2019 WATER RESOURCES MONITORING REPORT
EAST HELENA FACILITY

Prepared for:

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF EXHIBITS

LIST OF ACRONYMS AND ABBREVIATIONS

AMSL	Above Mean Sea Level
bgs	Below Ground Surface
CAMP	Corrective Action Monitoring Plan
CAMU	Corrective Action Management Unit
cfs	Cubic Feet Per Second
CM	Corrective Measure
CMS	Corrective Measures Study
COC	Constituents of Concern
COEH	City of East Helena
Custodial Trust	Montana Environmental Custodial Trust
DI	Deionized
DMP	Data Management Plan
DO	Dissolved Oxygen
EI	Environmental Indicator
ET	Evapotranspiration
EVCGWA	East Valley Controlled Groundwater Area
HHS	Human Health Standard
IM	Interim Measures
METG	Montana Environmental Trust Group
mg/L	milligrams/liter
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SAI	Source Area Investigations
SC	Specific Conductance
SPHC	South Plant Hydraulic Control
SWL	Static Water Level
TDS	Total Dissolved Solids
TMDL	Total Maximum Daily Load
USEPA	United States Environmental Protection Agency
WRM	Water Resources Monitoring

EXECUTIVE SUMMARY

Hydrometrics, Inc. conducted groundwater and surface water monitoring for the Former East Helena Smelter Project in 2019. The East Helena Smelter produced lead bullion from a variety of concentrates and other feed stock from 1888 until 2001 when the smelter was permanently shut down. Smelting activities have resulted in water quality impacts to local groundwater with the primary contaminants of concern arsenic and selenium. The 2019 monitoring program is a continuation of annual monitoring programs designed to document the effectiveness of remedial measures completed to date, with a focus on groundwater contaminant concentrations trends and status (expanding, contracting, stable) of the groundwater arsenic and selenium plumes.

The overall objective of the 2019 monitoring program was to continue assessment of groundwater quality status and trends within and downgradient of the former smelter, and to evaluate the effectiveness of interim and other remedial measures at reducing concentrations and migration of groundwater contaminants. The 2019 monitoring program included semi-annual streamflow and water quality sampling at ten sites on or tributary to Prickly Pear Creek, seasonal groundwater level monitoring at 186 monitoring wells, groundwater quality sampling at 78 monitoring wells, and semiannual water quality monitoring at 20 residential/public water supply wells. All water quality samples were analyzed for an extended suite of parameters including general chemistry constituents and trace metals, including the primary contaminants of concern (COCs) arsenic and selenium. All 2019 data was reviewed and validated for data quality, and entered into the East Helena Project electronic database.

The 2019 groundwater levels, surface water flows, and groundwater chemistry continued to be affected to some degree by the above average 2018 and 2019 precipitation. Groundwater elevations on the former smelter site were generally one to three feet higher in 2019 as compared to previous years due to the climatic conditions, although the 2019 water levels were lower than in 2018. Overall, water levels have declined by up to 10 feet in response to recent remedial measures. In general, groundwater contaminant concentrations continued to decline in response to the recently completed interim remedial measures with the 2019 arsenic concentration at the North Plant Arsenic Source Area and selenium concentration in the West Selenium Source Area the lowest recorded to date. Downgradient (north) of the former smelter, arsenic and selenium concentrations were generally stable or decreasing in 2019 in response to the completed interim remedial measures. Arsenic concentrations at some wells along the west margin of the downgradient arsenic plume continued to increase slightly in 2019 due to a westward shift in the plume caused by elimination of a large irrigation ditch and associated groundwater recharge to the west.

Plume geometry and stability metrics, including average plume concentrations, plume areas and plume centroid locations show the downgradient arsenic and selenium plumes to be largely stable, with a notable retraction of the downgradient selenium plume boundary noted in 2019. Plume metrics on the former smelter site show that the plumes continue to decrease in size and concentration in the groundwater contaminant source areas, with the average arsenic and selenium concentrations both decreasing by approximately 50% between 2010 and 2019.

While not considered primary COCs, zinc and cadmium have shown varying concentration trends over the past two years, although concentrations generally remain much lower than historic concentrations when the smelter was operating. Currently, drinking water standards are exceeded at two wells for zinc and three wells for cadmium on the Plant Site, with no downgradient monitoring or residential wells exceeding the applicable drinking water standards. The localized occurrence of increased zinc and cadmium concentrations may be due to fluctuating groundwater levels in response to above average 2018/2019 precipitation, and/or slight changes in groundwater pH. These wells will continue to be monitored in 2020 to further assess the long-term groundwater concentration trends.

Groundwater monitoring in the Corrective Action Management Unit (CAMU) landfill area monitoring wells showed consistent groundwater quality in 2019 compared to previous years. Most CAMU area wells continue to show stable concentrations of arsenic (0.01 to 0.02 mg/L) consistent with naturally occurring background arsenic concentrations in this area. Monitoring well MW-6, which has shown elevated arsenic concentrations in the past, decreased from 0.072 mg/L in 2017 to 0.03 mg/L in 2019. Selenium concentrations at all CAMU area wells have consistently been less than the 0.05 mg/L drinking water standard.

The 2019 groundwater quality data was compared to groundwater model predictive analyses prepared in 2015 as part of the East Helena Smelter Corrective Measures Study (CMS) program. The comparison shows relatively good agreement between the computer-generated predicted groundwater conditions and concentration trends and the 2019 measured conditions and trends.

2019 WATER RESOURCES MONITORING REPORT
EAST HELENA FACILITY

1.0 INTRODUCTION

This report presents a summary of water resources monitoring (WRM) activities conducted in 2019 for the former East Helena Smelter remediation project. For purposes of this WRM report, the project area includes the former East Helena smelter site or Facility[1], and the surrounding area encompassing two groundwater plumes and the project groundwater monitoring network. The WRM program has been implemented by the Montana Environmental Trust Group (METG), Trustee of the Montana Environmental Custodial Trust (the Custodial Trust). The 2019 monitoring activities are part of the Corrective Measures Study (CMS) implemented by the Custodial Trust to identify and address groundwater contamination originating from the Facility, under the Resource Conservation and Recovery Act (RCRA) Corrective Action Program. This report summarizes the WRM activities and associated data collected in 2019 as outlined in the 2019 Corrective Action Monitoring Plan (CAMP). Information provided in this report will serve as a foundation for planning and implementation of future long-term WRM activities, along with ongoing remedial measure evaluations and other CMS-related activities.

1.1 PROJECT BACKGROUND

The former East Helena Smelter was a custom lead smelter located in Lewis and Clark County, Montana (Figure 1-1). The former smelter began operations in 1888 and produced lead bullion from smelting of a variety of foreign and domestic concentrates, ores, fluxes, and other non-ferrous metal bearing materials. In addition to lead bullion, the Facility produced copper by-products and food-grade sulfuric acid. The Facility ceased operation in April 2001.

The Facility covers approximately 142 acres located primarily on the Prickly Pear Creek alluvial plain. The Facility is bounded to the east and northeast by Prickly Pear Creek; to the west and southwest by uplands or foothills comprised of Tertiary-age sediments; and to the north by U.S. Highway 12 and the American Chemet plant (a manufacturer of copper and zinc-based chemicals). The City of East Helena (COEH) business district and residential areas are located immediately north of Highway 12 (Figure 1-1). Prior to 2014, the Facility was bordered to the south by Upper Lake, a large manmade lake/marsh complex. Upper Lake has since been eliminated and the Prickly Pear Creek channel and floodplain lowered to reduce groundwater levels and groundwater interaction with contaminated soils (Section 1.2). The site background and history of the former smelter is described further in numerous reports including Hydrometrics, 1999, 2010, 2017, CH2M, 2018, and GSI, 2014.

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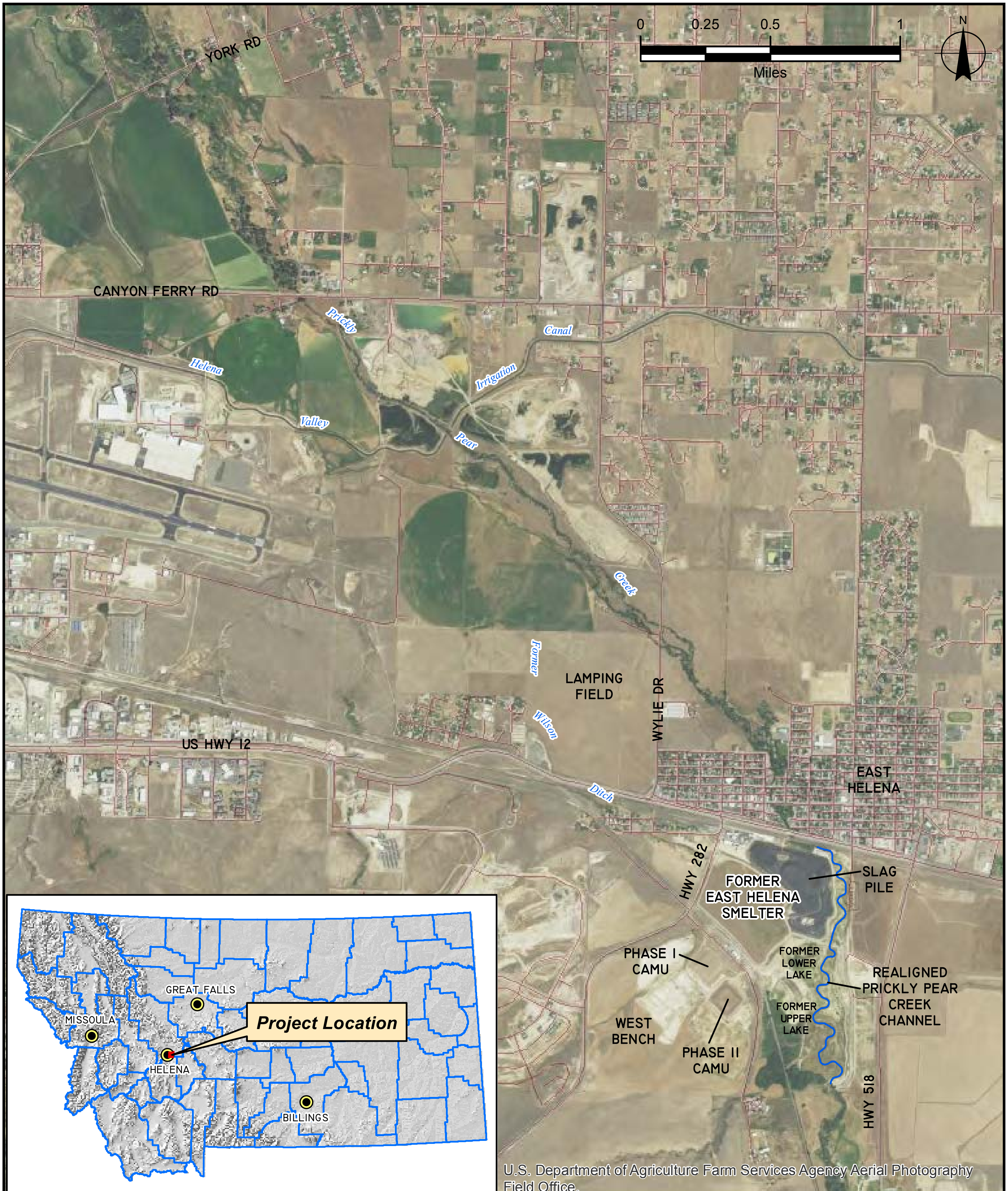
[1] The former smelter site or Facility refers to the approximately 142 acres previously occupied by the East Helena Lead Smelter.



Hydrometrics, Inc. Consulting Scientists and Engineers Date Saved: 3/6/2020 11:04:28 AM	2019 WATER RESOURCES MONITORING REPORT EAST HELENA FACILITY	**PROJECT LOCATION AND FEATURES**	**FIGURE** **1-1**

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Soils and non-native fill material (i.e., slag, ore, concentrates, demolition debris) located on the Facility contain elevated concentrations of a number of contaminants, primarily arsenic, selenium, and certain trace metals. Contaminants within site soils and fill are the result of more than a century of ore handling and processing, storage and disposal of smelting wastes and byproducts, and periodic releases of plant process water. The contaminated soil/fill represents the primary historic source of contaminant loading to groundwater. Loading of contaminants to groundwater has resulted in the generation and migration of groundwater plumes (arsenic and selenium) from the Facility to the north and northwest. The Custodial Trust has implemented a number of interim corrective measures (IMs) concurrent with the CMS, including the South Plant Hydraulic Control project, contaminant source removal, and Plant Site capping (CH2M, 2018). The primary purpose of the IMs completed to date by the Custodial Trust is to reduce contaminant mass loading to groundwater and downgradient migration of contaminants from the Facility in order to protect public health and the environment.

1.2 CORRECTIVE MEASURES STUDY PROGRAM

The Custodial Trust is in the final phase of a CMS for the East Helena Facility, under oversight of the United States Environmental Protection Agency (USEPA). The CMS is one of the RCRA Corrective Actions being conducted at the Facility pursuant to the First Modification to the 1998 RCRA Consent Decree (U.S. District Court, 2012), and has involved the completion of several site investigations designed to delineate groundwater contaminant source areas and aid in selection of groundwater contaminant corrective measures. Concurrent with the CMS program, the Custodial Trust has implemented a number of IMs intended to address ongoing groundwater contaminant loading. The three IMs completed to date include:

1. The South Plant Hydraulic Control (SPHC) IM: The SPHC IM is a multicomponent remedial action intended to lower groundwater levels across the Facility. Since the primary source of contaminant loading to groundwater is groundwater flow through contaminated Facility soils and associated contaminant leaching, lowering the water table has reduced the volume of contaminated soil in contact with groundwater and associated contaminant leaching. Components of the SPHC include: 1) dewatering of former Upper Lake immediately south of the Facility, previously a major source of recharge to the Facility groundwater system; 2) removal of the Smelter Dam from Prickly Pear Creek thereby lowering the creek stage by up to 15 feet and reducing leakage from the creek to the shallow groundwater system; and 3) reconstructing Prickly Pear Creek upstream of and adjacent to the Facility to further reduce the creek stage and leakage to groundwater.
2. Plant Site Evapotranspiration Cover IM: The evapotranspiration (ET) Cover IM included placement of an engineered soil cover over approximately 57 acres of the western portion of the Facility where smelting operations and associated activities occurred (the Former Plant Site). The ET Cover is designed to store precipitation infiltration in the engineered soil cap for subsequent evapotranspiration during the growing season. The purpose of the ET Cover IM is to minimize deep percolation of incident precipitation and snowmelt water through contaminated vadose zone soils and associated leaching of contaminants to groundwater.
3. Contaminant Source Removal IM: Source removal actions were performed on the Facility to remove areas of localized, higher contaminant concentration soils from below the groundwater table. Source removal actions were completed in the southern portion of the

Facility (South Plant Area), including the former Tito Park and Upper Ore Storage areas, and in the Former Acid Plant Area. The excavated soils were placed beneath the ET Cover and the excavations backfilled with clean soil.

Additional information on the completed IMs is available in the draft CMS Report (CH2M, 2018). Evaluation of the IM effectiveness in terms of the groundwater system response is a primary focus of the East Helena Project CAMP.

1.3 CORRECTIVE ACTION MONITORING PROGRAM

The groundwater and surface water monitoring activities performed in 2019 were conducted in accordance with the 2019 CAMP (Hydrometrics, 2019a). As described in the CAMP, the overall objective of the 2019 monitoring program was to continue assessment of groundwater quality status and trends within and downgradient of the former smelter, and to evaluate the effectiveness of interim and other remedial measures at reducing concentrations and migration of groundwater contaminants. Similar to 2017 and 2018, the 2019 program focused on performance monitoring appropriate to the CMS phase of a RCRA Corrective Action remediation project including the following objectives:

(1) Assessment of sitewide groundwater level trends and groundwater flow directions;

(2) Assessment of groundwater quality trends at specific wells located in both Facility source areas and downgradient areas;

(3) Assessment of arsenic and selenium plume geometry and stability;

(4) Evaluation of residential/public water supply well water quality in the area of former smelter site impacts;

(5) Evaluation of surface water flow and quality trends, from upstream of the Facility through the Prickly Pear Creek realignment area, and downstream to Canyon Ferry Road; and

(6) Continued evaluation of groundwater chemistry in Corrective Action Management Unit (CAMU) area wells.

Assessment of groundwater level trends, groundwater quality trends, and arsenic and selenium plume geometry and stability (objectives (1), (2), and (3) above) are addressed through a remedy performance monitoring data evaluation program, as outlined in the 2019 CAMP (Hydrometrics, 2019a). This data evaluation program forms the basis of the discussion of 2019 monitoring results for groundwater levels groundwater quality trends, and plume geometry/stability in Section 3.3 of this WRM report.

This document presents a summary of the 2019 groundwater and surface water monitoring activities and resulting data. The scope of monitoring activities is presented in Section 2 and monitoring results presented in Section 3.

2.0 2019 MONITORING SCOPE

The 2019 monitoring program included semi-annual monitoring at an extensive network of groundwater and surface water locations spanning the project area. The sampling protocol is detailed in the 2019 CAMP (Hydrometrics, 2019a), and followed established standard operating procedures included in the Project Quality Assurance Project Plan (QAPP; Hydrometrics, 2015a) and the Project Data Management Plan (DMP; Hydrometrics, 2011). The scope of the 2019 monitoring is described below.

2.1 SURFACE WATER MONITORING

The 2019 surface water monitoring program included semi-annual surface water level or stage measurements, streamflow measurements and water quality sampling in June and October. The semi-annual monitoring events included ten monitoring sites, (Table 2-1, Figure 2-1) with eight sites located on Prickly Pear Creek and two sites (Trib-1B and Trib-1D) located on a spring-fed tributary drainage flowing from the southwest through the former Upper and Lower Lake areas on the south end of the Facility to Prickly Pear Creek (Figure 2-1). Although the 2019 CAMP included monitoring at nine surface water sites, Trib-1B was added to the June and October monitoring events to provide additional data on metals concentration and loading trends along the tributary drainage. Surface water elevations were measured in June and October at all ten sites using a survey grade GPS. The elevation surveys were conducted concurrently with site-wide groundwater static water level (SWL) measurements to allow development of site-wide potentiometric maps incorporating groundwater and surface water elevation data. Besides documenting groundwater flow directions and gradients, the resulting data was used to assess potential gaining and losing reaches of Prickly Pear Creek. The surface water monitoring schedule is in Table 2-1. Streamflow and water quality monitoring was conducted at eight of the ten surface water sites during high flow (June) and low flow (October) conditions (Table 2-1).

Surface water samples were analyzed for the parameters shown in Table 2-2, including field analysis of pH, specific conductance (SC), dissolved oxygen (DO) and water temperature, and laboratory analysis of common constituents and total recoverable metals by Energy Laboratories in Helena, Montana. All of the 2019 surface water stage, flow, and water quality results have been entered into the project database and validated for data quality and usability per the project QAPP (Hydrometrics, 2015a). The 2019 validated database is included in Appendix A. Surface water monitoring results for 2019 are discussed in Section 3.1.

2.2 2019 GROUNDWATER MONITORING

The 2019 groundwater monitoring program included groundwater level and water quality monitoring at a wide network of monitoring wells and residential/public water supply wells. The current monitoring well network includes more than 180 monitoring wells with well coverage extending from south (upgradient) of the Facility northward approximately four miles, to about 1600 feet beyond Canyon Ferry Road. Monitoring well depths range from less than 10 feet for some wells located near Prickly Pear Creek, to 247 feet (EH-145D) north of Canyon Ferry Road. The groundwater monitoring network is shown on Exhibit 1.

Table 2-1. 2019 Surface Water Monitoring Locations and Schedule

Site ID	Northing	Easting	Description	June/October Water Elevation	June/October Flow and Water Quality
Semi-Annual Sampling Sites					
PPC-3A	856283.87	1361694.37	Prickly Pear Creek upstream of former smelter site	**X**	**X**
PPC-4A	858437.51	1361223.39	Prickly Pear Creek realigned channel upstream of former smelter dam, in former Upper Lake area	**X**	**X**
PPC-5A	859568.08	1361450.05	Prickly Pear Creek realigned channel downstream of former smelter dam; near historic site PPC-5	**X**	**X**
PPC-7	861473.74	1360743.50	Prickly Pear Creek channel upstream of Highway 12 bridge; between slag pile and Highway 12	**X**	**X**
PPC-8	863372.55	1360137.99	Prickly Pear Creek at West Gail Street in East Helena	**X**	
PPC-36A	864556.11	1358753.31	Prickly Pear Creek approximately 3,500 feet downstream of former smelter site	**X**	**X**
PPC-9A	865555.92	1357841.22	Prickly Pear Creek approximately 5,250 feet downstream of former smelter site	**X**	
SG-16	872677.17	1350559.96	Prickly Pear Creek downstream of Canyon Ferry Road bridge	**X**	**X**
Trib-1B	858476.2701	1360181.888	Tributary drainage south of Facility, upstream of site Trib-1D	**X**	**X**
Trib-1D	859392.30	1361402.33	Tributary drainage immediately upstream of Prickly Pear Creek confluence	**X**	**X**

Site locations shown on Figure 2-1.
Sites listed in upstream to downstream order.

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Table 2-2. 2019 Surface Water Sample Analytical Parameter List

Parameter	Analytical Method [(1)]	Project Required Detection Limit (mg/L)
Physical Parameters		
pH	150.2/SM 4500H-B	0.1 s.u.
Specific Conductance	120.1/SM 2510B	1 µmhos/cm
TDS	SM 2540C	10
TSS	SM 2540D	10
Common Ions		
Alkalinity	SM 2320B	1
Bicarbonate	SM 2320B	1
Sulfate	300.0	1
Chloride	300.0/SM 4500CL-B	1
Calcium	215.1/200.7	5
Magnesium	242.1/200.7	5
Sodium	273.1/200.7	5
Potassium	258.1/200.7	5
Trace Constituents (Total Recoverable)		
Antimony (Sb)	200.7/200.8	0.0005
Arsenic (As)	200.8/SM 3114B	0.001
Cadmium (Cd)	200.7/200.8	0.00003
Copper (Cu)	200.7/200.8	0.002
Iron (Fe)	200.7/200.8	0.02
Lead (Pb)	200.7/200.8	0.0003
Manganese (Mn)	200.7/200.8	0.01
Mercury (Hg)	245.2/245.1/200.8/SM 3112B	0.000005
Selenium (Se)	200.7/200.8/SM 3114B	0.001
Thallium (Tl)	200.7/200.8	0.0002
Zinc (Zn)	200.7/200.8	0.008
Field Parameters		
Stream Flow	HF-SOP-37/-44/-46	NA
Water Temperature	HF-SOP-20	0.1 °C
Dissolved Oxygen (DO)	HF-SOP-22	0.01 mg/L
pH	HF-SOP-20	0.01 s.u.
Specific Conductance (SC)	HF-SOP-79	1 µmhos/cm

Notes:

(1) Analytical methods are from *Standard Methods for the Examination of Water and Wastewater* (SM) or EPA's *Methods for Chemical Analysis of Water and Waste* (1983).

2.2.1 Groundwater Level Monitoring

Groundwater level monitoring has been a key component of the monitoring program during recent years due to its relevance to the groundwater remediation program. As described in Section 1, the objective of the SPHC IM is to lower groundwater levels on the Facility thereby reducing groundwater interaction with, and contaminant leaching from, Plant Site soils. The groundwater level data also provides information on changing hydraulic gradients and groundwater (and contaminant) flow directions, and provides for development of project-area groundwater potentiometric maps.

Groundwater levels were measured at approximately 186 wells in June and October. All water levels were measured manually with electronic meters with depths to water from the top of the well casing recorded to the nearest 0.01 foot. The depth to water measurements were converted to elevations (relative to mean sea level) using surveyed casing elevations for each well. The water level monitoring events were all completed in a single day to provide a snapshot of seasonal groundwater elevation conditions, and were coordinated with the surface water elevation surveys (Section 2.1) to provide more comprehensive water level datasets for the project area. The 2019 water level monitoring schedule is included in Table 2-3 with results presented in Section 3.3.

2.2.2 Groundwater Quality Monitoring

The 2019 groundwater monitoring program included groundwater quality sampling at 23 monitoring wells in June and 78 wells in October (Table 2-3). In addition, residential and public water supply well sampling was conducted in June and October to monitor the quality of local drinking water sources at 20 residential/public water supply wells (Table 2-4, Exhibit 1). The residential/public water supply well sampling program includes measurement of water levels (where well access permits) and collection of groundwater samples for water quality analyses, with the water quality data provided to the well owners. The COEH public water supply wells (numbers R18, R19, and R20, Table 2-4 and Exhibit 1) are included in each semi-annual sampling event.

Groundwater quality samples were analyzed for the parameters shown in Table 2-5, including field analysis of pH, SC, DO, turbidity, oxidation/reduction potential, and water temperature, and laboratory analysis of common constituents and trace metals (dissolved at monitoring wells and total and dissolved at residential/water supply wells) by Energy Laboratories in Helena, Montana. All groundwater data collected under the 2019 CAMP has been entered into the project database and validated for data quality and usability. The validated database is included in Appendix A. Groundwater monitoring results for residential wells are presented in Section 3.2, and monitoring well results are presented in Section 3.3.

Table 2-3. 2019 Monitoring Well Sampling Schedule

Well ID	Northing	Easting	MP Elevation	Water Levels	Water Quality Monitoring	
				June / October	June	October
2843 Canyon Ferry	872346.4170	1354330.0040	NA	X	X	X
2853 Canyon Ferry	872391.5330	1354773.2360	NA	X	X	X
Amchem4	861677.0140	1359836.2390	NA			X
Amchem Injection	861628.3080	1360331.4230	NA			X
ASIW-1	859803.7500	1362064.5200	3913.75	X		
ASIW-2	860471.8300	1363184.5870	3909.13	X		
Dartman	864632.3180	1360118.0550	3863.03		X	X
DH-1	861171.5317	1359021.4900	3910.89	X		
DH-10A	861456.8081	1360608.8168	3886.97	X		
DH-13	860561.0489	1359795.4104	3909.66	X		
DH-14	859527.8759	1361225.1135	3916.06	X		
DH-15	861541.0629	1360256.9955	3889.82	X		X
DH-17	860997.4140	1359668.6307	3904.84	X	X	X
DH-18	860535.2929	1359814.8334	3910.21	X		
DH-2	859910.4322	1358532.4429	3936.91	X		
DH-20	858989.3710	1360128.4527	3930.89	X		
DH-22	859690.0706	1359816.2344	3930.08	X		
DH-23	860270.2165	1360217.4896	3915.93	X		
DH-24	861412.6262	1359442.0091	3899.59	X		
DH-27	859923.8461	1360046.4609	3912.70	X		
DH-3	858002.5720	1359985.2180	3947.48	X		
DH-30	859935.1871	1360099.5558	3914.23	X		
DH-36	860631.4997	1359936.3381	3907.98	X		
DH-4	859526.8209	1361217.1986	3917.26	X		
DH-42	859587.2008	1359938.7981	3931.61	X		X
DH-47	859460.0231	1360402.0232	3922.33	X		
DH-48	861493.5490	1358990.7080	3905.96	X		
DH-5	859641.3787	1360792.8184	3921.18	X		
DH-50	861385.2562	1359571.7629	3904.76	X		
DH-51	861330.2543	1359700.3266	3904.34	X		
DH-52	861372.1393	1360876.1592	3889.18	X		X
DH-53	861343.6803	1361117.6658	3892.87	X		
DH-54	862057.3039	1359471.1481	3890.27	X		
DH-55	860568.8169	1360945.5551	3972.76	X		X
DH-56	861098.4318	1360350.7443	3958.17	X	X	X
DH-57	860328.9453	1360256.3855	3915.26	X		
DH-58	860620.3468	1360149.7987	3899.64	X		
DH-59	859632.0757	1360058.6049	3917.74	X		
DH-5A	859639.6847	1360786.2674	3921.92	X		

Table 2-3. 2019 Monitoring Well Sampling Schedule

Well ID	Northing	Easting	MP Elevation	Water Levels	Water Quality Monitoring	
				June / October	June	October
DH-6	861527.0799	1360252.4195	3889.85	X		X
DH-61	860401.8562	1359292.9314	3919.62	X		
DH-62	860406.7352	1359291.4704	3919.40	X		
DH-63	861507.1600	1359149.8337	3905.37	X		
DH-64	861382.7472	1359476.2570	3904.02	X		
DH-65	861207.1996	1360879.4052	3945.85	X		
DH-66	861005.1400	1359333.4093	3913.43	X	X	X
DH-67	861657.6447	1359095.5118	3899.77	X		X
DH-68	859814.1624	1361072.1959	3943.28	X		
DH-69	859899.5982	1360783.8944	3934.40	X		X
DH-7	861281.5224	1361580.6838	3898.66	X		
DH-70	859738.6045	1360346.8143	3918.94	X		
DH-71	859876.6862	1359640.5437	3925.12	X		
DH-72	859627.5477	1360069.2019	3918.51	X		
DH-73	860573.7778	1360394.4012	3899.82	X		
DH-74	860942.4611	1360679.4656	4001.49	X		
DH-75	860942.0961	1360685.1136	4001.55	X		
DH-76	860173.6276	1360887.0582	3994.28	X		
DH-77	860292.4800	1359639.2500	3930.04	X		
DH-78	860848.9600	1359368.2200	3918.86	X		
DH-79	860422.2150	1359937.1910	3916.04	X	X	X
DH-8	860693.1656	1359404.7242	3916.83	X		X
DH-80	859665.4470	1360005.8920	3919.52	X	X	X
DH-82	861377.1610	1359161.9690	3908.18	X		
DH-83	860783.4290	1359388.4600	3918.83	X		
DH-9	860570.6829	1360370.6073	3896.56	X		
East-PZ-1	860384.3830	1362260.6940	3911.93	X		
East-PZ-2	859218.0970	1362203.2540	3924.58	X		
East-PZ-4	857903.6430	1362039.5880	3935.66	X		
East-PZ-6	857123.2100	1362002.4930	3943.83	X		
East-PZ-7	858720.4890	1361949.2990	3928.83	X		
EH-100	862197.1906	1358800.8944	3889.83	X		X
EH-101	862185.0606	1359841.7343	3879.95	X		X
EH-102	862174.5306	1360751.1015	3880.45	X		X
EH-103	862095.3328	1359303.1174	3890.54	X		X
EH-104	862312.6614	1358282.5224	3887.83	X		X
EH-106	862709.9336	1358337.1193	3882.07	X		X
EH-107	862700.4946	1358801.9914	3880.15	X		X
EH-109	862428.7931	1358738.2975	3885.67	X		

Table 2-3. 2019 Monitoring Well Sampling Schedule

Well ID	Northing	Easting	MP Elevation	Water Levels	Water Quality Monitoring	
				June / October	June	October
EH-110	862408.9392	1359199.7346	3884.05	X		X
EH-111	863063.8249	1358121.6708	3876.50	X		X
EH-112	863053.5629	1358509.6340	3875.78	X		
EH-113	863390.2062	1357972.3721	3871.34	X		
EH-114	863127.7487	1357769.7575	3878.07	X	X	X
EH-115	862717.8146	1357963.0351	3883.29	X	X	X
EH-116	863344.5863	1357810.9784	3874.52	X		
EH-117	863491.1940	1357815.1024	3871.33	X		X
EH-118	863059.9069	1357370.9703	3879.95	X		X
EH-119	863617.6238	1357263.0875	3873.75	X		X
EH-120	864330.2403	1357409.9332	3865.78	X	X	X
EH-121	864410.1362	1358127.8227	3869.49	X		X
EH-122	864415.3102	1358469.6481	3868.08	X		
EH-123	863027.3459	1356631.3057	3885.71	X	X	X
EH-124	863928.3931	1356666.4917	3874.46	X		X
EH-125	864978.4430	1357089.9698	3863.22	X		X
EH-126	865515.7970	1356002.7980	3870.00	X		X
EH-127	865361.5553	1357810.2814	3860.75	X		
EH-128	863371.5473	1355903.6412	3892.17	X		
EH-129	865649.6907	1355425.0881	3870.21	X	X	X
EH-130	866018.0120	1356641.2087	3858.55	X	X	X
EH-131	867032.6409	1356912.0212	3834.44	X		
EH-132	864040.3529	1355360.4083	3893.90	X		X
EH-133	864766.2675	1355354.8343	3884.36	X		
EH-134	865643.4817	1355425.5451	3870.21	X	X	X
EH-135	865688.5946	1357384.9762	3852.25	X		X
EH-136	866625.8837	1357248.9015	3838.59	X		
EH-137	867047.7809	1357895.6672	3839.66	X		
EH-138	867179.0458	1355646.4718	3839.70	X	X	X
EH-139	867197.4533	1354635.3043	3839.78	X	X	X
EH-140	867962.2620	1356224.7870	3812.08	X		
EH-141	868713.2950	1354782.7040	3813.32	X	X	X
EH-142	870077.4710	1353868.6000	3804.68	X		
EH-143	870683.7490	1354372.7630	3803.37	X	X	X
EH-144D	874170.1440	1354086.1220	3778.86	X		
EH-144M	874170.2050	1354096.2940	3778.95	X		
EH-144S	874170.3570	1354091.1800	3778.70	X		
EH-145D	873225.3800	1355535.0100	3789.60	X		
EH-145S	873230.4000	1355543.7500	3790.09	X		

Table 2-3. 2019 Monitoring Well Sampling Schedule

Well ID	Northing	Easting	MP Elevation	Water Levels	Water Quality Monitoring	
				June / October	June	October
EH-200	862018.2570	1353065.2499	3953.33	X		
EH-201	861475.9040	1353968.1921	3973.48	X		
EH-202	861250.6755	1357113.7358	3930.56	X		
EH-203	860233.8575	1356623.2108	4003.92	X		
EH-204	860660.9927	1358703.6006	3925.69	X	X	X
EH-205	861652.5237	1358687.0616	3900.66	X		
EH-206	862969.4011	1356012.7840	3898.10	X		X
EH-208	863930.4941	1354401.5732	3910.58	X		
EH-209	864742.1995	1353102.0008	3898.34	X		
EH-210	861653.6027	1358674.6787	3901.19	X	X	X
EH-211	862223.9360	1356747.9170	3905.75	X		
EH-212	862222.6280	1356753.3600	3905.90	X		
EH-50	862195.6926	1358817.9994	3889.39	X		X
EH-51	862186.9796	1359828.4153	3880.09	X		X
EH-52	862191.6556	1360752.3375	3880.50	X		X
EH-53	863387.4722	1358268.8315	3872.82	X		X
EH-54	863345.3893	1359822.3324	3869.66	X		X
EH-57	862618.4258	1357736.4835	3885.05	X		
EH-57A	862625.8977	1357731.0375	3885.45	X		X
EH-58	861985.3850	1361553.1999	3888.15	X		X
EH-59	862766.0055	1361023.2440	3876.57	X		X
EH-60	862093.3668	1359295.7834	3888.46	X		X
EH-61	862095.8588	1359282.0974	3889.77	X		X
EH-62	863373.6172	1358812.9774	3875.07	X		X
EH-63	862682.4886	1359427.4311	3878.32	X		X
EH-64	862710.9196	1359200.8666	3882.67	X		
EH-65	862702.9806	1358789.9274	3879.96	X		X
EH-66	864406.8992	1358105.3308	3869.48	X		X
EH-67	864405.9092	1358454.5661	3869.46	X		
EH-68	863877.1312	1360331.4723	3867.60	X	X	X
EH-69	863791.1154	1360852.6083	3869.10	X	X	X
EH-70	864971.9141	1357077.7828	3863.48	X		X
EHMW-3	868386.9702	1356618.4238	3825.45	X		
EHTW-3	868576.0698	1356692.1916	3827.66	X		
IW-01	864945.8740	1354765.6430	3888.28	X		
IW-02	865731.8830	1353973.5110	3871.08	X		
MW-1	858771.6535	1358766.7575	3953.05	X		X
MW-10	858554.2009	1359549.2659	3946.28	X		X
MW-11	857959.4701	1358516.7490	3973.33	X		X

Table 2-3. 2019 Monitoring Well Sampling Schedule

Well ID	Northing	Easting	MP Elevation	Water Levels	Water Quality Monitoring	
				June / October	June	October
MW-2	859191.6356	1358745.8415	3945.97	X		X
MW-3	859196.8246	1359132.3857	3940.95	X		X
MW-4	858802.4764	1359150.0127	3947.06	X		X
MW-5	858414.7012	1358930.2411	3956.18	X		X
MW-6	858876.2702	1359556.4689	3938.14	X		X
MW-7	858777.0044	1358177.7736	3963.67	X		X
MW-8	857962.2351	1359400.9312	3958.65	X		X
MW-9	857977.4420	1358978.9840	3965.36	X		X
PBTW-1	861055.8909	1359662.6777	3907.85	X		
PBTW-2	861165.7887	1359622.4268	3906.73	X		
PPCRPZ-02	858388.3477	1360904.9182	3923.17	X		
PRB-1	861019.3720	1359488.1840	3910.83	X		
PRB-2	861114.8098	1359753.5985	3905.34	X		
PRB-3	860983.8120	1359418.5272	3912.96	X		
PZ-36A	864560.5170	1358731.2910	3858.96	X		
PZ-36B	864557.5720	1358724.5180	3858.75	X		
PZ-36C	864554.6450	1358718.7630	3859.60	X		
PZ-9A	865510.3780	1357868.3890	3850.70	X		
PZ-9B	865507.2270	1357867.0950	3849.43	X		
SC-1	862196.3525	1358838.9750	3890.42	X		
SDMW-1	860514.5930	1359962.8781	3914.28	X		
SDMW-2	860448.2571	1359851.2283	3914.17	X		
SDMW-3	860203.9396	1359859.3573	3918.07	X		
SDMW-4	860218.1176	1360144.9397	3917.66	X		
SDMW-5	860446.6991	1359750.3085	3921.29	X		
SP-3	861487.4030	1358277.0514	3905.91	X		
SP-4	861277.8344	1358887.3922	3908.16	X		
SP-5	861578.6048	1358912.3022	3903.52	X		
TW-1	860392.8781	1359940.7995	3918.26	X		
TW-2	860351.2000	1359895.9000	3931.43	X		
ULM-PZ-1	857498.2490	1360521.7270	3924.24	X		
ULTP-1	858779.0631	1360264.2920	3919.63	X		
ULTP-2	858262.1761	1360427.4600	3921.23	X		
			Total # Wells Per Event	**186**	**23**	**78**

All monitoring locations shown on Exhibit 1.
NA - Not Available

Table 2-4. 2019 Residential/Public Water Supply Well Sampling Sites and Schedule

Map Key (see Exhibit 1)	Northing	Easting	Water Quality Monitoring	
			June	October
R1	863425.39	1359501.01	X	X
R2	863266.68	1359337.84	X	X
R3	863296.03	1360955.74	X	X
R4	863053.71	1361184.11	X	X
R5	864206.53	1358674.56	X	X
R6	866156.57	1356934.48	X	X
R7	872346.42	1354330.00	X	X
R8	872391.53	1354773.24	X	X
R9	872086.41	1355030.70	X	X
R10	863376.30	1361815.27	X	X
R11	863255.39	1358240.44	X	X
R12	861502.42	1362101.41	X	X
R13	855347.37	1359909.48	X	X
R14	863233.58	1359840.14	X	X
R15	861784.41	1356574.41	X	X
R16	861925.29	1356400.09	X	X
R17	861781.59	1356290.54	X	X
R18	872558.37	1356681.06	X	X
R19	871444.75	1356882.84	X	X
R20	868437.60	1356673.10	X	X

Well locations shown on Exhibit 1.

Table 2-5. 2019 Groundwater Sample Analytical Parameter List

Parameter	Analytical Method[1]	Project Required Detection Limit (mg/L)	Montana Groundwater Human Health Standards (mg/L)[2]
Physical Parameters			
pH	150.2/SM 4500H-B	0.1 s.u.	NA
Specific Conductance	120.1/SM 2510B	1 µmhos/cm	NA
TDS	SM 2540C	10	NA
TSS	SM 2540D	10	NA
Common Ions			
Alkalinity	SM 2320B	1	NA
Bicarbonate	SM 2320B	1	NA
Sulfate	300.0	1	NA
Chloride	300.0/SM 4500CL-B	1	NA
Bromide	300.0	0.05	NA
Calcium	215.1/200.7	1	NA
Magnesium	242.1/200.7	1	NA
Sodium	273.1/200.7	1	NA
Potassium	258.1/200.7	1	NA
Trace Constituents (Total and/or Dissolved) [3][4]			
Antimony (Sb)	200.7/200.8	0.003	0.006
Arsenic (As)	200.8/SM 3114B	0.002	0.01
Cadmium (Cd)	200.7/200.8	0.001	0.005
Copper (Cu)	200.7/200.8	0.001	1.3
Iron (Fe)	200.7/200.8	0.02	NA
Lead (Pb)	200.7/200.8	0.005	0.015
Manganese (Mn)	200.7/200.8	0.01	NA
Mercury (Hg)	245.2/245.1/200.8/SM 3112B	0.001	0.002
Selenium (Se)	200.7/200.8/SM 3114B	0.001	0.05
Thallium (Tl)	200.7/200.8	0.001	0.002
Zinc (Zn)	200.7/200.8	0.01	2
Field Parameters [5]			
Static Water Level	HF-SOP-10	0.01 ft	NA
Water Temperature	HF-SOP-20	0.1 °C	NA
Dissolved Oxygen (DO)	HF-SOP-22	0.01 mg/L	NA
pH	HF-SOP-20	0.01 pH standard unit	NA
Turbidity		0.1 NTU	NA
ORP/Eh	HF-SOP-23	1 mV	NA
Specific Conductance (SC)	HF-SOP-79	1 µmhos/cm	NA

Notes:

(1) Analytical methods are from *Standard Methods for the Examination of Water and Wastewater* (SM) or EPA's *Methods for Chemical Analysis of Water and Waste* (1983).

(2) Standards from Montana Circular DEQ-7 (June 2019 Version). NA = not applicable (no human health standard).

(3) Residential/water supply well samples analyzed for total and dissolved trace constituents; monitoring well samples analyzed for dissolved metals only.

(4) Samples to be analyzed for dissolved constituents will be field-filtered through a 0.45 µm filter.

(5) Field parameters measured in a flow-through cell in accordance with project SOPs.

2.3 DATA MANAGEMENT AND QUALITY CONTROL

Procedures for data review, validation, and reporting are presented and discussed in the East Helena QAPP (Hydrometrics, 2015a), the DMP (Hydrometrics, 2011), and the 2019 CAMP (Hydrometrics, 2019a). Included in these documents are control limits and criteria for specific types of field and laboratory quality control (QC) samples, data validation and verification methods, potential corrective actions if criteria are not met, and database management procedures. Field QC samples collected for the groundwater monitoring program included deionized (DI) water blanks, equipment rinsate blanks (to evaluate the effectiveness of the decontamination procedure), and field duplicate samples, all collected at a frequency of 5% (1 per 20 field samples) for both monitoring wells and residential wells. Field QC samples for surface water included DI blanks and field duplicate samples, both collected at a frequency of 5% (1 per 20 samples).

The DMP includes checklists for review of both field and laboratory documentation (prior to formal validation of laboratory data), and post-validation review and approval of the East Helena database (Hydrometrics, 2011). All data collected under the 2019 WRM program has been reviewed and validated in accordance with these procedures and entered into the East Helena Project water quality database. The 2019 data validation and verification process resulted in qualification of a small percentage of the total data points collected as estimated due to minor QC sample exceedances (e.g., field duplicate control limit exceedances). For the spring 2019 data set, 99.3% of the surface water results, 99.7% of the monitoring well results, and 100% of the residential well results were accepted without any qualifiers applied; for the fall 2019 data set, 99% of the surface water results, 99.7% of the monitoring well results, and 99.2% of the residential well results were accepted without any qualifiers applied. One field SC result obtained during the spring 2019 monitoring well sampling event was rejected due to significant inconsistency with laboratory SC and total dissolved solids (TDS) measurements and previous field SC results for the sampling location; all other WRM data collected during 2019 was categorized as usable following the validation process.

3.0 2019 WATER RESOURCES MONITORING RESULTS

3.1 SURFACE WATER MONITORING RESULTS

The 2019 surface water monitoring program included measurement of surface water elevations, streamflow rates, and surface water quality sampling (Section 2.1). The surface water elevation data was used in conjunction with concurrent groundwater elevation data to develop site-wide groundwater potentiometric maps and evaluate groundwater flow directions and groundwater / surface water interactions. The streamflow and surface water quality data was used to delineate gaining and losing segments of Prickly Pear Creek, and document current water quality conditions in the project area.

3.1.1 Surface Water Elevation and Flow

Streamflow and elevation measurements were recorded in June and October 2019. The streamflow and stream stage data is included in Table 3-1 with site locations shown on Figure 2-1. Figure 3-1 shows continuous streamflow data for 2010 through 2019 from a USGS gaging station on Prickly Pear Creek approximately five miles upstream of the Facility. As shown on the hydrograph, 2019 Prickly Pear Creek flows were higher than the median flow rates for the period of record, with a maximum flow of 243 cubic feet per second (cfs) occurring on May 27th. Late season flows were particularly elevated compared to the long-term median due to above average snowpack and precipitation in 2018 and 2019. The higher streamflow and precipitation experienced in 2019 (and 2018) have a direct impact on the Plant Site and downgradient groundwater conditions (Hydrometrics, 2019b).

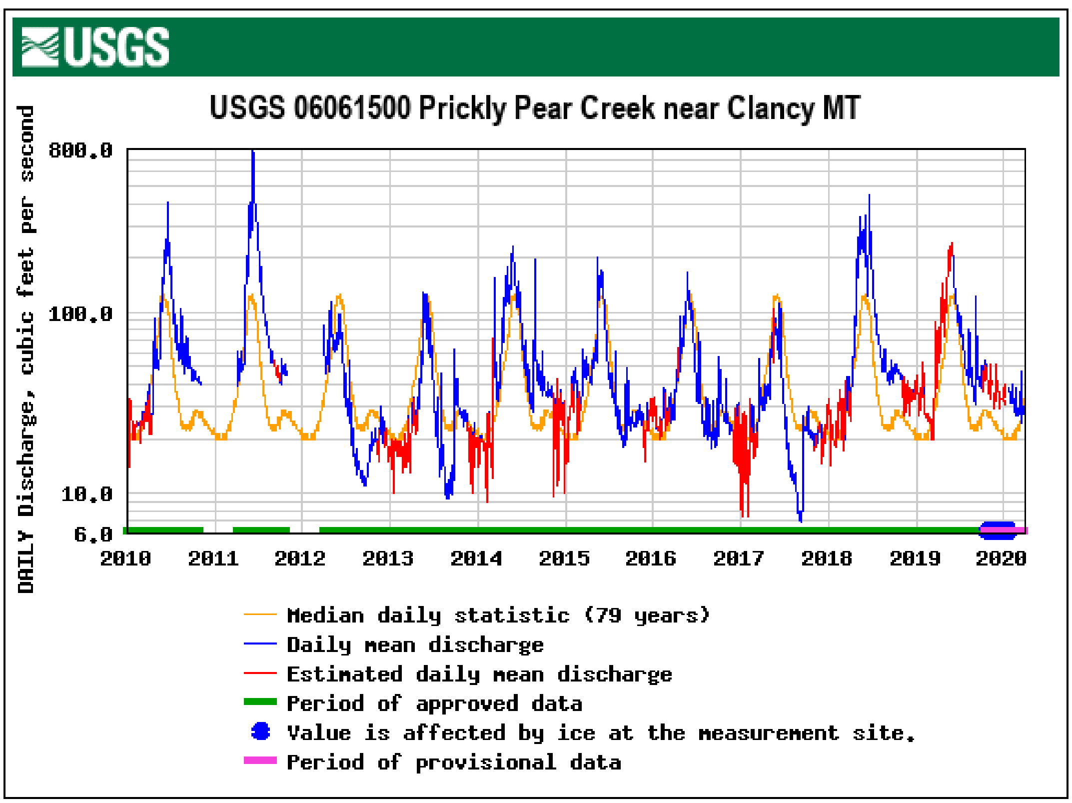
Similar to past years, the 2019 data indicates that Prickly Pear Creek flow adjacent to the Facility (PPC-3A, -4A, -5A, and -7) was relatively consistent from upstream to downstream in both June and October (Table 3-1). The 2019 results are consistent with previous flow data, suggesting there is limited net interaction between Prickly Pear Creek and the local groundwater system adjacent to the Facility. Flow rates and trends at sites PPC-4A and PPC-5A, located on the realigned segment of the creek, are similar to those measured in previous years indicating that the realignment project, completed as part of the SPHC IM, has maintained the historic condition of no significant flow gains or losses adjacent to the Facility. Downstream of the Facility, however, the 2019 (and previous) flow data shows flow rates consistently decrease in a downstream direction indicating leakage from the creek to groundwater. Although irrigation diversion flows were not measured in 2019, previous comprehensive synoptic flow data accounting for irrigation diversions has shown net leakage losses on the order of 10 to 20 cfs between Highway 12 and Canyon Ferry Road (sites PPC-7 and SG-16, Figure 2-1; Hydrometrics, 2018, 2019b).

TABLE 3-1. 2019 PRICKLY PEAR CREEK STREAMFLOW AND STAGE MEASUREMENTS

Monitoring Site	Location	Stream Stage - ft AMSL		Stream Flow - cfs	
		6/17/2019	10/17/2019	6/17/2019	10/17/2019
PPC-3A	PPC Upstream of Facility	3928.55	3927.33	237	64
PPC-4A	PPC Adjacent to Facility	3911.18	3910.13	239	64
Trib-1B	Tributary drainage south of Facility	3915.53	3915.07	0.045 E	0.011 E
Trib-1D	Tributary site at PPC Confluence	3905.22	3905.11	0.056 E	0.056 E
PPC-5A	PPC Adjacent to Facility	3903.50	3902.42	241	63
PPC-7	PPC Downstream Facility Boundary	3883.16	3881.92	nm*	64
PPC-8	PPC at West Gail Street in East Helena	3868.06	3867.04	nm	nm
PPC-36A	PPC 0.7 miles downstream of Facility	3855.81	3854.90	nm*	61
PPC-9A	PPC 1.0 mile downstream of smelter	3846.39	3845.72	nm	nm
SG-16	PPC 2.9 miles downstream of Facility	3766.85	3766.57	212	56

PPC - Prickly Pear Creek
AMSL - Above Mean Sea Level
Sites listed in upstream to downstream order; locations shown on Figure 2-1.
nm - not measured per 2019 CAMP
nm - not measured due to unsafe wading conditions*
E - Flow estimated

FIGURE 3-1. 2010 THROUGH 2019 PRICKLY PEAR CREEK FLOWS UPSTREAM OF THE FORMER SMELTER



3.1.2 Semi-Annual Surface Water Quality Results

The 2019 semi-annual surface water quality data is summarized in Table 3-2 with the complete dataset in Appendix A. The seasonal data shows Prickly Pear Creek water to be a calcium-bicarbonate type water with alkaline pH and TDS concentrations ranging from 116 to 201 milligrams/liter (mg/L) seasonally. Seasonal concentrations of major ions (calcium, magnesium, sodium, potassium, sulfate) are very consistent from upstream of the smelter site (site PPC-3A) to downstream site SG-16 near Canyon Ferry Road, with October low flow concentrations about twice the June high flow concentrations.

Total recoverable trace metal concentrations are also relatively low and consistent throughout the sampled reach of Prickly Pear Creek (Table 3-2, Appendix A). A number of trace metals including antimony, selenium, and thallium were below the laboratory reporting limits in all 2019 samples. Water quality criterion exceedances (DEQ-7 surface water standards; MDEQ, 2019) in Prickly Pear Creek were limited to total recoverable lead and zinc, which both exceeded the hardness-dependent chronic aquatic life criteria in all six June samples (Table 3-2). The water quality exceedances occurred both upstream and downstream of the Facility, indicating that upstream contaminant sources are producing these exceedances. The occurrence of elevated metals concentrations far upstream of the Facility has been noted in numerous studies, including the watershed total maximum daily load (TMDL) document (USEPA, 2004b). Overall, the 2019 Prickly Pear Creek water quality monitoring results are consistent with past sampling results dating back more than 20 years.

Sampling results from tributary drainage sites Trib-1B and Trib-1D show a number of water quality exceedances, particularly at upstream site Trib-1B. Water quality at Trib-1B exceeded the aquatic criteria for cadmium, copper, lead, and zinc in June, and cadmium, lead, and zinc in October. The only exceedance recorded at site Trib-1D, located immediately upstream of the confluence with Prickly Pear Creek, was for arsenic in June at 0.011 mg/L (compared to the 0.010 mg/L standard, Table 3-2). Elevated metals concentrations throughout the tributary drainage have been documented through past sampling, resulting in removal of approximately 350 cubic yards of metals-impacted soils in the vicinity of Trib-1B in November 2018. Table 3-3 includes a comparison of the 2019 concentrations in the tributary drainage compared to 2017 and 2018 pre-soil removal concentrations. As shown in Table 3-3, 2019 concentrations of most constituents are less than the 2017 and 2018 pre-soil removal concentrations with average 2019 concentrations 10% to 60% lower at site Trib-1B and 20% to 90% lower at downstream site Trib-1D. The 2019 data also show a modest increase in the tributary pH. The one exception is average manganese concentrations with the 2019 concentrations higher than the average pre-removal concentrations at both locations. The 2019 seasonal manganese concentrations vary widely at both sites suggesting the apparent increase may be due to the limited post-removal dataset available. The tributary sites will be included in the 2020 monitoring program to further assess post-soil removal concentrations.

Table 3-2. 2019 Surface Water Quality Monitoring Results

Monitoring Site	Prickly Pear Creek						Tributary Drainage	
	PPC-3A	PPC-4A	PPC-5A	PPC-7	PPC-36A	SG-16	TRIB-1B	TRIB-1D
Sample Date	**6/7/19**	**6/7/19**	**6/7/19**	**6/7/19**	**6/7/19**	**6/7/19**	**6/7/19**	**6/7/19**
Field Parameters								
pH (s.u.)	7.95	7.87	7.86	7.86	7.87	7.94	6.88	9.13
SC (µmhos/cm)	156	155	155	155	152	154	535	509
Flow (cfs)	237	239	241	NM	NM	212	0.045 E	0.056 E
Laboratory Analyses								
Total Dissolved Solids	116	116	118	117	118	119	351	372
Calcium	18	18	19	20	18	18	62	52
Magnesium	4	4	4	4	4	4	14	19
Sodium	6	6	6	6	6	6	27	26
Potassium	2	2	2	2	2	2	5	3
Chloride	3	3	3	3	3	3	10	8
Sulfate	24	25	24	24	24	24	76	167
Trace Metals (Total Recoverable)								
Antimony	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0017	0.0010
Arsenic	0.005	0.005	0.005	0.006	0.005	0.005	0.010	0.011
Cadmium	0.00032	0.00030	0.00029	0.00033	0.00031	0.00035	0.03100	0.00026
Copper	0.005	0.005	0.006	0.006	0.006	0.006	0.026	0.003
Iron	0.62	0.76	0.86	0.84	0.82	0.93	0.48	0.84
Lead	0.0082	0.0104	0.0088	0.0103	0.0096	0.0110	0.0202	0.0019
Manganese	0.07	0.07	0.08	0.08	0.07	0.08	1.34	0.35
Selenium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	0.078	0.080	0.089	0.085	0.080	0.083	1.43	0.019
Sample Date	**10/17/19**	**10/17/19**	**10/17/19**	**10/17/19**	**10/17/19**	**10/17/19**	**10/17/19**	**10/17/19**
Field Parameters								
pH (s.u.)	8.29	8.36	8.11	8.22	8.14	8.18	7.87	8.84
SC (µmhos/cm)	295	293	304	300	302	305	487	650
Flow (cfs)	64	64	63	64	61	56	0.011 E	0.056 E
Laboratory Analyses								
Total Dissolved Solids	201	199	186	192	190	191	344	461
Calcium	34	34	34	35	34	35	62	86
Magnesium	8	8	8	8	8	8	15	18
Sodium	13	13	12	13	13	13	27	25
Potassium	3	3	3	3	3	3	4	5
Chloride	7	7	7	7	6	6	11	11
Sulfate	56	56	57	57	51	52	91	184
Trace Metals (Total Recoverable)								
Antimony	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0030	0.0008
Arsenic	0.003	0.004	0.004	0.004	0.003	0.004	0.005	0.005
Cadmium	0.00021	0.00023	0.00021	0.00025	0.00024	0.00028	0.01280	0.00014
Copper	<0.002	<0.002	<0.002	0.002	0.002	0.002	0.015	<0.002
Iron	0.19	0.20	0.25	0.26	0.24	0.29	0.32	0.60
Lead	0.0015	0.0022	0.0018	0.0031	0.0024	0.0028	0.0157	0.0020
Manganese	0.04	0.04	0.05	0.05	0.05	0.05	0.07	1.69
Selenium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	0.088	0.088	0.090	0.094	0.092	0.094	0.739	0.023

All concentrations in mg/L unless otherwise noted.

Concentration exceeds applicable surface water quality standard. (shaded cells)

Prickly Pear Creek sites listed in upstream to downstream order.

NM - Not Measured; E - Estimated

Complete 2019 database in Appendix A.

Table 3-3. 2017/18 and 2019 Tributary Drainage Concentration Comparison

	Sulfate	Arsenic	pH	Cadmium	Copper	Iron	Lead	Manganese	Zinc
	mg/L	mg/L	S.U.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Trib-1B									
4/17/2017	160	0.004	7.02	0.0710	0.021	0.35	0.0366	0.48	5.36
5/5/2017	NM	NM	6.68	NM	NM	NM	NM	NM	3.94
6/19/2017	140	0.022	8.31	0.0186	0.024	0.91	0.0332	0.32	0.959
5/25/2018	87	0.007	6.25	0.0239	0.022	0.18	0.008	0.20	1.38
2017/18 Average	**129**	**0.011**	**7.07**	**0.038**	**0.022**	**0.48**	**0.0259**	**0.33**	**2.91**
6/7/2019	76	0.010	6.88	0.0310	0.026	0.48	0.0202	1.34	1.43
10/17/2019	91	0.005	7.87	0.0128	0.015	0.32	0.0157	0.07	0.739
2019 Average	**84**	**0.007**	**7.38**	**0.022**	**0.021**	**0.40**	**0.0179**	**0.71**	**1.08**
% Reduction	**35%**	**32%**	**-4%**	**42%**	**8%**	**17%**	**31%**	**-112%**	**63%**
Trib-1D									
4/17/2017	210	0.017	8.09	0.00259	0.008	3.57	0.0228	1.14	0.240
6/19/2017	250	0.011	8.49	0.00079	0.011	1.11	0.0120	0.21	0.041
10/2/2017	260	0.020	9.20	0.00014	0.004	0.22	0.0031	0.02	0.008
5/25/2018	134	0.011	7.60	0.00875	0.015	1.22	0.0061	0.39	0.894
7/19/2018	209	0.021	9.72	0.0002	0.003	0.19	0.0012	0.03	0.011
10/12/2018	276	0.007	8.70	0.00021	0.002	0.47	0.0032	0.63	0.019
2017/18 Average	**223**	**0.015**	**8.63**	**0.00211**	**0.0072**	**1.13**	**0.0081**	**0.40**	**0.202**
6/7/2019	167	0.011	9.13	0.00026	0.003	0.84	0.0019	0.35	0.019
10/17/2019	184	0.005	8.84	0.00014	0.002	0.60	0.0020	1.69	0.023
2019 Average	**176**	**0.008**	**8.99**	**0.00020**	**0.0025**	**0.72**	**0.0020**	**1.02**	**0.021**
% Reduction	**21%**	**45%**	**-4%**	**91%**	**65%**	**36%**	**76%**	**-153%**	**90%**

NM - Not Measured
Metals analyses are total recoverable fraction.

3.2 RESIDENTIAL / PUBLIC WATER SUPPLY SAMPLING RESULTS

Table 3-4 includes a statistical summary of the 2019 residential/water supply well arsenic and selenium concentrations along with an exceedance summary of State of Montana human health standards (HHSs) for groundwater (MDEQ, 2019). Complete analytical results, including both total and dissolved metals concentrations, are included in Appendix A with residential well locations shown on Exhibit 1. With the exception of iron and manganese at a few residential wells, the total and dissolved metals concentrations are virtually identical.

As shown in the table, no water supply wells exhibited HHS exceedances for selenium in 2019, while four of the twenty wells showed HHS exceedances for arsenic, consistent with previous results for these wells. The four wells with arsenic exceedances are located either south (upgradient) of the Facility or to the west in an area of known naturally occurring groundwater arsenic (see Section 3.3). There were no exceedances recorded in 2019 or in previous years at the three COEH municipal water supply wells located north of the Facility (Well IDs R18, R19, and R20 in Table 3-4).

3.3 GROUNDWATER MONITORING RESULTS AND DATA ANALYSIS

This section presents a summary of current groundwater quality conditions and trends, and the status of the groundwater arsenic and selenium plumes. With completion of the scheduled IMs in 2016, the CAMP program has transitioned from a contaminant source area characterization and plume delineation program, to a remedy performance monitoring program appropriate to the remediation and CMS phase of a RCRA Corrective Action remediation project (Hydrometrics, 2019a). In their *Handbook of Groundwater Protection and Cleanup Policies for RCRA Corrective Action* (USEPA, 2004a), USEPA defines performance monitoring as "the periodic measurement of physical and/or chemical parameters to evaluate whether a remedy is performing as expected." More recently published USEPA guidance on groundwater remediation completion strategies (USEPA, 2013, 2014a, 2014b) includes discussions of recommended remedy evaluation strategies. Based on these guidance documents, and goals and objectives specific to the East Helena Project (Section 1), the 2019 performance monitoring program included two components:

(1) Groundwater level and contaminant concentration trend analyses at selected wells in Facility contaminant source areas, and near the leading edges of the arsenic and selenium plumes; and
(2) Contaminant plume stability analyses.

Following is a summary of 2019 groundwater conditions in the Project area, followed by discussions of the two performance monitoring components.

3.3.1 General Groundwater Conditions

The hydrogeology and geochemistry of the East Helena Facility and Project Area has been described in several documents including Hydrometrics, 2010, 2015b, and 2016; GSI, 2014; and CH2M, 2018. The alluvial aquifer on the Facility extends from the top of the saturated zone or water table, downward to a low permeability tertiary ash/clay basal layer. On the Facility, the depth to groundwater varies from less than 10 feet below ground surface (bgs) in the south and near Prickly

Table 3-4. Summary of 2019 Residential/Public Water Supply Well Water Quality Data

Map Key (see Exhibit 1)	Use	# of Samples	Dissolved Arsenic (mg/L)				Dissolved Selenium (mg/L)			
			Concentration			HHS Exceedances	Concentration			HHS Exceedances
			Min	Max	Mean		Min	Max	Mean	
R1	Drinking/Irrigation	3	<0.002	<0.002	<0.002	0	<0.001	<0.001	<0.001	0
R2	Irrigation	1	<0.002	<0.002	<0.002	0	0.002	0.002	0.002	0
R3	Drinking	2	<0.002	<0.002	<0.002	0	0.002	0.006	0.004	0
R4	Irrigation	2	<0.002	<0.002	<0.002	0	0.002	0.003	0.0025	0
R5	Drinking/Irrigation	2	<0.002	<0.002	<0.002	0	<0.001	<0.001	<0.001	0
R6	Drinking/Irrigation	2	<0.002	<0.002	<0.002	0	0.002	0.003	0.0025	0
R7	Drinking/Irrigation	2	<0.002	<0.002	<0.002	0	0.001	0.001	0.001	0
R8	Drinking/Irrigation	3	<0.002	<0.002	<0.002	0	<0.001	<0.001	<0.001	0
R9	Drinking/Irrigation	3	<0.002	<0.002	<0.002	0	<0.001	<0.001	<0.001	0
R10	Irrigation	1	<0.002	<0.002	<0.002	0	0.002	0.002	0.002	0
R11	Drinking/Irrigation	2	<0.002	<0.002	<0.002	0	0.042	0.043	0.0425	0
R12	Drinking/Irrigation	2	<0.002	<0.002	<0.002	0	0.002	0.002	0.002	0
R13	Drinking/Irrigation	2	0.014	0.015	0.0145	2	0.001	0.001	0.001	0
R14	Irrigation	3	<0.002	<0.002	<0.002	0	<0.001	<0.001	<0.001	0
R15	Drinking/Irrigation	2	0.015	0.017	0.016	2	0.002	0.002	0.002	0
R16	Drinking/Irrigation	1	0.017	0.017	0.017	1	0.002	0.002	0.002	0
R17	Drinking/Irrigation	2	0.017	0.018	0.0175	2	0.002	0.002	0.002	0
R18	Public Water Supply	2	<0.002	<0.002	<0.002	0	<0.001	<0.001	<0.001	0
R19	Public Water Supply	2	<0.002	<0.002	<0.002	0	<0.001	<0.001	<0.001	0
R20	Public Water Supply	2	<0.002	<0.002	<0.002	0	<0.001	<0.001	<0.001	0

All concentrations are dissolved fraction; total metals concentrations included in Appendix A.
HHS - Human Health Standard from MDEQ, 2019: arsenic = 0.010 mg/L, selenium = 0.050 mg/L

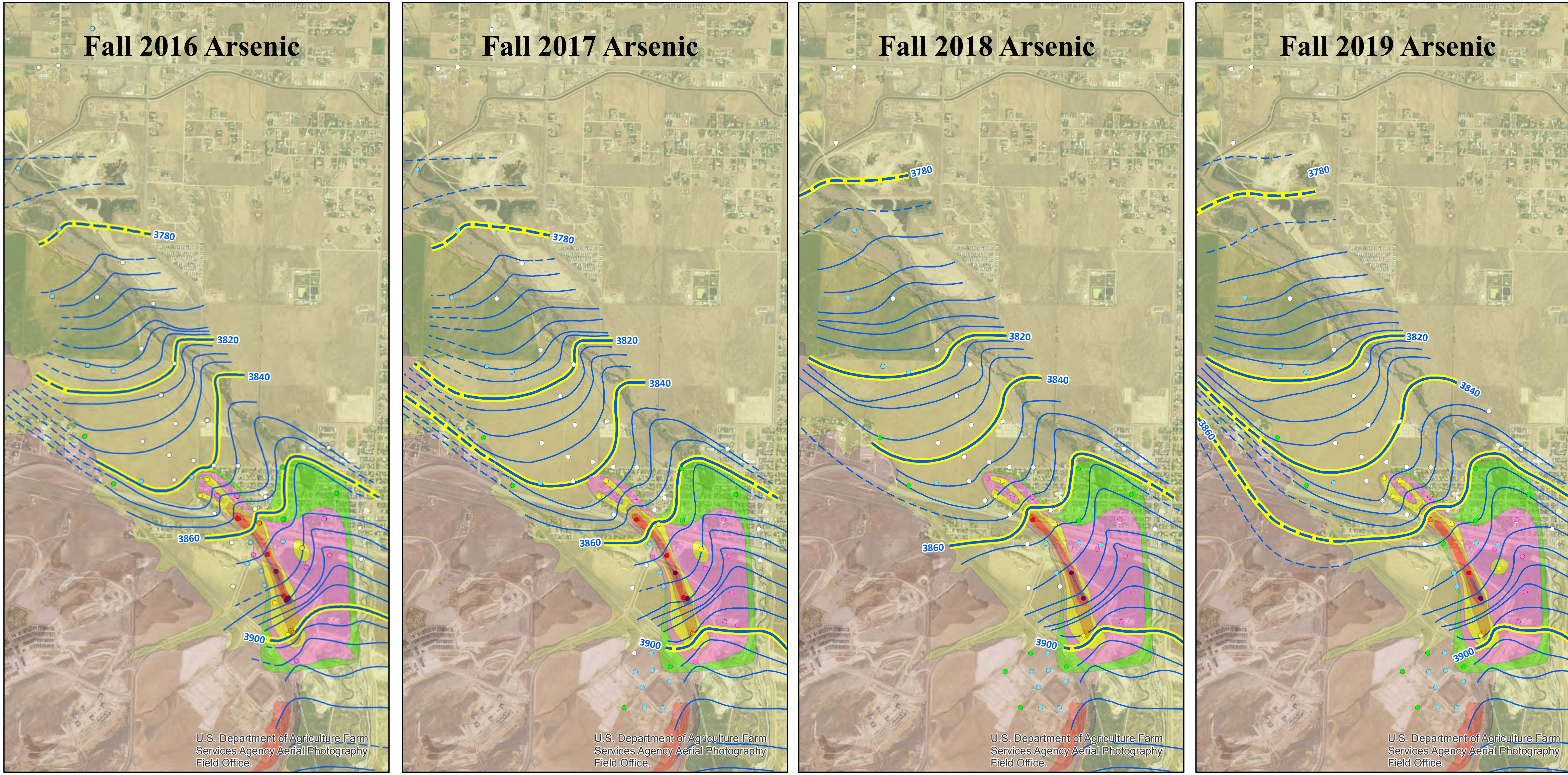
Pear Creek, to about 50 feet bgs in the northwest portion of the Facility. The base of the aquifer (the ash/clay layer) varies in depth from about 20 feet bgs in the southwest portion of the Facility, to more than 70 feet in the northeast portion. As a result, the saturated thickness of the alluvial aquifer ranges from about 10 feet in the south, to about 20 feet in the north of the Facility. A deeper groundwater system also occurs beneath the Facility with the deeper system comprised of isolated to poorly interconnected sandy lenses or zones within the Tertiary sediment unit. The contaminated soils/fill and groundwater plumes are largely restricted to the upper alluvial aquifer.

As previously noted, the primary groundwater constituents of concern (COCs) are arsenic and selenium, both of which exceed applicable HHSs in groundwater beneath and downgradient of the Facility. Secondary COCs exceeding HHSs in localized portions of the Facility, and rarely if ever in downgradient groundwater, include antimony, cadmium, and zinc. The 2019 arsenic and selenium groundwater plumes, as well as the 2016, 2017, and 2018 plumes for comparison, are shown on Figures 3-2 and 3-3, respectively.

Groundwater contaminant source areas have been delineated through a number of studies dating back more than two decades, with the two most recent investigations presented in Hydrometrics, 2015b and 2016. Based on results of prior investigations, confirmed or suspected historic (i.e., during smelter operations) groundwater contaminant sources include the South Plant Area (Tito Park, former Acid Plant Sediment Drying area, and Upper Ore Storage Area), former Lower Lake, the former Acid Plant settling pond area, former Speiss/Dross Area, and the former Lower Ore Storage Area (Figure 3-4). Based on the 2014 and 2015 Source Area Investigations (SAIs) and other data evaluations conducted as part of the CMS, the primary post-smelter closure contaminant source areas included portions of the South Plant Area, the former Acid Plant settling pond area (both areas where source removal IMs were subsequently implemented), the West Selenium Source Area, the North Plant Arsenic Source Area, and the slag pile. The SPHC, source removals and ET Cover IMs, and the planned slag pile remedial action (regrading and capping) are intended to further address these source areas.

The configuration and geometry of the current arsenic plume (Figure 3-2) shows the primary Plant Site plume extending approximately 0.5 miles northwest of the Facility into the COEH, with a more diffuse (lower concentration) plume extending north of the slag pile. Maximum concentrations near 100 mg/L arsenic occur isolated within the Speiss/Dross slurry wall, with maximum concentrations outside of the slurry wall in the 15 to 40 mg/L range immediately north of the slurry wall in the North Plant Site Source Area (Figure 3-4). The downgradient boundary of the arsenic plume as defined by the 0.01 mg/L (HHS) concentration contour is located along the north and west edges of East Helena, and has remained relatively stable since at least 2001 when the Facility was shutdown. An area of arsenic-bearing groundwater south and west of the former smelter (the “west arsenic area”), with arsenic concentrations in the 0.005 to 0.025 mg/L range, is believed to be derived from groundwater interactions with naturally-occurring arsenic-bearing Tertiary-age volcanoclastic sediments.

The selenium plume (Figure 3-3) extends offsite significantly further than the arsenic plume, due to a lower rate of geochemical attenuation (adsorption or coprecipitation) and the associated relatively



Legend

As Contours	As Conc (mg/L)	Surficial Geology	Groundwater Potentiometric Contour
0.011 - 0.100 mg/L	<0.002	Qac - Alluvium/Colluvium	5-foot Contour
0.101 - 1.00 mg/L	0.002 - 0.010	Qa - Alluvium	5-foot Contour (Inferred)
1.01 - 5.00 mg/L	0.011 - 0.100	Qt - Terrace Gravel	
5.01 - 10.0 mg/L	0.101 - 1.0	QTg - Older Gravel	
10.1 - 20.0 mg/L	1.01 - 5.0	OGts - Tuff and Tuffaceous Sediment	
> 20.0 mg/L	5.01 - 10.0	Ys - Spokane Formation	
	10.01 - 20.0		
	> 20.0		

N

0 0.5 1

Scale in Miles

2019 WATER RESOURCES MONITORING REPORT EAST HELENA FACILITY	2016-2019 GROUNDWATER ARSENIC PLUMES AND POTENTIOMETRIC CONTOURS EAST HELENA FACILITY	FIGURE 3-2

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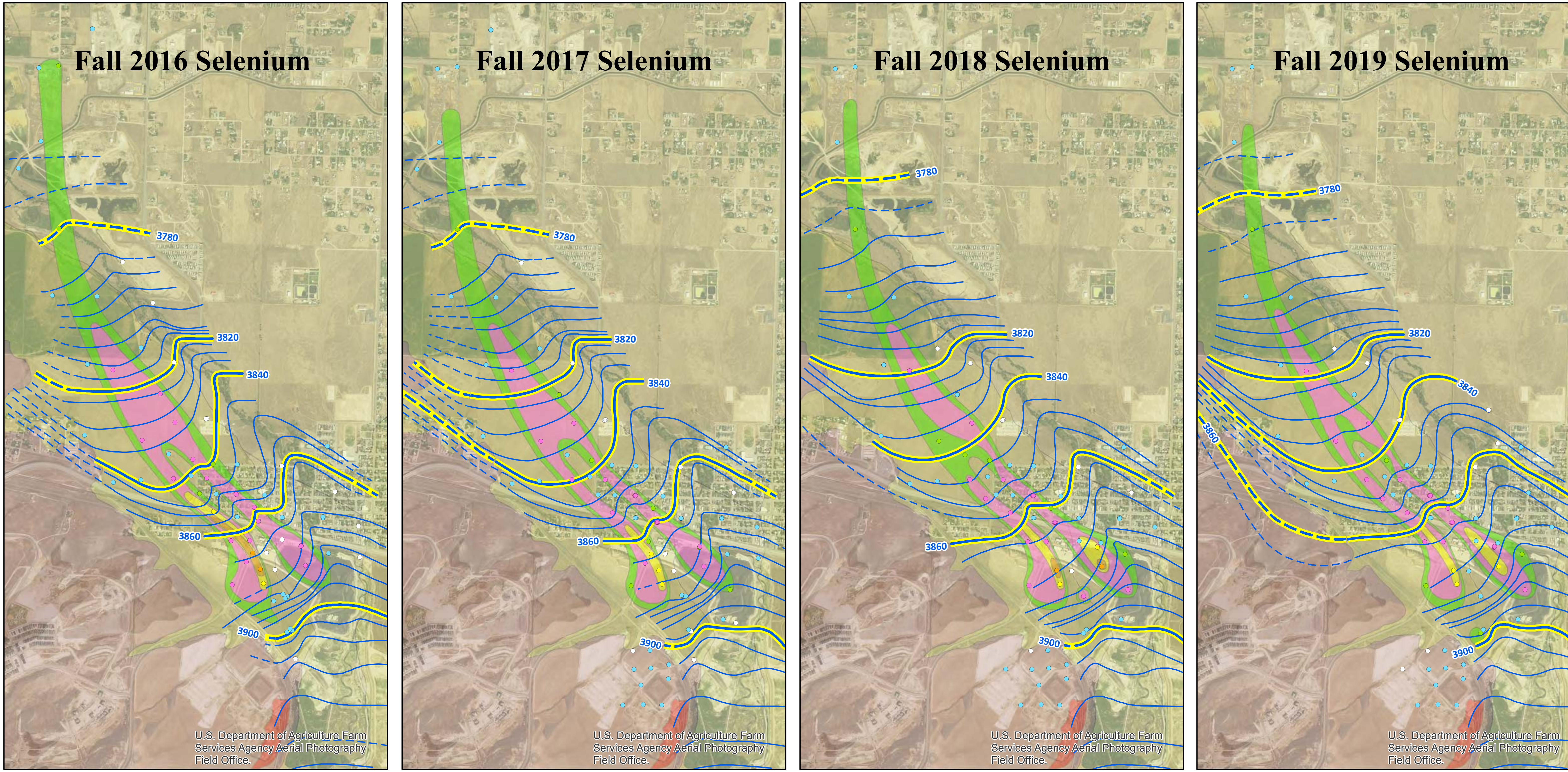

Legend

Se Contours	Se Conc (mg/L)	Surficial Geology	Groundwater Potentiometric Contours
0.051 - 0.100 mg/L	<0.001	Qac - Alluvium/Colluvium	5-foot Contour
0.101 - 0.500 mg/L	0.001-0.050	Qa - Alluvium	5-foot Contour (Inferred)
0.501 - 1.0 mg/L	0.051-0.100	Qt - Terrace Gravel	
1.01 - 3.0 mg/L	0.101-0.500	QTg - Older Gravel	
> 3.0 mg/L	0.501-1.0	OGts - Tuff and Tuffaceous Sediment	
	1.01-3.0	Ys - Spokane Formation	
	>3.0		

N

0 0.5 1

Scale in Miles

2019 WATER RESOURCES MONITORING REPORT EAST HELENA FACILITY	2016-2019 GROUNDWATER SELENIUM PLUMES AND POTENTIOMETRIC CONTOURS EAST HELENA FACILITY	FIGURE 3-3

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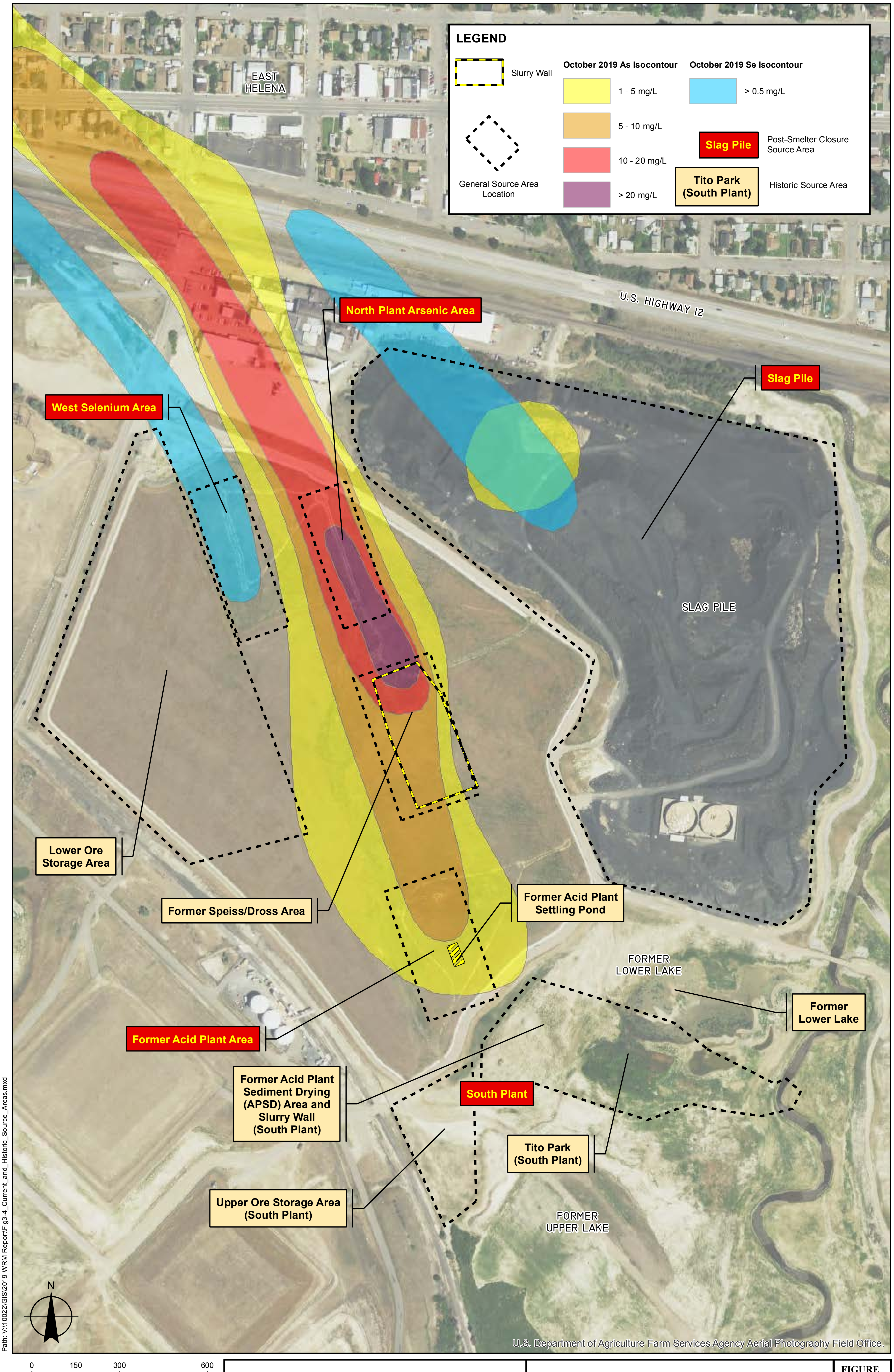

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2019 WATER RESOURCES MONITORING REPORT
EAST HELENA FACILITY

HISTORIC AND POST-SMELTER CLOSURE GROUNDWATER CONTAMINANT SOURCE AREAS

FIGURE 3-4

conservative transport behavior of selenium, with the 0.05 mg/L (HHS) selenium plume extending approximately two miles northwest of the Facility. The primary current groundwater selenium sources are the West Selenium Source Area (west lobe) and the slag pile (east lobe) (Figure 3-4).

3.3.2 Groundwater Level and Concentration Trends

3.3.2.1 Groundwater Level Trends

Groundwater level trends on the Facility are of particular interest since reducing groundwater levels is a large component of the corrective measures program. As previously noted, the main objective of the SPHC IM is to reduce groundwater levels on the Facility, thereby reducing groundwater interaction with contaminated soils and associated contaminant leaching to groundwater.

Appendix B includes the 2019 manual groundwater level measurements from the project area (in addition to the manual measurements, 34 of the project area monitoring wells are instrumented for continuous water level recording). Figure 3-5 includes groundwater hydrographs illustrating groundwater level trends for various portions of the Facility. Groundwater levels over most of the Facility have decreased since 2012 in response to the SPHC IM and other IM-related activities. Groundwater levels in the Acid Plant Area, illustrated by well DH-59, have declined by close to 10 feet from 2012, when the SPHC IM was initiated, through 2019. Water levels had decreased by close to 12 feet as of 2017 before increasing slightly in 2018 due to the exceptionally high snowpack and precipitation (particularly springtime precipitation) that year (Section 3.1.1). The hydrograph for well DH-66 (Figure 3-5) shows that water levels in the West Selenium Source Area have declined 7 to 8 feet from 2012 through 2019. Water levels had decreased by about 10 feet as of 2017 before rebounding slightly in 2018. In the North Plant Site Arsenic Source Area (well DH-17), water levels declined 7 to 8 feet through 2019, while water levels beneath the slag pile (well DH-55), have shown little or no change in response to the SPHC IM. Groundwater levels in the eastern portion of the Facility (i.e., beneath the slag pile), are controlled by the relatively constant Prickly Pear Creek stage while water levels at the other locations were historically heavily influenced by the former Upper Lake, which was drained as part of the SPHC IM.

The IM-induced groundwater level declines between 2012 and 2019 have resulted in the desaturation of some of the most contaminated Facility soils, thereby reducing groundwater interactions with and contaminant leaching from these soils. The Figure 3-5 hydrographs include the elevation of the Tertiary ash/clay layer representing the base of the plume-bearing upper alluvial groundwater system at each location. In the former Acid Plant area, groundwater elevations have decreased from about 3901 feet AMSL to about 3894 feet as of October 2019 with the ash/clay layer at about 3885 feet. This represents a decrease in saturated thickness from 16 feet to 9 feet in this source area. The reduced saturated thickness, and relatively consistent hydraulic gradient over that time, represents an approximate 45% reduction in the groundwater flux through the former Acid Plant area. Using similar comparisons for the West Selenium Source Area (well DH-66) and North Plant Arsenic Source Area (DH-17) yields reductions in the saturated thickness and groundwater flux of about 30% and 25%, respectively for these areas. The reduced groundwater flux through the contaminant source areas results in a corresponding reduction in the groundwater contaminant load leaving the Facility, thereby reducing downgradient groundwater loads and concentrations.

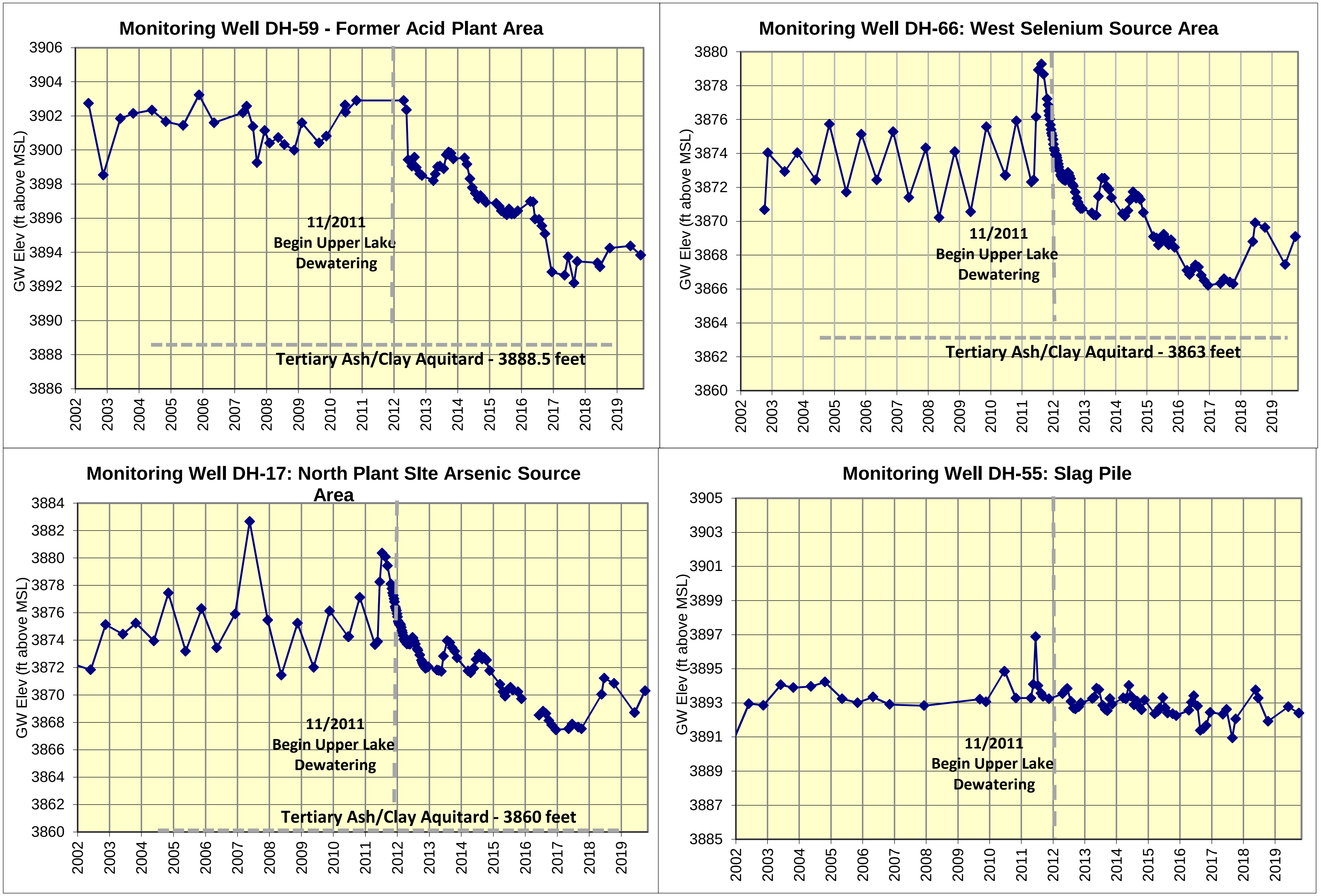


FIGURE 3-5. GROUNDWATER LEVEL HYDROGRAPHS FROM FACILITY SOURCE AREA MONITORING WELLS

Figure 3-6 shows groundwater elevation changes throughout the project area since inception of the CM/IM program in 2011. The figure shows both the 2017 and 2019 water level changes since inception of the CM/IM program to illustrate not only the effects of the IM program, but also the short-term effects of the exceptionally high precipitation experienced in 2018 and 2019. Groundwater levels throughout much of the study area have declined since 2011 with the largest declines (>9 feet) as of 2019 occurring in the south plant area, due mainly to elimination of former Upper and Lower Lake as part of the SPHC IM, and in the western portion of Lamping Field in response to decommissioning of Wilson Ditch, formerly a significant seasonal source of groundwater recharge (Figure 3-6). Besides desaturating remaining contaminated soils, the larger declines in the south plant area have also decreased the hydraulic gradient, and thus the groundwater flux and associated contaminant load, leaving the Plant Site. The larger declines along the west side of Lamping Field are responsible for the slight westward shift observed in the selenium plume since 2012.

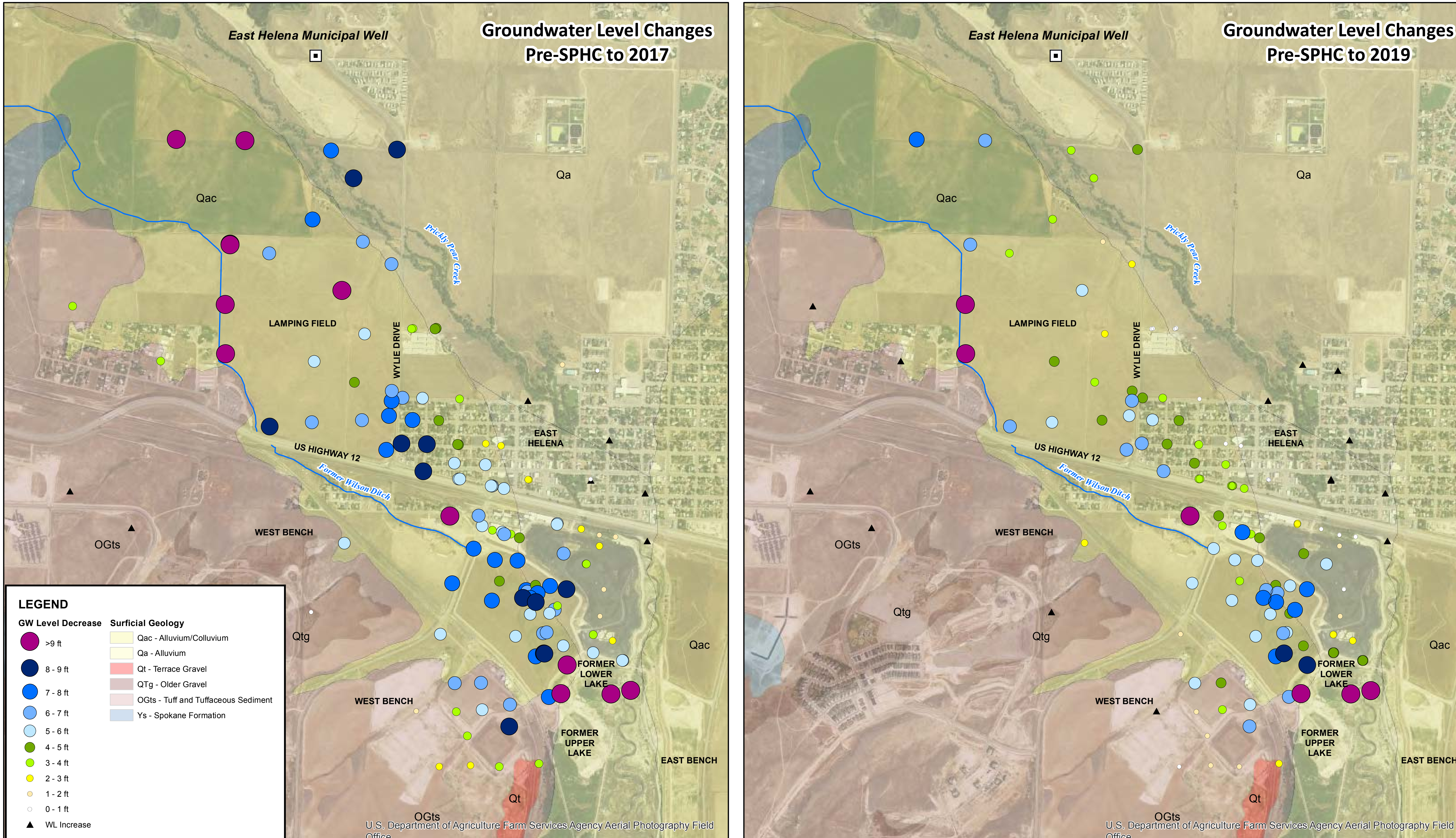
Also apparent in Figure 3-6 is the increase in groundwater levels from 2017 to 2019 on both the Plant Site and even more so downgradient (to the north). The Plant Site increases are believed due primarily to the high 2018 and 2019 precipitation, while the northernmost water level increases are in response to precipitation patterns as well as other non-project related land use practices such as groundwater pumping and irrigation (Hydrometrics, 2018). Figure 3-6 also shows the relatively small water level declines (1 to 3 feet) recorded in the eastern portion of the Plant Site beneath the slag pile, and slight water level increases north of the Plant Site in East Helena. This last observation exemplifies the influence of Prickly Pear Creek on the local groundwater flow and plume migration patterns with groundwater impacts from the former smelter primarily restricted to areas west of the creek.

3.3.2.2 <u>Groundwater Concentration Trends</u>

The 2019 CAMP specified trend analysis at 23 wells for both the primary COCs at the Facility (arsenic and selenium), as well as the indicator geochemical parameters sulfate and chloride, and groundwater levels. Remediation phase performance trend analyses currently focus on wells in three primary areas of interest: (1) the Facility source areas, including the Acid Plant area, slag pile area, West Selenium area, and North Plant Site Arsenic area; (2) wells defining the downgradient extent of the arsenic plume; and (3) wells defining the downgradient extent of the selenium plume. Wells selected for concentration trend analyses are listed in Table 3-5 and are shown on Figure 3-7. The parameter trends have been segregated into the two periods prior to and following the initial implementation of IMs in late 2011 including:

1. RCRA Facility Investigation (RFI) period (2002-October 2011); and
2. RCRA Interim Measure/Corrective Measure (IM/CM) implementation period (November 2011-2019).

The complete set of arsenic and selenium trend plots for the trend analysis wells are shown on Figures 3-8 and 3-9 with additional constituent graphs (chloride and sulfate) included in Appendix C. Appendix D includes COC (arsenic and selenium) trend plots for a larger set of wells



NOTE: Groundwater level changes calculated as the difference between 2002 -2010 average elevations (pre-SPHC) and 2017/2019 average elevations.

0 0.25 0.5
Scale In Miles
N

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2019 WATER RESOURCES MONITORING REPORT
EAST HELENA FACILITY

PROJECT AREA
GROUNDWATER LEVEL CHANGES
2017 AND 2019

FIGURE
3-6

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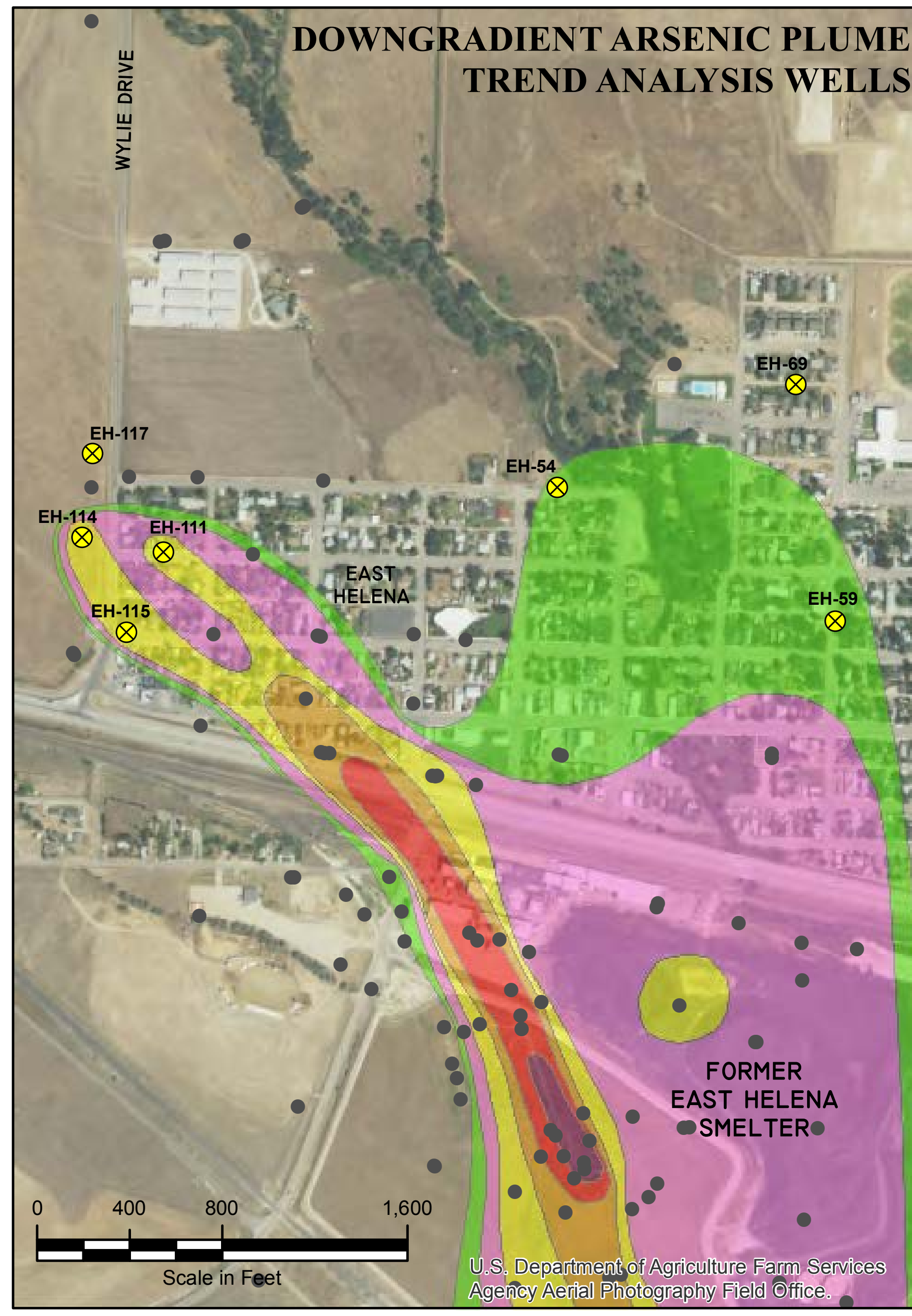
Table 3-5. 2019 Concentration Trend Analysis Monitoring Wells

Well	Northing	Easting	Target Area
DH-42	859587.20	1359938.80	Acid Plant
DH-80	859665.45	1360005.89	Acid Plant
DH-17	860997.41	1359668.63	North Plant Arsenic
DH-79	860422.215	1359937.191	North Plant Arsenic
DH-6	861527.08	1360252.42	Slag Pile
DH-15	861541.06	1360257.00	Slag Pile
DH-52	861372.14	1360876.16	Slag Pile
DH-56	861098.43	1360350.74	Slag Pile
DH-66	861005.14	1359333.41	West Selenium
DH-8	860693.17	1359404.72	West Selenium
2843 Canyon Ferry Road	872346.42	1354330.00	Downgradient Selenium Plume
2853 Canyon Ferry Road	872391.53	1354773.24	Downgradient Selenium Plume
EH-138	867179.05	1355646.47	Downgradient Selenium Plume
EH-139	867197.45	1354635.30	Downgradient Selenium Plume
EH-141	868713.30	1354782.70	Downgradient Selenium Plume
EH-143	870683.75	1354372.76	Downgradient Selenium Plume
EH-54	863345.39	1359822.33	Downgradient Arsenic Plume
EH-59	862766.01	1361023.24	Downgradient Arsenic Plume
EH-69	863791.12	1360852.61	Downgradient Arsenic Plume
EH-111	863063.82	1358121.67	Downgradient Arsenic Plume
EH-114	863127.75	1357769.76	Downgradient Arsenic Plume
EH-115	862717.81	1357963.04	Downgradient Arsenic Plume
EH-117	863491.19	1357815.10	Downgradient Arsenic Plume



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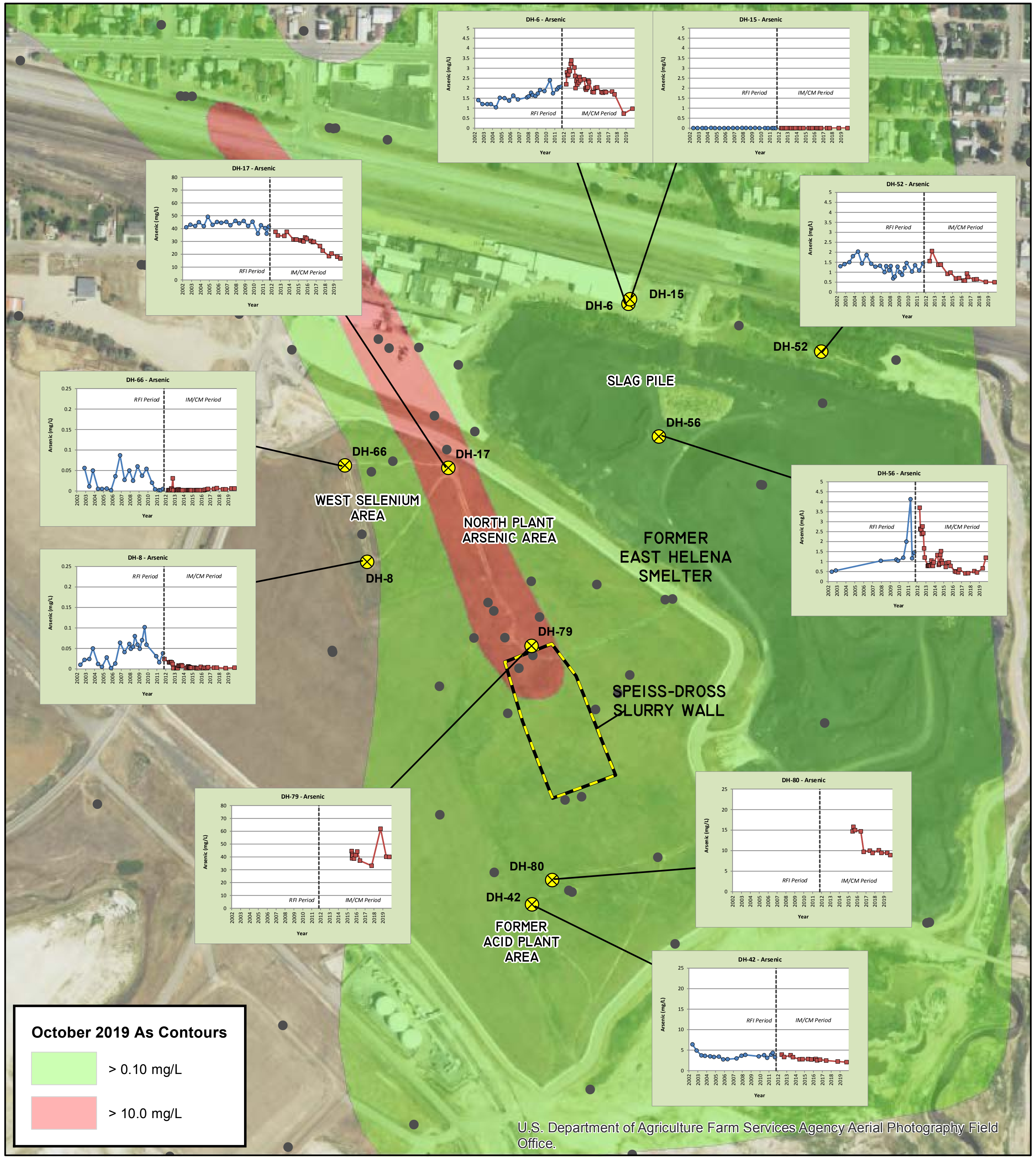
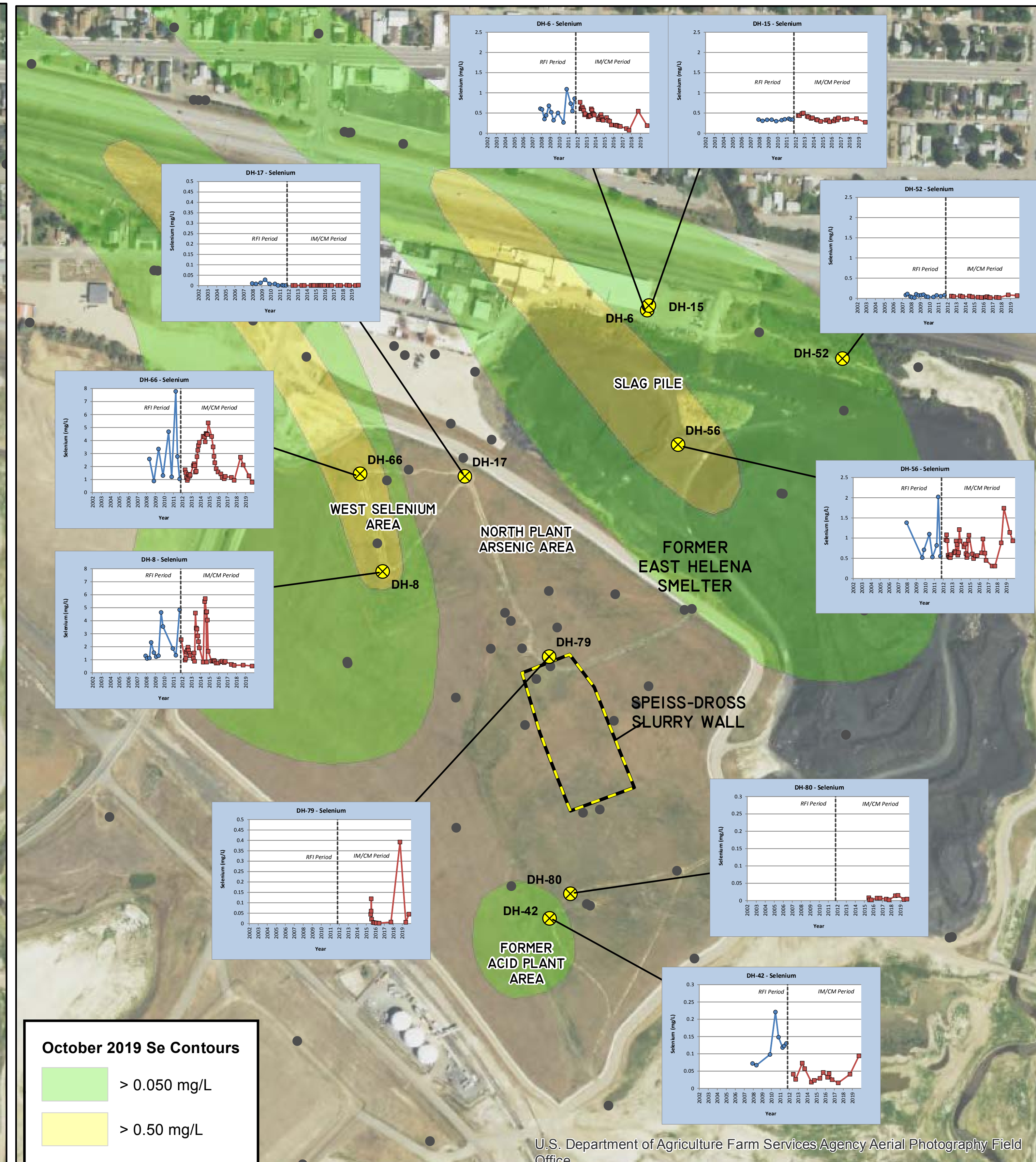
2019 WATER RESOURCES MONITORING REPORT EAST HELENA FACILITY	**2019 PERFORMANCE EVALUATION TREND ANALYSIS MONITORING WELLS**	**FIGURE 3-7**



PLANT SITE SOURCE AREA ARSENIC TRENDS



PLANT SITE SOURCE AREA SELENIUM TRENDS

NOTE: Arsenic trend graphs have green background; selenium trend graphs have blue background

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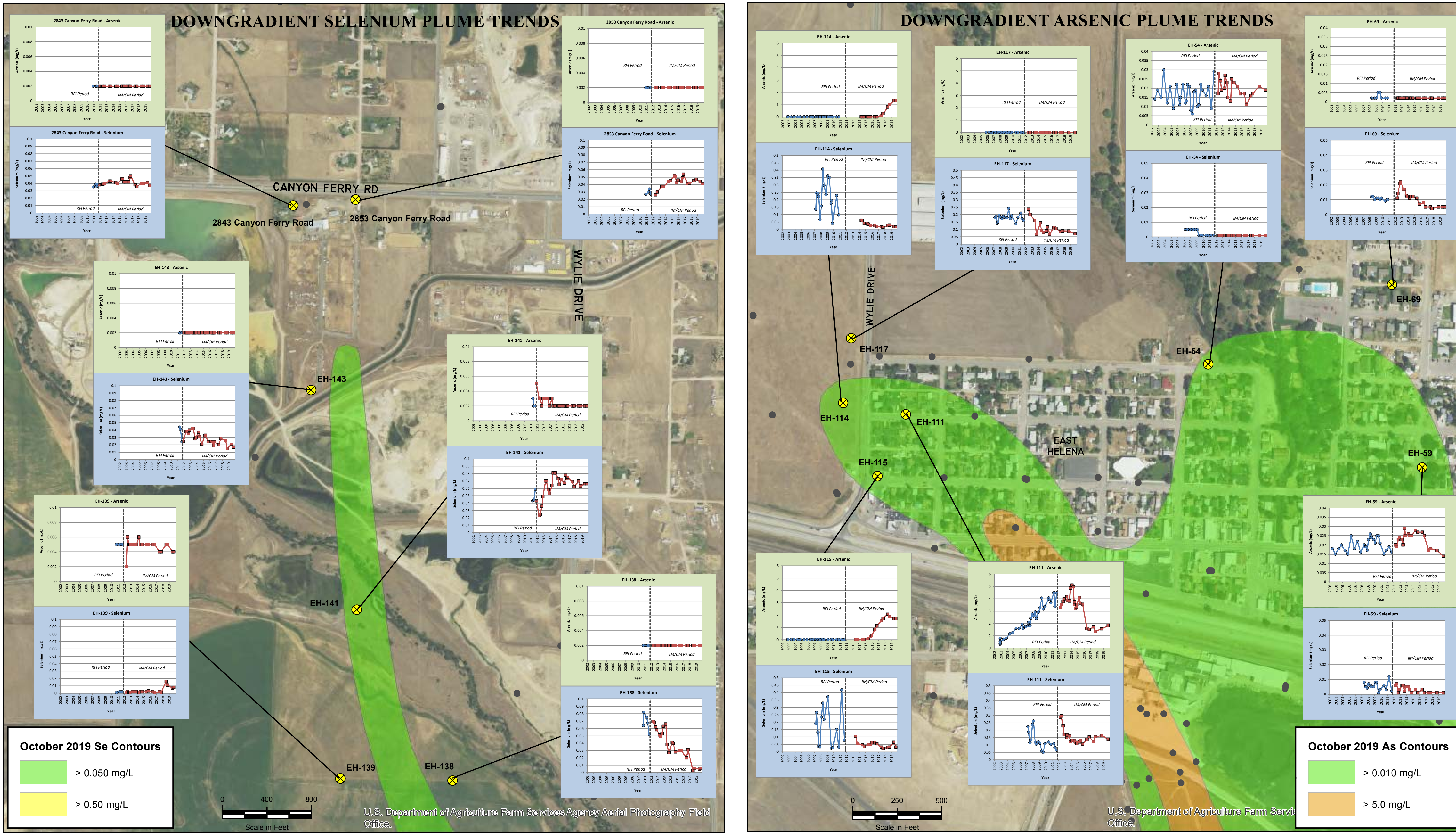
2019 WATER RESOURCES MONITORING REPORT EAST HELENA FACILITY	2019 PERFORMANCE EVALUATION TRENDS PLANT SITE AREA	FIGURE 3-8



NOTE: Arsenic trend graphs have green background; selenium trend graphs have blue background

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2019 WATER RESOURCES MONITORING REPORT EAST HELENA FACILITY	2019 PERFORMANCE EVALUATION TRENDS DOWNGRADIENT SELENIUM AND ARSENIC PLUME AREAS	FIGURE 3-9

throughout the Plant Site and downgradient plume monitoring areas. Based on the trend plots shown on Figures 3-8 and 3-9 and presented in Appendix C, arsenic and selenium concentration trends are summarized below.

Acid Plant Area

In the Acid Plant area, arsenic concentrations have decreased at well DH-42 during both the 2002 to 2012 RFI phase and 2013 to 2019 IM/CM phase. Selenium trends at DH-42 have been more variable (Figure 3-8), but overall concentrations have been lower during the recent IM/CM period (0.016 to 0.094 mg/L) compared with the RFI period (0.067 to 0.221 mg/L). Monitoring well DH-80, completed in 2015 to document the water quality response to the acid plant area soil removal IM showed a significant decrease in arsenic concentrations following the 2016 removal action, from about 15 mg/L to 10 mg/L, and decreased to its lowest level on record, 8.93 mg/L, in October 2019. The selenium concentration at DH-80 increased from 0.002 to 0.015 mg/L in 2018, presumably in response to short-term increase in groundwater levels and possible associated changes in geochemical conditions, before decreasing again to 0.003 mg/L in 2019.

Slag Pile Area

Concentration trend plots for slag pile area wells DH-6, DH-15, DH-52, and DH-56 are included in Figure 3-8 and Appendix C. Arsenic concentrations at all four wells were either stable or increased during the RFI phase, and have decreased during the IM/CM phase. For example, the arsenic concentration at DH-6 has decreased from a high of 3.38 mg/L in November 2012 to 0.97 mg/L in October 2019, and DH-56 decreased from 3.7 to 1.19 mg/L arsenic from 2012 to 2019 (73% and 70% reductions, respectively). The arsenic concentration at DH-56 has shown a notable increase from 2017 to 2019 (0.416 to 1.19 mg/L), most likely due to above average precipitation recorded in 2018 and 2019.

Selenium concentrations at slag pile wells DH-6 and DH-56 decreased in 2019 after showing notable increases in 2018 (Figure 3-8). At DH-6, selenium concentrations were 0.07, 0.55, and 0.19 mg/L in 2017, 2018, and 2019, respectively, while DH-56 concentrations were 0.31, 1.74 and 0.93 mg/L during the same period. Similar trends also occurred for indicator parameters chloride and sulfate at these two wells, indicative of a slag pile source. Similar to arsenic at well DH-80 described above, the increase is believed to be attributable to the above average precipitation in 2018 and 2019, with saturation of the slag pile base and/or increased infiltration through the slag pile being potential leaching and transport mechanisms. Groundwater levels and concentrations will be evaluated further in 2020 at these wells to better assess the contaminant loading mechanism(s) and concentration trends. It should be noted that the slag pile is scheduled to be regraded and capped in 2020 and/or 2021 to reduce infiltration through the pile.

West Selenium Area

Concentration trend plots for West Selenium Area wells DH-66 and DH-8 are shown on Figure 3-8 and included in Appendix C. Arsenic concentrations in wells DH-66 and DH-8 have historically been relatively low (0.1 mg/L or lower), and decreased to near or below the 0.002 mg/L analytical detection limit after 2011. Selenium concentrations at wells DH-8 and DH-66 were highly variable historically, ranging from approximately 1 to nearly 8 mg/L. After IM implementation began in

2011, selenium concentrations increased consistently at DH-66 through 2014, possibly due to nearby construction activities, and have since decreased to near historic minimum levels of about 1.0 mg/L. Selenium concentrations at DH-66 did spike in June 2018 (2.72 mg/L) but have since decreased to their lowest level on record, 0.786 mg/L, in October 2019. The groundwater level in well DH-66 peaked at about 3870 feet in early July 2018, the highest level recorded since 2014, which may be related to the 2018 spike in the selenium concentration. The October 2019 selenium concentration at DH-8, 0.518 mg/L, was also the lowest concentration recorded at that well.

North Plant Source Area

Arsenic and selenium trend plots for North Plant Area wells DH-17 and DH-79 are shown on Figure 3-8. Arsenic concentrations at DH-17 continued to decrease in 2019 with the October 2019 concentrations (16.7 mg/L), approximately one-third the RFI phase concentrations of 40 to 50 mg/L. Arsenic concentrations at well DH-79, located immediately downgradient of the Speiss/Dross slurry wall, returned to typical IM/CM period concentrations of 40 mg/L after spiking to 62 mg/L in 2018. Selenium concentrations remained low at DH-17 in 2019 (0.002 mg/L) while concentrations at DH-79 decreased to 0.045 mg/L after spiking to 0.39 mg/L in October 2018 (Figure 3-8). Similar to some other plant source area, wells the 2018 concentration spikes at well DH-79 may have been related to short-term water level increases at this well observed during 2018.

Downgradient Concentration Trends

Arsenic and selenium concentration trends for wells along the downgradient end of the arsenic plume, including EH-111, EH-114, EH-115, and EH-117 in the higher concentration western portion of the plume, and EH-54, EH-59, and EH-69 in the lower concentration eastern portion of the plume, are shown on Figure 3-9 with additional plots (chloride and sulfate) in Appendix C. Well EH-111, which has historically represented the furthest downgradient extent of arsenic concentrations greater than 1 mg/L (with maximum concentrations in the 5 mg/L range), has shown a significant decrease from 2015 through 2019. The October 2019 arsenic concentration at EH-111 (1.84 mg/L) is approximately 65% lower than the peak concentration of 5.1 mg/L in February 2014. Concentrations of other constituents at EH-111 have shown variable trends: selenium concentrations initially increased in the post-2011 period but have since stabilized at about 0.15 mg/L.

Water quality trends at wells EH-114 and EH-115 (south and west of EH-111; Figure 3-9) show the impacts of the westward plume shift observed in the IM/CM period. Prior to 2011, arsenic concentrations were below detect and selenium, sulfate, and chloride concentrations were highly variable as these wells received seasonal influxes of water from the West Selenium source area, with low arsenic concentrations and elevated selenium concentrations. In the last several years, arsenic concentrations have increased at both wells and selenium concentrations have decreased (Figure 3-9). These trends are attributable to the lack of seasonal recharge and altered flow direction, and possibly altered geochemical conditions, due to the decommissioning of Wilson Ditch in 2012. The arsenic concentration at both of these wells appears to be stabilizing or decreasing as of 2019.

In the eastern, lower concentration portion of the arsenic plume, arsenic concentrations are currently between 0.014 and 0.019 mg/L at EH-54 and EH-59, and below reporting limits (<0.002 mg/L) at EH-69, similar to pre-IM/CM concentrations. Selenium and sulfate concentrations at EH-59 and

EH-69 have both decreased during the IM/CM period while groundwater quality at EH-54 has remained relatively consistent, with selenium concentrations at all three wells currently 0.005 mg/L or less.

Trends analyses wells near the downgradient end of the selenium plume include former residential wells 2843 and 2853 Canyon Ferry Road, EH-138, EH-139, EH-141, and EH-143 (Figure 3-9). Available data for the pre-IM period before 2011 is limited to three to four samples for this well set, precluding RFI phase trend analyses, with the available data indicating the following:

- Arsenic – concentrations in the downgradient area are consistently low, ranging from <0.001 to 0.006 mg/L, less than the 0.01 mg/L HHS, and showing no trends over time.
- Selenium – At EH-139 on the west side of the downgradient plume, the selenium concentration increased from <0.001 to 0.003 mg/L pre-2018, to 0.011 to 0.016 mg/L in 2018, due to the slight westward plume shift. The concentration has since decreased slightly to 0.007 to 0.008 mg/L in 2019. At well EH-138, located along the east side of the plume between the plume and East Helena municipal well #3, the selenium concentration decreased from 0.031 to 0.006 mg/L from October 2017 to October 2018 and 2019. At the other wells defining the downgradient selenium plume (2843 and 2853 Canyon Ferry Road wells, EH-141, EH-143), selenium concentrations have shown slight to moderate decreasing trends over the last 3 or more years (Figure 3-9), accompanied by similar trends in the indicator parameters chloride and sulfate (Appendix C). As of October 2019, the selenium concentration exceeded the 0.05 mg/L groundwater standard in only one downgradient trend analysis well, EH-141 at 0.066 mg/L in both June and October 2019.

Overall, arsenic and selenium concentrations show decreasing trends at most source area and downgradient wells during the IM/CM period (post-2011). The short-term increases noted at some source area wells in 2018 are believed to be due to well above average precipitation rates in 2018 and associated groundwater level changes, with concentrations at most of those wells decreasing in 2019. The slight to moderate decreasing selenium concentration trends exhibited at downgradient wells are due to a slight westward shift in the plume as well as an overall decrease in downgradient selenium groundwater loads and concentrations. Based on these trends, the downgradient extent of the selenium plume in 2019 has receded by several hundred feet as compared to 2018 and prior years.

3.3.3 Contaminant Plume Stability

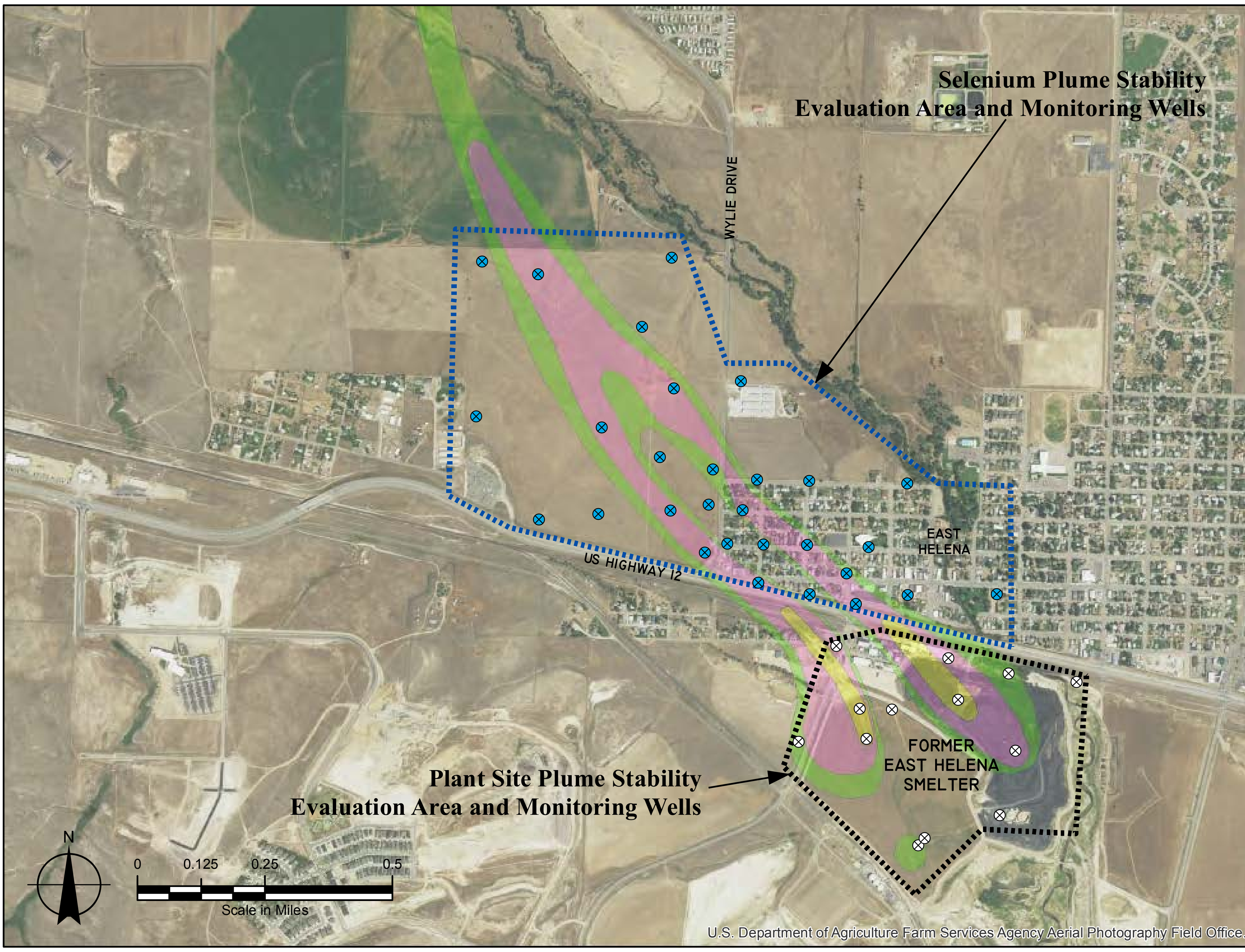
Another component of the East Helena groundwater remedy performance evaluation is plume stability analyses for the primary groundwater COCs arsenic and selenium. While contaminant concentration trends at individual wells within and downgradient of the primary source areas on the Facility may show varying trends (increasing or decreasing), particularly during the remediation phase of remedy monitoring, evaluation of plume stability allows an additional comprehensive assessment of plume characteristics on the former Plant Site and the area directly downgradient of the Facility, including any changes over time in metrics such as total plume area, average plume concentration, and plume concentration centroid location.

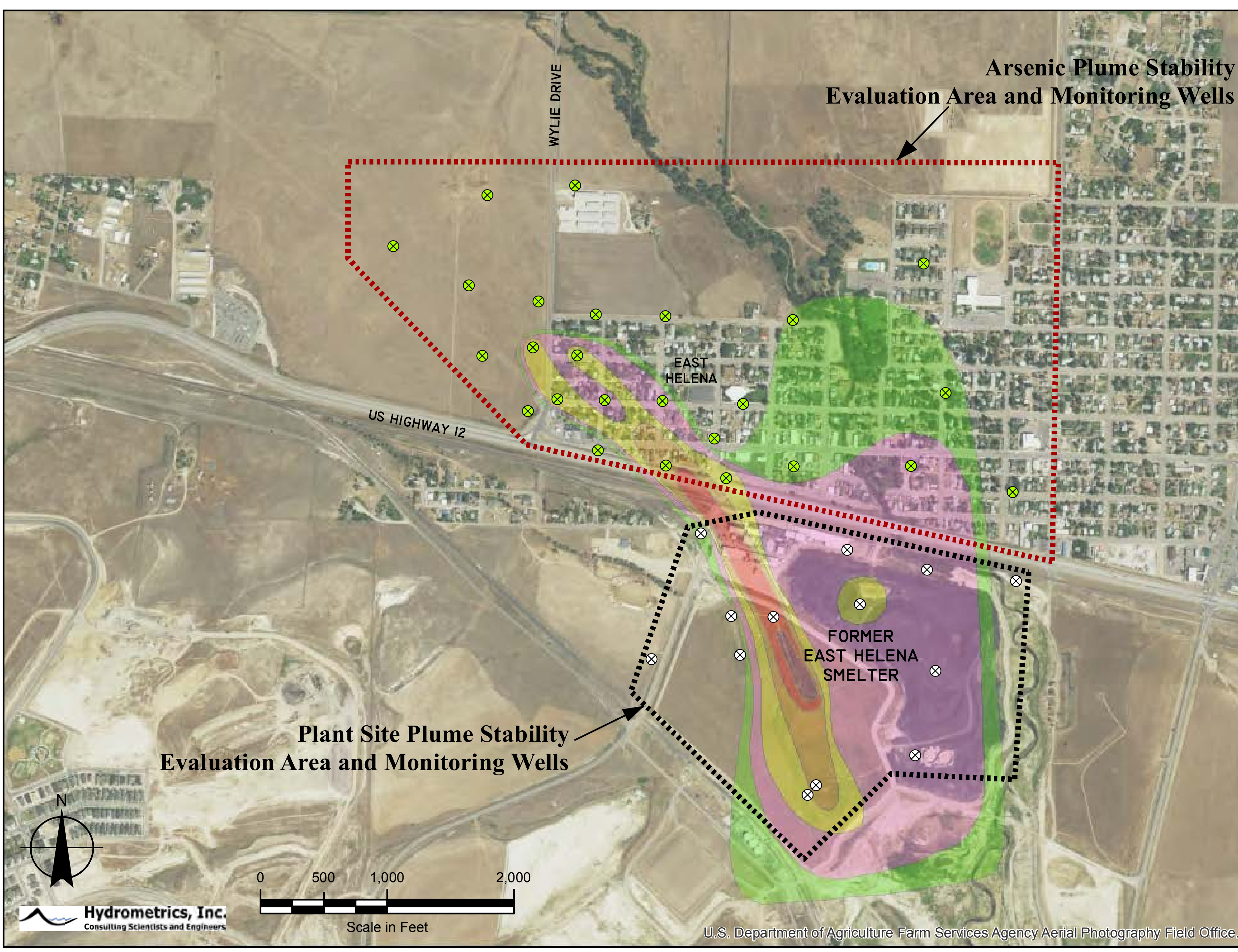
The calculation methods for arsenic and selenium plume stability are based on methods outlined in Ricker (2008). This method was originally developed as a tool to evaluate the stabilization of contaminated groundwater migration, in accordance with the requirements of Government Performance and Results Act Environmental Indicator (EI) RCRIS Code CA 750 (Migration of Contaminated Groundwater Under Control). The evaluation procedure involves the following steps:

1. Define the areas for which plume characteristics will be calculated. For the purposes of remediation phase performance evaluation monitoring described in the 2019 CAMP, arsenic and selenium plume areas on the former smelter site ("Plant Site plume stability"), and in the near downgradient areas in the COEH and in Lamping Field were selected, to allow integration of results from multiple monitoring points into a single analytically-derived measure of plume characteristics. The arsenic and selenium plume stability evaluation areas are shown on Figure 3-10.
2. Select a representative set of monitoring wells from the monitoring well network with sufficient spatial distribution to define the extent of the contaminant plume within the plume stability evaluation areas over multiple years. The selected well sets for the plume stability analyses are shown on Figure 3-10 and summarized in Table 3-6. Note that the selected off-site well set for selenium covers a greater area than the off-site well set for arsenic, since the plume configurations are different.
3. For each well, calculate an annual average concentration of the COC. Below detect values were replaced with the detection limit for calculation of averages.
4. Generate a grid file of interpolated concentration values within the given plume stability area for an individual monitoring year and contaminant, using spatial analysis software such as Surfer® by Golden Software. As suggested in Ricker (2008), grid files were generated on log-transformed concentration data (for smoother interpolation), then transformed back to original concentration units prior to further calculations.
5. Use the grid file to calculate various average plume metrics for the monitoring year, including:
   a. Plume area;
   b. Average plume concentration; and
   c. Plume centroid of concentration.

Calculated values are then compared over time to determine any trends in total plume area or average plume concentration. In addition, Ricker (2008) notes that for shrinking plumes, the plume centroid of concentration (or mass) should recede toward the source over time; if the plume is transient (migrating away from the source) or expanding, the centroid of concentration will show migration downgradient away from the source. Therefore, by calculating and plotting centroids of concentration over a number of years, plume stability (expanding, stable, shrinking, or transient) can be evaluated.

Based on the available groundwater data for the plume stability well sets shown in Table 3-6, off-site arsenic and selenium plume stability metrics have been calculated for monitoring years 2010 (representing conditions prior to implementation of IMs), and 2014, 2015, 2016, 2017, 2018, and





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2019 WATER RSOURCES MONITORING REPORT EAST HELENA FACILITY	2019 PLUME STABILITY EVALUATION AREAS AND MONITORING WELLS	FIGURE 3-10

Table 3-6. 2019 Plume Stability Analysis Monitoring Wells

Arsenic Plume Stability Analysis Wells

Well/Well Set*	X	Y
EH-104	1358282.522	862312.6614
EH-106	1358337.119	862709.9336
EH-110	1359199.735	862408.9392
EH-111	1358121.671	863063.8249
EH-114	1357769.757	863127.7487
EH-115	1357963.035	862717.8146
EH-117	1357815.102	863491.194
EH-118	1357370.97	863059.9069
EH-119	1357263.087	863617.6238
EH-120	1357409.933	864330.2403
EH-124	1356666.492	863928.3931
EH-50/100	1358817.999	862195.6926
EH-51/101	1359828.415	862186.9796
EH-52/102	1360752.337	862191.6556
EH-53	1358268.831	863387.4722
EH-54	1359822.332	863345.3893
EH-57A	1357731.038	862625.8977
EH-58	1361553.2	861985.385
EH-59	1361023.244	862766.0055
EH-60/61/103	1359295.783	862093.3668
EH-62	1358812.977	863373.6172
EH-63	1359427.431	862682.4886
EH-65/107	1358789.927	862702.9806
EH-66/121	1358105.331	864406.8992
EH-69	1360852.608	863791.1154

Selenium Plume Stability Analysis Wells

Well/Well Set*	X	Y
EH-104	1358282.522	862312.6614
EH-106	1358337.119	862709.9336
EH-110	1359199.735	862408.9392
EH-111	1358121.671	863063.8249
EH-114	1357769.757	863127.7487
EH-115	1357963.035	862717.8146
EH-117	1357815.102	863491.194
EH-118	1357370.97	863059.9069
EH-119	1357263.087	863617.6238
EH-120	1357409.933	864330.2403
EH-123	1356631.306	863027.3459
EH-124	1356666.492	863928.3931
EH-126	1356002.798	865515.797
EH-129/134	1355425.088	865649.6907
EH-132	1355360.408	864040.3529
EH-135	1357384.976	865688.5946
EH-206	1356012.784	862969.4011
EH-50/100	1358817.999	862195.6926
EH-51/101	1359828.415	862186.9796
EH-52/102	1360752.337	862191.6556
EH-53	1358268.831	863387.4722
EH-54	1359822.332	863345.3893
EH-57A	1357731.038	862625.8977
EH-60/61/103	1359295.783	862093.3668
EH-62	1358812.977	863373.6172
EH-63	1359427.431	862682.4886
EH-65/107	1358789.927	862702.9806
EH-66/121	1358105.331	864406.8992
EH-70/125	1357077.783	864971.9141

Plant Site Plume Stability Analysis Wells

Well/Well Set*	X	Y
DH-6/15	1360252.419	861527.0799
DH-7	1361580.684	861281.5224
DH-8	1359404.724	860693.1656
DH-17	1359668.631	860997.414
DH-42	1359938.798	859587.2008
DH-52	1360876.159	861372.1393
DH-55	1360945.555	860568.8169
DH-56	1360350.744	861098.4318
DH-66	1359333.409	861005.14
DH-67	1359095.512	861657.6447
DH-69	1360783.894	859899.5982
EH-204	1358703.601	860660.9927

*NOTE: Data from well sets (paired wells) will be combined to yield a single overall average concentration for a given monitoring year for plume stability calculations.

2019 (representing conditions during ongoing implementation of IMs). Due to variable monitoring frequencies for some Plant Site wells and the potential effects on plume stability calculations, Plant Site plume stability metrics have been calculated for monitoring years 2010 (prior to IM implementation), and 2016, 2017, 2018, and 2019 (during IM implementation).

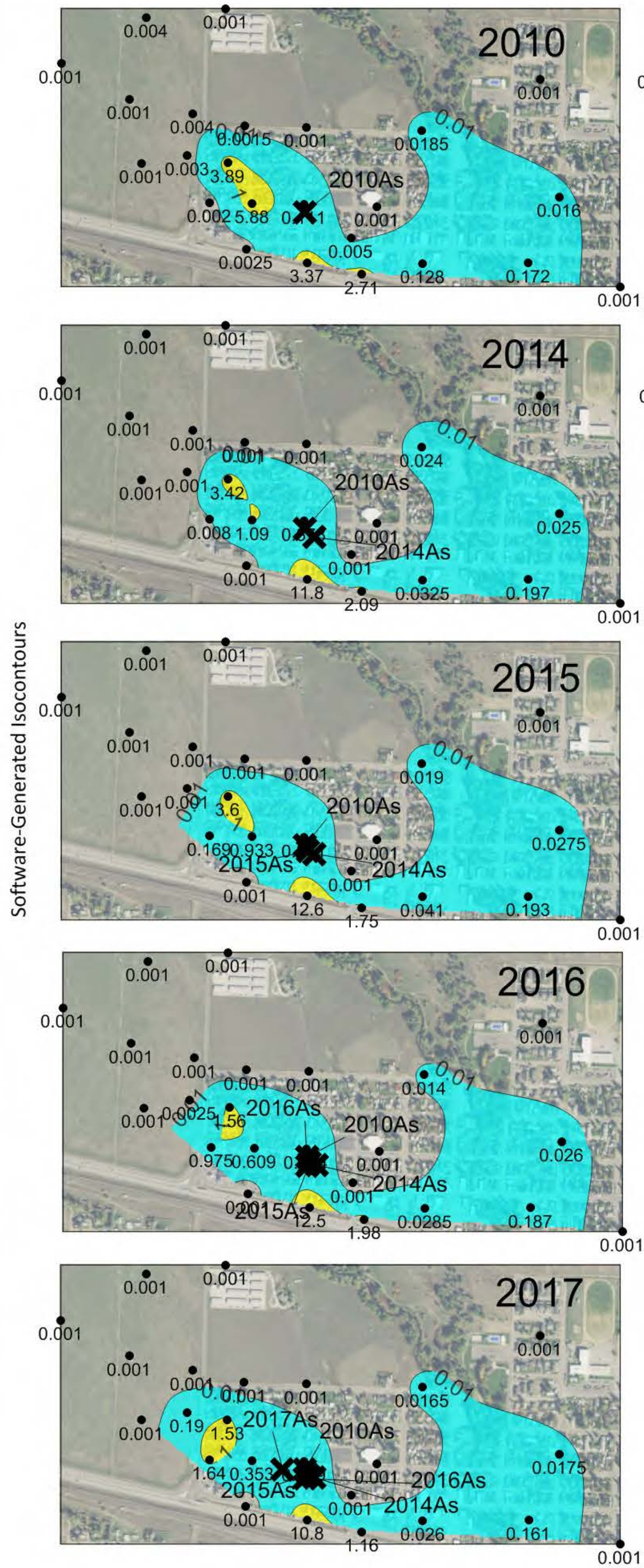
3.3.3.1 Arsenic Plume Stability Results

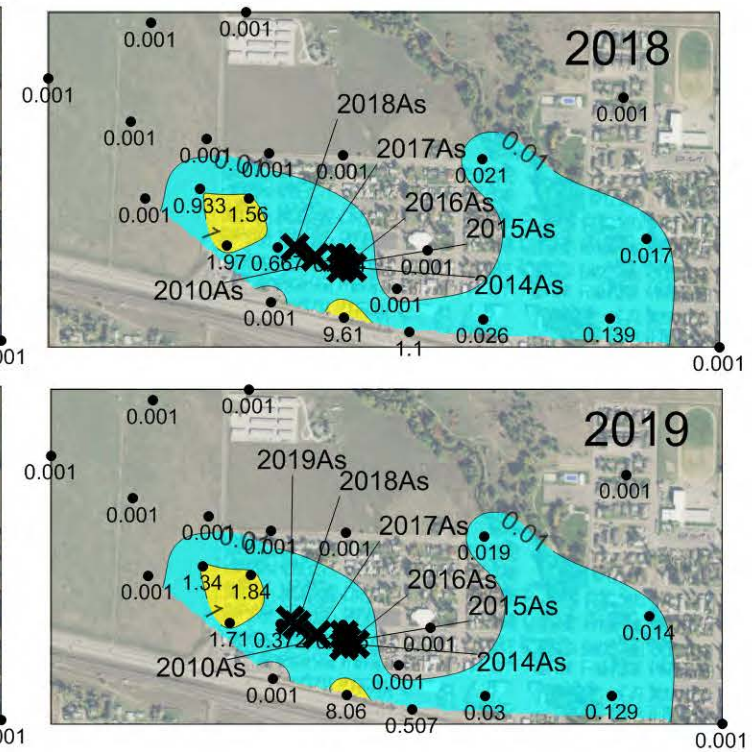
The arsenic plume stability analysis results are summarized on Figure 3-11, including software-generated arsenic contours, a table summarizing plume areas and average concentrations, and a map showing the locations of the calculated plume centroids for 2010, 2014, 2015, 2016, 2017, 2018, and 2019. The overall plume area with arsenic concentrations above the 0.01 mg/L groundwater standard is virtually unchanged from 2010 to 2019 (66 acres) with relatively minor variability during intervening years. Average arsenic concentrations within the 0.01 mg/L contour declined from 0.203 mg/L in 2010 to 0.173 mg/L in 2017 before increasing to 0.203 mg/L again in 2019. The locations of the calculated plume centroid shows a distinctive westward shift from 2010 through 2019 (Figure 3-11).

Overall, the arsenic plume stability metrics suggest that the arsenic plume is relatively stable with a slight westward shift in the plume centroid over time attributable to the decommissioning of Wilson Ditch and associated loss of a recharge source west of the plumes (Section 3.3.2.1). The relatively stable downgradient plume area and concentrations is not unexpected. As noted in previous studies (Hydrometrics, 2016), although the Plant Site arsenic concentrations have decreased significantly since inception of the CM/IM program in 2010 (see Section 3.3.3.3), downgradient concentrations are not expected to decrease significantly in the near future due to the release of adsorbed arsenic from the downgradient soils. By decreasing the Plant Site concentrations and arsenic loading to downgradient soils however, the completed IMs are intended to prevent future advancement of the downgradient arsenic plume. The arsenic plume stability results are generally consistent with observations based on preparation of hand-drawn arsenic isocontour maps. The fall 2011 and fall 2019 0.01 mg/L hand-drawn arsenic contours shown on Figure 3-11 illustrate the stability in overall plume area, along with the recent shift to the west in the higher concentration western portion of the arsenic plume.

3.3.3.2 Selenium Plume Stability Results

Selenium plume stability analysis results are summarized on Figure 3-12. The overall plume area with selenium concentrations above the 0.05 mg/L groundwater standard increased from 74 acres in 2010 to a maximum of 114 acres in 2016, before decreasing to 74 and 82 acres in 2018 and 2019, respectively. Average selenium concentrations showed an overall decrease from 2010 (0.112 mg/L) to 2019 (0.088 mg/L). The plume centroid location for selenium shifted to the west and north between 2010 and 2016, shifted slightly northward in 2017, before retreating southward in 2018 and 2019 (Figure 3-12). Also apparent in Figure 3-12, particularly in the 2017 through 2019 computer generated plume map, is the apparent fragmentation of the plume between the Facility and Lamping Field. This is attributable to the significant decreases observed in the upgradient West Selenium source area since 2015 (Section 3.3.3.3).

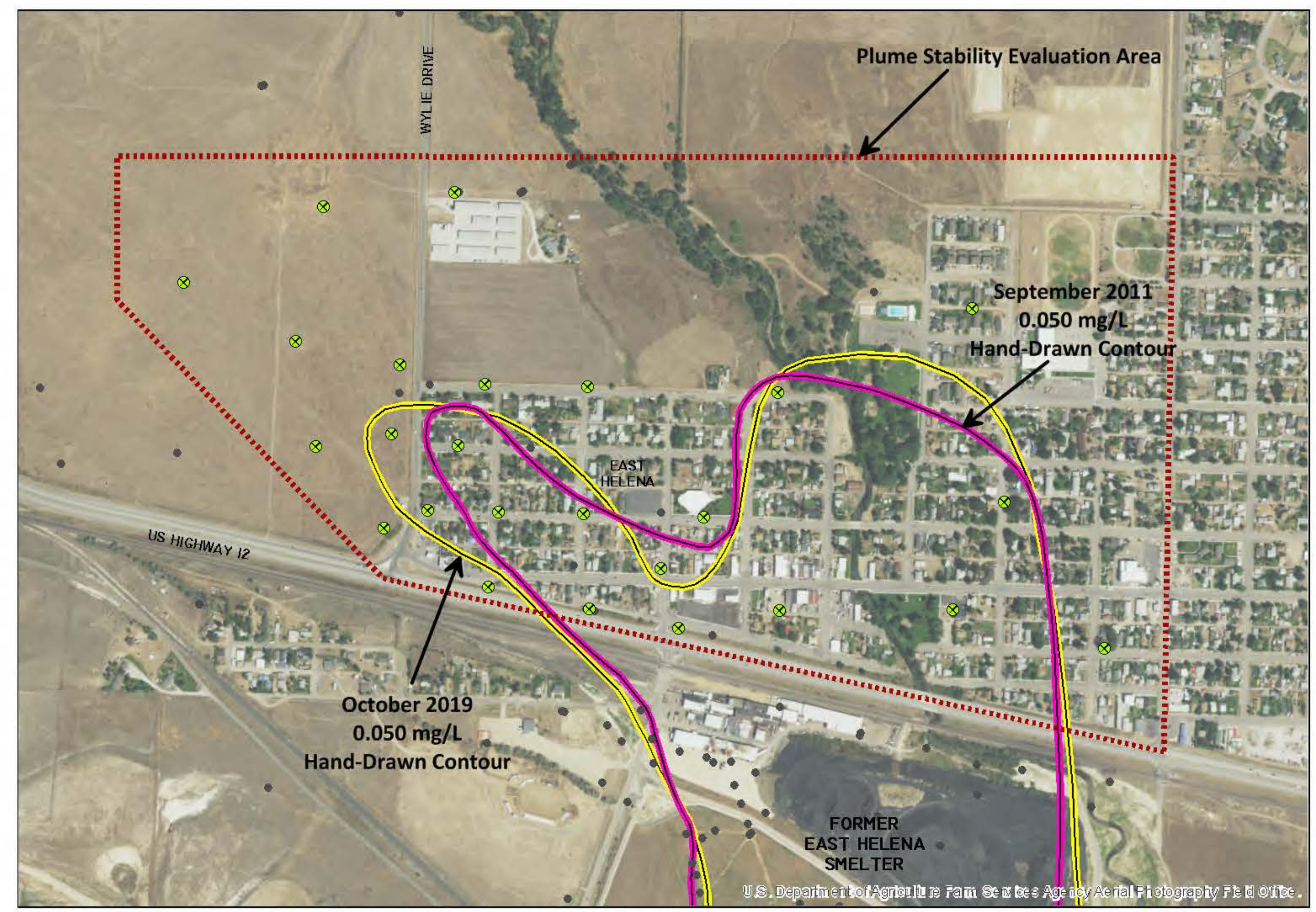




X = calculated plume centroid for given year

Plume stability metrics calculated using method of Ricker (2008)

Year	Planar Area (acres)	Average Arsenic Concentration (mg/L)
2010	66	0.203
2014	68	0.167
2015	68	0.175
2016	64	0.167
2017	65	0.173
2018	68	0.211
2019	**66**	**0.203**



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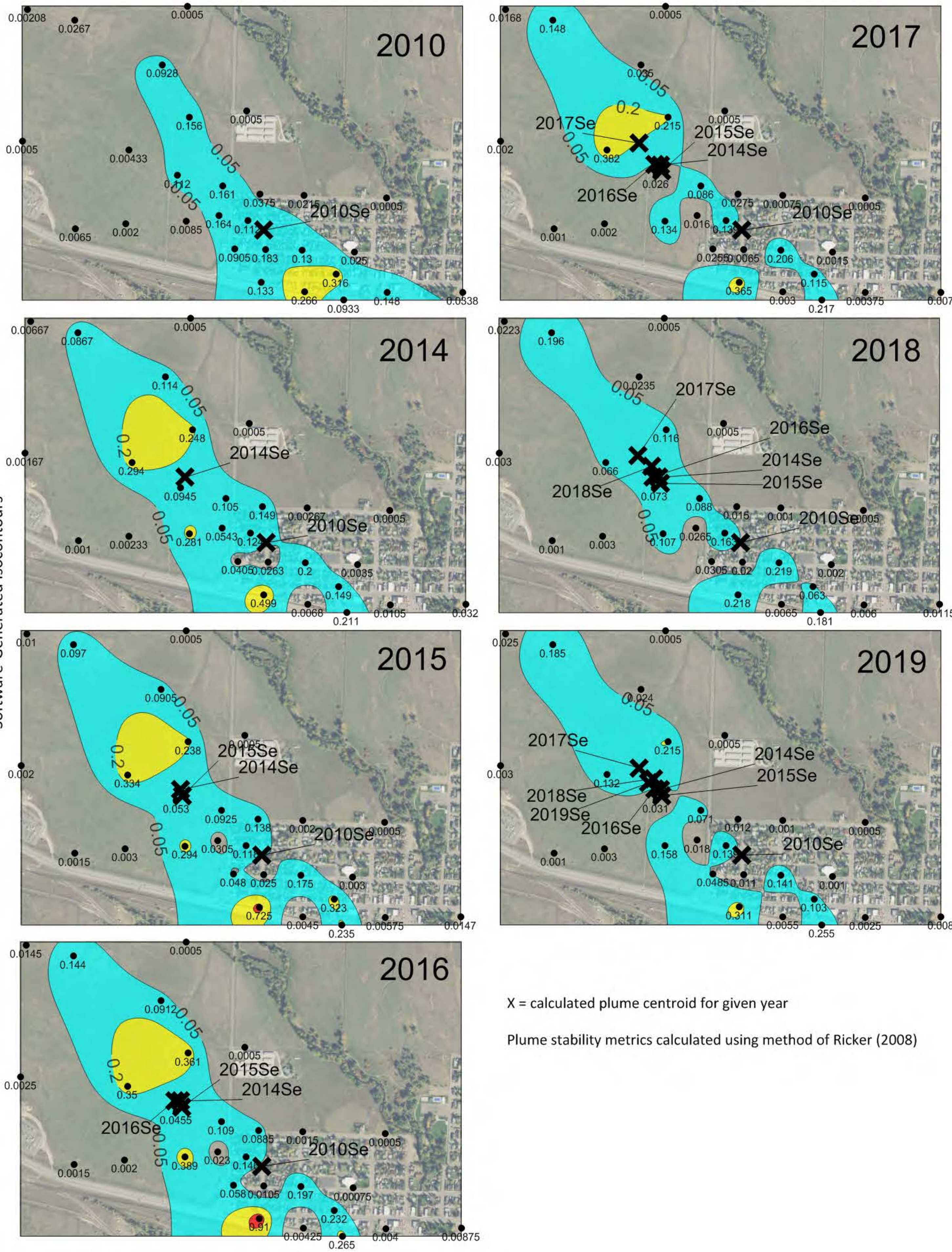
2019 WATER RESOURCES MONITORING REPORT
EAST HELENA FACILITY

ARSENIC PLUME STABILITY EVALUATION RESULTS

FIGURE

3-11

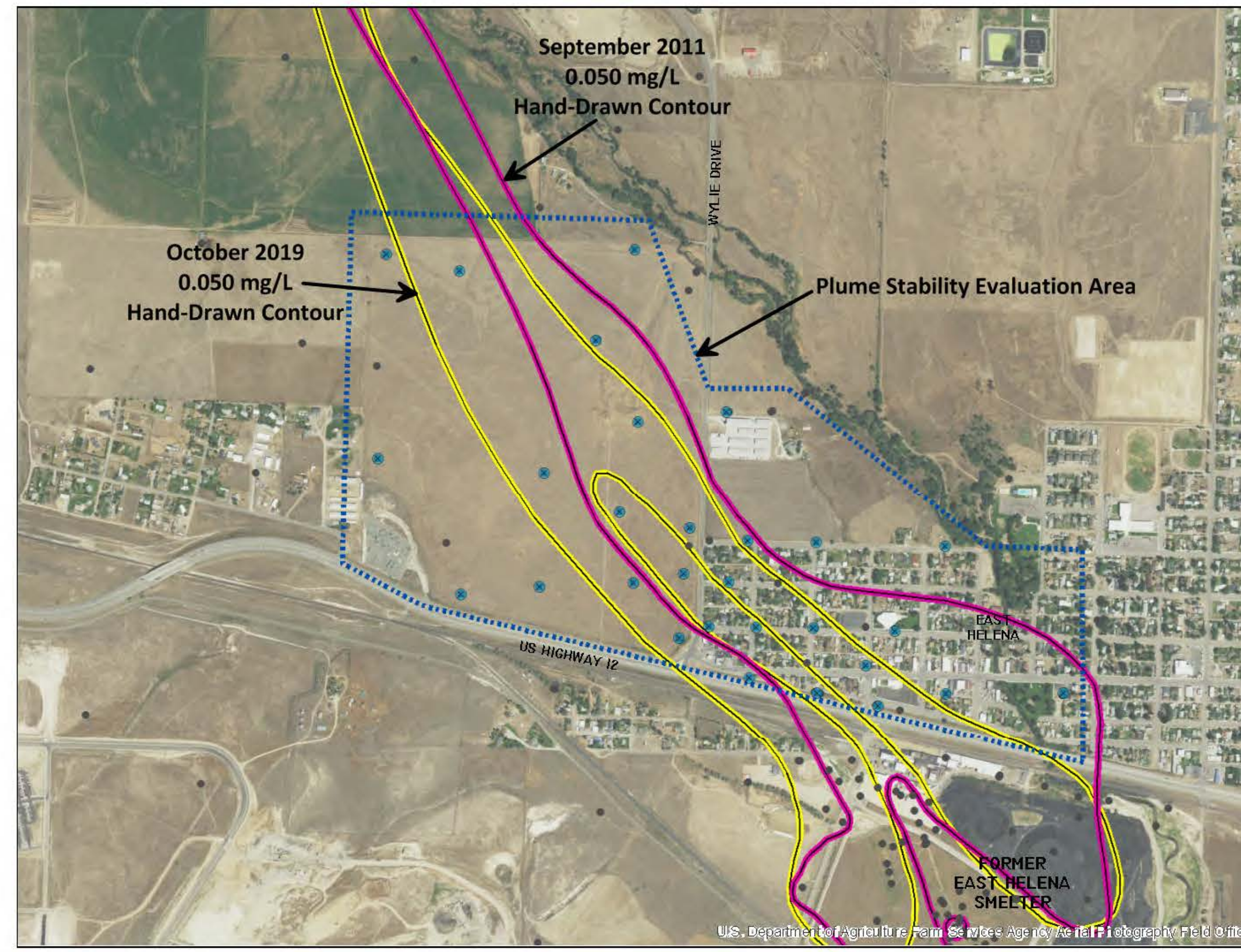
Software-Generated Isocontours



X = calculated plume centroid for given year

Plume stability metrics calculated using method of Ricker (2008)

Year	Planar Area (acres)	Average Selenium Concentration (mg/L)
2010	74	0.112
2014	111	0.123
2015	112	0.121
2016	114	0.136
2017	79	0.108
2018	74	0.078
2019	**82**	**0.088**



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2019 WATER RESOURCES MONITORING REPORT
EAST HELENA FACILITY

SELENIUM PLUME STABILITY EVALUATION RESULTS

FIGURE

3-12

Overall, the downgradient selenium plume metrics shown in Figure 3-12 suggest the plume is receding. The southward migration of the plume centroid in 2018 and 2019, and retraction of the downgradient plume extent of several hundred feet in 2019 (Section 3.3.2.2) both indicate a receding plume. The increase in average concentrations from 2010 to 2016, before decreasing from 2017 to 2019, is consistent with the temporary concentration increases noted at upgradient West Selenium Source well DH-66 (Section 3.3.2.2) through 2014, which is believed to be attributable to remediation construction activities in the area at that time.

3.3.3.3 Plant Site Arsenic and Selenium Plume Stability Results

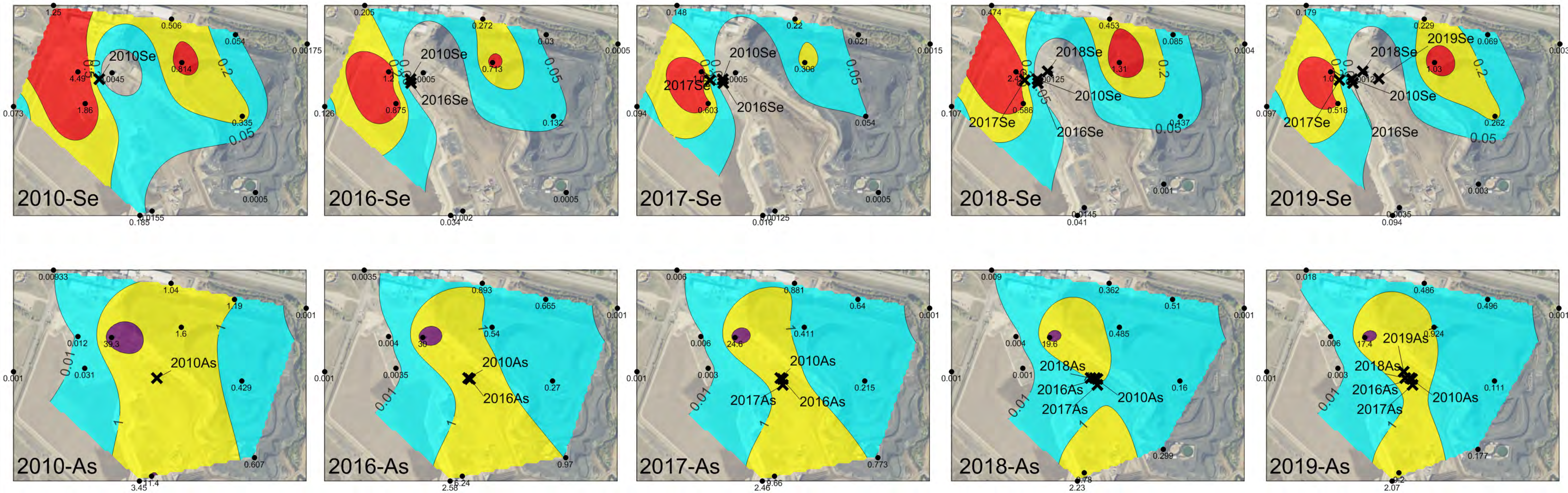
Plume stability metrics for pre-IM (2010) and post-IM (2016, 2017, 2018, and 2019) conditions were also calculated for arsenic and selenium, based on data from 13 Facility wells (Table 3-6; Figure 3-13). Plume stability results show a 2010 to 2019 reduction in overall selenium plume area from 67 to 51 acres, and a reduction in the arsenic plume area of 82 to 71 acres. Average 2010 to 2019 concentrations have decreased from 0.45 to 0.24 mg/L for selenium, and 2.25 to 1.02 mg/L for arsenic. These trends reflect the generally decreasing concentration trends for arsenic and selenium observed in the Plant Site source areas. The locations of the calculated arsenic plume centroid shows little change from 2010 to 2019, while the selenium plume centroid shows a notable eastward shift in 2018/2019. The recent eastward shift in the selenium plume centroid is due to a greater influence from the slag pile source area as the West Selenium source area concentrations continue to decrease. The slag pile is scheduled to be regraded and partially capped in the next few years to address that source.

As source area contaminant concentrations of both arsenic and selenium continue to decrease over time, average Plant Site plume concentrations should also continue to decrease. In time, this should result in decreases in the downgradient selenium plume concentrations and extent. For arsenic, the decreasing source area concentrations should eventually translate to decreasing downgradient concentrations, although that process is expected to take much longer for arsenic than for selenium due to the greater attenuation affinity for arsenic. In the meantime, the decrease in source area concentrations will aid in stabilizing the arsenic plume and preventing further downgradient expansion.

3.3.4 CAMU Area Monitoring Results

One objective of the 2019 monitoring program was to continue to evaluate groundwater quality in the vicinity of the two RCRA landfills, the CAMUs, located immediately southwest of the Facility (Figure 1-1). The CAMU groundwater monitoring network includes 11 monitoring wells ranging from 40 to 72 feet deep. All 11 wells were sampled in October 2019 to document current groundwater quality. Trend plots for arsenic, selenium, chloride, and sulfate at the CAMU wells through October 2019 are shown on Figure 3-14.

Overall the 2019 CAMU monitoring results are consistent with previous monitoring results. For example, CAMU wells MW-2, MW-3, MW-7, MW-10, and MW-11 (Exhibit 1) yielded arsenic concentrations ranging from 0.008 to 0.018 mg/L (compared with the groundwater HHS of 0.01 mg/L). These results are consistent with previous observations and attributable to naturally



Year	Parameter	Planar Area (acres)	Average Concentration (mg/L)
2010	Selenium	67	0.45
2016		48	0.27
2017		35	0.23
2018		52	0.34
2019		51	0.24

Year	Parameter	Planar Area (acres)	Average Concentration (mg/L)
2010	Arsenic	82	2.25
2016		77	1.29
2017		77	1.19
2018		69	0.94
2019		71	1.02

Software-generated contours are shown on each plot

X = calculated plume centroid for given year

Plume stability metrics calculated using method of Ricker (2008)

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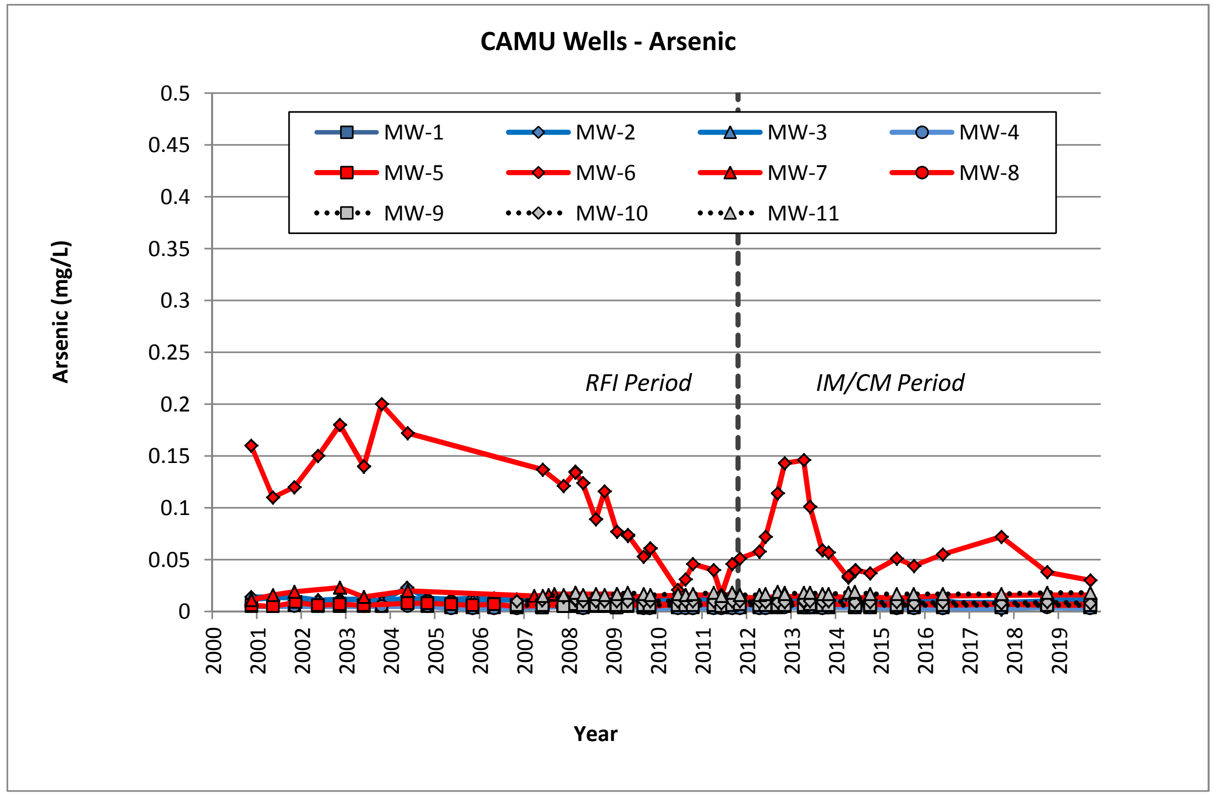
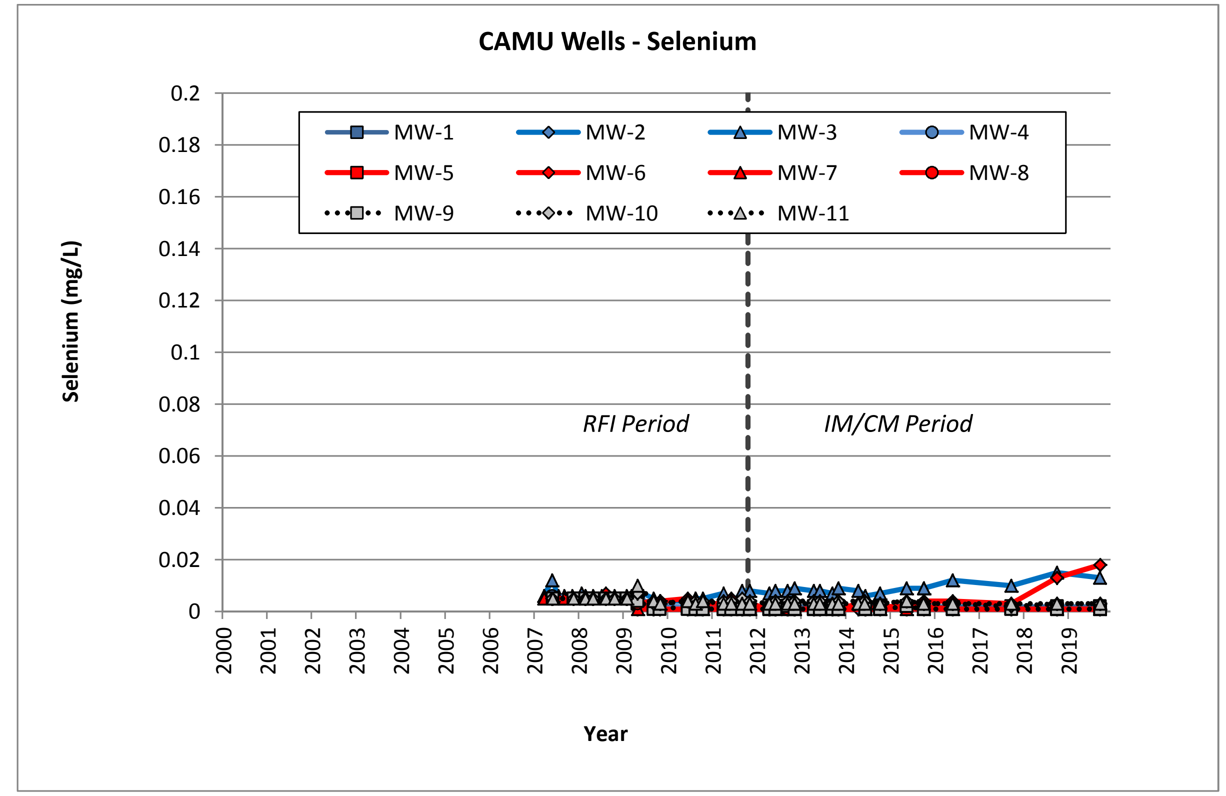
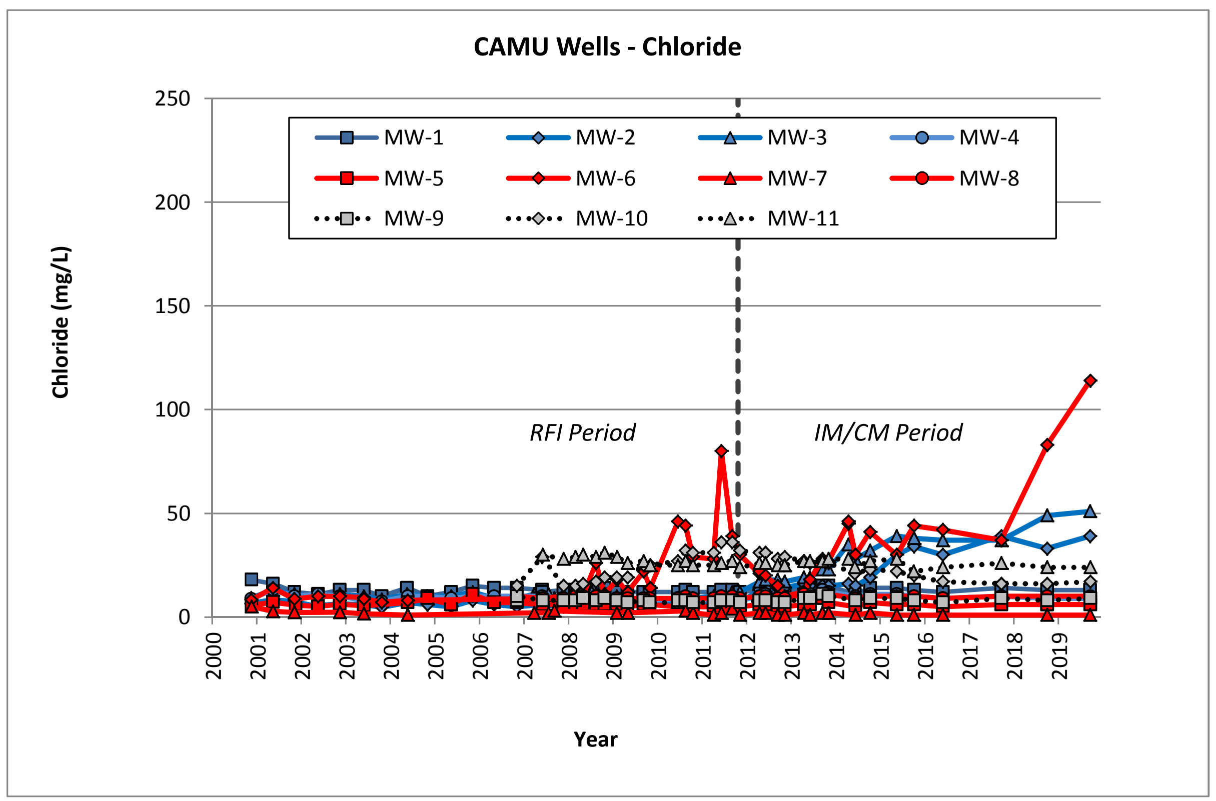
PLANT SITE PLUME STABILITY EVALUATION RESULTS

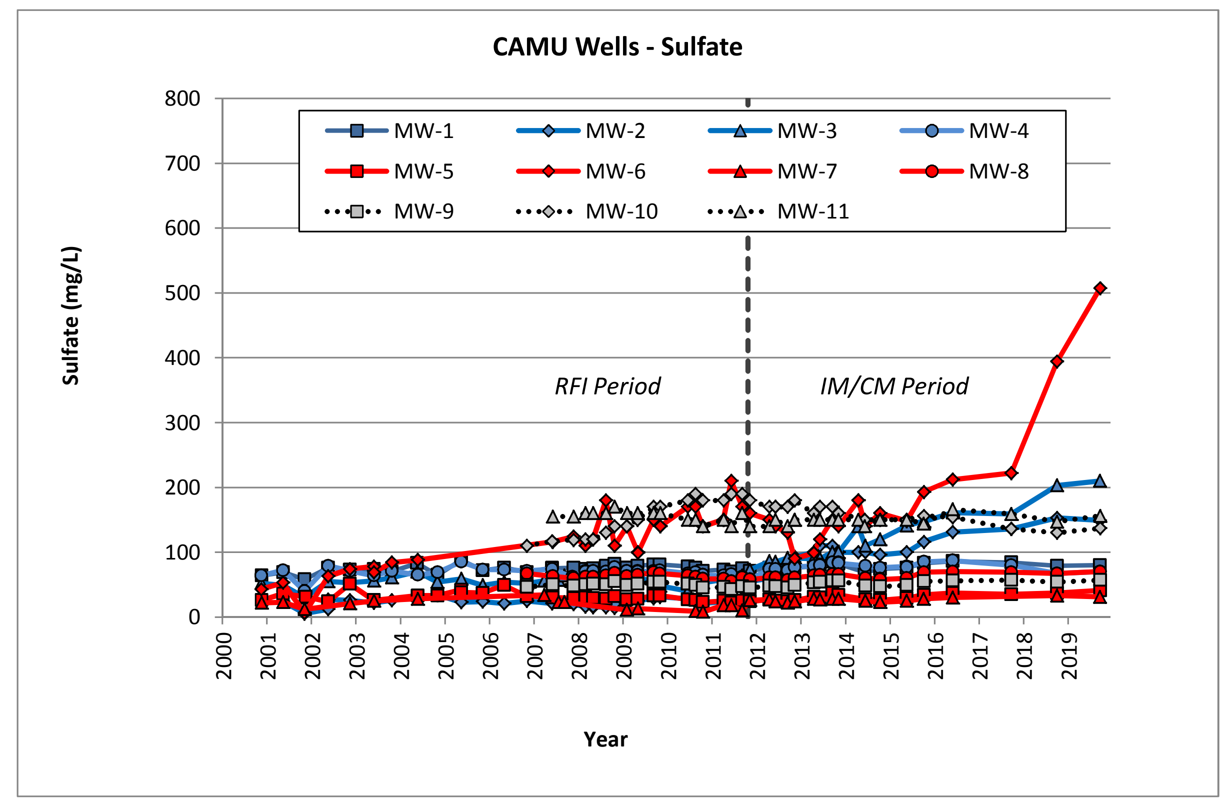
FIGURE

3-13









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*Well locations shown on Exhibit 1

2019 WATER RESOURCES MONITORING REPORT EAST HELENA FACILITY	CAMU AREA GROUNDWATER QUALITY TRENDS	FIGURE 3-14

K:\project\10022\Annual Monitoring Reports\2019 WRM Report\CAMU_Graph_Data_2019.xlsx\CAMU Graphs 2019 occurring groundwater arsenic derived from the Tertiary volcanoclastic sediments in this area. Arsenic at well MW-6 has been higher than other wells since the beginning of the monitoring record (Figure 3-14), suggesting some Plant Site influence. From October 2017 to October 2019, however, the arsenic concentration at MW-6 decreased from 0.072 to 0.03 mg/L. Selenium concentrations at all CAMU monitoring wells were well below the 0.05 mg/L HHS in October 2019 although the selenium concentrations at wells MW-3 and MW-6 have shown recent increases. Between October 2017 and October 2019, the selenium concentration at MW-6 increased from 0.01 to 0.018 mg/L (Figure 3-14). Despite these increases, selenium concentrations remain well below the HHS in all CAMU area wells. The only other notable metals concentration trends at the CAMU wells were for manganese at wells MW-2 and MW-6. Manganese in October 2019 was the highest on record at MW-2 (0.51 mg/L) and the lowest on record at well MW-6 (0.70 mg/L). The lower manganese concentration at MW-6 could indicate more oxidizing groundwater conditions, which could also lead to the increase in selenium (more mobile under oxidizing conditions) and the decrease in arsenic (less mobile under oxidizing conditions) observed in October 2019. All other metals were near or less than analytical detection limits in the CAMU well samples (Appendix A).

Sulfate and chloride concentrations at MW-2, MW-3, and MW-6 along the north and northeast sides of the CAMU (adjacent to the Plant Site; see Exhibit 1) indicate a growing influence from Plant Site groundwater, with concentrations increasing significantly at all three wells, particularly in 2018 and 2019 (Figure 3-14). The 2018/19 increases correspond with the increase in groundwater levels resulting from the above average precipitation experienced those years (Section 3.3.2.1), causing westward migration of Plant Site groundwater. The Plant Site influence on chloride and sulfate concentrations at these wells also corresponds with the relatively elevated (although decreasing) arsenic concentrations at well MW-6 and the slight increases in selenium concentrations at MW-3 and MW-6.

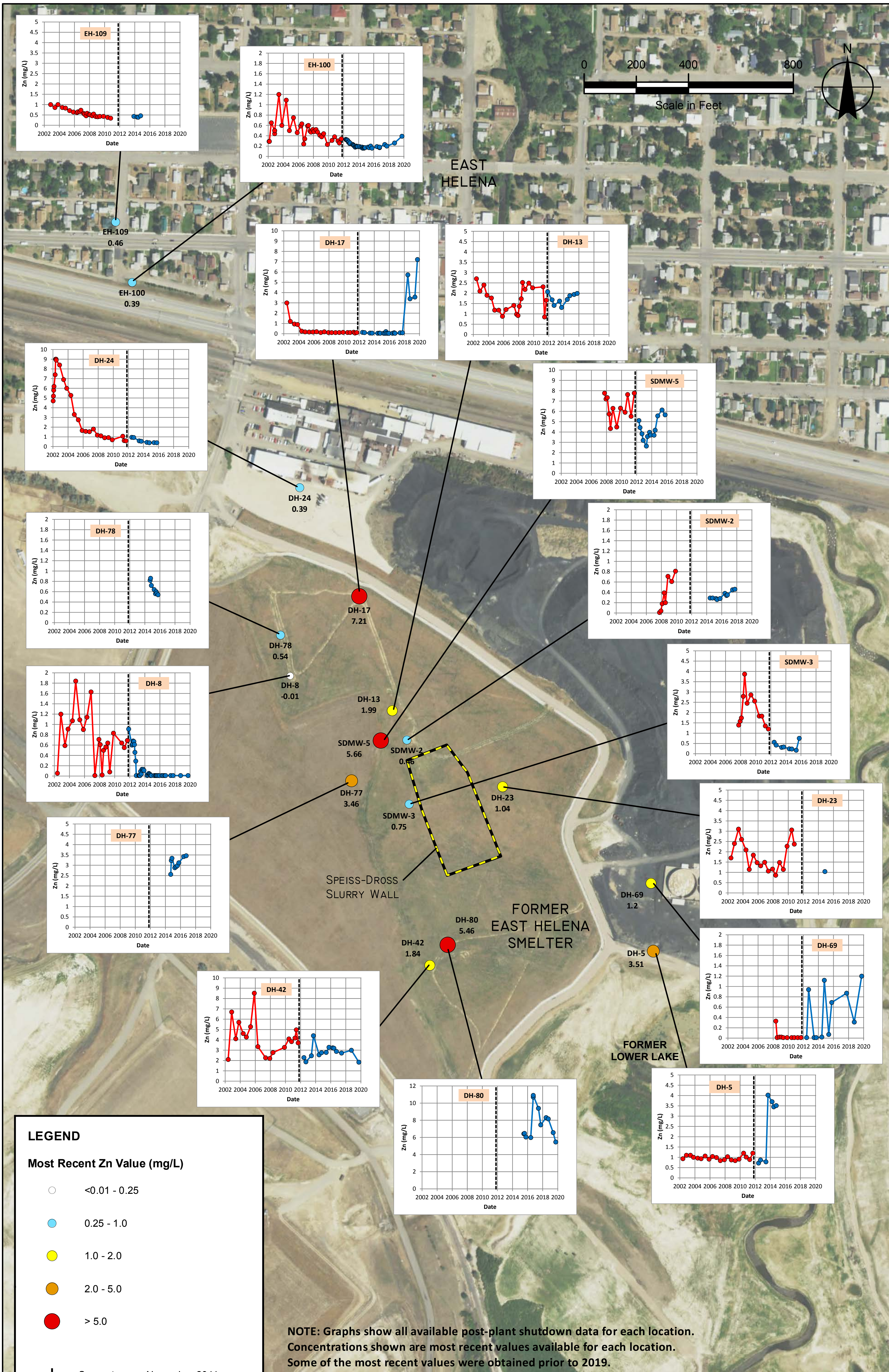
3.3.5 Zinc and Cadmium Concentrations and Trends

Although arsenic and selenium are the primary groundwater COCs for the former East Helena Smelter Site, the WRM program includes a number of other parameters that have been detected at elevated concentrations in Facility groundwater in the past, or that may be associated with metal smelting operations (Table 2-5). As discussed in the 2018 WRM Report for the Facility (Hydrometrics, 2019b), both zinc and cadmium have persisted at elevated groundwater concentrations in certain areas of the former smelter, with concentrations of both constituents showing increasing trends in recent years at some wells. Updates regarding current concentration distributions and temporal trends for both zinc and cadmium through 2019 are presented below.

Groundwater zinc concentrations beneath process areas during the operational period of the smelter occasionally reached concentrations above 50 mg/L, with a few samples over 100 mg/L. These concentrations largely occurred in wells within and around the former Acid Plant, and were associated with releases from the process water circuit and contaminated Acid Plant sludges, and with low groundwater pH values (pH<5.0). Downgradient of the Acid Plant, wells such as DH-13 and DH-24 (see Exhibit 1) showed maximum concentrations above 30 mg/L prior to the 2001 smelter shutdown. Following the smelter shutdown, however, zinc concentrations have decreased, and although isolated areas of higher concentrations have remained, maximum observed concentrations are much lower than during the operational period. The October 2019 groundwater monitoring data in Appendix A show elevated zinc concentrations above 1.0 mg/L at four wells (DH-17, DH-80, DH-42, and DH-69), lower concentrations from 0.1 to 0.5 mg/L at three wells (EH-100, DH-66, and DH-55); all of the remaining October 2019 groundwater samples from both on and off-site monitoring wells and residential wells had low zinc concentrations (<0.01 to 0.02 mg/L). Concentrations at two wells (DH-17 (7.21 mg/L) and DH-80 (5.46 mg/L)) exceeded the 2.0 mg/L groundwater HHS.

Figure 3-15 shows zinc concentration trends for a selected set of wells during the post-plant shutdown period (after 2002), along with the most recent zinc concentration observed at each well (note that many of the wells shown on Figure 3-15 have not been sampled for several years, so the Figure 3-17 data may not reflect current conditions). As shown on Figure 3-15, zinc concentrations at monitoring well DH-17, located in the North Plant Arsenic Source Area, increased abruptly from typical values less than 0.1 mg/L to 5.72 mg/L in June 2018, decreasing slightly before increasing again in October 2019 to 7.21 mg/L. A recent slight increase in zinc concentration at downgradient well EH-100 from about 0.2 to 0.4 mg/L has occurred over the same period. Other plant site areas showing higher zinc concentrations during the post-shutdown period include wells DH-42 and DH-80 (most recent zinc concentrations 1.84 to 5.46 mg/L) in the former Acid Plant area; DH-5 and DH-69 (1.2 to 3.51 mg/L) near the south end of the slag pile; and DH-77, SDMW-5, and DH-13 (1.99 to 5.66 mg/L) in the Speiss-Dross area (Figure 3-15). Zinc concentrations in Acid Plant area wells DH-42 and DH-80 decreased over the last 1 to 2 years, and concentrations at DH-69 have been seasonally variable (higher during fall monitoring events), while the other wells noted have not been sampled for several years.

Zinc concentrations above the HHS of 2.0 mg/L occurred frequently at well DH-17 prior to 2003, with concentrations as high as 8.2 mg/L in the late 1980s, but had decreased significantly since the 2001 smelter shutdown. The increased zinc concentrations at this well in 2018 and 2019 are believed to be related to the higher groundwater levels during those years, and/or varying geochemical conditions related to the increased groundwater recharge. As noted in the 2018 WRM report (Hydrometrics, 2019b), the groundwater pH has decreased slightly at well DH-17 during the same period that zinc concentrations have increased. From 2012 through 2017, the average pH at well DH-17 was 7.3; in 2018 and 2019, the average pH at DH-17 was 6.8. Although this pH change is relatively modest, the mobility of metals such as zinc in groundwater is sensitive to even small changes in pH, with increased solubility and decreased adsorption occurring as pH decreases. The ongoing elevated zinc concentrations in October 2019 at wells DH-42 and DH-80 in the former Acid Plant area, for example, are associated with groundwater pH values of 6.1 at DH-42 and 4.4 at DH-80. In addition, the sulfate and chloride trend plots for well DH-17 in Appendix C do not show concentration increases for these indicator parameters coincident with the rapid zinc concentration increases in 2018 and 2019. Increases in these other constituents would be expected if the source of zinc at DH-17 was influx of poor quality water from some upgradient plant site area. This suggests the most likely source is release of zinc from local aquifer materials due to higher water levels and/or geochemical changes such as decreasing pH. Additional monitoring of selected wells is planned as part of the 2020 CAMP to provide more detailed information on the current distribution of zinc in plant site groundwater, along with updated data on zinc concentration trends.



2019 WATER RESOURCES MONITORING REPORT
EAST HELENA FACILITY

ZINC CONCENTRATIONS AND TRENDS IN PLANT SITE GROUNDWATER

FIGURE
3-15

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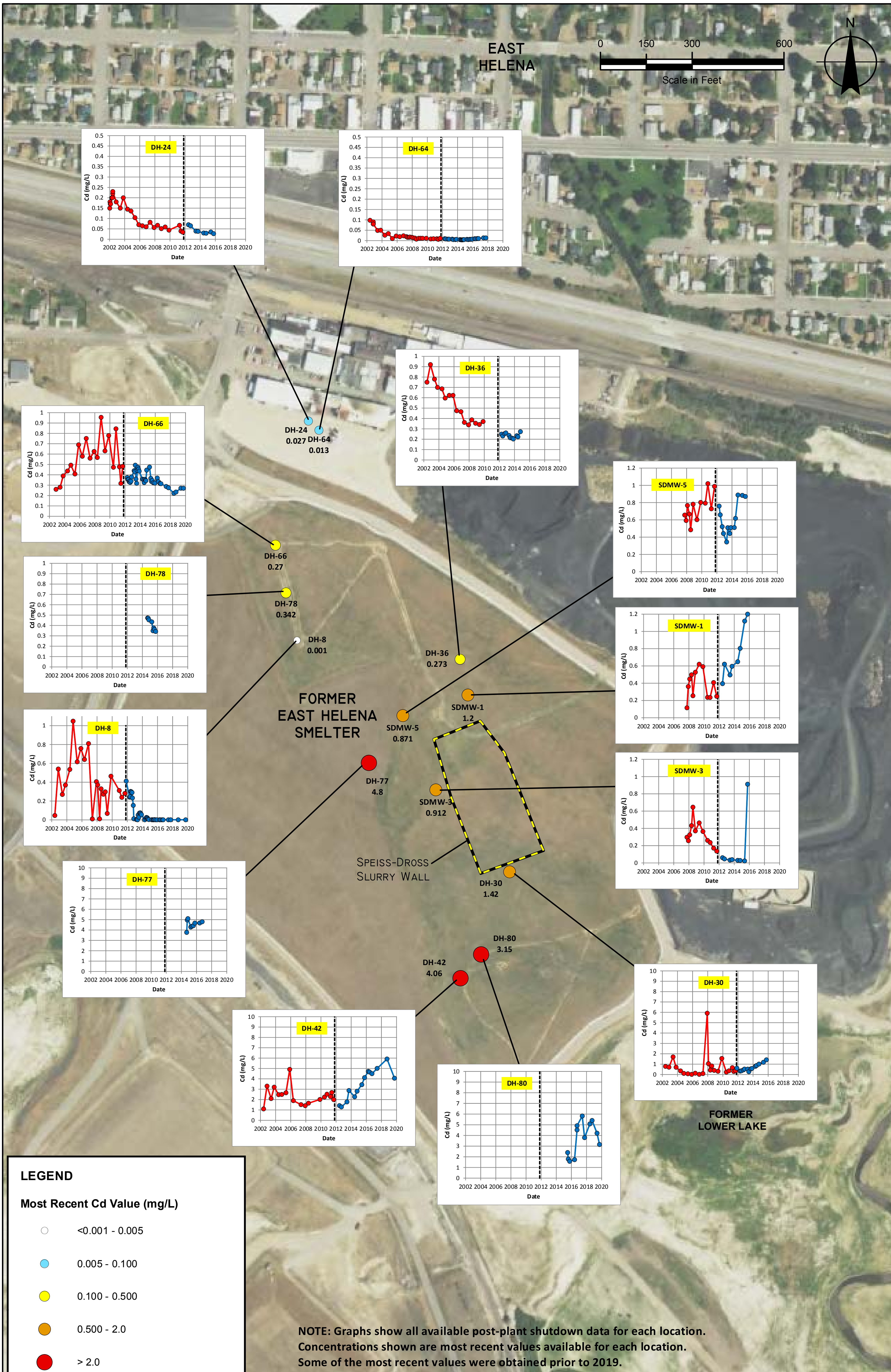
Similar to zinc, cadmium concentrations in Facility groundwater were historically elevated in the former Acid Plant area, due to process water releases, contaminated sediments, and low pH values, with concentrations often above 10 mg/L and periodically above 20 mg/L in area monitoring wells (Figure 3-16). Downgradient at well DH-13, a maximum concentration of 24.5 mg/L was reached in 1993; however, migration of cadmium was more limited than that of zinc. Downgradient well DH-24, where zinc concentrations reached more than 30 mg/L historically, showed a maximum cadmium concentration of about 0.5 mg/L, and EH-100 (maximum zinc concentration of 1.2 mg/L) showed a maximum cadmium concentration of 0.006 mg/L. As with zinc, following the 2001 smelter shutdown cadmium concentrations decreased, with isolated areas of higher concentrations remaining at present. The October 2019 groundwater monitoring data in Appendix A show elevated cadmium concentrations above 1.0 mg/L at two wells (DH-80, DH-42), and a lower concentration of 0.27 mg/L at one well (DH-66); all of the remaining October 2019 groundwater samples from both on and off-site monitoring wells and residential wells had low cadmium concentrations (<0.001 to 0.003 mg/L). Only the concentrations at DH-80, DH-42, and DH-66 exceeded the 0.005 mg/L groundwater HHS.

Figure 3-16 presents post-shutdown (after 2002) cadmium concentration trends for selected wells, and the most recent cadmium concentration observed at each well (as with zinc, some of the most recent cadmium values shown on Figure 3-16 were obtained one or more years before 2019). Based on the most recent available data, the highest cadmium concentrations in Facility groundwater occur in and downgradient of the former Acid Plant area at wells DH-80, DH-42, and DH-77 (3.15 to 4.8 mg/L), with slightly lower concentrations in the Speiss-Dross area at wells SDMW-1, SDMW-3, SDMW-5, and DH-30 (0.871 to 1.42 mg/L) (Figure 3-16). This area is in large part coincident with the area of elevated zinc concentrations, although cadmium concentrations are less widely distributed and have remained low at well DH-17 (0.002 mg/L in October 2019), and at the south end of the slag pile (DH-69) where higher zinc concentrations have been observed (Figure 3-15). The cadmium concentration at Acid Plant area well DH-42, which had been showing an increasing trend and peaked in October 2018 at 5.92 mg/L, decreased by about 30% in October 2019 to 4.06 mg/L. Acid Plant well DH-80 has decreased in cadmium concentration during the last several monitoring events by 40%, from 5.4 mg/L in October 2018 to 3.15 mg/L in October 2019 (Figure 3-16). Conversely, the wells around the Speiss-Dross area generally show increasing cadmium concentration trends during the IM implementation period after 2011, although the most recent samples from these wells were collected in 2015 (Figure 3-16).

Although cadmium adsorption and mobility in groundwater is sensitive to pH changes, similar to zinc, the cadmium concentration increases the Speiss-Dross area wells do not appear to be related to a general decrease in pH; the increase in cadmium at well SDMW-1 shown on Figure 3-16, for example, was not accompanied by a pH decrease. These cadmium trends also predate the elevated plant site water levels observed in 2018 and 2019. It is possible that the increasing cadmium concentration trends observed at central Plant Site and Acid Plant wells observed after 2011 are an initial response to water level and groundwater flux changes resulting from the SPHC IM. Additional monitoring of selected wells is planned as part of the 2020 CAMP to provide more detailed



2019 WATER RESOURCES MONITORING REPORT EAST HELENA FACILITY	CADMIUM CONCENTRATIONS AND TRENDS IN PLANT SITE GROUNDWATER	FIGURE 3-16

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information on the current cadmium concentration distribution and trends in plant site groundwater. It should be noted that, despite the persistent elevated zinc and cadmium groundwater concentrations in certain areas of the former smelter, no off-site migration of concentrations above the HHS is currently indicated for either of these constituents.

3.4 COMPARISON OF MODEL-PREDICTED CONDITIONS TO OBSERVED CONDITIONS

Design and implementation of the IMs and other CMS actions, such as design of the East Valley Controlled Groundwater Area (EVCGWA), were based on extensive site investigations and technical evaluations, including development of a numerical groundwater flow model and contaminant fate and transport model (Newfields, 2016). One objective of the numerical models was to forecast the groundwater response to the various IMs and other potential groundwater CMs. This section presents a comparison of the model predictive analyses to actual current groundwater conditions.

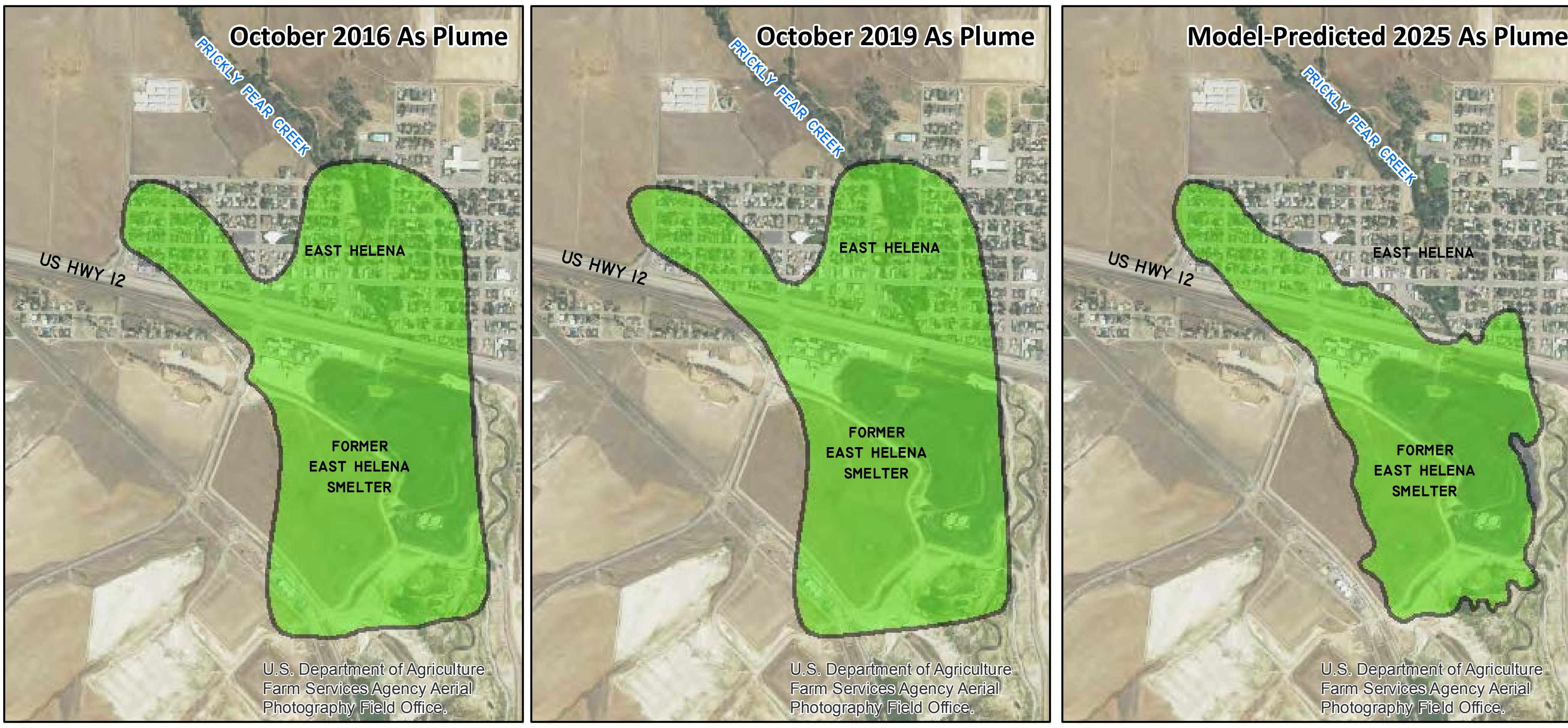
Prior to performing predictive simulations, the groundwater model was calibrated to 2011 groundwater elevations, groundwater flow rates, and arsenic and selenium concentrations on and downgradient of the former smelter. The 2011 calibrated model served as the base-case scenario for comparison to subsequent simulations reflecting various IMs and CMs proposed or being considered. The predictive simulations ran from 2015 to 2025, and included projected arsenic and selenium concentration trends at select wells, arsenic and selenium plume configurations at the end of the 10 year period (2025), and arsenic and selenium plume volumes (acre-feet) and contaminant mass (kg) at the end of the 10 year simulation period. The majority of predictive model results are not directly comparable to the plume stability metrics presented in Section 3.3.3 or the 2019 groundwater monitoring results for various reasons including:

- The plume stability metrics (Section 3.3.3) are based on the East Helena/Lamping Field area where consistent long-term monitoring data is available for periodic comparison, while the model considers the entire downgradient area extending three miles north of the Facility.
- The plume stability metrics include plume area (acres) while the model includes plume volume (acre-feet).
- The predictive model simulations include plume configurations for 2011 (pre-IM base-case), 2014 and 2025, precluding direct comparison to the most recent (2019) plumes.

Despite these differences, a semi-quantitative comparison of the predictive model results and the 2019 monitoring data is presented below.

Plume Configuration

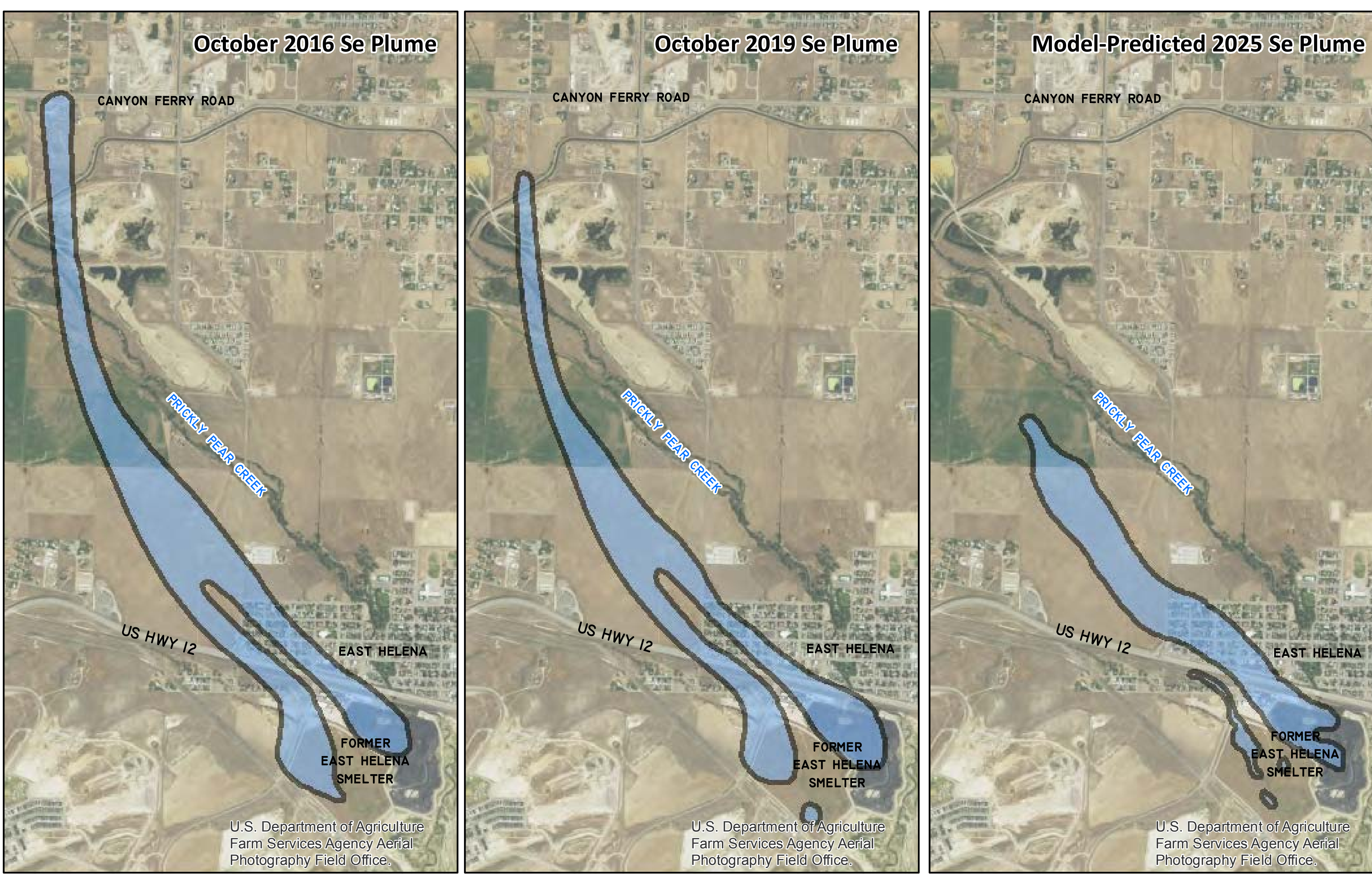
Figure 3-17 shows the October 2016 and 2019 arsenic and selenium plume boundaries based on actual monitoring data, compared to the 2025 model-predicted boundaries. As shown, the selenium plume has receded approximately 1,400 feet from 2016 to 2019, and the model predicts the plume will recede an additional 4,000 feet by 2025. Due to geochemical effects, as well as annual variations in precipitation and other factors, the selenium plume is not expected to recede in a linear fashion.



Arsenic 0.010 mg/L (Groundwater Human Health Standard) Plume Outlines

0 750 1,500 3,000

Scale In Feet



Selenium 0.050 mg/L (Groundwater Human Health Standard) Plume Outlines

0 0.25 0.5 1

Scale In Miles

N

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2019 WATER RESOURCES MONITORING REPORT EAST HELENA FACILITY	**2016 AND 2019 GROUNDWATER PLUMES AND GROUNDWATER MODEL-PREDICTED 2025 PLUMES**	**FIGURE 3-17**

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As anticipated, the arsenic plume has not exhibited significant recession since 2016, nor is it predicted to change significantly in the coming years (Figure 3-17). As noted in Section 3.3.3.1, the downgradient extent of the arsenic plume is not expected change appreciably in the coming years due to the strong affinity for arsenic to adsorb to soils, the resulting high arsenic soil concentrations in areas historically impacted by high groundwater concentrations, and the tendency for arsenic to desorb from soils back to groundwater as groundwater concentrations decrease. Although the plume area has not, and is not expected to show significant recession in the near future, the plume metrics (Section 3.3.3.1) show that plant site groundwater arsenic concentrations have decreased by more than 50% on average (Figure 3-13).

Plant Site Mass

Table 3-7 shows the model predicted reduction in the mass of arsenic and selenium in Plant Site groundwater for the 2011 to 2025 period, as well as estimated reductions for the IM/CM period to date based on the 2019 monitoring results. While the modeled results are presented as the simulated mass of COCs (kilograms) based on the modeled groundwater volumes and concentrations, the measured values are represented by the calculated plume areas times the plume average concentrations as shown in Figure 3-13. As such, the measured values do not represent the actual mass since they do not account for the plume depth and volume; however, they do provide a reasonable approximation of mass reduction. In actuality, the measured reductions in Table 3-7 likely underestimate the actual mass reduction realized since initiation of the IMs, since the reduced groundwater levels and aquifer thickness achieved through the SPHC IM have reduced the volume of groundwater and thus the mass more than represented by the plume area alone.

TABLE 3-7. MODEL PREDICTED 2025 PLANT SITE CONTAMINANT MASS REDUCTIONS VERSUS 2019 ESTIMATED REDUCTIONS

	Model Results			Measured Results		
	2011 Mass	2025 Mass	2011 to 2025 Reduction	2010 Area x Concentration	2019 Area x Concentration	2010 to 2019 Reduction
Arsenic	1639	679	59%	184.5	72.42	61%
Selenium	114	32	72%	30.15	12.24	59%

Modeled mass in kilograms; measured "mass" presented as plume area (acres) times average concentration (mg/L). Measured results shown on Figure 3-13.

As shown in Table 3-7, the groundwater model predicted an arsenic mass reduction in the Plant Site groundwater of 59% by 2025, while the monitoring data show an estimated reduction of 61% as of 2019. The corresponding selenium reductions are 72% for the 2025 model predictions and 59% for the 2019 estimated reductions. Overall, the 2019 estimated Plant Site reductions compare well to the model predicted reductions, keeping in mind the differing timelines and information utilized in the two methods. As noted above, a similar comparison of arsenic and selenium mass in downgradient groundwater cannot be performed at this time due to differing downgradient areas used in the model and the plume stability analyses (Section 3.3.3). However, based on a strictly qualitative review of the model predictions with the plume areas and average concentrations presented in Figures 3-11 and 3-12, the downgradient arsenic mass reduction as of 2019 may be on the order of 10% to 20% (based on a similar reduction in groundwater levels) compared to a model predicted reduction of 58% by 2025 (Newfields, 2016), and the selenium reduction may be on the order of 20% to 25% compared to the 2025 prediction of 41%. The 2020 monitoring program may include elements to aid in a more direct comparison of COC mass reductions based on the 2020 data.

Individual Well Trends

Table 3-8 presents a comparison of model predicted and measured arsenic and selenium concentrations for monitoring wells included in the model predictive simulations. The model results included simulated concentration trend graphs for the 2015 to 2025 period with the 2019 predicted concentrations in Table 3-8 taken from the graphs. For arsenic, the model included predictive trends for wells EH-111 and DH-64. Although DH-64 was not sampled in 2019, well DH-17, located in the arsenic plume about 430 feet upgradient of DH-64, showed an arsenic concentration of 16.7 mg/L in October 2019, compared with the model prediction for DH-64 of 14 mg/L (Table 3-8). For EH-111, located in East Helena northwest of the Plant Site (Exhibit 1), the 2019 model predicted arsenic concentration is approximately 1.3 mg/L while the October 2019 sample concentration was 1.8 mg/L. As shown in Figure 3-9, the arsenic concentration at EH-111 had decreased to 1.35 mg/L in October 2017 before increasing in 2018 in response to the high precipitation and increased groundwater levels that year.

TABLE 3-8. ESTIMATED 2019 MODEL PREDICTED CONCENTRATIONS VERSUS MEASURED 2019 CONCENTRATIONS

Monitoring Well	Location	2019 Arsenic - mg/L		2019 - Selenium mg/L	
		Modeled	Measured	Modeled	Measured
DH-64	North Plant Site	14	16.7+	---	NM
DH-66	West Selenium Source Area	---	0.006/0.006*	0.40	1.28/0.78*
EH-103	East Helena Business District	---	<0.002	0.30	0.36
EH-104	East Helena Business District	---	<0.002	0.01	0.31
EH-111	East Helena Business District	1.3	1.8	---	0.14
EH-126	North Lamping Field	---	0.002	0.02	0.19

Site locations shown on Exhibit 1.
NM - Not Measured
--- Not included in predictive model.
+ DH-64 not sampled in 2019; value shown is from nearby well DH-17.
* DH-66 measured concentrations are for June and October 2019; all other wells sampled in October only.

The predictive model included selenium concentration trends for wells DH-66, located on the Plant Site in the West Selenium Source Area, and EH-103 and EH-104 in East Helena, and EH-126 in north Lamping Field (Exhibit 1). At DH-66, the June and October 2019 concentrations were 1.28 and 0.78 mg/L, for a 2019 average measured concentration of 1.0 mg/L, compared to a model predicted concentration of 0.40 mg/L. Although the measured concentrations are higher than the predicted concentration, both 2019 concentrations represent a significant decrease from the maximum pre-IM/CM period concentration of 8 mg/L. At EH-103, the predicted (0.30 mg/L) and measured (0.36 mg/L) concentrations compare very well. Conversely, predicted and measured concentrations at wells EH-104 and EH-126 show greater divergence with the measured concentrations an order of magnitude greater than the predicted concentrations (Table 3-8). In both cases, these differences are due primarily to the westward selenium plume shift, with monitoring wells located east of these sites (EH-100, EH-125) showing order of magnitude or more decreases in selenium concentrations during the IM/CM period.

Overall, the 2019 arsenic and selenium concentrations and plume characteristics correspond well to the predictive model results. The 2020 groundwater monitoring program may be modified to allow for more direct comparison to the model-predicted groundwater conditions for the midpoint of the 2015 to 2025 predictive modeling period.

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APPENDIX A

2019 SURFACE WATER AND GROUNDWATER DATABASE

APPENDIX A1

2019 MONITORING WELL WATER QUALITY DATABASE

			Field Parameters							General Chemistry				
Station ID	**Sample Date**	**Depth To Water (ft)**	**pH (s.u.)**	**SC (µmhos/cm)**	**Diss O_2 (mg/L)**	**ORP (mV)**	**E_H (mV)**	**Turbidity (NTU)**	**Water Temp (°C)**	**Lab pH (s.u.)**	**Lab SC (µmhos/cm)**	**Total Alkalinity as CaCO3**	**Total Suspended Solids**	**Total Dissolved Solids**
2843 Canyon Ferry Rd	6/5/2019	30.11	7.37	653	4.72			0.0	10.6	7.5	654	130	<10	417
2843 Canyon Ferry Rd	10/16/2019	26.20	7.31	647	4.82	3	224	3.8	10.2	7.3	657	130	<10	427
2853 Canyon Ferry Rd	6/5/2019	31.53	7.40	692	4.48	59	280	2.1	10.3	7.3	698	130	<10	466
2853 Canyon Ferry Rd (Dup)	6/5/2019	31.53	7.40	692	4.47	59	280	0.0	10.3	7.3	699	130	<10	478
2853 Canyon Ferry Rd	10/16/2019	27.39	7.30	686	4.46	13	234	3.5	10.1	7.3	695	130	<10	458
Amchem Injection	10/10/2019		7.45	362	2.10	208	407	0.4	37.5	7.3	347	120	<10	256
Amchem4	10/10/2019		7.82	334	2.85	228	448	1.3	11.7	7.2	346	110	10	260
Dartman	6/5/2019		7.08	335	1.32			0.0	9.1	7.4	339	96	<10	215
Dartman	10/15/2019		7.25	332	1.23	-11	211	5.3	9.0	7.2	329	94	<10	198
DH-6	10/11/2019	17.19	7.37	1278	2.78	257	478	0.8	9.5	7.6	1280	160	<10	822
DH-15	10/11/2019	17.17	6.98	1590	0.19	254	475	0.7	10.4	7.2	1610	160	<10	1240
DH-17	6/6/2019	48.71	6.89	1499	0.11	14	233	3.9	12.9	7.0	1490	250	<10	1030
DH-17	10/8/2019	47.03	6.73	1395	1.31	72	291	3.9	12.9	6.9	1390	280	<10	947
DH-42	10/8/2019	48.91	6.10	952	3.17	137	355	1000 J-	13.4	6.9	962	210	5900	690
DH-52	10/11/2019	6.95	7.40	1141	0.92	261	482	1.2	10.8	7.6	1150	120	<10	794
DH-55	10/11/2019	80.54	7.22	2984	0.32	64	285	1.3	9.6	7.3	3030	140	<10	2400
DH-55 (Dup)	10/11/2019	80.54	7.22	2978	0.31	64	286	1.3	9.6	7.4	2990	140	<10	2360
DH-56	6/6/2019	82.75	7.68	4732	2.32	394	615	6.9	10.4	7.7	4730	310	<10	3470
DH-56 (Dup)	6/6/2019	82.75	7.68	4722	2.30	394	615	6.9	10.4	7.7	4730	310	10	3510
DH-56	10/11/2019	81.90	8.01	4422	2.86	85	306	3.8	10.6	8.0	4510	280	<10	3000
DH-66	6/6/2019	51.76	6.54	2988	1.98	384	603	5.3	12.9	6.6	3000	220	15	2460
DH-66	10/8/2019	50.08	6.61	2741	2.41	155	374	4.1	12.9	6.7	2700	220	19	2260
DH-67	10/7/2019	33.91	6.40	1362	1.39	250	469	3.1	11.9	6.5	1390	160	<10	1040
DH-69	10/11/2019	35.75	6.93	1068	0.32	-27	193	5.8	11.2	7.1	1090	190	17	724
DH-79	6/6/2019	54.44	7.92	1263 R	8.06	-75	141	8.9	16.4	7.9	2350	360	29	1610
DH-79	10/8/2019	53.25	7.97	2679	1.50	-47	169	16.0	16.4	7.8	2640	340	46	1840
DH-8	10/8/2019	51.09	7.12	4262	1.73	126	345	0.8	13.0	7.3	4260	320	<10	3800
DH-80	6/6/2019	49.03	4.50	872	0.16	240	458	5.7	13.2	4.6	869	<4	20	632
DH-80	10/8/2019	49.26	4.41	838	0.32	204	422	6.6	13.4	4.7	836	4	26	604
DH-80 (Dup)	10/8/2019	49.26	4.43	838	0.30	203	421	6.6	13.4	4.7	836	4	26	611
EH-50	10/11/2019	28.52	6.44	1400	1.29	264	483	1.3	11.8	6.6	1420	170	<10	967
EH-51	10/8/2019	15.18	6.92	413	8.21	102	323	2.5	10.3	7.1	414	96	<10	266
EH-52	10/7/2019	7.41	6.74	496	2.45	241	459	0.4	13.6	6.9	510	120	<10	326
EH-53	10/7/2019	28.51	6.93	533	13.28	250	470	0.5	11.1	7.1	541	150	<10	334
EH-54	10/7/2019	8.48	6.81	343	5.40	251	470	10.4	12.4	7.0	351	100	15	223
EH-57A	10/2/2019	39.51	6.84	1232	4.56	237	457	0.5	11.3	7.0	1250	250	<10	863
EH-58	10/4/2019	12.72	6.62	414	2.40	256	476	0.4	11.0	6.9	415	110	<10	278
EH-59	10/7/2019	7.49	6.75	491	0.85	252	471	1.7	12.2	6.9	504	150	<10	305
EH-60	10/10/2019	23.79	6.05	1737	2.27	202	422	1.9	11.6	6.4	1920	170	<10	1320
EH-61	10/10/2019	25.56	6.86	2012	0.06	207	427	1.3	11.6	7.0	2060	160	<10	1550
EH-62	10/7/2019	26.85	6.90	411	8.06	258	479	0.6	10.2	7.1	422	120	<10	258
EH-63	10/7/2019	21.05	6.93	381	9.93	251	472	4.5	10.3	7.1	392	94	16	238
EH-65	10/10/2019	26.66	6.48	1540	0.62	245	465	8.3	11.3	6.6	1600	180	11	1090
EH-66	10/1/2019	29.55	7.20	375	9.91	247	468	8.0	9.5	7.5	388	120	26	242
EH-68	6/5/2019	8.32	6.78	408	6.03	291	515	0.7	6.7	6.9	418	130	13	253
EH-68	10/4/2019	10.20	6.65	467	1.99	255	473	1.9	13.8	6.9	464	170	17	300
EH-69	6/5/2019	19.95	6.83	458	3.93	311	532	5.3	10.6	7.0	471	120	40	300
EH-69	10/7/2019	18.65	6.54	476	7.73	259	479	6.4	10.9	7.0	486	120	21	303
EH-70	10/2/2019	34.67	6.84	723	6.78	186	406	3.7	10.7	7.1	733	130	11	499
EH-100	10/11/2019	29.03	6.50	1595	0.15	263	483	0.5	12.2	6.7	1640	180	<10	1090
EH-101	10/8/2019	15.56	6.83	347	8.09	132	353	0.5	9.8	7.1	349	83	<10	213
EH-102	10/7/2019	8.55	6.85	449	1.78	238	459	0.4	10.1	7.1	461	100	<10	281
EH-103	10/10/2019	26.15	6.87	1828	0.09	187	406	2.3	12.1	7.0	1890	150	<10	1450
EH-104	10/8/2019	36.14	6.64	1626	7.00	152	372	0.6	11.4	6.8	1600	220	<10	1200
EH-106	10/10/2019	30.35	6.53	1136	1.81	193	413	1.9	11.7	6.7	1170	180	10	799
EH-107	10/10/2019	23.22	6.75	1325	0.06	172	391	4.7	12.3	7.0	1330	170	<10	946
EH-110	10/10/2019	21.59	7.10	925	1.06	235	455	0.7	11.9	7.2	960	150	<10	610
EH-111	10/10/2019	30.60	6.52	1656	0.07	188	408	2.1	11.5	6.7	1700	150	10	1240
EH-114	6/5/2019	35.92	6.55	1332	0.35	291	510	3.3	11.9	6.7	1350	170	11	960

			Field Parameters								General Chemistry				
Station ID	Sample Date	Depth To Water (ft)	pH (s.u.)	SC (µmhos/cm)	Diss O_2 (mg/L)	ORP (mV)	E_H (mV)	Turbidity (NTU)	Water Temp (°C)	Lab pH (s.u.)	Lab SC (µmhos/cm)	Total Alkalinity as CaCO3	Total Suspended Solids	Total Dissolved Solids
EH-114	10/3/2019	33.92	6.51	1343	0.69	185	405	4.6	11.3	6.7	1380	170	10	980
EH-114 (Dup)	10/3/2019	33.92	6.51	1342	0.70	185	405	4.6	11.3	6.7	1380	170	<10	987
EH-115	6/5/2019	38.36	6.43	1299	0.13	280	499	1.8	12.4	6.6	1310	180	10	935
EH-115	10/11/2019	36.34	6.47	1290	0.61	258	478	2.1	11.8	6.7	1320	190	<10	913
EH-117	10/2/2019	28.85	6.65	1193	6.31	244	464	3.2	10.8	6.9	1200	180	15	860
EH-118	10/3/2019	47.60	6.53	1340	2.52	200	420	12.5	11.3	6.8	1390	220	37	1010
EH-119	10/3/2019	34.55	6.57	1273	0.52	156	376	1.8	11.4	6.8	1310	180	<10	948
EH-120	6/5/2019	30.34	6.66	1512	0.72	470	690	1.0	11.5	6.8	1530	150	<10	1170
EH-120	10/2/2019	30.97	6.62	1311	1.22	219	439	2.4	11.4	6.8	1340	140	<10	1020
EH-121	10/1/2019	29.21	6.90	274	4.36	244	465	0.5	9.6	7.2	288	79	<10	179
EH-123	6/5/2019	45.83	7.19	627	5.91	516	735	2.0	12.3	7.3	640	160	<10	422
EH-123	10/1/2019	44.14	7.21	658	6.17	251	470	3.6	12.2	7.3	679	160	10	465
EH-124	10/2/2019	38.03	6.99	1139	3.29	221	441	1.0	10.9	7.2	1160	230	<10	828
EH-125	10/2/2019	35.31	6.85	397	4.02	207	427	2.7	10.9	7.2	399	96	<10	256
EH-126	10/2/2019	53.83	7.09	1208	4.58	223	443	4.1	11.3	7.2	1240	200	12	937
EH-129	6/4/2019	58.02	7.33	634	5.89	216	435	1.9	12.1	7.4	638	160	<10	452
EH-129	10/2/2019	54.47	7.25	636	6.27	267	486	1.8	11.9	7.5	644	160	<10	448
EH-130	6/4/2019	44.96	7.02	283	4.81	205	426	6.4	10.4	7.2	287	80	<10	198
EH-130	10/1/2019	44.45	6.71	279	5.12	207	428	2.3	10.0	7.2	295	81	<10	191
EH-132	10/2/2019	60.33	7.30	656	4.54	261	481	1.6	13.7	7.4	661	130	<10	475
EH-134	6/4/2019	58.04	7.48	445	6.34	211	430	0.5	12.9	7.6	452	140	<10	328
EH-134	10/2/2019	54.40	7.40	446	5.74	207	426	0.8	12.7	7.6	454	140	<10	316
EH-135	10/1/2019	29.30	6.98	287	5.38	236	459	2.0	8.5	7.2	303	82	<10	192
EH-138	7/23/2019	42.81	7.38	365	6.90	105	326	1.8	10.6	7.3	373	99	<10	243
EH-138	10/1/2019	42.85	7.04	377	7.21	213	434	0.9	9.7	7.3	392	100	<10	257
EH-139	7/23/2019	48.10	7.30	627	8.97	99	319	1.0	11.3	7.4	641	200	<10	430
EH-139	10/1/2019	47.73	7.25	625	9.29	226	447	0.9	10.7	7.4	643	190	<10	434
EH-141	6/4/2019	33.28	7.25	765	4.71	207	427	0.7	11.1	7.3	772	160	<10	560
EH-141	10/2/2019	28.82	7.09	800	4.53	245	466	0.5	10.8	7.4	812	170	<10	582
EH-141 (Dup)	10/2/2019	28.82	7.09	800	4.52	245	466	0.5	10.8	7.4	820	170	<10	589
EH-143	6/4/2019	34.48	7.22	496	5.52	192	413	0.8	10.4	7.3	505	120	<10	349
EH-143	10/1/2019	29.74	7.16	452	6.42	235	456	1.2	10.2	7.4	470	120	<10	305
EH-204	6/5/2019	55.96	7.11	1878	2.83	305	525	2.6	11.8	7.2	1910	260	<10	1480
EH-204	10/7/2019	55.87	7.16	1886	4.12	244	464	1.1	11.5	7.2	1940	260	<10	1510
EH-206	10/1/2019	48.71	7.52	537	6.45	244	462	3.3	13.3	7.6	554	190	32	363
EH-210	6/5/2019	37.77	7.23	977	6.98	308	527	1.2	12.6	7.4	994	140	12	720
EH-210	10/7/2019	36.98	7.30	997	10.15	245	464	2.7	12.4	7.4	1020	140	20	734
MW-1	10/3/2019	52.63	7.31	445	8.23	228	448	8.4	11.6	7.5	462	120	24	322
MW-2	10/3/2019	39.62	6.91	898	0.10	140	360	0.6	11.1	7.1	923	230	<10	639
MW-3	10/3/2019	34.97	6.92	974	0.45	200	420	0.5	10.8	7.1	1010	230	<10	708
MW-4	10/3/2019	48.78	7.26	475	8.42	206	426	3.8	11.4	7.5	495	160	16	342
MW-5	10/4/2019	53.69	7.46	367	8.17	227	446	22.8	12.1	7.8	370	140	44	256
MW-6	10/4/2019	31.47	6.91	1706	0.81	265	485	1.8	10.7	7.1	1670	250	<10	1340
MW-7	10/3/2019	56.10	7.52	245	8.74	167	387	24.9	11.8	7.7	256	87	24	202
MW-8	10/4/2019	52.60	7.27	483	6.80	244	464	4.9	11.2	7.5	483	160	32	339
MW-9	10/4/2019	52.12	7.38	447	8.46	241	462	12.3	11.0	7.7	447	150	33	309
MW-10	10/4/2019	44.54	7.27	770	5.12	256	476	3.9	11.3	7.4	769	250	17	536
MW-11	10/4/2019	63.27	7.66	649	9.01	227	446	2.0	13.1	7.7	643	110	<10	456

NOTES: All concentrations in mg/L except as indicated.

J- = QC criterion exceeded (estimated value with potential low bias)

J+ = QC criterion exceeded (estimated value with potential high bias)

R = value rejected during validation

		Major Ions								Dissolved (D) Metals										
Station ID	Sample Date	Calcium	Magnesium	Sodium	Potassium	Bicarbonate	Chloride	Sulfate	Bromide	Sb (D)	As (D)	Cd (D)	Cu (D)	Fe (D)	Pb (D)	Mn (D)	Hg (D)	Se (D)	Tl (D)	Zn (D)
2843 Canyon Ferry Rd	6/5/2019	79	18	28	4	160	16	170	0.82	<0.003	<0.002	<0.001	<0.001	0.06	<0.005	<0.01	<0.001	0.041	<0.001	<0.01
2843 Canyon Ferry Rd	10/16/2019	80	17	30	4	160	16	164	0.74	<0.003	<0.002	<0.001	<0.001	0.07	<0.005	<0.01	<0.001	0.037	<0.001	<0.01
2853 Canyon Ferry Rd	6/5/2019	89	19	29	4	160	17	189	0.88	<0.003	<0.002	<0.001	<0.001	0.04	<0.005	<0.01	<0.001	0.044	<0.001	<0.01
2853 Canyon Ferry Rd (Dup)	6/5/2019	90	20	29	4	160	17	190	0.89	<0.003	<0.002	<0.001	<0.001	0.04	<0.005	<0.01	<0.001	0.044	<0.001	<0.01
2853 Canyon Ferry Rd	10/16/2019	85	18	31	4	160	17	180	0.81	<0.003	<0.002	<0.001	<0.001	0.07	<0.005	<0.01	<0.001	0.041	<0.001	<0.01
Amchem Injection	10/10/2019	37	8	16	4	140	4	45	0.22	<0.003	0.007	<0.001	0.006	<0.02	<0.005	<0.01	<0.001	0.001	<0.001	<0.01
Amchem4	10/10/2019	37	8	16	4	140	4	45	0.22	<0.003	0.007	<0.001	0.004	0.08	<0.005	<0.01	<0.001	0.002	<0.001	<0.01
Dartman	6/5/2019	38	9	15	3	120	3	65	0.08	<0.003	<0.002	<0.001	<0.001	0.22	<0.005	0.02	<0.001	<0.001	<0.001	<0.01
Dartman	10/15/2019	36	8	15	3	110	3	60	0.07	<0.003	<0.002	<0.001	<0.001	0.22	<0.005	0.02	<0.001	<0.001	<0.001	<0.01
DH-6	10/11/2019	42	7	156	111	190	20	362	0.36	0.045	0.972	<0.001	0.006	0.03 J+	<0.005	<0.01	<0.001	0.188	<0.001	<0.01
DH-15	10/11/2019	171	39	145	7	190	15	651	0.83	<0.003	<0.002	<0.001	0.013	<0.02	<0.005	0.02	<0.001	0.27	<0.001	<0.01
DH-17	6/6/2019	79	20	204	19	310	19	450	2.1	<0.003	18.1	0.001	0.002	0.22	<0.005	2.17	<0.001	<0.001	<0.001	3.56
DH-17	10/8/2019	57	14	220	16	340	16	378	1.9	<0.003	16.7	0.002	0.003	0.19	<0.005	1.86	<0.001	0.002	<0.001	7.21
DH-42	10/8/2019	121	32	32	8	250	14	261	0.7	<0.003	2.07	4.06	0.005	<0.02	<0.005	3.13	0.045	0.094	0.003	1.84
DH-52	10/11/2019	76	13	103	75	140	8	381	0.24	0.026	0.496	<0.001	0.001	0.03 J+	<0.005	<0.01	<0.001	0.069	<0.001	<0.01
DH-55	10/11/2019	255	47	271	196	170	23	1340	0.7	0.024	0.111	<0.001	0.003	0.03 J+	<0.005	0.07	<0.001	0.262	0.015	0.14
DH-55 (Dup)	10/11/2019	257	47	269	196	170	23	1350	0.7	0.025	0.115	<0.001	0.003	0.03 J+	<0.005	0.07	<0.001	0.252	0.015	0.14
DH-56	6/6/2019	104	19	652	445	380	35	1950	2.2	0.03	0.659	<0.001	0.003	<0.02	<0.005	<0.01	<0.001	1.14	<0.001	<0.01
DH-56 (Dup)	6/6/2019	105	18	654	448	380	35	1970	2.3	0.029	0.677	<0.001	0.003	<0.02	<0.005	<0.01	<0.001	1.11	<0.001	<0.01
DH-56	10/11/2019	72	13	593	508	340	29	1670	1.7	0.033	1.19	<0.001	0.003	0.03 J+	<0.005	<0.01	<0.001	0.93	<0.001	<0.01
DH-66	6/6/2019	424	130	106	10	260	247	1090	20	<0.003	0.006	0.271	0.004	<0.02	<0.005	<0.01	0.002	1.28	<0.001	0.16
DH-66	10/8/2019	354	106	106	10	270	190	979	15.3	<0.003	0.006	0.27	0.003	0.02	<0.005	<0.01	0.001	0.786	<0.001	0.17
DH-67	10/7/2019	127	43	92	7	200	41	446	2.5	<0.003	0.018	<0.001	0.002	<0.02	<0.005	<0.01	<0.001	0.179	<0.001	<0.01
DH-69	10/11/2019	97	9	80	52	230	7	317	0.2	0.009	0.177	<0.001	0.002	7.52	<0.005	2.94	<0.001	0.003	0.006	1.2
DH-79	6/6/2019	42	17	432	20	440	47	731	2.6	<0.003	40.1	<0.001	0.003	0.26	<0.005	1.92	<0.001	0.006	<0.001	<0.01
DH-79	10/8/2019	39	15	543	21	420	61	851	4.3	<0.003	40	<0.001	0.005	0.05	<0.005	1.67	<0.001	0.045	<0.001	0.01
DH-8	10/8/2019	658	154	115	18	390	380	1670	27.8	<0.003	0.003	0.001	0.002	0.03	<0.005	<0.01	0.002	0.518	0.003	<0.01
DH-80	6/6/2019	75	20	37	8	5 U	12	392	0.3	<0.003	9.47	4.21	0.011	9.03	<0.005	3.61	<0.001	0.003	0.226	6.56
DH-80	10/8/2019	67	17	38	8	5	12	349	0.28	<0.003	8.93	3.15	0.002	8.2	<0.005	3.4	<0.001	0.004	0.211	5.46
DH-80 (Dup)	10/8/2019	66	17	38	8	5	12	352	0.28	<0.003	8.89	3.07	0.001	8.14	<0.005	3.37	<0.001	0.003	0.213	5.37
EH-50	10/11/2019	86	27	188	6	210	65	390	1.34	<0.003	6.44	<0.001	0.002	0.03 J+	<0.005	0.01	<0.001	0.009	<0.001	<0.01
EH-51	10/8/2019	27	5	31	19	120	11	70	<0.05	<0.003	0.056	<0.001	<0.001	0.03	<0.005	<0.01	<0.001	0.003	<0.001	<0.01
EH-52	10/7/2019	43	9	25	23	140	9	98	<0.05	0.013	0.256	<0.001	0.001	<0.02	<0.005	<0.01	<0.001	0.007	<0.001	<0.01
EH-53	10/7/2019	32	10	65	4	180	14	76	0.08	<0.003	<0.002	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.012	<0.001	<0.01
EH-54	10/7/2019	38	8	15	3	120	6	55	<0.05	<0.003	0.019	<0.001	0.001	0.02	<0.005	<0.01	<0.001	<0.001	<0.001	<0.01
EH-57A	10/2/2019	131	37	79	6	300	78	284	1.26	<0.003	<0.002	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.17	<0.001	<0.01
EH-58	10/4/2019	49	11	19	4	130	12	78	<0.05	<0.003	<0.002	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.003	<0.001	<0.01
EH-59	10/7/2019	50	11	21	13	180	10	78	<0.05	0.006	0.014	<0.001	0.002	0.03	<0.005	<0.01	<0.001	0.001	<0.001	<0.01
EH-60	10/10/2019	122	36	228	13	210	148	526	1.2	<0.003	1.52	<0.001	0.003	0.03	<0.005	13.4	<0.001	<0.001	<0.001	0.02
EH-61	10/10/2019	157	28	268	16	190	30	797	1.2	<0.003	<0.002	<0.001	0.001	<0.02	<0.005	0.89	<0.001	0.401	<0.001	<0.01
EH-62	10/7/2019	44	10	18	4	140	12	59	<0.05	<0.003	<0.002	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.001	<0.001	<0.01
EH-63	10/7/2019	39	9	19	4	110	16	54	<0.05	<0.003	<0.002	<0.001	<0.001	0.02	<0.005	<0.01	<0.001	0.001	<0.001	<0.01
EH-65	10/10/2019	112	28	188	10	220	76	440	0.76	<0.003	0.25	<0.001	0.002	<0.02	<0.005	0.32	<0.001	0.116	<0.001	<0.01
EH-66	10/1/2019	46	11	15	3	150	7	51	<0.05	<0.003	<0.002	<0.001	<0.001	0.02	<0.005	<0.01	<0.001	<0.001	<0.001	<0.01
EH-68	6/5/2019	47	11	17	3	160	8	63	<0.05	<0.003	<0.002	<0.001	0.001	<0.02	<0.005	<0.01	<0.001	0.001	<0.001	<0.01
EH-68	10/4/2019	61	14	19	4	200	7	62	<0.05	<0.003	<0.002	<0.001	0.002	<0.02	<0.005	<0.01	<0.001	<0.001	<0.001	<0.01
EH-69	6/5/2019	46	10	31	4	140	10	98	0.05	<0.003	<0.002	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.005	<0.001	<0.01
EH-69	10/7/2019	48	11	32	4	140	14	81	<0.05	<0.003	<0.002	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.005	<0.001	<0.01
EH-70	10/2/2019	52	17	74	3	160	17	205	0.5	<0.003	<0.002	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.04	<0.001	<0.01
EH-100	10/11/2019	71	27	242	10	220	21	552	1.72	<0.003	9.68	0.003	0.004	<0.02	<0.005	9.55	<0.001	0.002	<0.001	0.39
EH-101	10/8/2019	26	5	25	16	100	10	60	<0.05	<0.003	0.004	<0.001	<0.001	0.04	<0.005	<0.01	<0.001	0.002	<0.001	<0.01
EH-102	10/7/2019	29	7	46	7	120	10	91	0.09	<0.003	<0.002	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.009	<0.001	<0.01
EH-103	10/10/2019	187	37	182	11	180	26	750	1.9	<0.003	<0.002	<0.001	0.002	0.03	<0.005	0.21	<0.001	0.363	<0.001	0.01
EH-104	10/8/2019	170	43	113	6	270	82	472	2.1	<0.003	<0.002	<0.001	0.002	0.02	<0.005	<0.01	<0.001	0.311	<0.001	<0.01
EH-106	10/10/2019	94	22	122	6	220	41	307	1.36	<0.003	0.372	<0.001	<0.001	<0.02	<0.005	0.03	<0.001	0.011	<0.001	<0.01
EH-107	10/10/2019	117	25	140	6	200	32	424	0.61	<0.003	<0.002	<0.001	0.002	0.04	<0.005	0.08	<0.001	0.165	<0.001	<0.01
EH-110	10/10/2019	42	8	141	6	180	38	212	0.28	<0.003	<0.002	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.103	<0.001	<0.01
EH-111	10/10/2019	122	32	202	11	180	32	649	1.7	<0.003	1.84	<0.001	0.001	0.03	<0.005	8.06	<0.001	0.139	<0.001	<0.01
EH-114	6/5/2019	93	25	160	6	210	30	461	1.9	<0.003	1.33	<0.001	0.001	<0.02	<0.005	<0.01	<0.001	0.019	<0.001	<0.01

		Major Ions								Dissolved (D) Metals										
Station ID	**Sample Date**	**Calcium**	**Magnesium**	**Sodium**	**Potassium**	**Bicarbonate**	**Chloride**	**Sulfate**	**Bromide**	**Sb (D)**	**As (D)**	**Cd (D)**	**Cu (D)**	**Fe (D)**	**Pb (D)**	**Mn (D)**	**Hg (D)**	**Se (D)**	**Tl (D)**	**Zn (D)**
EH-114	10/3/2019	95	24	175	7	210	29	462	1.84	<0.003	1.34	<0.001	0.001	<0.02	<0.005	<0.01	<0.001	0.017	<0.001	<0.01
EH-114 (Dup)	10/3/2019	95	25	174	7	200	29	465	1.85	<0.003	1.38	<0.001	0.001	<0.02	<0.005	<0.01	<0.001	0.016	<0.001	<0.01
EH-115	6/5/2019	104	28	140	6	210	31	436	1.9	<0.003	1.71	<0.001	0.002	<0.02	<0.005	<0.01	<0.001	0.065	<0.001	<0.01
EH-115	10/11/2019	104	30	147	6	230	39	383	1.56	<0.003	1.72	<0.001	0.002	0.03 J+	<0.005	<0.01	<0.001	0.032	<0.001	<0.01
EH-117	10/2/2019	91	23	146	6	220	39	369	1.33	<0.003	<0.002	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.071	<0.001	<0.01
EH-118	10/3/2019	140	42	97	7	260	62	385	1.87	<0.003	<0.002	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.158	<0.001	<0.01
EH-119	10/3/2019	111	31	132	6	220	30	427	1.94	<0.003	<0.002	<0.001	0.001	<0.02	<0.005	<0.01	<0.001	0.031	<0.001	<0.01
EH-120	6/5/2019	174	38	112	6	180	28	625	1.7	<0.003	<0.002	<0.001	<0.001	0.03	<0.005	<0.01	<0.001	0.246	<0.001	<0.01
EH-120	10/2/2019	141	31	107	5	170	27	516	1.73	<0.003	<0.002	<0.001	<0.001	0.02	<0.005	<0.01	<0.001	0.184	<0.001	<0.01
EH-121	10/1/2019	31	7	14	2	96	7	50	<0.05	<0.003	<0.002	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	<0.001	<0.001	<0.01
EH-123	6/5/2019	61	16	39	7	190	28	116	0.23	<0.003	0.006	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.003	<0.001	<0.01
EH-123	10/1/2019	69	18	42	7	200	33	127	0.26	<0.003	0.005	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.003	<0.001	<0.01
EH-124	10/2/2019	133	36	59	7	280	52	299	1.73	<0.003	<0.002	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.132	<0.001	<0.01
EH-125	10/2/2019	33	9	34	3	120	10	81	0.1	<0.003	<0.002	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.008	<0.001	<0.01
EH-126	10/2/2019	125	50	69	5	240	36	416	2.18	<0.003	0.002	<0.001	<0.001	0.03	<0.005	<0.01	<0.001	0.185	<0.001	<0.01
EH-129	6/4/2019	62	20	36	7	200	20	127	0.58	<0.003	0.005	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.051	<0.001	<0.01
EH-129	10/2/2019	64	21	35	6	200	20	134	0.6	<0.003	0.004	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.045	<0.001	<0.01
EH-130	6/4/2019	29	7	16	2	97	6	50	<0.05	<0.003	<0.002	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	<0.001	<0.001	<0.01
EH-130	10/1/2019	30	7	15	2	98	6	51	<0.05	<0.003	<0.002	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	<0.001	<0.001	<0.01
EH-132	10/2/2019	64	20	35	9	160	25	157	0.61	<0.003	0.02	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.003	<0.001	<0.01
EH-134	6/4/2019	46	12	24	6	170	10	66	0.1	<0.003	0.005	<0.001	0.001	0.03	<0.005	<0.01	<0.001	0.002	<0.001	<0.01
EH-134	10/2/2019	46	13	23	6	170	11	70	0.11	<0.003	0.005	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.002	<0.001	<0.01
EH-135	10/1/2019	33	7	14	3	100	6	54	<0.05	<0.003	<0.002	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	<0.001	<0.001	<0.01
EH-138	7/23/2019	33	9	30	2	120	7	65	0.06	<0.003	<0.002	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.005	<0.001	<0.01
EH-138	10/1/2019	35	9	31	3	120	8	75	0.09	<0.003	<0.002	<0.001	<0.001	0.09	<0.005	<0.01	<0.001	0.006	<0.001	<0.01
EH-139	7/23/2019	56	28	33	7	240	14	97	0.16	<0.003	0.004	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.007	<0.001	<0.01
EH-139	10/1/2019	56	27	34	8	240	16	108	0.19	<0.003	0.004	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.008	<0.001	<0.01
EH-141	6/4/2019	84	22	44	7	190	20	197	0.99	<0.003	0.002	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.066	<0.001	<0.01
EH-141	10/2/2019	90	24	44	7	200	21	216	1.06	<0.003	0.002	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.066	<0.001	<0.01
EH-141 (Dup)	10/2/2019	89	24	44	7	200	21	218	1.06	<0.003	0.002	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.068	<0.001	<0.01
EH-143	6/4/2019	50	12	30	4	140	11	111	0.35	<0.003	<0.002	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.021	<0.001	<0.01
EH-143	10/1/2019	50	12	30	4	140	10	101	0.26	<0.003	<0.002	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.017	<0.001	<0.01
EH-204	6/5/2019	277	64	72	11	320	93	660	4.5	<0.003	<0.002	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.097	<0.001	<0.01
EH-204	10/7/2019	243	58	77	12	320	88	607	4.2	<0.003	<0.002	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.097	<0.001	<0.01
EH-206	10/1/2019	65	15	19	9	230	34	46	0.07	<0.003	0.029	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.001	<0.001	<0.01
EH-210	6/5/2019	120	27	45	9	170	38	301	3.9	<0.003	<0.002	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.111	<0.001	<0.01
EH-210	10/7/2019	109	25	47	10	170	36	280	3.85	<0.003	<0.002	<0.001	<0.001	0.02	<0.005	<0.01	<0.001	0.11	<0.001	<0.01
MW-1	10/3/2019	49	10	26	5	140	13	80	0.13	<0.003	0.004	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.002	<0.001	<0.01
MW-2	10/3/2019	121	25	28	7	280	39	190	0.26	<0.003	0.011	<0.001	<0.001	<0.02	<0.005	0.51	<0.001	<0.001	<0.001	<0.01
MW-3	10/3/2019	135	29	29	8	280	51	210	0.35	<0.003	0.009	<0.001	<0.001	<0.02	<0.005	0.04	<0.001	0.013	<0.001	<0.01
MW-4	10/3/2019	54	11	29	7	200	9	70	0.07	<0.003	0.003	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.001	<0.001	<0.01
MW-5	10/4/2019	42	9	25	4	170	6	41	0.06	<0.003	0.006	<0.001	<0.001	0.03	<0.005	<0.01	<0.001	0.001	<0.001	<0.01
MW-6	10/4/2019	257	55	40	9	300	114	507	0.68	<0.003	0.030	<0.001	0.002	<0.02	<0.005	0.7	<0.001	0.018	<0.001	<0.01
MW-7	10/3/2019	18	5	20	5	110	1	31	<0.05	<0.003	0.016	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	<0.001	<0.001	<0.01
MW-8	10/4/2019	61	12	24	7	190	10	70	0.07	<0.003	0.007	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.001	<0.001	<0.01
MW-9	10/4/2019	53	10	27	5	190	9	57	0.07	<0.003	0.006	<0.001	<0.001	0.04	<0.005	<0.01	<0.001	0.001	<0.001	<0.01
MW-10	10/4/2019	101	24	37	7	300	17	137	0.12	<0.003	0.008	<0.001	<0.001	<0.02	<0.005	<0.01	<0.001	0.003	<0.001	<0.01
MW-11	10/4/2019	53	12	61	11	140	24	156	0.21	<0.003	0.018	<0.001	<0.001	0.02	<0.005	<0.01	<0.001	0.003	<0.001	<0.01

NOTES: All concentrations in mg/L except as indicated.
J- = QC criterion exceeded (estimated value with potential low bias)
J+ = QC criterion exceeded (estimated value with potential high bias)
R = value rejected during validation

APPENDIX A2

2019 RESIDENTIAL WELL
WATER QUALITY DATABASE

			Field Parameters							General Chemistry					Major Ions							
Map Key (see Exhibit 1)	Sample Date	Depth To Water (ft)	pH (s.u.)	SC (µmhos/cm)	Diss O_2 (mg/L)	ORP (mV)	E_H (mV)	Turbidity (NTU)	Water Temp (°C)	Lab pH (s.u.)	Lab SC (µmhos/cm)	Total Alkalinity as CaCO3	Total Suspended Solids	Total Dissolved Solids	Calcium	Magnesium	Sodium	Potassium	Bicarbonate	Chloride	Sulfate	Bromide
R1	6/4/2019		6.31	319	4.89	142	363	2.2	10.1	7.0	324	85	<10	218	35	8	14	3	100	8	58	<0.05
R1 (Dup)	6/4/2019		6.31	319	5.00	142	363	2	10.2	7.0	324	85	<10	213	37	8	14	3	100	8	58	<0.05
R1	10/15/2019		7.06	288	3.84	78	300	0.48	8.7	7.1	305	87	<10	174	34	7	13	3	110	6	50	<0.05
R2	6/4/2019		6.57	320	3.54	123	344	0.6	10.2	7.2	323	87	<10	215	37	8	14	3	110	7	56	<0.05
R3	6/4/2019		6.41	489	6.13	166	387	0.1	10	7.0	490	110	<10	316	56	11	23	14	140	19	93	<0.05
R3	10/15/2019		6.91	433	3.29	119	336	0.16	14.3	7.0	448	130	<10	259	46	9	23	15	160	10	73	<0.05
R4	6/6/2019		6.83	361	3.65	152	372	0.7	10.7	7.1	372	95	<10	231	33	7	27	3	110	8	76	0.2
R4	10/15/2019		7.14	367	3.43	41	262	0.08	9.8	7.3	380	96	<10	227	35	8	28	3	120	8	71	0.19
R5	6/6/2019		6.86	279	5.35	153	374	6.6	9.6	7.1	289	79	<10	175	29	6	13	3	95	7	48	<0.05
R5	10/15/2019		7.25	297	6.52	64	286	0.49	9.5	7.2	308	78	<10	174	34	7	14	3	95	8	54	<0.05
R6	6/4/2019		6.60	432	3.88	139	360	1.5	9.4	7.2	434	110	<10	316	51	11	17	5	130	6	94	0.18
R6	10/16/2019		7.19	445	3.92	89	310	0.93	9.7	7.3	454	110	<10	295	54	11	17	5	130	7	100	0.24
R7	6/5/2019	31.60	7.35	295	4.36			0.02	10.6	7.3	305	88	<10	192	33	7	16	3	110	6	53	<0.05
R7	10/16/2019	27.00	7.44	294	4.73	55	275	1.39	10.8	7.4	309	89	<10	180	34	7	16	3	110	6	51	<0.05
R8	6/5/2019	32.78	7.27	283	3.26			0.02	10.8	7.3	287	84	<10	174	32	7	14	3	100	6	47	<0.05
R8	10/16/2019	28.30	7.37	285	3.86	44	265	0.32	10.6	7.3	294	84	<10	171	32	7	14	3	100	6	46	<0.05
R9	6/5/2019	35.33	7.25	284	0.63			0.02	11.6	7.3	286	96	<10	177	35	8	13	3	120	6	37	<0.05
R9	10/16/2019	30.51	7.34	283	1.24	46	265	1.21	11.9	7.3	292	91	<10	164	32	7	14	3	110	6	41	<0.05
R10	6/4/2019		6.53	371	3.95	121	341	0.2	11.4	7.0	374	100	<10	241	47	11	15	3	120	11	58	0.1
R11	6/4/2019		6.50	807	1.70	149	369	3.1	11.7	7.0	801	130	<10	603	103	22	26	6	150	23	238	2.96
R11	10/16/2019		6.98	805	1.70	76	296	1.11	11.8	7.1	817	130	<10	567	106	23	27	6	160	24	240	3.08
R12	6/6/2019		7.15	366	5.33	234	454	0.5	10.8	7.3	384	100	<10	235	41	9	16	3	120	7	80	0.09
R12	10/15/2019	17.10	7.39	352	7.40	91	292	0.35	10.4	7.4	372	98	<10	215	42	9	16	3	120	7	69	<0.05
R13	6/6/2019	18.09	7.17	581	6.19	197	419	2	9.2	7.3	599	230	<10	367	67	14	37	6	280	14	65	0.09
R13	10/17/2019	19.26	7.24	650	3.88	64	285	0.3	8.9	7.3	647	280	<10	398	84	17	34	7	340	14	45	0.11
R14	6/4/2019	11.52	6.24	341	6.25	143	365	3.3	9	7.0	346	81	<10	229	41	9	13	3	99	14	61	<0.05
R14	10/15/2019	13.90	7.06	316	3.87	75	297	0.48	8.1	7.1	329	86	<10	189	37	8	14	3	100	7	57	<0.05
R14 (Dup)	10/15/2019	13.90	7.06	316	3.87	75	297	0.48	8.1	7.1	327	87	<10	188	37	8	14	3	110	7	56	<0.05
R15	6/7/2019		7.55	739	8.85	209	429	0.1	11.6	7.6	764	200	<10	527	80	21	40	15	240	31	131	0.27
R15	10/18/2019		7.58	705	8.31	62	282	0.14	11.7	7.7	700	190	<10	495	75	19	39	14	240	27	109	0.23
R16	10/18/2019		7.67	710	15.35	12	232	1.7	11.5	7.7	704	170	<10	490	70	19	43	14	210	29	121	0.24
R17	6/7/2019	84.68	7.61	482	10.68	158	377	2	12.2	7.9	514	140	<10	364	47	13	33	12	160	17	90	0.17
R17	10/18/2019	83.75	7.72	515	9.38	54	273	0.12	12.3	7.8	510	140	<10	377	49	13	33	12	170	16	86	0.16
R18	6/7/2019		7.04	302	7.71	220	439	0.2	12.6	7.4	311	100	<10	201	33	8	14	3	120	7	37	<0.05
R18	10/18/2019		7.64	284	3.84	100	320	0.21	10.7	7.3	285	93	<10	183	33	7	13	3	110	6	39	<0.05
R19	6/7/2019		7.09	282	8.28	171	392	17.2	10.2	7.2	290	85	<10	193	32	7	13	3	100	7	45	<0.05
R19	10/18/2019		7.62	291	7.45	73	294	14.7	10.3	7.2	291	86	<10	200	33	7	13	3	100	7	42	<0.05
R20	6/7/2019		7.00	297	7.60	197	420	0.68	8.1	7.2	307	85	<10	199	33	7	14	3	100	7	54	<0.05
R20	10/18/2019		7.44	291	7.44	75	297	23.3	8.4	7.2	292	85	<10	204	33	7	13	3	100	6	48	<0.05

NOTES: All concentrations in mg/L except as indicated.
J = estimated value due to QC criterion exceedance
Locations shown on Exhibit 1

		Dissolved (D) and Total (T) Metals																					
Map Key (see Exhibit 1)	Sample Date	Sb (D)	Sb (T)	As (D)	As (T)	Cd (D)	Cd (T)	Cu (D)	Cu (T)	Fe (D)	Fe (T)	Pb (D)	Pb (T)	Mn (D)	Mn (T)	Hg (D)	Hg (T)	Se (D)	Se (T)	Tl (D)	Tl (T)	Zn (D)	Zn (T)
R1	6/4/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	0.008	0.008	0.03	0.24	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01
R1 (Dup)	6/4/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	0.008	0.008	0.03	0.24	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01
R1	10/15/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	0.006	0.006 J	0.04	0.08	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01
R2	6/4/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	<0.001	0.001	<0.02	0.03	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	0.002	0.002	<0.001	<0.001	<0.01	<0.01
R3	6/4/2019	0.004	0.003	<0.002	<0.002	<0.001	<0.001	0.023	0.028	<0.02	<0.02	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	0.006	0.006	<0.001	<0.001	<0.01	<0.01
R3	10/15/2019	0.004	0.004	<0.002	<0.002	<0.001	<0.001	0.055	0.073 J	<0.02	0.02	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	0.002	0.002	<0.001	<0.001	<0.01	0.01
R4	6/6/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	<0.001	<0.001	0.03	0.04	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	0.003	0.003	<0.001	<0.001	<0.01	<0.01
R4	10/15/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	<0.001	<0.001	0.05	0.1	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	0.002	0.002	<0.001	<0.001	<0.01	0.01
R5	6/6/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	0.001	0.001	<0.02	0.17	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	0.01
R5	10/15/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	0.001	0.001 J	0.03	0.04	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	0.01
R6	6/4/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	0.002	0.002	<0.02	<0.02	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	0.002	0.002	<0.001	<0.001	<0.01	<0.01
R6	10/16/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	0.005	0.005	<0.02	0.03	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	0.003	0.003	<0.001	<0.001	0.02	0.02
R7	6/5/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	0.012	0.012	<0.02	0.11	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	0.001	0.001	<0.001	<0.001	<0.01	<0.01
R7	10/16/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	0.009	0.01	0.02	0.13	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	0.001	0.001	<0.001	<0.001	<0.01	<0.01
R8	6/5/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	0.002	0.002	<0.02	0.10	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01
R8	10/16/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	0.001	0.001	0.02	0.05	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01
R9	6/5/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	0.001	0.002	<0.02	0.2	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01
R9	10/16/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	0.002	0.003	0.03	0.19	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01
R10	6/4/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	0.003	0.003	<0.02	0.04	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	0.002	0.002	<0.001	<0.001	<0.01	<0.01
R11	6/4/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	0.004	0.004	<0.02	0.18	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	0.044	0.043	<0.001	<0.001	0.05	0.03
R11	10/16/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	0.002	0.004	<0.02	0.07	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	0.042	0.042	<0.001	<0.001	0.02	0.02
R12	6/6/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	0.003	0.004	<0.02	0.02	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	0.002	0.002	<0.001	<0.001	<0.01	<0.01
R12	10/15/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	0.019	0.022 J	0.03	0.02	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	0.002	0.002	<0.001	<0.001	<0.01	<0.01
R13	6/6/2019	<0.003	<0.003	0.014	0.013	<0.001	<0.001	0.016	0.015	<0.02	0.02	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	0.001	0.001	<0.001	<0.001	0.02	0.02
R13	10/17/2019	<0.003	<0.003	0.015	0.014	<0.001	<0.001	0.01	0.014	<0.02	0.05	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	0.001	0.001	<0.001	<0.001	0.01	0.01
R14	6/4/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	<0.001	0.002	<0.02	0.51	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.02	0.02
R14	10/15/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	0.001	0.002 J	0.12	0.51	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.02	0.02
R14 (Dup)	10/15/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	0.002	0.004 J	0.1	0.5	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.02	0.02
R15	6/7/2019	<0.003	<0.003	0.015	0.014	<0.001	<0.001	0.001	0.001	<0.02	<0.02	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	0.002	0.002	<0.001	<0.001	<0.01	<0.01
R15	10/18/2019	<0.003	<0.003	0.017	0.016	<0.001	<0.001	<0.001	<0.001	<0.02	<0.02	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	0.002	0.002	<0.001	<0.001	<0.01	<0.01
R16	10/18/2019	<0.003	<0.003	0.017	0.018	<0.001	<0.001	<0.001	0.001	<0.02	0.25	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	0.002	0.002	<0.001	<0.001	0.01	0.02
R17	6/7/2019	<0.003	<0.003	0.017	0.017	<0.001	<0.001	<0.001	<0.001	<0.02	<0.02	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	0.002	0.002	<0.001	<0.001	<0.01	<0.01
R17	10/18/2019	<0.003	<0.003	0.018	0.018	<0.001	<0.001	<0.001	<0.001	<0.02	<0.02	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	0.002	0.002	<0.001	<0.001	<0.01	<0.01
R18	6/7/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	<0.001	<0.001	<0.02	<0.02	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01
R18	10/18/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	0.001	0.002	<0.02	<0.02	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01
R19	6/7/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	<0.001	<0.001	<0.02	<0.02	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01
R19	10/18/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	<0.001	<0.001	<0.02	<0.02	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01
R20	6/7/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	<0.001	<0.001	<0.02	<0.02	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01
R20	10/18/2019	<0.003	<0.003	<0.002	<0.002	<0.001	<0.001	0.001	0.001	<0.02	0.03	<0.005	<0.005	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01

NOTES: All concentrations in mg/L except as indicated.
J = estimated value due to QC criterion exceedance
Locations shown on Exhibit 1

APPENDIX A3

2019 SURFACE
WATER QUALITY DATABASE

Station ID	Sample Date	Field pH (s.u.)	Field SC (µmhos/cm)	Diss O2 (mg/L)	Water Temp (°C)	Flow (cfs)	Lab pH (s.u.)	Lab SC (µmhos/cm)	Total Alkalinity as CaCO3	Total Dissolved Solids	Total Suspended Solids	Ca (TR)	Mg (TR)	Na (TR)	K (TR)
PPC-36A	6/7/2019	7.87	152	9.4	9.3	NM*	7.9	162	47	118	19	18	4	6	2
PPC-36A	10/17/2019	8.14	302	10.37	6.1	61	8.1	311	83	190	<10	34	8	13	3
PPC-36A (Dup)	10/17/2019	8.13	302	10.38	6.1	61	8.1	310	84	189	<10	35	8	13	3
PPC-3A	6/7/2019	7.95	156	9.45	9.2	237	7.8	163	47	116	18	18	4	6	2
PPC-3A	10/17/2019	8.29	295	10.30	6.8	64	8.1	304	82	201	<10	34	8	13	3
PPC-4A	6/7/2019	7.87	155	9.42	9.4	239	7.9	164	48	116	16	18	4	6	2
PPC-4A (Dup)	6/7/2019	7.87	157	9.42	9.4	239	7.8	164	47	116	17	18	4	6	2
PPC-4A	10/17/2019	8.36	293	10.37	6.7	64	8.1	306	82	199	<10	34	8	13	3
PPC-5A	6/7/2019	7.86	155	9.21	9.3	241	7.8	164	48	118	19	19	4	6	2
PPC-5A	10/17/2019	8.11	304	10.41	6.7	63	8.1	308	83	186	<10	34	8	12	3
PPC-7	6/7/2019	7.86	155	9.34	9.3	NM*	7.9	162	47	117	19	20	4	6	2
PPC-7	10/17/2019	8.22	300	10.40	6.2	64	8.1	309	83	192	<10	35	8	13	3
SG-16	6/7/2019	7.94	154	9.36	9.6	212	7.9	162	47	119	18	18	4	6	2
SG-16	10/17/2019	8.18	305	10.33	6.3	56	8.1	315	83	191	<10	35	8	13	3
Trib-1B	6/7/2019	6.88	535	0.90	13.4	0.045 E	7	549	190	351	<10	62	14	27	5
Trib-1B	10/17/2019	7.87	487	1.35	5.6	0.011 E	7.1	535	170	344	39	62	15	27	4
Trib-1D	6/7/2019	9.13	509	9.83	14.6	0.056 E	9.1	527	86	372	<10	52	19	26	3
Trib-1D	10/17/2019	8.84	650	11.00	9.2	0.056 E	7.8	672	150	461	<10	86	18	25	5

NOTES: All concentrations in mg/L except as indicated

NM* = not measured due to unsafe conditions; flow measured at PPC-8 (between PPC-36A and PPC-7) on 6/7/2019 was 237 cfs.

(TR) = total recoverable

J = QC criterion exceeded (estimated value)

E = Estimated

Station ID	Sample Date	HCO3	Cl	SO4	Sb (TR)	As (TR)	Cd (TR)	Cu (TR)	Fe (TR)	Pb (TR)	Mn (TR	Hg (TR)	Se (TR)	Tl (TR)	Zn (TR)
PPC-36A	6/7/2019	56	3	24	<0.0005	0.005	0.00031	0.006	0.82	0.0096	0.07	0.000016	<0.001	<0.0002	0.080
PPC-36A	10/17/2019	100	6	51	<0.0005	0.003	0.00024	0.002	0.24	0.0024	0.05	<0.000005	<0.001	<0.0002	0.092
PPC-36A (Dup)	10/17/2019	100	6	51	<0.0005	0.003	0.00026	0.002	0.26	0.0022	0.05	<0.000005	<0.001	<0.0002	0.095
PPC-3A	6/7/2019	57	3	24	<0.0005	0.005	0.00032	0.005	0.62	0.0082	0.07	0.000012	<0.001	<0.0002	0.078
PPC-3A	10/17/2019	99	7	56	<0.0005	0.003	0.00021	<0.002	0.19	0.0015	0.04	<0.000005	<0.001	<0.0002	0.088
PPC-4A	6/7/2019	57	3	25	<0.0005	0.005	0.00030	0.005	0.76	0.0104	0.07	0.000016	<0.001	<0.0002	0.080
PPC-4A (Dup)	6/7/2019	57	3	23	<0.0005	0.005	0.00035	0.006	0.79	0.0120	0.08	0.000012	<0.001	<0.0002	0.086
PPC-4A	10/17/2019	99	7	56	<0.0005	0.004	0.00023	<0.002	0.20	0.0022	0.04	<0.000005	<0.001	<0.0002	0.088
PPC-5A	6/7/2019	58	3	24	<0.0005	0.005	0.00029	0.006	0.86	0.0088	0.08	0.000014	<0.001	<0.0002	0.089
PPC-5A	10/17/2019	100	7	57	<0.0005	0.004	0.00021	<0.002	0.25	0.0018	0.05	<0.000005	<0.001	<0.0002	0.090
PPC-7	6/7/2019	57	3	24	<0.0005	0.006	0.00033	0.006	0.84	0.0103	0.08	0.000019	<0.001	<0.0002	0.085
PPC-7	10/17/2019	100	7	57	<0.0005	0.004	0.00025	0.002	0.26	0.0031	0.05	<0.000005	<0.001	<0.0002	0.094
SG-16	6/7/2019	56	3	24	<0.0005	0.005	0.00035	0.006	0.93	0.0110	0.08	0.000017	<0.001	<0.0002	0.083
SG-16	10/17/2019	100	6	52	<0.0005	0.004	0.00028	0.002	0.29	0.0028	0.05	<0.000005	<0.001	<0.0002	0.094
Trib-1B	6/7/2019	230	10	76	0.0017	0.010	0.03100	0.026	0.48	0.0202	1.34	0.000138	<0.001	0.0006	1.43
Trib-1B	10/17/2019	200	11	91	0.0030	0.005	0.01280	0.015	0.32	0.0157	0.07	0.000079	<0.001	0.0003	0.739
Trib-1D	6/7/2019	85	8	167	0.0010	0.011	0.00026	0.003	0.84	0.0019	0.35	0.00001	<0.001	<0.0002	0.019
Trib-1D	10/17/2019	180	11	184	0.0008	0.005	0.00014	<0.002	0.60	0.0020	1.69	<0.000005	<0.001	<0.0002	0.023

NOTES: All concentrations in mg/L except as indicated

NM = not measured

(TR) = total recoverable

J = QC criterion exceeded (estimated value)

E = Estimated

APPENDIX B

2019 GROUNDWATER ELEVATION DATA

2019 PROJECT-WIDE MONTHLY GROUNDWATER LEVEL MEASUREMENTS
EAST HELENA PROJECT

		Depth to Water		Groundwater Elevation	
SiteID	**MP Elevation**	**Jun-19**	**Sep-19**	**Jun-19**	**Sep-19**
EH-100	3889.83	30.62	28.94	3859.21	3860.89
EH-101	3879.95	15.08	15.17	3864.87	3864.78
EH-102	3880.45	8.04	8.45	3872.41	3872.00
EH-103	3890.54	27.65	26.05	3862.89	3864.49
EH-104	3887.83	38.30	36.16	3849.53	3851.67
EH-106	3882.07	31.42	30.30	3850.65	3851.77
EH-107	3880.15	23.74	23.06	3856.41	3857.09
EH-109	3885.67	27.72	26.13	3857.95	3859.54
EH-110	3884.05	23.01	21.44	3861.04	3862.61
EH-111	3876.50	32.74	30.39	3843.76	3846.11
EH-112	3875.78	30.67	28.12	3845.11	3847.66
EH-113	3871.34	29.81	27.54	3841.53	3843.80
EH-114	3878.07	36.03	33.90	3842.04	3844.17
EH-115	3883.29	38.43	36.24	3844.86	3847.05
EH-116	3874.52	33.44	31.49	3841.08	3843.03
EH-117	3871.33	30.76	28.81	3840.57	3842.52
EH-118	3879.95	39.68	37.60	3840.27	3842.35
EH-119	3873.75	36.40	34.54	3837.35	3839.21
EH-120	3865.78	30.57	30.87	3835.21	3834.91
EH-121	3869.49	26.56	29.82	3842.93	3839.67
EH-122	3868.08	22.08	26.28	3846.00	3841.80
EH-123	3885.71	45.83	44.18	3839.88	3841.53
EH-124	3874.46	39.71	38.03	3834.75	3836.43
EH-125	3863.22	34.38	35.17	3828.84	3828.05
EH-126	3870.00	56.65	53.74	3813.35	3816.26
EH-127	3860.75	25.81	30.82	3834.94	3829.93
EH-128	3892.17	DRY	DRY	DRY	DRY
EH-129	3870.21	58.11	54.36	3812.10	3815.85
EH-130	3858.55	45.08	44.37	3813.47	3814.18
EH-131	3834.44	33.57	32.35	3800.87	3802.09
EH-132	3893.90	61.84	60.37	3832.06	3833.53
EH-133	3884.36	58.51	56.85	3825.85	3827.51
EH-134	3870.21	58.14	54.29	3812.07	3815.92
EH-135	3852.25	25.89	29.22	3826.36	3823.03
EH-136	3838.59	28.27	29.99	3810.32	3808.60
EH-137	3839.66	37.21	36.23	3802.45	3803.43
EH-138	3839.70	47.25	42.78	3792.45	3796.92
EH-139	3839.78	54.40	47.67	3785.38	3792.11
EH-140	3812.08	25.14	21.24	3786.94	3790.84
EH-141	3813.32	33.54	28.61	3779.78	3784.71
EH-142	3804.68	33.76	28.96	3770.92	3775.72
EH-143	3803.37	34.68	29.70	3768.69	3773.67
EH-144D	3778.86	23.88	18.65	3754.98	3760.21
EH-144M	3778.95	26.85	21.22	3752.10	3757.73
EH-144S	3778.70	28.36	22.80	3750.34	3755.90
EH-145D	3789.60	31.75	25.74	3757.85	3763.86
EH-145S	3790.09	32.81	26.72	3757.28	3763.37
EH-206	3898.10	49.51	48.74	3848.59	3849.36

2019 PROJECT-WIDE MONTHLY GROUNDWATER LEVEL MEASUREMENTS
EAST HELENA PROJECT

		Depth to Water		Groundwater Elevation	
SiteID	**MP Elevation**	**Jun-19**	**Sep-19**	**Jun-19**	**Sep-19**
EH-208	3910.58	55.18	54.83	3855.40	3855.75
EH-209	3898.34	40.54	32.93	3857.80	3865.41
EH-50	3889.39	30.11	28.41	3859.28	3860.98
EH-51	3880.09	14.78	14.80	3865.31	3865.29
EH-52	3880.50	6.85	7.30	3873.65	3873.20
EH-53	3872.82	30.20	28.13	3842.62	3844.69
EH-54	3869.66	6.93	7.98	3862.73	3861.68
EH-57	3885.05	DRY	DRY	DRY	DRY
EH-57A	3885.45	41.72	39.54	3843.73	3845.91
EH-58	3888.15	12.73	12.73	3875.42	3875.42
EH-59	3876.57	7.36	7.35	3869.21	3869.22
EH-60	3888.46	25.38	23.70	3863.08	3864.76
EH-61	3889.77	27.11	25.45	3862.66	3864.32
EH-62	3875.07	24.78	26.26	3850.29	3848.81
EH-63	3878.32	20.22	20.66	3858.10	3857.66
EH-64	3882.67	26.42	26.80	3856.25	3855.87
EH-65	3879.96	26.50	26.06	3853.46	3853.90
EH-66	3869.48	26.12	29.45	3843.36	3840.03
EH-67	3869.46	22.54	27.03	3846.92	3842.43
EH-68	3867.60	8.39	10.00	3859.21	3857.60
EH-69	3869.10	20.03	18.56	3849.07	3850.54
EH-70	3863.48	33.62	34.54	3829.86	3828.94
EHMW-3	3825.45	42.38	37.99	3783.07	3787.46
EHTW-3	3827.66	45.08	40.36	3782.58	3787.30
PZ-36A	3858.96	6.49	15.19	3852.47	3843.77
PZ-36B	3858.75	6.52	DRY	3852.23	DRY
PZ-36C	3859.60	7.90	DRY	3851.70	DRY
PZ-9A	3850.70	5.71	DRY	3844.99	DRY
PZ-9B	3849.43	6.92	13.99	3842.51	3835.44
SC-1	3890.42	33.24	32.13	3857.18	3858.29
ASIW-1	3915.99	18.35	18.61	3897.64	3897.38
ASIW-2	3909.13	32.10	31.54	3877.03	3877.59
DH-1	3910.89	43.23	43.00	3867.66	3867.89
DH-10A	3886.97	6.30	8.16	3880.67	3878.81
DH-13	3923.91	51.37	50.22	3872.54	3873.69
DH-14	3916.06	13.17	13.76	3902.89	3902.30
DH-15	3889.82	17.92	17.02	3871.90	3872.80
DH-17	3917.56	48.85	47.25	3868.71	3870.31
DH-18	3924.93	49.49	49.18	3875.44	3875.75
DH-2	3936.91	60.51	60.76	3876.40	3876.15
DH-20	3927.09	17.78	18.07	3909.31	3909.02
DH-22	3948.63	DRY	DRY	DRY	DRY
DH-23	3931.82	35.37	35.42	3896.45	3896.40
DH-24	3899.59	36.63	34.77	3862.96	3864.82
DH-27	3946.21	54.90	55.11	3891.31	3891.10
DH-3	3947.48	30.78	30.98	3916.70	3916.50
DH-30	3943.24	51.21	51.42	3892.03	3891.82
DH-36	3920.66	45.89	45.94	3874.77	3874.72

2019 PROJECT-WIDE MONTHLY GROUNDWATER LEVEL MEASUREMENTS
EAST HELENA PROJECT

		Depth to Water		Groundwater Elevation	
SiteID	**MP Elevation**	**Jun-19**	**Sep-19**	**Jun-19**	**Sep-19**
DH-4	3917.26	14.18	14.70	3903.08	3902.56
DH-42	3942.63	48.76	49.04	3893.87	3893.59
DH-47	3926.82	20.20	21.23	3906.62	3905.59
DH-48	3905.96	36.76	DRY	3869.20	DRY
DH-5	3921.18	17.56	17.74	3903.62	3903.44
DH-50	3904.76	36.33	36.06	3868.43	3868.70
DH-51	3904.34	36.30	35.28	3868.04	3869.06
DH-52	3889.18	5.17	6.81	3884.01	3882.37
DH-53	3892.87	7.83	9.57	3885.04	3883.30
DH-54	3890.27	26.13	24.51	3864.14	3865.76
DH-55	3972.76	79.98	80.36	3892.78	3892.40
DH-56	3958.17	82.85	81.81	3875.32	3876.36
DH-57	3929.53	43.52	42.95	3886.01	3886.58
DH-58	3919.33	43.52	42.22	3875.81	3877.11
DH-59	3937.44	43.69	45.32	3893.75	3892.12
DH-5A	3921.92	18.20	18.36	3903.72	3903.56
DH-6	3889.85	17.98	17.03	3871.87	3872.82
DH-61	3926.84	DRY	DRY	DRY	DRY
DH-62	3926.95	56.08	56.15	3870.87	3870.80
DH-63	3905.37	40.50	38.73	3864.87	3866.64
DH-64	3904.02	37.45	35.75	3866.57	3868.27
DH-65	3945.85	61.44	62.83	3884.41	3883.02
DH-66	3919.28	51.84	50.19	3867.44	3869.09
DH-67	3899.77	35.70	34.00	3864.07	3865.77
DH-68	3943.28	44.07	44.35	3899.21	3898.93
DH-69	3934.40	35.49	35.68	3898.60	3898.81
DH-7	3898.66	14.91	15.47	3883.75	3883.19
DH-70	3933.91	33.54	33.69	3900.37	3900.22
DH-71	3944.88	56.45	DRY	3888.43	DRY
DH-72	3939.67	43.42	43.49	3896.25	3896.18
DH-73	3918.08	39.14	38.04	3878.94	3880.04
DH-74	4001.49	122.64	123.06	3878.85	3883.38
DH-75	4001.55	123.10	123.53	3878.45	3883.01
DH-76	3994.28	98.53	98.79	3895.75	3895.49
DH-77	3932.20	53.74	53.68	3878.46	3878.52
DH-78	3921.12	52.67	51.38	3868.45	3869.74
DH-79	3928.80	54.53	53.44	3874.27	3875.36
DH-80	3942.36	49.10	49.36	3893.26	3893.00
DH-82	3908.18	42.79	40.95	3865.39	3867.23
DH-83	3922.14	52.21	51.47	3869.93	3870.67
DH-8	3923.38	51.80	51.28	3871.58	3872.10
DH-9	3918.08	33.68	DRY	3884.40	DRY
East-PZ-1	3911.93	22.70	22.90	3889.23	3889.03
East-PZ-2	3924.58	23.87	23.76	3900.71	3900.82
East-PZ-4	3935.66	19.62	19.98	3916.04	3915.68
East-PZ-6	3943.83	23.11	23.67	3920.72	3920.16
East-PZ-7	3928.83	17.73	18.25	3911.10	3910.58
EH-200	3953.33	26.92	27.13	3926.41	3926.20

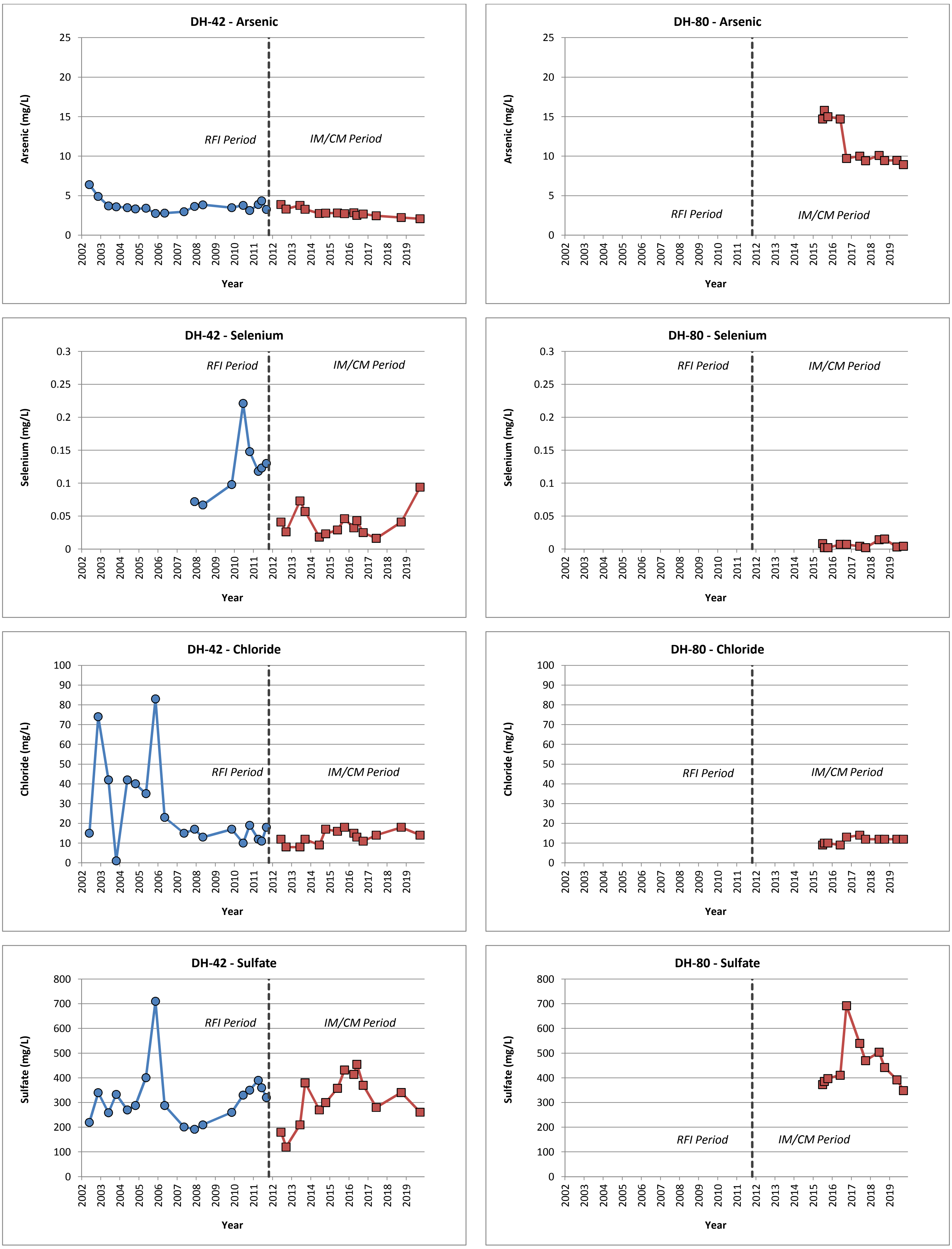
2019 PROJECT-WIDE MONTHLY GROUNDWATER LEVEL MEASUREMENTS
EAST HELENA PROJECT

		Depth to Water		Groundwater Elevation	
SiteID	**MP Elevation**	**Jun-19**	**Sep-19**	**Jun-19**	**Sep-19**
EH-201	3973.48	91.55	90.26	3881.93	3883.22
EH-202	3930.56	65.42	65.41	3865.14	3865.15
EH-203	4003.92	104.39	104.04	3899.53	3899.88
EH-204	3925.69	56.01	56.02	3869.68	3869.67
EH-205	3900.66	35.36	33.96	3865.30	3866.70
EH-210	3901.19	37.39	37.16	3863.80	3864.03
EH-211	3905.75	50.14	49.98	3855.61	3855.77
EH-212	3905.90	50.25	50.51	3855.65	3855.39
MW-1	3953.05	52.57	52.73	3900.48	3900.32
MW-10	3946.28	44.32	44.66	3901.96	3901.62
MW-11	3973.33	63.42	63.46	3909.91	3909.87
MW-2	3945.97	39.48	39.70	3906.49	3906.27
MW-3	3940.95	34.70	35.01	3906.25	3905.94
MW-4	3947.06	48.69	48.91	3898.37	3898.15
MW-5	3956.18	53.75	53.91	3902.43	3902.27
MW-6	3938.14	31.33	31.51	3906.81	3906.63
MW-7	3963.67	56.34	56.29	3907.33	3907.38
MW-8	3958.65	52.50	52.74	3906.15	3905.91
MW-9	3959.01	52.19	52.31	3906.82	3906.70
PBTW-1	3914.59	46.11	44.50	3868.48	3870.09
PBTW-2	3906.73	38.77	37.14	3867.96	3869.59
PRB-1	3918.37	50.29	48.71	3868.08	3869.66
PRB-2	3905.34	36.58	34.97	3868.76	3870.37
PRB-3	3919.19	51.31	49.70	3867.88	3869.49
SDMW-1	3925.11	51.30	50.08	3873.81	3875.03
SDMW-2	3928.09	52.88	53.00	3875.21	3875.09
SDMW-3	3935.14	52.96	52.93	3882.18	3882.21
SDMW-4	3936.10	51.28	50.97	3884.82	3885.13
SDMW-5	3929.86	54.65	54.09	3875.21	3875.77
TW-1	3930.10	51.55	50.87	3878.55	3879.23
TW-2	3931.44	53.26	52.84	3878.18	3878.60
SP-3	3905.91	DRY	DRY	DRY	DRY
SP-4	3908.16	DRY	DRY	DRY	DRY
SP-5	3903.52	DRY	DRY	DRY	DRY
ULM-PZ-1	3924.40	5.36	5.60	3919.04	3918.80
PPCRPZ-02	3919.76	7.09	7.70	3912.67	3912.06
ULTP-1	3919.63	In Pond	No Access	In Pond	No Access
ULTP-2	3921.23	6.45	6.83	3914.78	3914.40
PVC Piezo	?	NM	NM	NM	NM
IW-01	3888.28	66.52	65.46	3821.76	3822.82
IW-02	3871.08	51.96	51.22	3819.12	3819.86

All measurements in feet; elevations relative to mean sea level.

APPENDIX C

SITE-WIDE GROUNDWATER CONCENTRATION TREND GRAPHS



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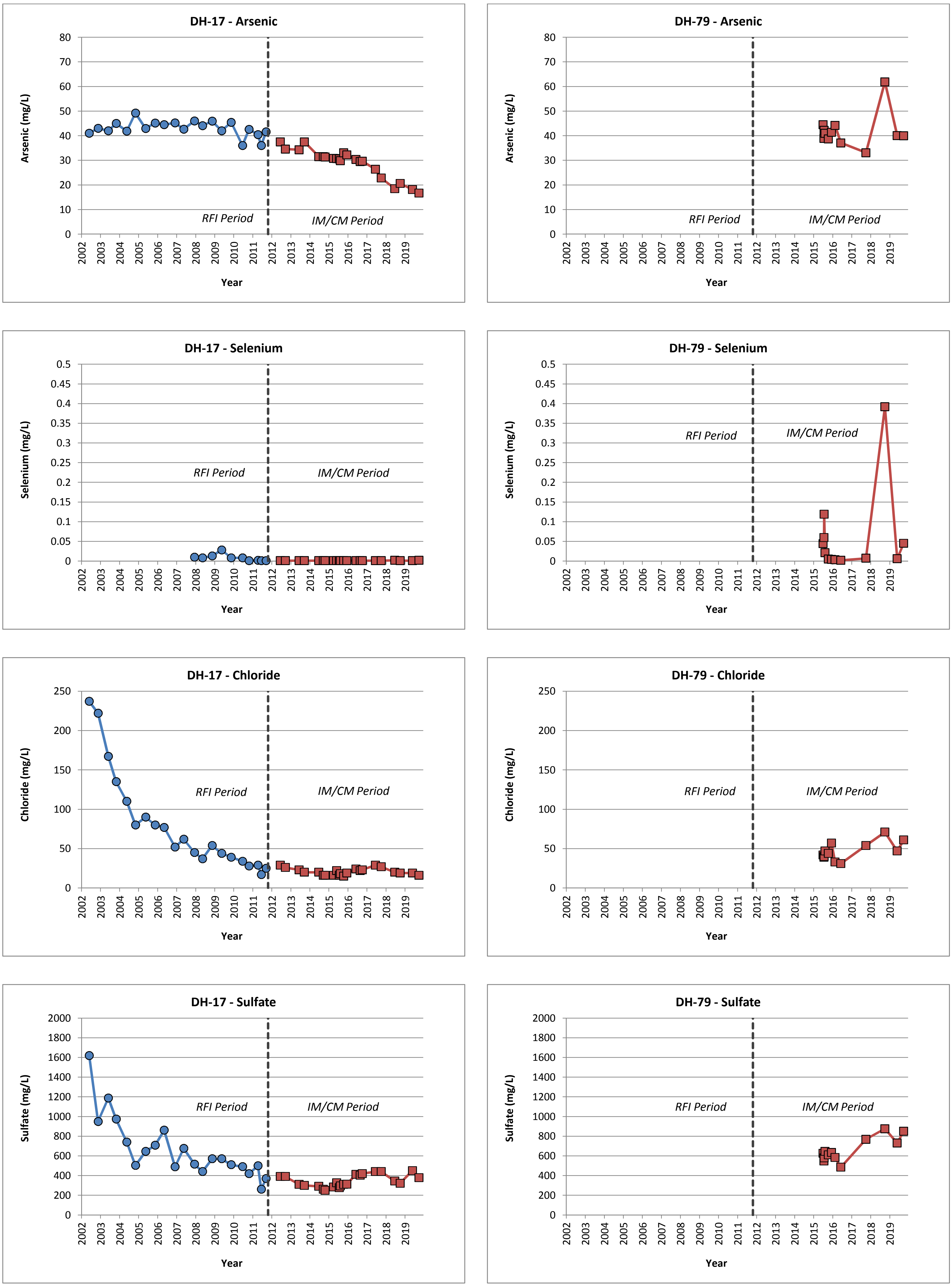
2019 WATER RESOURCES MONITORING REPORT EAST HELENA FACILITY	**FORMER ACID PLANT AREA GROUNDWATER QUALITY TRENDS**	FIGURE **C-1**



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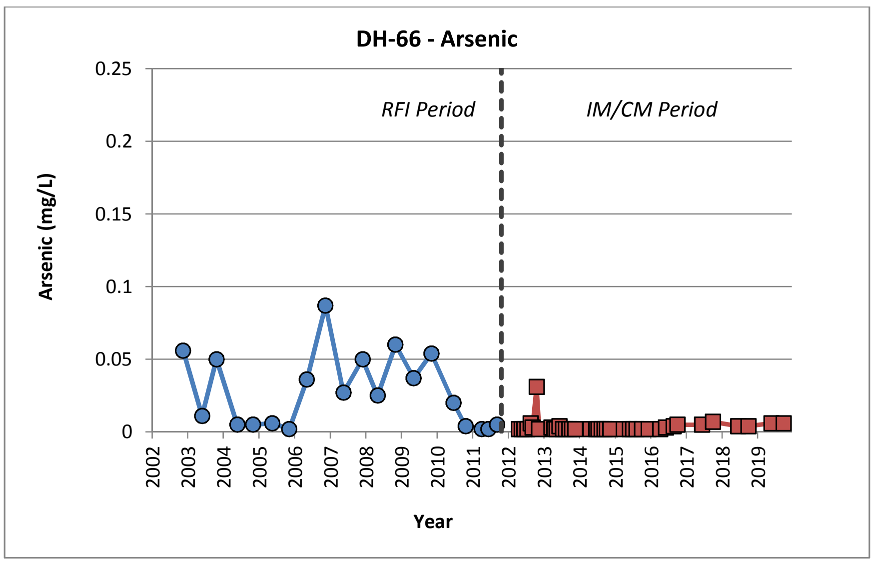
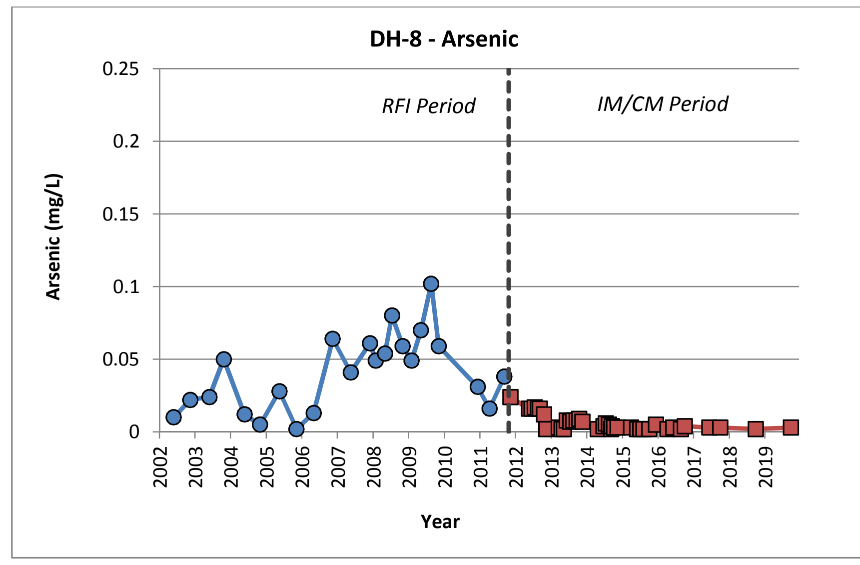
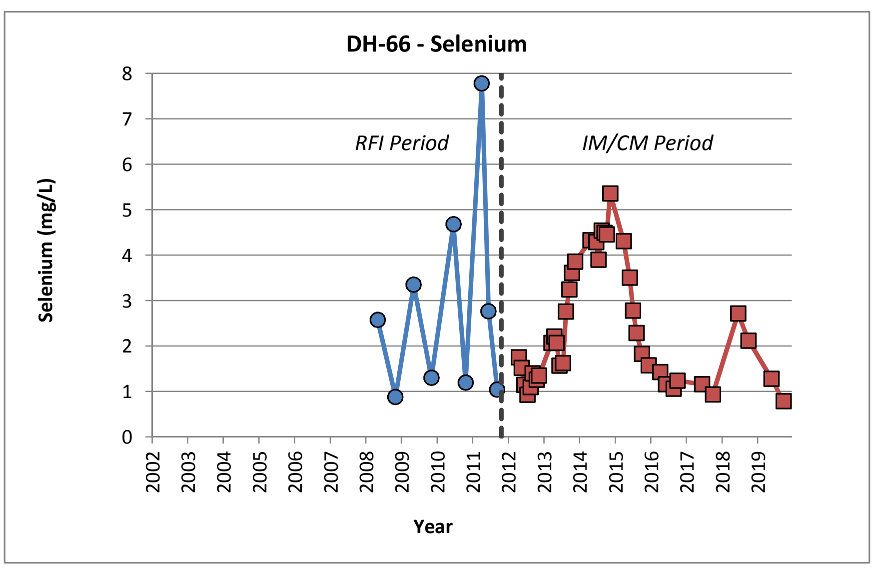
2019 WATER RESOURCES
MONITORING REPORT
EAST HELENA FACILITY

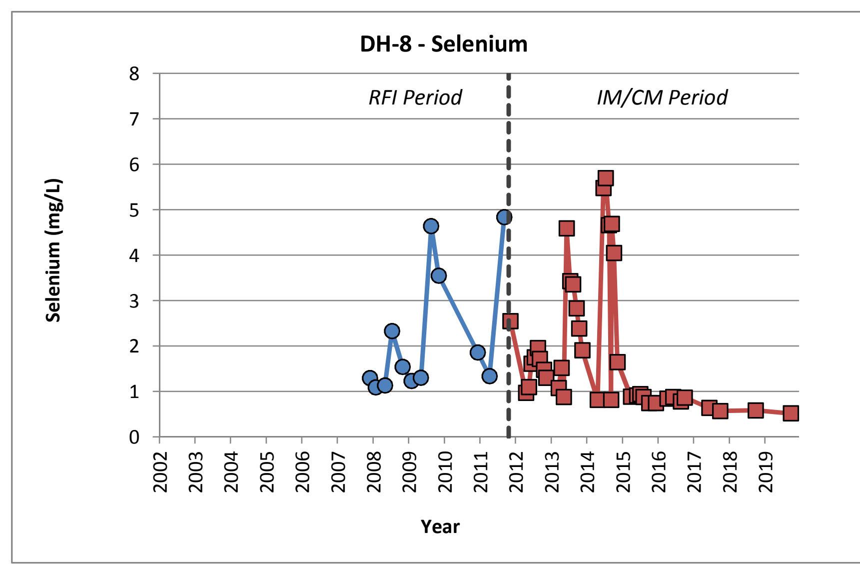
NORTH PLANT ARSENIC AREA
GROUNDWATER QUALITY TRENDS

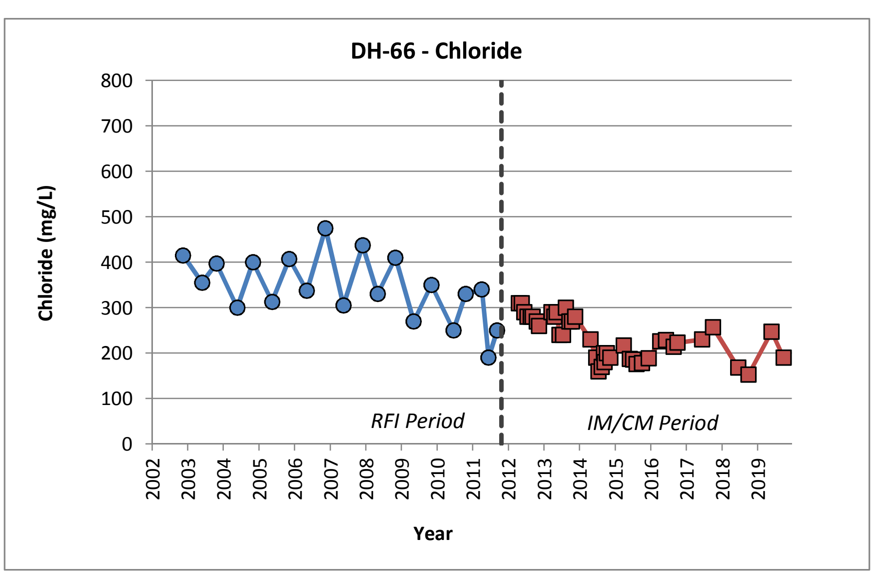
FIGURE
C-2

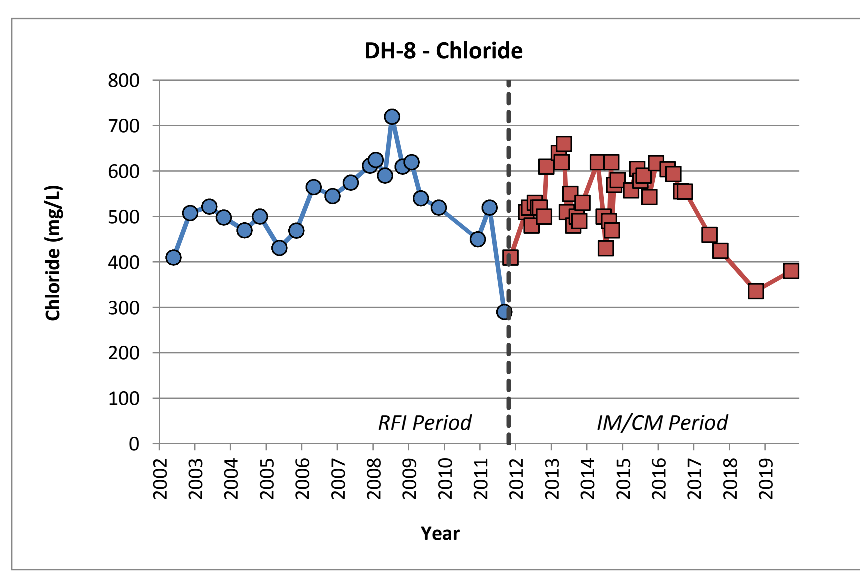


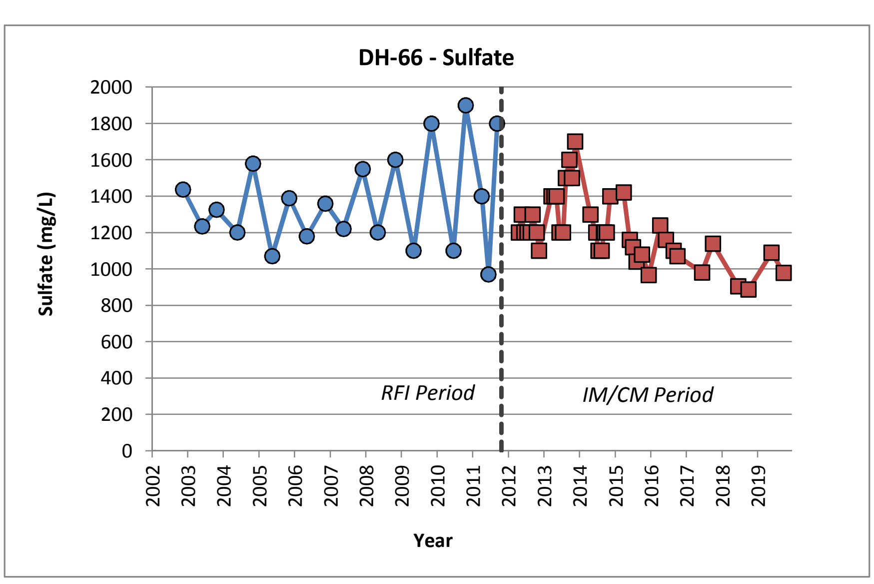


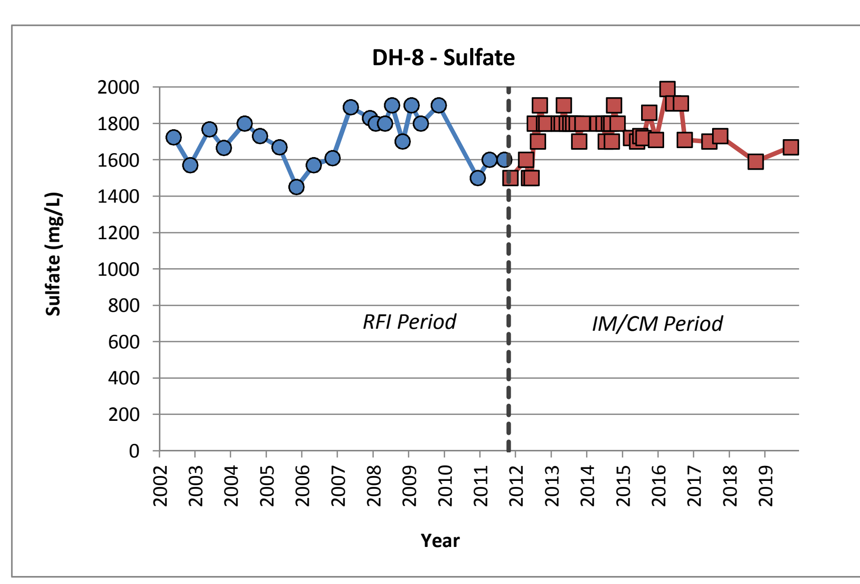












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MONITORING REPORT
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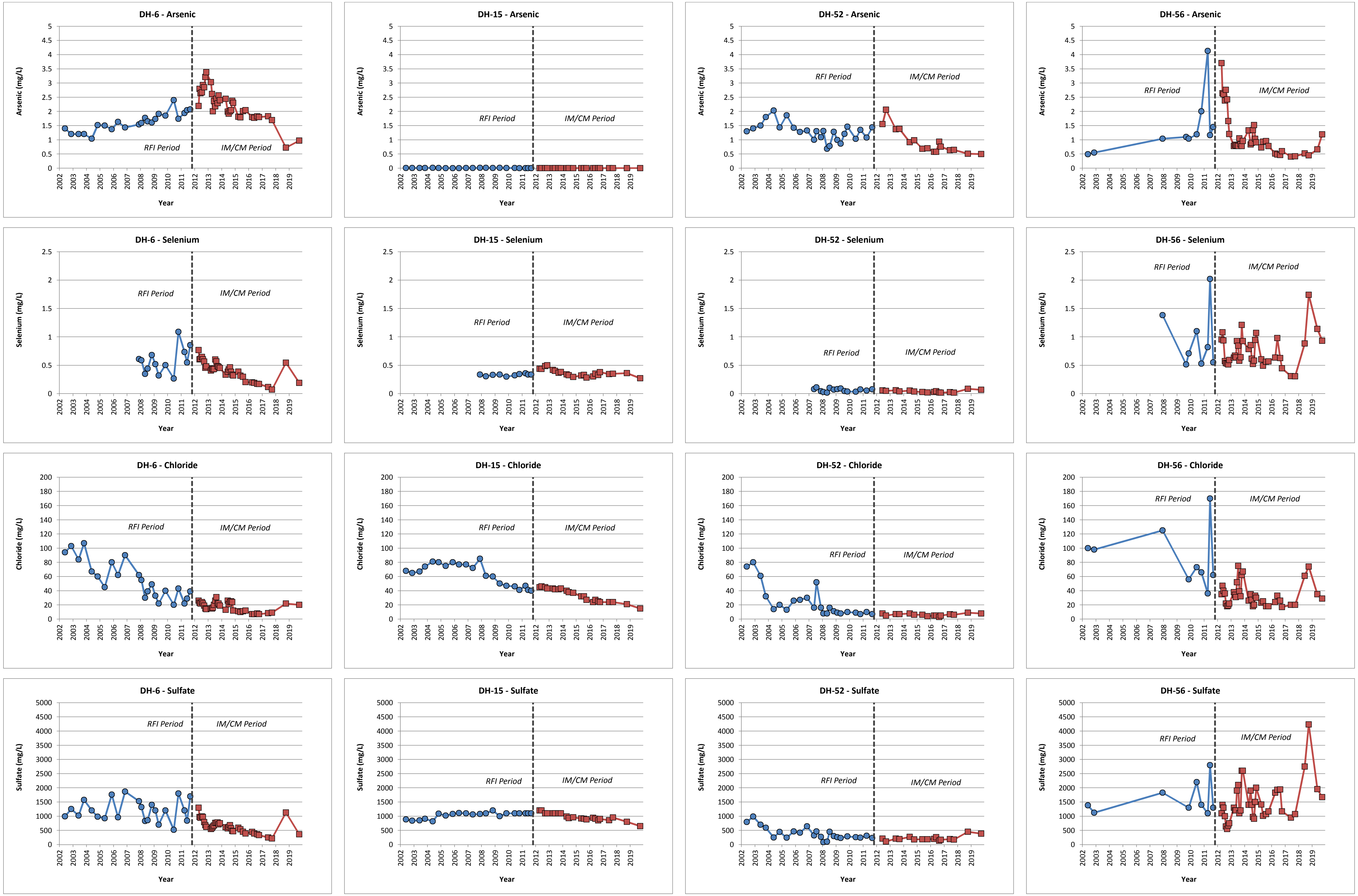
WEST SELENIUM AREA
GROUNDWATER QUALITY TRENDS

FIGURE
C-3



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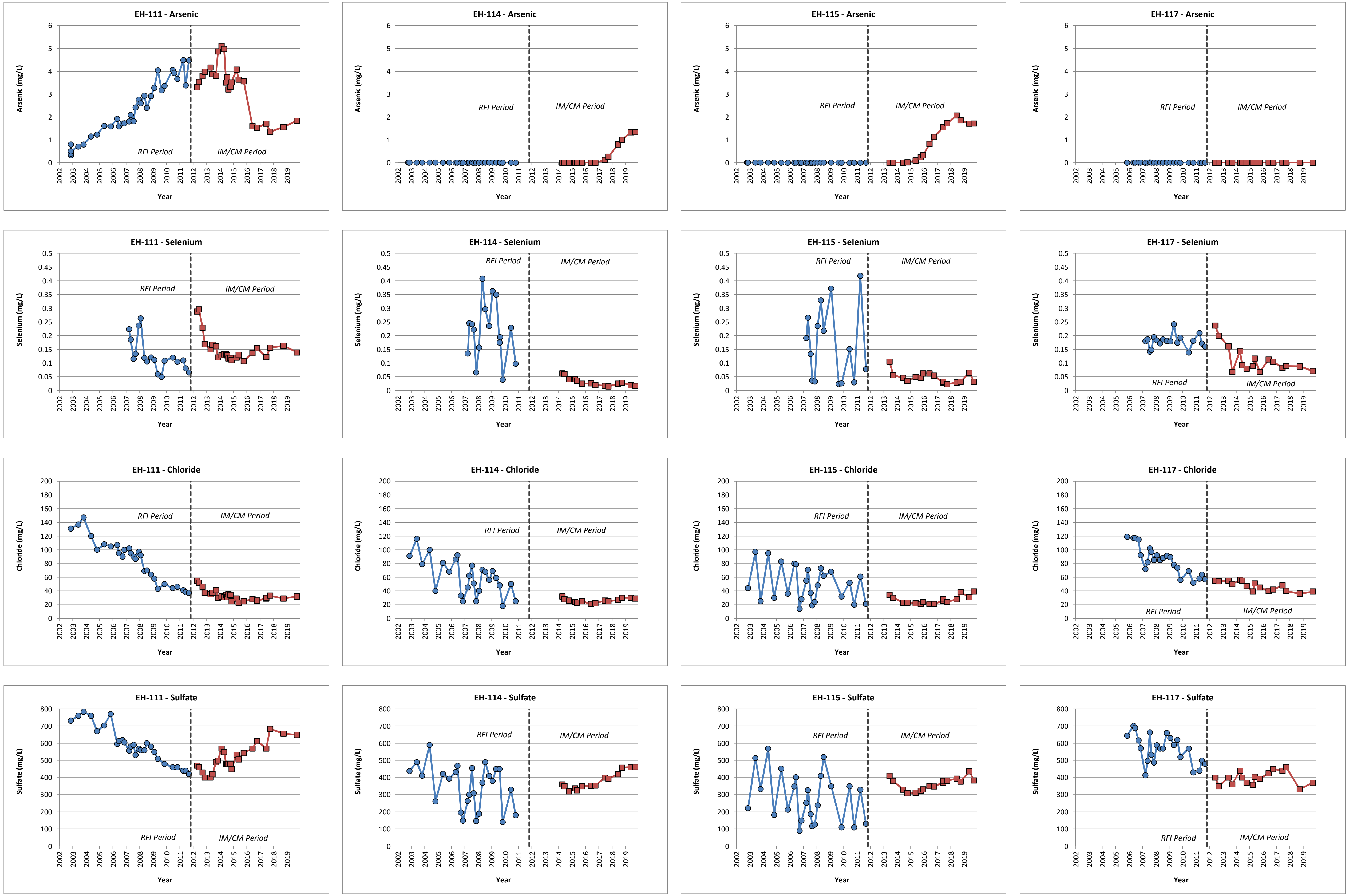
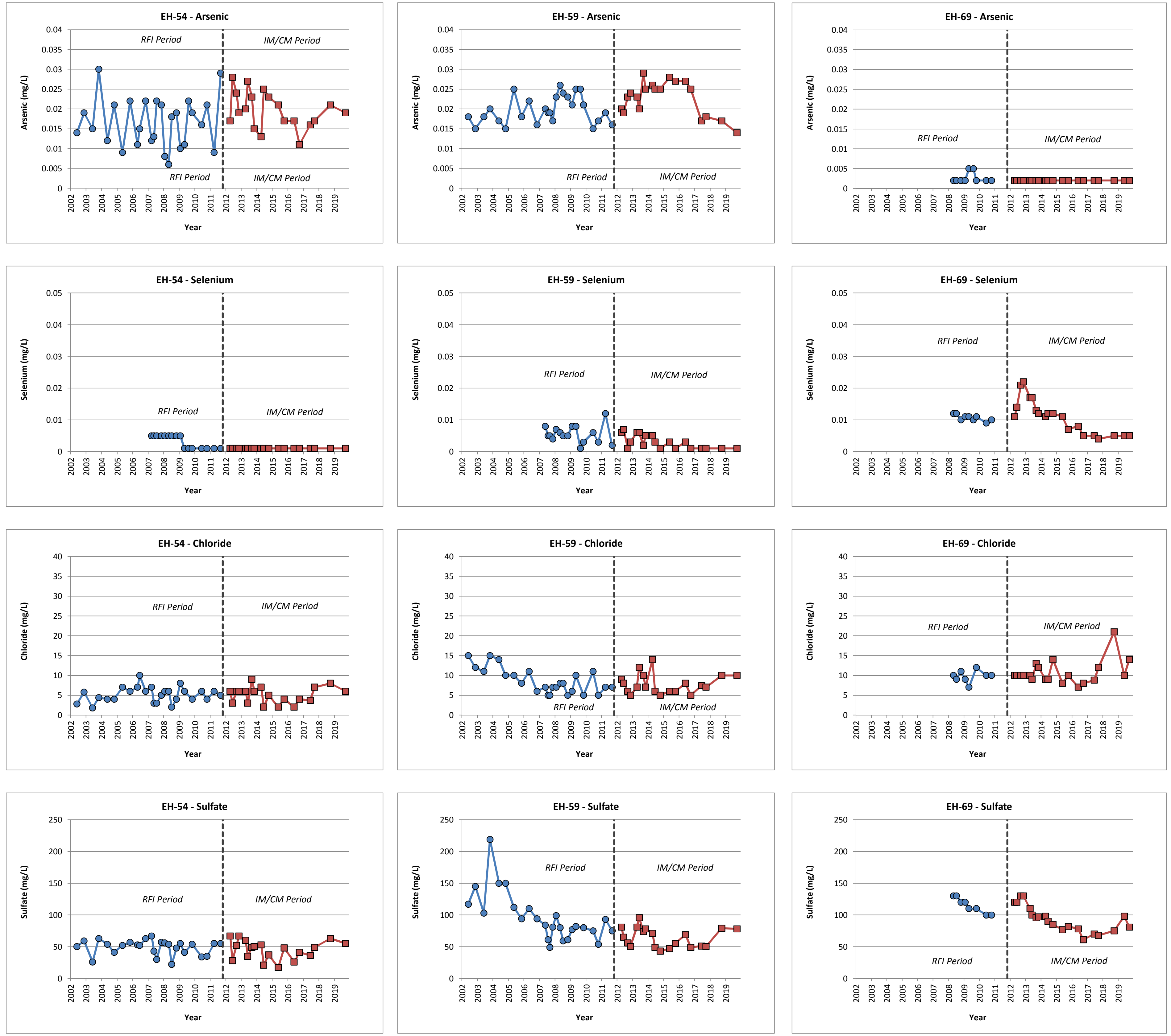
2019 WATER RESOURCES MONITORING REPORT EAST HELENA FACILITY	SLAG PILE AREA GROUNDWATER QUALITY TRENDS	FIGURE C-4

K:\project\10022\2019 WRM Report\Appendices\Appendix C\AsSeClSO4_TrendData_2019Report.xlsx\Slag Pile Graphs 2019



2019 WATER RESOURCES MONITORING REPORT EAST HELENA FACILITY	DOWNGRADIENT ARSENIC PLUME AREA (WEST) GROUNDWATER QUALITY TRENDS	FIGURE C-5

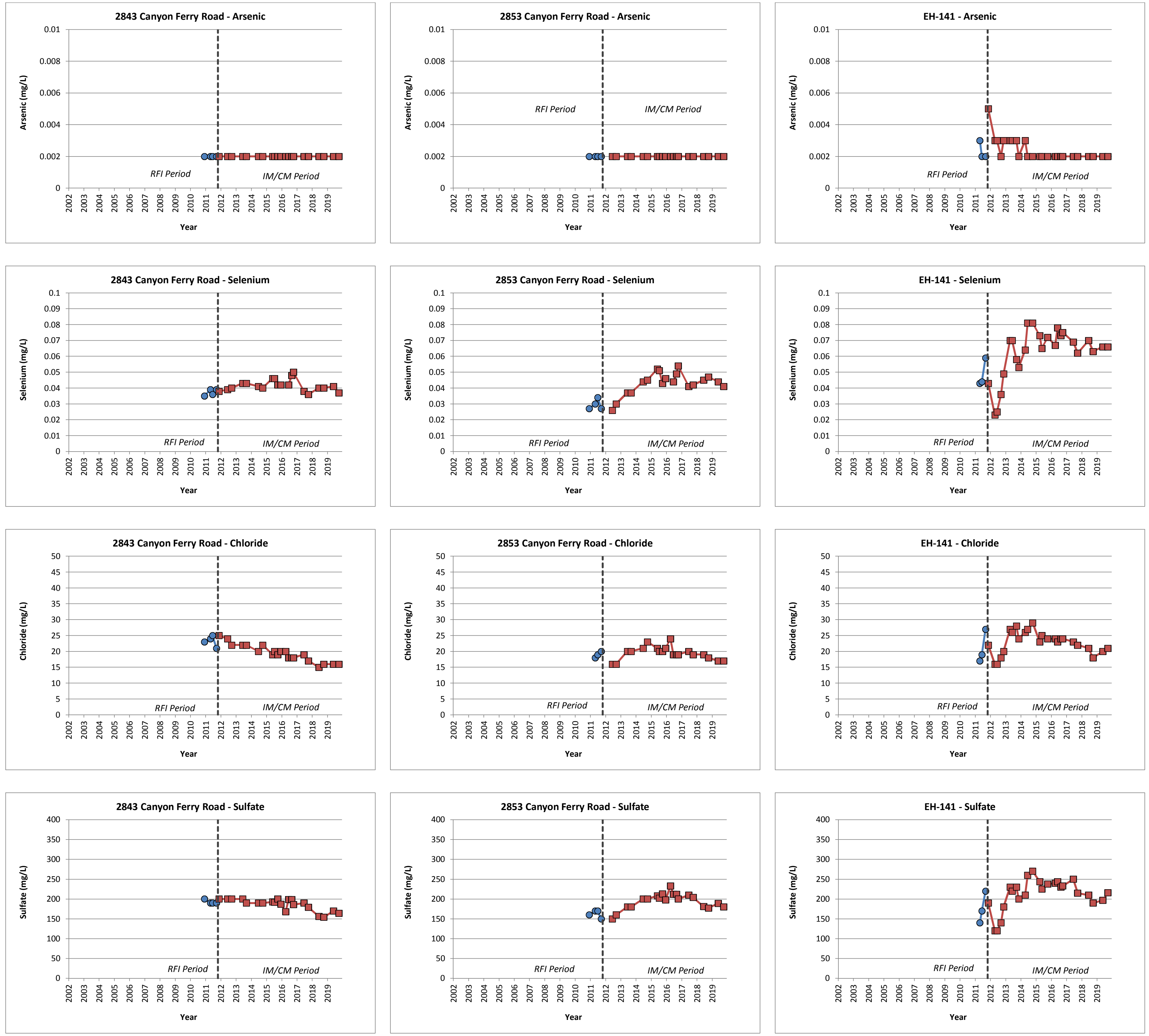


2019 WATER RESOURCES MONITORING REPORT
EAST HELENA FACILITY

DOWNGRADIENT ARSENIC PLUME AREA (EAST) GROUNDWATER QUALITY TRENDS

FIGURE **C-5**

K:\project\10022\2019 WRM Report\Appendices\Appendix C\AsSeClSO4_TrendData_2019Report.xlsx\DG As Graphs 2019

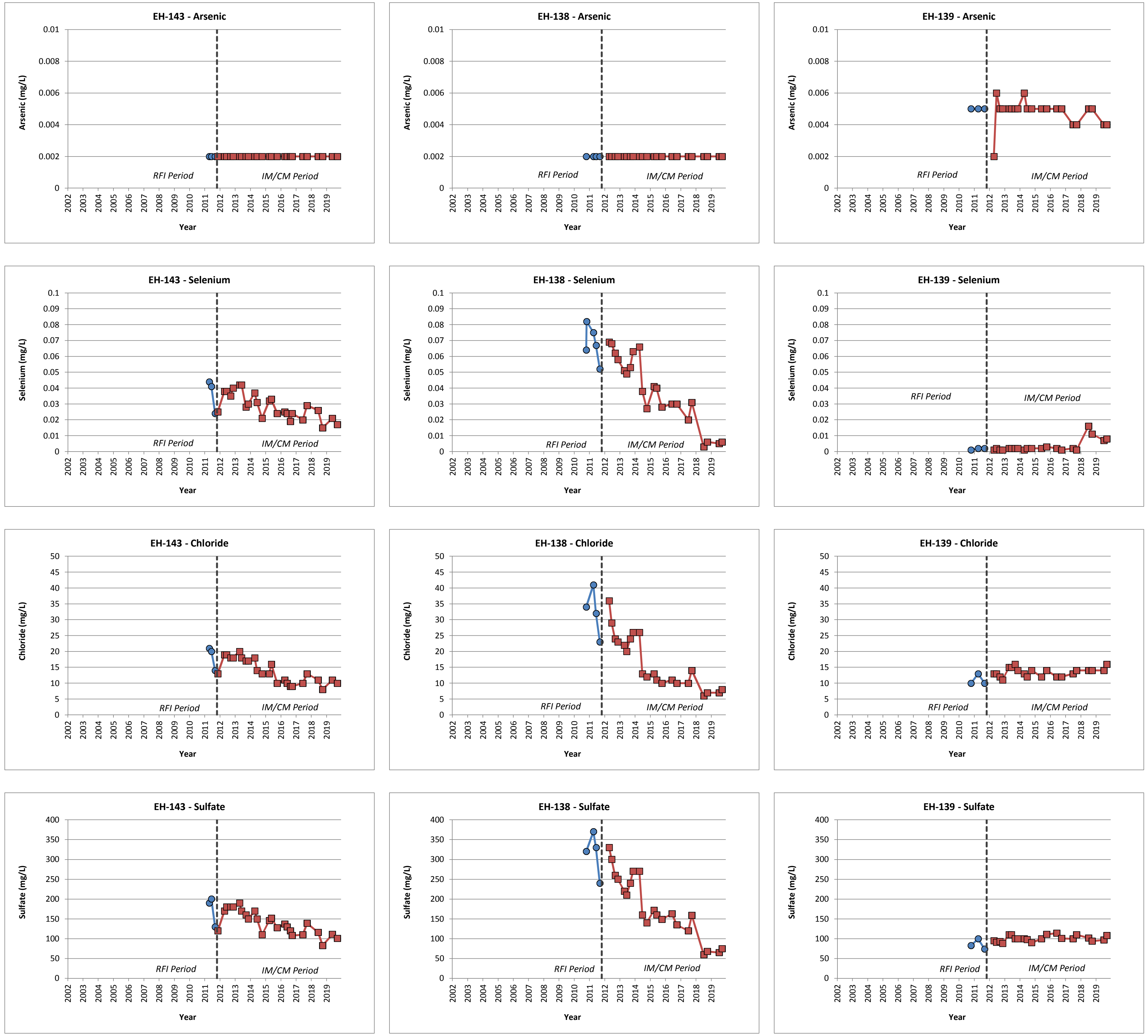


2019 WATER RESOURCES
MONITORING REPORT
EAST HELENA FACILITY

DOWNGRADIENT SELENIUM PLUME AREA
GROUNDWATER QUALITY TRENDS

FIGURE
C-6

K:\project\10022\2019 WRM Report\Appendices\Appendix C\AsSeClSO4_TrendData_2019Report.xlsx\DG Se Graphs 2019



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2019 WATER RESOURCES
MONITORING REPORT
EAST HELENA FACILITY

**DOWNGRADIENT SELENIUM PLUME AREA
GROUNDWATER QUALITY TRENDS**

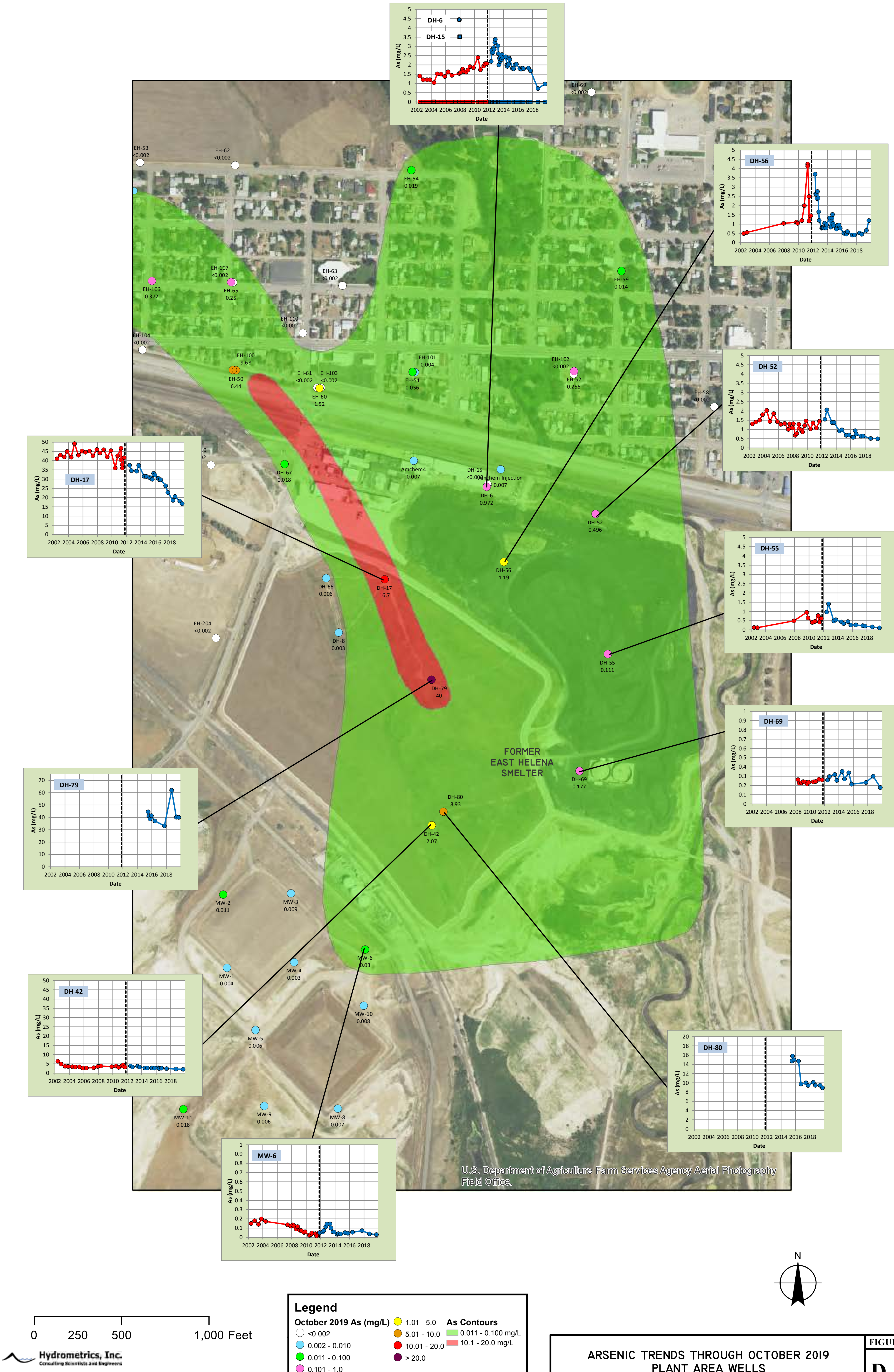
FIGURE

C-6

K:\project\10022\2019 WRM Report\Appendices\Appendix C\AsSeClSO4_TrendData_2019Report.xlsx\DG Se Graphs 2019

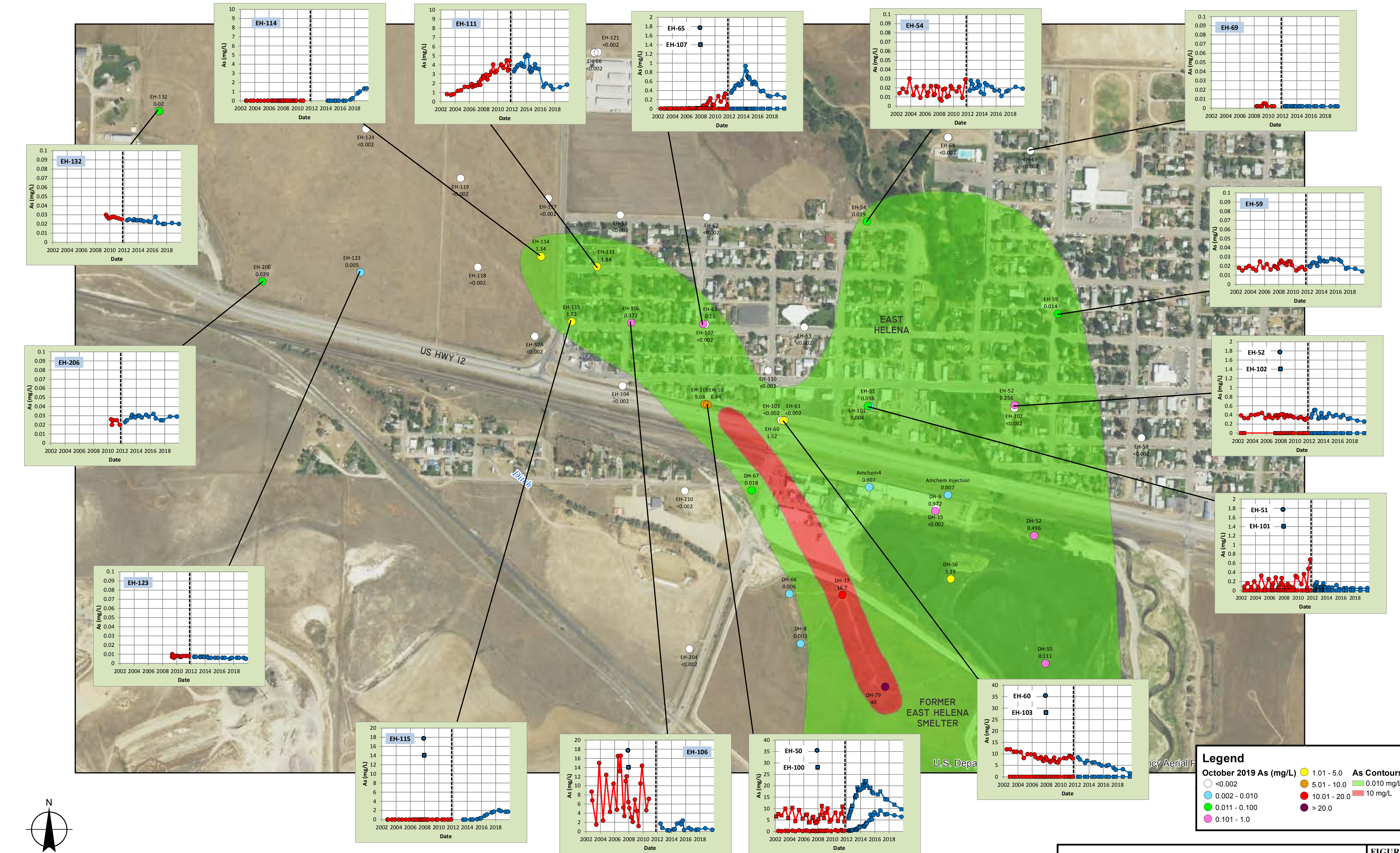
APPENDIX D

ARSENIC AND SELENIUM TREND PLOT MAPS



ARSENIC TRENDS THROUGH OCTOBER 2019
PLANT AREA WELLS

FIGURE
D-1



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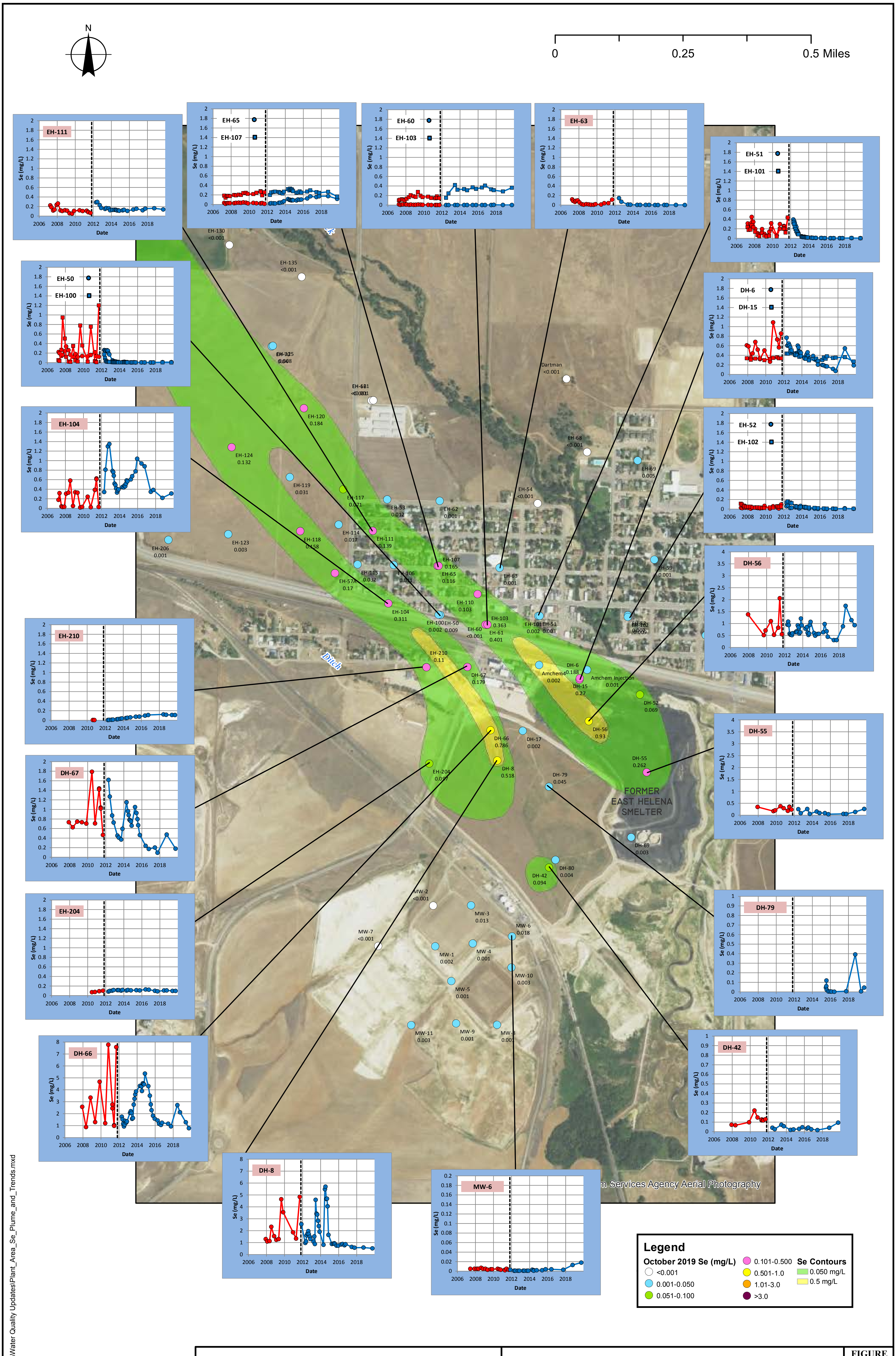
V:\10022\GIS\Water Quality Updates\EH_Area_As_Plume_and_Trends.mxd

ARSENIC TRENDS THROUGH OCTOBER 2019
EAST HELENA AREA WELLS

FIGURE
D-2



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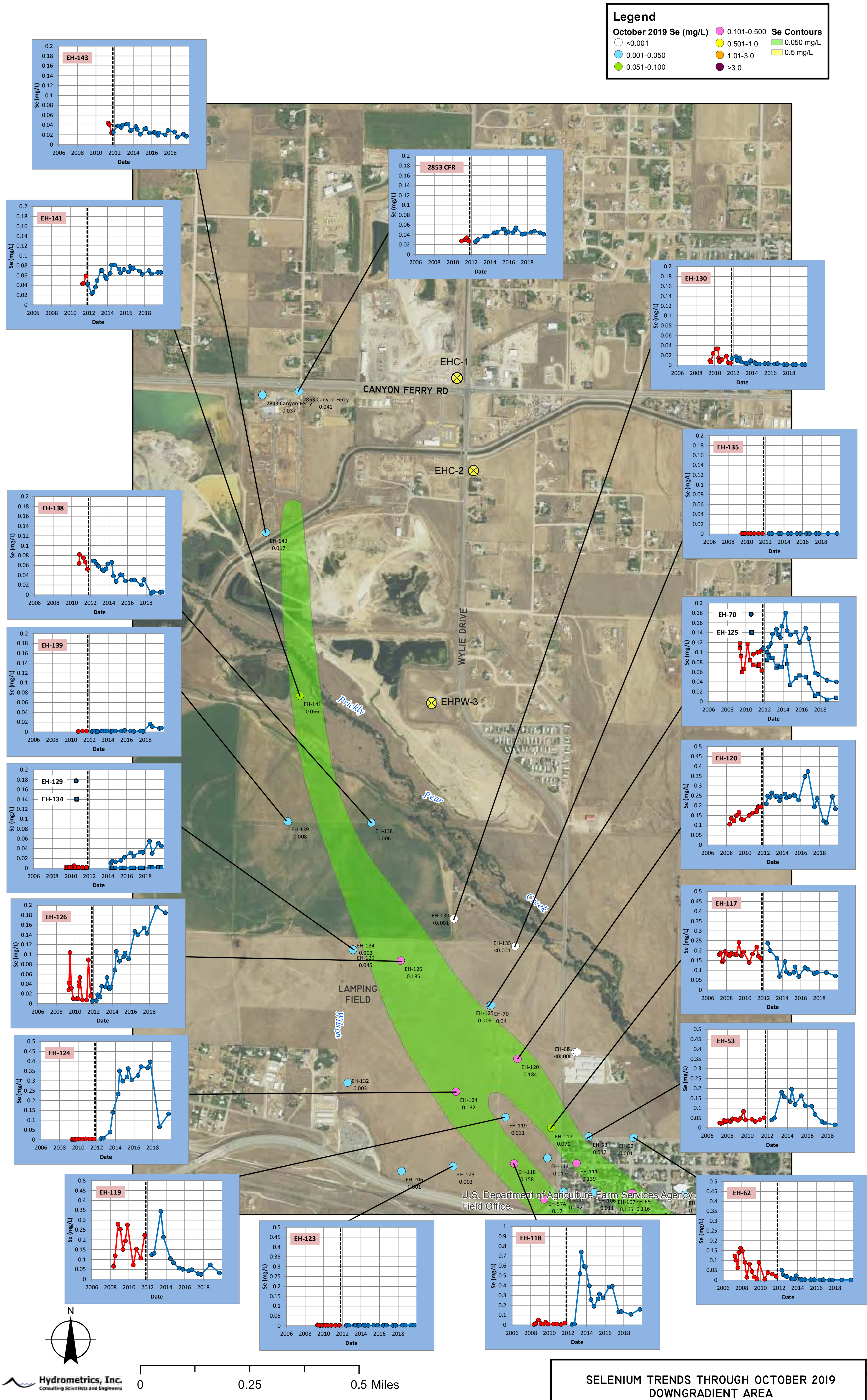
SELENIUM TRENDS THROUGH OCTOBER 2019
FACILITY AREA WELLS

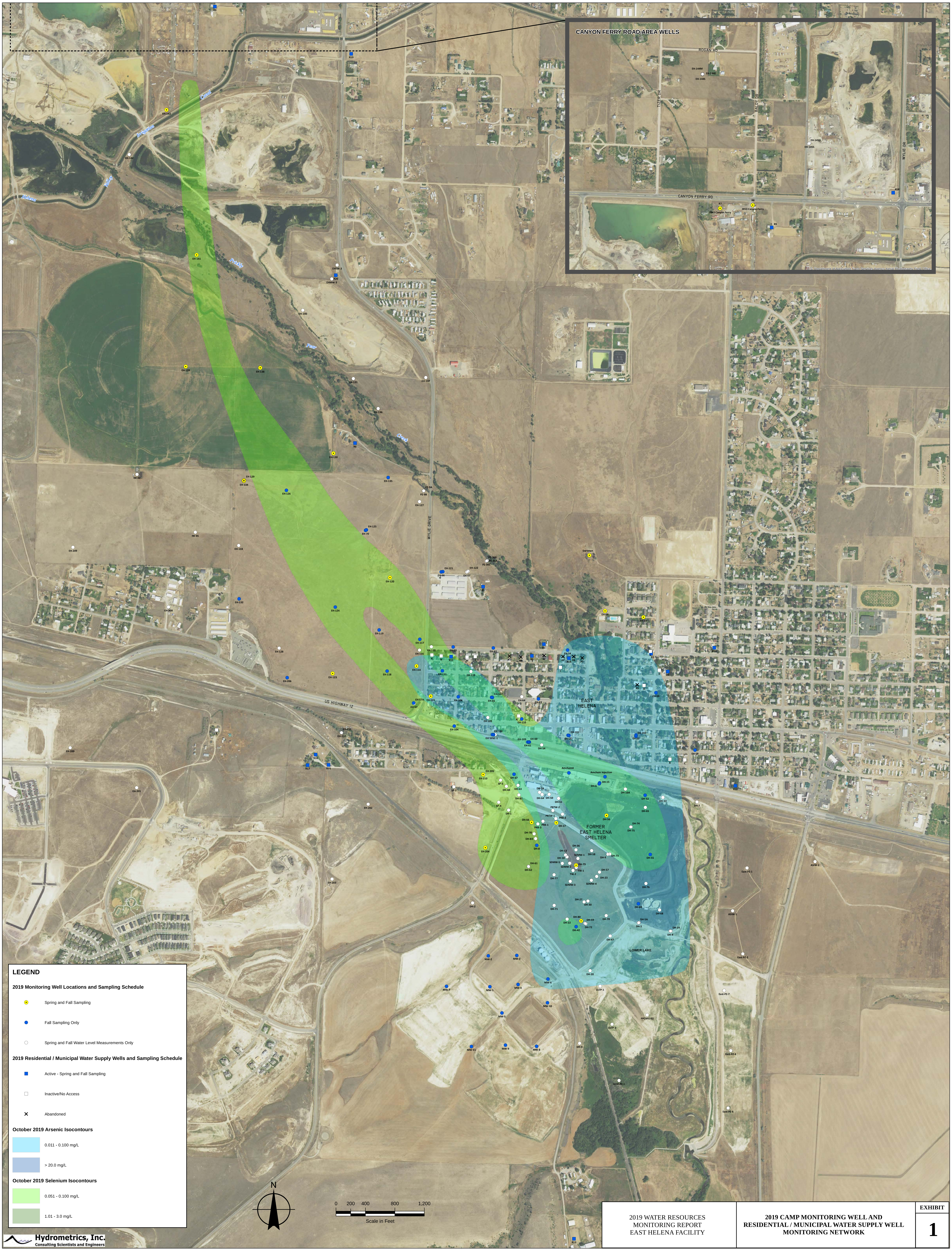
FIGURE
D-3



SELENIUM TRENDS THROUGH OCTOBER 2019
DOWNGRADIENT AREA

FIGURE
D-4

EXHIBITS



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2019 WATER RESOURCES MONITORING REPORT EAST HELENA FACILITY	**2019 CAMP MONITORING WELL AND RESIDENTIAL / MUNICIPAL WATER SUPPLY WELL MONITORING NETWORK**	**EXHIBIT 1**