, AK101,8260C,8270D,353.2, SM2320B, SM2540C, SM2540D
580-71706-1	GW	0917MW26GW	580-71706-11	10/5/2016		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-71706-1	GW	0917MW27GW	580-71706-12	10/5/2016		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-71706-1	GW	0917MW28GW	580-71706-13	10/2/2016		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-71706-1	GW	0917MW29GW	580-71706-14	10/3/2016		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-71706-1	GW	0917MW31GW	580-71706-15	10/1/2016		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-71706-1	GW	0917MW33GW	580-71706-17	10/2/2016		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-71706-1	GW	0917MW40GW	580-71706-18	10/4/2016	FD of 0917MW91GW	6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-71706-1	GW	0917MW42GW	580-71706-19	10/5/2016	MS/MSD	6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-71706-1	GW	0917MW43GW	580-71706-20	10/2/2016		6010B, 6020A, 7471A, 300.0,353.2, SM2320B, SM2540C, SM2540D
580-71706-1	GW	0917MW90GW	580-71706-21	10/4/2016	FD of 0917MW06GW	6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-71706-1	GW	0917MW91GW	580-71706-22	10/4/2016	FD of 0917MW40GW	6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-71706-1	GW	0917MW93GW	580-71706-23	10/4/2016	FD of 0917MW22GW	6010B, 6020A, 7471A, 300.0,AK102/103, AK101,8260C,8270D,353.2, SM2320B, SM2540C, SM2540D
580-71706-1	GW	0917EB03GW	580-71706-01	10/6/2016	EB	6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-71706-1	GW	0917RS09GW	580-71706-32	10/6/2016	RB	6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-71706-1	GW	Trip Blank	580-71706-33	9/22/2016	TB	8260C, AK101

EB= Equipment Blank (uncertified bailer)
RB= Rinsate Blank (non-dedicated pumps)
TB = Trip Blank
FD = Field Duplicate

Table 2 - List of Samples Qualified for Holding Time Exceedance

Method	Analyte	Sample IDs	HT	Sampling Date	Analysis Date	Qual
SM2540 D	TSS	0917MW01GW	7 day	9/16/2017	10/02/2017 & 10/11/2017	J
SM2540 D	TSS	0917MW06GW	7 day	9/19/2017	10/02/2017 & 10/11/2017	J
SM2540 D	TSS	0917MW08GW	7 day	9/18/2017	10/02/2017 & 10/11/2017	J
SM2540 D	TSS	0917MW10GW	7 day	9/19/2017	10/02/2017 & 10/11/2017	J
SM2540 D	TSS	0917MW16GW	7 day	9/18/2017	10/02/2017 & 10/11/2017	J
SM2540 D	TSS	0917MW17GW	7 day	9/18/2017	10/02/2017 & 10/11/2017	J
SM2540 D	TSS	0917MW26GW	7 day	9/24/2017	10/02/2017 & 10/11/2017	J
SM2540 D	TSS	0917MW27GW	7 day	9/19/2017	10/02/2017 & 10/11/2017	J
SM2540 D	TSS	0917MW28GW	7 day	9/24/2017	10/02/2017 & 10/11/2017	J
SM2540 D	TSS	0917MW29GW	7 day	9/18/2017	10/02/2017 & 10/11/2017	J
SM2540 D	TSS	0917MW31GW	7 day	9/17/2017	10/02/2017 & 10/11/2017	J
SM2540 D	TSS	0917MW32GW	7 day	9/17/2017	10/02/2017 & 10/11/2017	J
SM2540 D	TSS	0917MW33GW	7 day	9/19/2017	10/02/2017 & 10/11/2017	J
SM2540 D	TSS	0917MW40GW	7 day	9/19/2017	10/02/2017 & 10/11/2017	J
SM2540 D	TSS	0917MW43GW	7 day	9/18/2017	10/02/2017 & 10/11/2017	J
SM2540 D	TSS	0917MW90GW	7 day	9/19/2017	10/02/2017 & 10/11/2017	J
SM2540 D	TSS	0917MW91GW	7 day	9/19/2017	10/02/2017 & 10/11/2017	J
SM2540 C & D	TSS and TDS	0917RD05SW	7 day	9/15/2017	10/02/2017 & 10/11/2017	J
SM2540 C & D	TSS and TDS	0917RD06SW	7 day	9/15/2017	10/02/2017 & 10/11/2017	J
SM2540 C & D	TSS and TDS	0917RD08SW	7 day	9/15/2017	10/02/2017 & 10/11/2017	J
SM2540 C & D	TSS and TDS	0917RD09SW	7 day	9/15/2017	10/02/2017 & 10/11/2017	J
SM2540 C & D	TSS and TDS	0917RD10SW	7 day	9/15/2017	10/02/2017 & 10/11/2017	J
SM2540 C & D	TSS and TDS	0917RD14SW	7 day	9/15/2017	10/02/2017 & 10/11/2017	J
SM2540 C & D	TSS and TDS	0917RD15SW	7 day	9/15/2017	10/02/2017 & 10/11/2017	J
SM2540 C & D	TSS and TDS	0917RD50SW	7 day	9/15/2017	10/02/2017 & 10/11/2017	J
SM2540 C	TDS	0917RS09GW	7 day	9/25/2017	10/11/2017	J
SM 2320B	Alkalinity as CO3/HCO3	0917MW01GW	14 day	9/16/2017	10/04/2017	J
SM 2320B	Alkalinity as CO3/HCO3	0917MW08GW	14 day	9/18/2017	10/03/2017	J
SM 2320B	Alkalinity as CO3/HCO3	0917MW10GW	14 day	9/19/2017	10/03/2017	J
SM 2320B	Alkalinity as CO3/HCO3	0917MW16GW	14 day	9/18/2017	10/03/2017	J
SM 2320B	Alkalinity as CO3/HCO3	0917MW17GW	14 day	9/18/2017	10/03/2017	J
SM 2320B	Alkalinity as CO3/HCO3	0917MW31GW	14 day	9/17/2017	10/02/2017	J

Table 2 - List of Samples Qualified for Holding Time Exceedance

Method	Analyte	Sample IDs	HT	Sampling Date	Analysis Date	Qual
SM 2320B	Alkalinity as CO3/HCO3	0917MW32GW	14 day	9/17/2017	10/02/2017	J
SM 2320B	Alkalinity as CO3/HCO3	0917RD05SW	14 day	9/15/2017	10/02/2017	J
SM 2320B	Alkalinity as CO3/HCO3	0917RD06SW	14 day	9/15/2017	10/02/2017	J
SM 2320B	Alkalinity as CO3/HCO3	0917RD08SW	14 day	9/15/2017	10/02/2017	J
SM 2320B	Alkalinity as CO3/HCO3	0917RD09SW	14 day	9/15/2017	10/02/2017	J
SM 2320B	Alkalinity as CO3/HCO3	0917RD10SW	14 day	9/15/2017	10/02/2017	J
SM 2320B	Alkalinity as CO3/HCO3	0917RD14SW	14 day	9/15/2017	10/02/2017	J
SM 2320B	Alkalinity as CO3/HCO3	0917RD15SW	14 day	9/15/2017	10/02/2017	J
SM 2320B	Alkalinity as CO3/HCO3	0917RD50SW	14 day	9/15/2017	10/02/2017	J

Table 3a - List of Positive Results for Blank Samples

Method	Sample ID	Sample Type	Analyte	Result	Analysis Type	Units	PQL
AK10/103	MB 580-258381/1-A	AQ	DRO	0.0545J	MB	mg/L	0.10
EPA 8270D	MB 580-257833/1-A	AQ	Phenol	0.154 J	MB	ug/L	4.0
EPA 9060	MB 580-258885/3	AQ	TOC	0.227 J	MB	mg/L	1.0
EPA 300.0	MB 580-257887/1-A	AQ	Chloride	0.421J	MB	mg/L	0.9
EPA 300.0	MB 580-257833/1-A	AQ	Sulfate	0.282J	MB	mg/L	1.2
EPA 300.0	MB 580-257948/40	AQ	Sulfate	0.385J	MB	mg/L	1.2
EPA 300.0	0917EB03GW	AQ	Fluoride	0.54J	MB	mg/L	0.2
EPA 6020A	0917EB03GW	AQ	Barium	0.00098J	EB	mg/L	0.006
EPA 6020A	0917EB03GW	AQ	Antimony	0.00081J	EB	mg/L	0.002
EPA 6020A	0917EB03GW	AQ	Chromium	0.011J	EB	mg/L	0.002
EPA 6020A	0917EB03GW	AQ	Nickel	0.00067J	EB	mg/L	0.015
EPA 6020A	0917EB03GW	AQ	Thallium	0.00034J	EB	mg/L	0.005
EPA 300.0	0917RS09GW	AQ	Chloride	0.42J	EB	mg/L	0.9
EPA 300.0	0917RS09GW	AQ	Sulfate	0.38J	EB	mg/L	1.2
EPA 6020A	0917RS09GW	AQ	Barium	0.00047J	EB	mg/L	0.006
EPA 6020A	0917RS09GW	AQ	Antimony	0.0018J	EB	mg/L	0.002
EPA 6010B	0917RS09GW	AQ	Calcium	0.21J	EB	mg/L	1.1
EPA 8260C	Trip Blank	AQ	Toluene	0.038J	TB	ug/L	0.2

Table 3b - List of Samples Qualified for Method Blank Contamination

Method	Sample ID	Analyte	Blank Result	Sample Result	Sample Qual	Units	PQL
EPA 8270D	0917MW19GW	Phenol	0.154	0.16	U	mg/L	3.8
EPA 8270D	0917MW22GW	Phenol	0.154	0.19	U	mg/L	3.8
EPA 8270D	0917MW93GW	Phenol	0.154	0.16	U	mg/L	3.8
AK102/103	0917MW19GW	DRO	0.0545J	0.071	U	mg/L	0.10
AK102/103	0917MW22GW	DRO	0.0545J	0.045	U	mg/L	0.10
AK102/103	0917MW93GW	DRO	0.0545J	0.050	U	mg/L	0.10
EPA 300.0	0917RS09GW	Chloride	0.421J	0.42	U	mg/L	0.9
EPA 300.0	0917RS09GW	Sulfate	0.282J	0.38	U	mg/L	1.2
EPA 300.0	0917MW31GW	Sulfate	0.385J	1.3	U	mg/L	1.2

Table 3c - List of Samples Qualified for Equipment or Rinsate Blank Contamination

Method	Sample ID	Analyte	Blank Result	Sample Result	Sample Qual	Units	PQL
EPA 300.0	0917MW09GW	Fluoride	0.54J	0.073	U	mg/L	0.2
EPA 6020A	0917MW09GW	Nickel	0.00067J	0.0028	U	mg/L	0.015
EPA 6020A	0917MW31GW	Sulfate	0.38J	1.3	U	mg/L	1.2
EPA 6020A	0917MW27GW	Antimony	0.0018J	0.0076	U	mg/L	0.002
EPA 6020A	0917MW28GW	Antimony	0.0018J	0.0071	U	mg/L	0.002
EPA 6020A	0917MW29GW	Antimony	0.0018J	0.0062	U	mg/L	0.002
EPA 6020A	0917MW32GW	Antimony	0.0018J	0.0027	U	mg/L	0.002
EPA 8260C	0917MW19GW	Toluene	0.038J	0.051	U	ug/L	0.2
EPA 8260C	0917MW22GW	Toluene	0.038J	0.069	U	ug/L	0.2
EPA 8260C	0917MW93GW	Toluene	0.038J	0.064	U	ug/L	0.2

Table 4 - List of Samples with Surrogates outside Control Limits

Method	Sample ID	Sample Type	Analyte	Rec.	Low Limit	High Limit	Dil Fac	Sample Qual.
None.								

Table 5a - List of MS/MSD Recoveries outside Control Limits

Method	Sample ID	Sample Type	Analyte	Orig. Result	Spike Amount	Rec.	Dil Fac.	Low Limit	High Limit	Sample Qual
EPA 300.0	0917MW01GW	AQ	Fluoride	0.52	50	111	1.0	90	110	J+
EPA 300.0	0917MW01GW	AQ	Chloride	0.13	5.0	115	1.0	90	110	J+
AK102/103	0917MW19GW	AQ	DRO	0.071	2.01	63	1.0	75	125	None- ND
EPA 353.2	0917MW10GW	AQ	Nitrate-Nitrite as N	0.15U	0.5	77	1.0	90	110	None- ND
EPA 353.2	0917MW16GW	AQ	Nitrate-Nitrite as N	0.12J	0.5	33	1.0	90	110	J-
EPA 353.2	0917MW42GW	AQ	Nitrate-Nitrite as N	0.15U	0.5	83	1.0	90	110	None- ND

Table 5b - List of Lab and MS Duplicate RPDs outside Control Limits

Sample ID	Analyte	Method	RPD	RPD Limit	No. of Affected Samples	Samp Qual
0917MW19GW	Bis(2-ethyhexyl) Phthalate	EPA 8270D	36	35	1	J

Table 6 - List of LCS Recoveries outside Control Limits

Method	Sample ID	Analyte	% Rec.	Low Limit	High Limit	No. of Affected Samples	Samp Qual
EPA 8270D	LCS 580-229524/3-A	Bis(2-ethylhexyl) phthalate	166	22	150	2	J+

*= no qualification required

Table 7- Samples that were Re-analyzed

Sample ID	Lab ID	Method	Sample Type	Action
None.				

Table 8a – Summary of Field Duplicate Results

Method	Analyte	Units	0917MW06GW	0917MW90GW	RPD	Rating	Sample Qualifier
EPA 300.0	Chloride	mg/L	0.54 J	0.91	51%	Poor	J
EPA 300.0	Fluoride	mg/L	0.094 J	.20 U	Not Applicable	Good	None
EPA 300.0	Sulfate	mg/L	27	26	3.7%	Good	None
SM2320B	Alkalinity	mg/L	170	170	0.0%	Good	None
SM2320B	Bicarbonate Alkalinity	mg/L	170	170	0.0%	Good	None
SM2320C	TDS	mg/L	11J	8.4J	26.8%	Good	None
EPA 6010B	Calcium	mg/L	31	32	3.2%	Good	None
EPA 6010B	Iron	mg/L	2.7	2.7	0.0%	Good	None
EPA 6010B	Magnesium	mg/L	28	28	0.0%	Good	None
EPA 6010B	Potassium	mg/L	0.80	0.79	1.3%	Good	None
EPA 6010B	Sodium	mg/L	4.4	4.5	2.2%	Good	None
EPA 6020A	Antimony	mg/L	0.0076U	0.0079U	0.0%	Good	None
EPA 6020A	Arsenic	mg/L	0.042	0.043	2.4%	Good	None
EPA 6020A	Barium	mg/L	0.093	0.091	1.1%	Good	None
EPA 6020A	Cobalt	mg/L	0.0017J	0.0017J	0.0%	Good	None
EPA 6020A	Manganese	mg/L	0.63	0.64	1.6%	Good	None
EPA 6020A	Nickel	mg/L	0.0027	0.0027	0.0%	Good	None

Table 8b - Summary of Field Duplicate Results

Method	Analyte	Units	0917MW40GW	0917MW91GW	RPD	Rating	Sample Qualifier
EPA 300.0	Chloride	mg/L	0.85	0.86	1.2%	Good	None
EPA 300.0	Fluoride	mg/L	0.041J	0.17J	> 100%	Poor	No Additional
EPA 300.0	Sulfate	mg/L	23	24	4%	Good	None
SM2320B	Alkalinity	mg/L	290	310	7%	Good	None
SM2320B	Bicarbonate Alkalinity	mg/L	290	310	7%	Good	None
SM2540D	TSS	mg/L	5.8 J	5.6 J	35%	Good	None
EPA 6010B	Calcium	mg/L	49	49	0%	Good	None
EPA 6010B	Iron	mg/L	0.056	0.060	7%	Good	None
EPA 6010B	Magnesium	mg/L	48	49	2%	Good	None
EPA 6010B	Potassium	mg/L	0.89J	0.89J	0.%	Good	None
EPA 6010B	Sodium	mg/L	2.2	2.2	0%	Good	None
EPA 6020A	Antimony	mg/L	0.010	0.0094	6%	Good	None
EPA 6020A	Arsenic	mg/L	0.22	0.23	10%	Good	None
EPA 6020A	Barium	mg/L	0.13	0.14	7%	Good	None
EPA 6020A	Beryllium	mg/L	0.002U	0.00028J	Not Applicable	Good	None
EPA 6020A	Cobalt	mg/L	0.030	0.030	0%	Good	None
EPA 6020A	Manganese	mg/L	0.32	0.33	3%	Good	None
EPA 6020A	Nickel	mg/L	0.12	0.12	0%	Good	None

Table 8c + Summary of Field Duplicate Results

Method	Analyte	Units	0917MW22GW	0917MW93GW	RPD	Rating	Sample Qualifier
EPA 8260C	Toluene	ugL	0.064 J	0.051 J	22%	Good	No Additional
EPA 8270D	Benzoic acid	ugL	1.1	2.8 U	NA	Good	None
EPA 8270D	Benzyl alcohol	ugL	0.19	0.15	24%	Good	None
EPA 8270D	Bis(2-ethyhexyl) Phthalate	ugL	6.4 J	14 U	Not Applicable	Good	None
EPA 8270D	Phenol	ugL	0.19U	0.16 U	Not Applicable	Good	None
AK102/103	DRO	mg/L	0.045U	0.050U	Not Applicable	Good	None
EPA 300.0	Chloride	mg/L	0.39J	0.78J	65%	Poor	No Additional
EPA 300.0	Fluoride	mg/L	0.12J	0.03 J	> 100%	Poor	Not Applicable
EPA 300.0	Sulfate	mg/L	5.5	5.5	0.0%	Good	None
EPA 353.2	Nitrate-Nitrite as N	mg/L	0.061	0.062	1.6%	Good	None
SM2320B	Alkalinity	mg/L	68	69	1.5%	Good	None
ESM2320B	Bicarbonate Alkalinity	mg/L	68	69	1.5%	Good	None
EPA 6010B	Calcium	mg/L	12	12	0.0%	Good	None
EPA 6010B	Magnesium	mg/L	9.7	9.1	6.4%	Good	None
EPA 6010B	Sodium	mg/L	2.3	2.2	4.4%	Good	None
EPA 6010B	Antimony	mg/L	0.51	0.48	6.1%	Good	None
EPA 6010B	Arsenic	mg/L	0.13	0.12	8.0%	Good	None
EPA 6020A	Barium	mg/L	0.041	0.038	7.6%	Good	None
EPA 6020A	Beryllium	mg/L	0.0025J	0.0010U	Not Applicable	Good	None
EPA 6020A	Manganese	mg/L	0.0010U	0.0025J	Not Applicable	Good	None
EPA 6020A	Nickel	mg/L	0.0014J	0.0014J	0.0%	Good	None

Table 8d – Summary of Field Duplicate Results

Method	Analyte	Units	0917RD10SW	0917RD50SW	RPD	Rating	Sample Qualifier
EPA 9060	Total Organic Carbon	mg/L	3.5	3.5	0.0%	Good	None
SM 2540C	Total Dissolved Solids	mg/L	85	85	0.0%	Good	None
SM 2540D	Total Suspended Solids	mg/L	2.0	2.2	9.5%	Good	None
EPA 300.0	Chloride	mg/L	0.81	0.81	0.0%	Good	None
EPA 300.0	Sulfate	mg/L	7.0	7.0	0.0%	Good	None
EPA 353.2	Nitrate-Nitrite as N	mg/L	0.21	0.22	4.7%	Good	None
SM2320B	Alkalinity	mg/L	62	43	36%	Good	None
SM2320B	Bicarbonate Alkalinity	mg/L	62	43	36%	Good	None
EPA 6010B	Calcium	mg/L	15	14	6.9%	Good	None
EPA 6010B	Iron	mg/L	0.5U	0.17J	Not Applicable	Good	None
EPA 6010B	Magnesium	mg/L	7.8	7.3	6.6%	Good	None
EPA 6010B	Sodium	mg/L	1.6	1.4	4.4%	Good	None
EPA 6010B	Antimony	mg/L	0.0024	0.0017J	34%	Good	None
EPA 6020A	Barium	mg/L	0.022	0.020	9.5%	Good	None
EPA 6020A	Manganese	mg/L	0.012	0.011	33%	Good	None
EPA 6010B	Dissolved Calcium	mg/L	14	14	0.0%	Good	None
EPA 6010B	Dissolved Magnesium	mg/L	7.4	7.5	8.7%	Good	None
EPA 6010B	Dissolved Sodium	mg/L	1.5	1.5	0.0%	Good	None
EPA 6010B	Dissolved Antimony	mg/L	0.0024	0.0021	13%	Good	None
EPA 6020A	Dissolved Barium	mg/L	0.018	0.020	10.5%	Good	None
EPA 6020A	Dissolved Manganese	mg/L	0.0045 J	0.030 J	> 100%	Poor	Not Applicable

DATA REVIEW MEMORANDUM

DATE: December 7, 2017

TO: Mark Longtine, Project Manager, E & E, Seattle, WA

FROM: Howard Edwards, E & E, San Francisco, CA

SUBJ: Data Review: Red Devil Mine 2017 SMA GW

REFERENCE:

Project ID	Lab Work Order	Lab
1001095.0015.01	580-71717-1	Test America – Seattle

1. SAMPLE IDENTIFICATION

For the sampling activities at the Red Devil Mine site, Ecology and Environment, Inc. (E & E) collected the samples listed in Table 1. Project-specific matrix spike/matrix spike duplicates (MS/MSD) were designated in the field, except where noted. All samples were sent to Test America's lab in Seattle, Washington, for all listed analyses. This report addresses only Test America-generated data.

The analytical report was issued by Test America on October 17, 2017. The data in the analytical report were reviewed for field and laboratory precision, accuracy, and completeness in accordance with procedures and quality control (QC) limits, the current laboratory Quality Assurance Manual (QAM) and current standard operating procedures (SOPs). Laboratory data qualifiers for identified analytes and analyte quantitation were accepted. Any additional data review qualifiers added are noted below and listed on the tables at the end of this memorandum. Definitions of all data qualifiers are given in the report.

Work Orders, Tests, and Number of Samples Included in this Data Review Memo

Work Orders/ Job Number	Matrix	Test Method	Method Name	Number of Samples
580-71717-1	Ground Water	EPA 6010B/6020A	Total TAL Metals by ICP	17
580-71717-1	Ground Water	EPA 7470A	Mercury (CVAA)	17
580-71717-1	Ground Water	EPA 353.2	Nitrate-Nitrite as N	17
580-71717-1	Ground Water	EPA 300	Inorganic Ions (Cl, F, SO4)	17
580-71717-1	Ground Water	SM2320B	Alkalinity as CO3/HCO3	17
580-71717-1	Ground Water	SM2540D	TSS	1
580-71717-1	Rinsate Blank	SM2320B	Alkalinity as CO3/HCO3	1
580-71717-1	Equipment Blank	EPA 7470A	Mercury (CVAA)	1
580-71717-1	Equipment Blank	EPA 6010B/6020A	Total TAL Metals by ICP	1
580-71717-1	Equipment Blank	EPA 7470A	Mercury (CVAA)	1

2. SAMPLE PROCEDURES

All samples were collected as specified in the work plan and documented on the chain-of-custody (COC) and in field notebooks. Samples were analyzed as specified on the COC. Samples were packaged, shipped, and received as specified in the work plan. All samples must be received cold (4 ±2 degrees Celsius [^{o}C]) and in good condition as documented on the Cooler Receipt Form.

REVIEW RESULTS

All sample procedures were followed and the sample coolers were received at temperatures between 0.1 and 0.9 ^{o}C. No problems with the condition of the samples upon receipt were documented.

3. LABORATORY DATA

3.1 HOLDING TIMES

Holding times are established and monitored to ensure analytical results accurately represent analyte concentrations in a sample at the time of collection. These results are presented in Table 2 (if applicable). Exceeding the holding time for a sample generally results in a loss of the analyte due to a variety of mechanisms, such as deposition on the sample container walls or precipitation.

REVIEW RESULTS

A sample requiring the determination of total suspended solids (TSS) was received by the laboratory with two days of holding times but the sample was analyzed four days after the holding time had expired. The method and project specified holding time is seven days. All associated TSS data was J qualified as estimated. All other samples were analyzed within the project and method specified holding times for all analytes (see Table 2).

3.2 BLANKS

Laboratory and field blank samples are analyzed and evaluated to determine the existence and magnitude of possible contamination during the sampling and analysis process. These results are presented in Table 3 (if applicable). If the analyte is present in the sample at similar trace levels (less than 5 times the blank concentration), then the analyte is likely a common background contaminant from some phase of the sampling, extraction, or analytical procedure and associated low-level sample concentrations are not considered to be site related. Sample results in these cases are qualified as not detected, U.

REVIEW RESULTS

All laboratory method blanks were performed at the required frequency. As noted in Table 3a, analyte concentrations in the method blanks were detected for chloride and sulfate. All method blank analytes were found at concentrations below the practical quantitation limit (PQL). All associated reported concentration of chloride and sulfate that were less than 5 times the concentration found in the preparation blank/ method blank (MB) were U qualified as not detected.

Phenol and DRO, which was found in the MB, was detected in three associated sample at a similar concentrations was U qualified as not detected. Sulfate was detected in one associated samples that had less than 5 times the concentration found in the preparation blank/ method blank (MB) and the results were U qualified. Chloride was detected in 16 associated samples at less than 5 times the concentration found in the preparation blank/ method blank (MB) and the results were U qualified. A summary of qualified data due to method blank contamination is presented in Table 3b.

One rinsate blank was collected, with several EPA Method 6020 and 300.0 analytes detected in at concentrations less than the PQL. All associated sample results that were detected at levels less than 5 times the blank were U qualified as not detected. Associated samples with detection greater than 5 times the blank were not qualified. A summary of qualified data due to equipment rinsate blank contamination is presented in Table 3c.

3.3 SURROGATE SPIKE RECOVERY

Laboratory performance for individual samples analyzed for organic compounds is established by means of surrogate spiking activities. Samples are spiked with surrogate compounds prior to preparation and analysis. Unusually low or high surrogate recovery values may indicate some deficiency in the analytical system or that some matrix effects exist, resulting in low or high sample results for target compounds. Sample surrogate recoveries outside QC limits (if applicable) are presented in Table 4.

REVIEW RESULTS

No methods that required surrogates were performed.

3.4 MATRIX SPIKE AND MATRIX SPIKE DUPLICATE ANALYSIS

The MS/MSD analyses are intended to provide information about the effects that the sample matrix exerts on the digestion / extraction and measurement methodology. MS recovery values that do not meet laboratory QC criteria may indicate that sample analyte results are being attenuated in the analysis procedure. The potential sample bias may be estimated by noting the degree to which the MS concentration was elevated or lowered in the spike analysis. However, this estimated bias should serve only as an approximation; sample-specific problems may be the cause of the discrepancy, particularly in soil samples.

Recoveries of a post-digestion spike or a laboratory control sample (LCS) are used to verify that the analytical methodology is acceptable and that MS recoveries are due to matrix effects. An MSD analysis is performed to evaluate the precision of the sample results. Precision is measured as the relative percent difference (RPD) between analytical results for duplicate samples. The laboratory's failure to produce similar results for MSD samples may indicate that the samples were non-homogeneous (particularly in soil samples), or that method defects may exist in the laboratory's techniques.

Recovery calculations are not required if the spiking concentration added is less than 25% of the sample background concentration.

MS/MSD recoveries outside QC limits (if applicable) are presented in Table 5a. MS/MSD and sample/MD, and serial dilution recovery precision outside of control limits are presented in Table 5b. Serial dilution recovery precision outside of control limits are presented in Table 5c.

REVIEW RESULTS

The MS/MSD sample analyses were performed on two samples 0917MW48GW and 0917MW051GW at the required frequency. Matrix duplicates (MD) were also performed on these samples. MS/MSD recoveries were within the control limits generated by the laboratory with the following exceptions:

- For sample 0917MW51GW, the MS recovery (89%) for Nitrate Nitrite as N by EPA 353.2 was slightly below laboratory control limits of 90% to 110%. The results for Nitrate Nitrite as N in associated samples was not qualified since the spike duplicate was within the control limits.

The accuracy of sample/MD and MS/MSD recoveries were within the control limits generated by the laboratory with the following exceptions:

- For sample 0917MW48GW, the EPA Methods EPA 8020A had MD RPDs for chromium, cobalt, nickel, and zinc that were above laboratory control limits. The chromium, cobalt, nickel, and zinc in sample 0917MW48GW was qualified as estimated "J." Only 0917MW48GW was qualified since the MS/MSD and LCS recoveries were within acceptable laboratory control limits.

The accuracy of ICP serial dilution recoveries were within the control limits generated by the laboratory with the following exceptions:

- For sample 0917MW48GW, the EPA Methods EPA 8010C had serial dilution recovery for calcium and magnesium were significantly above the laboratory control limits of 10 % difference. The calcium and magnesium in all associated samples was qualified as estimated "J."

3.5 LABORATORY CONTROL SAMPLE ANALYSIS

The LCS is analyzed to monitor the efficiency of the digestion/extraction procedure and analytical instrument operation. The ability of the laboratory to successfully analyze an LCS demonstrates that there are no analytical problems related to the digestion/sample preparation procedures and/or instrument operations. The LCS results outside QC limits are presented in Table 6 (if applicable). Sporadic and marginal QC failures for multiple component methods do not indicate an analytical concern. If recoveries are high and the compounds are not detected in the samples, then no data qualification is required. All recoveries should be above 10% or the non-detect results flagged “UR” as rejected.

REVIEW RESULTS

- All LCS analyses were within control limits and performed at the required frequency for all method.

3.6 COMPOUND IDENTIFICATION AND QUANTITATION

Compound identities are assigned by comparing sample compound retention times to retention times from known (standard) compounds and identification of an acceptable mass spectrum. Compounds detected below the PQL in samples should be considered estimated and are qualified "J." The samples with compounds above the linear range were all re-analyzed at a higher dilution factor.

REVIEW RESULTS

All compound identification and quantitation criteria were achieved

As noted in Table 7, no samples were reported as reanalyzed.

4. FIELD DUPLICATE SAMPLE RESULTS

Field duplicate samples were collected and analyzed as an indication of overall precision for both field and laboratory. Field duplicate results are summarized in Table 8 (if applicable). The results are expected to have more variability than laboratory duplicates, which measure only laboratory precision. It is expected also that soil field duplicates will exhibit greater variance than water field duplicates due to the difficulties associated with collecting identical field samples. The QC criteria used to assess field duplicate samples for this project was limits of 70% RPD for soils and 40% RPD for waters, or twice the general laboratory duplicate criteria. If a given compound in both the regular sample and associated field duplicate sample was below the laboratory PQL, or the compound was not detected in one of the samples, then the compound is generally not qualified due to field duplicate precision. There are no guidelines regarding data qualification based on poor field duplicate precision. Professional judgment was used to determine whether or not to qualify results.

REVIEW RESULTS

Four field duplicates analyses were performed on this SDG. The RPD ratings are listed on Tables 8a through 8b as “Good” if the RPD is less than field duplicate QC criteria of 40% and as “Poor” if the RPD exceeded the field duplicate QC criteria.

All the results show good precision in the sample pair with the exceptions noted on Tables 8a through 8b. Qualifiers were only added to the field duplicate sample pair results as noted.

5. OVERALL ASSESSMENT OF DATA

All data were reviewed and considered usable with qualification as noted in this report. All non-detect results were reported as “U” qualified at the PQL except where noted based upon blank contamination. All reported data at concentration less than the PQL were J qualified as estimated.

Table 1 - Sample Listing

Work Order	Matrix	Sample ID	Lab ID	Sample Date	QA/QC	Analysis
580-71717-1	GW	0917MW44GW	580-71717-1	9/30/2016		6010B, 6020A, 7471A, SM 2320B, 353.2
580-71717-1	GW	0917MW45GW	580-71717-2	9/30/2016		6010B, 6020A, 7471A, SM 2320B, 353.2
580-71717-1	GW	0917MW46GW	580-71717-3	9/29/2016		6010B, 6020A, 7471A, SM 2320B, 353.2
580-71717-1	GW	0917MW47GW	580-71717-4	10/1/2016		6010B, 6020A, 7471A, SM 2320B, 353.2
580-71717-1	GW	0917MW48GW	580-71717-5	10/1/2016	MS/MSD	6010B, 6020A, 7471A, SM 2320B, 353.2
580-71717-1	GW	0917MW49GW	580-71717-6	10/3/2016		6010B, 6020A, 7471A, SM 2320B, 353.2
580-71717-1	GW	0917MW50GW	580-71717-7	10/2/2016		6010B, 6020A, 7471A, SM 2320B, 353.2
580-71717-1	GW	0917MW51GW	580-71717-8	10/3/2016	MS/MSD	6010B, 6020A, 7471A, SM 2320B, 353.2
580-71717-1	GW	0917MW52GW	580-71717-9	10/4/2016		6010B, 6020A, 7471A, SM 2320B, 353.2
580-71717-1	GW	0917MW53GW	580-71717-10	10/5/2016		6010B, 6020A, 7471A, SM 2320B, 353.2
580-71717-1	GW	0917MW54GW	580-71717-11	10/5/2016		6010B, 6020A, 7471A, SM 2320B, 353.2
580-71717-1	GW	0917MW55GW	580-71717-12	10/5/2016		6010B, 6020A, 7471A, SM 2320B, 353.2
580-71717-1	GW	0917MW56GW	580-71717-13	10/2/2016		6010B, 6020A, 7471A, SM 2320B, 353.2
580-71717-1	GW	0917MW57GW	580-71717-14	10/3/2016		6010B, 6020A, 7471A, SM 2320B, 353.2
580-71717-1	GW	0917MW58GW	580-71717-15	10/1/2016		6010B, 6020A, 7471A, SM 2320B, 353.2
580-71717-1	GW	0917MW59GW	580-71717-16	10/2/2016		6010B, 6020A, 7471A, SM 2320B, 353.2
580-71717-1	GW	0917RS92GW	580-71717-17	10/4/2016	FD of 0917MW52GW	6010B, 6020A, 7471A, SM 2320B, 353.2
580-71717-1	GW	0917RS08GW	580-71717-18	10/5/2016	RB	6010B, 6020A, 7471A, SM 2320B, 353.2, SM2540D

RB= Rinsate Blank (non-dedicated pumps)
FD = Field Duplicate

Table 2 - List of Samples Qualified for Holding Time Exceedance

Method	Analyte	Sample IDs	HT	Sampling Date	Analysis Date	Qual
SM2540 D	TSS	0917RS08GW	7 day	9/24/2017	10/05/2017	J

Table 3a - List of Positive Results for Blank Samples

Method	Sample ID	Sample Type	Analyte	Result	Analysis Type	Units	PQL
EPA 300.0	MB 580-257887/3	AQ	Chloride	0.421J	MB	mg/L	0.9
EPA 300.0	MB 580-257833/3	AQ	Sulfate	0.282J	MB	mg/L	1.2
EPA 300.0	0917RS08GW	AQ	Chloride	0.42J	MB	mg/L	0.9
EPA 300.0	0917RS08GW	AQ	Sulfate	0.44J	MB	mg/L	1.2
EPA 6020A	0917RS08GW	AQ	Barium	0.00018J	EB	mg/L	0.0018
EPA 6020A	0917RS08GW	AQ	Chromium	0.0017J	EB	mg/L	0.0004
EPA 6020A	0917RS08GW	AQ	Copper	0.0030	EB	mg/L	0.002
EPA 6020A	0917RS08GW	AQ	Nickel	0.00018J	EB	mg/L	0.003
EPA 6020A	0917RS08GW	AQ	Vanadium	0.00093J	EB	mg/L	0.006

Table 3b - List of Samples Qualified for Method Blank Contamination

Method	Sample ID	Analyte	Blank Result	Sample Result	Sample Qual	Units	PQL
EPA 300.0	0917MW44GW	Chloride	0.421	1.3	U	mg/L	0.9
EPA 300.0	0917MW45GW	Chloride	0.421	0.95	U	mg/L	0.9
EPA 300.0	0917MW46GW	Chloride	0.421	0.76J	U	mg/L	0.9
EPA 300.0	0917MW47GW	Chloride	0.421	0.99	U	mg/L	0.9
EPA 300.0	0917MW49GW	Chloride	0.421	0.72J	U	mg/L	0.9
EPA 300.0	0917MW50GW	Chloride	0.421	0.69J	U	mg/L	0.9
EPA 300.0	0917MW51GW	Chloride	0.421	0.79J	U	mg/L	0.9
EPA 300.0	0917MW52GW	Chloride	0.421	0.65J	U	mg/L	0.9
EPA 300.0	0917MW53GW	Chloride	0.421	1.1	U	mg/L	0.9
EPA 300.0	0917MW54GW	Chloride	0.421	0.92	U	mg/L	0.9
EPA 300.0	0917MW55GW	Chloride	0.421	1.6	U	mg/L	0.9
EPA 300.0	0917MW56GW	Chloride	0.421	0.96	U	mg/L	0.9
EPA 300.0	0917MW57GW	Chloride	0.421	1.1	U	mg/L	0.9
EPA 300.0	0917MW58GW	Chloride	0.421	0.75J	U	mg/L	0.9

Table 3b - List of Samples Qualified for Method Blank Contamination

Method	Sample ID	Analyte	Blank Result	Sample Result	Sample Qual	Units	PQL
EPA 300.0	0917MW59GW	Chloride	0.421	0.1.4	U	mg/L	0.9
EPA 300.0	0917RS92GW	Chloride	0.421	0.64J	U	mg/L	0.9
EPA 300.0	0917RS08GW	Chloride	0.421J	0.42J	U	mg/L	0.9
EPA 300.0	0917RS08GW	Sulfate	0.282J	0.44J	U	mg/L	1.2

Table 3c - List of Samples Qualified for Equipment or Rinsate Blank Contamination

Method	Sample ID	Analyte	Blank Result	Sample Result	Sample Qual	Units	PQL
EPA 6020A	0917MW44GW	Chromium	0.00017J	0.00037 J	U	mg/L	0.0004
EPA 6020A	0917MW45GW	Chromium	0.00017J	0.00066	U	mg/L	0.0004
EPA 6020A	0917MW51GW	Chromium	0.00017J	0.00053	U	mg/L	0.0004
EPA 6020A	0917MW52GW	Chromium	0.00017J	0.00049	U	mg/L	0.0004
EPA 6020A	0917MW53GW	Chromium	0.00017J	0.00079	U	mg/L	0.0004
EPA 6020A	0917MW56GW	Chromium	0.00017J	0.00027 J	U	mg/L	0.0004
EPA 6020A	0917MW58GW	Chromium	0.00017J	0.00023 J	U	mg/L	0.0004
EPA 6020A	0917RS92GW	Chromium	0.00017J	0.00064	U	mg/L	0.0004
EPA 6020A	0917MW44GW	Copper	0.003	0.0042	U	mg/L	0.002
EPA 6020A	0917MW45GW	Copper	0.003	0.0041	U	mg/L	0.002
EPA 6020A	0917MW46GW	Copper	0.003	0.0049	U	mg/L	0.002
EPA 6020A	0917MW47GW	Copper	0.003	0.0049	U	mg/L	0.002
EPA 6020A	0917MW48GW	Copper	0.003	0.0050	U	mg/L	0.002
EPA 6020A	0917MW49GW	Copper	0.003	0.0042	U	mg/L	0.002
EPA 6020A	0917MW50GW	Copper	0.003	0.0063	U	mg/L	0.002
EPA 6020A	0917MW51GW	Copper	0.003	0.0043	U	mg/L	0.002
EPA 6020A	0917MW52GW	Copper	0.003	0.0032	U	mg/L	0.002
EPA 6020A	0917MW53GW	Copper	0.003	0.0034	U	mg/L	0.002
EPA 6020A	0917MW54GW	Copper	0.003	0.0043	U	mg/L	0.002
EPA 6020A	0917MW56GW	Copper	0.003	0.0043	U	mg/L	0.002
EPA 6020A	0917MW57GW	Copper	0.003	0.0039	U	mg/L	0.002

Table 3c - List of Samples Qualified for Equipment or Rinsate Blank Contamination

Method	Sample ID	Analyte	Blank Result	Sample Result	Sample Qual	Units	PQL
EPA 6020A	0917MW58GW	Copper	0.003	0.0035	U	mg/L	0.002
EPA 6020A	0917MW59GW	Copper	0.003	0.0059	U	mg/L	0.002
EPA 6020A	0917RS92GW	Copper	0.003	0.0040	U	mg/L	0.002
EPA 6020A	0917MW44GW	Vanadium	0.00093J	0.0011	U	mg/L	0.004
EPA 6020A	0917MW45GW	Vanadium	0.00093J	0.0010	U	mg/L	0.004
EPA 6020A	0917MW46GW	Vanadium	0.00093J	0.0024	U	mg/L	0.004
EPA 6020A	0917MW47GW	Vanadium	0.00093J	0.0035	U	mg/L	0.004
EPA 6020A	0917MW48GW	Vanadium	0.00093J	0.0033	U	mg/L	0.004
EPA 6020A	0917MW49GW	Vanadium	0.00093J	0.0055	U	mg/L	0.004
EPA 6020A	0917MW50GW	Vanadium	0.00093J	0.0038	U	mg/L	0.004
EPA 6020A	0917MW51GW	Vanadium	0.00093J	0.0014	U	mg/L	0.004
EPA 6020A	0917MW52GW	Vanadium	0.00093J	0.0013	U	mg/L	0.004
EPA 6020A	0917MW53GW	Vanadium	0.00093J	0.0019	U	mg/L	0.004
EPA 6020A	0917MW54GW	Vanadium	0.00093J	0.0031	U	mg/L	0.004
EPA 6020A	0917MW56GW	Vanadium	0.00093J	0.00082	U	mg/L	0.004
EPA 6020A	0917MW57GW	Vanadium	0.00093J	0.0027	U	mg/L	0.004
EPA 6020A	0917MW58GW	Vanadium	0.00093J	0.00095	U	mg/L	0.004
EPA 6020A	0917MW59GW	Vanadium	0.00093J	0.0034	U	mg/L	0.004
EPA 6020A	0917RS92GW	Vanadium	0.00093J	0.0012	U	mg/L	0.004

Table 4 - List of Samples with Surrogates outside Control Limits

Method	Sample ID	Sample Type	Analyte	Rec.	Low Limit	High Limit	Dil Fac	Sample Qual.
None.								

Table 5a - List of MS/MSD Recoveries outside Control Limits

Method	Sample ID	Sample Type	Analyte	Orig. Result	Spike Amount	Rec.	Dil Fac.	Low Limit	High Limit	Sample Qual
EPA 353.2	0917MW51GW	AQ	Nitrate-Nitrite as N	0.062 J	0.5	89	1.0	90	110	None

Table 5b - List of MD and MS Duplicate, and Serial Dilution RPDs outside Control Limits

Sample ID	Analyte	Method	RPD	RPD Limit	No. of Affected Samples	Samp Qual
0917MW48GW	Chromium	EPA 8020A	117	20	1	J
0917MW48GW	Cobalt	EPA 8020A	30	20	1	J
0917MW48GW	Nickel	EPA 8020A	42	20	1	J
0917MW48GW	Zinc	EPA 8020A	42	20	1	J

Table 5c - List of Serial Dilution RPDs outside Control Limits

Sample ID	Analyte	Method	RPD	RPD Limit	No. of Affected Samples	Samp Qual
0917MW48GW	Calcium	EPA 8010A	46	10	17	J
0917MW48GW	Magnesium	EPA 8010A	45	10	17	J

Table 6 - List of LCS Recoveries outside Control Limits

Method	Sample ID	Analyte	% Rec.	Low Limit	High Limit	No. of Affected Samples	Samp Qual
	None						

Table 7 –List of Samples that were Re-analyzed

Sample ID	Lab ID	Method	Sample Type	Action
None.				

Table 8a - Summary of Field Duplicate Results

Method	Analyte	Units	0917MW52GW	0917MW92GW	RPD	Rating	Sample Qualifier
EPA 300.0	Chloride	mg/L	0.65 U	0.64 U	Not Applicable	Good	None
EPA 300.0	Sulfate	mg/L	2.2	2.1	4.7%	Good	None
EPA 353.2	Nitrate-Nitrite as N	mg/L	0.78	0.80	2.5%	Good	None
SM2320B	Alkalinity	mg/L	70	68	2.9%	Good	None
SM2320B	Bicarbonate Alkalinity	mg/L	70	68	2.9%	Good	None
EPA 6010B	Aluminum	mg/L	1.5 U	0.11 J	Not Applicable	Good	None
EPA 6010B	Calcium	mg/L	13	13	0.0%	Good	None
EPA 6010B	Magnesium	mg/L	8.1	8.4	3.6%	Good	None
EPA 6010B	Sodium	mg/L	2.6	2.6	0.0%	Good	None
EPA 6020A	Arsenic	mg/L	0.0055	0.0057	3.6%	Good	None
EPA 6020A	Antimony	mg/L	0.00034 J	0.00032 J	6.1%	Good	None
EPA 6020A	Barium	mg/L	0.030	0.031	3.3%	Good	None
EPA 6020A	Chromium	mg/L	0.00049	0.00064	27%	Good	None
EPA 6020A	Cobalt	mg/L	0.00043	0.00048	9.0%	Good	None
EPA 6020A	Copper	mg/L	0.0032	0.0040	22%	Good	None
EPA 6020A	Manganese	mg/L	0.12	0.13	8.0%	Good	None
EPA 6020A	Nickel	mg/L	0.0017J	0.0018J	5.7%	Good	None
EPA 6020A	Vanadium	mg/L	0.0013J	0.0012J	8.0%	Good	None
EPA 6020A	Zinc	mg/L	0.0020J	0.0029J	37%	Good	None

Table 8b Summary of Field Duplicate Results

Method	Analyte	Units	0917MW40GW	0917MW91GW	RPD	Rating	Sample Qualifier
EPA 300.0	Chloride	mg/L	0.85	0.86	1.2%	Good	None
EPA 300.0	Fluoride	mg/L	0.041J	0.17J	> 100%	Poor	No Additional
EPA 300.0	Sulfate	mg/L	23	24	4%	Good	None
SM2320B	Alkalinity	mg/L	290	310	7%	Good	None
SM2320B	Bicarbonate Alkalinity	mg/L	290	310	7%	Good	None
SM2540D	TSS	mg/L	5.8 J	5.6 J	35%	Good	None
EPA 6010B	Calcium	mg/L	49	49	0%	Good	None
EPA 6010B	Iron	mg/L	0.056	0.060	7%	Good	None
EPA 6010B	Magnesium	mg/L	48	49	2%	Good	None
EPA 6010B	Potassium	mg/L	0.89J	0.89J	0.%	Good	None
EPA 6010B	Sodium	mg/L	2.2	2.2	0%	Good	None
EPA 6020A	Antimony	mg/L	0.010	0.0094	6%	Good	None
EPA 6020A	Arsenic	mg/L	0.22	0.23	10%	Good	None
EPA 6020A	Barium	mg/L	0.13	0.14	7%	Good	None
EPA 6020A	Beryllium	mg/L	0.002U	0.00028J	Not Applicable	Good	None
EPA 6020A	Cobalt	mg/L	0.030	0.030	0%	Good	None
EPA 6020A	Manganese	mg/L	0.32	0.33	3%	Good	None
EPA 6020A	Nickel	mg/L	0.12	0.12	0%	Good	None

DATA REVIEW MEMORANDUM

DATE: December 12, 2017

TO: Mark Longtine, Project Manager, E & E, Seattle, WA

FROM: Howard Edwards, E & E, San Francisco, CA

SUBJ: Data Review: Red Devil Mine 2017 SMA Soil

REFERENCE:

Project ID	Lab Work Order	Lab
1001095.0015.01	580-71114-1	Test America – Seattle

1. SAMPLE IDENTIFICATION

For the sampling activities at the Red Devil Mine site, Ecology and Environment, Inc. (E & E) collected the samples listed in Table 1. Project-specific matrix spike/matrix spike duplicates (MS/MSD) were designated in the field, except where noted. All samples were sent to Test America's lab in Seattle, Washington, for all listed analyses. This report addresses only Test America generated data.

The analytical report was issued by Test America on October 17, 2017. The data in the analytical report were reviewed for field and laboratory precision, accuracy, and completeness in accordance with procedures and quality control (QC) limits, the current laboratory Quality Assurance Manual (QAM) and current standard operating procedures (SOPs). Laboratory data qualifiers for identified analytes and analyte quantitation were accepted. Any additional data review qualifiers added are noted below and listed on the tables at the end of this memorandum. Definitions of all data qualifiers are given in the report.

Work Orders, Tests, and Number of Samples Included in this Data Review Memo

Work Orders/ Job Number	Matrix	Test Method	Method Name	Number of Samples
580-71114-1	Soil	EPA 6010B/6020A	Total TAL Metals by ICP/MS	10
580-71114-1	Soil	EPA 7470A	Mercury (CVAA)	10
580-71114-1	Soil	EPA 9060	Total Organic Carbon	10
580-71114-1	Soil	ASTM D2216	Percent Solid and Moisture	10
580-71114-1	Rinsate Blank Water	EPA 6010B/6020A	Total TAL Metals by ICP/MS	1
580-71114-1	Rinsate Blank Water	EPA 7470A	Mercury (CVAA)	1
580-71114-1	Rinsate Blank Water	EPA 9060	Total Organic Carbon	1
580-71114-1	Equipment Blank Water	EPA 6010B/6020A	Total TAL Metals by ICP/MS	1
580-71114-1	Equipment Blank Water	EPA 7470A	Mercury (CVAA)	1
580-71114-1	Equipment Blank Water	EPA 9060	Total Organic Carbon	1

2. SAMPLE PROCEDURES

All samples were collected as specified in the work plan and documented on the chain-of-custody (COC) and in field notebooks. Samples were analyzed as specified on the COC. Samples were packaged, shipped, and received as specified in the work plan. All samples must be received cold (4 ±2 degrees Celsius [^{o}C]) and in good condition as documented on the Cooler Receipt Form.

REVIEW RESULTS

All sample procedures were followed and the sample cooler was received at a temperature of -0.2^{o}C. There were no documented problems with the condition of the samples upon receipt were documented.

3. LABORATORY DATA

3.1 HOLDING TIMES

Holding times are established and monitored to ensure analytical results accurately represent analyte concentrations in a sample at the time of collection. These results are presented in Table 2 (if applicable). Exceeding the holding time for a sample generally results in a loss of the analyte due to a variety of mechanisms, such as deposition on the sample container walls or precipitation.

REVIEW RESULTS

All samples were analyzed within the project and method specified holding times for all analytes (see Table 2).

3.2 BLANKS

Laboratory and field blank samples are analyzed and evaluated to determine the existence and magnitude of possible contamination during the sampling and analysis process. These results are presented in Table 3 (if applicable). If the analyte is present in the sample at similar trace levels (less than 5 times the blank concentration), then the analyte is likely a common background contaminant from some phase of the sampling, extraction, or analytical procedure and associated low-level sample concentrations are not considered to be site related. Sample results in these cases are qualified as not detected, U.

REVIEW RESULTS

All laboratory method blanks were performed at the required frequency. As noted in Table 3a, analytes were not detected in the method blanks for any method.

One rinsate blank and one equipment were collected, with most EPA Method 6010 EPA 6020 analytes detected in at concentrations less than the PQL and several analytes detected at concentration less than twice the PQL. Chromium and manganese were present in both the rinsate and equipment blank at level up to 8 times the PQL. All associated sample results were detected at levels greater than 5 times the blank and thus no data was U qualified. All associated samples with detections greater than 5 times the blank were not qualified. A summary of qualified data due to equipment or rinsate blank contamination is presented in Table 3c.

3.3 SURROGATE SPIKE RECOVERY

Laboratory performance for individual samples analyzed for organic compounds is established by means of surrogate spiking activities. Samples are spiked with surrogate compounds prior to preparation and analysis. Unusually low or high surrogate recovery values may indicate some deficiency in the analytical system or that some matrix effects exist, resulting in low or high sample results for target compounds. Sample surrogate recoveries outside QC limits (if applicable) are presented in Table 4.

REVIEW RESULTS

No methods which required surrogates were performed.

3.4 MATRIX SPIKE AND MATRIX SPIKE DUPLICATE ANALYSIS

The MS/MSD analyses are intended to provide information about the effects that the sample matrix exerts on the digestion / extraction and measurement methodology. MS recovery values that do not meet laboratory QC criteria may indicate that sample analyte results are being attenuated in the analysis procedure. The potential sample bias may be estimated by noting the degree to which the MS concentration was elevated or lowered in the spike analysis. However, this estimated bias should serve only as an approximation; sample-specific problems may be the cause of the discrepancy, particularly in soil samples.

Recoveries of a post-digestion spike or a laboratory control sample (LCS) are used to verify that the analytical methodology is acceptable and that MS recoveries are due to matrix effects. An MSD analysis is performed to evaluate the precision of the sample results. Precision is measured as the relative percent difference (RPD) between analytical results for duplicate samples. The laboratory's failure to produce similar results for MSD samples may indicate that the samples were non-homogeneous (particularly in soil samples), or that method defects may exist in the laboratory's techniques.

Recovery calculations are not required if the spiking concentration added is less than 25% of the sample background concentration.

MS/MSD recoveries outside QC limits (if applicable) are presented in Table 5a. MS/MSD and sample duplicate, recovery precision outside of control limits are presented in Table 5b. Serial dilution recovery precision outside of control limits are presented in Table 5c.

REVIEW RESULTS

The MS/MSD sample analyses were performed on one sample 17SM79SB11 at the required frequency. Matrix spike recoveries were within the control limits generated by the laboratory with the following exceptions:

- The MS recovery for Calcium, Sodium and Potassium by EPA 6010B was above laboratory control limits of 80 % to 120%. The results for Calcium, Sodium and Potassium in associated samples were J+ qualified as high biased estimates. Since the post digestion results were within laboratory control limits, a matrix related interference is suspected.

- The MS recovery for Barium, Chromium, Selenium and Vanadium by EPA 6020A was above laboratory control limits of 80 % to 120%. The results for Barium, Chromium, Selenium and Vanadium in associated samples were J+ qualified as high biased estimates. Since the post digestion results were within laboratory control limits, a matrix related interference is suspected.

The accuracy of sample duplicate and MS/MSD recoveries were within the control limits generated by the laboratory with the following exceptions:

- For EPA Methods EPA 8020A had sample replicate RPDs for selenium that was above laboratory control limits. The selenium in all associated samples were qualified as estimated "J."

The accuracy of ICP serial dilution recoveries were within the control limits generated by the laboratory with the following exceptions:

- EPA Methods EPA 6010B and 6020A had serial dilution recovery for aluminum, calcium, magnesium, arsenic, chromium, copper, lead, vanadium, and zinc that were above the laboratory control limits of 10 % difference. Those analytes in all associated samples was qualified as estimated "J. "

3.5 LABORATORY CONTROL SAMPLE ANALYSIS

The LCS is analyzed to monitor the efficiency of the digestion/extraction procedure and analytical instrument operation. The ability of the laboratory to successfully analyze an LCS demonstrates that there are no analytical problems related to the digestion/sample preparation procedures and/or instrument operations. The LCS results outside QC limits are presented in Table 6 (if applicable). Sporadic and marginal QC failures for multiple component methods do not indicate an analytical concern. If recoveries are high and the compounds are not detected in the samples, then no data qualification is required. All recoveries should be above 10% or the non-detect results flagged "UR" as rejected.

REVIEW RESULTS

All LCS analyses were within control limits and performed at the required frequency for all method.

3.6 COMPOUND IDENTIFICATION AND QUANTITATION

Compound identities are assigned by comparing sample compound retention times to retention times from known (standard) compounds and identification of an acceptable mass spectrum. Compounds detected below the PQL in samples should be considered estimated and are qualified "J." The samples with compounds above the linear range were all re-analyzed at a higher dilution factor.

REVIEW RESULTS

All compound identification and quantitation criteria were achieved. As noted in Table 7, three sample for total mercury were reanalyzed after dilution.

4. FIELD DUPLICATE SAMPLE RESULTS

Field duplicate samples were collected and analyzed as an indication of overall precision for both field and laboratory. Field duplicate results are summarized in Table 8 (if applicable). The results are expected to have more variability than laboratory duplicates, which measure only laboratory precision. It is expected also that soil field duplicates will exhibit greater variance than water field duplicates due to the difficulties associated with collecting identical field samples. The QC criteria used to assess field duplicate samples for this project was limits of 70% RPD for soils and 40% RPD for waters, or twice the general laboratory duplicate criteria. If a given compound in both the regular sample and associated field duplicate sample was below the laboratory PQL, or the compound was not detected in one of the samples, then the compound is generally not qualified due to field duplicate precision. There are no guidelines regarding data qualification based on poor field duplicate precision. Professional judgment was used to determine whether or not to qualify results.

REVIEW RESULTS

One field duplicates analyses were performed on this SDG. The RPD ratings are listed on Tables 8 as “Good” if the RPD is less than field duplicate QC criteria of 70% and as “Poor” if the RPD exceeded the field duplicate QC criteria.

All the results show good precision in the sample pair with the exception of mercury noted on Tables 8. Qualifiers were only added to the field duplicate sample pair results as noted.

5. OVERALL ASSESSMENT OF DATA

All data were reviewed and considered usable with qualification as noted in this report. All non-detect results were reported as “U” qualified at the PQL except where noted based upon blank contamination. All reported data at concentration less than the PQL were J qualified as estimated.

Table 1 - Sample Listing

Work Order	Matrix	Sample ID	Lab ID	Sample Date	QA/QC	Analysis
580-71114-1	Water	17EB01SB	580-71114-1	8/31/2017	Equipment Blank	6010B, 6020A, 7471A,9060 ASTM D2216
580-71114-1	Soil	17SM150SB09	580-71114-2	8/28/2017	FD of 17SM78SB09	6010B, 6020A, 7471A,9060 ASTM D2216
580-71114-1	Soil	17SM79SB05	580-71114-3	8/25/2017		6010B, 6020A, 7471A,9060 ASTM D2216
580-71114-1	Soil	17SM79SB11	580-71114-4	8/25/2017	MS/MSD	6010B, 6020A, 7471A,9060 ASTM D2216
580-71114-1	Soil	17SM81SB03	580-71114-5	8/29/2017		6010B, 6020A, 7471A,9060 ASTM D2216
580-71114-1	Soil	17SM81SB07	580-71114-6	8/29/2017		6010B, 6020A, 7471A,9060 ASTM D2216
580-71114-1	Soil	17SM82SB06	580-71114-7	8/23/2017		6010B, 6020A, 7471A,9060 ASTM D2216
580-71114-1	Soil	17SM82SB09	580-71114-8	8/23/2017		6010B, 6020A, 7471A,9060 ASTM D2216
580-71114-1	Soil	17SM86SB03	580-71114-9	8/30/2017		6010B, 6020A, 7471A,9060 ASTM D2216
580-71114-1	Water	17RS01SB	580-71114-10	8/31/2017	Rinse Blank	6010B, 6020A, 7471A,9060 ASTM D2216
580-71114-1	Soil	17SM78SB09	580-71114-11	8/28/2017	FD of 17SM150SB09	6010B, 6020A, 7471A,9060 ASTM D2216
580-71114-1	Soil	17SM78SB17	580-71114-12	8/28/2017		6010B, 6020A, 7471A,9060 ASTM D2216

Rinsate Blank =Collected from Macro-core cutting shoe.
Equipment blank =Collected from Macro-core liner.
FD = Field Duplicate

Table 2 - List of Samples Qualified for Holding Time Exceedance

Method	Analyte	Sample IDs	HT	Sampling Date	Analysis Date	Qual
None						

Table 3a - List of Positive Results for Blank Samples

Method	Sample ID	Sample Type	Analyte	Result	Analysis Type	Units	PQL
EPA 9060	17EB01SB	AQ	Total Organic Carbon	0.54J	EB	mg/L	1.0
EPA 6010B	17EB01SB	AQ	Aluminum	0.40J	EB	mg/L	1.5
EPA 6010B	17EB01SB	AQ	Calcium	0.54J	EB	mg/L	1.1
EPA 6010B	17EB01SB	AQ	Iron	0.95	EB	mg/L	0.5
EPA 6010B	17EB01SB	AQ	Magnesium	0.22J	EB	mg/L	1.12
EPA 6020A	17EB01SB	AQ	Arsenic	0.0016	EB	mg/L	0.0010
EPA 6020A	17EB01SB	AQ	Antimony	0.00063	EB	mg/L	0.0004
EPA 6020A	17EB01SB	AQ	Barium	0.013	EB	mg/L	0.0012
EPA 6020A	17EB01SB	AQ	Chromium	0.0031	EB	mg/L	0.0004
EPA 6020A	17EB01SB	AQ	Cobalt	0.00035J	EB	mg/L	0.0004
EPA 6020A	17EB01SB	AQ	Copper	0.0014J	EB	mg/L	0.002
EPA 6020A	17EB01SB	AQ	Lead	0.00031J	EB	mg/L	0.0008
EPA 6020A	17EB01SB	AQ	Manganese	0.055	EB	mg/L	0.002
EPA 6020A	17EB01SB	AQ	Nickel	0.0014J	EB	mg/L	0.003
EPA 6020A	17EB01SB	AQ	Vanadium	0.0019J	EB	mg/L	0.004
EPA 6020A	17EB01SB	AQ	Zinc	0.0066J	EB	mg/L	0.007
EPA 9060	17RS01SB	AQ	Total Organic Carbon	0.48	RB	mg/L	1.0
EPA 6010B	17RS01SB	AQ	Iron	0.51J	RB	mg/L	0.5
EPA 6020A	17RS01SB	AQ	Arsenic	0.00047J	RB	mg/L	0.0010
EPA 6020A	17RS01SB	AQ	Antimony	0.00023J	RB	mg/L	0.0004
EPA 6020A	17RS01SB	AQ	Barium	0.00031J	RB	mg/L	0.0012
EPA 6020A	17RS01SB	AQ	Chromium	0.0029	RB	mg/L	0.0004
EPA 6020A	17RS01SB	AQ	Cobalt	0.00010J	RB	mg/L	0.0004
EPA 6020A	17RS01SB	AQ	Copper	0.0011J	RB	mg/L	0.0008
EPA 6020A	17RS01SB	AQ	Manganese	0.0086	RB	mg/L	0.002
EPA 6020A	17RS01SB	AQ	Nickel	0.0018J	RB	mg/L	0.003
EPA 6020A	17RS01SB	AQ	Vanadium	0.00078J	RB	mg/L	0.004
EPA 6020A	17RS01SB	AQ	Zinc	0.0032J	RB	mg/L	0.007

RB = Rinsate Blank
EB = Equipment blank

Table 3b - List of Samples Qualified for Method Blank Contamination

Method	Sample ID	Analyte	Blank Result	Sample Result	Sample Qual	Units	PQL
	None						

Table 3c - List of Samples Qualified for Equipment or Rinsate Blank Contamination

Method	Sample ID	Analyte	Blank Result	Sample Result	Sample Qual	Units	PQL
	None						

Table 4 - List of Samples with Surrogates Outside Control Limits

Method	Sample ID	Sample Type	Analyte	Rec.	Low Limit	High Limit	Dil Fac	Sample Qual.
	None							

Table 5a - List of MS/MSD Recoveries Outside Control Limits

Method	Sample ID	Sample Type	Analyte	Orig. Result	Spike Amount	Rec.	Dil Fac.	Low Limit	High Limit	Sample Qual *
EPA 6010B	17SM79SB11	Soil	Calcium	2600	1120	182	1.0	80	120	J+
EPA 6010B	17SM79SB11	Soil	Sodium	120	1120	132	1.0	80	120	J+
EPA 6010B	17SM79SB11	Soil	Potassium	570	1120	168	1.0	80	120	J+
EPA 6020A	17SM79SB11	Soil	Barium	160	182	122	1.0	80	120	J+
EPA 6020A	17SM79SB11	Soil	Chromium	24	18.2	135	1.0	80	120	J+
EPA 6020A	17SM79SB11	Soil	Selenium	0.75	182	122	1.0	80	120	J+
EPA 6020A	17SM79SB11	Soil	Vanadium	40	45.5	126	1.0	80	120	J+

* Results less than PQL are not additionally qualified

Table 5b - List of Lab and MS Duplicate RPDs Outside Control Limits

Sample ID	Analyte	Method	RPD	RPD Limit	No. of Affected Samples	Samp Qual
17SM79SB11	Selenium	EPA 6020 A	35	20	10	J

Table 5c - List of Serial Dilution Percent Recovery Outside Control Limits

Sample ID	Analyte	Method	%D	%D Limit	No. of Affected Samples	Samp Qual
17SM79SB11	Aluminum	EPA 6010B	80	10	10	J
17SM79SB11	Calcium	EPA 6010A	80	10	10	J
17SM79SB11	Magnesium	EPA 6010B	79	10	10	J
17SM79SB11	Arsenic	EPA 6020A	12	10	10	J
17SM79SB11	Chromium	EPA 6020A	15	10	10	J
17SM79SB11	Copper	EPA 6020A	12	10	10	J
17SM79SB11	Lead	EPA 6020A	12	10	10	J
17SM79SB11	Vanadium	EPA 6020A	13	10	10	J
17SM79SB11	Zinc	EPA 6020A	19	10	10	J

Table 6 - List of LCS Recoveries Outside Control Limits

Method	Sample ID	Analyte	%Rec.	Low Limit	High Limit	No. of Affected Samples	Samp Qual
	none						

Table 7 - Samples that Were Re-analyzed

Sample ID	Lab ID	Method	Sample Type	Action
17SM150SB09	580-71114-2	EPA 7471A	Soil	None
17SM82SB09	580-71114-8	EPA 7471A	Soil	None
17SM78SB09	580-71114-11	EPA 7471A	Soil	None

Table 8 - Summary of Field Duplicate Results

Method	Analyte	Units	17SM78SB09	017SM150SB09	RPD	Rating	Sample Qualifier
EPA 9060	Total Organic Carbon	mg/kg	4,500	5,300	16 %	Good	None
D 2216	Percent Solids	%	82.7	82.9	0.2%	Good	None
D 2216	Percent Moisture	%	17.3	17.1	1.2%	Good	None
EPA 6010B	Aluminum	mg/kg	15,000	15,000	0.0%	Good	None
EPA 6010B	Calcium	mg/kg	2,200	2,300	4.4%	Good	None
EPA 6010B	Iron	mg/kg	20,000	21,000	4.9%	Good	None
EPA 6010B	Magnesium	mg/kg	4,500	4,600	2.2%	Good	None
EPA 6010B	Potassium	mg/kg	590	650	9.7%	Good	None
EPA 6010B	Sodium	mg/kg	92J	95J	3.2%	Good	None
EPA 6020A	Arsenic	mg/kg	17	18	5.7%	Good	None
EPA 6020A	Antimony	mg/kg	5.0	4.4	13%	Good	None
EPA 6020A	Barium	mg/kg	160	160	0.0%	Good	None
EPA 6020A	Beryllium	mg/kg	0.42	0.40	4.8%	Good	None
EPA 6020A	Cadmium	mg/kg	0.21	0.22	4.7%	Good	None
EPA 6020A	Chromium	mg/kg	25	25	0.0%	Good	None
EPA 6020A	Cobalt	mg/kg	9	9.5	5.4%	Good	None
EPA 6020A	Copper	mg/kg	26	27	22%	Good	None
EPA 6020A	Lead	mg/kg	7.6	8.0	3.8%	Good	None
EPA 6020A	Manganese	mg/kg	270	280	3.6%	Good	None
EPA 6020A	Nickel	mg/kg	26	27	3.8%	Good	None
EPA 6020A	Selenium	mg/kg	0.70	0.58	19%	Good	None
EPA 6020A	Silver	mg/kg	0.086	0.092	6.7%	Good	None
EPA 6020A	Thallium	mg/kg	0.089J	0.091J	2.2%	Good	None
EPA 6020A	Vanadium	mg/kg	40	42	4.9%	Good	None
EPA 6020A	Zinc	mg/kg	61	63	3.2%	Good	None
EPA 7471A	Mercury	mg/kg	3.0	1.4	73%	Poor	J

DATA REVIEW MEMORANDUM

DATE: December 13, 2017

TO: Mark Longtine, Project Manager, E & E, Seattle, WA

FROM: Howard Edwards, E & E, San Francisco, CA

SUBJ: Data Review: Red Devil Mine 2017 MPA Soil-Arsenic

REFERENCE:

Project ID	Lab Work Order	Lab
1001095.0015.03	K1709898	ALS – Kelso
1001095.0015.03	K1709904	ALS – Kelso
1001095.0015.03	K1709907	ALS – Kelso
1001095.0015.03	K1709908	ALS – Kelso
1001095.0015.03	K1709912	ALS – Kelso
1001095.0015.03	K1710523	ALS – Kelso

1. SAMPLE IDENTIFICATION

For the sampling activities at the Red Devil Mine site, Ecology and Environment, Inc. (E & E) collected the samples listed in Table 1. Project-specific matrix spike/matrix spike duplicates (MS/MSD) were designated in the field, except where noted. All samples were sent to ALS laboratory in Kelso, Washington, for all listed analyses. This report addresses only ALS-generated data.

The six analytical reports were issued by ALS on the following dates:

- October 16, 2017, for SDG: K1709904,
- October 18, 2017, for SDG: K1709898,
- October 18, 2017, for SDG: K1709907,
- October 31, 2017, for SDG: K1710523,
- November 6, 2017, for SDG: K1709908, and
- November 7, 2017, for SDG: K1709912.

The data in the analytical reports were reviewed for field and laboratory precision, accuracy, and completeness in accordance with procedures and quality control (QC) limits, the current laboratory Quality Assurance Manual (QAM), and current standard operating procedures (SOPs). Laboratory data qualifiers for identified analytes and analyte quantitation were accepted. Any additional data review qualifiers added are noted below and listed on the tables at the end of this memorandum. Definitions of all data qualifiers are given in the report.

Work Orders, Tests, and Number of Samples Included in this Data Review Memo

Work Orders/ Job Number	Matrix	Test Method	Method Name	Number of Samples
K1709898	Soil	EPA 6010C	Total Arsenic, by ICP	130
K1709898	Soil	EPA 6010C	TCLP for Arsenic s by ICP	130
K1709898	Rinsate Blank Water	EPA 6010C	Total Arsenic, by ICP	1
K1709898	Equipment Blank Water	EPA 6010C	Total Arsenic, by ICP	6

2. SAMPLE PROCEDURES

All samples were collected as specified in the work plan and documented on the chain-f-custody (COC) and in field notebooks, with the following exceptions:

- Sample 17MP107SB28 was not listed on any COC and was not received by ALS. A sample designated as 17MP107SB57, which is identified in field documentation as the field duplicate of 17MP107SB28, was received and analyzed. For this report, lab sample K1709898-007 is reported as sample 17MP107SB28.
- Rinsate blanks were not collected at the required frequency (discussed in Section 3.2), and
- Field duplicates were not collected at the required frequency (discussed in Chapter 4).

Samples were analyzed as specified on the COC. Samples were packaged, shipped, and received as specified in the work plan. All samples must be received cold (4 ±2 degrees Celsius [^{o}C]) and in good condition as documented on the Cooler Receipt Form.

REVIEW RESULTS

All sample procedures were followed and most samples (111 of 137 samples) were received at temperature of between 0.2°C and 2.8 °C. There were documented problems with the condition of these samples upon receipt. Twenty-eight soil sample in SDG K1709904 were received at 15.7 °C. However, this did not result in qualification since the preservation temperature is not a method requirement.

3. LABORATORY DATA

3.1 HOLDING TIMES

Holding times are established and monitored to ensure analytical results accurately represent analyte concentrations in a sample at the time of collection. These results are presented in Table 2 (if applicable). Exceeding the holding time for a sample generally results in a loss of the analyte due to a variety of mechanisms, such as deposition on the sample container walls or precipitation.

REVIEW RESULTS

All other samples were analyzed within the project and method specified holding times for all analytes (see Table 2).

3.2 BLANKS

Laboratory and field blank samples are analyzed and evaluated to determine the existence and magnitude of possible contamination during the sampling and analysis process. These results are presented in Table 3 (if applicable). If the analyte is present in the sample at similar trace levels (less than 5 times the blank concentration), then the analyte is likely a common background contaminant from some phase of the sampling, extraction, or analytical procedure and associated low-level sample concentrations are not considered to be site related. Sample results in these cases are qualified as not detected, U.

REVIEW RESULTS

All laboratory method blanks were performed at the required frequency. As noted in Table 3a, the analyte was not detected in any of the method blanks.

One equipment blank and six rinsate blanks were collected on September 16, 2017, following a final equipment decontamination. The analyte was not detected in equipment blank or rinsate. No samples were qualified as noted in Tables 3b and 3c.

It should be noted that rinsate blanks were not collected every 20 samples as required by the sampling plan, but at the end of the sampling event after 130 samples had been collected. Thus, appropriate rinsate blanks were not generated that could be used for the evaluation of possible contamination in the first 130 samples collected during this sampling event.

3.3 SURROGATE SPIKE RECOVERY

Laboratory performance for individual samples analyzed for organic compounds is established by means of surrogate spiking activities. Samples are spiked with surrogate compounds prior to preparation and analysis. Unusually low or high surrogate recovery values may indicate some deficiency in the analytical system or that some matrix effects exist, resulting in low or high sample results for target compounds. Sample surrogate recoveries outside QC limits (if applicable) are presented in Table 4.

REVIEW RESULTS

No methods that required surrogates were performed.

3.4 MATRIX SPIKE AND MATRIX SPIKE DUPLICATE ANALYSIS

The MS/MSD analyses are intended to provide information about the effects that the sample matrix exerts on the digestion / extraction and measurement methodology. MS recovery values that do not meet laboratory QC criteria may indicate that sample analyte results are being attenuated in the analysis procedure. The potential sample bias may be estimated by noting the degree to which the MS concentration was elevated or lowered in the spike analysis. However, this estimated bias should serve only as an approximation; sample-specific problems may be the cause of the discrepancy, particularly in soil samples.

Recoveries of a post-digestion spike or a laboratory control sample (LCS) are used to verify that the analytical methodology is acceptable and that MS recoveries are due to matrix effects. An MSD analysis is performed to evaluate the precision of the sample results. Precision is measured as the relative percent difference (RPD) between analytical results for duplicate samples. The laboratory's failure to produce similar results for MSD samples may indicate that the samples were non-homogeneous (particularly in soil samples), or that method defects may exist in the laboratory's techniques.

Recovery calculations are not required if the spiking concentration added is less than 25% of the sample background concentration.

MS/MSD recoveries outside QC limits (if applicable) are presented in Table 5a. MS/MSD and sample/MD, and serial dilution recovery precision outside of control limits are presented in Table 5b. Serial dilution recovery precision outside of control limits are presented in Table 5c.

REVIEW RESULTS

The MS sample analyses were performed on multiple samples at the required frequency. Matrix spike recoveries were within the control limits generated by the laboratory with the following exceptions:

- The MS recovery for total arsenic by EPA 6010C was above laboratory control limits of 75% to 125% for SDG K1709908. The arsenic results for that sample was J- qualified as low biased estimates. Since the SDGs had a second MS sample, which was in control, only the spiked sample was qualified.
- The MS recovery for total arsenic by EPA 6010C was above laboratory control limits of 75% to 125% for SDG K1709904. The arsenic results for that sample was J- qualified as low biased estimates. Samples in this SDG were J- qualified since the accuracy of the replicate sample was also out of control.

The accuracy of replicate samples based on recoveries were within the control limits generated by the laboratory with the following exceptions:

- The replicate RPDs for all the total arsenic replicates in SDG K1709904 were above laboratory control limits. The arsenic concentration in all associated samples were qualified as estimated "J."
- The replicate RPD for one of two replicates in SDG K1709907, 1709908 and 1709898, were above laboratory control limits. The arsenic concentration in

samples 17MP113SB28, 17MP111SB18.4, and 17MP111SB28 were qualified as estimated "J."

The accuracy of ICP serial dilution recoveries were within the control limits generated by the laboratory for all SDGs.

3.5 LABORATORY CONTROL SAMPLE ANALYSIS

The LCS is analyzed to monitor the efficiency of the digestion/extraction procedure and analytical instrument operation. The ability of the laboratory to successfully analyze an LCS demonstrates that there are no analytical problems related to the digestion/sample preparation procedures and/or instrument operations. The LCS results outside QC limits are presented in Table 6 (if applicable). Sporadic and marginal QC failures for multiple component methods do not indicate an analytical concern. If recoveries are high and the compounds are not detected in the samples, then no data qualification is required. All recoveries should be above 10% or the non-detect results flagged “UR” as rejected.

REVIEW RESULTS

All LCS analyses were within control limits and performed at the required frequency for all method.

3.6 COMPOUND IDENTIFICATION AND QUANTITATION

Compound identities are assigned by comparing sample compound retention times to retention times from known (standard) compounds and identification of an acceptable mass spectrum. Compounds detected below the PQL in samples should be considered estimated and are qualified "J." The samples with compounds above the linear range were all re-analyzed at a higher dilution factor.

REVIEW RESULTS

All compound identification and quantitation criteria were achieved. As noted in Table 7, no samples were reanalyzed.

4. FIELD DUPLICATE SAMPLE RESULTS

Field duplicate samples were collected and analyzed as an indication of overall precision for both field and laboratory. Field duplicate results are summarized in Table 8 (if applicable). The results are expected to have more variability than laboratory duplicates, which measure only laboratory precision. It is expected also that soil field duplicates will exhibit greater variance than water field duplicates due to the difficulties associated with collecting identical field samples. The QC criteria used to assess field duplicate samples for this project was limits of 70% RPD for soils and 40% RPD for waters, or twice the general laboratory duplicate criteria. If a given compound in both the regular sample and associated field duplicate sample was below the laboratory PQL, or the compound was not detected in one of the samples, then the compound is generally not qualified due to field duplicate precision. There are no guidelines regarding data qualification based on poor field duplicate precision. Professional judgment was used to determine whether or not to qualify results.

REVIEW RESULTS

Ten field duplicates analyses were performed on these SDGs. The RPD ratings are listed on Tables 8a through 8g as “Good” if the RPD is less than field duplicate QC criteria of 70% and as “Poor” if the RPD exceeded the field duplicate QC criteria.

All the results show good precision in the sample pairs with the exception of sample pair 17MP113SB24 and 17MP113SB55 as noted on Table 8f. Qualifiers were only added to the field duplicate sample pair results as noted.

It should be noted that 10 field duplicates were collected for the 130 samples, which did not meet the 10% requirement for field duplicates as required by the sampling plan.

5. OVERALL ASSESSMENT OF DATA

All data were reviewed and considered usable with qualification as noted in this report. All non-detect results were reported as “U” qualified at the PQL except where noted based upon blank contamination. All reported data at concentration less than the PQL were J qualified as estimated.

Table 1 - Sample Listing

Work Order	Matrix	Sample ID	Lab ID	Sample Date	QA/QC	Analysis
K1709898	Soil	17MP107SB04	K1709898-001	9/14/17		6010C for arsenic, TCLP for arsenic
K1709898	Soil	17MP107SB08	K1709898-002	9/14/17		6010C for arsenic, TCLP for arsenic
K1709898	Soil	17MP107SB12	K1709898-003	9/14/17		6010C for arsenic, TCLP for arsenic
K1709898	Soil	17MP107SB20	K1709898-004	9/14/17	MS/MSD	6010C for arsenic, TCLP for arsenic
K1709898	Soil	17MP107SB24	K1709898-005	9/14/17		6010C for arsenic, TCLP for arsenic
K1709898	Soil	17MP107SB56	K1709898-006	9/14/17	FD of 17MP107SB16	6010C for arsenic, TCLP for arsenic
K1709898	Soil	17MP107SB28	K1709898-007	9/14/17	Listed as 17MP107SB57	6010C for arsenic, TCLP for arsenic
K1709898	Soil	17MP108SB04	K1709898-008	9/14/17		6010C for arsenic, TCLP for arsenic
K1709898	Soil	17MP108SB08	K1709898-009	9/14/17		6010C for arsenic, TCLP for arsenic
K1709898	Soil	17MP108SB12	K1709898-010	9/14/17		6010C for arsenic, TCLP for arsenic
K1709898	Soil	17MP108SB16	K1709898-011	9/14/17	MS/MSD	6010C for arsenic, TCLP for arsenic
K1709898	Soil	17MP108SB20	K1709898-012	9/14/17		6010C for arsenic, TCLP for arsenic
K1709898	Soil	17MP108SB24	K1709898-013	9/14/17	FD of 17MP108SB58	6010C for arsenic, TCLP for arsenic
K1709898	Soil	17MP108SB28	K1709898-014	9/14/17		6010C for arsenic, TCLP for arsenic
K1709898	Soil	17MP108SB58	K1709898-015	9/14/17	FD of 17MP108SB24	6010C for arsenic, TCLP for arsenic
K1709898	Soil	17MP108SB59	K1709898-016	9/14/17		6010C for arsenic, TCLP for arsenic
K1709898	Soil	17MP107SB16	K1709898-017	9/14/17	FD of 17MP107SB56	6010C for arsenic, TCLP for arsenic
K1709904	Soil	17MP111SB04	K1709904-001	9/12/17		6010C for arsenic, TCLP for arsenic
K1709904	Soil	17MP111SB08	K1709904-002	9/12/17		6010C for arsenic, TCLP for arsenic
K1709904	Soil	17MP111SB12	K1709904-003	9/12/17		6010C for arsenic, TCLP for arsenic
K1709904	Soil	17MP111SB16	K1709904-004	9/12/17	FD of 17MP111SB53	6010C for arsenic, TCLP for arsenic
K1709904	Soil	17MP111SB18.4	K1709904-005	9/12/17	MS/MSD	6010C for arsenic, TCLP for arsenic
K1709904	Soil	17MP111SB53	K1709904-006	9/12/17	FD of 17MP111SB16	6010C for arsenic, TCLP for arsenic
K1709904	Soil	17MP112SB04	K1709904-007	9/10/17		6010C for arsenic, TCLP for arsenic
K1709904	Soil	17MP112SB08	K1709904-008	9/10/17		6010C for arsenic, TCLP for arsenic

Table 1 - Sample Listing

Work Order	Matrix	Sample ID	Lab ID	Sample Date	QA/QC	Analysis
K1709904	Soil	17MP112SB12	K1709904-009	9/10/17		6010C for arsenic, TCLP for arsenic
K1709904	Soil	17MP112SB16	K1709904-010	9/10/17		6010C for arsenic, TCLP for arsenic
K1709904	Soil	17MP112SB20	K1709904-011	9/10/17		6010C for arsenic, TCLP for arsenic
K1709904	Soil	17MP115SB04	K1709904-012	9/8/17		6010C for arsenic, TCLP for arsenic
K1709904	Soil	17MP115SB08	K1709904-013	9/8/17	FD of 17MP115SB51	6010C for arsenic, TCLP for arsenic
K1709904	Soil	17MP115SB12	K1709904-014	9/8/17		6010C for arsenic, TCLP for arsenic
K1709904	Soil	17MP115SB16	K1709904-015	9/8/17		6010C for arsenic, TCLP for arsenic
K1709904	Soil	17MP115SB20	K1709904-016	9/8/17		6010C for arsenic, TCLP for arsenic
K1709904	Soil	17MP115SB21.1	K1709904-017	9/8/17		6010C for arsenic, TCLP for arsenic
K1709904	Soil	17MP115SB51	K1709904-018	9/8/17	FD of 17MP115SB08	6010C for arsenic, TCLP for arsenic
K1709904	Soil	17MP116SB04	K1709904-019	9/8/17		6010C for arsenic, TCLP for arsenic
K1709904	Soil	17MP116SB08	K1709904-020	9/8/17		6010C for arsenic, TCLP for arsenic
K1709904	Soil	17MP116SB12	K1709904-021	9/8/17		6010C for arsenic, TCLP for arsenic
K1709904	Soil	17MP116SB16	K1709904-022	9/8/17		6010C for arsenic, TCLP for arsenic
K1709904	Soil	17MP116SB20	K1709904-023	9/8/17		6010C for arsenic, TCLP for arsenic
K1709904	Soil	17MP116SB22.2	K1709904-024	9/8/17		6010C for arsenic, TCLP for arsenic
K1709904	Soil	17MP121SB04	K1709904-025	9/8/17		6010C for arsenic, TCLP for arsenic
K1709904	Soil	17MP121SB08	K1709904-026	9/8/17		6010C for arsenic, TCLP for arsenic
K1709904	Soil	17MP121SB12	K1709904-027	9/8/17	FD of 17MP121SB52	6010C for arsenic, TCLP for arsenic
K1709904	Soil	17MP121SB52	K1709904-028	9/8/17	FD of 17MP121SB12	6010C for arsenic, TCLP for arsenic
K1709907	Soil	17MP102SB04	K1709907-001	9/11/17		6010C for arsenic, TCLP for arsenic
K1709907	Soil	17MP102SB08	K1709907-002	9/11/17		6010C for arsenic, TCLP for arsenic
K1709907	Soil	17MP102SB12	K1709907-003	9/11/17		6010C for arsenic, TCLP for arsenic
K1709907	Soil	17MP102SB16	K1709907-004	9/11/17		6010C for arsenic, TCLP for arsenic
K1709907	Soil	17MP113SB04	K1709907-005	9/10/17		6010C for arsenic, TCLP for arsenic

Table 1 - Sample Listing

Work Order	Matrix	Sample ID	Lab ID	Sample Date	QA/QC	Analysis
K1709907	Soil	17MP113SB08	K1709907-006	9/10/17		6010C for arsenic, TCLP for arsenic
K1709907	Soil	17MP113SB12	K1709907-007	9/10/17		6010C for arsenic, TCLP for arsenic
K1709907	Soil	17MP113SB16	K1709907-008	9/10/17		6010C for arsenic, TCLP for arsenic
K1709907	Soil	17MP113SB20	K1709907-009	9/10/17		6010C for arsenic, TCLP for arsenic
K1709907	Soil	17MP113SB24	K1709907-010	9/10/17	FD of 17MP113SB55	6010C for arsenic, TCLP for arsenic
K1709907	Soil	17MP113SB28	K1709907-011	9/10/17	MS/MSD	6010C for arsenic, TCLP for arsenic
K1709907	Soil	17MP113SB29	K1709907-012	9/10/17		6010C for arsenic, TCLP for arsenic
K1709907	Soil	17MP113SB55	K1709907-013	9/10/17	FD of 17MP113SB24	6010C for arsenic, TCLP for arsenic
K1709907	Soil	17MP117SB04	K1709907-014	9/6/17		6010C for arsenic, TCLP for arsenic
K1709907	Soil	17MP117SB08	K1709907-015	9/6/17		6010C for arsenic, TCLP for arsenic
K1709907	Soil	17MP117SB12	K1709907-016	9/6/17		6010C for arsenic, TCLP for arsenic
K1709907	Soil	17MP117SB16	K1709907-017	9/6/17		6010C for arsenic, TCLP for arsenic
K1709907	Soil	17MP117SB20	K1709907-018	9/6/17		6010C for arsenic, TCLP for arsenic
K1709907	Soil	17MP117SB24	K1709907-019	9/6/17		6010C for arsenic, TCLP for arsenic
K1709907	Soil	17MP117SB28	K1709907-020	9/6/17		6010C for arsenic, TCLP for arsenic
K1709907	Soil	17MP117SB32	K1709907-021	9/6/17		6010C for arsenic, TCLP for arsenic
K1709907	Soil	17MP120SB04	K1709907-022	9/7/17	FD of 17MP120SB50	6010C for arsenic, TCLP for arsenic
K1709907	Soil	17MP120SB08	K1709907-023	9/7/17		6010C for arsenic, TCLP for arsenic
K1709907	Soil	17MP120SB12	K1709907-024	9/8/17		6010C for arsenic, TCLP for arsenic
K1709907	Soil	17MP120SB16	K1709907-025	9/8/17		6010C for arsenic, TCLP for arsenic
K1709907	Soil	17MP120SB18.3	K1709907-026	9/8/17		6010C for arsenic, TCLP for arsenic
K1709907	Soil	17MP120SB50	K1709907-027	9/7/17	FD of 17MP120SB04	6010C for arsenic, TCLP for arsenic
K1709908	Soil	17MP103SB04	K1709908-001	9/11/17		6010C for arsenic, TCLP for arsenic
K1709908	Soil	17MP103SB08	K1709908-002	9/11/17		6010C for arsenic, TCLP for arsenic
K1709908	Soil	17MP103SB12	K1709908-003	9/11/17		6010C for arsenic, TCLP for arsenic

Table 1 - Sample Listing

Work Order	Matrix	Sample ID	Lab ID	Sample Date	QA/QC	Analysis
K1709908	Soil	17MP103SB16	K1709908-004	9/11/17		6010C for arsenic, TCLP for arsenic
K1709908	Soil	17MP103SB18.4	K1709908-005	9/11/17		6010C for arsenic, TCLP for arsenic
K1709908	Soil	17MP104SB04	K1709908-006	9/11/17		6010C for arsenic, TCLP for arsenic
K1709908	Soil	17MP104SB08	K1709908-007	9/11/17		6010C for arsenic, TCLP for arsenic
K1709908	Soil	17MP104SB12	K1709908-008	9/11/17		6010C for arsenic, TCLP for arsenic
K1709908	Soil	17MP104SB16	K1709908-009	9/11/17		6010C for arsenic, TCLP for arsenic
K1709908	Soil	17MP104SB20	K1709908-010	9/11/17		6010C for arsenic, TCLP for arsenic
K1709908	Soil	17MP104SB24	K1709908-011	9/11/17		6010C for arsenic, TCLP for arsenic
K1709908	Soil	17MP104SB28	K1709908-012	9/11/17	MS/MSD	6010C for arsenic, TCLP for arsenic
K1709908	Soil	17MP104SB29.5	K1709908-013	9/11/17		6010C for arsenic, TCLP for arsenic
K1709908	Soil	17MP106SB04	K1709908-014	9/11/17		6010C for arsenic, TCLP for arsenic
K1709908	Soil	17MP106SB08	K1709908-015	9/11/17		6010C for arsenic, TCLP for arsenic
K1709908	Soil	17MP106SB12	K1709908-016	9/11/17		6010C for arsenic, TCLP for arsenic
K1709908	Soil	17MP109SB54	K1709908-017	9/12/17	FD of 17MP109SB24	6010C for arsenic, TCLP for arsenic
K1709908	Soil	17MP114SB04	K1709908-018	9/8/17		6010C for arsenic, TCLP for arsenic
K1709908	Soil	17MP114SB08	K1709908-019	9/8/17		6010C for arsenic, TCLP for arsenic
K1709908	Soil	17MP114SB12	K1709908-020	9/8/17		6010C for arsenic, TCLP for arsenic
K1709908	Soil	17MP114SB16	K1709908-021	9/8/17		6010C for arsenic, TCLP for arsenic
K1709908	Soil	17MP114SB20	K1709908-022	9/8/17	MS/MSD	6010C for arsenic, TCLP for arsenic
K1709908	Soil	17MP114SB21.2	K1709908-023	9/8/17		6010C for arsenic, TCLP for arsenic
K1709908	Soil	17MP109SB04	K1709908-024	9/12/17		6010C for arsenic, TCLP for arsenic
K1709908	Soil	17MP109SB08	K1709908-025	9/12/17		6010C for arsenic, TCLP for arsenic
K1709908	Soil	17MP109SB12	K1709908-026	9/12/17		6010C for arsenic, TCLP for arsenic
K1709908	Soil	17MP109SB16	K1709908-027	9/12/17		6010C for arsenic, TCLP for arsenic
K1709908	Soil	17MP109SB20	K1709908-028	9/12/17		6010C for arsenic, TCLP for arsenic

Table 1 - Sample Listing

Work Order	Matrix	Sample ID	Lab ID	Sample Date	QA/QC	Analysis
K1709904	Soil	17MP109SB24	K1709904-029	9/8/17	FD of 17MP109SB54	6010C for arsenic, TCLP for arsenic
K1709904	Soil	17MP109SB25.5	K1709904-030	9/8/17		6010C for arsenic, TCLP for arsenic
K1709912	Soil	17MP110SB08	K1709912-001	9/12/17		6010C for arsenic, TCLP for arsenic
K1709912	Soil	17MP110SB12	K1709912-002	9/12/17		6010C for arsenic, TCLP for arsenic
K1709912	Soil	17MP110SB16	K1709912-003	9/12/17		6010C for arsenic, TCLP for arsenic
K1709912	Soil	17MP110SB20	K1709912-004	9/12/17		6010C for arsenic, TCLP for arsenic
K1709912	Soil	17MP105SB04	K1709912-005	9/10/17		6010C for arsenic, TCLP for arsenic
K1709912	Soil	17MP105SB08	K1709912-006	9/10/17		6010C for arsenic, TCLP for arsenic
K1709912	Soil	17MP105SB12	K1709912-007	9/10/17		6010C for arsenic, TCLP for arsenic
K1709912	Soil	17MP105SB16	K1709912-008	9/10/17		6010C for arsenic, TCLP for arsenic
K1709912	Soil	17MP105SB20	K1709912-009	9/10/17	FD of 17MP105SB53	6010C for arsenic, TCLP for arsenic
K1709912	Soil	17MP105SB24	K1709912-010	9/10/17		6010C for arsenic, TCLP for arsenic
K1709912	Soil	17MP105SB28	K1709912-011	9/10/17	MS/MSD	6010C for arsenic, TCLP for arsenic
K1709912	Soil	17MP105SB53	K1709912-012	9/10/17	FD of 17MP105SB20	6010C for arsenic, TCLP for arsenic
K1709912	Soil	17MP118SB04	K1709912-013	9/7/17		6010C for arsenic, TCLP for arsenic
K1709912	Soil	17MP118SB08	K1709912-014	9/7/17		6010C for arsenic, TCLP for arsenic
K1709912	Soil	17MP118SB12	K1709912-015	9/7/17		6010C for arsenic, TCLP for arsenic
K1709912	Soil	17MP118SB16	K1709912-016	9/7/17		6010C for arsenic, TCLP for arsenic
K1709912	Soil	17MP118SB20	K1709912-017	9/7/17		6010C for arsenic, TCLP for arsenic
K1709912	Soil	17MP118SB24	K1709912-018	9/7/17		6010C for arsenic, TCLP for arsenic
K1709912	Soil	17MP118SB26	K1709912-019	9/7/17		6010C for arsenic, TCLP for arsenic
K1709912	Soil	17MP119SB04	K1709912-020	9/7/17		6010C for arsenic, TCLP for arsenic
K1709912	Soil	17MP119SB08	K1709912-021	9/7/17		6010C for arsenic, TCLP for arsenic
K1709912	Soil	17MP119SB12	K1709912-022	9/7/17		6010C for arsenic, TCLP for arsenic
K1709912	Soil	17MP119SB16	K1709912-023	9/7/17		6010C for arsenic, TCLP for arsenic

Table 1 - Sample Listing

Work Order	Matrix	Sample ID	Lab ID	Sample Date	QA/QC	Analysis
K1709912	Soil	17MP119SB20	K1709912-024	9/7/17		6010C for arsenic, TCLP for arsenic
K1709912	Soil	17MP119SB24	K1709912-025	9/7/17		6010C for arsenic, TCLP for arsenic
K1709912	Soil	17MP119SB27	K1709912-026	9/7/17	FD of 7MP119SB49	6010C for arsenic, TCLP for arsenic
K1709912	Soil	17MP119SB49	K1709912-027	9/7/17	FD of 17MP119SB27	6010C for arsenic, TCLP for arsenic
K1709912	Soil	17MP110SB04	K1709912-028	9/12/17		6010C for arsenic, TCLP for arsenic
K1710523	Soil	0917RS02SB	K1710523-001	9/15/17	Rinsate Blank	6010C for arsenic, TCLP for arsenic
K1710523	Soil	0917RS03SB	K1710523-002	9/15/17	Rinsate Blank	6010C for arsenic, TCLP for arsenic
K1710523	Soil	0917RS04SB	K1710523-003	9/15/17	Rinsate Blank	6010C for arsenic, TCLP for arsenic
K1710523	Soil	0917RS05SB	K1710523-004	9/15/17	Rinsate Blank	6010C for arsenic, TCLP for arsenic
K1710523	Soil	0917RS06SB	K1710523-005	9/15/17	Rinsate Blank	6010C for arsenic, TCLP for arsenic
K1710523	Soil	0917RS07SB	K1710523-006	9/15/17	Rinsate Blank	6010C for arsenic, TCLP for arsenic
K1710523	Soil	0917EB02SB	K1710523-007	9/15/17	Equipment blank	6010C for arsenic, TCLP for arsenic
Notes: Rinsate Blank =Collected from Macro-core cutting shoe. Equipment blank =Collected from Macro-core liner. FD = Field Duplicate						

Table 2 - List of Samples Qualified for Holding Time Exceedance

Method	Analyte	Sample IDs	HT	Sampling Date	Analysis Date	Qual
None						

Table 3a - List of Positive Results for Blank Samples

Method	Sample ID	Sample Type	Analyte	Result	Analysis Type	Units	PQL
	None						

Table 3b - List of Samples Qualified for Method Blank Contamination

Method	Sample ID	Analyte	Blank Result	Sample Result	Sample Qual	Units	PQL
	None						

Table 3c - List of Samples Qualified for Equipment or Rinsate Blank Contamination

Method	Sample ID	Analyte	Blank Result	Sample Result	Sample Qual	Units	PQL
	None						

Table 4 - List of Samples with Surrogates outside Control Limits

Method	Sample ID	Sample Type	Analyte	Rec.	Low Limit	High Limit	Dil Fac	Sample Qual.
	None							

Table 5a - List of Matrix Spike Recoveries outside Control Limits

Method	Sample ID	Sample Type	Analyte	Orig. Result	Spike Amount	Rec.	Dil Fac.	Low Limit	High Limit	Sample Qual
EPA 6010C	17MP114SB20	Soil	Total Arsenic	83	93.4	44	1.0	75	125	J-
EPA 6010C	17MP111SB18.4	Soil	Total Arsenic	64.2	112	73	1.0	75	125	J-

Table 5b - List of Replicate RPDs outside Control Limits

Sample ID	Analyte	Method	RPD	RPD Limit	No. of Affected Samples	Samp Qual
17MP114SB20	Total Arsenic	EPA 6010C	37	20	1	J
17MP107SB20	Total Arsenic	EPA 6010C	23	20	1	J
17MP113SB28	Total Arsenic	EPA 6010C	37	20	1	J
17MP111SB18.4	Total Arsenic	EPA 6010C	39	20	28	J

Table 5c - List of Serial Dilution Percent Recovery outside Control Limits

Sample ID	Analyte	Method	%D	%D Limit	No. of Affected Samples	Samp Qual
None						

Table 6 - List of LCS Recoveries outside Control Limits

Method	Sample ID	Analyte	%Rec.	Low Limit	High Limit	No. of Affected Samples	Samp Qual
	None						

Table 7 - Samples that Were Re-analyzed

Sample ID	Lab ID	Method	Sample Type	Action
None				

Table 8a - Summary of Field Duplicate Results

Method	Analyte	Units	17MP107SB16	17MP107SB56	RPD	Rating	Sample Qualifier
EPA 6010C	Total Arsenic	mg/kg	2,390	2,430	1.7%	Good	None
EPA 6010C	TCLP Arsenic	mg/L	2.44	2.42	8.2%	Good	None
TCLP = Toxicity Characteristic Leaching Procedure							

Table 8b - Summary of Field Duplicate Results

Method	Analyte	Units	17MP108SB24	17MP108SB58	RPD	Rating	Sample Qualifier
EPA 6010C	Total Arsenic	mg/kg	3,440	3,540	2.9%	Good	None
EPA 6010C	TCLP Arsenic	mg/L	13.6	12.0	13%	Good	None
TCLP = Toxicity Characteristic Leaching Procedure							

Table 8c - Summary of Field Duplicate Results

Method	Analyte	Units	17MP111SB16	17MP111SB53	RPD	Rating	Sample Qualifier
EPA 6010C	Total Arsenic	mg/kg	41.9 J	43.7 J	4.2%	Good	None
EPA 6010C	TCLP Arsenic	mg/L	0.05U	0.05U	0%	Good	None
TCLP = Toxicity Characteristic Leaching Procedure							

Table 8d - Summary of Field Duplicate Results

Method	Analyte	Units	17MP115SB08	17MP115SB51	RPD	Rating	Sample Qualifier
EPA 6010C	Total Arsenic	mg/kg	3,680 J	2,760 J	29%	Good	None
EPA 6010C	TCLP Arsenic	mg/L	5.76	4.51	24%	Good	None
TCLP = Toxicity Characteristic Leaching Procedure							

Table 8e - Summary of Field Duplicate Results

Method	Analyte	Units	17MP121SB12	17MP121SB52	RPD	Rating	Sample Qualifier
EPA 6010C	Total Arsenic	mg/kg	249 J	374 J	40%	Good	None
EPA 6010C	TCLP Arsenic	mg/L	0.168	0.160	4.9%	Good	None
TCLP = Toxicity Characteristic Leaching Procedure							

Table 8f - Summary of Field Duplicate Results

Method	Analyte	Units	17MP113SB24	17MP113SB55	RPD	Rating	Sample Qualifier
EPA 6010C	Total Arsenic	mg/kg	411	950	79%	Poor	J
EPA 6010C	TCLP Arsenic	mg/L	1.05	1.23	16%	Good	None
TCLP = Toxicity Characteristic Leaching Procedure							

Table 8g - Summary of Field Duplicate Results

Method	Analyte	Units	17MP120SB04	17MP120SB50	RPD	Rating	Sample Qualifier
EPA 6010C	Total Arsenic	mg/kg	3,110	3,170	1.9%	Good	None
EPA 6010C	TCLP Arsenic	mg/L	3.03	3.09	2.0%	Good	None
TCLP = Toxicity Characteristic Leaching Procedure							

Table 8h - Summary of Field Duplicate Results

Method	Analyte	Units	17MP109SB24	17MP109SB54	RPD	Rating	Sample Qualifier
EPA 6010C	Total Arsenic	mg/kg	186	146	24%	Good	None
EPA 6010C	TCLP Arsenic	mg/L	0.05 U	0.05 U	0.0%	Good	None
TCLP = Toxicity Characteristic Leaching Procedure							

Table 8i – Summary of Field Duplicate Results

Method	Analyte	Units	17MP105SB20	17MP105SB53	RPD	Rating	Sample Qualifier
EPA 6010C	Total Arsenic	mg/kg	114	109	4.5%	Good	None
EPA 6010C	TCLP Arsenic	mg/L	0.05 U	0.05 U	0.0%	Good	None
TCLP = Toxicity Characteristic Leaching Procedure							

Table 8j – Summary of Field Duplicate Results

Method	Analyte	Units	17MP119SB27	17MP119SB49	RPD	Rating	Sample Qualifier
EPA 6010C	Total Arsenic	mg/kg	148	136	8.5%	Good	None
EPA 6010C	TCLP Arsenic	mg/L	0.05 U	0.05 U	0.0%	Good	None
TCLP = Toxicity Characteristic Leaching Procedure							

DATA REVIEW MEMORANDUM

DATE: July 25, 2018

TO: Jonathan Reeve, Project Manager, E & E, Seattle, WA

FROM: Howard Edwards, E & E, San Francisco, CA

SUBJ: Data Review: Red Devil Mine 2018 Spring Baseline

REFERENCE:

Project ID	Lab Work Order	Lab
1001095.0009.05	EEI-SA1601	Brooks Applied Labs – Seattle

Validated data is attached to the end of this memorandum.

1. SAMPLE IDENTIFICATION

For the sampling activities at Red Devil Mine, Ecology and Environment, Inc. (E & E) collected the samples listed in Table 1. Project-specific matrix spike/matrix spike duplicates (MS/MSD) were designated in the field. All samples were sent to Brooks Applied Labs in Seattle, Washington for all analyses. This report addresses only Brooks Applied Labs generated data.

The analytical report was issued by Brooks Applied Labs on July 4, 2018. The data in the analytical report were reviewed for field and laboratory precision, accuracy, and completeness in accordance with procedures and quality control (QC) limits, the current laboratory Quality Assurance Manual (QAM) and current standard operating procedures (SOPs). Any additional data review qualifiers added are noted below and listed on the tables at the end of this memorandum. Definitions of all data qualifiers are given in the report.

Work Orders, Tests, and Number of Samples Included in this Data Review Memo

Work Orders/ Job Number	Matrix	Test Method	Method Name	Number of Samples
EEI-SA1601	Surface Water	EPA 1631	Total Low-Level Mercury (CVAFS)	8
EEI-SA1601	Surface Water	EPA 1631	Dissolved Low-Level Mercury (CVAFS)	8
EEI-SA1601	Ground Water	EPA 1631	Total Low-Level Mercury (CVAFS)	22
EEI-SA1601	Ground Water	EPA 1631	Dissolved Low-Level Mercury (CVAFS)	22
EEI-SA1601	Rinse Blank	EPA 1631	Total Low-Level Mercury (CVAFS)	2
EEI-SA1601	Rinse Blank	EPA 1631	Dissolved Low-Level Mercury (CVAFS)	2
EEI-SA1601	Trip Blank	EPA 1631	Total Low-Level Mercury (CVAFS)	4
EEI-SA1601	Field Blank	EPA 1631	Dissolved Low-Level Mercury (CVAFS)	7

2. SAMPLE PROCEDURES

All samples were collected as specified in the work plan and documented on the chain-of-custody (COC) and in field notebooks. Samples were analyzed as specified on the COC. Samples were packaged, shipped, and received as specified in the work plan. All samples for organic analyses must be received cold (4 ±2 degrees Celsius [°C]) and in good condition as documented on the Cooler Receipt Form.

REVIEW RESULTS

All sample procedures were followed and the sample coolers were received by the laboratory at 17.9°C. Since the samples were acidified in the field, the Field Sampling Plan specification indicating a 4 ±2°C requirement, is not necessary since the temperature specified in the Field Sampling Plan is not a method requirement. As a result and the temperature of the received samples did not result in qualification of data.

3. LABORATORY DATA

3.1 HOLDING TIMES

Holding times are established and monitored to ensure analytical results accurately represent analyte concentrations in a sample at the time of collection. These qualified results based upon missed holding times are presented in Table 2 (if applicable). Exceeding the holding time for a sample generally results in a loss of the analyte due to a variety of mechanisms, such as deposition on the sample container walls or precipitation.

REVIEW RESULTS

All samples were analyzed within the method holding time with the exception of a rinsate blank QA sample that was filter by the lab after the sample holding time for filtration. The associated data was "J" qualified.

3.2 BLANKS

All laboratory blanks are integrated into the method and all results are corrected for blank values provided that the laboratory blank values are within method-set limits. When blanks are outside of the method limits, associated samples are reanalyzed. Method blanks are shown in Table 3a. No data was qualified due to laboratory method blanks (see Table 3b).

Field blank and rinsate blank samples are analyzed and evaluated to determine the existence and magnitude of possible contamination during the sampling and analysis process. All field blanks with reported results are also presented in Table 3a (if applicable). If the mercury is present in the sample at similar trace levels (less than five times the blank concentration), then the analyte is likely a common background contaminant from some phase of the sampling, extraction, or analytical procedure and associated low-level sample concentrations are not considered to be site related. Sample results in these cases are qualified as not-detected, "U".

REVIEW RESULTS

All laboratory (method) were performed at the required frequencies. As noted in Table 3a, the mercury concentrations in the method blanks were below the practical quantitation limit (PQL). As indicated in Table 3b, no samples were qualified based on laboratory blanks. Field blanks were performed at the required frequency. All field blanks were reported at a concentration above the detection limit but below the quantitation limit. All associated reported concentrations of mercury in samples that were less than five times the concentration found in their associated field blank were “U” qualified as not-detected. A total of seven samples were “U” qualified based on the field blanks.

Two sets of equipment rinsate blanks (filtered and unfiltered) for the bladder pump were collected. The rinsate blank on May 20, 2018 was found to contain both dissolved mercury (2.29 J nanograms per liter [ng/L]) and total mercury (154 ng/L) at a concentration above the method reporting limit. The 5/20/2018 rinsate blank was reanalyzed several times for total mercury, with the re-analyses supporting the initial reported concentration. All associated sample results that were detected at levels less than five times the blank were “U” qualified as not-detected. A total of six total mercury samples and one dissolved mercury samples were “U” qualified as not-detected.

The rinsate blank on May 24, 2018 was found to contain total mercury (5.35 ng/L) at a concentration above the method reporting limit. Dissolved mercury (0.17 ng/L) was below the method reporting limit. All associated samples with detections had mercury detections greater than five times the rinsate blank and therefor no additional “U” qualification were needed due to this rinsate blank.

A summary of qualified data due to equipment rinsate blank contamination is also presented in Table 3c.

3.3 MATRIX SPIKE AND MATRIX SPIKE DUPLICATE ANALYSIS

The MS/MSD analyses are intended to provide information about the effects that the sample matrix exerts on the digestion/extraction and measurement methodology. MS recovery values that do not meet laboratory QC criteria may indicate that sample analyte results are being attenuated in the analysis procedure. The potential sample bias may be estimated by noting the degree to which the MS concentration was elevated or lowered in the spike analysis. However, this estimated bias should serve only as an approximation; sample-specific problems may be the cause of the discrepancy, particularly in soil samples.

Recovery calculations are not required if the spiking concentration added is less than 25 percent of the sample background concentration.

REVIEW RESULTS

The MS/MSD sample analyses were performed on 9 of the 75 samples at the required frequency. All MS/MSD recoveries and accuracies were within the control limits and required no qualifications.

A summary of sample data qualified due to MS/MSD precision and accuracy are presented in Tables 5a and 5b (if applicable).

3.4 LABORATORY CONTROL SAMPLE ANALYSIS

The laboratory control sample (LCS) or Certified Reference Material standard is analyzed to monitor the efficiency of the digestion/extraction procedure and analytical instrument operation. The ability of the laboratory to successfully analyze an LCS or Certified Reference Material standard demonstrates that there are no analytical problems related to the digestion/sample preparation procedures and/or instrument operations. The LCS or Certified Reference Material standard results outside QC limits are presented in Table 6 (if applicable). Sporadic and marginal QC failures for multiple component methods do not indicate an analytical concern. If recoveries are high and the compounds are not detected in the samples, then no data qualification is required. All recoveries should be above 10 percent or the non-detect results flagged “UR” as rejected.

REVIEW RESULTS

The analysis of the Certified Reference Material Samples were within control limits.

3.5 COMPOUND IDENTIFICATION AND QUANTITATION

Compound identities are assigned by comparing sample compound retention times to retention times from known (standard) compounds and identification of an acceptable mass spectrum. Compounds detected below the PQL in samples should be considered estimated and are qualified "J." The samples with compounds above the linear range were all reanalyzed at a higher dilution factor.

REVIEW RESULTS

All compound identification and quantitation criteria were achieved and reported based upon the method. As noted in Table 7, three filtered samples were reported as being reanalyzed due to the initial analysis result being below the reporting limit. A larger aliquot of all three samples was re-analyzed with the re-analysis and reported. Also, as noted in Table 7, two unfiltered samples were reported as being reanalyzed due to the initial analysis concentration exceeding the calibration range. A smaller aliquot of all three samples were reanalyzed with the reanalysis confirming the initial analysis concentrations.

The four field blank samples were reported as being reanalyzed due to the initial analysis results that yielded detectable concentration of mercury. The reanalysis confirms the initial results.

4. FIELD DUPLICATE SAMPLE RESULTS

Four field duplicate samples were collected and analyzed as an indication of overall precision for both field and laboratory. Field duplicate results are summarized in Tables 8a, 8b and 8c (if applicable). The results are expected to have more variability than laboratory duplicates, which measure only laboratory precision. It is expected also that soil field duplicates will exhibit greater variance than water field duplicates due to the difficulties associated with collecting identical field samples. The QC criteria used to assess field duplicate samples for this project was limits of 70 percent RPD for soils and 40 percent RPD for waters, or twice the general laboratory duplicate criteria. If a given compound in both the regular sample and associated field duplicate sample was below the laboratory PQL, or the compound was not detected in one of the samples, then the compound is generally not qualified due to field duplicate precision. There are no guidelines regarding data qualification based on poor field duplicate precision. Professional judgment was used to determine whether or not to qualify results.

REVIEW RESULTS

Three field duplicates analyses were performed on this Sample Delivery Group. The RPD ratings are listed on Tables 8a through 8c as “Good” if the RPD is less than field duplicate QC criteria of 40 percent and as “Poor” if the RPD exceeded the field duplicate QC criteria.

All results show good precision in the sample pair for both total and dissolved mercury.

5. OVERALL ASSESSMENT OF DATA

The data from several of the QA samples suggest the following:

- That there was a contamination problem associated with the collection of field sample as indicated by the daily field blanks collected in the field during the sampling event. Field blanks had mercury concentration that ranged from 0.17 to 0.4 ng/L, which raised the reporting limit to 0.85 to 2.0 ng/L.
- That there was an apparent equipment decontamination problem with the non-dedicated bladder pump that was used to collect some of the groundwater samples. The equipment rinsate blank water had an unfiltered total mercury concentration of 154 ng/L and filtered dissolved mercury concentration of 2.29 ng/L; since the associated ground water had a mercury range of 3.5 to 31.9 ng/L the elevated mercury indicates the potential for contamination of the bladder pump during the decontamination process. The bladder pump decontamination process and environmental setting should be further reviewed for future sampling and analysis for low-level mercury analysis using EPA Method 1631 to determine how the rinsate blank is becoming contaminated.

All data were reviewed and considered usable with qualification as noted in this report. All non-detect results were reported as “U” qualified at the PQL except where noted based upon blank contamination. All reported data at concentration less than the PQL were “J” qualified as estimated.

Table 1 - Sample Listing

Work Order	Matrix	Sample ID	Lab ID	Sample Date	QA/QC	Analysis
EE-IS-1601	Blank	0518FB06	1822005-01	5/23/2018	Field Blank	EPA 1631
EE-IS-1601	Blank	0518FB07	1822005-02	5/24/2018	Field Blank	EPA 1631
EE-IS-1601	GW	0518MW42GW	1822005-03	5/24/2018	MS/MSD	EPA 1631
EE-IS-1601	F-GW	0518MW42GW	1822005-04	5/24/2018		EPA 1631
EE-IS-1601	Blank	0518EB01	1822005-05	5/24/2018	Equipment Blank	EPA 1631
EE-IS-1601	Blank	0518EB01	1822005-06	5/24/2018	Equipment Blank	EPA 1631
EE-IS-1601	Blank	0518FB01	1822005-07	5/18/2018	Field Blank	EPA 1631
EE-IS-1601	Blank	0518FB02	1822005-08	5/19/2018	Field Blank	EPA 1631
EE-IS-1601	Blank	0518FB03	1822005-09	5/20/2018	Field Blank	EPA 1631
EE-IS-1601	Blank	0518FB04	1822005-10	5/21/2018	Field Blank	EPA 1631
EE-IS-1601	Blank	0518FB05	1822005-11	5/23/2018	Field Blank	EPA 1631
EE-IS-1601	GW	0518MW01GW	1822005-12	5/18/2018		EPA 1631
EE-IS-1601	F-GW	0518MW01GW	1822005-13	5/18/2018		EPA 1631
EE-IS-1601	GW	0518MW06GW	1822005-14	5/20/2018		EPA 1631
EE-IS-1601	F-GW	0518MW06GW	1822005-15	5/20/2018		EPA 1631
EE-IS-1601	GW	0518MW08GW	1822005-16	5/19/2018	MS/MSD and FD of 0518MW98GW	EPA 1631
EE-IS-1601	F-GW	0518MW08GW	1822005-17	5/19/2018	FD of 0518MW98GW	EPA 1631
EE-IS-1601	GW	0518MW09GW	1822005-18	5/22/2018		EPA 1631
EE-IS-1601	F-GW	0518MW09GW	1822005-19	5/22/2018		EPA 1631
EE-IS-1601	GW	0518MW100GW	1822005-20	5/21/2018	FD of 0518MW40GW	EPA 1631
EE-IS-1601	F-GW	0518MW100GW	1822005-21	5/21/2018	FD of 0518MW40GW	EPA 1631
EE-IS-1601	GW	0518MW10GW	1822005-22	5/22/2018		EPA 1631
EE-IS-1601	F-GW	0518MW10GW	1822005-23	5/22/2018		EPA 1631
EE-IS-1601	GW	0518MW16GW	1822005-24	5/21/2018	MS/MSD	EPA 1631
EE-IS-1601	F-GW	0518MW16GW	1822005-25	5/21/2018		EPA 1631
EE-IS-1601	GW	0518MW17GW	1822005-26	5/20/2018		EPA 1631
EE-IS-1601	F-GW	0518MW17GW	1822005-27	5/20/2018		EPA 1631
EE-IS-1601	GW	0518MW19GW	1822005-28	5/21/2018		EPA 1631
EE-IS-1601	F-GW	0518MW19GW	1822005-29	5/21/2018		EPA 1631
EE-IS-1601	GW	0518MW22GW	1822005-30	5/24/2018	MS/ MSD	EPA 1631
EE-IS-1601	F-GW	0518MW22GW	1822005-31	5/24/2018		EPA 1631
EE-IS-1601	GW	0518MW26GW	1822005-32	5/23/2018		EPA 1631
EE-IS-1601	F-GW	0518MW26GW	1822005-33	5/23/2018		EPA 1631
EE-IS-1601	GW	0518MW27GW	1822005-34	5/23/2018		EPA 1631
EE-IS-1601	F-GW	0518MW27GW	1822005-35	5/23/2018		EPA 1631
EE-IS-1601	GW	0518MW28GW	1822005-36	5/23/2018		EPA 1631
EE-IS-1601	F-GW	0518MW28GW	1822005-37	5/23/2018		EPA 1631
EE-IS-1601	GW	0518MW29GW	1822005-38	5/20/2018	MS/MSD	EPA 1631
EE-IS-1601	F-GW	0518MW29GW	1822005-39	5/20/2018		EPA 1631
EE-IS-1601	GW	0518MW31GW	1822005-40	5/19/2018		EPA 1631
EE-IS-1601	F-GW	0518MW31GW	1822005-41	5/19/2018		EPA 1631
EE-IS-1601	GW	0518MW32GW	1822005-42	5/19/2018	MS/MSD	EPA 1631
EE-IS-1601	F-GW	0518MW32GW	1822005-43	5/19/2018		EPA 1631
EE-IS-1601	GW	0518MW33GW	1822005-44	5/21/2018		EPA 1631
EE-IS-1601	F-GW	0518MW33GW	1822005-45	5/21/2018		EPA 1631

Table 1 - Sample Listing

Work Order	Matrix	Sample ID	Lab ID	Sample Date	QA/QC	Analysis
EE-IS-1601	GW	0518MW40GW	1822005-46	5/21/2018	FD of 0518MW100GW	EPA 1631
EE-IS-1601	F-GW	0518MW40GW	1822005-47	5/21/2018	FD of 0518MW100GW	EPA 1631
EE-IS-1601	GW	0518MW43GW	1822005-48	5/21/2018		EPA 1631
EE-IS-1601	F-GW	0518MW43GW	1822005-49	5/20/2018		EPA 1631
EE-IS-1601	GW	0518MW59GW	1822005-50	5/20/2018	MS/MSD	EPA 1631
EE-IS-1601	F-GW	0518MW59GW	1822005-51	5/20/2018		EPA 1631
EE-IS-1601	GW	0518MW98GW	1822005-52	5/19/2018	MS/MSD and FD of 0518MW8GW	EPA 1631
EE-IS-1601	F-GW	0518MW98GW	1822005-53	5/19/2018	FD of 0518MW8GW	EPA 1631
EE-IS-1601	SW	0518RD05SW	1822005-54	5/19/2018	MS/MSD	EPA 1631
EE-IS-1601	F-SW	0518RD05SW	1822005-55	5/19/2018		EPA 1631
EE-IS-1601	SW	0518RD06SW	1822005-56	5/19/2018		EPA 1631
EE-IS-1601	F-SW	0518RD06SW	1822005-57	5/19/2018		EPA 1631
EE-IS-1601	SW	0518RD08SW	1822005-58	5/19/2018		EPA 1631
EE-IS-1601	F-SW	0518RD08SW	1822005-59	5/19/2018		EPA 1631
EE-IS-1601	SW	0518RD09SW	1822005-60	5/19/2018		EPA 1631
EE-IS-1601	F-SW	0518RD09SW	1822005-61	5/19/2018		EPA 1631
EE-IS-1601	SW	0518RD100SW	1822005-62	5/19/2018	FD of 0518RD14SW	EPA 1631
EE-IS-1601	F-SW	0518RD100SW	1822005-63	5/19/2018	FD of 0518RD14SW	EPA 1631
EE-IS-1601	SW	0518RD10SW	1822005-64	5/19/2018		EPA 1631
EE-IS-1601	F-SW	0518RD10SW	1822005-65	5/19/2018		EPA 1631
EE-IS-1601	SW	0518RD14SW	1822005-66	5/19/2018	FD of 0518RD100SW	EPA 1631
EE-IS-1601	F-SW	0518RD14SW	1822005-67	5/19/2018	FD of 0518RD100SW	EPA 1631
EE-IS-1601	SW	0518RD15SW	1822005-68	5/19/2018		EPA 1631
EE-IS-1601	F-SW	0518RD15SW	1822005-69	5/19/2018		EPA 1631
EE-IS-1601	Blank	0518RS01	1822005-70	5/20/2018	Rinse Blank	EPA 1631
EE-IS-1601	Blank	0518RS01	1822005-71	5/20/2018	Rinse Blank	EPA 1631
EE-IS-1601	Blank	Trip Blank 1	1822005-72	unknown	Trip Blank	EPA 1631
EE-IS-1601	Blank	Trip Blank 2	1822005-73	unknown	Trip Blank	EPA 1631
EE-IS-1601	Blank	Trip Blank 3	1822005-74	unknown	Trip Blank	EPA 1631
EE-IS-1601	Blank	Trip Blank 4	1822005-75	unknown	Trip Blank	EPA 1631

F-SW = Filtered surface water
F-GW =Filtered ground water
FD = Field duplicate sample
SW = Surface water
GW = Ground water

Table 2 - List of Samples Qualified for Holding Time Exceedance

Method	Analyte	Sample IDs	HT	Sampling Date	Analysis Date	Qual
None						

Table 3a - List of Positive Results for Blank Samples

Method	Sample ID	Sample Type	Analyte	Result**	Analysis Type	Units	PQL
EPA1631	B181398-BLK1	AQ	Total mercury	0.05	MB	ng/L	0.40
EPA1631	B181398-BLK2	AQ	Total mercury	0.02	MB	ng/L	0.40
EPA1631	B181398--BLK3	AQ	Total mercury	0.06	MB	ng/L	0.40
EPA1631	B181398--BLK4	AQ	Total mercury	0.03	MB	ng/L	0.40
EPA1631	B181399-BLK1	AQ	Total mercury	0.10	MB	ng/L	0.40
EPA1631	B181399-BLK2	AQ	Total mercury	0.08	MB	ng/L	0.40
EPA1631	B181399-BLK3	AQ	Total mercury	0.07	MB	ng/L	0.40
EPA1631	B181399-BLK4	AQ	Total mercury	0.10	MB	ng/L	0.40
EPA1631	B181476-BLK1	AQ	Total mercury	0.07	MB	ng/L	0.40
EPA1631	B181476-BLK2	AQ	Total mercury	0.05	MB	ng/L	0.40
EPA1631	B181476-BLK3	AQ	Total mercury	0.08	MB	ng/L	0.40
EPA1631	B181476-BLK4	AQ	Total mercury	0.07	MB	ng/L	0.40
EPA1631	0518FB07	AQ	Total mercury	0.20 J	FB	ng/L	0.40
EPA1631	0518EB01	AQ	Total mercury	5.35	EB	ng/L	0.40
EPA1631	0518FB01	AQ	Total mercury	0.17 J	FB	ng/L	0.40
EPA1631	0518FB02	AQ	Total mercury	0.27 J	FB	ng/L	0.40
EPA1631	0518FB03	AQ	Total mercury	0.23 J	FB	ng/L	0.40
EPA1631	0518FB04	AQ	Total mercury	0.40	FB	ng/L	0.40
EPA1631	0518FB05	AQ	Total mercury	0.20 J	RB	ng/L	0.40
EPA1631	0518RS01	AQ	Total mercury	154	FB	ng/L	0.40
EPA1631	0518RS01	AQ	Dissolved mercury	2.29 J	FB	ng/L	0.40

Table 3b - List of Samples Qualified for Method Blank Contamination

Method	Sample ID	Analyte	Blank Result	Sample Result	Sample Qual	PQL
None *						

*EPA 1631 method monitors laboratory blank concentration and uses blank concentration to correct reported sample data. Detected values less than the quantitation limit are normal.
** Field blanks (FB) and Rinsate blank (RB) value are laboratory blank corrected.

Table 3c - List of Samples Qualified for Field or Equipment Rinsate Blank Contamination

Method	Sample ID	Analyte	Blank Result ng/L	Sample Result ng/L	Sample Qual	PQL ng/L
EPA 1631	0518MW40GW	Total Mercury	154	5.08	U	0.4
EPA 1631	0518MW100GW	Total Mercury	154	3.49	U	0.4
EPA 1631	0518MW29GW	Total Mercury	154	8.40	U	0.4
EPA1631	0518MW31GW	Total Mercury	154	15.7	U	0.4
EPA1631	0518MW43GW	Total Mercury	154	15.8	U	0.4
EPA1631	0518MW59GW	Total Mercury	154	10.5	U	0.4
EPA 1631	0518MW43GW	Dissolved Mercury	2.29 J	1.97	U	0.4
EPA1631	0518MW10GW	Dissolved Mercury	0.20	0.66	U	0.4
EPA1631	0518MW29GW	Dissolved Mercury	0.23	0.61	U	0.4
EPA 1631	0518MW31GW	Dissolved Mercury	0.27	0.80	U	0.4
EPA1631	0518MW100GW	Dissolved Mercury	0.40	0.66	U	0.4
EPA1631	0518MW59GW	Dissolved Mercury	0.23	0.27	U	0.4
EPA1631	0518MW40GW	Dissolved Mercury	0.40	0.79	U	0.4
EPA1631	0518MW19GW	Dissolved Mercury	0.40	0.63	U	0.4

Table 4 - List of Samples with Surrogates outside Control Limits

Method	Sample ID	Sample Type	Analyte	Rec.	Low Limit	High Limit	Dil Fac	Sample Qual.
None.								

Table 5a - List of MS/MSD Recoveries outside Control Limits

Method	Sample ID	Sample Type	Analyte	Orig. Result	Spike Amount	Rec.	Dil Fac.	Low Limit	High Limit	Sample Qual
None										

Table 5b - List of Lab and MS Duplicate RPDs outside Control Limits

Sample ID	Analyte	Method	RPD	RPD Limit	No. of Affected Samples	Samp Qual
None						

Table 6 - List of LCS Recoveries outside Control Limits

Method	Sample ID	Analyte	% Rec.	Low Limit	High Limit	No. of Affected Samples	Samp Qual
None							

Table 7 –Samples that were Re-analyzed

Sample ID	Lab ID	Method	Sample Type	Action
0518EB01	1822005-05	EPA1631	Equipment Blank	Re-analysis due to mercury detection in sample. Detection confirmed.
0518EB01	1822005-06	EPA1631	Filtered Equipment Blank	Re-analysis due to mercury detection in sample. Detection confirmed.
0518FB01	1822005-07	EPA1631	Field Blank	Re-analysis due to mercury detection in sample. Detection confirmed.
0518FB02	1822005-08	EPA1631	Field Blank	Re-analysis due to mercury detection in sample. Detection confirmed.
0518FB03	1822005-09	EPA1631	Field Blank	Re-analysis due to mercury detection in sample. Detection confirmed.
0518FB04	1822005-10	EPA1631	Field Blank	Re-analysis due to mercury detection in sample. Detection confirmed.
0518FB05	1822005-11	EPA1631	Field Blank	Re-analysis due to mercury detection in sample. Detection confirmed.
0518RD06SW	1822005-56	EPA1631	surface water	Re-analysis due to detection above calibration range. Concentration confirmed- No associated qualification
0518RD09SW	1822005-60	EPA1631	surface water	Re-analysis due to detection above calibration range. Concentration confirmed- No associated qualification
0518RD14SW	1822005-66	EPA1631	surface water	Re-analysis due to detection above calibration range. Concentration confirmed- No associated qualification
0518RD15SW	1822005-68	EPA1631	surface water	Re-analysis due to detection above calibration range. Concentration confirmed- No associated qualification
0518RD09SW	1822005-61	EPA1631	Filtered surface water	Re-analysis done to confirm low detection. Concentration confirmed- No associated qualification

Table 8a – Summary of Field Duplicate Results

Method	Analyte	Units	0518MW08GW	0518MW98GW	RPD	Rating	Sample Qualifier
EPA 1631	Mercury	ng/L	7.97	7.84	1.6	Good	None
EPA 1631	Dissolved Mercury	ng/L	1.87	1.77	2.7	Good	None

Table 8b – Summary of Field Duplicate Results

Method	Analyte	Units	0518MW40GW	0518MW100GW	RPD	Rating	Sample Qualifier
EPA 1631	Mercury	ng/L	5.08	3.49	37.1	Good	None
EPA 1631	Dissolved Mercury	ng/L	0.79	0.66	17.8	Good	None

Table 8c – Summary of Field Duplicate Results

Method	Analyte	Units	0518RD14SW	0518RD100SW	RPD	Rating	Sample Qualifier
EPA 1631	Mercury	ng/L	760	553	31	Good	None
EPA 1631	Dissolved Mercury	ng/L	7.0	7.11	1.6	Good	None

DATA REVIEW MEMORANDUM

DATE: July 30, 2018

TO: Jonathan Reeve, Project Manager, E & E, Seattle, WA

FROM: Howard Edwards, E & E, San Francisco, CA

SUBJ: Data Review: Red Devil Mine 2018 Spring

REFERENCE:

Project ID	Lab Work Order	Lab
1001095.0015.01	580-77594-1	Test America – Seattle

1. SAMPLE IDENTIFICATION

For the sampling activities at Red Devil Mine, Ecology and Environment, Inc. (E & E) collected the samples listed in Table 1. Project-specific matrix spike/matrix spike duplicates (MS/MSD) were designated in the field, except where noted. All samples were sent to Test America's lab in Seattle, Washington for all listed analyses. This report addresses only Test America generated data.

The analytical report was issued by Test America on June 14, 2018. The data in the analytical report were reviewed for field and laboratory precision, accuracy, and completeness in accordance with procedures and quality control (QC) limits, the current laboratory Quality Assurance Manual (QAM) and current standard operating procedures (SOPs). Laboratory data qualifiers for identified analytes and analyte quantitation were accepted. Any additional data review qualifiers added are noted below and listed on the tables at the end of this memorandum. Definitions of all data qualifiers are given in the report.

Work Orders, Tests, and Number of Samples Included in this Data Review Memo

Work Orders/ Job Number	Matrix	Test Method	Method Name	Number of Samples
580-77594-1	Surface Water	EPA 7470A	Mercury (CVAA)	8
580-77594-1	Surface Water	EPA 6010B/6020A	Total TAL Metals by ICP	8
580-77594-1	Surface Water	EPA 7470A	Dissolved Mercury (CVAA)	8
580-77594-1	Surface Water	EPA 6010B/6020A	Dissolved TAL Metals by ICP	8
580-77594-1	Surface Water	EPA 9060	TOC	8
580-77594-1	Surface Water	SM2540D	TSS	8
580-77594-1	Surface Water	SM2540C	TDS	8
580-77594-1	Surface Water	EPA 300.0	Inorganic Ions (Cl, F, SO4)	8
580-77594-1	Surface Water	EPA 353.2	Nitrate-Nitrite as N	8
580-77594-1	Surface Water	SM2320B	Alkalinity as CO3/HCO3	8
580-77594-1	Ground Water	EPA 6010B/6020A	Total TAL Metals by ICP	22
580-77594-1	Ground Water	EPA 7470A	Mercury (CVAA)	22
580-77594-1	Ground Water	EPA 300.0	Inorganic Ions (Cl, F, SO4)	22
580-77594-1	Ground Water	EPA 353.2	Nitrate-Nitrite as N	22
580-77594-1	Ground Water	SM2320B	Alkalinity as CO3/HCO3	22
580-77594-1	Ground Water	EPA 8270D	SVOCs	3
580-77594-1	Ground Water	AK102/103	DRO	3
580-77594-1	Ground Water	EPA 8260C	BTEX	3
580-77594-1	Ground Water	AK101	GRO	3
580-77594-1	Ground Water	SM2540D	TSS	22
580-77594-1	Ground Water	SM2540C	TDS	0
580-77594-1	Equipment Blank	EPA 7470A	Mercury (CVAA)	1
580-77594-1	Equipment Blank	EPA 6010C/6020A	Total TAL Metals by ICP	1
580-77594-1	Equipment Blank	EPA 300.0	Inorganic Ions (Cl, F, SO4)	1
580-77594-1	Equipment Blank	SM2540D	TSS	1
580-77594-1	Equipment Blank	EPA 353.2	Nitrate-Nitrite as N	1
580-77594-1	Equipment Blank	SM2320B	Alkalinity as CO3/HCO3	1
580-77594-1	Trip Blank	EPA 8260C	BTEX	2
580-77594-1	Trip Blank	AK101	GRO	2

2. SAMPLE PROCEDURES

All samples were collected as specified in the work plan and documented on the chain-of-custody (COC) and in field notebooks. Samples were analyzed as specified on the COC. Samples were packaged, shipped, and received as specified in the work plan. All samples must be received cold (4 ±2 degrees Celsius [ºC]) and in good condition as documented on the Cooler Receipt Form.

REVIEW RESULTS

All sample procedures were followed and the eight sample coolers were received at a temperature of between – 0.2 and 3.2 ºC. No problems with the condition of the samples upon receipt were documented.

3. LABORATORY DATA

3.1 HOLDING TIMES

Holding times are established and monitored to ensure analytical results accurately represent analyte concentrations in a sample at the time of collection. These results are presented in Table 2 (if applicable). Exceeding the holding time for a sample generally results in a loss of the analyte due to a variety of mechanisms, such as deposition on the sample container walls or precipitation.

REVIEW RESULTS

All samples requiring the determination of total suspended solids (TSS) and total dissolved solids (TDS) were received by the laboratory either the day before the holding time expired or after the holding time had expired. The method and project specified holding time is seven days. All samples for TDS and one sample for TSS were determined to not be within the seven-day holding time. All associated TDS and TSS data were "J" qualified as estimated (see Table 2).

All other samples were analyzed within the project and method specified holding times for all analytes.

3.2 BLANKS

Laboratory and field blank samples are analyzed and evaluated to determine the existence and magnitude of possible contamination during the sampling and analysis process. These results are presented in Table 3a (if applicable). If the analyte is present in the sample at similar trace levels(less than five times the blank concentration), then the analyte is likely a common background contaminant from some phase of the sampling, extraction, or analytical procedure and associated low-level sample concentrations are not considered to be site related. Sample results in these cases are qualified as not-detected, “U”.

REVIEW RESULTS

All laboratory method blanks were performed at the required frequency. As noted in Table 3a, the total organic carbon (TOC) concentration in the method blanks (MBs) were detected at concentrations below the practical quantitation limit (PQL). As noted in Table 3b, all associated reported concentrations of TOC in samples were greater than five times the concentration found in the MB and thus the TOC data required no qualifications as noted in Table 3b. No other methods had MB detections, as noted in Table 3b.

One equipment blank and two trip blanks were collected. The equipment blanks were analyzed for metals by EPA methods 6010C, 6020B, 7470, 300, 353.2 and SM methods 2320B and 2540D. Antimony, chromium, and manganese were detected in the analysis by EPA 6020A of metals in the equipment blank, as noted in Table 3a, at concentrations below the practical quantitation limit (PQL). As noted in Table 3c, samples that had reported concentration of antimony, chromium, and manganese that were less than five times the concentration found in the MB were “U” qualified as not-detected.

The trip blanks, which were analyzed for organics constituents, had no reported analytes concentration above the method detection limits.

A summary of qualified data due to equipment rinsate blank contamination is presented in Table 3c.

3.3 SURROGATE SPIKE RECOVERY

Laboratory performance for individual samples analyzed for organic compounds is established by means of surrogate spiking activities. Samples are spiked with surrogate compounds prior to preparation and analysis. Unusually low or high surrogate recovery values may indicate some deficiency in the analytical system or that some matrix effects exist, resulting in low or high sample results for target compounds. Sample surrogate recoveries outside QC limits (if applicable) are presented in Table 4.

REVIEW RESULTS

No surrogates were outside their required QC limits.

3.4 MATRIX SPIKE AND MATRIX SPIKE DUPLICATE ANALYSIS

The MS/MSD analyses are intended to provide information about the effects that the sample matrix exerts on the digestion/extraction and measurement methodology. MS recovery values that do not meet laboratory QC criteria may indicate that sample analyte results are being attenuated in the analysis procedure. The potential sample bias may be estimated by noting the degree to which the MS concentration was elevated or lowered in the spike analysis. However, this estimated bias should serve only as an approximation; sample-specific problems may be the cause of the discrepancy, particularly in soil samples.

Recoveries of a post-digestion spike or a laboratory control sample (LCS) are used to verify that the analytical methodology is acceptable and that MS recoveries are due to matrix effects. An MSD and duplicate analyses are performed to evaluate the precision of the sample results. Precision is measured as the relative percent difference (RPD) between analytical results for duplicate samples. The laboratory's failure to produce similar results for MSD samples may indicate that the samples were non-homogeneous (particularly in soil samples), or that method defects may exist in the laboratory's techniques.

Recovery calculations are not required if the spiking concentration added is less than 25 percent of the sample background concentration.

REVIEW RESULTS

The lab duplicate and MS/MSD sample analyses were performed on the following samples at the required frequency:

- 0518MW22GW for all applicable methods
- 0518RD10SW for all applicable methods
- 0518MW98GW for 6010B, 6020A, and 7471A methods

- 0518RD14SW for 9060 method
- 0518MW42GW for 300.0 and 353.2 methods
- 0518MW43GW for 353.2 method

As shown in Table 5a, the MS/MSD recoveries were within the control limits generated by the laboratory with the following exceptions:

- The MS and MSD recovers for hexachlorocyclopentadiene and for diesel range organics in 0518MW22GW were low. The MSD recovery for butyl benzyl phthalate in 0518MW22GW was high. Since diesel range organics, hexachlorocyclopentadiene and butyl benzyl phthalate were not detected in samples, no qualifications were necessary.
- The MS and MSD recover for fluoride, chloride, and sulfate in 0518MW22GW were high. As a result fluoride, chloride, and sulfate in 0518MW22GW were qualified “J +” as being potentially biased high.
- The MS and MSD recovers for fluoride in 0518MW42GW were high. As a result fluoride, in 0518MW42GW were qualified “J +” as being potentially biased high.
- The MSD recover for chloride in 0518MW42GW were high. Since the MS recover was acceptable and the MSD recover were close to the 90-110 percent control limits (111 percent) no additional qualifications were necessary.
- The MS and MSD recover for nitrate/nitrites in 0518MW22GW, 0518MW42GW, 0518MW43GW and 0518RD10SW were low. As a result, all detected nitrate/nitrate data that were reported at concentration greater than the reporting limited were “J -” as being potentially biased low.

As shown in Table 5b, the laboratory and spike duplicates were within the control limits generated by the laboratory with the following exceptions:

- The duplicate analysis relative percent difference (RPD) for chromium and manganese in 0518MW22GW and for antimony and manganese in 0518MW98GW were high. As a result the associated detections, in 0518MW22GW and 0518MW98GW were qualified “J” as being estimated.
- The duplicate analysis RDP for dissolved cobalt in 0518RD10SW was high. However, those detections are already “J” qualified as being below the reporting level.

3.5 LABORATORY CONTROL SAMPLE ANALYSIS

The LCS is analyzed to monitor the efficiency of the digestion/extraction procedure and analytical instrument operation. The ability of the laboratory to successfully analyze an LCS demonstrates that there are no analytical problems related to the digestion/sample preparation procedures and/or instrument operations. The LCS results outside QC limits are presented in Table 6 (if applicable). Sporadic and marginal QC failures for multiple component methods do not indicate an analytical concern. If recoveries are high and the compounds are not detected in the samples, then no data qualification is required. All recoveries should be above 10 percent or the non-detect results flagged “UR” as rejected.

REVIEW RESULTS

The LCS analyses duplicate (LCSD) was slightly out of control for the analysis of the MS/MSD samples for EPA Method 8260 analysis for benzene, toluene, ethyl benzene, and xylenes. Since there were not detection in samples and since the LCS were in control for the sample analysis no qualifications were necessary

All other LCS analyses were within control limits and performed at the required frequency for all method.

3.6 COMPOUND IDENTIFICATION AND QUANTITATION

Compounds detected below the PQL in samples should be considered estimated and are qualified "J." The samples with compounds above the linear range were all reanalyzed at a higher dilution factor.

REVIEW RESULTS

All compound identification and quantitation criteria were achieved. As noted in Table 7b, no samples were reported as reanalyzed.

4. FIELD DUPLICATE SAMPLE RESULTS

Field duplicate samples were collected and analyzed as an indication of overall precision for both field and laboratory. Field duplicate results are summarized in Table 8 (if applicable). The results are expected to have more variability than laboratory duplicates, which measure only laboratory precision. It is also expected that soil field duplicates will exhibit greater variance than water field duplicates due to the difficulties associated with collecting identical field samples. The QC criteria used to assess field duplicate samples for this project was limits of 70 percent RPD for soils and 40 percent RPD for waters, or twice the general laboratory duplicate criteria. If a given compound in both the regular sample and associated field duplicate sample was below the laboratory PQL, or the compound was not detected in one of the samples, then the compound is generally not qualified due to field duplicate precision. There are no guidelines regarding data qualification based on poor field duplicate precision. Professional judgment was used to determine whether or not to qualify results.

REVIEW RESULTS

Five field duplicates analyses were performed on this Sample Delivery Group. The RPD ratings are listed on Tables 8a through 8e as "Good" if the RPD is less than field duplicate QC criteria of 40 percent and as "Poor" if the RPD exceeded the field duplicate QC criteria of 40 percent.

All the results show good precision in the sample pair with the following exceptions:

- Total aluminum in Table 8a (0518MW08GW and 0518MW98GW),
- Fluoride, TSS, TDS total chromium, total nickel, total vanadium, and total zinc in Table 8c (0518RD14SW and 0518RD100SW),

"J" qualifiers were added to the field duplicate sample pair results with poor RPD ratings as noted.

5. OVERALL ASSESSMENT OF DATA

All data were reviewed and considered usable with qualification as noted in this report. All non-detect results were reported as "U" qualified at the PQL except where noted based upon blank contamination. All reported data at concentration less than the PQL were "J" qualified as estimated.

Table 1 - Sample Listing

Work Order	Matrix	Sample ID	Lab ID	Sample Date	QA/QC	Analysis
580-77594-1	GW	0518MW42GW	580-77594-1	5/24/2018	MS/MSD for methods 300.0 and 353.2,	6010B, 6020A, 7470A, 300.0, 353.2, SM2320B, SM2540D
580-77594-1	EB	0518EB01	580-77594-2	5/24/2018	Blank	6010B, 6020A, 7470A, 300.0, 353.2, SM2320B, SM2540D
580-77594-1	GW	0518MW01GW	580-77594-3	5/18/2018		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540D
580-77594-1	GW	0518MW06GW	580-77594-4	5/20/2018		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540D
580-77594-1	GW	0518MW08GW	580-77594-5	5/19/2018	FD of 0518MW98GW	6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540D
580-77594-1	GW	0518MW09GW	580-77594-6	5/22/2018		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540D
580-77594-1	GW	0518MW100GW	580-77594-7	5/21/2018	FD of 0518MW40GW	6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540D
580-77594-1	GW	0518MW10GW	580-77594-8	5/22/2018		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540D
580-77594-1	GW	0518MW16GW	580-77594-9	5/21/2018		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540D
580-77594-1	GW	0518MW17GW	580-77594-10	5/21/2018		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540D
580-77594-1	GW	0518MW19GW	580-77594-11	5/21/2018	FD of 0518MW99GW	6010B, 6020A, 7471A, 300.0,AK102/103, AK101,8260c,8270D,353.2, SM2320B, SM2540D
580-77594-1	GW	0518MW22GW	580-77594-12	5/24/2018	MS/MSD	6010B, 6020A, 7471A, 300.0,AK102/103, AK101,8260C,8270D,353.2, SM2320B, SM2540D
580-77594-1	GW	0518MW26GW	580-77594-13	5/24/2018		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540D
580-77594-1	GW	0518MW27GW	580-77594-14	5/23/2018		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540D
580-77594-1	GW	0518MW28GW	580-77594-15	5/20/2018		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540D
580-77594-1	GW	0518MW29GW	580-77594-16	5/24/2018		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540D
580-77594-1	GW	0518MW31GW	580-77594-17	5/19/2018		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540D
580-77594-1	GW	0518MW32GW	580-77594-18	5/19/2018		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540D

Table 1 - Sample Listing

Work Order	Matrix	Sample ID	Lab ID	Sample Date	QA/QC	Analysis
580-77594-1	GW	0518MW33GW	580-77594-19	5/21/2018		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540D
580-77594-1	GW	0518MW40GW	580-77594-20	5/21/2018	FD of 0518MW100GW	6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540D
580-77594-1	GW	0518MW43GW	580-77594-21	5/21/2018		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540D
580-77594-1	GW	0518MW59GW	580-77594-22	5/20/2018		6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540D
580-77594-1	GW	0518MW98GW	580-77598-23	5/19/2018	FD of 0518MW08GW	6010B, 6020A, 7471A, 300.0, 353.2, SM2320B, SM2540D
580-77594-1	GW	0518MW99GW	580-77594-24	5/21/2018	FD of 0518MW19GW	6010B, 6020A, 7471A, 300.0,AK102/103, AK101,8260C,8270D,353.2, SM2320B, SM2540D
580-77594-1	SW	0518RD05SW	580-77594-25	5/21/2018		Unfiltered 6010B, Unfiltered 6020A, Unfiltered7471A, Filtered 6010B, Filtered 6020A, Unfiltered7471A, 9060, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-77594-1	SW	0518RD06SW	580-77594-26	5/19/2018		Unfiltered 6010B, Unfiltered 6020A, Unfiltered7471A, Filtered 6010B, Filtered 6020A, Unfiltered7471A, 9060, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-77594-1	SW	0518RD08SW	580-77594-27	5/19/2018		Unfiltered 6010B, Unfiltered 6020A, Unfiltered7471A, Filtered 6010B, Filtered 6020A, Unfiltered7471A, 9060, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-77594-1	SW	0518RD09SW	580-77594-28	5/19/2018		Unfiltered 6010B, Unfiltered 6020A, Unfiltered7471A, Filtered 6010B, Filtered 6020A, Unfiltered7471A, 9060, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-77594-1	SW	0518RD100SW	580-77594-29	5/19/2018	FD of 0518RD14SW	Unfiltered 6010B, Unfiltered 6020A, Unfiltered7471A, Filtered 6010B, Filtered 6020A, Unfiltered7471A, 9060, 300.0, 353.2, SM2320B, SM2540C, SM2540D

Table 1 - Sample Listing

Work Order	Matrix	Sample ID	Lab ID	Sample Date	QA/QC	Analysis
580-77594-1	SW	0518RD10SW	580-77594-30	5/19/2018	MS/MSD	Unfiltered 6010B, Unfiltered 6020A, Unfiltered7471A, Filtered 6010B, Filtered 6020A, Unfiltered7471A, 9060, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-77594-1	SW	0518RD14SW	580-77594-31	5/19/2018	FD of 0518RD100SW and MS/MS for EPA 9060	Unfiltered 6010B, Unfiltered 6020A, Unfiltered7471A, Filtered 6010B, Filtered 6020A, Unfiltered7471A, 9060, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-77594-1	SW	0518RD15SW	580-77594-32	5/19/2018		Unfiltered 6010B, Unfiltered 6020A, Unfiltered7471A, Filtered 6010B, Filtered 6020A, Unfiltered7471A, 9060, 300.0, 353.2, SM2320B, SM2540C, SM2540D
580-77594-1	TB	0518TB01	580-77594-34	9/21/2018	Trip Blank	8260C, AK101
580-77594-1	TB	0518TB02	580-77594-35	9/24/2018	Trip Blank	8260C, AK101

EB= Equipment Blank (uncertified bailer)
RB= Rinsate Blank (non-dedicated pumps)
TB = Trip Blank
FD = Field Duplicate

Table 2 - List of Samples Qualified for Holding Time Exceedance

Method	Analyte	Sample IDs	HT	Sampling Date	Analysis Date	Qual
SM2540 D	TSS	0518MW01GW	7 day	5/18/2018	5/26/2018	J
SM2540 D	TSD	0518RD05SW	7 day	5/21/2018	6/01/2018	J
SM2540 D	TSD	0518RD06SW	7 day	5/19/2018	6/01/2018	J
SM2540 D	TSD	0518RD08SW	7 day	5/19/2018	6/01/2018	J
SM2540 D	TSD	0518RD09SW	7 day	5/19/2018	6/01/2018	J
SM2540 D	TSD	0518RD100SW	7 day	5/19/2018	6/01/2018	J
SM2540 D	TSD	0518RD10SW	7 day	5/19/2018	6/01/2018	J
SM2540 D	TSD	0518RD14SW	7 day	5/19/2018	6/01/2018	J
SM2540 D	TSD	0518RD15SW	7 day	5/19/2018	6/01/2018	J

Table 3a - List of Positive Results for Blank Samples

Method	Sample ID	Sample Type	Analyte	Result	Analysis Type	Units	PQL
EPA 9060	580-275320/22	AQ	TOC	0.367 J	MB	mg/L	1.0
EPA 9060	580-275320/41	AQ	TOC	0.349 J	MB	mg/L	1.0
EPA 6020A	0518EB01	AQ	Antimony	0.00021 J	EB	mg/L	0.0004
EPA 6020A	0518EB01	AQ	Chromium	0.00023 J	EB	mg/L	0.0004
EPA 6020A	0518EB01	AQ	Manganese	0.00078 J	EB	mg/L	0.002
EB =Equipment Blank RB = Rinse Blank							

Table 3b - List of Samples Qualified for Method Blank Contamination

Method	Sample ID	Analyte	Blank Result	Sample Result	Sample Qual	Units	PQL
	None						

Table 3c - List of Samples Qualified for Field or Equipment Rinsate Blank Contamination

Method	Sample ID	Analyte	Blank Result mg/L	Sample Result mg/L	Sample Qual	PQL ng/L
EPA 6020A	0518MW10GW	chromium	0.00023 J	0.00050	U	0.0004
EPA 6020A	0518MW27GW	chromium	0.00023 J	0.00048	U	0.0004
EPA 6020A	0518MW31GW	antimony	0.00021 J	0.00013	U	0.0004
EPA 6020A	0518MW43GW	chromium	0.00023 J	0.00017	U	0.0004
EPA 6020A	0518MW59GW	antimony	0.00021 J	0.00047	U	0.0004
EPA 6020A	0518MW59GW	chromium	0.00023 J	0.00027	U	0.0004

Table 4 - List of Samples with Surrogates outside Control Limits

Method	Sample ID	Sample Type	Analyte	Rec.	Low Limit	High Limit	Dil Fac	Sample Qual.
.	None							

Table 5a - List of MS/MSD Recoveries outside Control Limits

Method	Sample ID	Sample Type	Analyte	Orig. Result	Spike Amount	Rec.	Dil Fac.	Low Limit	High Limit	Sample Qual
EPA 8270E	0518MW22GW	GW	Hexachlorocyclopentadiene	ND	1.91	29	1.0	45	135	None
EPA 8270E	0518MW22GW	GW	Hexachlorocyclopentadiene	ND	1.91	35	1.0	45	135	None
EPA 8270E	0518MW22GW	GW	butyl benzyl phthalate	ND	1.91	121	1.0	45	115	None
AK102/103	0518MW22GW	GW	Diesel Range Organics	ND	2.08	70	1.0	75	125	None
AK102/103	0518MW22GW	GW	Diesel Range Organics	ND	2.08	68	1.0	75	125	None
EPA 300	0518MW22GW	GW	Chloride	0.81	50.0	155	1.0	90	110	J +
EPA 300	0518MW22GW	GW	Fluoride	0.52	5.0	157	1.0	90	110	J +
EPA 300	0518MW22GW	GW	Sulfate	7.3	50.0	157	1.0	90	110	J +
EPA 300	0518MW22GW	GW	Chloride	0.81	50.0	159	1.0	90	110	J +
EPA 300	0518MW22GW	GW	Fluoride	0.52	5.0	162	1.0	90	110	J +
EPA 300	0518MW22GW	GW	Sulfate	7.3	50.0	162	1.0	90	110	J +
EPA 300	0518MW42GW	GW	Fluoride	0.12 J	5.0	113	1.0	90	110	J +
EPA 300	0518MW42GW	GW	Chloride	1.3	50.0	111	1.0	90	110	none
EPA 300	0518MW42GW	GW	Fluoride	0.12 J	5.0	114	1.0	90	110	J +
EPA 353.2	0518MW22GW	GW	Nitrate/Nitrite	0.11 J	0.5	74	1.0	90	110	J -
EPA 353.2	0518MW22GW	GW	Nitrate/Nitrite	0.11 J	0.5	65	1.0	90	110	J -
EPA 353.2	0518MW42GW	GW	Nitrate/Nitrite	ND	0.5	56	1.0	90	110	J -
EPA 353.2	0518MW42GW	GW	Nitrate/Nitrite	ND	0.5	57	1.0	90	110	J -
EPA 353.2	0518MW43GW	GW	Nitrate/Nitrite	ND	0.5	47	1.0	90	110	J -
EPA 353.2	0518MW43GW	GW	Nitrate/Nitrite	ND	0.5	48	1.0	90	110	J -
EPA 353.2	0518RD10SW	GW	Nitrate/Nitrite	0.32	0.5	82	1.0	90	110	J -
EPA 353.2	0518RD10SW	GW	Nitrate/Nitrite	0.32	0.5	84	1.0	90	110	J -

Table 5b - List of Lab and MS Duplicate RPDs outside Control Limits

Sample ID	Analyte	Method	RPD	RPD Limit	No. of Affected Samples	Samp Qual
0518MW22GW	chromium	EPA 6020A	50	20	1	J
0518MW22GW	Manganese	EPA 6020A	40	20	1	J
0518MW98GW	Antimony	EPA 6020A	36	20	1	J
0518MW98GW	Manganese	EPA 6020A	22	20	1	J
0518RD10SW	Cobalt	EPA 6020A	28	20	1	J

Table 6a - List of LCS Recoveries outside Control Limits

Method	Sample ID	Analyte	% Rec.	Low Limit	High Limit	No. of Affected Samples	Samp Qual
None							

Table 7a - List of IPC Serial Dilution Results outside Control Limits

Method	Sample ID	Analyte	% D.	Limit	No. of Affected Samples	Samp Qual
None						

Table 7b –Samples that were Re-analyzed

Sample ID	Lab ID	Method	Sample Type	Action
None				

Table 8a – Summary of Field Duplicate Results

Method	Analyte	Units	0518MW08GW	0518MW98GW	RPD	Rating	Sample Qualifier
EPA 7170A	Mercury	mg/L	0.0003 U	0.0003 U	0%	Good	None
EPA 6010C	Aluminum	mg/L	0.088 J	0.31 J	111%	Poor	J
EPA 6010C	Calcium	mg/L	7.6	7.6	0.0%	Good	None
EPA 6010C	Iron	mg/L	2.0 U	5.0 U	0%	Good	None
EPA 6010C	Magnesium	mg/L	5.6	5.9	5.2%	Good	None
EPA 6010C	Potassium	mg/L	0.28 J	0.46 J	9.7%	Good	None
EPA 6010C	Sodium	mg/L	1.1	1.0 J	3.2%	Good	None
EPA 6020A	Arsenic	mg/L	0.001 U	0.00022 J	5.7%	Good	None
EPA 6020A	Antimony	mg/L	0.00052	0.00081	13%	Good	None
EPA 6020A	Barium	mg/L	0.027	0.028	3.3%	Good	None
EPA 6020A	Beryllium	mg/L	0.0004 U	0.0004 U	0 %	Good	None
EPA 6020A	Cadmium	mg/L	0.0004 U	0.0004 U	0 %	Good	None
EPA 6020A	Chromium	mg/L	0.00073	0.00078	6.7 %	Good	None
EPA 6020A	Cobalt	mg/L	0.0004 U	0.0004 U	0 %	Good	None
EPA 6020A	Copper	mg/L	0.00071 J	0.002 U	0 %	Good	None
EPA 6020A	Lead	mg/L	0.0008 U	0.0008 U	0 %	Good	None
EPA 6020A	Manganese	mg/L	0.0011 J	0.0011 J	0 %	Good	None
EPA 6020A	Nickel	mg/L	0.00082 J	0.00079 J	3.7%	Good	None
EPA 6020A	Selenium	mg/L	0.008 U	0.008 U	0 %	Good	None
EPA 6020A	Silver	mg/L	0.0004 U	0.0004 U	0 %	Good	None
EPA 6020A	Thallium	mg/L	0.001 U	0.001 U	0 %	Good	None
EPA 6020A	Vanadium	mg/L	0.0040 U	0.00056 J	0 %	Good	None
EPA 6020A	Zinc	mg/L	0.007 U	0.007 U	0 %	Good	None
EPA 300.0	Chloride	mg/L	0.99	0.92	7.3	Good	None
EPA 300.0	Fluoride	mg/L	0.14 J	0.084 J	50 %	Good	None
EPA 300.0	Sulfate	mg/L	3.8	3.8	0.0%	Good	None
EPA 353.2	Nitrate/Nitrite as N	mg/L	0.49	0.47	4.2 %	Good	None
SM2320B	Alkalinity as CaCO3	mg/L	35	38	8.2 %	Good	None
SM2320B	Bicarbonate Alkalinity as CaCO3	mg/L	35	38	8.2 %	Good	None
SM2320B	Carbonate Alkalinity as CaCO3	mg/L	5 U	5 U	0 %	Good	None
SM2320B	Hydroxide Alkalinity as CaCO3	mg/L	5 U	5 U	0 %	Good	None
SM2540D	Total Suspended Solids	mg/L	2 U	2 U	0 %	Good	None

Table 8b – Summary of Field Duplicate Results

Method	Analyte	Units	0518MW40GW	0518MW100GW	RPD	Rating	Sample Qualifier
EPA 7170A	Mercury	mg/L	0.0003 U	0.0003 U	0%	Good	None
EPA 6010C	Aluminum	mg/L	1.0 U	1.0 U	0%	Good	None
EPA 6010C	Calcium	mg/L	52	50	1.9%	Good	None
EPA 6010C	Iron	mg/L	0.55J	0.53 J	3.7%	Good	None
EPA 6010C	Magnesium	mg/L	54	51	5.7%	Good	None
EPA 6010C	Potassium	mg/L	0.90	0.88 J	2.2%	Good	None
EPA 6010C	Sodium	mg/L	2.0	1.9	5.1%	Good	None
EPA 6020A	Arsenic	mg/L	0.26	0.26	0.0%	Good	None
EPA 6020A	Antimony	mg/L	0.014	0.014	0.0%	Good	None
EPA 6020A	Barium	mg/L	0.13	0.13	0.0 %	Good	None
EPA 6020A	Beryllium	mg/L	0.0004 U	0.0004 U	0 %	Good	None
EPA 6020A	Cadmium	mg/L	0.0004 U	0.0004 U	0 %	Good	None
EPA 6020A	Chromium	mg/L	0.0004 U	0.0004 U	0 %	Good	None
EPA 6020A	Cobalt	mg/L	0.031	0.031	0.0 %	Good	None
EPA 6020A	Copper	mg/L	0.002 U	0.002 U	0 %	Good	None
EPA 6020A	Lead	mg/L	0.0008 U	0.0008 U	0 %	Good	None
EPA 6020A	Manganese	mg/L	0.33	0.34	3.0 %	Good	None
EPA 6020A	Nickel	mg/L	0.12	0.12	0.0%	Good	None
EPA 6020A	Selenium	mg/L	0.008 U	0.008 U	0 %	Good	None
EPA 6020A	Silver	mg/L	0.0004 U	0.0004 U	0 %	Good	None
EPA 6020A	Thallium	mg/L	0.001 U	0.001 U	0 %	Good	None
EPA 6020A	Vanadium	mg/L	0.0040 U	0.004 U	0 %	Good	None
EPA 6020A	Zinc	mg/L	0.0040 J	0.0043 J	7.2 %	Good	None
EPA 300.0	Chloride	mg/L	1.5	1.6	6.4	Good	None
EPA 300.0	Fluoride	mg/L	0.22	0.22	0.0 %	Good	None
EPA 300.0	Sulfate	mg/L	22	22	0.0%	Good	None
EPA 353.2	Nitrate/Nitrite as N	mg/L	0.15 U	0.15 U	0 %	Good	None
SM2320B	Alkalinity as CaCO3	mg/L	300	310	3.3 %	Good	None
SM2320B	Bicarbonate Alkalinity as CaCO3	mg/L	300	310	3.3 %	Good	None
SM2320B	Carbonate Alkalinity as CaCO3	mg/L	5 U	5 U	0 %	Good	None
SM2320B	Hydroxide Alkalinity as CaCO3	mg/L	5 U	5 U	0 %	Good	None
SM2540D	Total Suspended Solids	mg/L	2 U	2 U	0 %	Good	None

Table 8c – Summary of Field Duplicate Results

Method	Analyte	Units	0518RD14SW	0518RD100SW	RPD	Rating	Sample Qualifier
EPA 7170A	Mercury	mg/L	0.00039 J	0.00047 J	19 %	Good	None
EPA 6010C	Aluminum	mg/L	1.6	1.9	17 %	Good	None
EPA 6010C	Calcium	mg/L	11	11	0.0 %	Good	None
EPA 6010C	Iron	mg/L	2.3	2.9	23 %	Good	None
EPA 6010C	Magnesium	mg/L	6.3	6.8	7.8 %	Good	None
EPA 6010C	Potassium	mg/L	0.51	0.52	1.9 %	Good	None
EPA 6010C	Sodium	mg/L	1.3	1.3	0.0 %	Good	None
EPA 6020A	Arsenic	mg/L	0.0097	0.0086	12 %	Good	None
EPA 6020A	Antimony	mg/L	0.015	0.011	31 %	Good	None
EPA 6020A	Barium	mg/L	0.045	0.034	28 %	Good	None
EPA 6020A	Beryllium	mg/L	0.0004 U	0.0004 U	0 %	Good	None
EPA 6020A	Cadmium	mg/L	0.0004 U	0.0004 U	0 %	Good	None
EPA 6020A	Chromium	mg/L	0.0026	0.0011	81 %	Bad	None
EPA 6020A	Cobalt	mg/L	0.0012	0.00088	31 %	Good	None
EPA 6020A	Copper	mg/L	0.0027	0.0021	25 %	Good	None
EPA 6020A	Lead	mg/L	0.0010	0.00091	7.0 %	Good	None
EPA 6020A	Manganese	mg/L	0.059	0.055	3.0 %	Good	None
EPA 6020A	Nickel	mg/L	0.0028	0.0017 J	49 %	Bad	None
EPA 6020A	Selenium	mg/L	0.008 U	0.008 U	0 %	Good	None
EPA 6020A	Silver	mg/L	0.0004 U	0.0004 U	0 %	Good	None
EPA 6020A	Thallium	mg/L	0.001 U	0.001 U	0 %	Good	None
EPA 6020A	Vanadium	mg/L	0.0049	0.0024 J	69 %	Bad	None
EPA 6020A	Zinc	mg/L	0.0076	0.0050 J	41 %	Bad	None
EPA 300.0	Chloride	mg/L	0.71 J	0.72 J	1.4 %	Good	None
EPA 300.0	Fluoride	mg/L	0.11 J	0.047 J	81.5 %	Bad	None
EPA 300.0	Sulfate	mg/L	6.4	6.8	6.1 %	Good	None
EPA 353.2	Nitrate/Nitrite as N	mg/L	0.26	0.26	0.0 %	Good	None
SM2320B	Alkalinity as CaCO3	mg/L	44	46	4.4 %	Good	None
SM2320B	Bicarbonate Alkalinity as CaCO3	mg/L	44	46	4.4 %	Good	None
SM2320B	Carbonate Alkalinity as CaCO3	mg/L	5 U	5 U	0 %	Good	None
SM2320B	Hydroxide Alkalinity as CaCO3	mg/L	5 U	5 U	0 %	Good	None
SM2540C	Total Dissolved Solid	mg/L	10 J	48 J	130 %	Bad	None
SM2540D	Total Suspended Solids	mg/L	62 J	2 U	190 %	Bad	None
EPA 9060	Total Organic Carbon	mg/L	3.2	3.2	0.0 %	Good	None

Table 8d – Summary of Field Duplicate Results

Method	Analyte	Units	0518RD14SW Dissolved	0518RD100SW Dissolved	RPD	Rating	Sample Qualifier
EPA 7170A	Mercury	mg/L	0.00030 U	.00030 U	0 %	Good	None
EPA 6010C	Aluminum	mg/L	1.0 U	1.0 U	0 %	Good	None
EPA 6010C	Calcium	mg/L	11	11	0.0 %	Good	None
EPA 6010C	Iron	mg/L	0.13 J	0.12 J	8 %	Good	None
EPA 6010C	Magnesium	mg/L	6.0	6.1	1.7 %	Good	None
EPA 6010C	Potassium	mg/L	0.20J	0.27 J	30 %	Good	None
EPA 6010C	Sodium	mg/L	1.2	1.2	0.0 %	Good	None
EPA 6020A	Arsenic	mg/L	0.0056	0.0055	1.8 %	Good	None
EPA 6020A	Antimony	mg/L	0.013	0.012	8%	Good	None
EPA 6020A	Barium	mg/L	0.017	0.017	0.0 %	Good	None
EPA 6020A	Beryllium	mg/L	0.0004 U	0.0004 U	0 %	Good	None
EPA 6020A	Cadmium	mg/L	0.0004 U	0.0004 U	0 %	Good	None
EPA 6020A	Chromium	mg/L	0.00025 J	0.00025 J	0.0 %	Good	None
EPA 6020A	Cobalt	mg/L	0.000096 J	0.000093 J	3.1 %	Good	None
EPA 6020A	Copper	mg/L	0.0020 U	0.0020 U	0 %	Good	None
EPA 6020A	Lead	mg/L	0.0008 U	0.0008 U	0 %	Good	None
EPA 6020A	Manganese	mg/L	0.021	0.021	0.0 %	Good	None
EPA 6020A	Nickel	mg/L	0.00029 J	0.00029 J	0.0 %	Good	None
EPA 6020A	Selenium	mg/L	0.008 U	0.008 U	0 %	Good	None
EPA 6020A	Silver	mg/L	0.0004 U	0.0004 U	0 %	Good	None
EPA 6020A	Thallium	mg/L	0.001 U	0.001 U	0 %	Good	None
EPA 6020A	Vanadium	mg/L	0.004 U	0.004 U	0 %	Good	None
EPA 6020A	Zinc	mg/L	0.007 U	0.007 U	0 %	Good	None

Table 8e – Summary of Field Duplicate Results

Method	Analyte	Units	0518MW19GW	0518MW99GW	RPD	Rating	Sample Qualifier
EPA 8270D	Din-octyl phthalate	µg/L	0.13 J	0.96 U	0%	Good	None
EPA 8270D	All other analytes	µg/L	Not Detected	Not Detected	0%	Good	None
EPA 8260C	Benzene	µg/L	3.0 U	3.0 U	0%	Good	None
EPA 8260C	Toluene	µg/L	2.0 U	2.0 U	0%	Good	None
EPA 8260C	Ethyl benzene	µg/L	3.0 U	3.0 U	0%	Good	None
EPA 8260C	m & p-xylene	µg/L	3.0 U	3.0 U	0%	Good	None
EPA 8260C	o-xylene	µg/L	2.0 U	2.0 U	0%	Good	None
AK101	Gasoline Range Organics	mg/L	0.25 U	0.25 U	0%	Good	None
AK102/103	Diesel Range Organics	mg/L	0.11 U	0.11 U	0%	Good	None

B Groundwater BTV ProUCL Input and Output

Background Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.14/16/2019 11:28:04 AM
From File	Average Conc by Parameter and Well Xtab 04092019_b.xls
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
Different or Future K Observations	1
Number of Bootstrap Operations	2000

Dissolved Low Level Mercury

General Statistics

Total Number of Observations	6	Number of Missing Observations	2
Number of Distinct Observations	6		
Number of Detects	5	Number of Non-Detects	1
Number of Distinct Detects	5	Number of Distinct Non-Detects	1
Minimum Detect	6.13E-04	Minimum Non-Detect	0.00196
Maximum Detect	0.00401	Maximum Non-Detect	0.00196
Variance Detected	1.78E-06	Percent Non-Detects	16.67%
Mean Detected	0.00216	SD Detected	0.00133
Mean of Detected Logged Data	-6.333	SD of Detected Logged Data	0.744

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	3.708	d2max (for USL)	1.822

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.971	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.171	Lilliefors GOF Test
5% Lilliefors Critical Value	0.343	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan Meier (KM) Background Statistics Assuming Normal Distribution

KM Mean	0.00195	KM SD	0.00119
95% UTL95% Coverage	**0.00637**	**95% KM UPL (t)**	**0.00454**
90% KM Percentile (z)	0.00347	**95% KM Percentile (z)**	**0.00391**
99% KM Percentile (z)	**0.00472**	**95% KM USL**	**0.00412**

DL/2 Substitution Background Statistics Assuming Normal Distribution

Mean	0.00196	SD	0.00129
95% UTL95% Coverage	0.00673	95% UPL (t)	0.00476
90% Percentile (z)	0.00361	95% Percentile (z)	0.00408
99% Percentile (z)	0.00495	95% USL	0.0043

DL/2 is not a recommended method. DL/2 provided for comparisons and historical reasons

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.226	Anderson-Darling GOF Test
5% A-D Critical Value	0.683	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.217	Kolmogorov-Smirnov GOF
5% K-S Critical Value	0.36	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.74	k star (bias corrected MLE)	1.229
Theta hat (MLE)	7.87E-04	Theta star (bias corrected MLE)	0.00175

nu hat (MLE)	27.4	nu star (bias corrected)	12.29
MLE Mean (bias corrected)	0.00216		
MLE Sd (bias corrected)	0.00194	95% Percentile of Chisquare (2kstar)	6.853

Gamma ROS Statistics using Imputed Non-Detects
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	6.13E-04	Mean	0.00346
Maximum	0.01	Median	0.0025
SD	0.00342	CV	0.987
k hat (MLE)	1.462	k star (bias corrected MLE)	0.842
Theta hat (MLE)	0.00237	Theta star (bias corrected MLE)	0.00411
nu hat (MLE)	17.55	nu star (bias corrected)	10.11
MLE Mean (bias corrected)	0.00346	MLE Sd (bias corrected)	0.00377
95% Percentile of Chisquare (2kstar)	5.364	90% Percentile	0.00832
95% Percentile	0.011	99% Percentile	0.0174

The following statistics are computed using Gamma ROS Statistics on Imputed Data
Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods

	WH	HW		WH	HW
95% Approx. Gamma UTL with 95% Coverage	0.0292	0.0345	95% Approx. Gamma UPL	0.0135	0.0144
95% Gamma USL	0.011	0.0114			

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00195	SD (KM)	0.00119
Variance (KM)	1.42E-06	SE of Mean (KM)	5.48E-04
k hat (KM)	2.659	k star (KM)	1.44
nu hat (KM)	31.9	nu star (KM)	17.28
theta hat (KM)	7.32E-04	theta star (KM)	0.00135
80% gamma percentile (KM)	0.00302	90% gamma percentile (KM)	0.00409
95% gamma percentile (KM)	0.00514	99% gamma percentile (KM)	0.0075

The following statistics are computed using gamma distribution and KM estimates
Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods

	WH	HW		WH	HW
95% Approx. Gamma UTL with 95% Coverage	0.0102	0.0115	95% Approx. Gamma UPL	0.00552	0.00576
95% KM Gamma Percentile	0.00431	0.0044	95% Gamma USL	0.00469	0.00482

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.952	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.232	Lilliefors GOF Test
5% Lilliefors Critical Value	0.343	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Background Lognormal ROS Statistics Assuming Lognormal Distribution Using Imputed Non-Detects

Mean in Original Scale	0.00194	Mean in Log Scale	-6.452
SD in Original Scale	0.0013	SD in Log Scale	0.727
95% UTL95% Coverage	0.0234	95% BCA UTL95% Coverage	0.00401
95% Bootstrap (%) UTL95% Coverage	0.00401	95% UPL (t)	0.00767
90% Percentile (z)	0.004	95% Percentile (z)	0.00521
99% Percentile (z)	0.00855	95% USL	0.00593

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean of Logged Data	-6.457	95% KM UTL (Lognormal)95% Coverage	0.0196

KM SD of Logged Data	0.68	95% KM UPL (Lognormal)	0.0069
95% KM Percentile Lognormal (z)	0.00481	95% KM USL (Lognormal)	0.00542

Background DL/2 Statistics Assuming Lognormal Distribution

Mean in Original Scale	0.00196	Mean in Log Scale	-6.432
SD in Original Scale	0.00129	SD in Log Scale	0.709
95% UTL95% Coverage	0.0223	95% UPL (t)	0.00752
90% Percentile (z)	0.00399	95% Percentile (z)	0.00516
99% Percentile (z)	0.00836	95% USL	0.00585

DL/2 is not a Recommended Method. DL/2 provided for comparisons and historical reasons.

Nonparametric Distribution Free Background Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Upper Limits for BTVs(no distinction made between detects and nondetects)

Order of Statistic, r	6	95% UTL with95% Coverage	0.00401
Approx, f used to compute achieved CC	0.316	Approximate Actual Confidence Coefficient achieved by U	0.265
Approximate Sample Size needed to achieve specified CC	59	95% UPL	0.00401
95% USL	0.00401	95% KM Chebyshev UPL	0.00756

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Total Low
Level Mercury

General Statistics

Total Number of Observations	6	Number of Distinct Observations	6
		Number of Missing Observations	2
Minimum	0.0158	First Quartile	0.0574
Second Largest	0.0897	Median	0.0682
Maximum	0.159	Third Quartile	0.0853
Mean	0.076	SD	0.0474
Coefficient of Variation	0.624	Skewness	0.959
Mean of logged Data	-2.778	SD of logged Data	0.764

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	3.708	d2max (for USL)	1.822

Normal GOF Test

Shapiro Wilk Test Statistic	0.931	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.788	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.219	Lilliefors GOF Test
5% Lilliefors Critical Value	0.325	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 95% Coverage	**0.252**	90% Percentile (z)	0.137
95% UPL (t)	**0.179**	**95% Percentile (z)**	**0.154**
95% USL	**0.162**	**99% Percentile (z)**	**0.186**

Gamma GOF Test

A-D Test Statistic	0.297	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.702	Detected data appear Gamma Distributed at 5% Significance Level

K-S Test Statistic	0.222	Kolmogorov-Smirnov Gamma GOF Test	
5% K-S Critical Value	0.335	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	2.648	k star (bias corrected MLE)	1.435
Theta hat (MLE)	0.0287	Theta star (bias corrected MLE)	0.0529
nu hat (MLE)	31.77	nu star (bias corrected)	17.22
MLE Mean (bias corrected)	0.076	MLE Sd (bias corrected)	0.0634
Background Statistics Assuming Gamma Distribution			
95% Wilson Hilferty (WH) Approx. Gamma UPL	0.23	90% Percentile	0.16
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.245	95% Percentile	0.201
95% WH Approx. Gamma UTL with 95% Coverage	0.434	99% Percentile	0.293
95% HW Approx. Gamma UTL with 95% Coverage	0.502		
95% WH USL	0.194	95% HW USL	0.203
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.908	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.788	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.271	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.325	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Background Statistics assuming Lognormal Distribution			
95% UTL with 95% Coverage	1.056	90% Percentile (z)	0.165
95% UPL (t)	0.328	95% Percentile (z)	0.218
95% USL	0.25	99% Percentile (z)	0.368
Nonparametric Distribution Free Background Statistics			
Data appear Normal at 5% Significance Level			
Nonparametric Upper Limits for Background Threshold Values			
Order of Statistic, r	6	95% UTL with 95% Coverage	0.159
Approx, f used to compute achieved CC	0.316	Approximate Actual Confidence Coefficient achieved by U	0.265
		Approximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	0.159	95% BCA Bootstrap UTL with 95% Coverage	0.159
95% UPL	0.159	90% Percentile	0.124
90% Chebyshev UPL	0.229	95% Percentile	0.141
95% Chebyshev UPL	0.299	99% Percentile	0.155
95% USL	0.159		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Well ID	Dissolved Antimony	D_Dissolved Antimony	Dissolved Arsenic	D_Dissolved Arsenic	Dissolved Low Level Mercury	D_Dissolved Low Level Mercury	Total Antimony	D_Total Antimony	Total Arsenic	D_Total Arsenic	Total Low Level Mercury	D_Total Low Level Mercury	Total Mercury (7470)	D_Total Mercury (7470)
MW19	0.317	1	2.9	1	0.001165	1	0.600625	1	1.80875	1	0.055160625	1		
MW28	6.24	1	23.7	1	0.073677778	1	11.4222222	1	83.0888889	1	1.502	1		
MW29	1.5685	1	25.55	1	0.00401	1	1.37166667	1	56.8777778	1	7.22E-02	1		
MW31	0.027	1	0.05	0	0.00271	1	0.46114286	1	1.54714286	1	8.97E-02	1	0.141833333	1
MW40					0.000613	1	8.76	1	169	1	0.064248	1	0.0885	1
MW42					0.05515	1	216	1	464	1	0.72676	1	0.3491	1
MW43					0.002283	1	5.94	1	215.6	1	0.015841	1	0.0852	1
MW59					0.0019575	0	4.55	1	72.5	1	0.158625	1	0.15	0

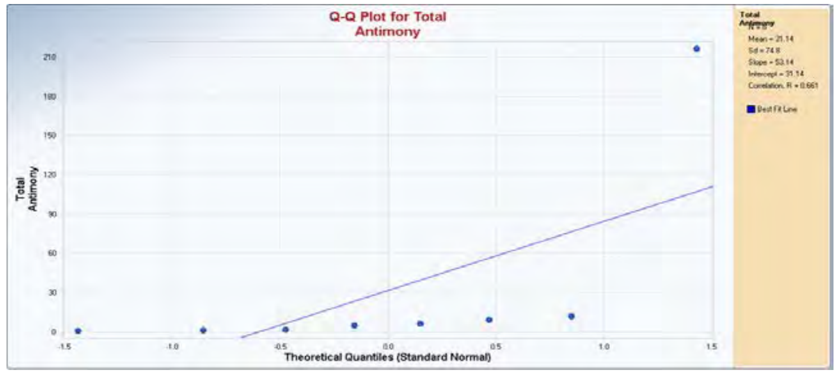
Well ID	Log Dissolved Antimony	D_Log Dissolved Antimony	Log Dissolved Arsenic	D_Log Dissolved Arsenic	Log Dissolved Low Level Mercury	D_Log Dissolved Low Level Mercury	Log Total Antimony	D_Log Total Antimony	Log Total Arsenic	D_Log Total Arsenic	Log Total Low Level Mercury	D_Log Total Low Level Mercury	Log Total Mercury (7470)	D_Log Total Mercury (7470)
MW19	-0.4989407	1	0.462398	1	-2.933674075	1	-0.22139659	1	0.25737854	1	-1.258370822	1		
MW28	0.79518459	1	1.374748	1	-1.132663482	1	1.05775061	1	1.91954295	1	0.176669933	1		
MW29	0.19548452	1	1.407391	1	-2.396855627	1	0.13724858	1	1.75494262	1	-1.141596493	1		
MW31	-1.5686362	1	-1.30103	0	-2.567030709	1	-0.33616451	1	0.18953042	1	-1.047321696	1	-0.84822169	1
MW40					-3.212539525	1	0.94250411	1	2.2278867	1	-1.192140387	1	-1.053056729	1
MW42					-1.258454483	1	2.33445375	1	2.66651798	1	-0.138608984	1	-0.457050151	1
MW43					-2.641494089	1	0.77378644	1	2.33364876	1	-1.800217406	1	-1.069560405	1
MW59					-2.708298229	0	0.6580114	0	1.86033801	0	-0.799628365	0	-0.823908741	0

Well ID	Dissolved Antimony	D_Dissolved Antimony	Dissolved Arsenic	D_Dissolved Arsenic	Dissolved Low Level Mercury	D_Dissolved Low Level Mercury	Total Antimony	D_Total Antimony	Total Arsenic	D_Total Arsenic	Total Low Level Mercury	D_Total Low Level Mercury	Total Mercury (7470)	D_Total Mercury (7470)
MW19	0.317	1	2.9	1	0.001165	1	0.600625	1	1.80875	1	0.055160625	1		
MW28	6.24	1	23.7	1			11.42222222	1	83.08888889	1				
MW29	1.5685	1	25.55	1	0.00401	1	1.371666667	1	56.87777778	1	7.22E-02	1		
MW31	0.027	1	0.05	0	0.00271	1	0.461142857	1	1.547142857	1	8.97E-02	1	0.141833333	1
MW40					0.000613	1	8.76	1	169	1	0.064248	1	0.0885	1
MW42					0.05515	1					0.72676	1		
MW43					0.002283	1	5.94	1	215.6	1	0.015841	1	0.0852	1
MW59					0.0019575	0	4.55	1	72.5	1	0.158625	1	0.15	0

Well ID	Log Dissolved Antimony	D_Log Dissolved Antimony	Log Dissolved Arsenic	D_Log Dissolved Arsenic	Log Dissolved Low Level Mercury	D_Log Dissolved Low Level Mercury	Log Total Antimony	D_Log Total Antimony	Log Total Arsenic	D_Log Total Arsenic	Log Total Low Level Mercury	D_Log Total Low Level Mercury	Log Total Mercury (7470)	D_Log Total Mercury (7470)
MW19	-0.4989407	1	0.462398	1	-2.933674075	1	-0.22139659	1	0.257378544	1	-1.258370822	1		
MW28	0.79518459	1	1.3747483	1			1.057750605	1	1.919542951	1				
MW29	0.19548452	1	1.4073909	1	-2.396855627	1	0.137248585	1	1.75494262	1	-1.141596493	1		
MW31	-1.5686362	1	-1.30103	0	-2.567030709	1	-0.33616451	1	0.189530417	1	-1.047321696	1	-0.84822169	1
MW40					-3.212539525	1	0.942504106	1	2.227886705	1	-1.192140387	1	-1.053056729	1
MW42					-1.258454483	1					-0.138608984	1		
MW43					-2.641494089	1	0.773786445	1	2.333648757	1	-1.800217406	1	-1.069560405	1
MW59					-2.708298229	0	0.658011397	0	1.860338007	0	-0.799628365	0	-0.823908741	0

Well ID	Dissolved Antimony	D_Dissolved Antimony	Dissolved Arsenic	D_Dissolved Arsenic	Dissolved Low Level Mercury	D_Dissolved Low Level Mercury	Total Antimony	D_Total Antimony	Total Arsenic	D_Total Arsenic	Total Low Level Mercury	D_Total Low Level Mercury	Total Mercury (7470)	D_Total Mercury (7470)
MW19	0.317	1	2.9	1	0.001165	1	0.600625	1	1.80875	1	0.055160625	1		
MW28	6.24	1	23.7	1			11.42222222	1	83.08888889	1				
MW29	1.5685	1	25.55	1	0.00401	1	1.371666667	1	56.87777778	1	7.22E-02	1		
MW31	0.027	1	0.05	0	0.00271	1	0.461142857	1	1.547142857	1	8.97E-02	1	0.141833333	1
MW40					0.000613	1	8.76	1	169	1	0.064248	1	0.0885	1
MW42														
MW43					0.002283	1	5.94	1	215.6	1	0.015841	1	0.0852	1
MW59					0.0019575	0	4.55	1	72.5	1	0.158625	1		

Well ID	Log Dissolved Antimony	D_Log Dissolved Antimony	Log Dissolved Arsenic	D_Log Dissolved Arsenic	Log Dissolved Low Level Mercury	D_Log Dissolved Low Level Mercury	Log Total Antimony	D_Log Total Antimony	Log Total Arsenic	D_Log Total Arsenic	Log Total Low Level Mercury	D_Log Total Low Level Mercury	Log Total Mercury (7470)	D_Log Total Mercury (7470)
MW19	-0.4989407	1	0.462398	1	-2.933674075	1	-0.22139659	1	0.257378544	1	-1.258370822	1		
MW28	0.79518459	1	1.3747483	1			1.057750605	1	1.919542951	1				
MW29	0.19548452	1	1.4073909	1	-2.396855627	1	0.137248585	1	1.75494262	1	-1.141596493	1		
MW31	-1.5686362	1	-1.30103	0	-2.567030709	1	-0.33616451	1	0.189530417	1	-1.047321696	1	-0.84822169	1
MW40					-3.212539525	1	0.942504106	1	2.227886705	1	-1.192140387	1	-1.053056729	1
MW42														
MW43					-2.641494089	1	0.773786445	1	2.333648757	1	-1.800217406	1	-1.069560405	1
MW59					-2.708298229	0	0.658011397	0	1.860338007	0	-0.799628365	0		



Outlier Tests for Selected Uncensored Variables

User Selected Options
Date/Time of Computation ProUCL 5.14/16/2019 9:51:59 AM
From File Average Conc by Parameter and Well Xtab 04092019.xls
Full Precision OFF

Dixon's Outlier Test for Total Antimony

Number of Observations = 8
10% critical value: 0.479
5% critical value: 0.554
1% critical value: 0.683

1. Observation Value 216 is a Potential Outlier (Upper Tail)?

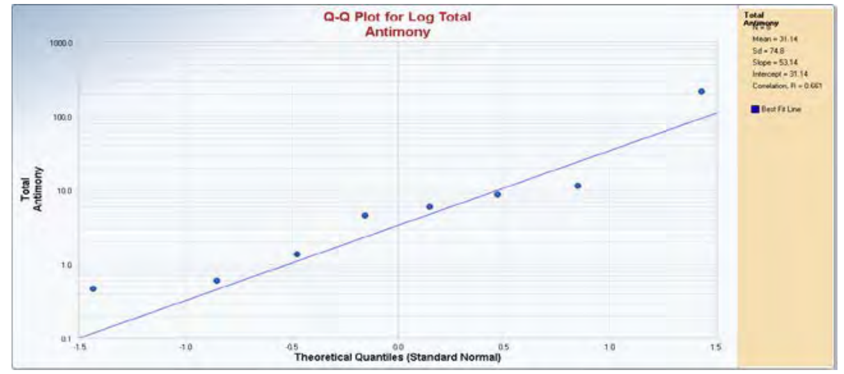
Test Statistic: 0.950

For 10% significance level, 216 is an outlier.
For 5% significance level, 216 is an outlier.
For 1% significance level, 216 is an outlier.

2. Observation Value 0.461142857142857 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.013

For 10% significance level, 0.461142857142857 is not an outlier.
For 5% significance level, 0.461142857142857 is not an outlier.
For 1% significance level, 0.461142857142857 is not an outlier.



Outlier Tests for Selected Uncensored Variables

User Selected Options
Date/Time of Computation ProUCL 5.14/16/2019 9:53:10 AM
From File Average Conc by Parameter and Well Xtab 04092019.xls
Full Precision OFF

Dixon's Outlier Test for Log Total Antimony

Number of Observations = 8
10% critical value: 0.479
5% critical value: 0.554
1% critical value: 0.683

1. Observation Value 2.33445375115093 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.500

For 10% significance level, 2.33445375115093 is an outlier.
For 5% significance level, 2.33445375115093 is not an outlier.
For 1% significance level, 2.33445375115093 is not an outlier.

2. Observation Value -0.336164513964224 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.082

For 10% significance level, -0.336164513964224 is not an outlier.
For 5% significance level, -0.336164513964224 is not an outlier.
For 1% significance level, -0.336164513964224 is not an outlier.

Outlier Tests for Selected Uncensored Variables

User Selected Options
Date/Time of Computation ProUCL 5.14/16/2019 9:58:35 AM
From File Average Conc by Parameter and Well Xtab 04092019_a.xls
Full Precision OFF

Outlier Tests for Selected Uncensored Variables

User Selected Options
Date/Time of Computation ProUCL 5.14/16/2019 10:00:42 AM
From File Average Conc by Parameter and Well Xtab 04092019_a.xls
Full Precision OFF

Dixon's Outlier Test for Total Antimony

Number of Observations = 7
10% critical value: 0.434
5% critical value: 0.507
1% critical value: 0.637

1. Observation Value 11.4222222222222 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.243

For 10% significance level, 11.4222222222222 is not an outlier.
For 5% significance level, 11.4222222222222 is not an outlier.
For 1% significance level, 11.4222222222222 is not an outlier.

2. Observation Value 0.461142857142857 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.013

For 10% significance level, 0.461142857142857 is not an outlier.
For 5% significance level, 0.461142857142857 is not an outlier.
For 1% significance level, 0.461142857142857 is not an outlier.

Dixon's Outlier Test for Log Total Antimony

Number of Observations = 7
10% critical value: 0.434
5% critical value: 0.507
1% critical value: 0.637

1. Observation Value 1.05775060521993 is a Potential Outlier (Upper Tail)?

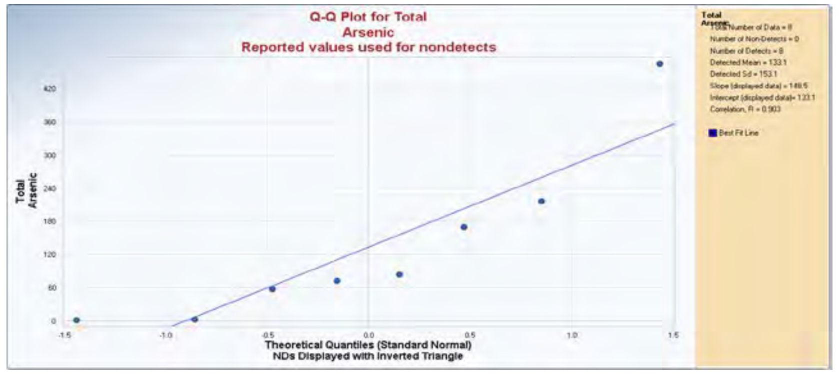
Test Statistic: 0.083

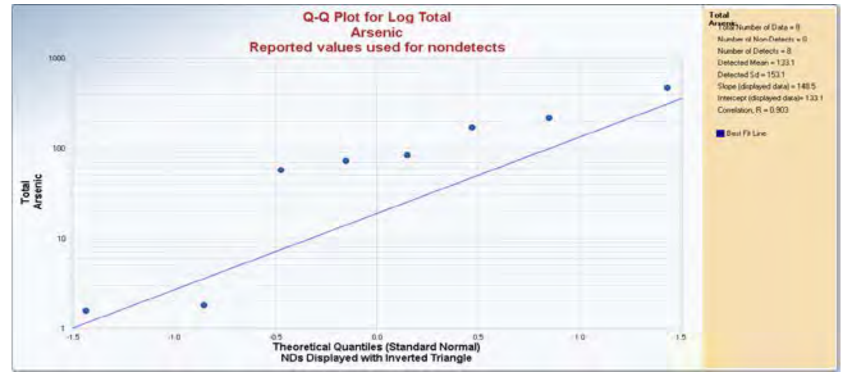
For 10% significance level, 1.05775060521993 is not an outlier.
For 5% significance level, 1.05775060521993 is not an outlier.
For 1% significance level, 1.05775060521993 is not an outlier.

2. Observation Value -0.336164513964224 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.082

For 10% significance level, -0.336164513964224 is not an outlier.
For 5% significance level, -0.336164513964224 is not an outlier.
For 1% significance level, -0.336164513964224 is not an outlier.





Outlier Tests for Selected Uncensored Variables

User Selected Options
Date/Time of Computation ProUCL 5.14/16/2019 10:04:14 AM
From File Average Conc by Parameter and Well Xtab 04092019.xls
Full Precision OFF

Dixon's Outlier Test for Total Arsenic

Number of Observations = 8
10% critical value: 0.479
5% critical value: 0.554
1% critical value: 0.683

1. Observation Value 464 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.537

For 10% significance level, 464 is an outlier.
For 5% significance level, 464 is not an outlier.
For 1% significance level, 464 is not an outlier.

2. Observation Value 1.54714285714286 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.001

For 10% significance level, 1.54714285714286 is not an outlier.
For 5% significance level, 1.54714285714286 is not an outlier.
For 1% significance level, 1.54714285714286 is not an outlier.

Outlier Tests for Selected Uncensored Variables

User Selected Options
Date/Time of Computation ProUCL 5.14/16/2019 10:06:49 AM
From File Average Conc by Parameter and Well Xtab 04092019_a.xls
Full Precision OFF

Outlier Tests for Selected Uncensored Variables

User Selected Options
Date/Time of Computation ProUCL 5.14/16/2019 10:04:53 AM
From File Average Conc by Parameter and Well Xtab 04092019.xls
Full Precision OFF

Dixon's Outlier Test for Log Total Arsenic

Number of Observations = 8
10% critical value: 0.479
5% critical value: 0.554
1% critical value: 0.683

1. Observation Value 2.66651798055488 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.138

For 10% significance level, 2.66651798055488 is not an outlier.
For 5% significance level, 2.66651798055488 is not an outlier.
For 1% significance level, 2.66651798055488 is not an outlier.

2. Observation Value 0.189530416611064 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.032

For 10% significance level, 0.189530416611064 is not an outlier.
For 5% significance level, 0.189530416611064 is not an outlier.
For 1% significance level, 0.189530416611064 is not an outlier.

Outlier Tests for Selected Uncensored Variables

User Selected Options
Date/Time of Computation ProUCL 5.14/16/2019 10:07:30 AM
From File Average Conc by Parameter and Well Xtab 04092019_a.xls
Full Precision OFF

Dixon's Outlier Test for Total Arsenic

Number of Observations = 7
10% critical value: 0.434
5% critical value: 0.507
1% critical value: 0.637

1. Observation Value 215.6 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.218

For 10% significance level, 215.6 is not an outlier.
For 5% significance level, 215.6 is not an outlier.
For 1% significance level, 215.6 is not an outlier.

2. Observation Value 1.54714285714286 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.001

For 10% significance level, 1.54714285714286 is not an outlier.
For 5% significance level, 1.54714285714286 is not an outlier.
For 1% significance level, 1.54714285714286 is not an outlier.

Dixon's Outlier Test for Log Total Arsenic

Number of Observations = 7
10% critical value: 0.434
5% critical value: 0.507
1% critical value: 0.637

1. Observation Value 2.3336487565147 is a Potential Outlier (Upper Tail)?

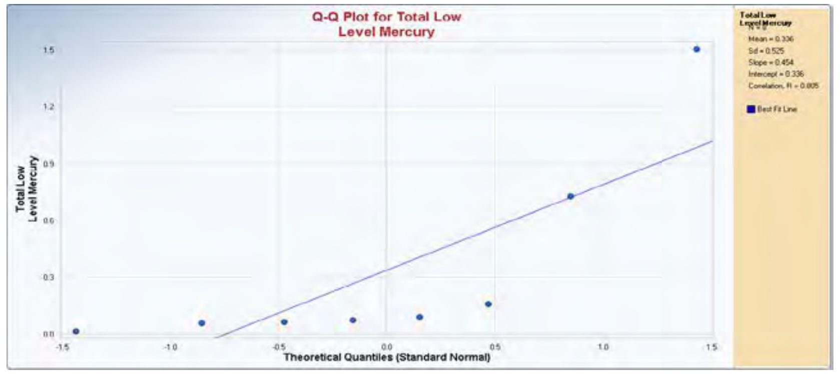
Test Statistic: 0.049

For 10% significance level, 2.3336487565147 is not an outlier.
For 5% significance level, 2.3336487565147 is not an outlier.
For 1% significance level, 2.3336487565147 is not an outlier.

2. Observation Value 0.189530416611064 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.032

For 10% significance level, 0.189530416611064 is not an outlier.
For 5% significance level, 0.189530416611064 is not an outlier.
For 1% significance level, 0.189530416611064 is not an outlier.



Outlier Tests for Selected Uncensored Variables

User Selected Options
Date/Time of Computation ProUCL 5.14/16/2019 10:11:08 AM
From File Average Conc by Parameter and Well Xtab 04092019.xls
Full Precision OFF

Dixon's Outlier Test for Total Low Level Mercury

Number of Observations = 8
10% critical value: 0.479
5% critical value: 0.554
1% critical value: 0.683

1. Observation Value 1.502 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.536

For 10% significance level, 1.502 is an outlier.
For 5% significance level, 1.502 is not an outlier.
For 1% significance level, 1.502 is not an outlier.

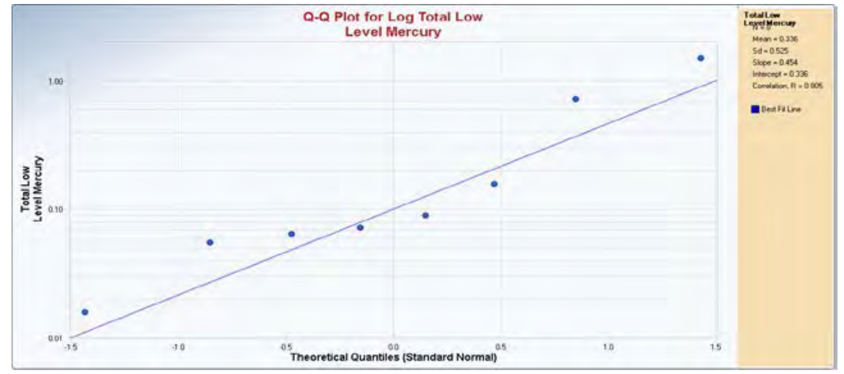
2. Observation Value 0.015841 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.055

For 10% significance level, 0.015841 is not an outlier.
For 5% significance level, 0.015841 is not an outlier.
For 1% significance level, 0.015841 is not an outlier.

Outlier Tests for Selected Uncensored Variables

User Selected Options
Date/Time of Computation ProUCL 5.14/16/2019 10:13:18 AM
From File Average Conc by Parameter and Well Xtab 04092019_a.xls
Full Precision OFF



Outlier Tests for Selected Uncensored Variables

User Selected Options
Date/Time of Computation ProUCL 5.14/16/2019 10:11:42 AM
From File Average Conc by Parameter and Well Xtab 04092019.xls
Full Precision OFF

Dixon's Outlier Test for Log Total Low Level Mercury

Number of Observations = 8
10% critical value: 0.479
5% critical value: 0.554
1% critical value: 0.683

1. Observation Value 0.17666993266815 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.220

For 10% significance level, 0.17666993266815 is not an outlier.
For 5% significance level, 0.17666993266815 is not an outlier.
For 1% significance level, 0.17666993266815 is not an outlier.

2. Observation Value -1.80021740603101 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.326

For 10% significance level, -1.80021740603101 is not an outlier.
For 5% significance level, -1.80021740603101 is not an outlier.
For 1% significance level, -1.80021740603101 is not an outlier.

Outlier Tests for Selected Uncensored Variables

User Selected Options
Date/Time of Computation ProUCL 5.14/16/2019 10:14:10 AM
From File Average Conc by Parameter and Well Xtab 04092019_a.xls
Full Precision OFF

Dixon's Outlier Test for Total Low Level Mercury

Number of Observations = 7
10% critical value: 0.434
5% critical value: 0.507
1% critical value: 0.637

1. Observation Value 0.72676 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.799

For 10% significance level, 0.72676 is an outlier.
For 5% significance level, 0.72676 is an outlier.
For 1% significance level, 0.72676 is an outlier.

2. Observation Value 0.015841 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.055

For 10% significance level, 0.015841 is not an outlier.
For 5% significance level, 0.015841 is not an outlier.
For 1% significance level, 0.015841 is not an outlier.

Dixon's Outlier Test for Log Total Low Level Mercury

Number of Observations = 7
10% critical value: 0.434
5% critical value: 0.507
1% critical value: 0.637

1. Observation Value -0.138608983754384 is a Potential Outlier (Upper Tail)?

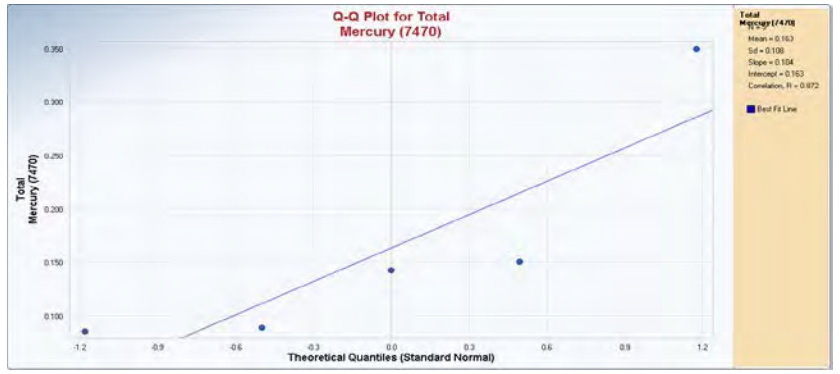
Test Statistic: 0.398

For 10% significance level, -0.138608983754384 is not an outlier.
For 5% significance level, -0.138608983754384 is not an outlier.
For 1% significance level, -0.138608983754384 is not an outlier.

2. Observation Value -1.80021740603101 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.326

For 10% significance level, -1.80021740603101 is not an outlier.
For 5% significance level, -1.80021740603101 is not an outlier.
For 1% significance level, -1.80021740603101 is not an outlier.



Outlier Tests for Selected Uncensored Variables

User Selected Options
Date/Time of Computation ProUCL 5.14/16/2019 10:23:14 AM
From File Average Conc by Parameter and Well Xtab 04092019.xls
Full Precision OFF

Dixon's Outlier Test for Total Mercury (7470)

Number of Observations = 5
10% critical value: 0.557
5% critical value: 0.642
1% critical value: 0.78

1. Observation Value 0.3491 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.754

For 10% significance level, 0.3491 is an outlier.
For 5% significance level, 0.3491 is an outlier.
For 1% significance level, 0.3491 is not an outlier.

2. Observation Value 0.0852 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.013

For 10% significance level, 0.0852 is not an outlier.
For 5% significance level, 0.0852 is not an outlier.
For 1% significance level, 0.0852 is not an outlier.

Outlier Tests for Selected Uncensored Variables

User Selected Options
Date/Time of Computation ProUCL 5.14/16/2019 10:24:04 AM
From File Average Conc by Parameter and Well Xtab 04092019.xls
Full Precision OFF

Dixon's Outlier Test for Log Total Mercury (7470)

Number of Observations = 5
10% critical value: 0.557
5% critical value: 0.642
1% critical value: 0.78

1. Observation Value -0.457050151185821 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.599

For 10% significance level, -0.457050151185821 is an outlier.
For 5% significance level, -0.457050151185821 is not an outlier.
For 1% significance level, -0.457050151185821 is not an outlier.

2. Observation Value -1.0695604052333 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.027

For 10% significance level, -1.0695604052333 is not an outlier.
For 5% significance level, -1.0695604052333 is not an outlier.
For 1% significance level, -1.0695604052333 is not an outlier.

Outlier Tests for Selected Uncensored Variables

User Selected Options
Date/Time of Computation ProUCL 5.14/16/2019 10:25:55 AM
From File Average Conc by Parameter and Well Xtab 04092019_a.xls
Full Precision OFF

Outlier Tests for Selected Uncensored Variables

User Selected Options
Date/Time of Computation ProUCL 5.14/16/2019 10:26:37 AM
From File Average Conc by Parameter and Well Xtab 04092019_a.xls
Full Precision OFF

Dixon's Outlier Test for Log Total Mercury (7470)

Number of Observations = 4
10% critical value: 0.679
5% critical value: 0.765
1% critical value: 0.889

1. Observation Value -0.823908740944319 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.099

For 10% significance level, -0.823908740944319 is not an outlier.
For 5% significance level, -0.823908740944319 is not an outlier.
For 1% significance level, -0.823908740944319 is not an outlier.

2. Observation Value -1.0695604052333 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.067

For 10% significance level, -1.0695604052333 is not an outlier.
For 5% significance level, -1.0695604052333 is not an outlier.
For 1% significance level, -1.0695604052333 is not an outlier.

Dixon's Outlier Test for Log Total Mercury (7470)

Number of Observations = 4
10% critical value: 0.679
5% critical value: 0.765
1% critical value: 0.889

1. Observation Value -0.823908740944319 is a Potential Outlier (Upper Tail)?

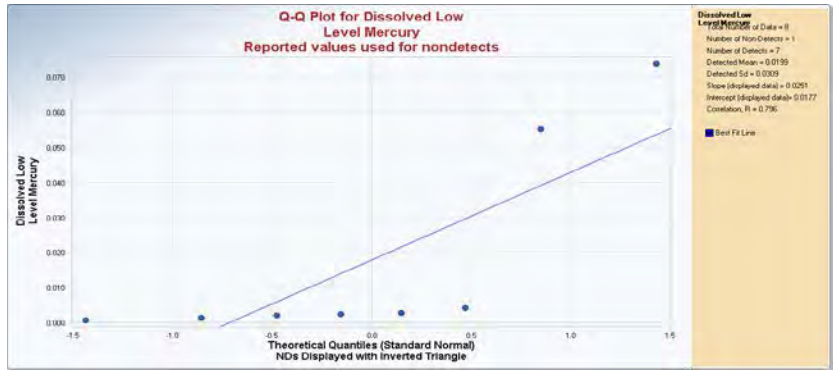
Test Statistic: 0.099

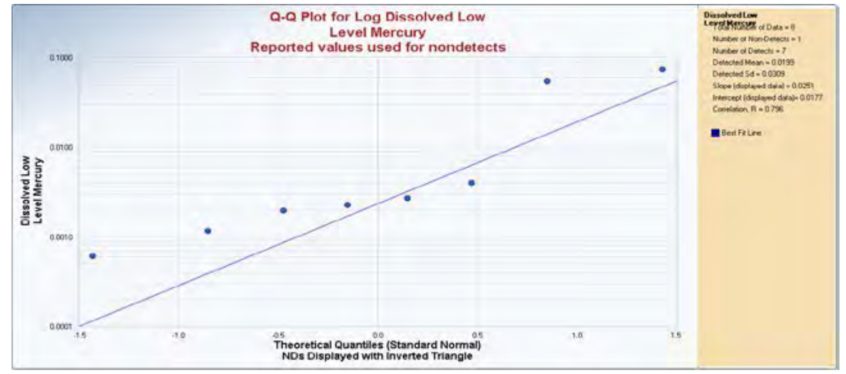
For 10% significance level, -0.823908740944319 is not an outlier.
For 5% significance level, -0.823908740944319 is not an outlier.
For 1% significance level, -0.823908740944319 is not an outlier.

2. Observation Value -1.0695604052333 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.067

For 10% significance level, -1.0695604052333 is not an outlier.
For 5% significance level, -1.0695604052333 is not an outlier.
For 1% significance level, -1.0695604052333 is not an outlier.





Outlier Tests for Selected Variables replacing nondetects with 1/2 the Detection Limit
User Selected Options
Date/Time of Computation ProUCL 5.14/16/2019 10:31:20 AM
From File Average Conc by Parameter and Well Xtab 04092019.xls
Full Precision OFF

Dixon's Outlier Test for Dissolved Low Level Mercury

Total N = 8
Number NDs = 1
Number Detects = 7
Number Data (n) = 8
10% critical value: 0.479
5% critical value: 0.554
1% critical value: 0.683
Note: NDs replaced by DL/2 in Outlier Test

1. Data Value 0.0736777777777778 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.255

For 10% significance level, 0.0736777777777778 is not an outlier.
For 5% significance level, 0.0736777777777778 is not an outlier.
For 1% significance level, 0.0736777777777778 is not an outlier.

2. Data Value 0.000613 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.007

For 10% significance level, 0.000613 is not an outlier.
For 5% significance level, 0.000613 is not an outlier.
For 1% significance level, 0.000613 is not an outlier.

Outlier Tests for Selected Variables replacing nondetects with 1/2 the Detection Limit
User Selected Options
Date/Time of Computation ProUCL 5.14/16/2019 10:37:06 AM
From File Average Conc by Parameter and Well Xtab 04092019_a.xls
Full Precision OFF

Outlier Tests for Selected Variables replacing nondetects with 1/2 the Detection Limit
User Selected Options
Date/Time of Computation ProUCL 5.14/16/2019 10:32:42 AM
From File Average Conc by Parameter and Well Xtab 04092019.xls
Full Precision OFF

Dixon's Outlier Test for Log Dissolved Low Level Mercury

Total N = 8
Number NDs = 1
Number Detects = 7
Number Data (n) = 8
10% critical value: 0.479
5% critical value: 0.554
1% critical value: 0.683
Note: NDs replaced by DL/2 in Outlier Test

1. Data Value -1.13266348152732 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.070

For 10% significance level, -1.13266348152732 is not an outlier.
For 5% significance level, -1.13266348152732 is not an outlier.
For 1% significance level, -1.13266348152732 is not an outlier.

2. Data Value -3.21253952548158 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.143

For 10% significance level, -3.21253952548158 is not an outlier.
For 5% significance level, -3.21253952548158 is not an outlier.
For 1% significance level, -3.21253952548158 is not an outlier.

Outlier Tests for Selected Variables replacing nondetects with 1/2 the Detection Limit
User Selected Options
Date/Time of Computation ProUCL 5.14/16/2019 10:43:22 AM
From File Average Conc by Parameter and Well Xtab 04092019_a.xls
Full Precision OFF

Dixon's Outlier Test for Dissolved Low Level Mercury

Total N = 7
Number NDs = 1
Number Detects = 6
Number Data (n) = 7
10% critical value: 0.434
5% critical value: 0.507
1% critical value: 0.637
Note: NDs replaced by DL/2 in Outlier Test

1. Data Value 0.05515 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.938

For 10% significance level, 0.05515 is an outlier.
For 5% significance level, 0.05515 is an outlier.
For 1% significance level, 0.05515 is an outlier.

2. Data Value 0.000613 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.007

For 10% significance level, 0.000613 is not an outlier.
For 5% significance level, 0.000613 is not an outlier.
For 1% significance level, 0.000613 is not an outlier.

Outlier Tests for Selected Variables replacing nondetects with 1/2 the Detection Limit

User Selected Options	
Date/Time of Computation	ProUCL 5.14/16/2019 10:45:06 AM
From File	Average Conc by Parameter and Well Xtab 04092019_b.xls
Full Precision	OFF

Dixon's Outlier Test for Log Dissolved Low Level Mercury

Total N = 7
Number NDs = 1
Number Detects = 6
Number Data (n) = 7
10% critical value: 0.434
5% critical value: 0.507
1% critical value: 0.637
Note: NDs replaced by DL/2 in Outlier Test

1. Data Value -1.25845448322379 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.049

For 10% significance level, -1.25845448322379 is not an outlier.
For 5% significance level, -1.25845448322379 is not an outlier.
For 1% significance level, -1.25845448322379 is not an outlier.

2. Data Value -3.21253952548158 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.143

For 10% significance level, -3.21253952548158 is not an outlier.
For 5% significance level, -3.21253952548158 is not an outlier.
For 1% significance level, -3.21253952548158 is not an outlier.

Outlier Tests for Selected Variables replacing nondetects with 1/2 the Detection Limit

User Selected Options	
Date/Time of Computation	ProUCL 5.14/16/2019 10:45:54 AM
From File	Average Conc by Parameter and Well Xtab 04092019_b.xls
Full Precision	OFF

Dixon's Outlier Test for Dissolved Low Level Mercury

Total N = 6
Number NDs = 1
Number Detects = 5
Number Data (n) = 6
10% critical value: 0.482
5% critical value: 0.56
1% critical value: 0.698
Note: NDs replaced by DL/2 in Outlier Test

1. Data Value 0.00401 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.383

For 10% significance level, 0.00401 is not an outlier.
For 5% significance level, 0.00401 is not an outlier.
For 1% significance level, 0.00401 is not an outlier.

2. Data Value 0.000613 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.108

For 10% significance level, 0.000613 is not an outlier.
For 5% significance level, 0.000613 is not an outlier.
For 1% significance level, 0.000613 is not an outlier.

Dixon's Outlier Test for Log Dissolved Low Level Mercury

Total N = 6
Number NDs = 1
Number Detects = 5
Number Data (n) = 6
10% critical value: 0.482
5% critical value: 0.56
1% critical value: 0.698
Note: NDs replaced by DL/2 in Outlier Test

1. Data Value -1.35414911463501 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.561

For 10% significance level, -1.35414911463501 is an outlier.
For 5% significance level, -1.35414911463501 is an outlier.
For 1% significance level, -1.35414911463501 is not an outlier.

2. Data Value -3.21253952548158 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.150

For 10% significance level, -3.21253952548158 is not an outlier.
For 5% significance level, -3.21253952548158 is not an outlier.
For 1% significance level, -3.21253952548158 is not an outlier.

Background Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.14/16/2019 10:54:30 AM
From File	BLM\Red Devil\Mineralized Groundwater\Revised Dataset 04092019\Average Conc by Parameter and Well Xtab 04092019.xlsx
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
New or Future K Observations	1
Number of Bootstrap Operations	2000

Total
Antimony

General Statistics			
Total Number of Observations	8	Number of Distinct Observations	8
Minimum	0.461	First Quartile	1.179
Second Largest	11.42	Median	5.245
Maximum	216	Third Quartile	9.426
Mean	31.14	SD	74.8
Coefficient of Variation	2.402	Skewness	2.813
Mean of logged Data	1.539	SD of logged Data	1.965
Critical Values for Background Threshold Values (BTVs)			
Tolerance Factor K (For UTL)	3.187	d2max (for USL)	2.032
Normal GOF Test			
Shapiro Wilk Test Statistic	0.467	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.818	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.479	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.283	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Background Statistics Assuming Normal Distribution			
95% UTL with 95% Coverage	269.5	90% Percentile (z)	127
95% UPL (t)	181.4	95% Percentile (z)	154.2
95% USL	183.1	99% Percentile (z)	205.1
Gamma GOF Test			
A-D Test Statistic	0.909	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.788	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.347	Kolmogorov-Smirnov Gamma GOF Test	
5% K-S Critical Value	0.315	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	0.353	k star (bias corrected MLE)	0.304
Theta hat (MLE)	88.11	Theta star (bias corrected MLE)	102.4
nu hat (MLE)	5.655	nu star (bias corrected)	4.867
MLE Mean (bias corrected)	31.14	MLE Sd (bias corrected)	56.45
Background Statistics Assuming Gamma Distribution			
95% Wilson Hilferty (WH) Approx. Gamma UPL	161.4	90% Percentile	91.68
95% Hawkins Wixley (HW) Approx. Gamma UPL	164.1	95% Percentile	141.8
95% WH Approx. Gamma UTL with 95% Coverage	409.6	99% Percentile	271.8
95% HW Approx. Gamma UTL with 95% Coverage	491.8		
95% WH USL	164.8	95% HW USL	168
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.922	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.818	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.199	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.283	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Background Statistics assuming Lognormal Distribution			
95% UTL with 95% Coverage	**2442**	90% Percentile (z)	57.78
95% UPL (t)	**241.5**	**95% Percentile (z)**	**118**
95% USL	**252.3**	**99% Percentile (z)**	**450.1**
Nonparametric Distribution Free Background Statistics			
Data appear Lognormal at 5% Significance Level			
Nonparametric Upper Limits for Background Threshold Values			
Order of Statistic, r	8	95% UTL with 95% Coverage	216
Approx, f used to compute achieved CC	0.421	Approximate Actual Confidence Coefficient achieved by U	0.337
		Approximate Sample Size needed to achieve specified CC	59

95% Percentile Bootstrap UTL with 95% Coverage	216	95% BCA Bootstrap UTL with 95% Coverage	216
95% UPL	216	90% Percentile	72.8
90% Chebyshev UPL	269.1	95% Percentile	144.4
95% Chebyshev UPL	377	99% Percentile	201.7
95% USL	216		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Total
Arsenic

General Statistics

Total Number of Observations	8	Number of Distinct Observations	8
Minimum	1.547	First Quartile	43.11
Second Largest	215.6	Median	77.79
Maximum	464	Third Quartile	180.7
Mean	133.1	SD	153.1
Coefficient of Variation	1.151	Skewness	1.673
Mean of logged Data	3.802	SD of logged Data	2.138

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	3.187	d2max (for USL)	2.032

Normal GOF Test

Shapiro Wilk Test Statistic	0.824	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.818	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.253	Lilliefors GOF Test
5% Lilliefors Critical Value	0.283	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 95% Coverage	**621**	90% Percentile (z)	329.3
95% UPL (t)	**440.7**	**95% Percentile (z)**	**384.9**
95% USL	**444.1**	**99% Percentile (z)**	**489.3**

Gamma GOF Test

A-D Test Statistic	0.372	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.757	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.21	Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value	0.308	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.572	k star (bias corrected MLE)	0.441
Theta hat (MLE)	232.8	Theta star (bias corrected MLE)	302
nu hat (MLE)	9.146	nu star (bias corrected)	7.05
MLE Mean (bias corrected)	133.1	MLE Sd (bias corrected)	200.4

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	681.1	90% Percentile	369.2
95% Hawkins Wixley (HW) Approx. Gamma UPL	824.1	95% Percentile	534.5
95% WH Approx. Gamma UTL with 95% Coverage	1506	99% Percentile	946.1
95% HW Approx. Gamma UTL with 95% Coverage	2151		
95% WH USL	692.8	95% HW USL	841

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.833	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.818	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.294	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.283	Data Not Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Background Statistics assuming Lognormal Distribution

95% UTL with 95% Coverage	40774	90% Percentile (z)	693.7
95% UPL (t)	3289	95% Percentile (z)	1508
95% USL	3448	99% Percentile (z)	6475

Nonparametric Distribution Free Background Statistics
Data appear Normal at 5% Significance Level

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	8	95% UTL with 95% Coverage	464

Approx, f used to compute achieved CC	0.421	Approximate Actual Confidence Coefficient achieved by U	0.337
		Approximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	464	95% BCA Bootstrap UTL with 95% Coverage	464
95% UPL	464	90% Percentile	290.1
90% Chebyshev UPL	620.3	95% Percentile	377.1
95% Chebyshev UPL	841	99% Percentile	446.6
95% USL	464		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Total Low Level Mercury

General Statistics			
Total Number of Observations	8	Number of Distinct Observations	8
Minimum	0.0158	First Quartile	0.062
Second Largest	0.727	Median	0.0809
Maximum	1.502	Third Quartile	0.301
Mean	0.336	SD	0.525
Coefficient of Variation	1.564	Skewness	2.019
Mean of logged Data	-2.073	SD of logged Data	1.47
Critical Values for Background Threshold Values (BTVs)			
Tolerance Factor K (For UTL)	3.187	d2max (for USL)	2.032
Normal GOF Test			
Shapiro Wilk Test Statistic	0.661	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.818	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.382	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.283	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Background Statistics Assuming Normal Distribution			
95% UTL with 95% Coverage	2.009	90% Percentile (z)	1.008
95% UPL (t)	1.391	95% Percentile (z)	1.199
95% USL	1.402	99% Percentile (z)	1.557
Gamma GOF Test			
A-D Test Statistic	0.706	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.754	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.284	Kolmogorov-Smirnov Gamma GOF Test	
5% K-S Critical Value	0.307	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	0.626	k star (bias corrected MLE)	0.475
Theta hat (MLE)	0.536	Theta star (bias corrected MLE)	0.707
nu hat (MLE)	10.02	nu star (bias corrected)	7.594
MLE Mean (bias corrected)	0.336	MLE Sd (bias corrected)	0.487
Background Statistics Assuming Gamma Distribution			
95% Wilson Hilferty (WH) Approx. Gamma UPL	**1.601**	90% Percentile	0.918
95% Hawkins Wixley (HW) Approx. Gamma UPL	1.694	**95% Percentile**	**1.313**
95% WH Approx. Gamma UTL with 95% Coverage	**3.56**	**99% Percentile**	**2.291**
95% HW Approx. Gamma UTL with 95% Coverage	4.275		
95% WH USL	**1.628**	95% HW USL	1.727
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.925	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.818	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.216	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.283	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Background Statistics assuming Lognormal Distribution			
95% UTL with 95% Coverage	13.63	90% Percentile (z)	0.828
95% UPL (t)	2.414	95% Percentile (z)	1.413
95% USL	2.494	99% Percentile (z)	3.847

Nonparametric Distribution Free Background Statistics
Data appear Gamma Distributed at 5% Significance Level

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	8	95% UTL with 95% Coverage	1.502
Approx, f used to compute achieved CC	0.421	Approximate Actual Confidence Coefficient achieved by U	0.337
		Approximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	1.502	95% BCA Bootstrap UTL with 95% Coverage	1.502
95% UPL	1.502	90% Percentile	0.959
90% Chebyshev UPL	2.006	95% Percentile	1.231
95% Chebyshev UPL	2.763	99% Percentile	1.448
95% USL	1.502		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Background Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.14/16/2019 11:00:58 AM
From File	Average Conc by Parameter and Well Xtab 04092019.xls
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
Different or Future K Observations	1
Number of Bootstrap Operations	2000

Dissolved Low Level Mercury

General Statistics

Total Number of Observations	8	Number of Missing Observations	0
Number of Distinct Observations	8		
Number of Detects	7	Number of Non-Detects	1
Number of Distinct Detects	7	Number of Distinct Non-Detects	1
Minimum Detect	6.13E-04	Minimum Non-Detect	0.00196
Maximum Detect	0.0737	Maximum Non-Detect	0.00196
Variance Detected	9.53E-04	Percent Non-Detects	12.50%
Mean Detected	0.0199	SD Detected	0.0309
Mean of Detected Logged Data	-5.31	SD of Detected Logged Data	1.851

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	3.187	d2max (for USL)	2.032

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.676	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.803	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.411	Lilliefors GOF Test
5% Lilliefors Critical Value	0.304	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Kaplan Meier (KM) Background Statistics Assuming Normal Distribution

KM Mean	0.0176	KM SD	0.0275
95% UTL95% Coverage	0.105	95% KM UPL (t)	0.0727
90% KM Percentile (z)	0.0528	95% KM Percentile (z)	0.0627
99% KM Percentile (z)	0.0815	95% KM USL	0.0734

DL/2 Substitution Background Statistics Assuming Normal Distribution

Mean	0.0176	SD	0.0294
95% UTL95% Coverage	0.111	95% UPL (t)	0.0766
90% Percentile (z)	0.0552	95% Percentile (z)	0.0659
99% Percentile (z)	0.0859	95% USL	0.0772

DL/2 is not a recommended method. DL/2 provided for comparisons and historical reasons

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.783	Anderson-Darling GOF Test
5% A-D Critical Value	0.758	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.348	Kolmogorov-Smirnov GOF
5% K-S Critical Value	0.329	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.461	k star (bias corrected MLE)	0.359
Theta hat (MLE)	0.0433	Theta star (bias corrected MLE)	0.0556
nu hat (MLE)	6.455	nu star (bias corrected)	5.022
MLE Mean (bias corrected)	0.0199		

MLE Sd (bias corrected)		0.0333	95% Percentile of Chisquare (2kstar)		3.094

Gamma ROS Statistics using Imputed Non-Detects
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum		6.13E-04	Mean		0.0187
Maximum		0.0737	Median		0.00336
SD		0.0288	CV		1.54
k hat (MLE)		0.51	k star (bias corrected MLE)		0.402
Theta hat (MLE)		0.0367	Theta star (bias corrected MLE)		0.0465
nu hat (MLE)		8.154	nu star (bias corrected)		6.43
MLE Mean (bias corrected)		0.0187	MLE Sd (bias corrected)		0.0295
95% Percentile of Chisquare (2kstar)		3.334	90% Percentile		0.0528
95% Percentile		0.0776	99% Percentile		0.14

The following statistics are computed using Gamma ROS Statistics on Imputed Data
Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods

	WH	HW		WH	HW
95% Approx. Gamma UTL with 95% Coverage	0.226	0.285	95% Approx. Gamma UPL	0.0972	0.106
95% Gamma USL	0.099	0.108			

Estimates of Gamma Parameters using KM Estimates

Mean (KM)		0.0176	SD (KM)		0.0275
Variance (KM)		7.54E-04	SE of Mean (KM)		0.0105
k hat (KM)		0.409	k star (KM)		0.339
nu hat (KM)		6.543	nu star (KM)		5.423
theta hat (KM)		0.0429	theta star (KM)		0.0518
80% gamma percentile (KM)		0.0276	90% gamma percentile (KM)		0.051
95% gamma percentile (KM)		0.0772	99% gamma percentile (KM)		0.144

The following statistics are computed using gamma distribution and KM estimates
Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods

	WH	HW		WH	HW
95% Approx. Gamma UTL with 95% Coverage	0.2	0.245	95% Approx. Gamma UPL	0.0844	0.0889
95% KM Gamma Percentile	0.0609	0.0612	95% Gamma USL	0.086	0.0909

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic		0.871	Shapiro Wilk GOF Test		
5% Shapiro Wilk Critical Value		0.803	Detected Data appear Lognormal at 5% Significance Level		
Lilliefors Test Statistic		0.259	Lilliefors GOF Test		
5% Lilliefors Critical Value		0.304	Detected Data appear Lognormal at 5% Significance Level		

Detected Data appear Lognormal at 5% Significance Level

Background Lognormal ROS Statistics Assuming Lognormal Distribution Using Imputed Non-Detects

Mean in Original Scale		0.0175	Mean in Log Scale		-5.569
SD in Original Scale		0.0294	SD in Log Scale		1.863
95% UTL95% Coverage		1.448	95% BCA UTL95% Coverage		0.0737
95% Bootstrap (%) UTL95% Coverage		0.0737	95% UPL (t)		0.161
90% Percentile (z)		0.0416	95% Percentile (z)		0.0818
99% Percentile (z)		0.291	95% USL		0.168

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean of Logged Data		-5.531	**95% KM UTL (Lognormal)95% Coverage**		**0.923**
KM SD of Logged Data		1.71	**95% KM UPL (Lognormal)**		**0.123**
95% KM Percentile Lognormal (z)		**0.066**	**95% KM USL (Lognormal)**		**0.128**

Background DL/2 Statistics Assuming Lognormal Distribution

Mean in Original Scale		0.0176	Mean in Log Scale		-5.512
SD in Original Scale		0.0294	SD in Log Scale		1.807
95% UTL95% Coverage		1.28	95% UPL (t)		0.152
90% Percentile (z)		0.0409	95% Percentile (z)		0.0789
99% Percentile (z)		0.27	95% USL		0.159

DL/2 is not a Recommended Method. DL/2 provided for comparisons and historical reasons.

Nonparametric Distribution Free Background Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Upper Limits for BTVs(no distinction made between detects and nondetects)

Order of Statistic, r		8	95% UTL with95% Coverage		0.0737
Approx, f used to compute achieved CC		0.421	Approximate Actual Confidence Coefficient achieved by U		0.337
Approximate Sample Size needed to achieve specified CC		59	95% UPL		0.0737
95% USL		0.0737	95% KM Chebyshev UPL		0.145

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.

Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Total
Mercury (7470)

General Statistics

Total Number of Observations	5	Number of Missing Observations	3
Number of Distinct Observations	5		
Number of Detects	4	Number of Non-Detects	1
Number of Distinct Detects	4	Number of Distinct Non-Detects	1
Minimum Detect	0.0852	Minimum Non-Detect	0.15
Maximum Detect	0.349	Maximum Non-Detect	0.15
Variance Detected	0.0155	Percent Non-Detects	20%
Mean Detected	0.166	SD Detected	0.125
Mean of Detected Logged Data	-1.973	SD of Detected Logged Data	0.656

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	4.203	d2max (for USL)	1.671

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.776	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.327	Lilliefors GOF Test
5% Lilliefors Critical Value	0.375	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan Meier (KM) Background Statistics Assuming Normal Distribution

KM Mean	0.154	KM SD	0.1
95% UTL95% Coverage	**0.575**	**95% KM UPL (t)**	**0.388**
90% KM Percentile (z)	0.282	**95% KM Percentile (z)**	**0.319**
99% KM Percentile (z)	**0.387**	**95% KM USL**	**0.322**

DL/2 Substitution Background Statistics Assuming Normal Distribution

Mean	0.148	SD	0.115
95% UTL95% Coverage	0.633	95% UPL (t)	0.417
90% Percentile (z)	0.296	95% Percentile (z)	0.338
99% Percentile (z)	0.416	95% USL	0.341

DL/2 is not a recommended method. DL/2 provided for comparisons and historical reasons

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.498	Anderson-Darling GOF Test
5% A-D Critical Value	0.659	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.281	Kolmogorov-Smirnov GOF
5% K-S Critical Value	0.397	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.958	k star (bias corrected MLE)	0.906
Theta hat (MLE)	0.0562	Theta star (bias corrected MLE)	0.183
nu hat (MLE)	23.67	nu star (bias corrected)	7.25
MLE Mean (bias corrected)	0.166		
MLE Sd (bias corrected)	0.175	95% Percentile of Chisquare (2kstar)	5.623

Gamma ROS Statistics using Imputed Non-Detects
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0852	Mean	0.155
Maximum	0.349	Median	0.109
SD	0.111	CV	0.718
k hat (MLE)	3.361	k star (bias corrected MLE)	1.478
Theta hat (MLE)	0.046	Theta star (bias corrected MLE)	0.105
nu hat (MLE)	33.61	nu star (bias corrected)	14.78
MLE Mean (bias corrected)	0.155	MLE Sd (bias corrected)	0.127
95% Percentile of Chisquare (2kstar)	7.738	90% Percentile	0.323
95% Percentile	0.405	99% Percentile	0.589

The following statistics are computed using Gamma ROS Statistics on Imputed Data
Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods

	WH	HW		WH	HW
95% Approx. Gamma UTL with 95% Coverage	0.931	1.018	95% Approx. Gamma UPL	0.461	0.471
95% Gamma USL	0.343	0.344			

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.154	SD (KM)	0.1
Variance (KM)	0.0101	SE of Mean (KM)	0.0523
k hat (KM)	2.357	k star (KM)	1.076
nu hat (KM)	23.57	nu star (KM)	10.76
theta hat (KM)	0.0653	theta star (KM)	0.143
80% gamma percentile (KM)	0.246	90% gamma percentile (KM)	0.348
95% gamma percentile (KM)	0.449	99% gamma percentile (KM)	0.684

The following statistics are computed using gamma distribution and KM estimates
Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods

	WH	HW		WH	HW
95% Approx. Gamma UTL with 95% Coverage	0.818	0.883	95% Approx. Gamma UPL	0.42	0.427
95% KM Gamma Percentile	0.315	0.314	95% Gamma USL	0.318	0.318

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.851	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.254	Lilliefors GOF Test
5% Lilliefors Critical Value	0.375	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Background Lognormal ROS Statistics Assuming Lognormal Distribution Using Imputed Non-Detects

Mean in Original Scale	0.154	Mean in Log Scale	-2.024
SD in Original Scale	0.111	SD in Log Scale	0.58
95% UTL95% Coverage	1.51	95% BCA UTL95% Coverage	0.349
95% Bootstrap (%) UTL95% Coverage	0.349	95% UPL (t)	0.511
90% Percentile (z)	0.278	95% Percentile (z)	0.343
99% Percentile (z)	0.509	95% USL	0.348

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean of Logged Data	-2.035	95% KM UTL (Lognormal)95% Coverage	1.229
KM SD of Logged Data	0.533	95% KM UPL (Lognormal)	0.454
95% KM Percentile Lognormal (z)	0.314	95% KM USL (Lognormal)	0.319

Background DL/2 Statistics Assuming Lognormal Distribution

Mean in Original Scale	0.148	Mean in Log Scale	-2.097
SD in Original Scale	0.115	SD in Log Scale	0.632
95% UTL95% Coverage	1.748	95% UPL (t)	0.537
90% Percentile (z)	0.276	95% Percentile (z)	0.347
99% Percentile (z)	0.534	95% USL	0.353

DL/2 is not a Recommended Method. DL/2 provided for comparisons and historical reasons.

Nonparametric Distribution Free Background Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Upper Limits for BTVs(no distinction made between detects and nondetects)

Order of Statistic, r	5	95% UTL with95% Coverage	0.349
Approx, f used to compute achieved CC	0.263	Approximate Actual Confidence Coefficient achieved by U	0.226
Approximate Sample Size needed to achieve specified CC	59	95% UPL	0.349
95% USL	0.349	95% KM Chebyshev UPL	0.633

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Background Statistics for Uncensored Full Data Sets

User Selected Options			
Date/Time of Computation	ProUCL 5.14/16/2019 11:10:58 AM		
From File	BLM\Red Devil\Mineralized Groundwater\Revised Dataset 04092019\Average Conc by Parameter and Well Xtab 04092019.xlsx		
Full Precision	OFF		
Confidence Coefficient	95%		
Coverage	95%		
New or Future K Observations	1		
Number of Bootstrap Operations	2000		

Total
Antimony

General Statistics			
Total Number of Observations	7	Number of Distinct Observations	7
		Number of Missing Observations	1
Minimum	0.461	First Quartile	0.986
Second Largest	8.76	Median	4.55
Maximum	11.42	Third Quartile	7.35
Mean	4.729	SD	4.264
Coefficient of Variation	0.902	Skewness	0.545
Mean of logged Data	0.991	SD of logged Data	1.304
Critical Values for Background Threshold Values (BTVs)			
Tolerance Factor K (For UTL)	3.399	d2max (for USL)	1.938
Normal GOF Test			
Shapiro Wilk Test Statistic	0.907	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.803	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.213	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.304	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Background Statistics Assuming Normal Distribution			
95% UTL with 95% Coverage	**19.22**	90% Percentile (z)	10.19
95% UPL (t)	**13.59**	**95% Percentile (z)**	**11.74**
95% USL	**12.99**	**99% Percentile (z)**	**14.65**
Gamma GOF Test			
A-D Test Statistic	0.352	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.727	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.188	Kolmogorov-Smirnov Gamma GOF Test	
5% K-S Critical Value	0.319	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	1.022	k star (bias corrected MLE)	0.679
Theta hat (MLE)	4.626	Theta star (bias corrected MLE)	6.96
nu hat (MLE)	14.31	nu star (bias corrected)	9.513
MLE Mean (bias corrected)	4.729	MLE Sd (bias corrected)	5.737
Background Statistics Assuming Gamma Distribution			
95% Wilson Hilferty (WH) Approx. Gamma UPL	20.44	90% Percentile	11.95
95% Hawkins Wixley (HW) Approx. Gamma UPL	22.85	95% Percentile	16.27
95% WH Approx. Gamma UTL with 95% Coverage	43.56	99% Percentile	26.6
95% HW Approx. Gamma UTL with 95% Coverage	55.23		
95% WH USL	18.64	95% HW USL	20.57
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.893	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.803	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.228	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.304	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Background Statistics assuming Lognormal Distribution			
95% UTL with 95% Coverage	226.5	90% Percentile (z)	14.32
95% UPL (t)	40.42	95% Percentile (z)	23
95% USL	33.71	99% Percentile (z)	55.92
Nonparametric Distribution Free Background Statistics			
Data appear Normal at 5% Significance Level			

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	7	95% UTL with 95% Coverage	11.42
Approx, f used to compute achieved CC	0.368	Approximate Actual Confidence Coefficient achieved by U	0.302
		Approximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	11.42	95% BCA Bootstrap UTL with 95% Coverage	11.42
95% UPL	11.42	90% Percentile	9.825
90% Chebyshev UPL	18.4	95% Percentile	10.62
95% Chebyshev UPL	24.6	99% Percentile	11.26
95% USL	11.42		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Total
Arsenic

General Statistics

Total Number of Observations	7	Number of Distinct Observations	7
		Number of Missing Observations	1
Minimum	1.547	First Quartile	29.34
Second Largest	169	Median	72.5
Maximum	215.6	Third Quartile	126
Mean	85.77	SD	80.56
Coefficient of Variation	0.939	Skewness	0.691
Mean of logged Data	3.468	SD of logged Data	2.072

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	3.399	d2max (for USL)	1.938

Normal GOF Test

Shapiro Wilk Test Statistic	0.905	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.803	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.228	Lilliefors GOF Test
5% Lilliefors Critical Value	0.304	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 95% Coverage	**359.6**	90% Percentile (z)	189
95% UPL (t)	**253.1**	**95% Percentile (z)**	**218.3**
95% USL	**241.9**	**99% Percentile (z)**	**273.2**

Gamma GOF Test

A-D Test Statistic	0.547	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.744	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.267	Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value	0.325	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.624	k star (bias corrected MLE)	0.452
Theta hat (MLE)	137.4	Theta star (bias corrected MLE)	189.7
nu hat (MLE)	8.743	nu star (bias corrected)	6.329
MLE Mean (bias corrected)	85.77	MLE Sd (bias corrected)	127.6

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	460.7	90% Percentile	236.8
95% Hawkins Wixley (HW) Approx. Gamma UPL	570.7	95% Percentile	341.5
95% WH Approx. Gamma UTL with 95% Coverage	1077	99% Percentile	601.4
95% HW Approx. Gamma UTL with 95% Coverage	1601		
95% WH USL	414.7	95% HW USL	503.2

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.788	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.803	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.323	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.304	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Background Statistics assuming Lognormal Distribution

95% UTL with 95% Coverage	36667	90% Percentile (z)	456.2
95% UPL (t)	2372	95% Percentile (z)	968.4
95% USL	1778	99% Percentile (z)	3974

Nonparametric Distribution Free Background Statistics
Data appear Normal at 5% Significance Level

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	7	95% UTL with 95% Coverage	215.6
Approx, f used to compute achieved CC	0.368	Approximate Actual Confidence Coefficient achieved by U	0.302
		Approximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	215.6	95% BCA Bootstrap UTL with 95% Coverage	215.6
95% UPL	215.6	90% Percentile	187.6
90% Chebyshev UPL	344.2	95% Percentile	201.6
95% Chebyshev UPL	461.2	99% Percentile	212.8
95% USL	215.6		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Total Low
Level Mercury

General Statistics

Total Number of Observations	7	Number of Distinct Observations	7
		Number of Missing Observations	1
Minimum	0.0158	First Quartile	0.0597
Second Largest	0.159	Median	0.0722
Maximum	0.727	Third Quartile	0.124
Mean	0.169	SD	0.25
Coefficient of Variation	1.478	Skewness	2.486
Mean of logged Data	-2.427	SD of logged Data	1.162

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	3.399	d2max (for USL)	1.938

Normal GOF Test

Shapiro Wilk Test Statistic	0.611	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.803	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.374	Lilliefors GOF Test
5% Lilliefors Critical Value	0.304	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 95% Coverage	1.018	90% Percentile (z)	0.489
95% UPL (t)	0.688	95% Percentile (z)	0.58
95% USL	0.653	99% Percentile (z)	0.75

Gamma GOF Test

A-D Test Statistic	0.643	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.731	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.284	Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value	0.321	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.901	k star (bias corrected MLE)	0.61
Theta hat (MLE)	0.187	Theta star (bias corrected MLE)	0.277
nu hat (MLE)	12.62	nu star (bias corrected)	8.543
MLE Mean (bias corrected)	0.169	MLE Sd (bias corrected)	0.216

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	**0.737**	90% Percentile	0.438
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.766	**95% Percentile**	**0.604**
95% WH Approx. Gamma UTL with 95% Coverage	**1.621**	**99% Percentile**	**1.006**
95% HW Approx. Gamma UTL with 95% Coverage	1.877		
95% WH USL	**0.669**	95% HW USL	0.688

Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.935	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.803	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.209	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.304	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			

Background Statistics assuming Lognormal Distribution			
95% UTL with 95% Coverage	4.585	90% Percentile (z)	0.392
95% UPL (t)	0.987	95% Percentile (z)	0.597
95% USL	0.84	99% Percentile (z)	1.318

Nonparametric Distribution Free Background Statistics
Data appear Gamma Distributed at 5% Significance Level

Nonparametric Upper Limits for Background Threshold Values			
Order of Statistic, r	7	95% UTL with 95% Coverage	0.727
Approx, f used to compute achieved CC	0.368	Approximate Actual Confidence Coefficient achieved by U	0.302
		Approximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	0.727	95% BCA Bootstrap UTL with 95% Coverage	0.727
95% UPL	0.727	90% Percentile	0.386
90% Chebyshev UPL	0.97	95% Percentile	0.556
95% Chebyshev UPL	1.333	99% Percentile	0.693
95% USL	0.727		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Background Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.14/16/2019 11:15:48 AM
From File	Average Conc by Parameter and Well Xtab 04092019_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
Different or Future K Observation	1
Number of Bootstrap Operations	2000

Dissolved Low
Level Mercury

General Statistics			
Total Number of Observations	7	Number of Missing Observations	1
Number of Distinct Observations	7		
Number of Detects	6	Number of Non-Detects	1
Number of Distinct Detects	6	Number of Distinct Non-Detects	1
Minimum Detect	6.13E-04	Minimum Non-Detect	0.00196
Maximum Detect	0.0552	Maximum Non-Detect	0.00196
Variance Detected	4.69E-04	Percent Non-Detects	14.29%
Mean Detected	0.011	SD Detected	0.0217
Mean of Detected Logged Data	-5.76	SD of Detected Logged Data	1.552

Critical Values for Background Threshold Values (BTVs)			
Tolerance Factor K (For UTL)	3.399	d2max (for USL)	1.938

Normal GOF Test on Detects Only		
Shapiro Wilk Test Statistic	0.549	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.788	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.46	Lilliefors GOF Test
5% Lilliefors Critical Value	0.325	Data Not Normal at 5% Significance Level
Data Not Normal at 5% Significance Level		

Kaplan Meier (KM) Background Statistics Assuming Normal Distribution			
KM Mean	0.00955	KM SD	0.0187
95% UTL95% Coverage	0.0729	95% KM UPL (t)	0.0483
90% KM Percentile (z)	0.0334	95% KM Percentile (z)	0.0402
99% KM Percentile (z)	0.0529	95% KM USL	0.0457

DL/2 Substitution Background Statistics Assuming Normal Distribution

Mean	0.00956	SD	0.0201
95% UTL95% Coverage	0.078	95% UPL (t)	0.0514
90% Percentile (z)	0.0354	95% Percentile (z)	0.0427
99% Percentile (z)	0.0564	95% USL	0.0486

DL/2 is not a recommended method. DL/2 provided for comparisons and historical reasons

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.847	Anderson-Darling GOF Test
5% A-D Critical Value	0.735	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.382	Kolmogorov-Smirnov GOF
5% K-S Critical Value	0.348	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.507	k star (bias corrected MLE)	0.365
Theta hat (MLE)	0.0217	Theta star (bias corrected MLE)	0.0301
nu hat (MLE)	6.087	nu star (bias corrected)	4.377
MLE Mean (bias corrected)	0.011		
MLE Sd (bias corrected)	0.0182	95% Percentile of Chisquare (2kstar)	3.128

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	6.13E-04	Mean	0.0108
Maximum	0.0552	Median	0.00271
SD	0.0198	CV	1.824
k hat (MLE)	0.58	k star (bias corrected MLE)	0.426
Theta hat (MLE)	0.0187	Theta star (bias corrected MLE)	0.0254
nu hat (MLE)	8.115	nu star (bias corrected)	5.97
MLE Mean (bias corrected)	0.0108	MLE Sd (bias corrected)	0.0166
95% Percentile of Chisquare (2kstar)	3.466	90% Percentile	0.0303
95% Percentile	0.0441	99% Percentile	0.0785

The following statistics are computed using Gamma ROS Statistics on Imputed Data

Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods

	WH	HW		WH	HW
95% Approx. Gamma UTL with 95% Coverage	0.136	0.164	95% Approx. Gamma UPL	0.0557	0.0583
95% Gamma USL	0.0498	0.0514			

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00955	SD (KM)	0.0187
Variance (KM)	3.48E-04	SE of Mean (KM)	0.00772
k hat (KM)	0.262	k star (KM)	0.245
nu hat (KM)	3.667	nu star (KM)	3.429
theta hat (KM)	0.0364	theta star (KM)	0.039
80% gamma percentile (KM)	0.0138	90% gamma percentile (KM)	0.0287
95% gamma percentile (KM)	0.0465	99% gamma percentile (KM)	0.094

The following statistics are computed using gamma distribution and KM estimates

Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods

	WH	HW		WH	HW
95% Approx. Gamma UTL with 95% Coverage	0.11	0.125	95% Approx. Gamma UPL	0.0441	0.0439
95% KM Gamma Percentile	0.0305	0.0291	95% Gamma USL	0.0393	0.0387

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.88	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.272	Lilliefors GOF Test
5% Lilliefors Critical Value	0.325	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Background Lognormal ROS Statistics Assuming Lognormal Distribution Using Imputed Non-Detects

Mean in Original Scale	0.00952	Mean in Log Scale	-5.98
SD in Original Scale	0.0202	SD in Log Scale	1.532
95% UTL95% Coverage	0.462	95% BCA UTL95% Coverage	0.0552
95% Bootstrap (%) UTL95% Coverage	0.0552	95% UPL (t)	0.0609
90% Percentile (z)	0.018	95% Percentile (z)	0.0314
99% Percentile (z)	0.0892	95% USL	0.0492

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean of Logged Data	-5.948	**95% KM UTL (Lognormal)95% Coverage**	**0.3**
KM SD of Logged Data	1.396	**95% KM UPL (Lognormal)**	**0.0474**
95% KM Percentile Lognormal (z)	**0.0259**	**95% KM USL (Lognormal)**	**0.039**

Background DL/2 Statistics Assuming Lognormal Distribution

Mean in Original Scale	0.00956	Mean in Log Scale	-5.927
SD in Original Scale	0.0201	SD in Log Scale	1.484
95% UTL95% Coverage	0.414	95% UPL (t)	0.0582
90% Percentile (z)	0.0179	95% Percentile (z)	0.0306
99% Percentile (z)	0.0842	95% USL	0.0473

DL/2 is not a Recommended Method. DL/2 provided for comparisons and historical reasons.

Nonparametric Distribution Free Background Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Upper Limits for BTVs(no distinction made between detects and nondetects)

Order of Statistic, r	7	95% UTL with95% Coverage	0.0552
Approx, f used to compute achieved CC	0.368	Approximate Actual Confidence Coefficient achieved by U	0.302
Approximate Sample Size needed to achieve specified CC	59	95% UPL	0.0552
95% USL	0.0552	95% KM Chebyshev UPL	0.0965

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Total
Mercury (7470)

General Statistics

Total Number of Observations	4	Number of Missing Observations	4
Number of Distinct Observations	4		
Number of Detects	3	Number of Non-Detects	1
Number of Distinct Detects	3	Number of Distinct Non-Detects	1
Minimum Detect	0.0852	Minimum Non-Detect	0.15
Maximum Detect	0.142	Maximum Non-Detect	0.15
Variance Detected	0.00101	Percent Non-Detects	25%
Mean Detected	0.105	SD Detected	0.0318
Mean of Detected Logged Data	-2.28	SD of Detected Logged Data	0.284

Warning: Data set has only 3 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	5.144	d2max (for USL)	1.462

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.794	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.767	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.367	Lilliefors GOF Test
5% Lilliefors Critical Value	0.425	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan Meier (KM) Background Statistics Assuming Normal Distribution

KM Mean	0.105	KM SD	0.026
95% UTL95% Coverage	**0.239**	**95% KM UPL (t)**	**0.173**
90% KM Percentile (z)	0.138	**95% KM Percentile (z)**	**0.148**
99% KM Percentile (z)	**0.166**	**95% KM USL**	**0.143**

DL/2 Substitution Background Statistics Assuming Normal Distribution

Mean	0.0976	SD	0.03
95% UTL95% Coverage	0.252	95% UPL (t)	0.177
90% Percentile (z)	0.136	95% Percentile (z)	0.147
99% Percentile (z)	0.167	95% USL	0.142

DL/2 is not a recommended method. DL/2 provided for comparisons and historical reasons

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	17.96	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.00586	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	107.8	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A		
MLE Sd (bias corrected)	N/A	95% Percentile of Chisquare (2kstar)	N/A

Gamma ROS Statistics using Imputed Non-Detects
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0852	Mean	0.105
Maximum	0.142	Median	0.0963
SD	0.026	CV	0.247
k hat (MLE)	23.88	k star (bias corrected MLE)	6.137
Theta hat (MLE)	0.00439	Theta star (bias corrected MLE)	0.0171
nu hat (MLE)	191	nu star (bias corrected)	49.09
MLE Mean (bias corrected)	0.105	MLE Sd (bias corrected)	0.0424
95% Percentile of Chisquare (2kstar)	21.39	90% Percentile	0.162
95% Percentile	0.183	99% Percentile	0.228

The following statistics are computed using Gamma ROS Statistics on Imputed Data
Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods

	WH	HW		WH	HW
95% Approx. Gamma UTL with 95% Coverage	0.288	0.298	95% Approx. Gamma UPL	0.182	0.184
95% Gamma USL	0.144	0.144			

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.105	SD (KM)	0.026
Variance (KM)	6.74E-04	SE of Mean (KM)	0.0184
k hat (KM)	16.42	k star (KM)	4.272
nu hat (KM)	131.4	nu star (KM)	34.18
theta hat (KM)	0.0064	theta star (KM)	0.0246
80% gamma percentile (KM)	0.144	90% gamma percentile (KM)	0.173
95% gamma percentile (KM)	0.2	99% gamma percentile (KM)	0.258

The following statistics are computed using gamma distribution and KM estimates
Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods

	WH	HW		WH	HW
95% Approx. Gamma UTL with 95% Coverage	0.288	0.298	95% Approx. Gamma UPL	0.182	0.183
95% KM Gamma Percentile	0.149	0.149	95% Gamma USL	0.143	0.143

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.806	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.767	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.361	Lilliefors GOF Test
5% Lilliefors Critical Value	0.425	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Background Lognormal ROS Statistics Assuming Lognormal Distribution Using Imputed Non-Detects

Mean in Original Scale	0.104	Mean in Log Scale	-2.28
SD in Original Scale	0.026	SD in Log Scale	0.232
95% UTL95% Coverage	0.337	95% BCA UTL95% Coverage	N/A
95% Bootstrap (%) UTL95% Coverage	N/A	95% UPL (t)	0.188
90% Percentile (z)	0.138	95% Percentile (z)	0.15
99% Percentile (z)	0.175	95% USL	0.144

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean of Logged Data	-2.28	95% KM UTL (Lognormal)95% Coverage	0.337
KM SD of Logged Data	0.232	95% KM UPL (Lognormal)	0.188
95% KM Percentile Lognormal (z)	0.15	95% KM USL (Lognormal)	0.144

Background DL/2 Statistics Assuming Lognormal Distribution

Mean in Original Scale	0.0976	Mean in Log Scale	-2.358
SD in Original Scale	0.03	SD in Log Scale	0.279
95% UTL95% Coverage	0.397	95% UPL (t)	0.197
90% Percentile (z)	0.135	95% Percentile (z)	0.15
99% Percentile (z)	0.181	95% USL	0.142

DL/2 is not a Recommended Method. DL/2 provided for comparisons and historical reasons.

Nonparametric Distribution Free Background Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Upper Limits for BTVs(no distinction made between detects and nondetects)

Order of Statistic, r	4	95% UTL with95% Coverage	0.15
Approx, f used to compute achieved CC	0.211	Approximate Actual Confidence Coefficient achieved by U	0.185
Approximate Sample Size needed to achieve specified CC	59	95% UPL	0.15
95% USL	0.15	95% KM Chebyshev UPL	0.232

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

C Bedrock Hydraulic Test Results

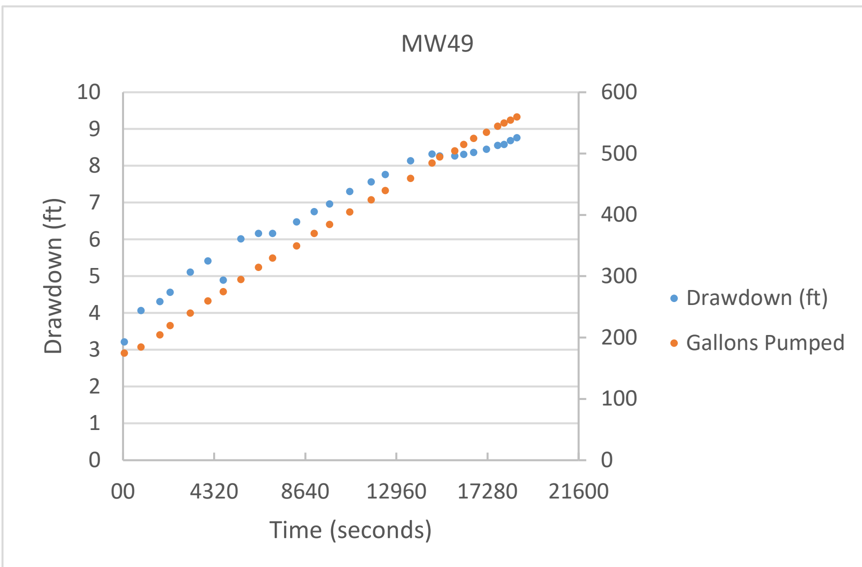
Red Devil Mine 2017 Well Development and Hydraulic Test Results

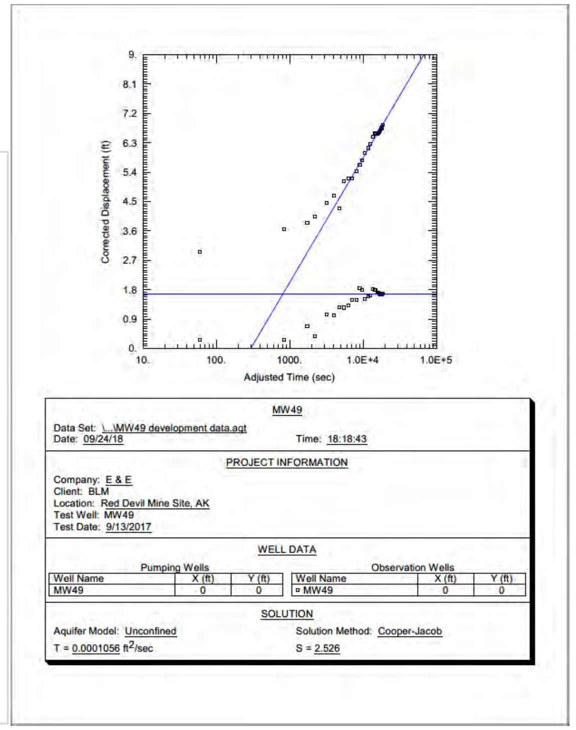
Development Data – Final Pumping Period Drawdown and Cumulative Water Pumped

Cooper-Jacob (1946) and Derivative Analysis

Theis (1935) Recovery Analysis

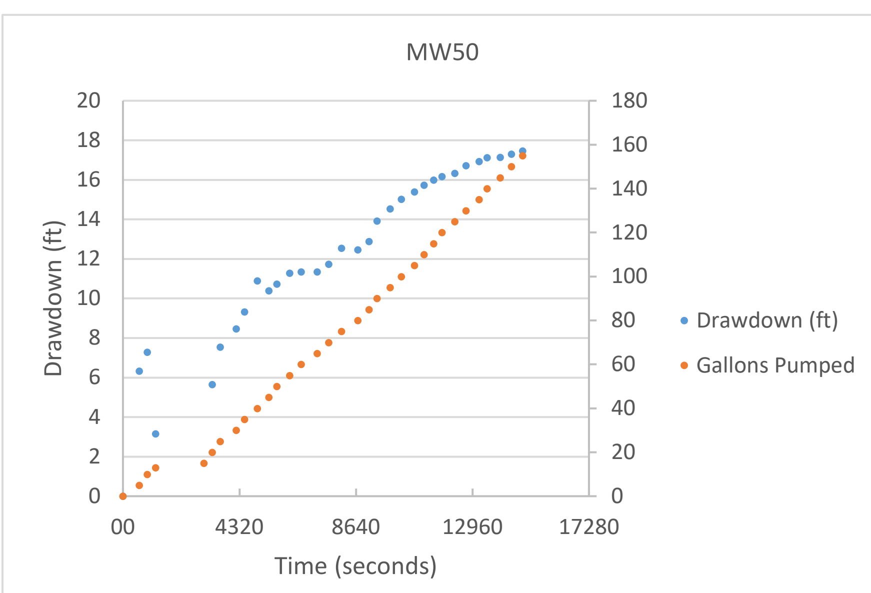
MW49

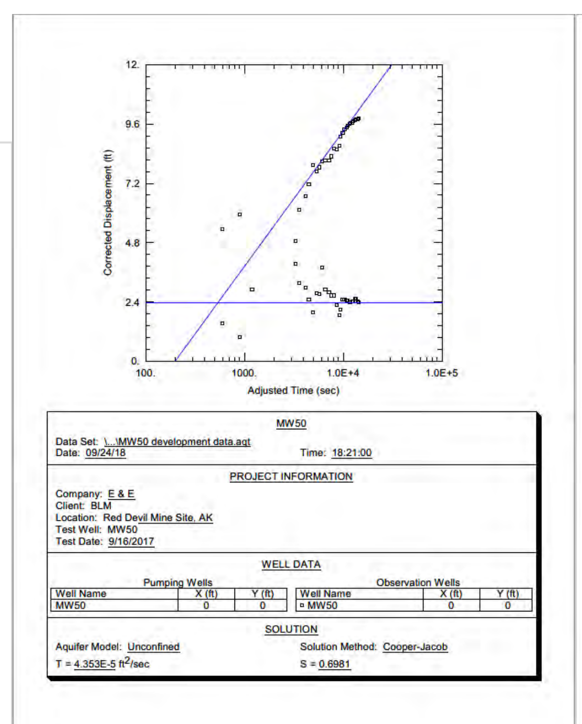


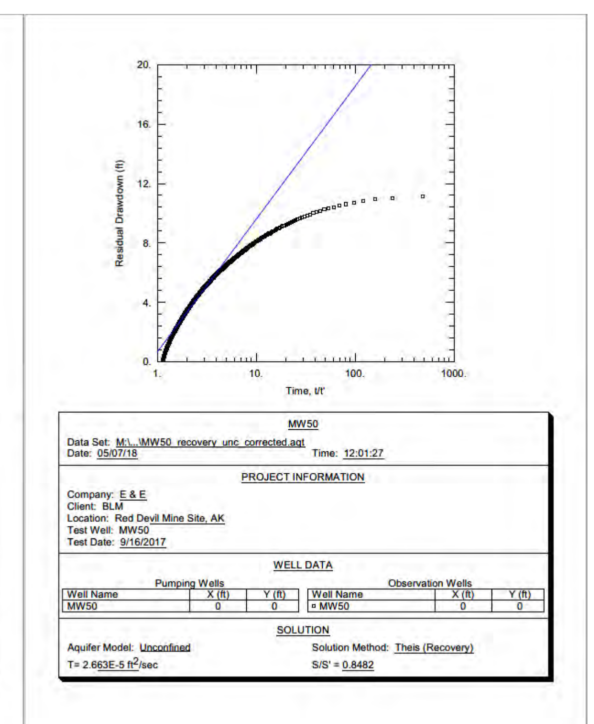


Recovery data not useable.

MW50



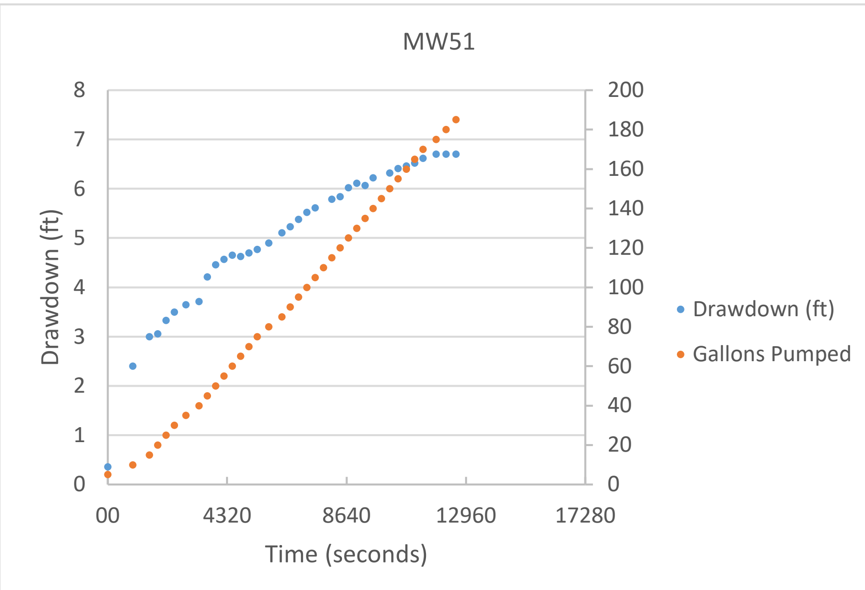


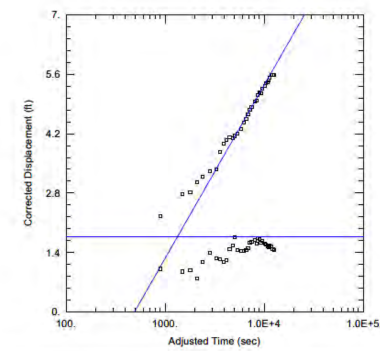


Red Devil Mine 2017 Well Development and Hydraulic Test Results

Development Data – Final Pumping Period Drawdown and Cumulative Water Pumped | **Cooper-Jacob (1946) and Derivative Analysis** | **Theis (1935) Recovery Analysis**

MW51





WELL TEST ANALYSIS

Data Set: \...\MW51 development data.aqt
Date: 09/24/18 Time: 18:23:49

PROJECT INFORMATION

Company: EEEPC
Client: BLM
Location: Red Devil, AK
Test Well: MW51
Test Date: 9/2017

AQUIFER DATA

Saturated Thickness: 20. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
MW51	0	0

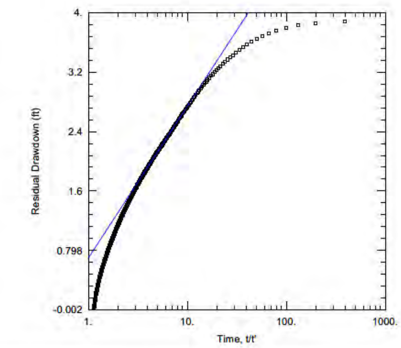
Observation Wells

Well Name	X (ft)	Y (ft)
▫ MW51	0	0

SOLUTION

Aquifer Model: Unconfined Solution Method: Cooper-Jacob

T = 8.976E-5 ft^2/sec S = 3.559



MW51

Data Set: M:\...\MW51_recovery_unc_corrected.aqt
Date: 05/07/18 Time: 12:04:00

PROJECT INFORMATION

Company: E & E
Client: BLM
Location: Red Devil Mine Site, AK
Test Well: MW51
Test Date: 9/16/2017

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
MW51	0	0

Observation Wells

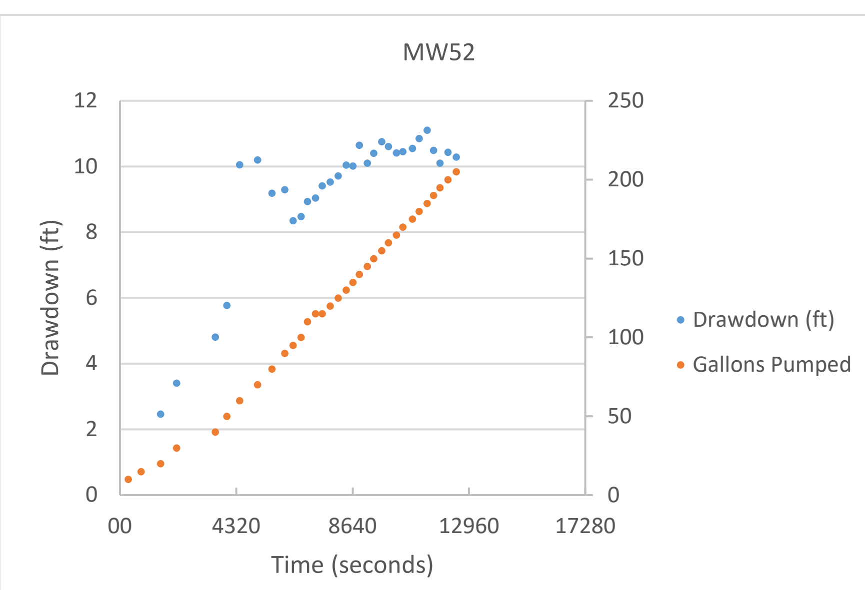
Well Name	X (ft)	Y (ft)
▫ MW51	0	0

SOLUTION

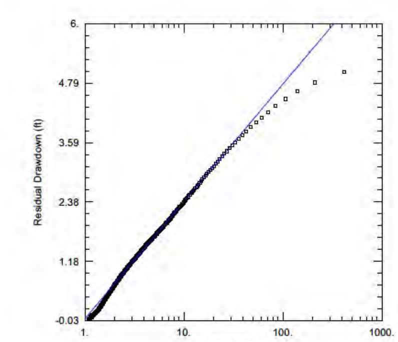
Aquifer Model: Unconfined Solution Method: Theis (Recovery)

T= 0.0001793 ft^2/sec S/S' = 0.4576

MW52



Pumping data not useable.



MW52

Data Set: M:\...\MW52_recovery_unc_corrected.aqt
Date: 05/07/18 Time: 12:10:23

PROJECT INFORMATION

Company: E & E
Client: BLM
Location: Red Devil Mine Site, AK
Test Well: MW52
Test Date: 9/10/2017

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
MW52	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ MW52	0	0

SOLUTION

Aquifer Model: Unconfined Solution Method: Theis (Recovery)

T= 0.0001692 ft^2/sec S/S' = 0.994

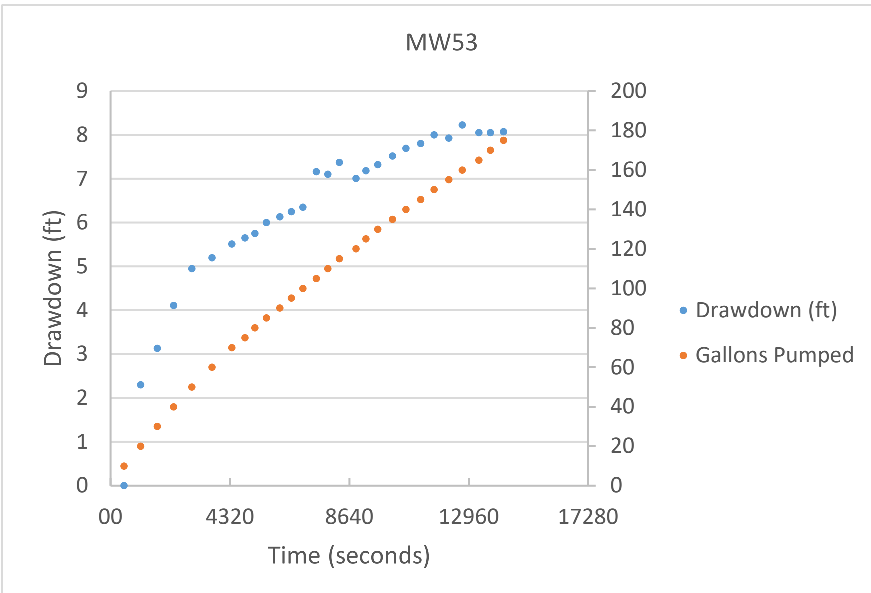
Red Devil Mine 2017 Well Development and Hydraulic Test Results

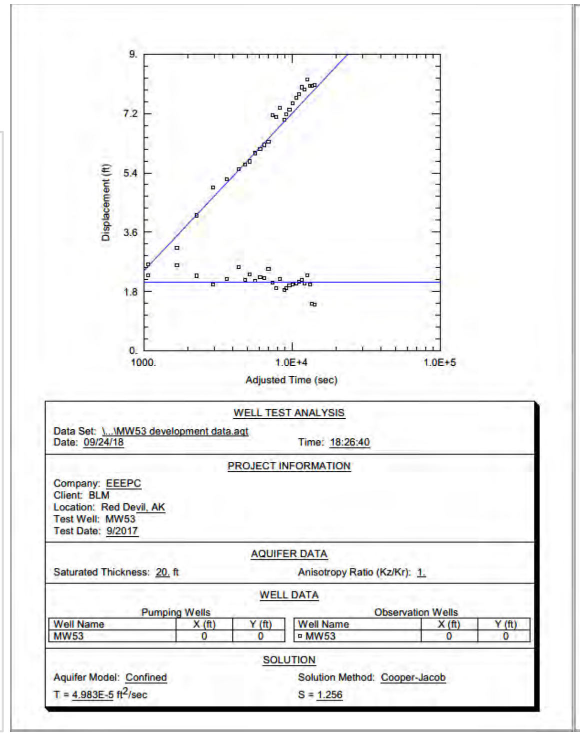
Development Data – Final Pumping Period Drawdown and Cumulative Water Pumped

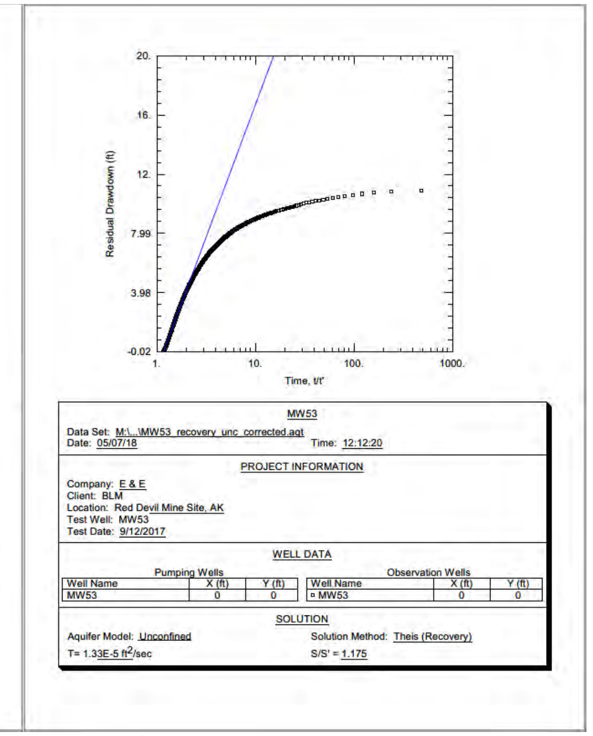
Cooper-Jacob (1946) and Derivative Analysis

Theis (1935) Recovery Analysis

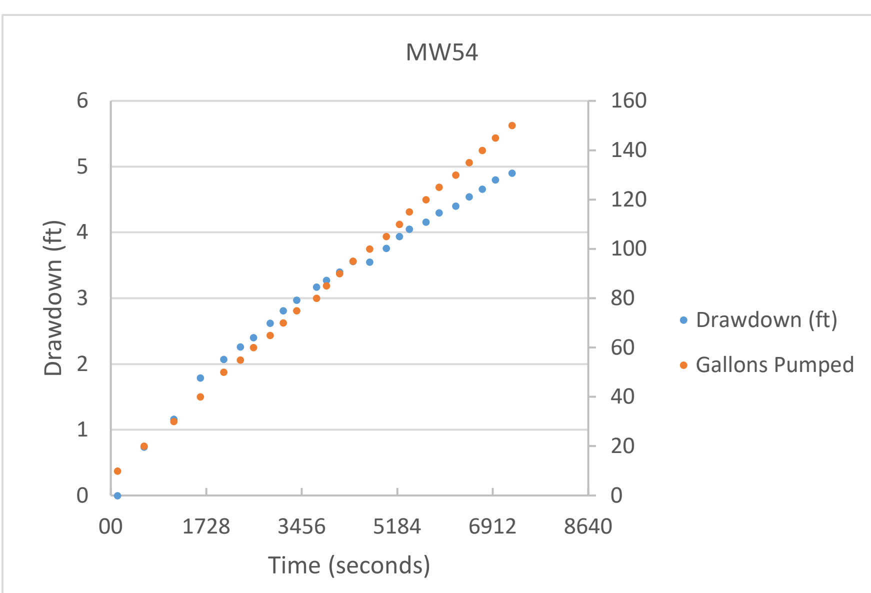
MW53

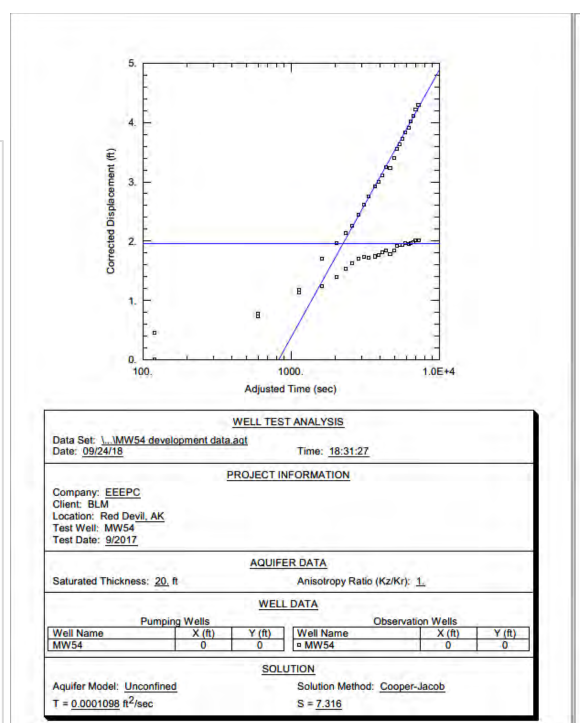


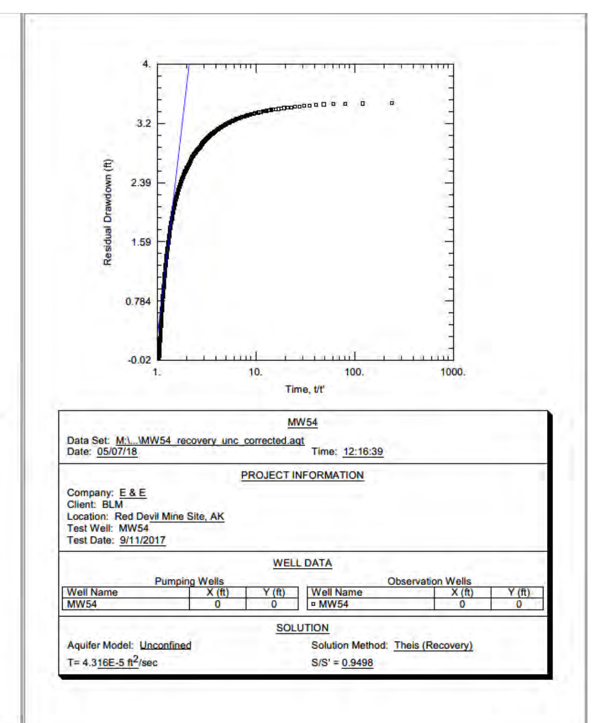




MW54







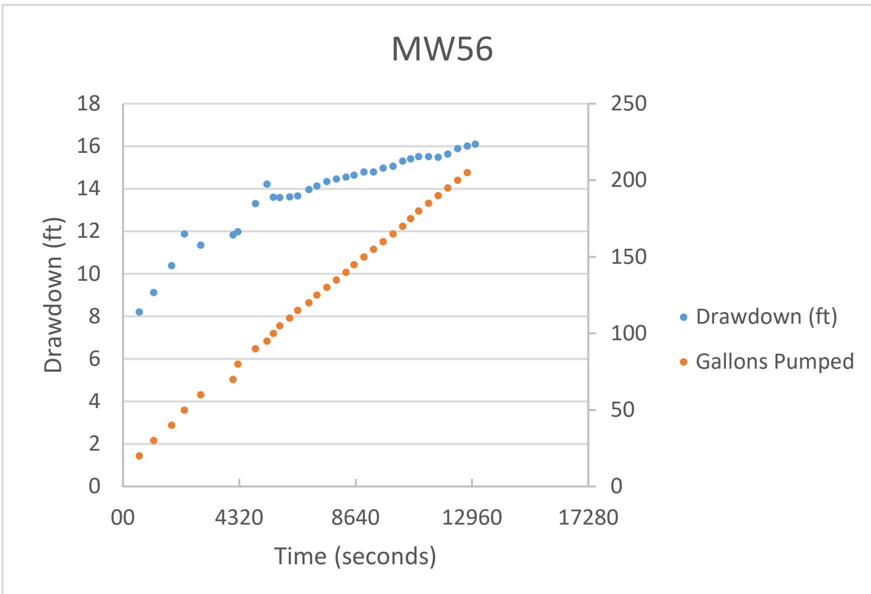
Red Devil Mine 2017 Well Development and Hydraulic Test Results

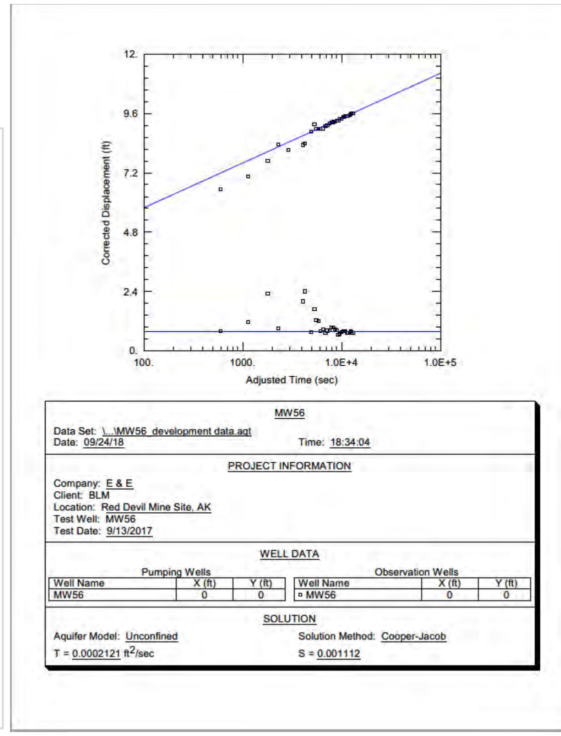
Development Data – Final Pumping Period Drawdown and Cumulative Water Pumped

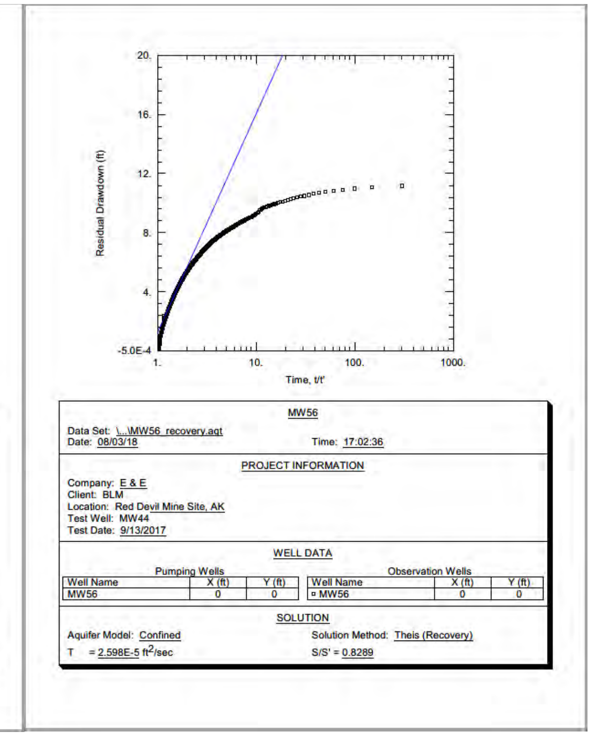
Cooper-Jacob (1946) and Derivative Analysis

Theis (1935) Recovery Analysis

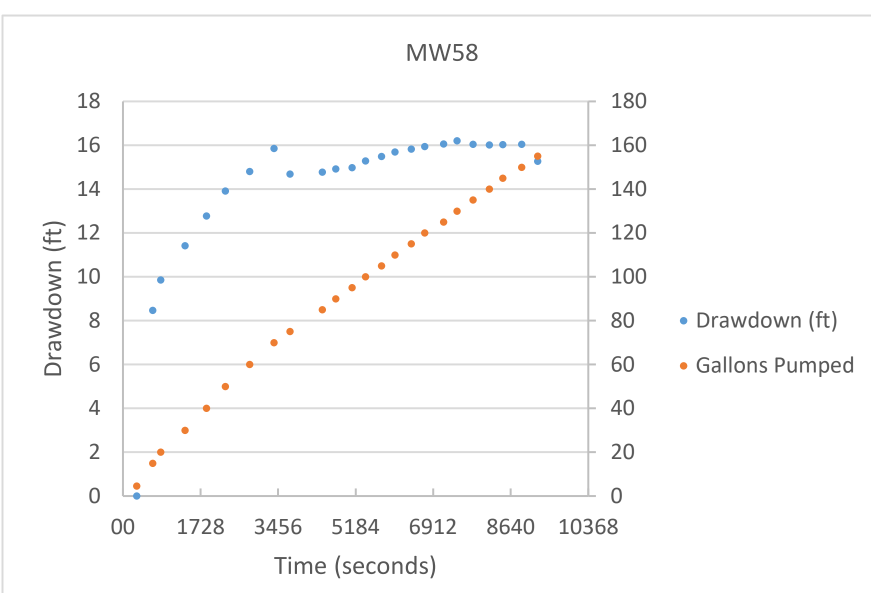
MW56







MW58



Pumping data not useable.