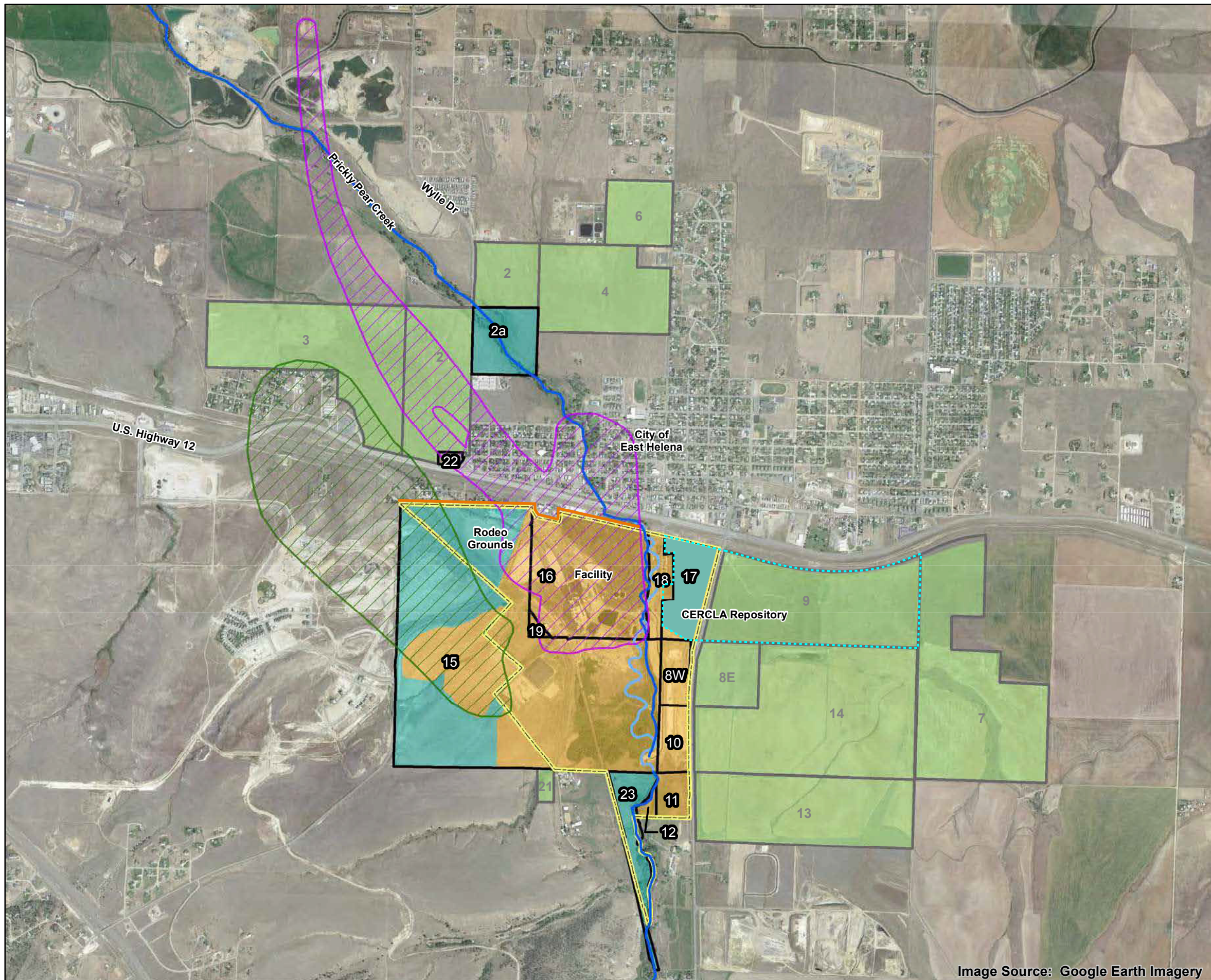


DRAFT

Figures



LEGEND

- Prickly Pear Creek
- Prickly Pear Creek Realignment
- CMS Parcel
- CMS Parcel Undergoing Corrective Action Parcel
- Boundary
- Area of Contamination Boundary Approximate
- Extent of Facility-related Groundwater Contamination (combined As and Se plumes)
- Residential Soil Disposal Area Boundary
- Point of Compliance

Notes

1. CMS = Corrective Measures Study
2. OU2 = Operable Unit 2
3. ROD = Record of Decision
4. CERCLA = Comprehensive Environmental Response, Compensation and Liability Act

LEGEND

- Undeveloped Land¹

Notes

1. ¹Parcel owned by the Custodial Trust that are not part of the CMS, but have a corrective measure set forth in the OU2 ROD

LEGEND

- West Arsenic Area

Notes

1. The west arsenic area occurs primarily from groundwater interaction with naturally-occurring arsenic-bearing soil and is not facility-related.

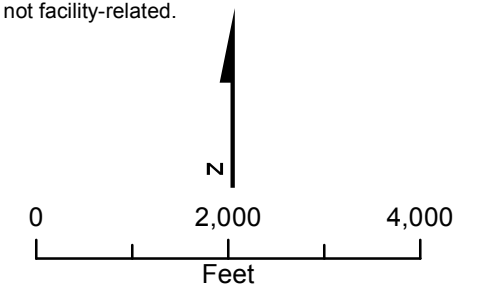


Figure 1-1
Geographic Boundaries of the CMS
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana

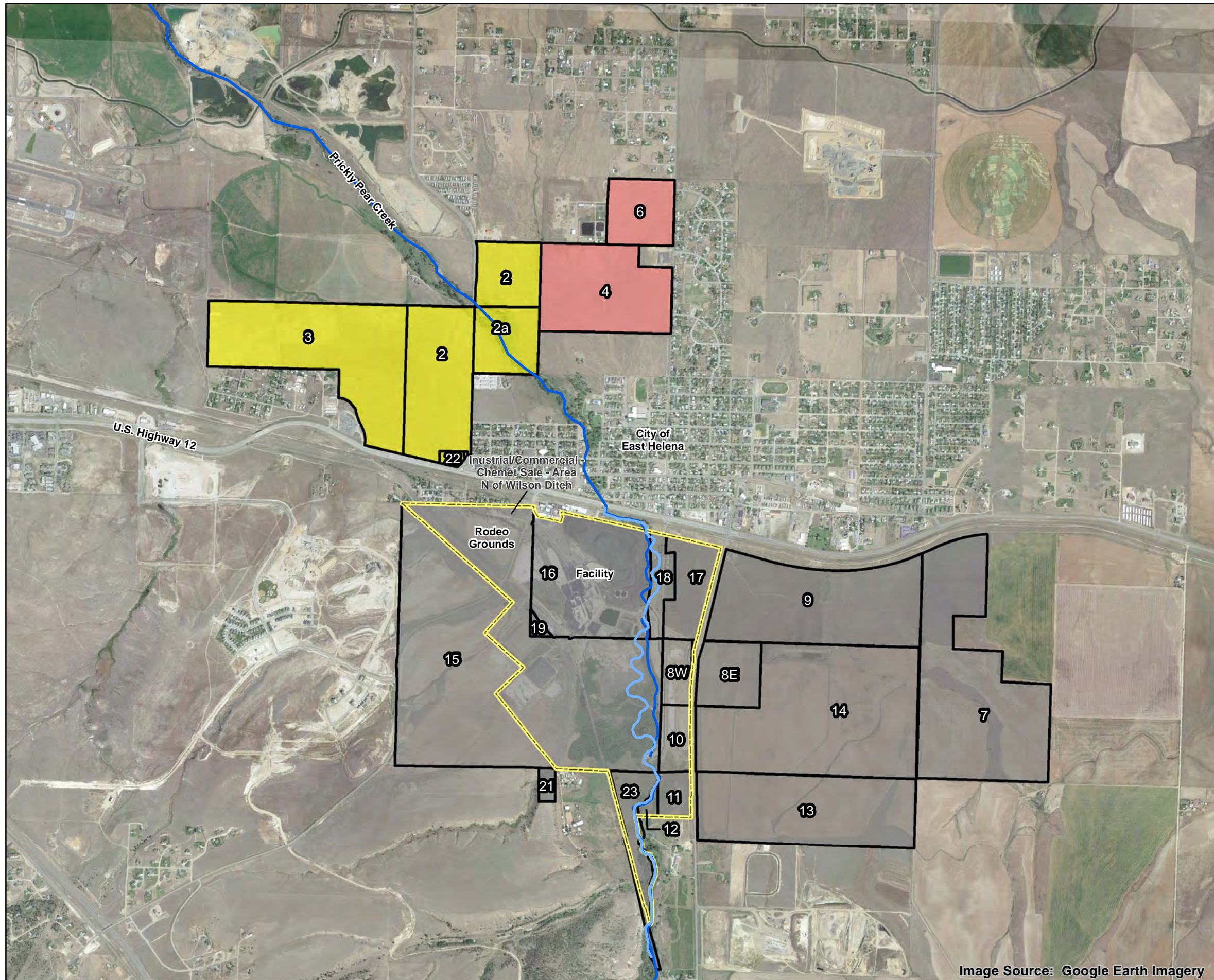
Image Source: Google Earth Imagery



U.S. Department of Agriculture Farm Services Agency Aerial Photography Field Office

Aerial photo date: September 2015

Figure 1-2
Site Areas and Features
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana



LEGEND

- Prickly Pear Creek
- Prickly Pear Creek Realignment
- Parcel Boundary
- Area of Contamination Boundary
- Land Use Areas**
- Commercial
- Industrial
- Residential

Note:
 Land uses shown are consistent with COEH zoning as approved by the Zoning Commission in November 2016. Effective December 15, 2016. Current use of Custodial Trust Parcels are legal non-conforming until the properties change hands.

COEH = City of East Helena

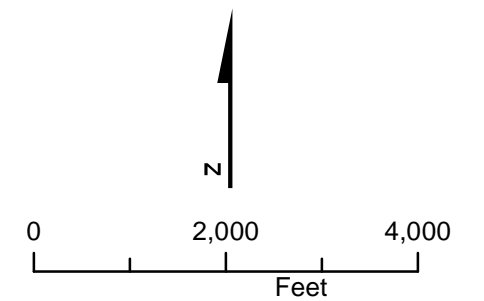
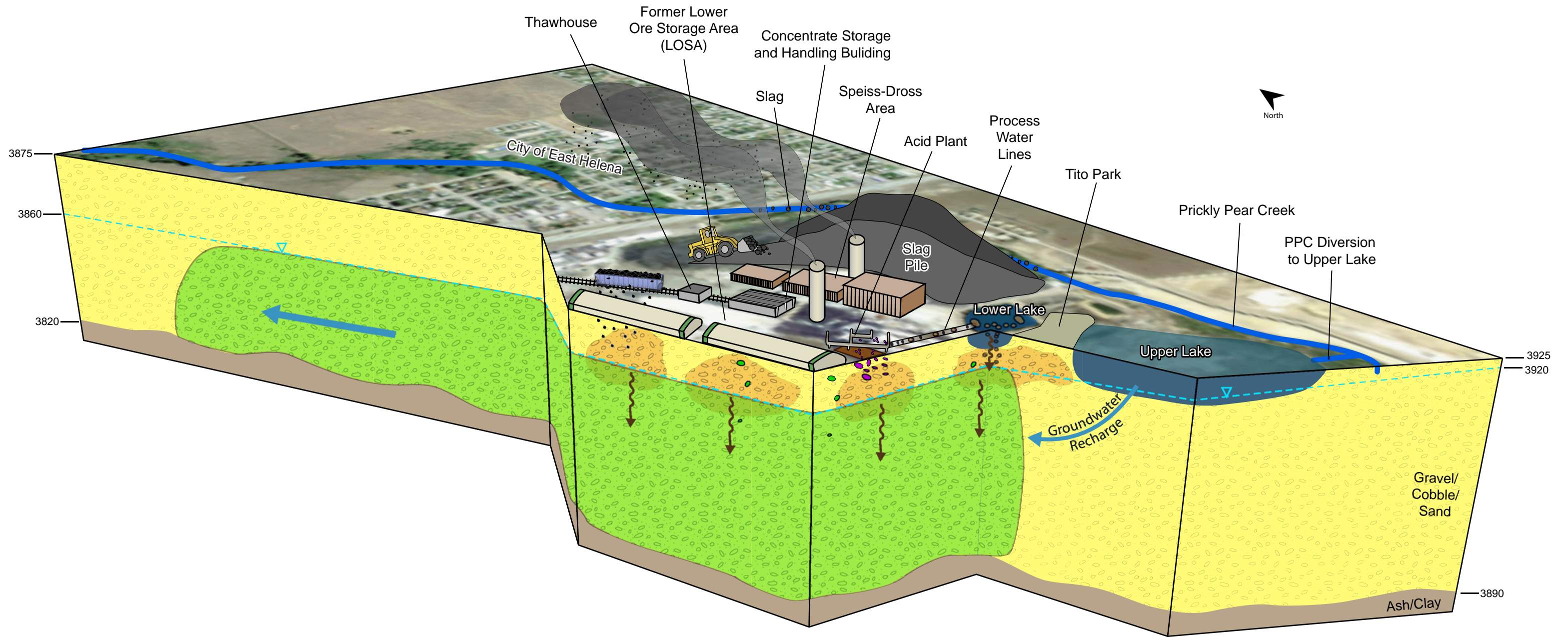


Figure 2-1
Reasonably Anticipated Land Use
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana

Image Source: Google Earth Imagery



LEGEND

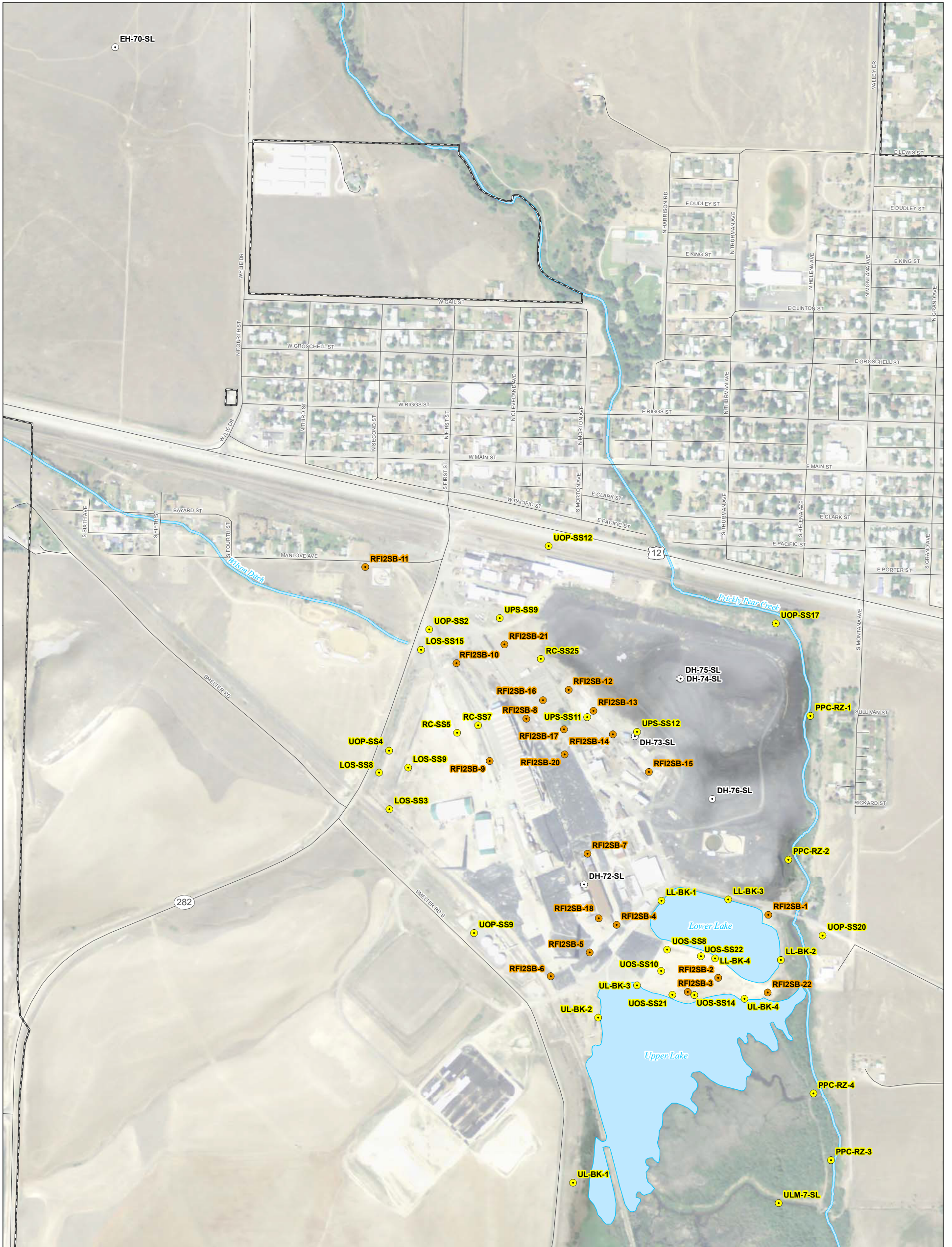
- Approximate Water Level
- Groundwater Flow Direction
- Plume
- Impacted Soil
- Process Water Leaks
- Infiltration/Leaching
- Fumed Slag
- Unfumed Slag
- Airborne Deposition
- Unfumed Slag Leachate
- Acid Plant Sediment Drying Bed
- Impacted Sediment

NOTE:
Darker colors represent higher contaminant concentrations.

Figure 3-1
Conceptual Model of Operational Smelter
(Through 2001)

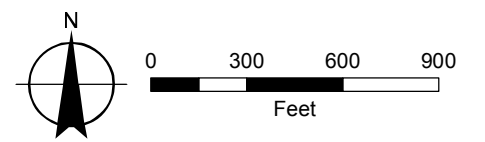
Former ASARCO East Helena Facility
Corrective Measures Study Report
East Helena, Montana





LEGEND

- Soil Boring
- Soil Sample
- Wells
- All Other Features
-
- Roads
- ~ Surface Water Features



MAP NOTES:

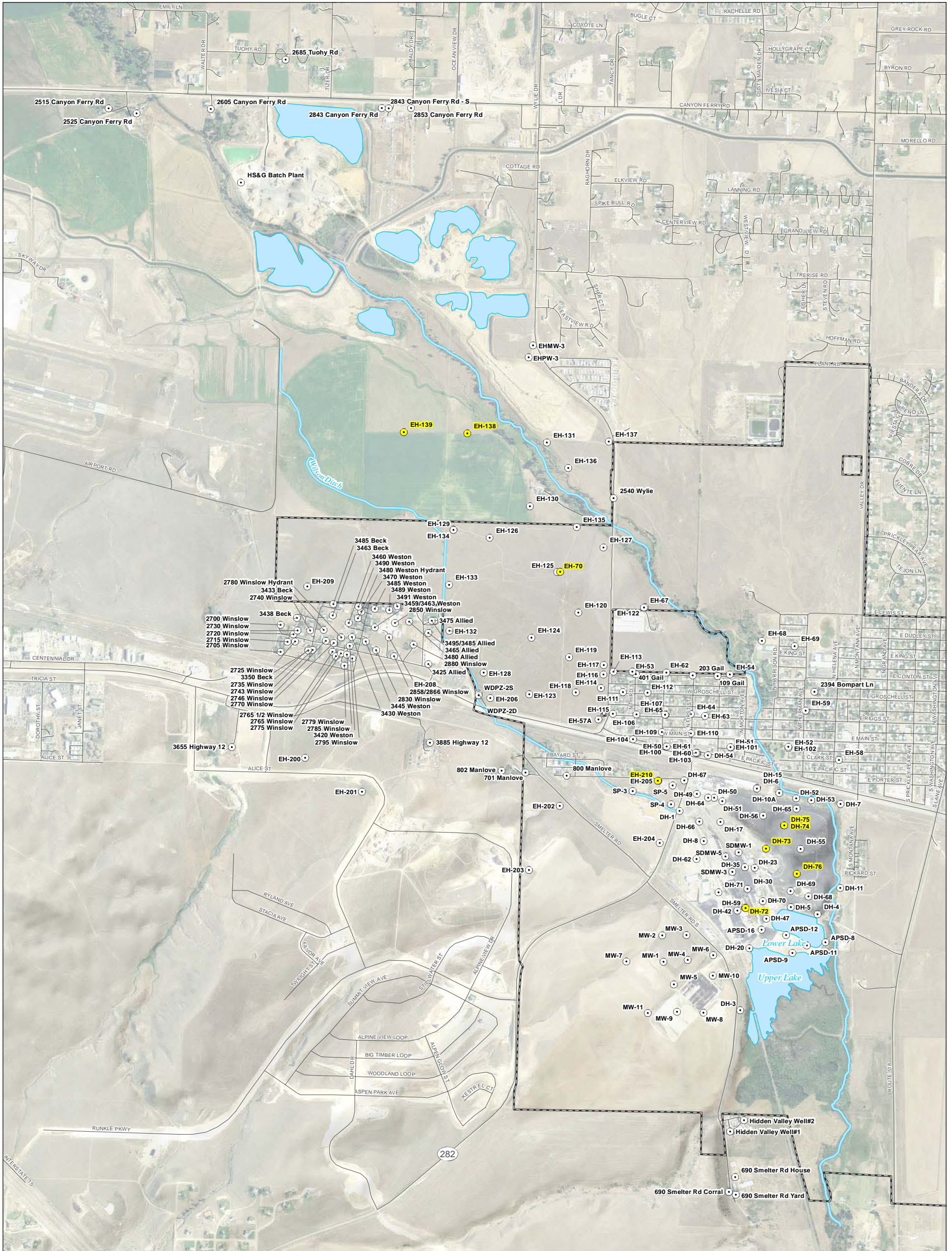
Date: April 17, 2011
 Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS



This figure was prepared by GSI Water Solutions, Inc. and Hydrometrics, Inc.

Figure 3-2
Phase II RFI Soil Sampling Locations
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana





LEGEND

- 2010 Groundwater Monitoring Locations
- Phase II Monitoring Wells
- East Helena City Limits
- Roads
- ~ Surface Water Features

MAP NOTES:

Date: April 22, 2011
 Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

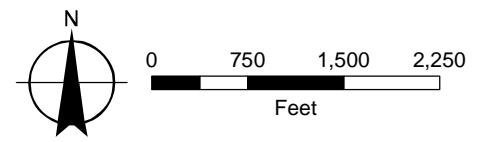
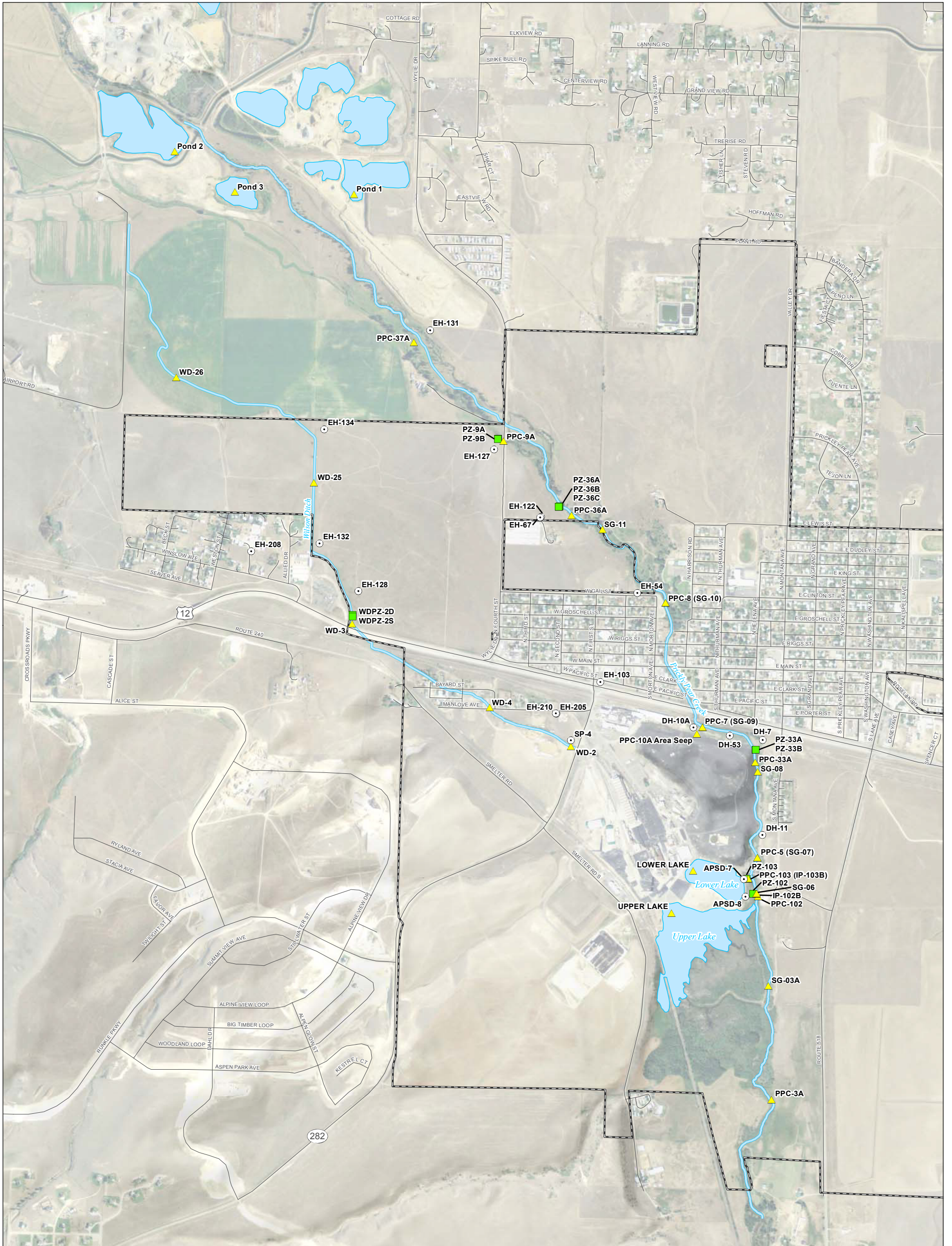


Figure 3-3
Phase II RFI Groundwater Monitoring Locations
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana



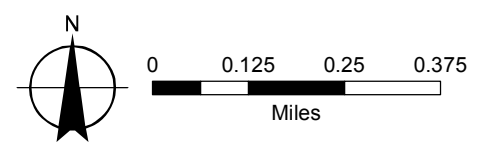
Note: This figure was prepared by GSI Water Solutions, Inc. and Hydrometrics, Inc.





LEGEND

- Groundwater Monitoring Location
- ▲ Surface Water Gauging Location
- Piezometer
- All Other Features**
- East Helena City Limits
- Roads
- ~ Surface Water Features



MAP NOTES:

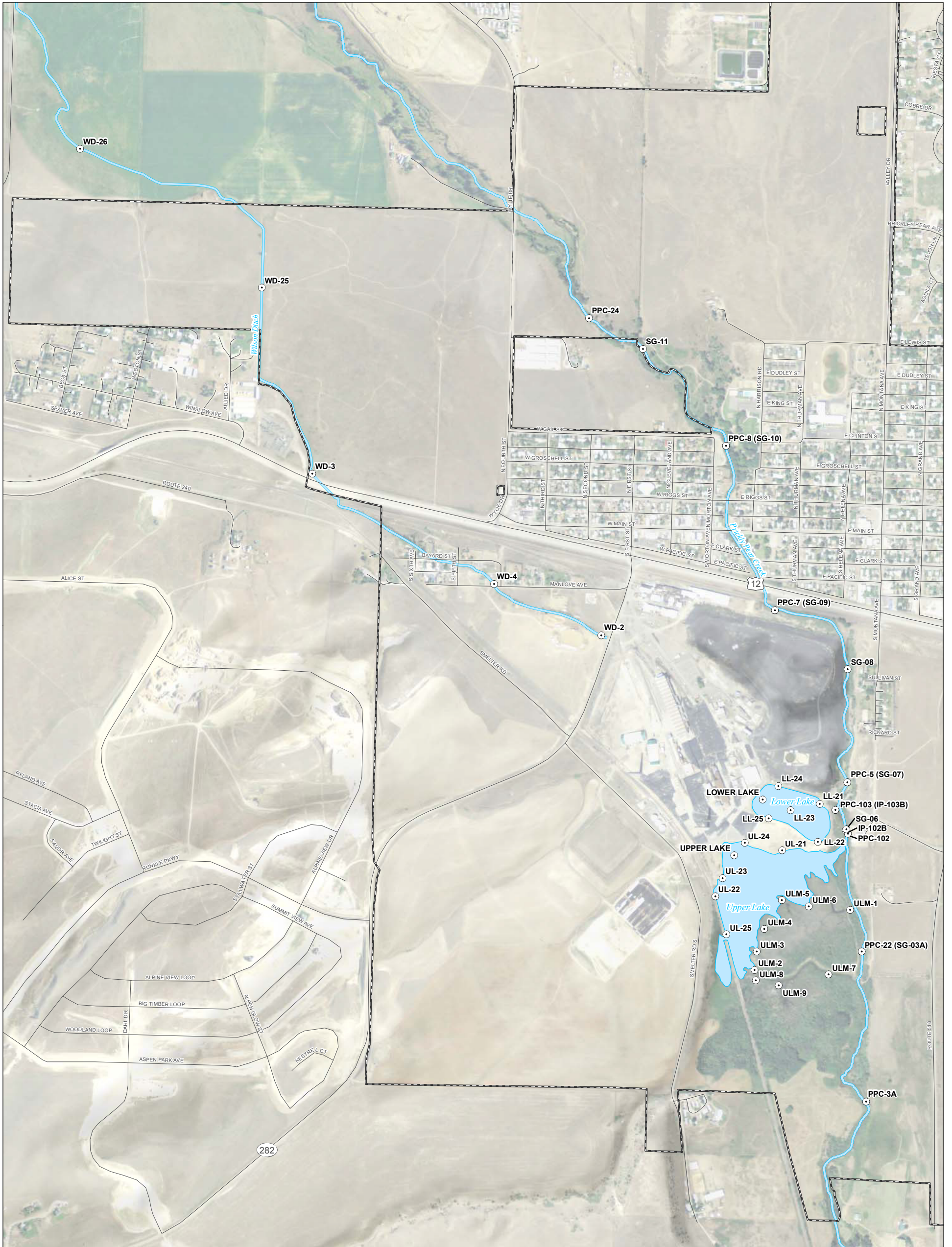
Date: May 12, 2011
 Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS

Figure 3-4
Phase II RFI Groundwater/Surface Water
Interaction Monitoring Locations
Former ASARCO East Helena Facility
Corrective Measures Study Report
East Helena, Montana



This figure was prepared by GSI Water Solutions, Inc. and Hydrometrics, Inc.





LEGEND

○ 2010 Surface Water Monitoring Location

All Other Features

□ East Helena City Limits

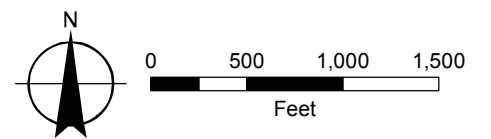
— Roads

~ Surface Water Features

MAP NOTES:

Date: May 12, 2011

Data Sources: Hydrometrics, USGS, Lewis and Clark County GIS



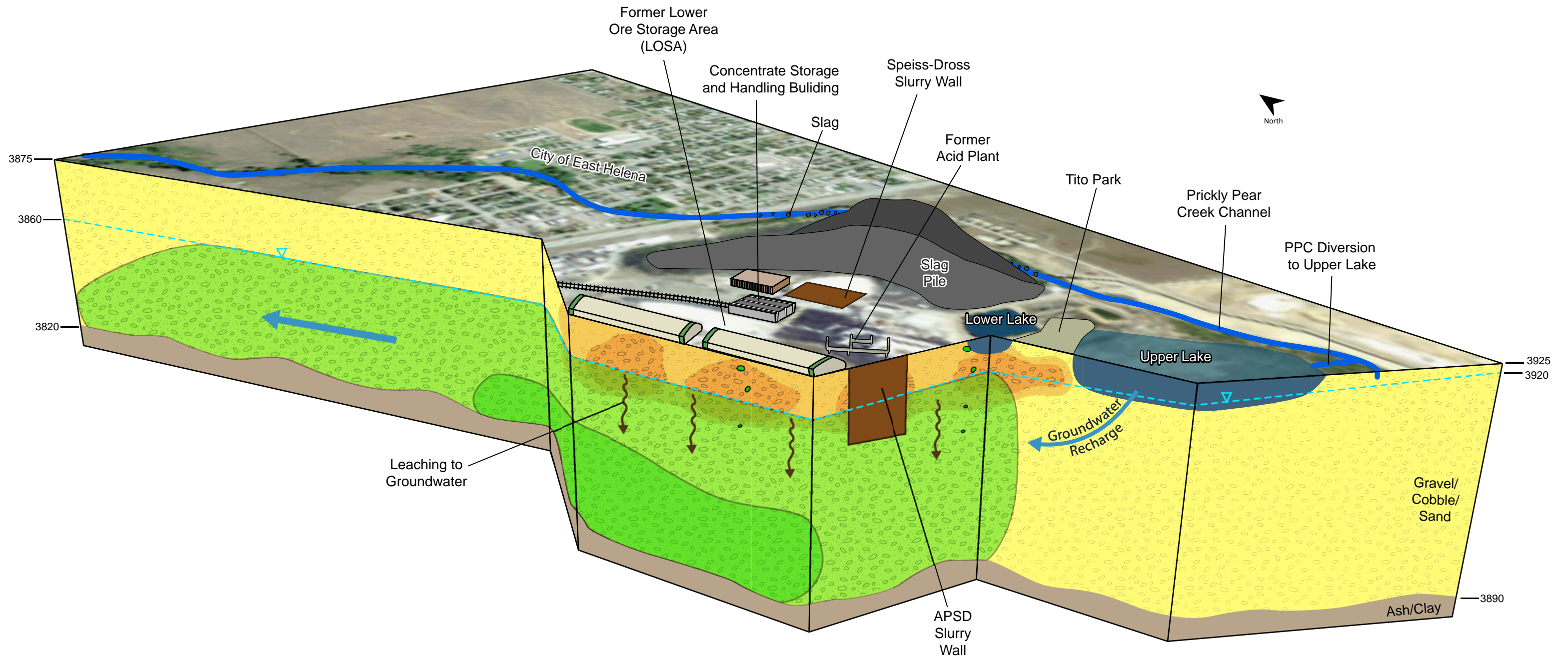
**Figure 3-5
Phase II RFI Surface Water Monitoring
Locations**

*Former ASARCO East Helena Facility
Corrective Measures Study Report
East Helena, Montana*



This figure was prepared by GSI Water Solutions, Inc. and Hydrometrics, Inc.





LEGEND

- Approximate Water Level
- Groundwater Flow Direction
- Plume
- Impacted Soil
- Fumed Slag
- Unfumed Slag
- Infiltration/Leaching
- Unfumed Slag Leachate

NOTE:
 Darker colors represent higher contaminant concentrations.
 APSD - Acid plant sediment drying bed

Figure 3-6
Conceptual Model of Post-Operational Smelter (2011)
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana

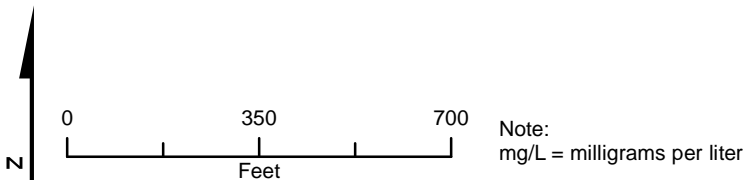
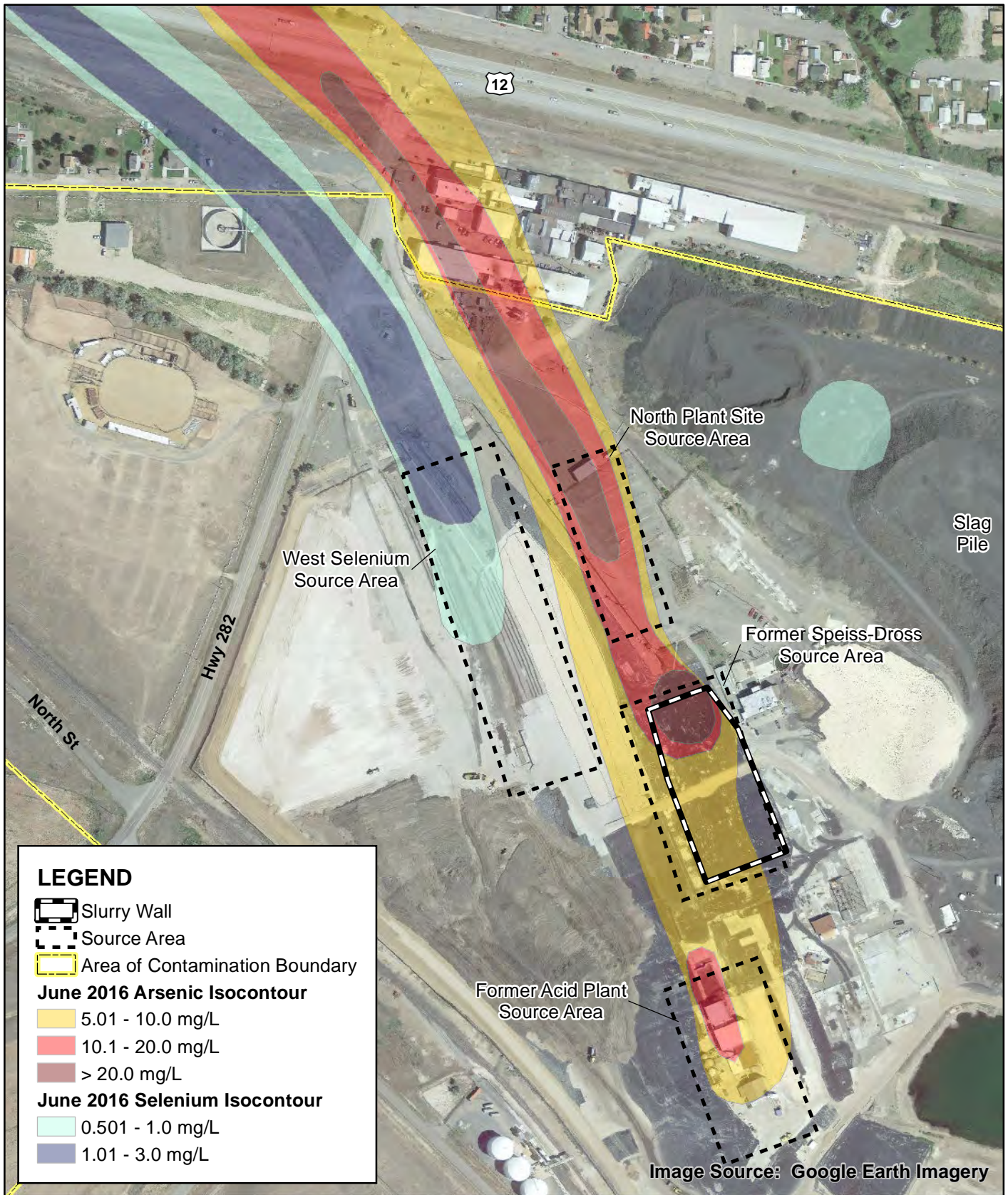
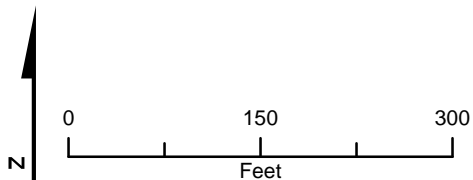
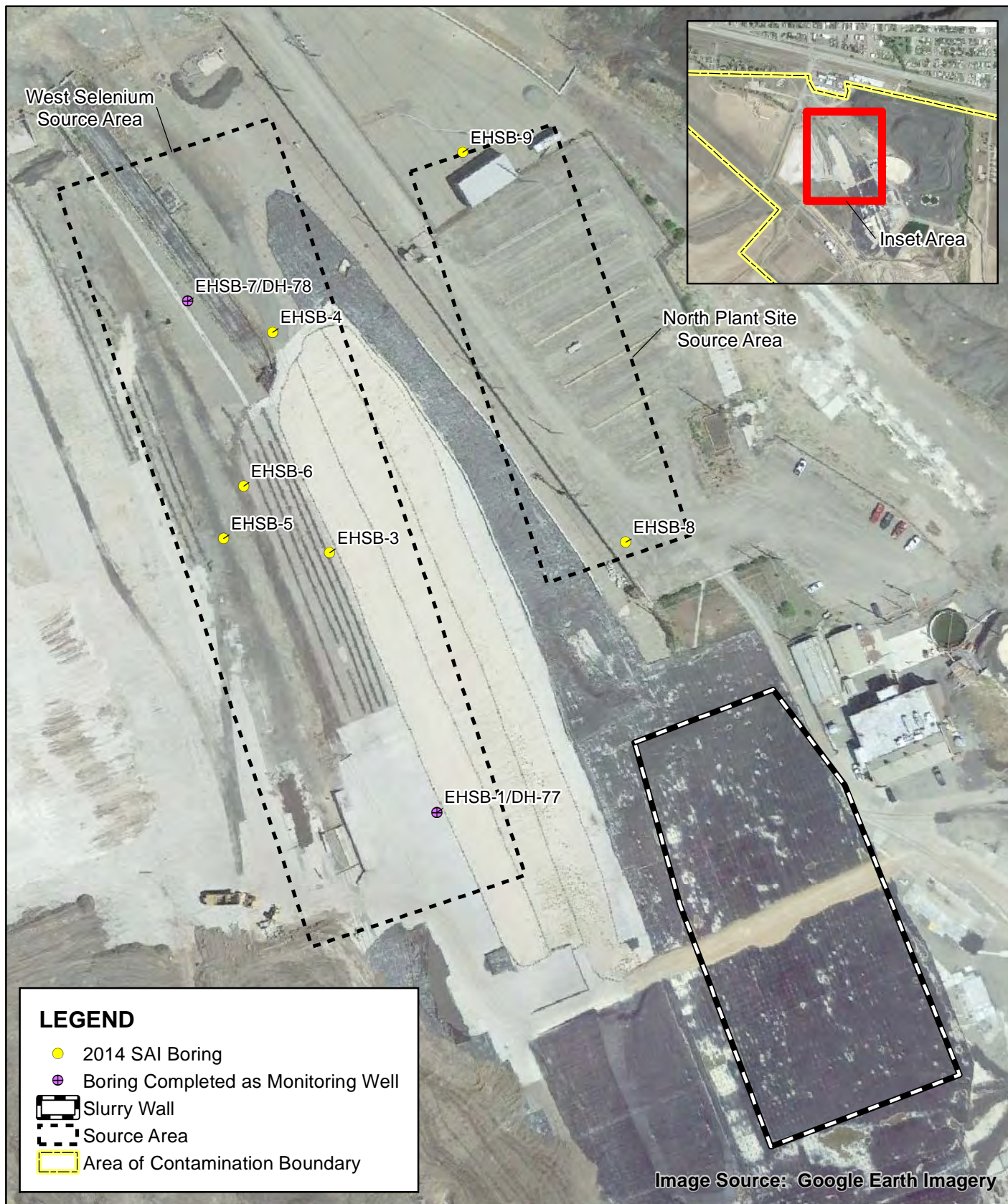


Figure 3-7
2014-2016 Investigated Source Areas
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana



Notes:
 1. Modified from Hydrometrics, Inc., 2015
 2. SAI = source area investigation

Figure 3-8
2014 Source Area
Investigation Locations

*Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana*

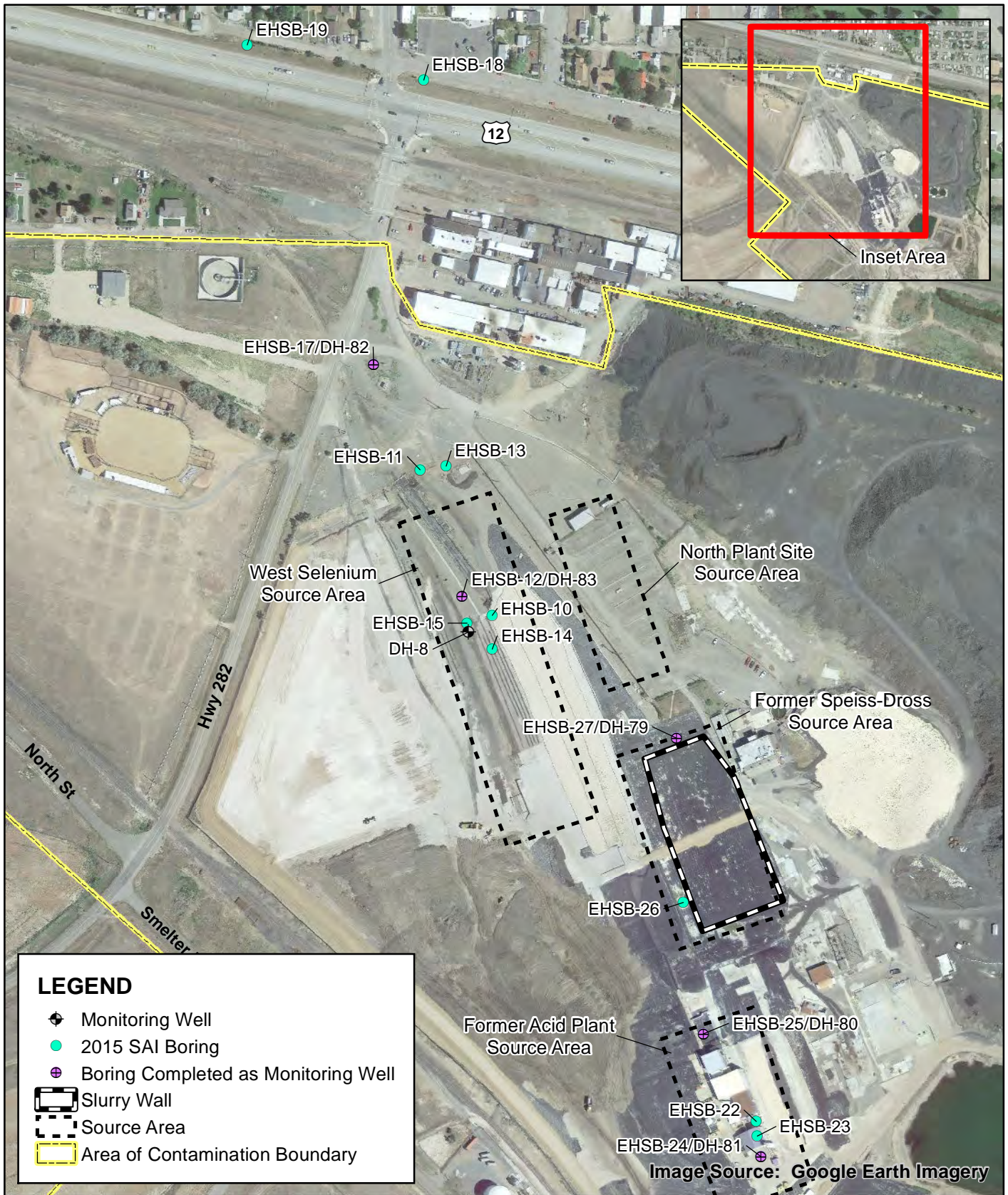
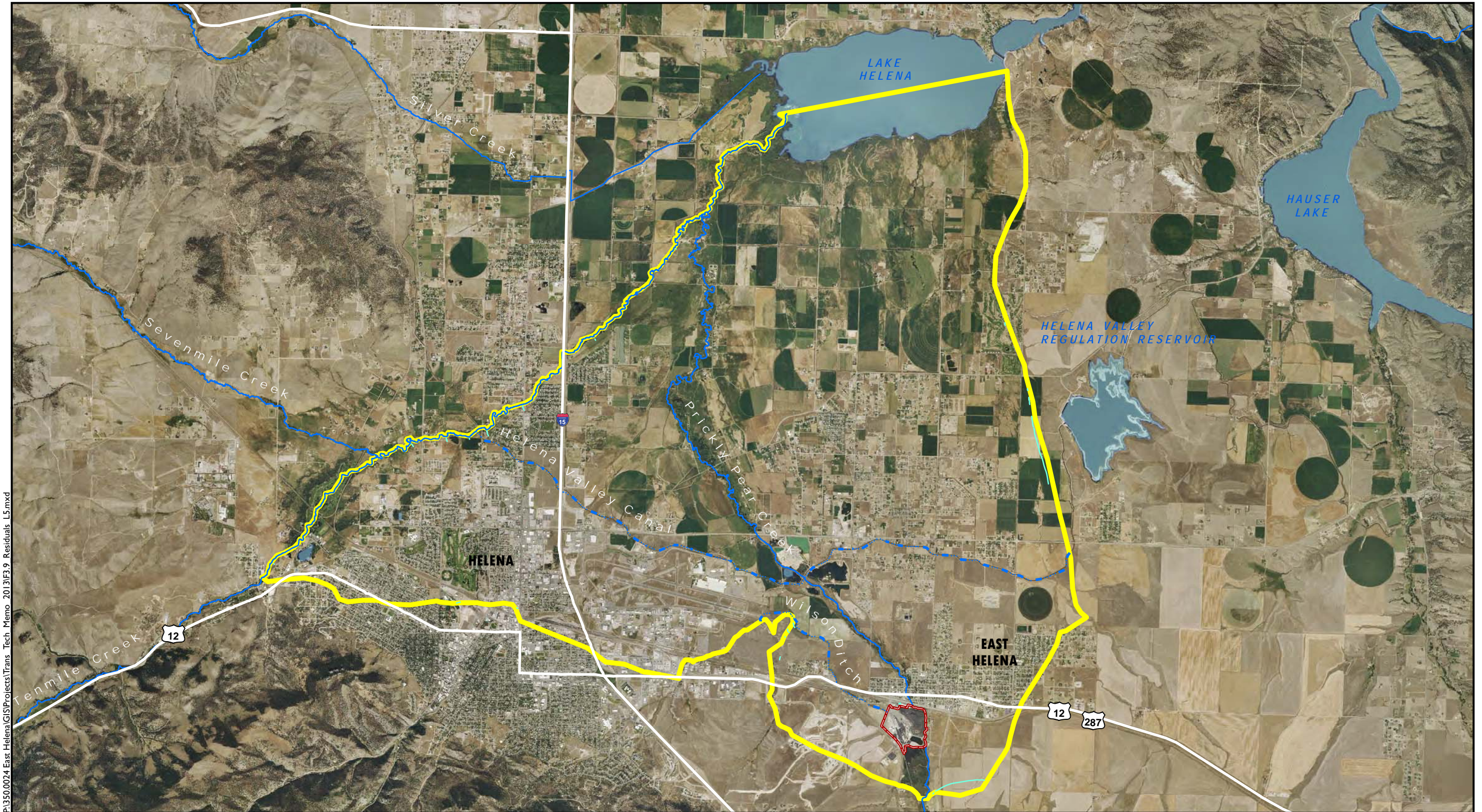


Figure 3-9
2015 Source Area
Investigation Locations
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana



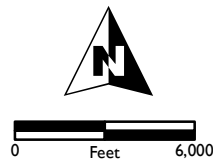
Figure 3-10
Slag Pile Investigation Locations
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana



P:\350.0024 East Helena\GIS\Projects\Trans Tech Memo 2013\F3.9 Residuals L5.mxd

Source: NAIP, 2011; METG, 2011

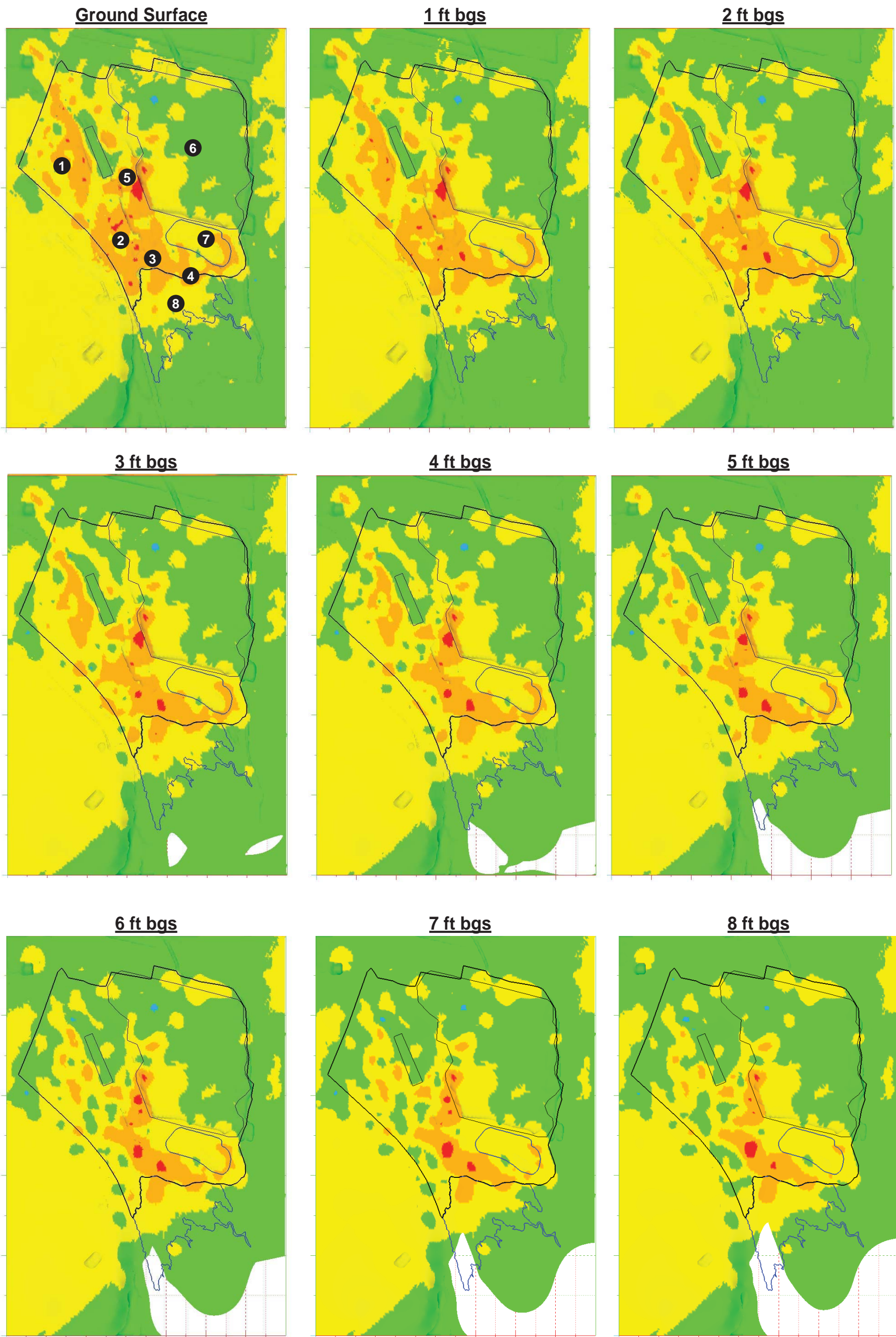
Provided by:



- Facility Boundary
- Model Domain

Figure 3-11
Model Domain
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana





LEGEND

Arsenic Concentrations *

- Dark Blue: <0.29 mg/kg
- Light Blue: 0.29 - 2.9 mg/kg
- Green: 2.9 - 40 mg/kg
- Yellow: 40 - 290 mg/kg
- Orange: 290 - 2,900 mg/kg
- Red: >2,900 mg/kg

Abbreviations:
bgs - below ground surface
ft - foot/feet
mg/kg - milligram per kilogram

* Red indicates highest concentrations of Arsenic remaining in soils at the site followed by orange and then yellow. Green is considered background concentrations.

KEY:

- ① Former Lower Ore Storage Area
- ② Former Acid Plant
- ③ Acid Plant Sediment Drying Area
- ④ Tito Park
- ⑤ Speiss Dross Area
- ⑥ Slag Pile
- ⑦ Lower Lake
- ⑧ Upper Lake

Notes:

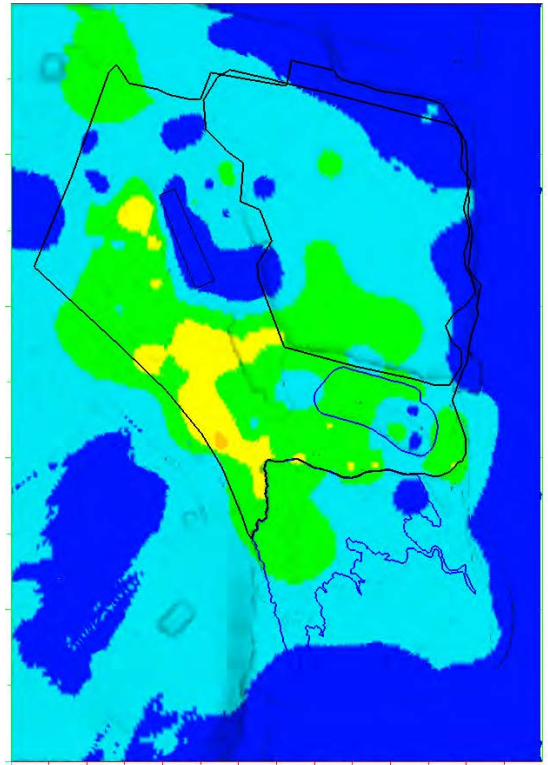
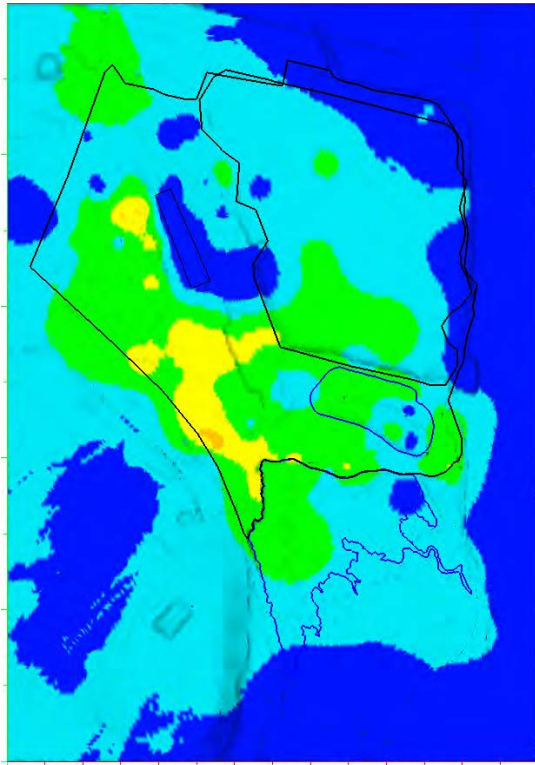
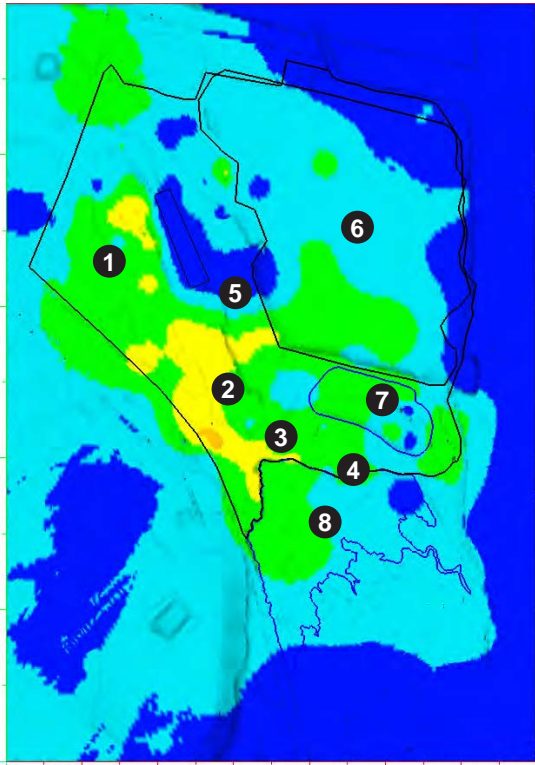
White area of 3-ft bgs to 8-ft bgs figures corresponds to the Tertiary ash/clay layer.
Figure developed to support soil removal evaluations using Mining Visualization System Software from 2012 through 2013.

Figure 3-12
Arsenic Contamination, Ground Surface to Depth of 8 Feet
Former ASARCO East Helena Facility
Corrective Measures Study Report
East Helena, Montana

Ground Surface

1 ft bgs

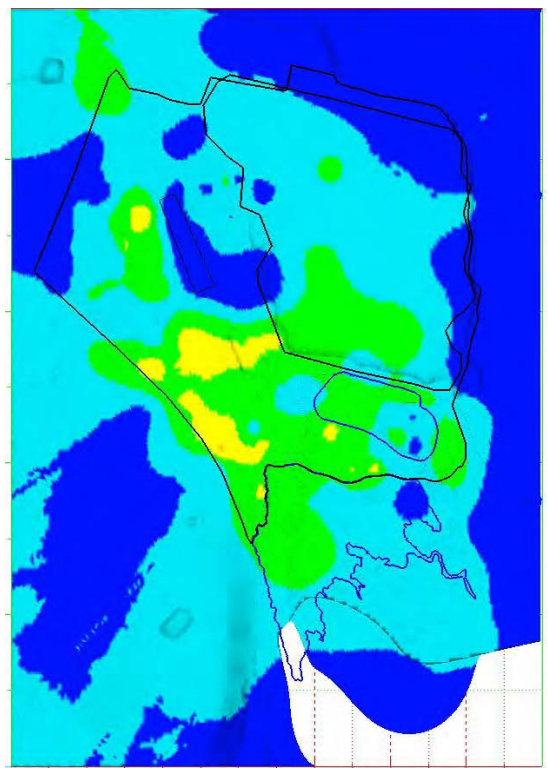
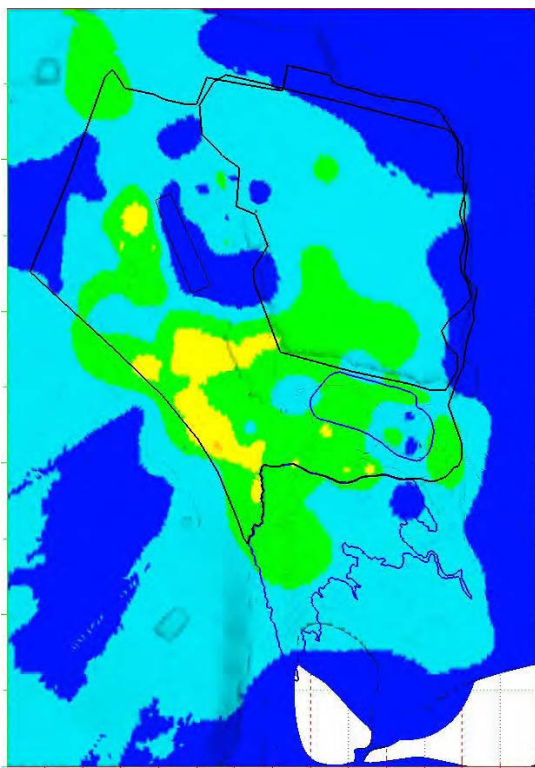
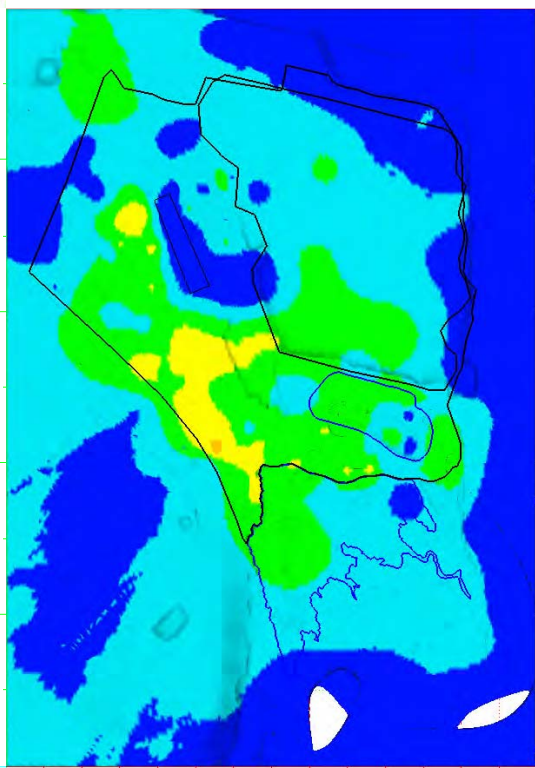
2 ft bgs



3 ft bgs

4 ft bgs

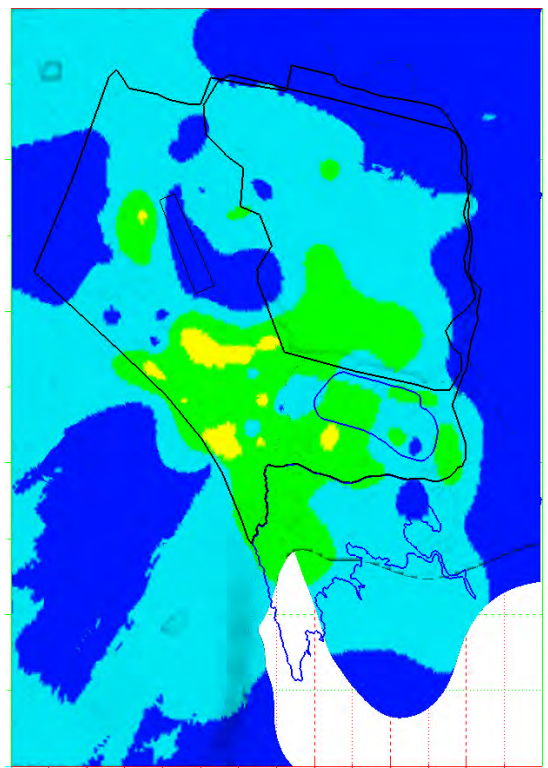
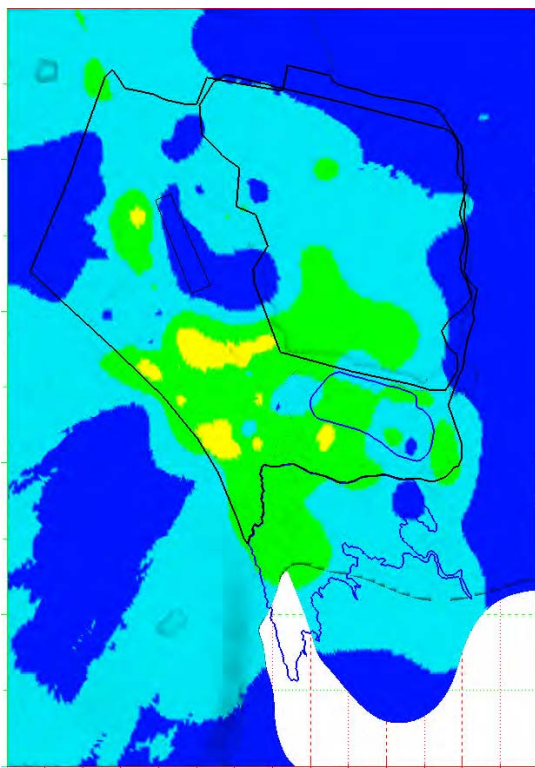
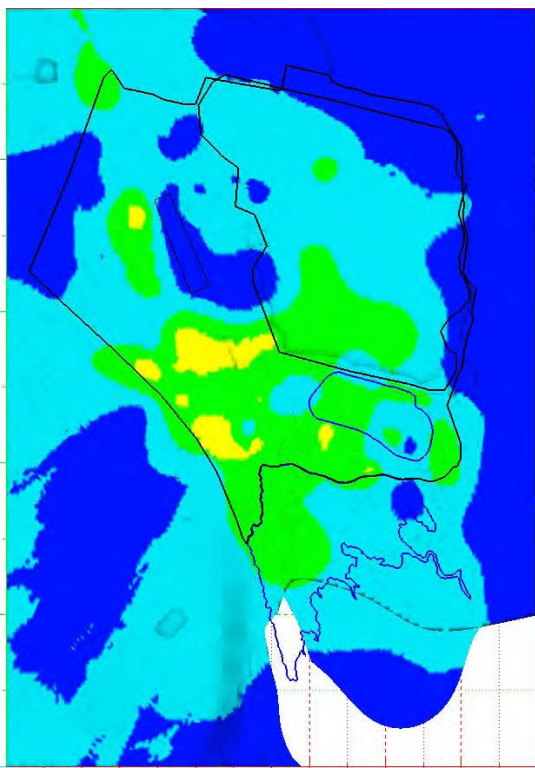
5 ft bgs



6 ft bgs

7 ft bgs

8 ft bgs



LEGEND

Selenium Concentrations *

- Dark Blue: <0.26 mg/kg
- Light Blue: 0.26 - 2.6 mg/kg
- Green: 2.6 - 26 mg/kg
- Yellow: 26 - 260 mg/kg
- Orange: 260 - 2,600 mg/kg

Abbreviations:
bgs - below ground surface
ft - foot/feet
mg/kg - milligram per kilogram

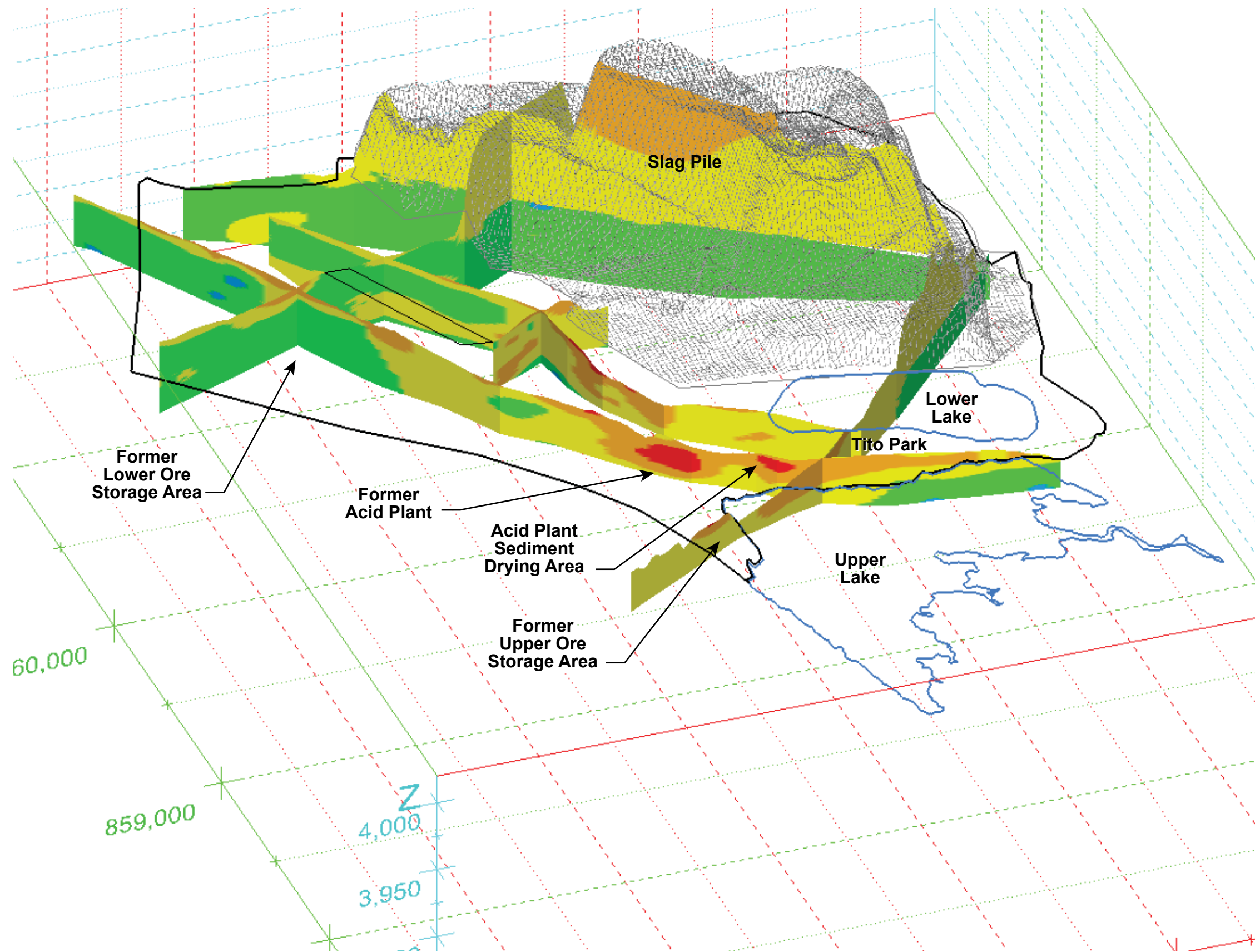
* Orange indicates highest concentrations of Selenium remaining in soils at the site followed by yellow and then green. Blues are considered background concentrations.

KEY:

- 1 Former Lower Ore Storage Area
- 2 Former Acid Plant
- 3 Acid Plant Sediment Drying Area
- 4 Tito Park
- 5 Speiss Dross Area
- 6 Slag Pile
- 7 Lower Lake
- 8 Upper Lake

Notes:
White area of 3-ft bgs to 8-ft bgs figures corresponds to the Tertiary ash/clay layer.
Figure developed to support soil removal evaluations using Mining Visualization System Software from 2012 through 2013.

Figure 3-13
Selenium Contamination, Ground Surface to Depth of 8 Feet
Former ASARCO East Helena Facility
Corrective Measures Study Report
East Helena, Montana



LEGEND

Arsenic Concentrations*

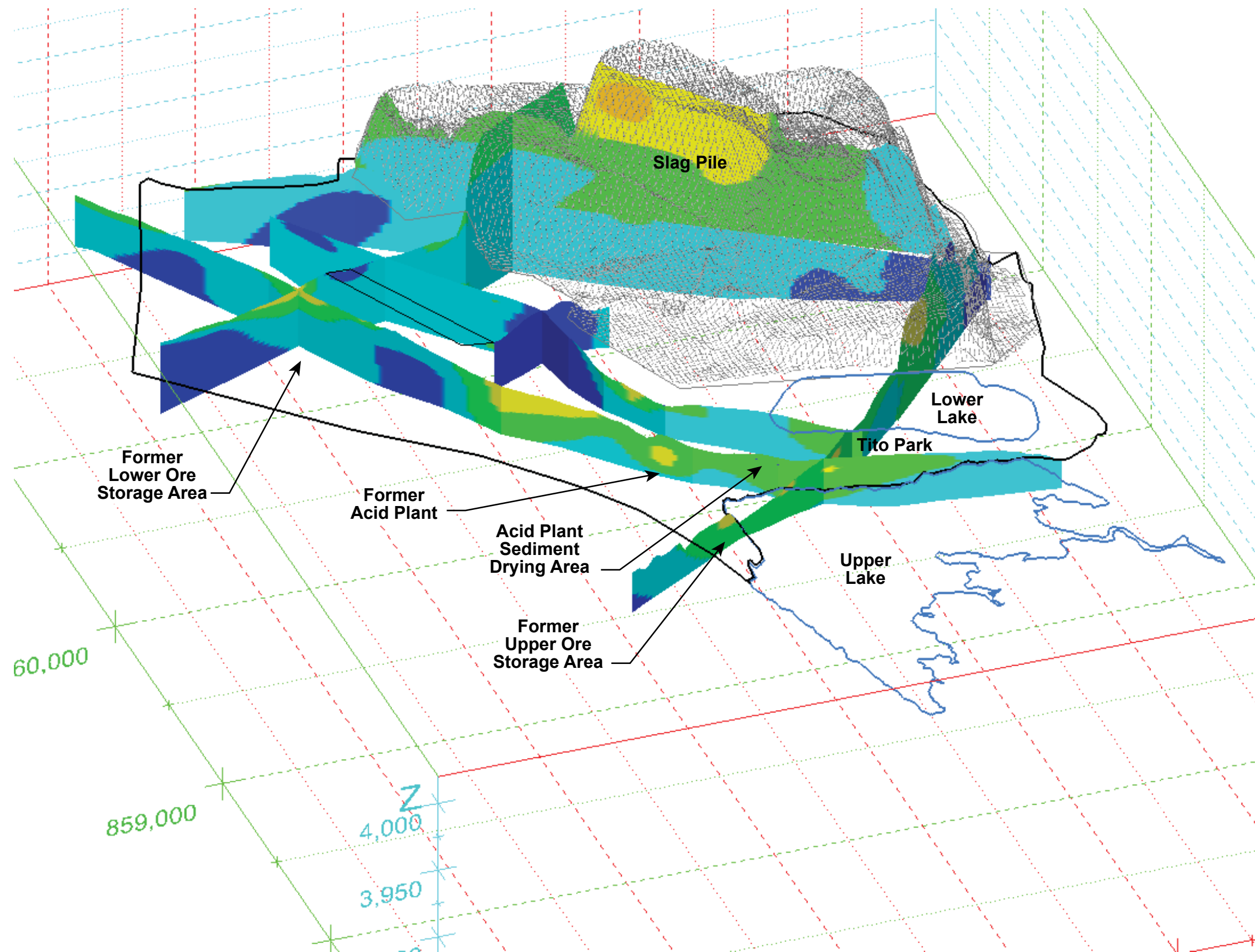
- Dark Blue: $<0.29\text{ mg/kg}$
- Light Blue: $0.29 - 2.9\text{ mg/kg}$
- Green: $2.9 - 40\text{ mg/kg}$
- Yellow: $40 - 290\text{ mg/kg}$
- Orange: $290 - 2,900\text{ mg/kg}$
- Red: $>2,900\text{ mg/kg}$

Abbreviation:
mg/kg = milligrams per kilogram

* Red indicates highest concentrations of Arsenic in soils at the site, followed by orange and then yellow. Green is considered background concentrations.

This figure shows the 3-Dimensional "cross sections" through the site to illustrate depth and location of impacts to site soils.

Figure 3-14
Arsenic Contamination in Soil –
Surface to Top of Tertiary Ash/Clay Layer
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana



LEGEND

Selenium Concentrations *

- Dark Blue: $<0.26\text{ mg/kg}$
- Light Blue: $0.26 - 2.6\text{ mg/kg}$
- Green: $2.6 - 26\text{ mg/kg}$
- Yellow: $26 - 260\text{ mg/kg}$
- Orange: $260 - 2,600\text{ mg/kg}$

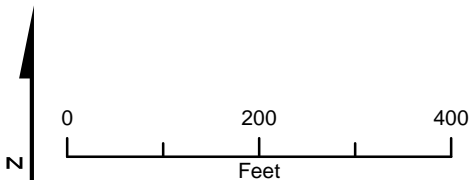
Abbreviation:
mg/kg = milligrams per kilogram

Abbreviation:
mg/kg = milligrams per kilogram

* Orange indicates highest concentrations of Selenium in soils at the site, followed by yellow and then green. Blues are considered background concentrations.

This figure shows the 3-Dimensional "cross sections" through the site to illustrate depth and location of impacts to site soils.

Figure 3-15
Selenium Contamination in Soil –
Surface to Top of Tertiary Ash/Clay Layer
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana



- Notes:
1. Demolition of all site structures was conducted as part of the construction of the ET Cover System IM
 2. ET = Evapotranspiration
 3. IM = Interim Measure

Figure 3-16
Tito Park Excavation Area
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana



Figure 3-17
Former Acid Plant Excavation Area
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana

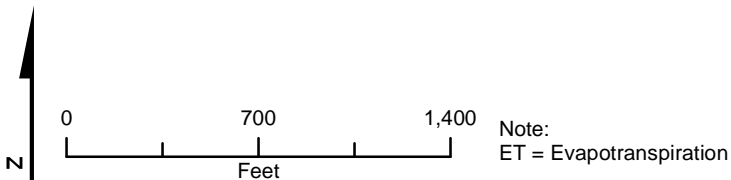
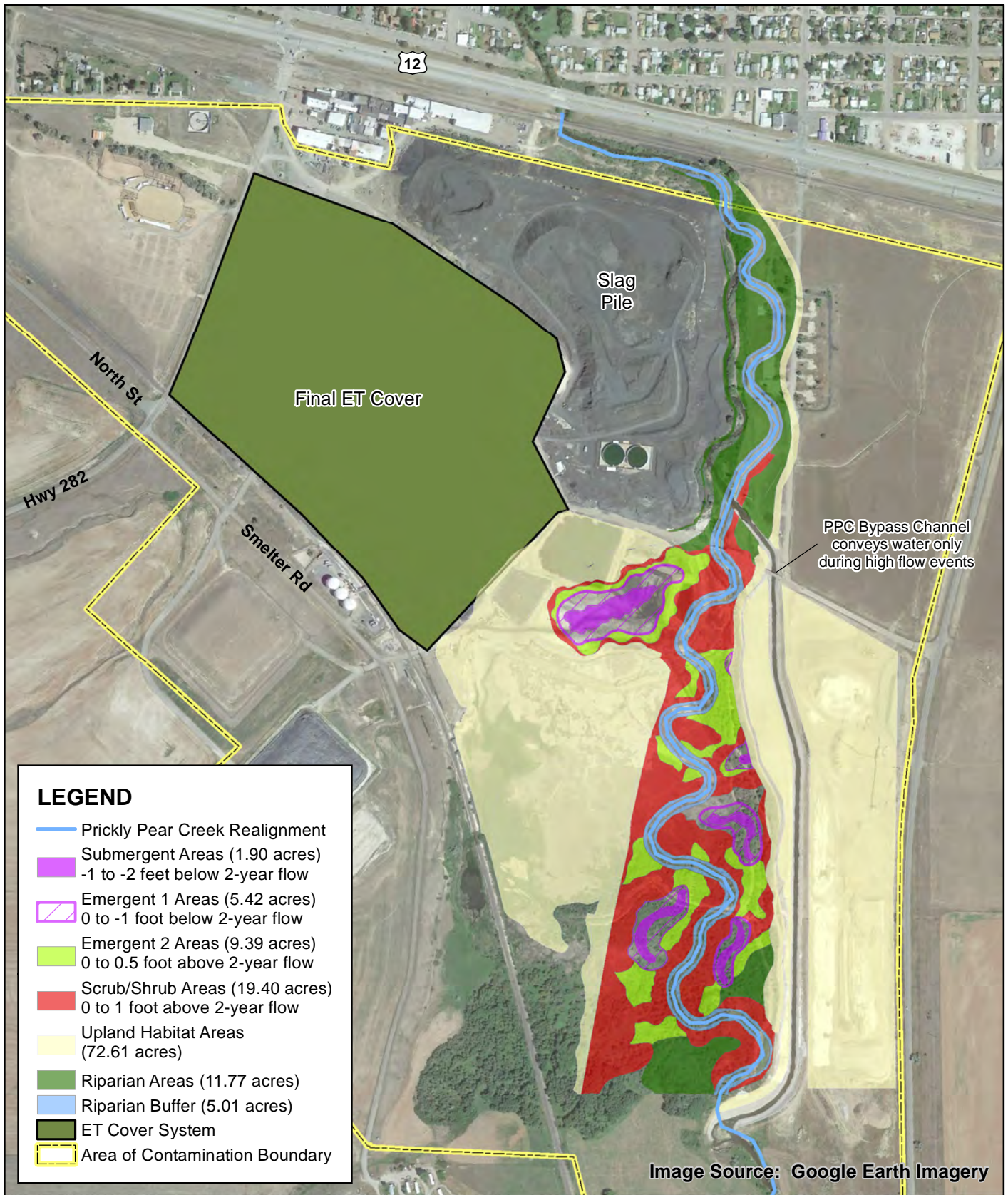


Figure 3-18
Prickly Pear Creek Realignment
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana



Note: Wetlands Replacement Plan provided by Pioneer Technical Services, Inc., January 2017.

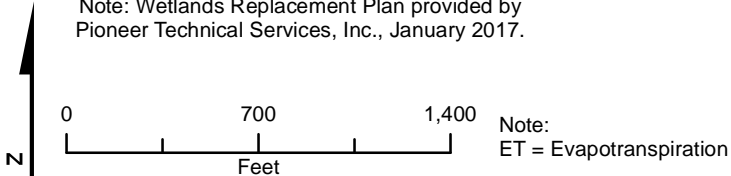
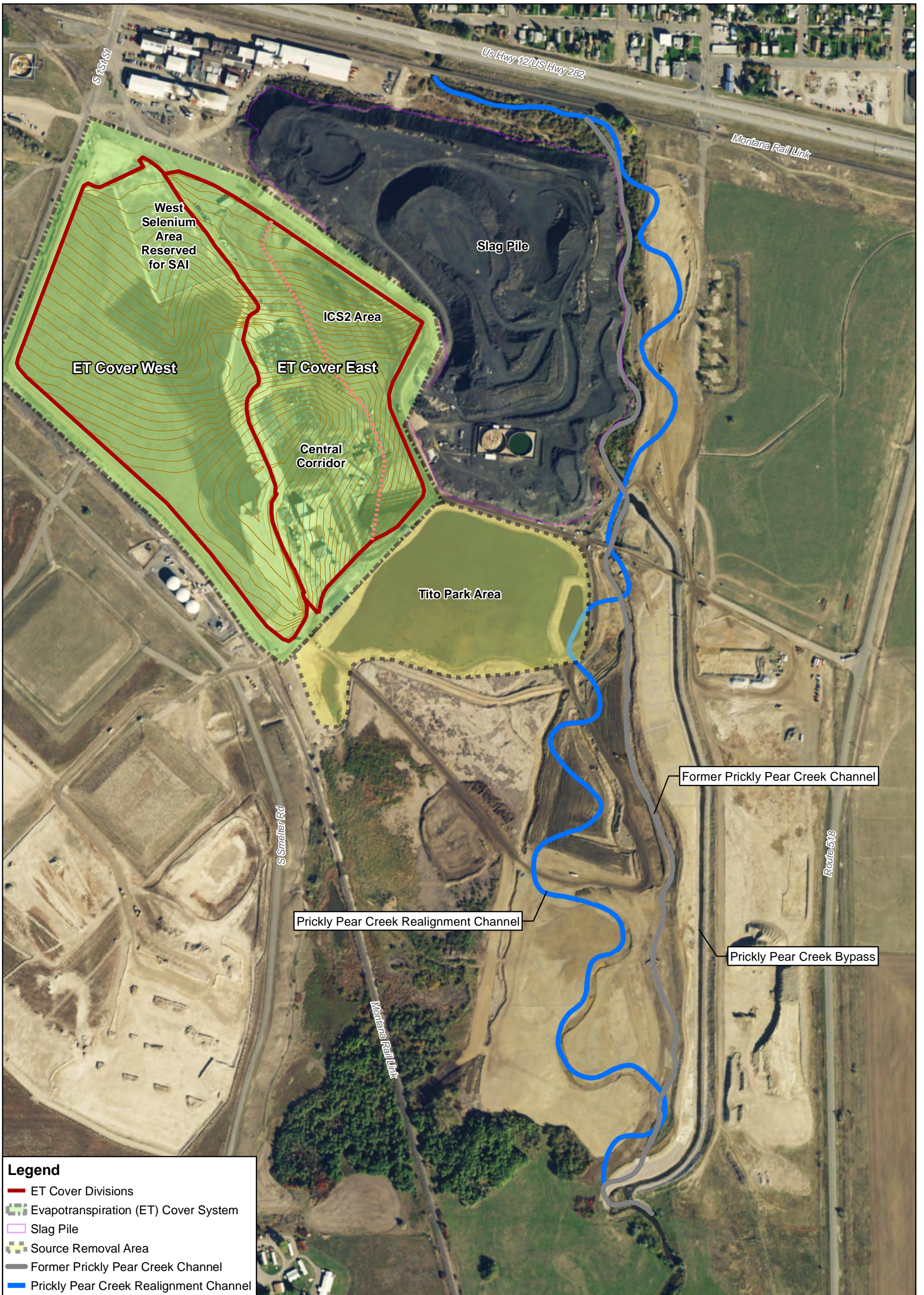


Figure 3-19
Prickly Pear Creek Revegetation Plan
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana



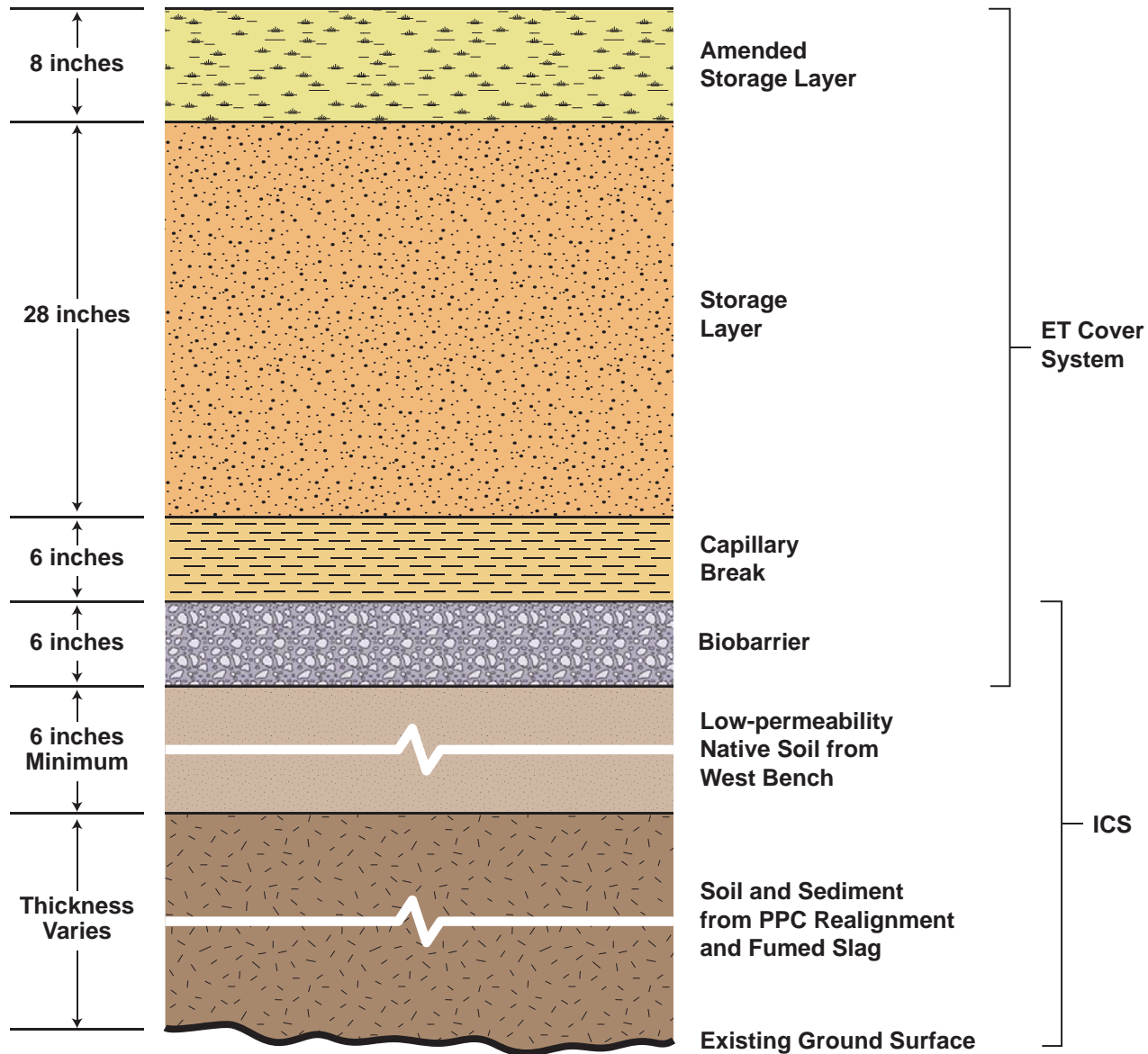
Legend

- ET Cover Divisions
- Evapotranspiration (ET) Cover System
- Slag Pile
- Source Removal Area
- Former Prickly Pear Creek Channel
- Prickly Pear Creek Realignment Channel

Note:
1) SAI - Source Area Investigation

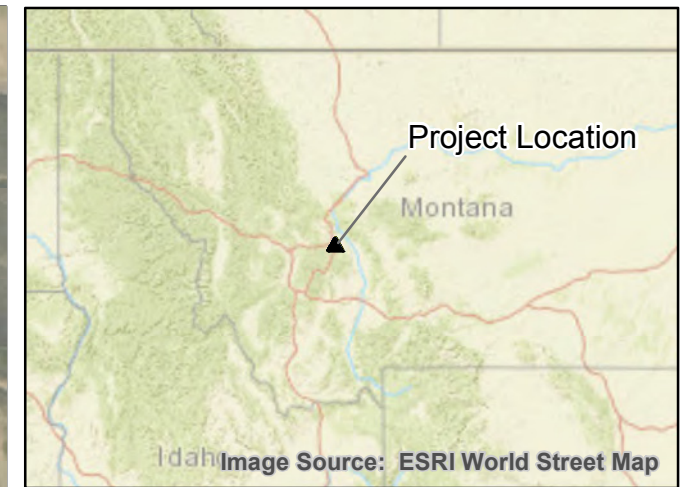
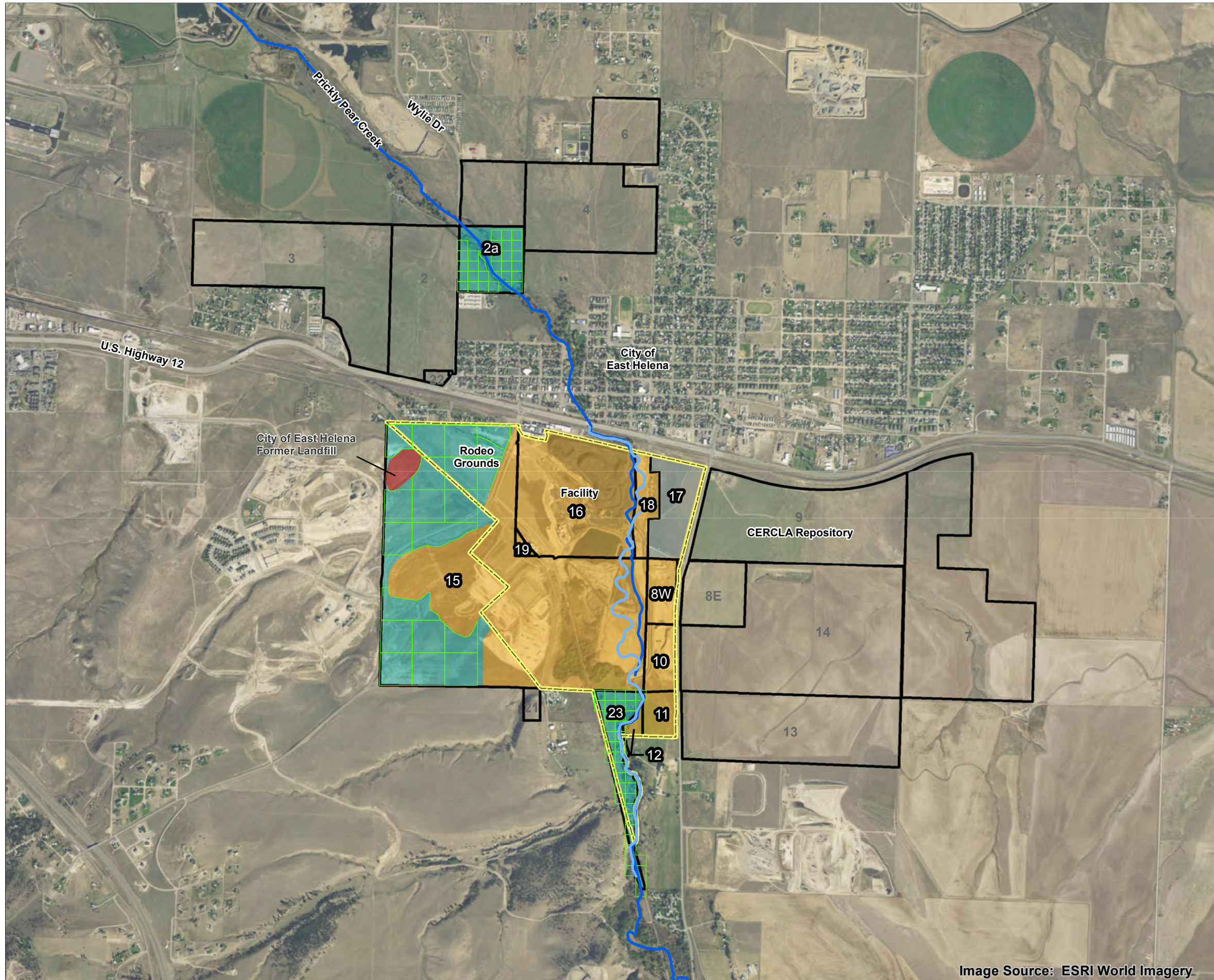


Figure 3-20
ET Cover System
Former ASARCO East Helena Facility
Corrective Measures Study Report
East Helena, Montana



Notes:
ET = Evapotranspiration
ICS = Interim Cover System
PPC = Prickly Pear Creek

Figure 3-21
ET Cover Cross-Section
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana



LEGEND

- Parcel Boundary
- Supplemental RFI Sampled DU
- Sampled CMS Parcel
- CMS Parcel Undergoing Corrective Action
- City of East Helena Former Landfill
- Area of Contamination Boundary
- Prickly Pear Creek
- Prickly Pear Creek Realignment

- Notes:
1. CMS = Corrective Measures Study
 2. SAP = Sampling outlined in the East Helena Facility Supplemental RFI Sampling and Analysis Plan, CH2M HILL, October 2015

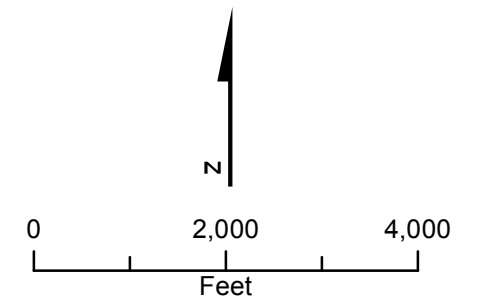
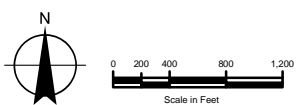
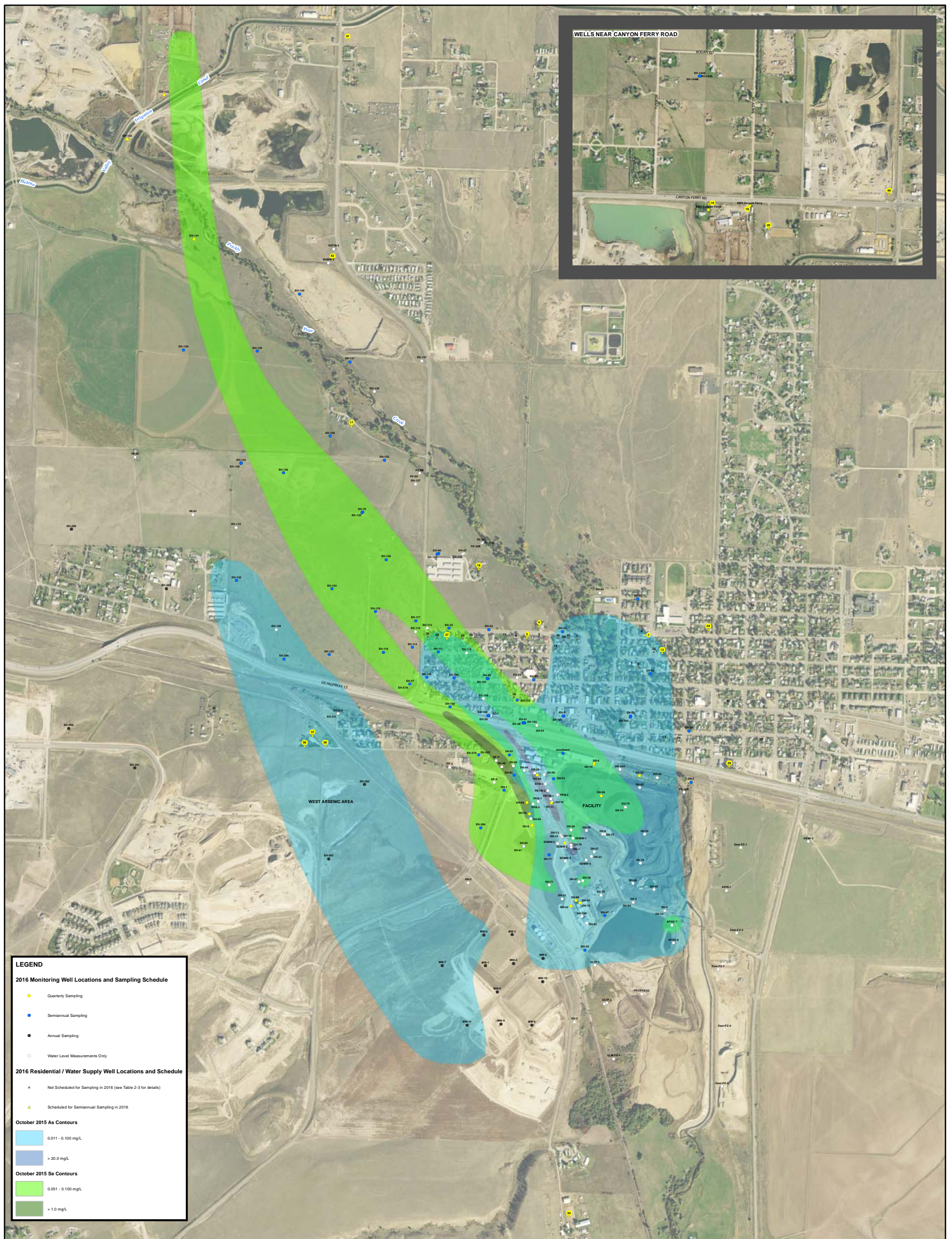


Figure 3-22
Overview of Supplemental RFI Sampling
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana

Image Source: ESRI World Imagery

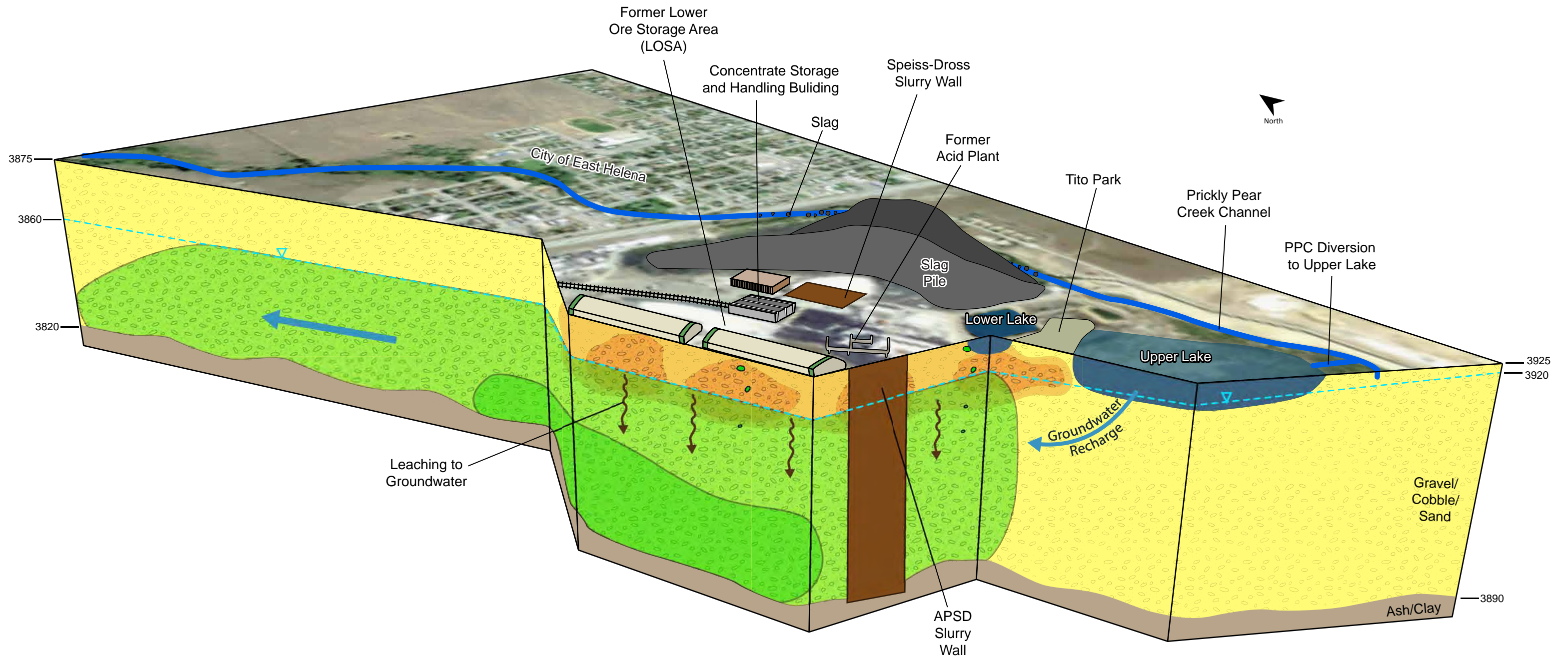


Note:
West Arsenic Plume - Occurs primarily from groundwater interaction with naturally-occurring arsenic-bearing soil and is not facility related.

Created by:
Hydrometrics, Inc.
Consulting Scientists and Engineers

Figure 3-23
2016 Monitoring Well and Semiannual Residential/Water Supply Well Sampling Locations
Former ASARCO East Helena Facility
Corrective Measures Study Report
East Helena, Montana



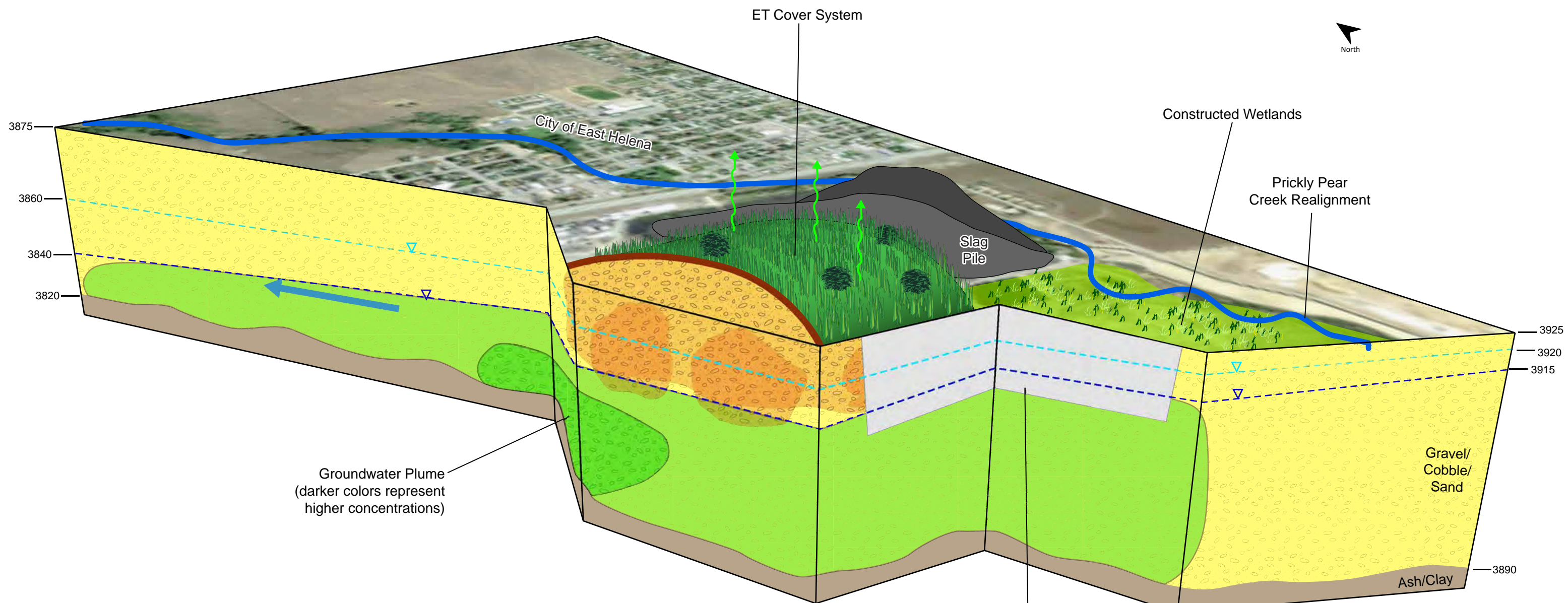


LEGEND

- Approximate Water Level
- Groundwater Flow Direction
- Plume
- Impacted Soil
- Fumed Slag
- Unfumed Slag
- Infiltration/Leaching
- Unfumed Slag Leachate

NOTE:
 Darker colors represent higher contaminant concentrations.
 APSD - Acid plant sediment drying bed

Figure 3-24
Conceptual Model of Post-Operational Smelter
 Former ASARCO East Helena Facility Corrective
 Measures Study Report



LEGEND

- Pre-SPHC-IM Approximate Water Level
- Post-SPHC-IM Approximate Water Level
- Groundwater Flow Direction
- Plume
- Impacted Soil
- Constructed Wetland
- ET Cover System

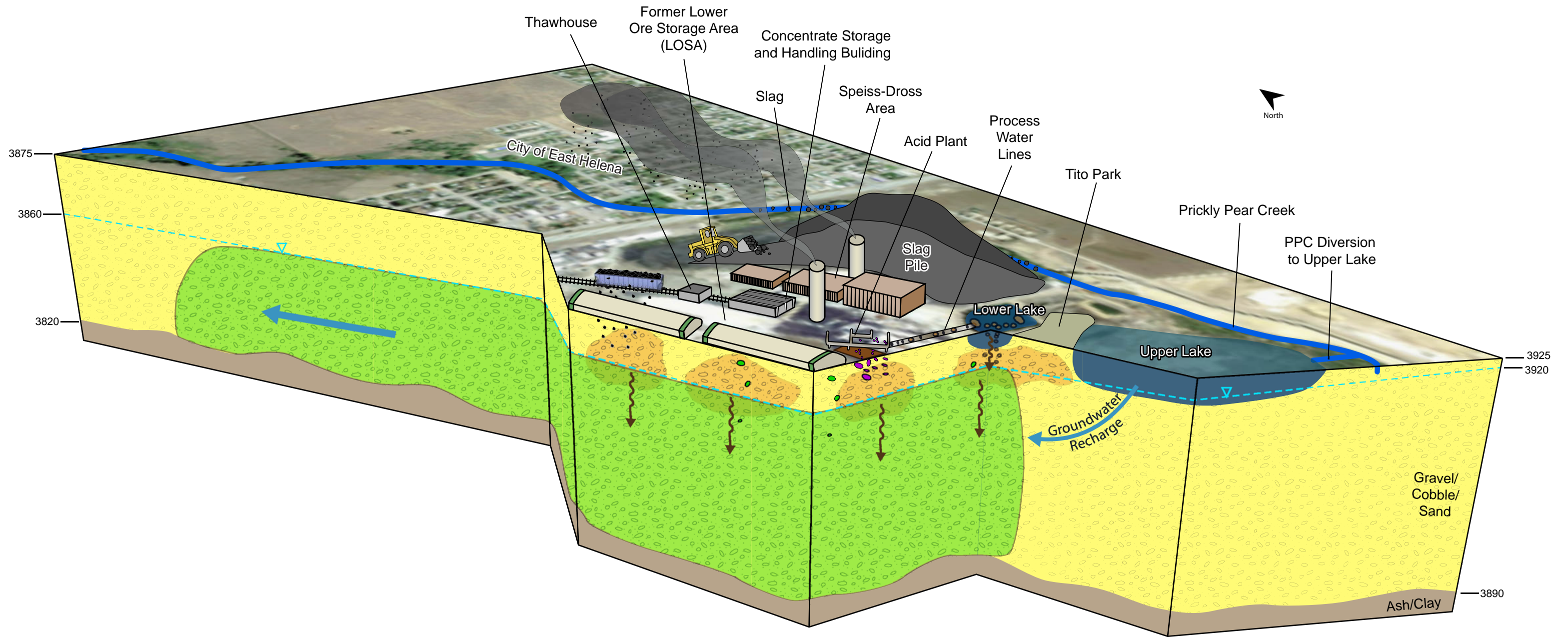
- Clean Backfill
- Evapotranspiration

NOTE:
 Darker colors represent higher contaminant concentrations.
 TPA = Tito Park area
 APSD = Acid plant settling drying bed
 AP - Acid plant
 ET - evapotranspiration
 SPHC IM - South Plant Hydraulic Control Interim Measure

Source Removal includes TPA, APSD slurry wall* and former AP Source Area

* APSD slurry wall breached down to Ash/Clay layer during source removal; wall not shown for clarity

Figure 3-25
Conceptual Model of Current Conditions
 Former ASARCO East Helena Facility Corrective Measures Study Report



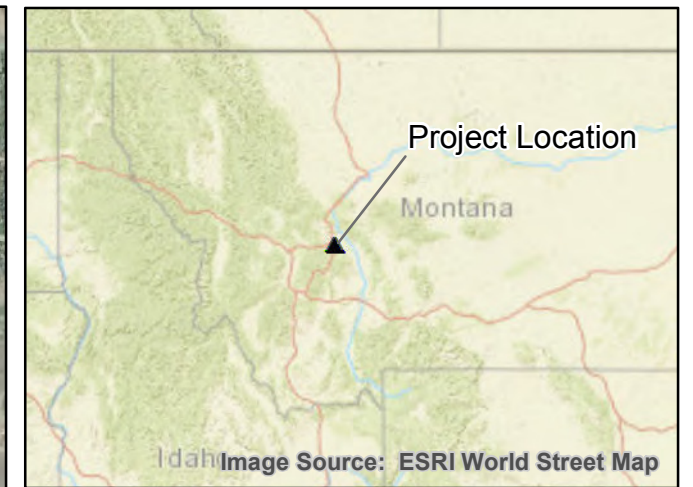
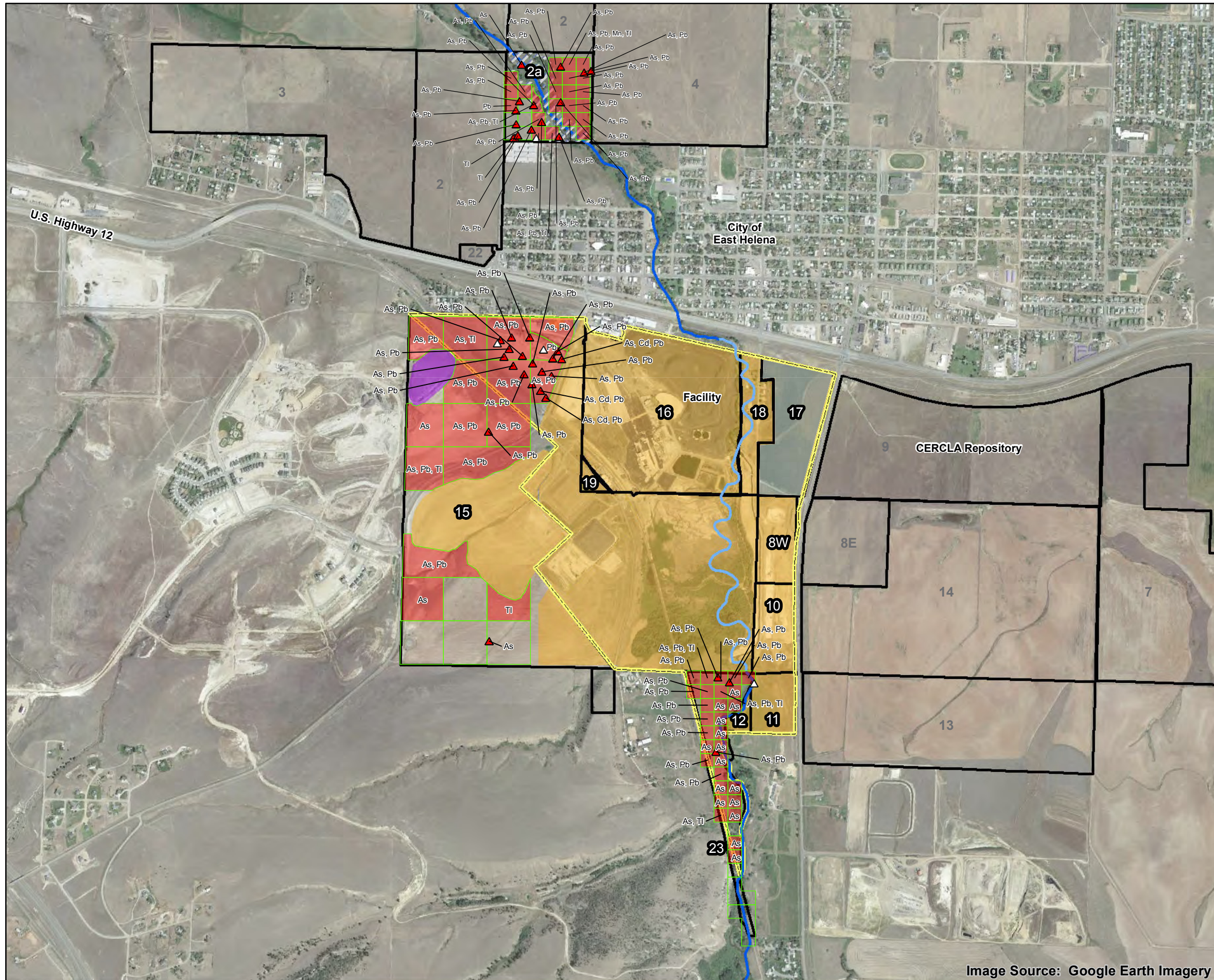
LEGEND

- Approximate Water Level
- Groundwater Flow Direction
- Plume
- Impacted Soil
- Process Water Leaks
- Infiltration/Leaching
- Fumed Slag
- Unfumed Slag
- Airborne Deposition
- Unfumed Slag Leachate
- Acid Plant Sediment Drying Bed
- Impacted Sediment

NOTE:
Darker colors represent higher contaminant concentrations.

Figure 3-26
Conceptual Model of Operational Smelter
(Through 2001)
Former ASARCO East Helena Facility
Corrective Measures Study Report
East Helena, Montana





LEGEND

- △ Historical Surface Soil Sample Location
- Supplemental RFI Sampled DU
- Exceeds Criteria
- CMS Parcel Undergoing Corrective Action
- Parcel Boundary
- Area of Contamination Boundary
- 100-year Floodplain (approx.)
- City of East Helena Former Landfill
- Prickly Pear Creek
- Prickly Pear Creek Realignment

Notes:

1. Red sample location exceeds residential use criteria for the metals shown.
As - arsenic
Cd - cadmium
Cr6 - hexavalent chromium
Pb - lead
Mn - manganese
Tl - thallium
2. DU = decision unit
3. Results compared to residential media cleanup standards (As and Pb) or Regional Screening Levels (Cd, Cr6, Mn, and Tl) as follows:
As - 35 milligrams per kilogram (mg/kg)
Cd - 71 mg/kg
Cr6 - 0.3 mg/kg
Pb - 400 mg/kg
Mn - 1,800 mg/kg
Tl - 0.78 mg/kg
4. CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
5. IM = Interim Measure
6. CMS = corrective measures study

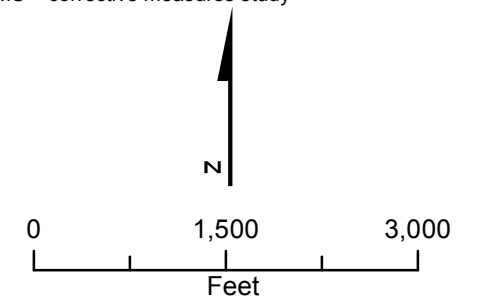
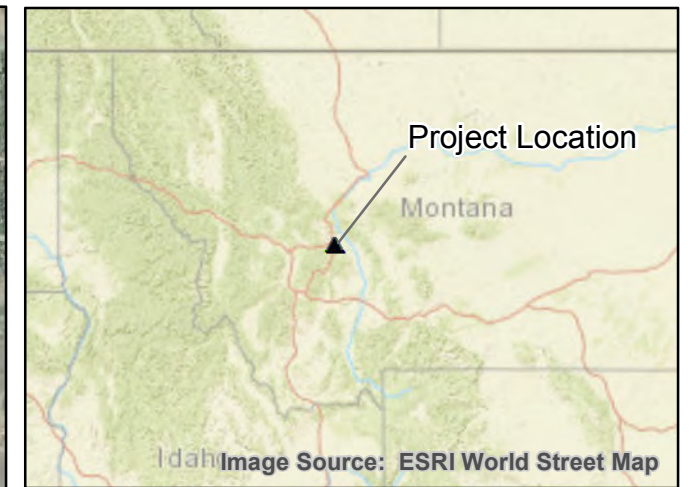
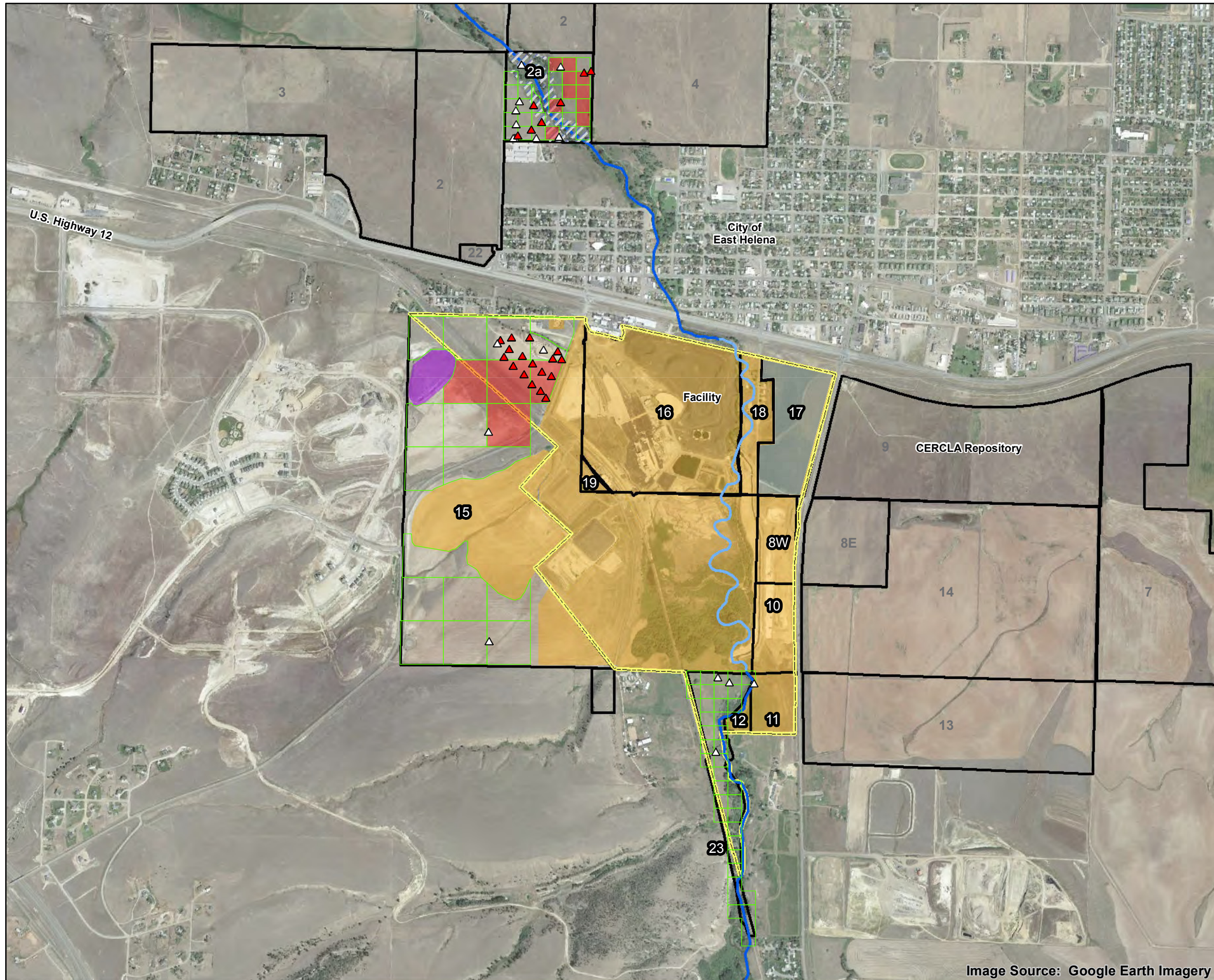


Figure 3-27
Comparison of Surface Soil Results to Residential Cleanup Standard
Former ASARCO East Helena Facility
Corrective Measures Study Report
East Helena, Montana



LEGEND

- △ Historical Surface Soil Sample Location
- Supplemental RFI Sampled DU
- Exceeds Criteria
- CMS Parcel Undergoing Corrective Action
- ▭ Parcel Boundary
- ▭ Area of Contamination Boundary
- ▨ 100-year Floodplain (approx.)
- City of East Helena Former Landfill
- Prickly Pear Creek
- Prickly Pear Creek Realignment

- Notes:
1. Red sample location exceeds industrial/commercial use criteria for lead (800 mg/kg).
 2. DU = decision unit
 3. RFI = Resource Conservation and Recover Act Facility Investigation
 4. CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
 5. IM = Interim Measure
 6. mg/kg = milligrams per kilogram
 7. CMS = corrective measures study

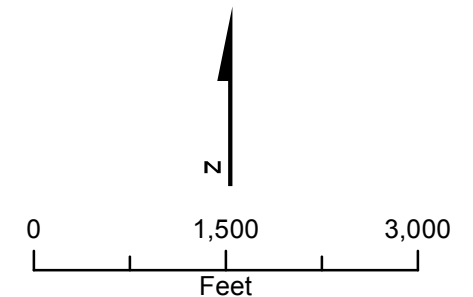
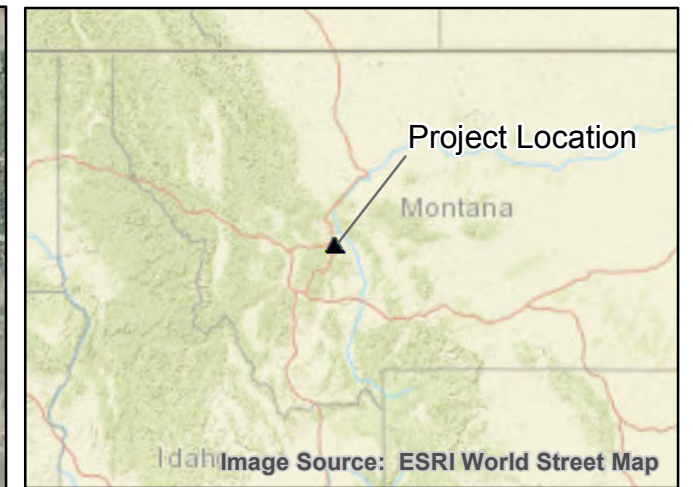
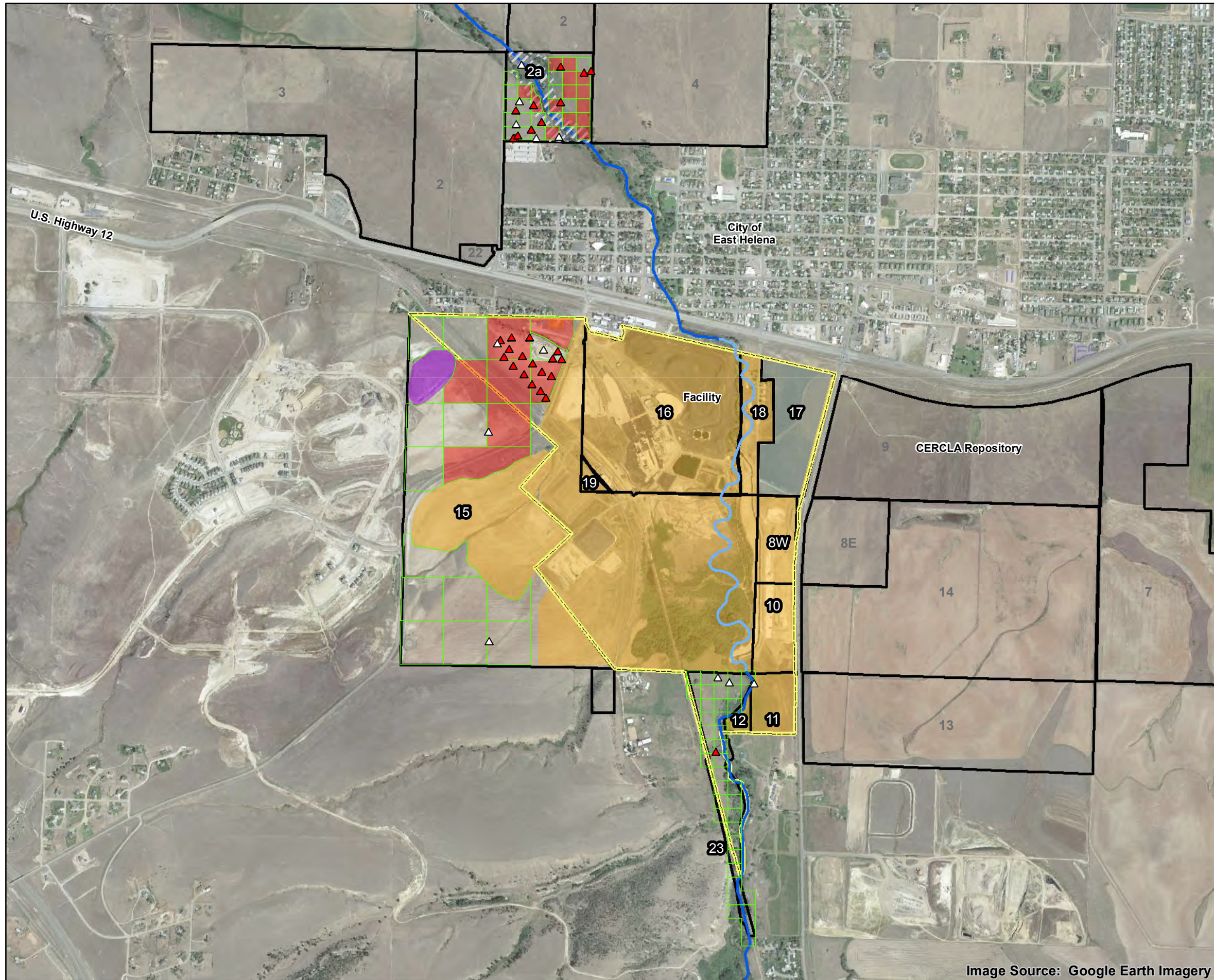


Figure 3-28
Comparison of Surface Soil Results to Industrial Media Cleanup Standard
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana

Image Source: Google Earth Imagery



LEGEND

- △ Historical Surface Soil Sample Location
- Supplemental RFI Sampled DU
- Exceeds Criteria
- CMS Parcel Undergoing Corrective Action
- Parcel Boundary
- Area of Contamination Boundary
- ▨ 100-year Floodplain (approx.)
- City of East Helena Former Landfill
- Prickly Pear Creek
- Prickly Pear Creek Realignment

- Notes:
1. Red sample location exceeds ecological media cleanup standard for lead of 650 mg/kg
 2. DU = decision unit
 3. RFI = Resource Conservation and Recovery Act Facility Investigation
 4. CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
 5. IM = Interim Measure
 6. mg/kg = milligrams per kilogram
 7. CMS = corrective measures study

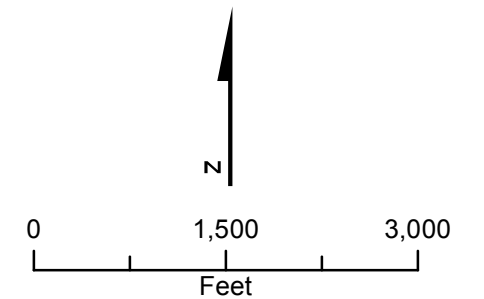
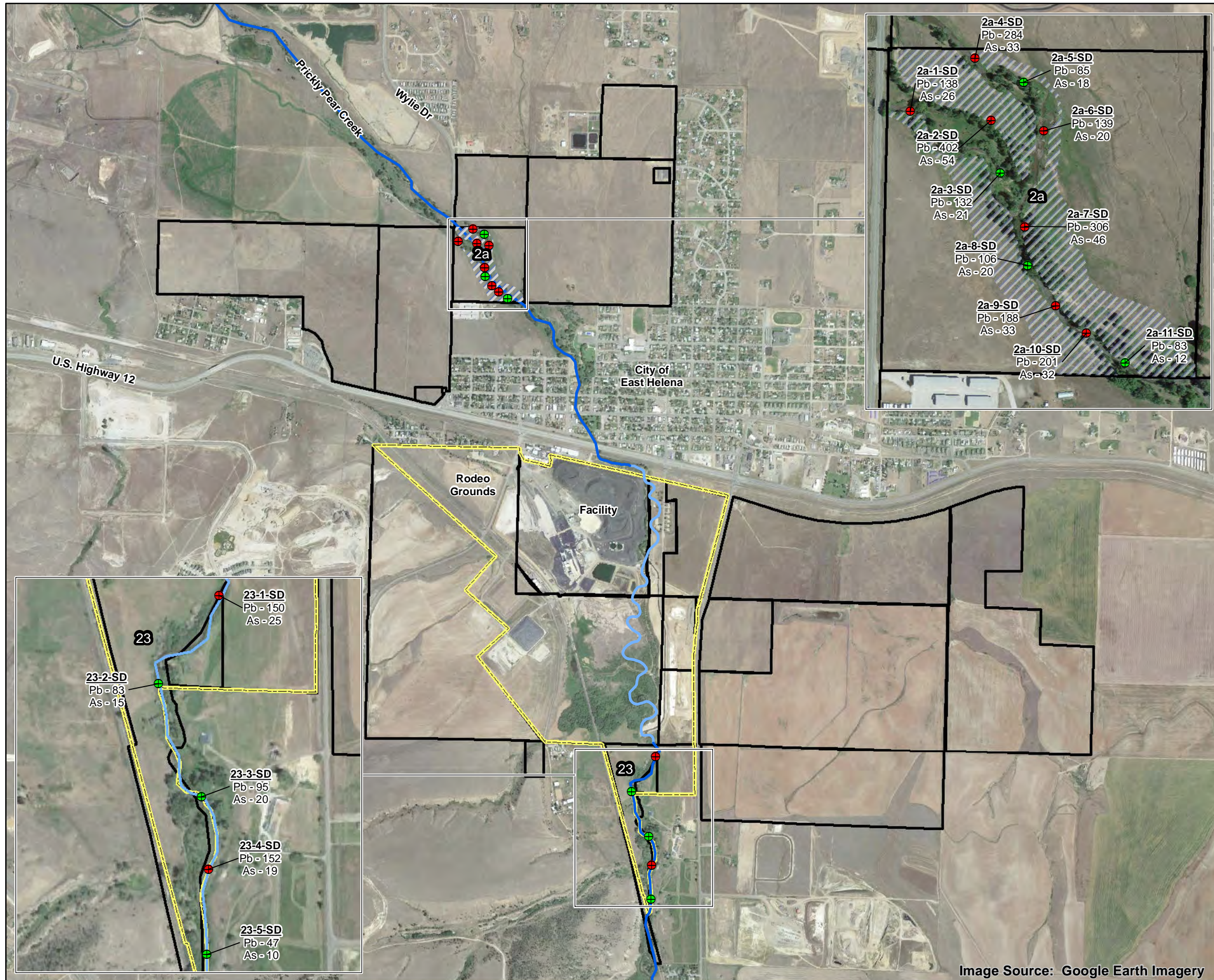


Figure 3-29
Comparison of Surface Soil Results to Ecological Media Cleanup Standard
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana

Image Source: Google Earth Imagery



LEGEND

- Sediment Sample Location (red exceeds criteria)
- Parcel Boundary
- Area of Contamination Boundary
- 100-year Floodplain (approx.)
- Prickly Pear Creek
- Prickly Pear Creek Realignment

- Notes:
1. Concentrations shown in milligrams per kilogram (mg/kg).
 2. Only lead (Pb) was detected above the no-effect level toxicity reference value of 123 mg/kg developed in the BERA.
 3. BERA - Final Baseline Ecological Risk Assessment (Gradient 2011)
 4. As - arsenic
 5. Analytical results are summarized in Table 3-7.

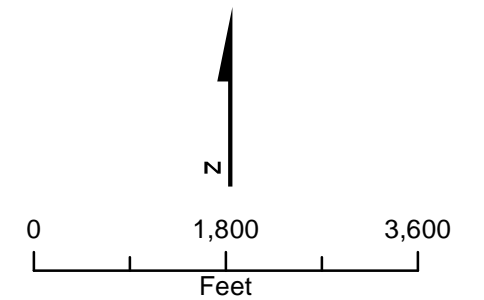


Figure 3-30
Extent of Arsenic and Lead in Sediment
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana

Image Source: Google Earth Imagery

DATE: 11/17/17 SHEET NUMBER: 31 OF 68 PROJECT: 1002111/1002111/0010000

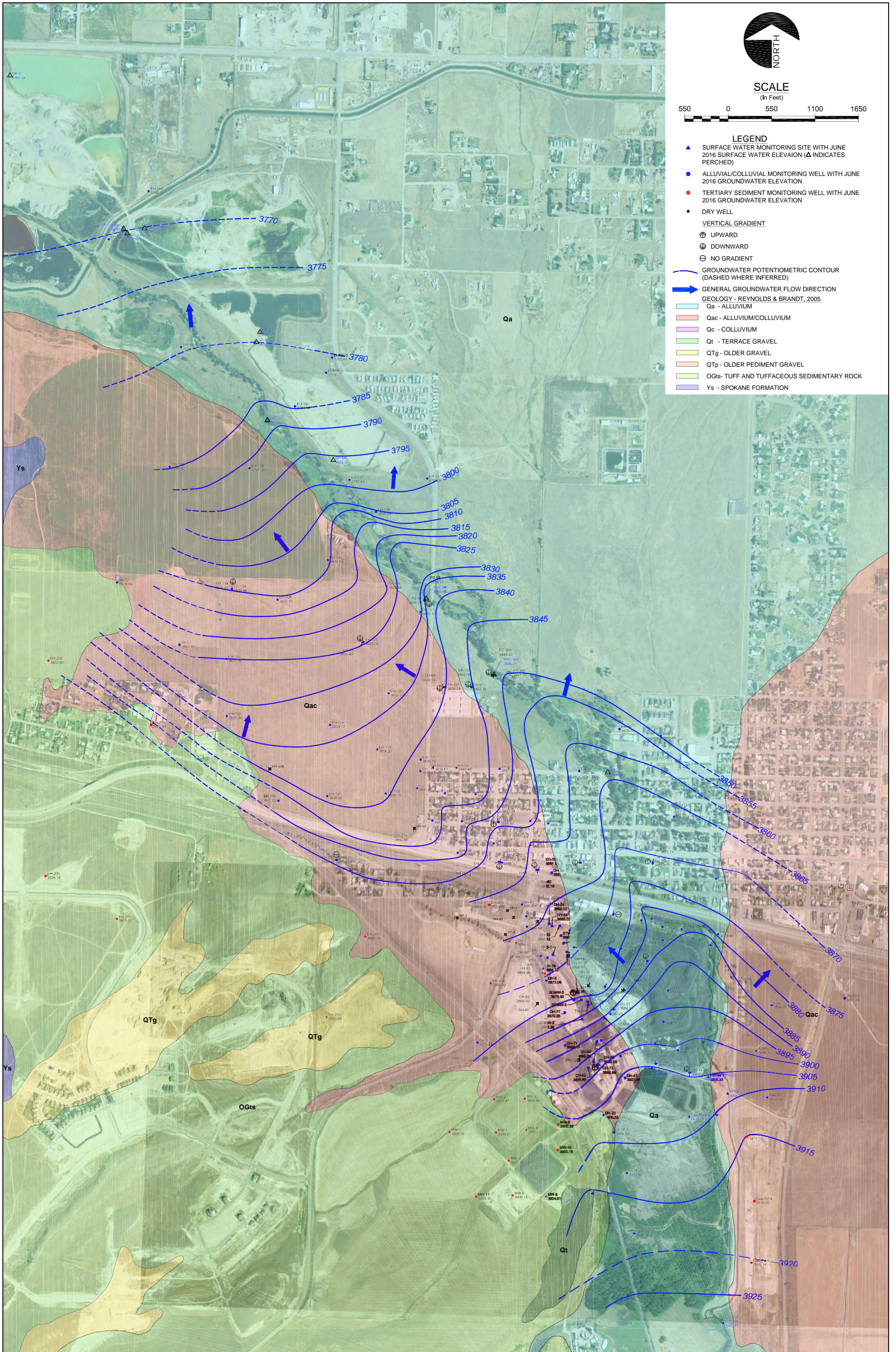
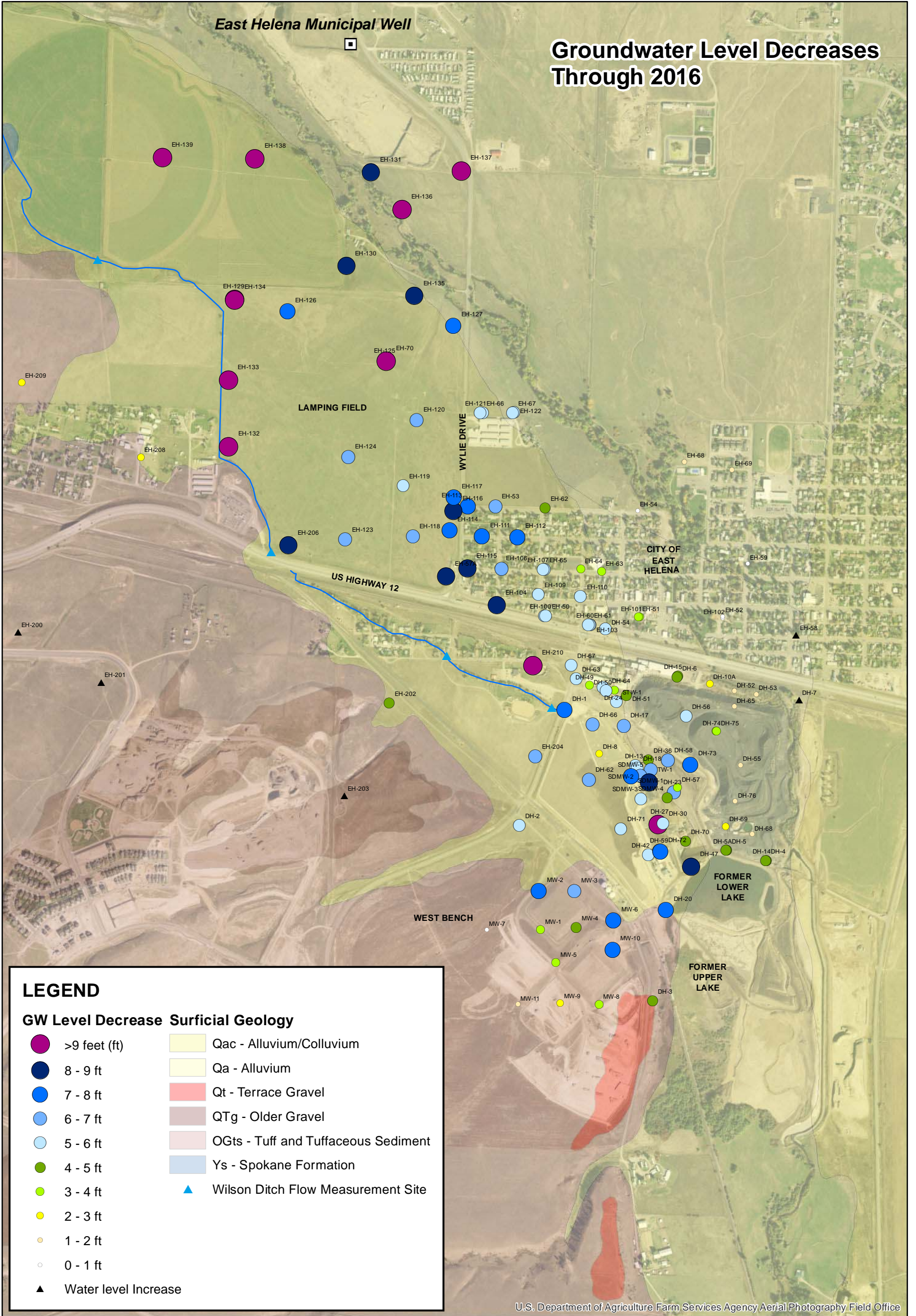


Figure 3-31
June 2016 Potentiometric Surface Map
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana

East Helena Municipal Well

Groundwater Level Decreases Through 2016

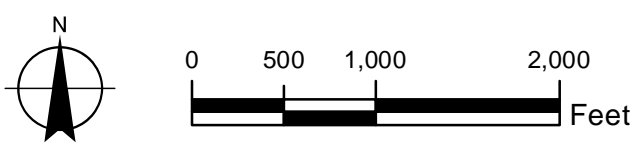


V:\110022\GIS\CMS Figures\SPHC_GWLevel_Changes_2016.mxd

LEGEND

GW Level Decrease	Surficial Geology
● >9 feet (ft)	Qac - Alluvium/Colluvium
● 8 - 9 ft	Qa - Alluvium
● 7 - 8 ft	Qt - Terrace Gravel
● 6 - 7 ft	QTg - Older Gravel
● 5 - 6 ft	OGts - Tuff and Tuffaceous Sediment
● 4 - 5 ft	Ys - Spokane Formation
● 3 - 4 ft	▲ Wilson Ditch Flow Measurement Site
● 2 - 3 ft	
● 1 - 2 ft	
○ 0 - 1 ft	
▲ Water level Increase	

U.S. Department of Agriculture Farm Services Agency Aerial Photography Field Office



NOTE: Groundwater level changes shown were calculated as the difference between 2002 -2010 average elevations and 2016 average elevations.

Created by Hydrometrics, Inc.: 11/18/2016 11:50:08 AM



SCO671189.64.07.01 SPHC_GWLevel_Changes_2016.ai 11/16

Figure 3-32
Relative Changes in Water Levels
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana



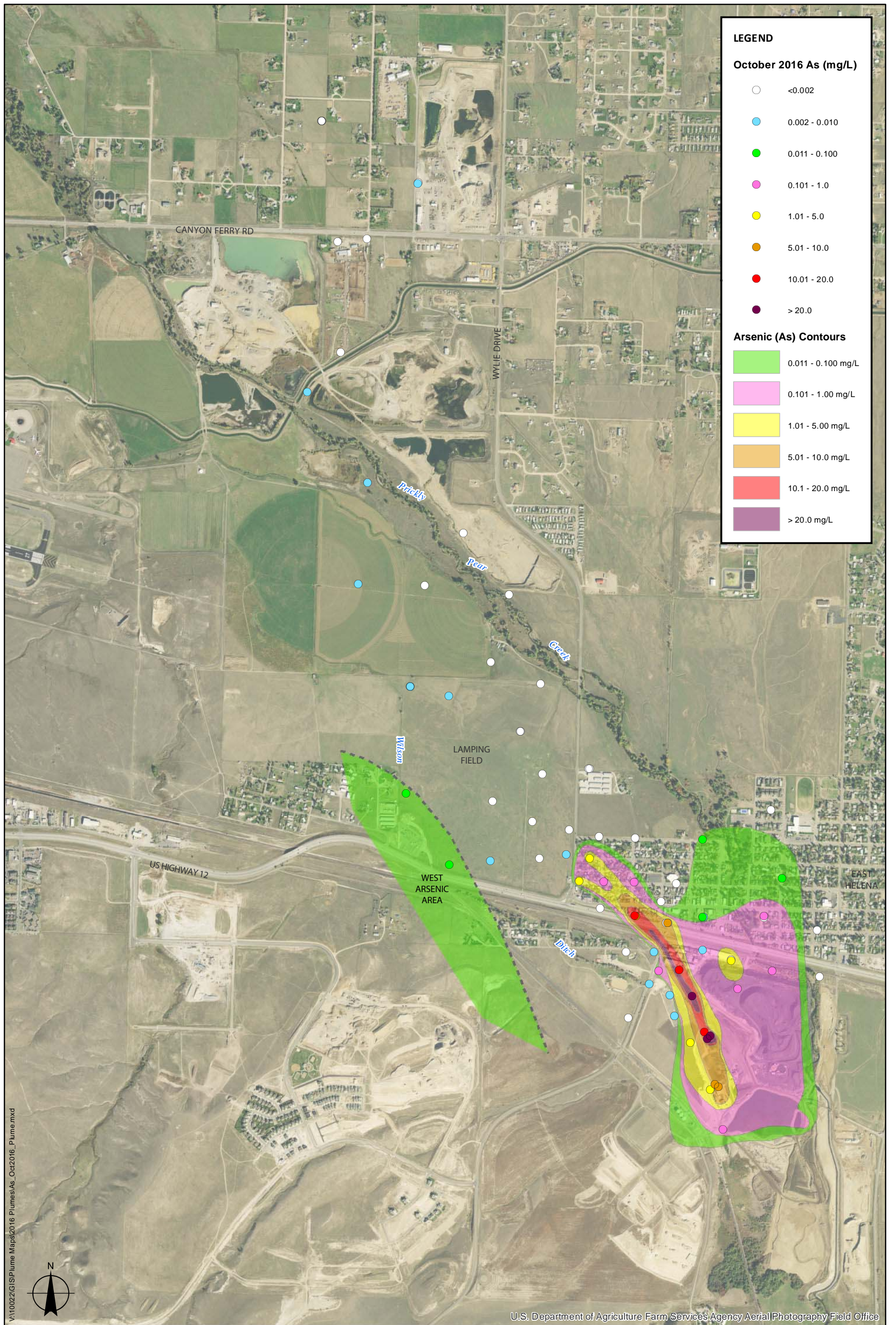


Figure 3-33
October 2016 Dissolved Arsenic
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana

Notes:
 1. mg/L - milligrams per liter
 2. West Arsenic Area - Occurs primarily from groundwater interaction with naturally-occurring arsenic-bearing soil and is not facility related.

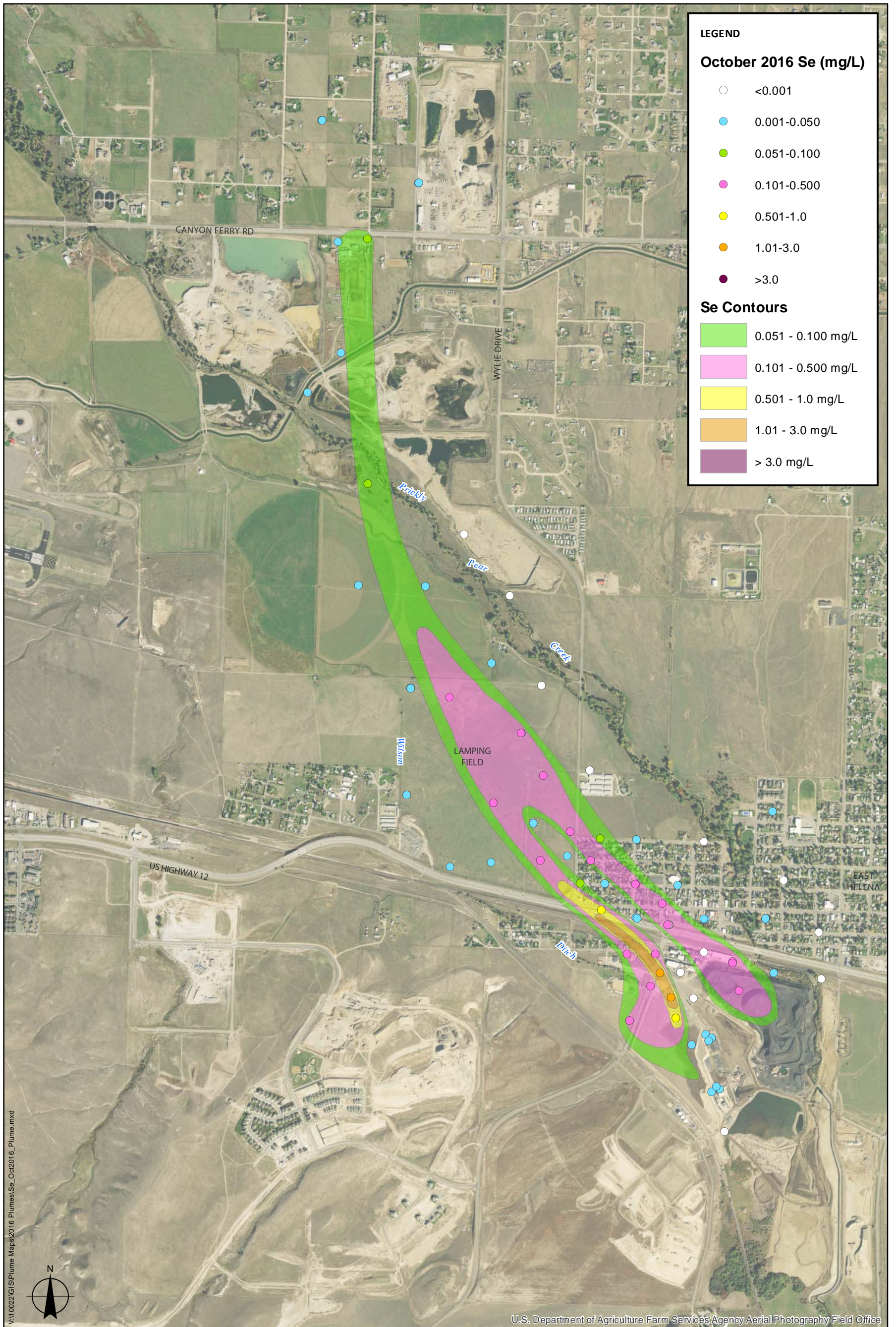


Figure 3-34
October 2016 Dissolved Selenium
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana

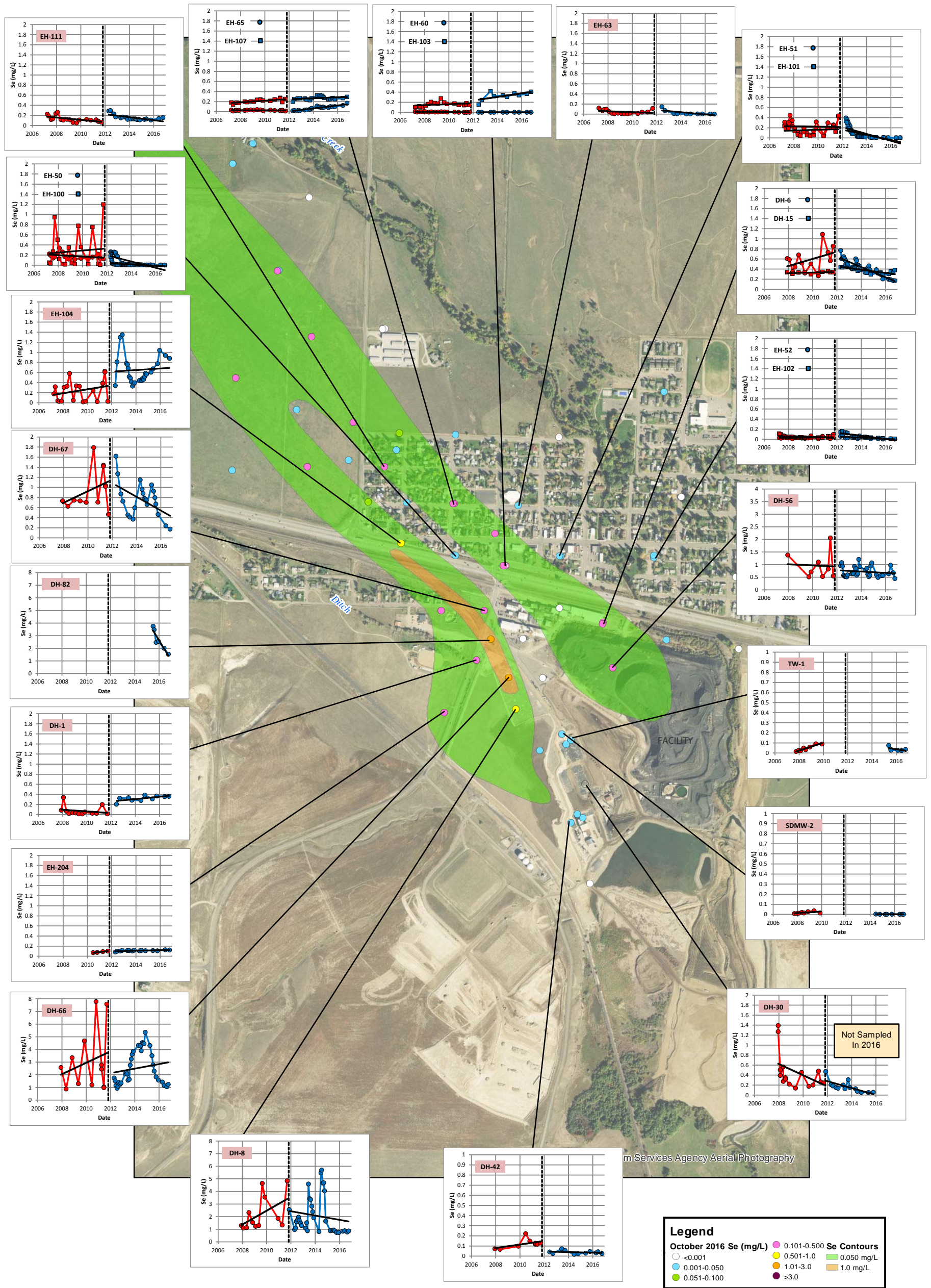


Figure 3-35
Selenium Trends Through October 2016
Plant Area Wells
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana

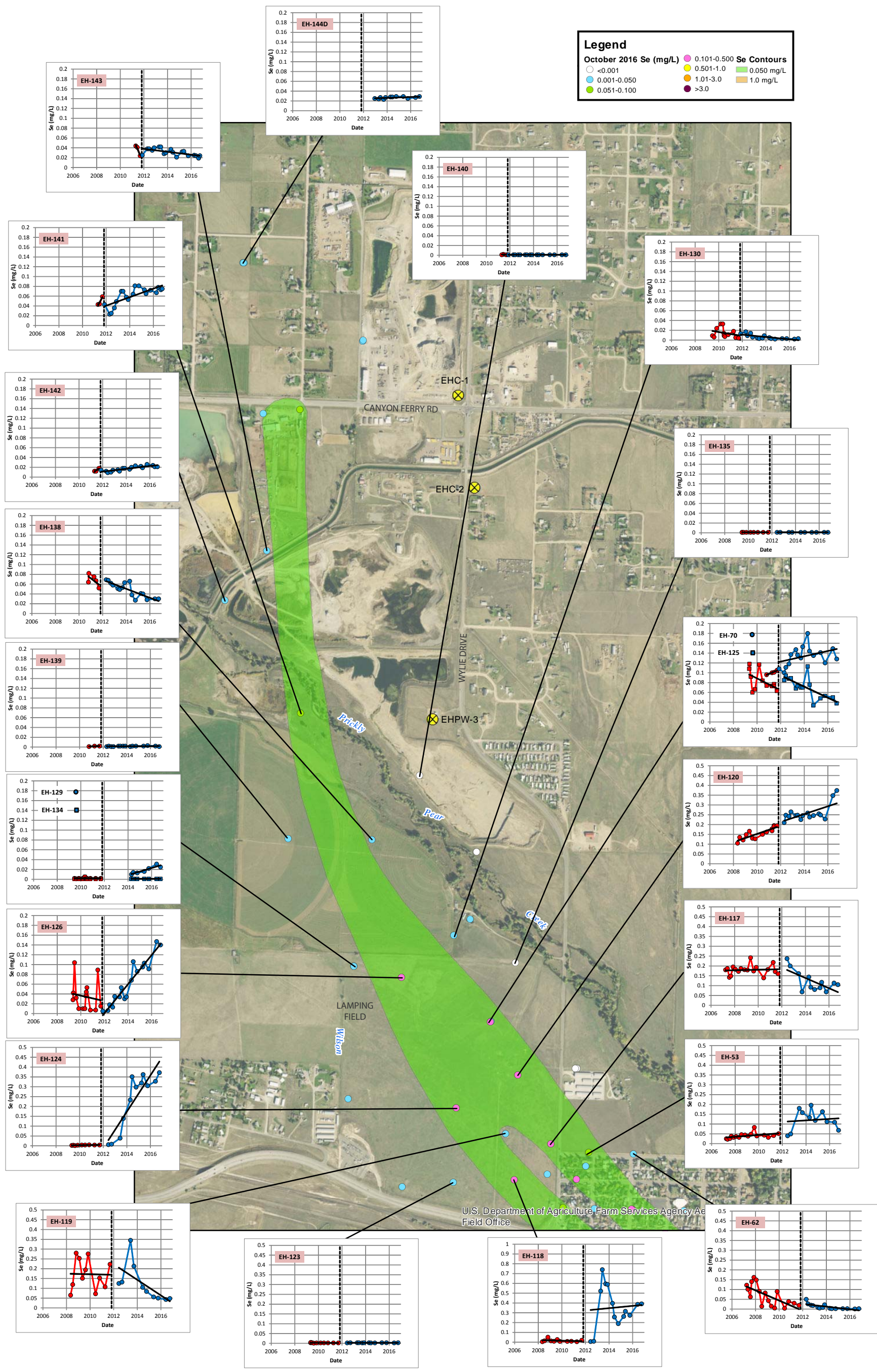


Figure 3-36
Selenium Trends Through October 2016
Downgradient Area
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana

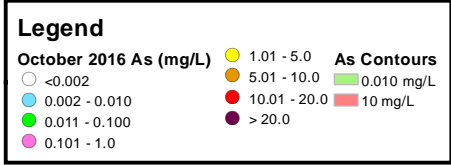
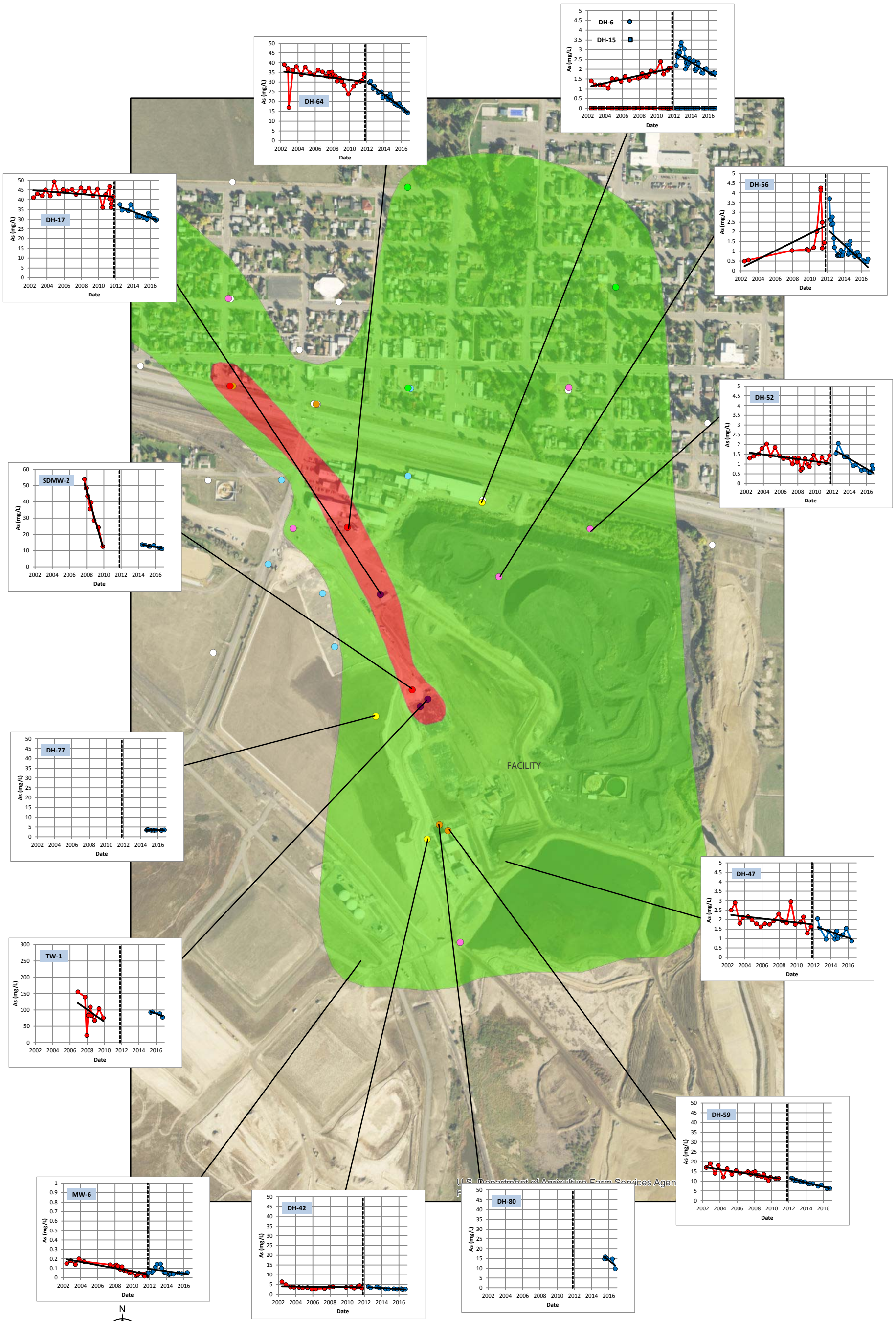
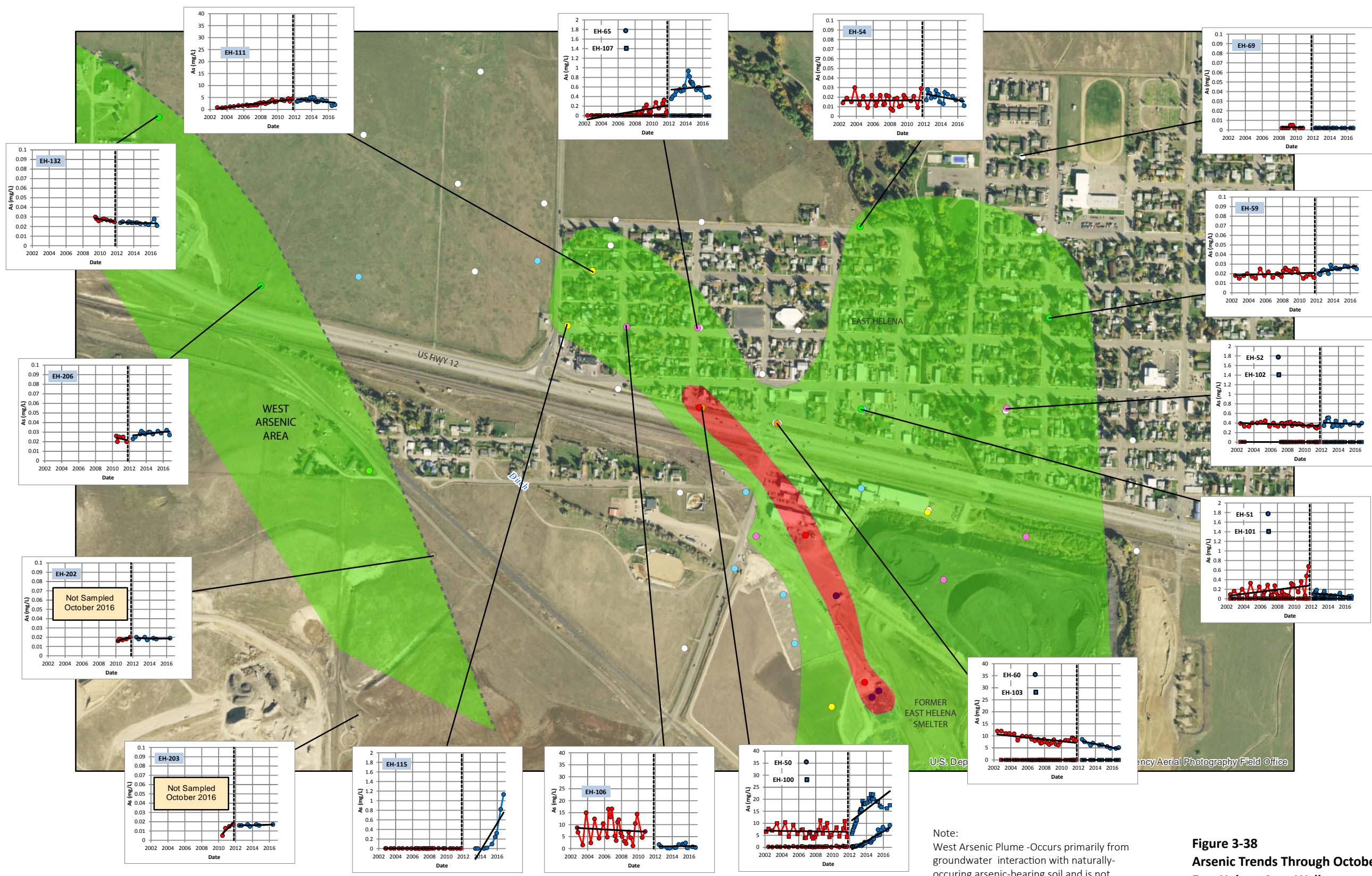


Figure 3-37
Arsenic Trends Through October 2016
Plant Area Wells
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana

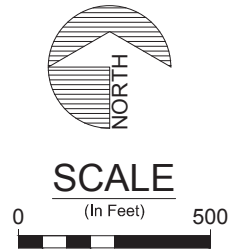


Note:
West Arsenic Plume -Occurs primarily from groundwater interaction with naturally-occurring arsenic-bearing soil and is not facility related.

Figure 3-38
Arsenic Trends Through October 2016
East Helena Area Wells
Former ASARCO East Helena Facility
Corrective Measures Study Report
East Helena, Montana

Produced by:
Hydrometrics, Inc.
Consulting Scientists and Engineers





ESTIMATED VOLUMES

TOTAL SLAG PILE	3,560,000 CY
POST-1982 UNFUMED PILE	585,000 CY

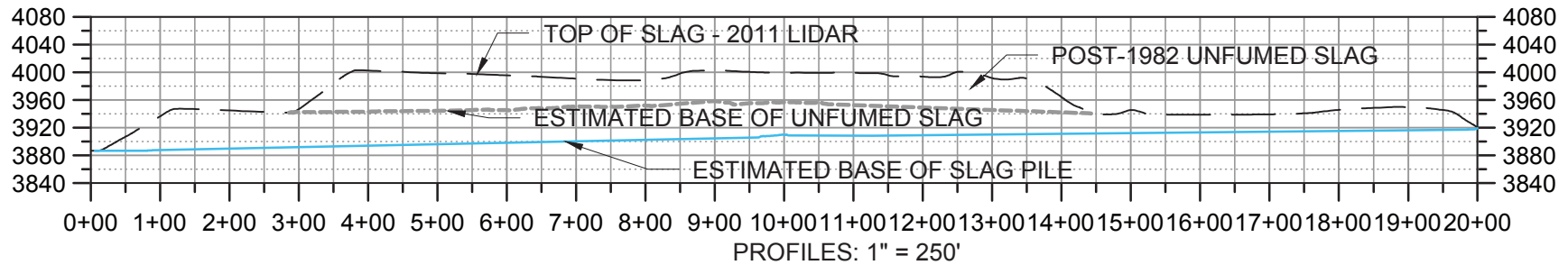
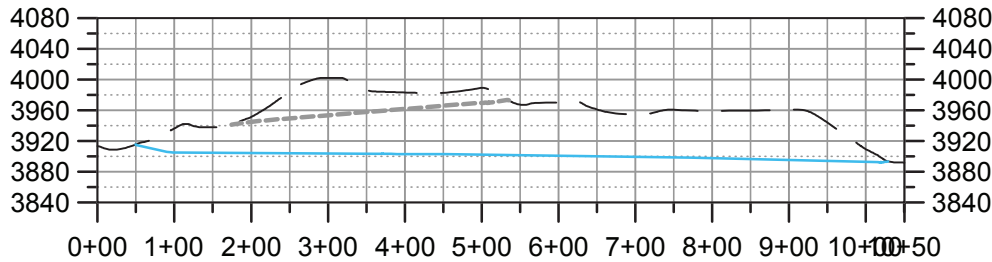
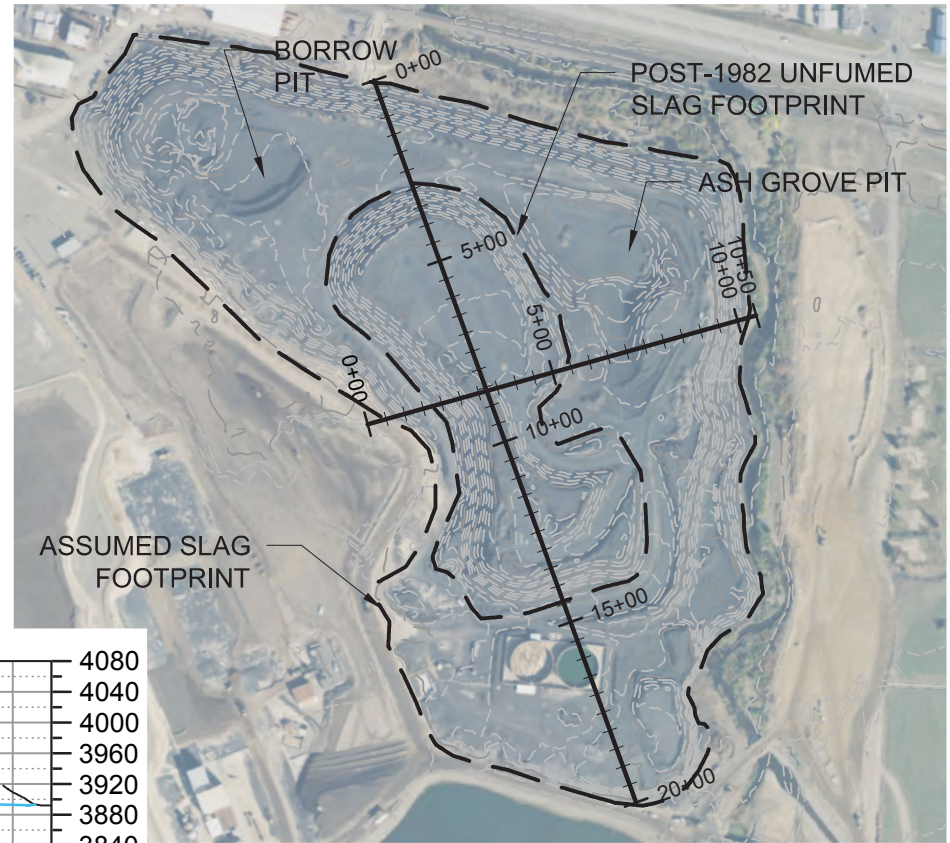
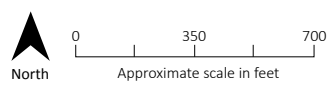
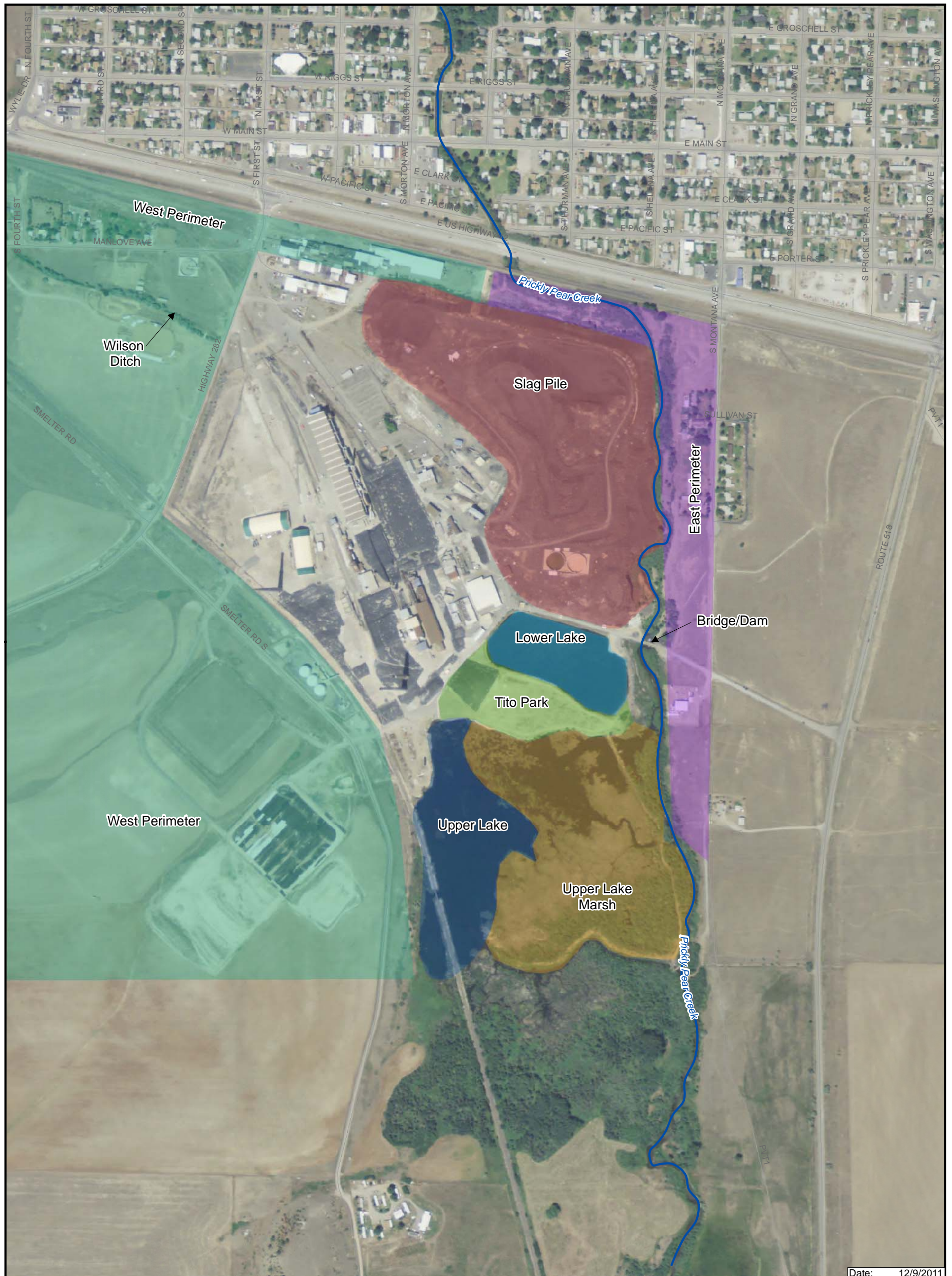


Figure 3-39
Slag Pile Topography
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana



MAP REFERENCES:
1) Montana NRIS, 2009.


Notes:
2009 aerial photography.
Figure developed by Gradient (2010). 

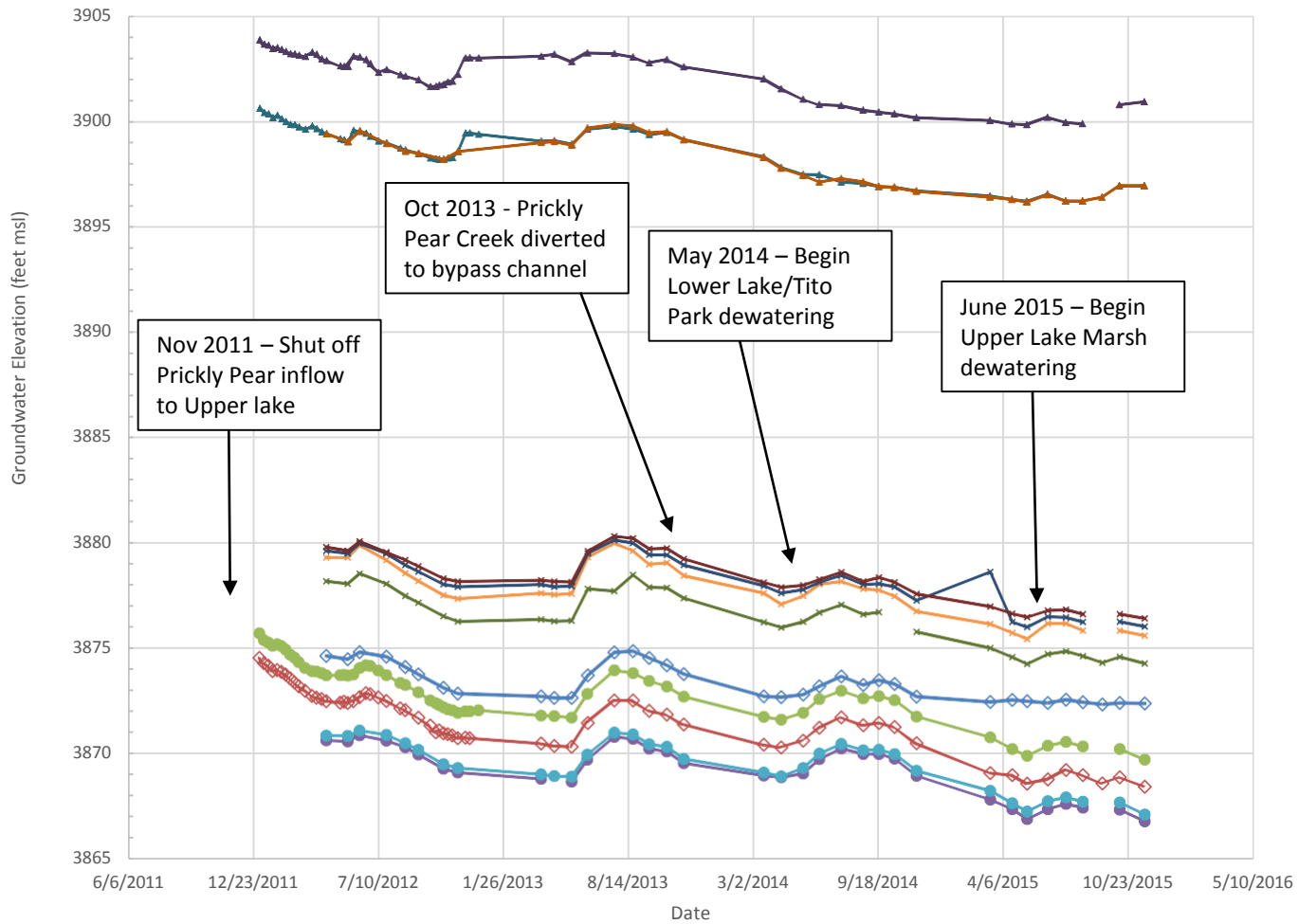
Figure 4-1
Areas Evaluated in the Baseline Ecological Risk Assessment
Former ASARCO East Helena Facility
Corrective Measures Study Report
East Helena, Montana



CMS Report Elements	2012				2013				2014				2015				2016			
	1st Q	2nd Q	3rd Q	4th Q	1st Q	2nd Q	3rd Q	4th Q	1st Q	2nd Q	3rd Q	4th Q	1st Q	2nd Q	3rd Q	4th Q	1st Q	2nd Q	3rd Q	4th Q
IM Implementation																				
MVS Evaluations & Report																				
2014 Source Area Inventory																				
2014 Source Area Investigation (SAI)																				
2014 SAI Summary Report																				
2015 SAI																				
2015 SAI Summary Report																				
GW Flow & CFT Model																				
2015 Screening-Level Remedy Evaluations																				
2016 Detailed Remedy Evaluations																				
2016 Slag Pile CSM and Remedy Evaluations																				
2016 Supplemental Modeling & Final Recommendations																				

Figure 5-1
CMS Report Program Elements
Former ASARCO East Helena Facility
Corrective Measures Study Report
East Helena, Montana

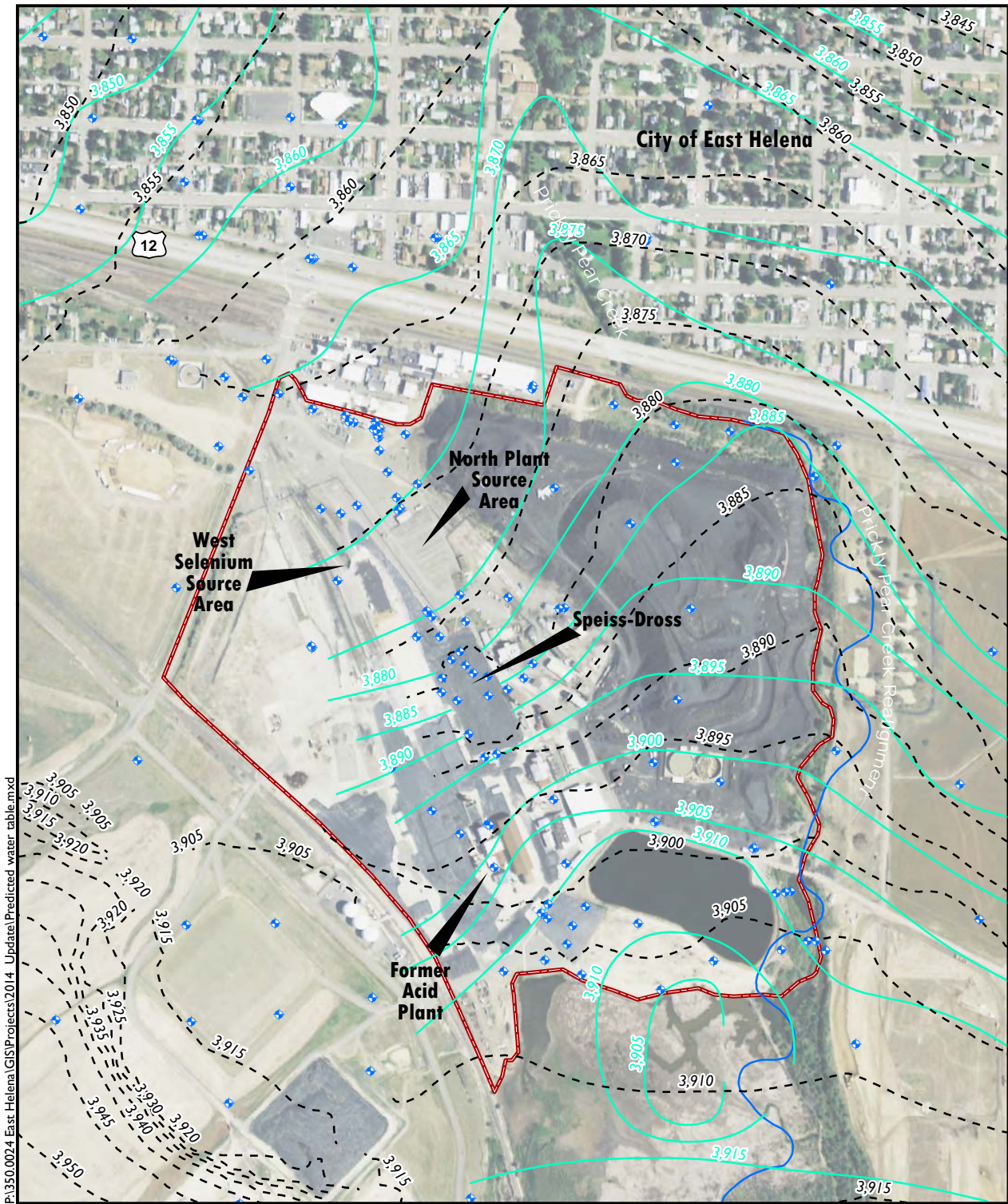




- ◆ DH-8 (West Selenium)
- ◇ DH-66 (West Selenium)
- DH-17 (North Plant)
- DH-24 (North Plant)
- DH-64 (North Plant)
- SDMW-1 (Speiss-Dross)
- ×— SDMW-2 (Speiss-Dross)
- ×— SDMW-5 (Speiss-Dross)
- ×— DH-13 (Speiss-Dross)
- DH-19R (Acid Plant)
- DH-42 (Acid Plant)
- DH-59 (Acid Plant)

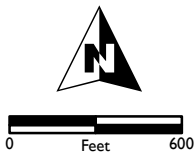
Figure 5-2
Groundwater Elevation Hydrograph for Indicator Wells
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana





P:\350.0024 East Helena\GIS\Projects\2014 Update\Predicted water table.mxd

Source: NAIP, 2013; METG, 2011



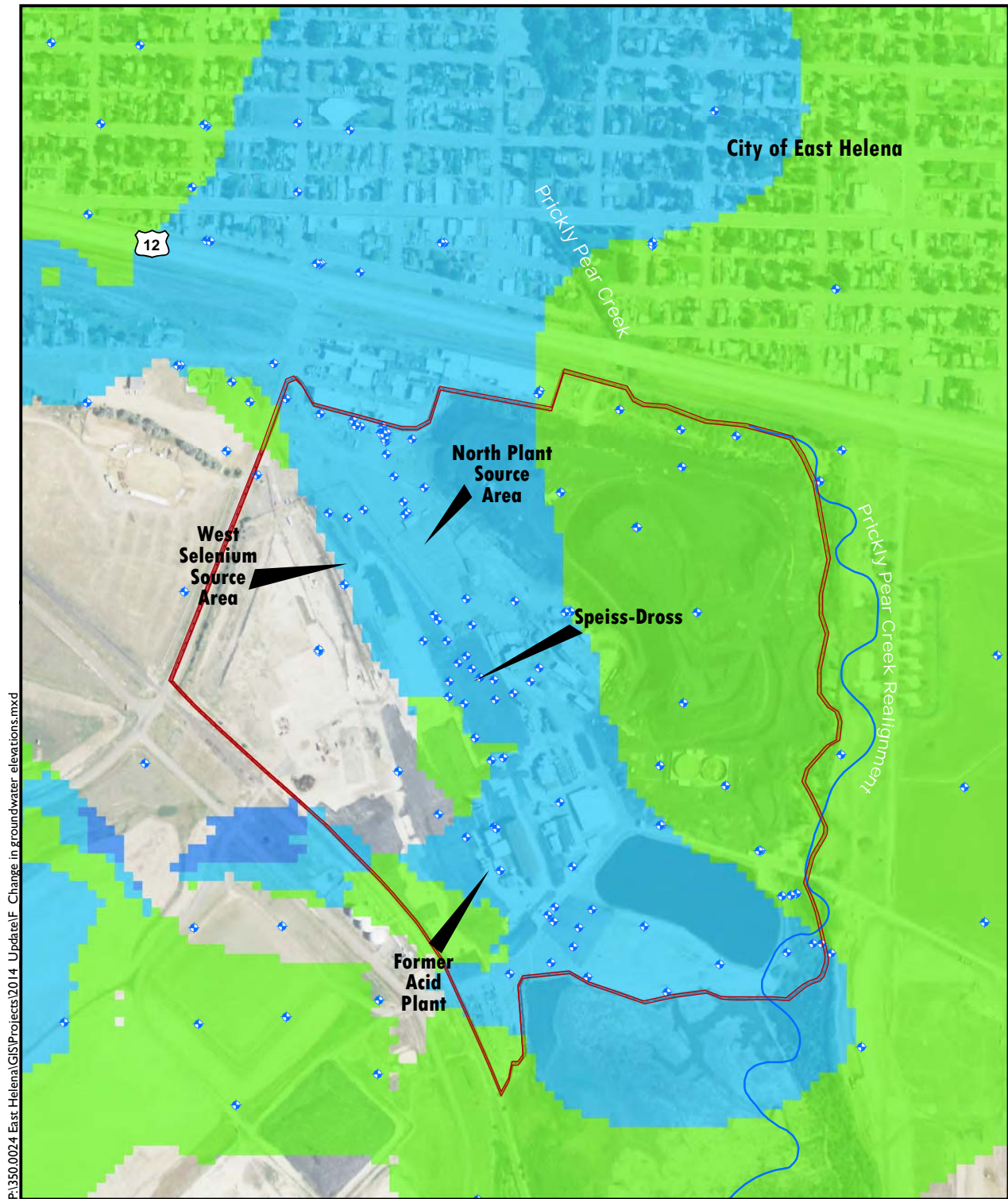
- + Monitoring Well
- - Simulated Potentiometric Contours (Layer 3)
- October 2015 Potentiometric Contours (Hydrometrics)
- Facility Boundary

Figure 5-3
Predicted Potentiometric Surface Elevations for 10-Year Simulation of IM Implementation

*Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana*

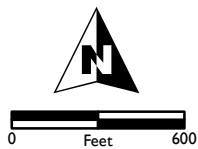
Created by:
NewFields





F:\350.0024 East Helena\GIS\Projects\2014 Update\F_Change in groundwater elevations.mxd

Source: NAIP, 2013; METG, 2011



- ◆ Monitoring Well
- Facility Boundary

Note: Change in groundwater elevation is the difference between the July-September quarter of the IM simulation and the 2014 calibration.

Change in Groundwater Elevation - Layer 3 (feet)

- < -5.0
- 2.5 to -5.0
- 0 to -2.5

Figure 5-4
Predicted Change in Groundwater Elevations for 10-Year Simulation of IM Implementation

*Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana*

Created by:



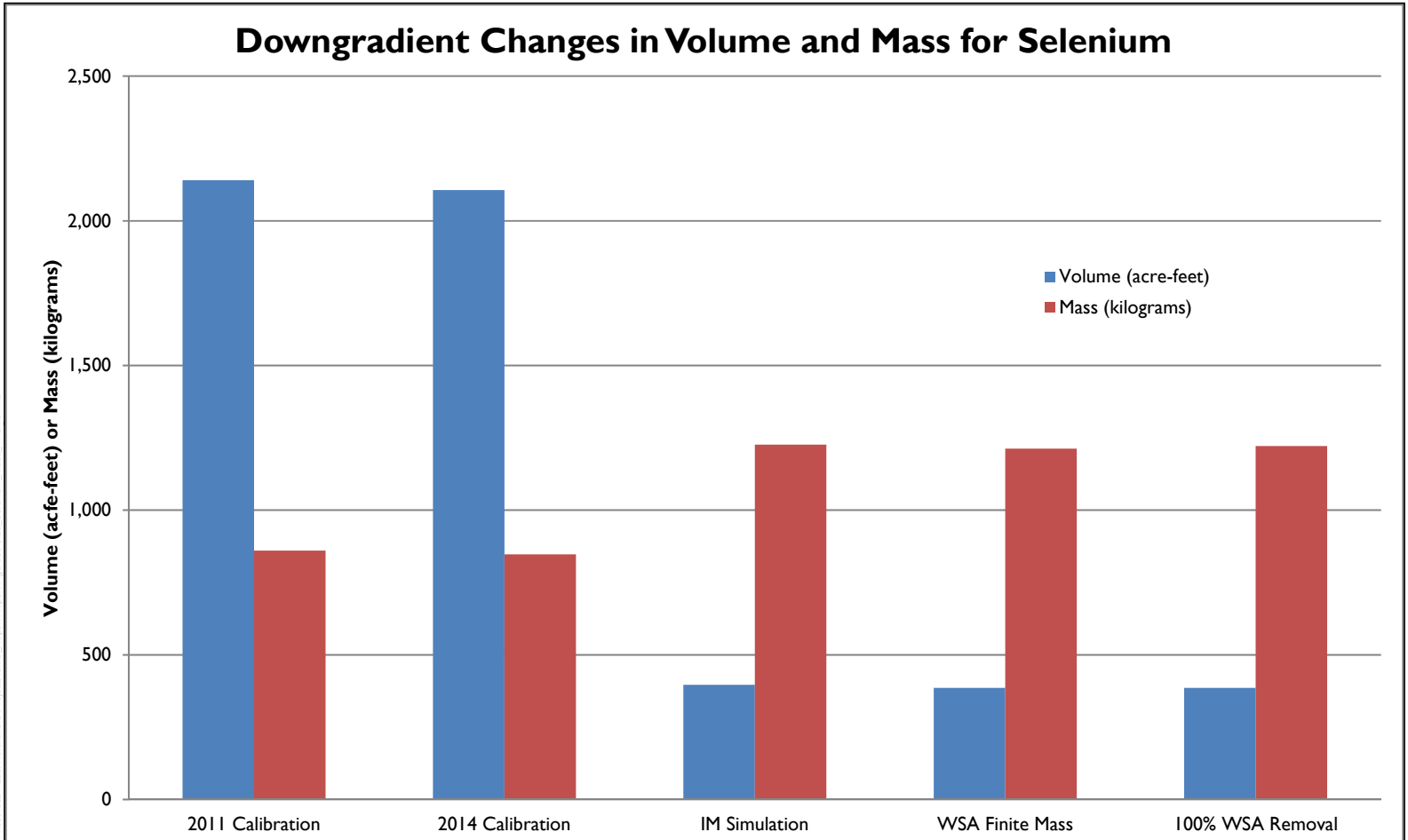
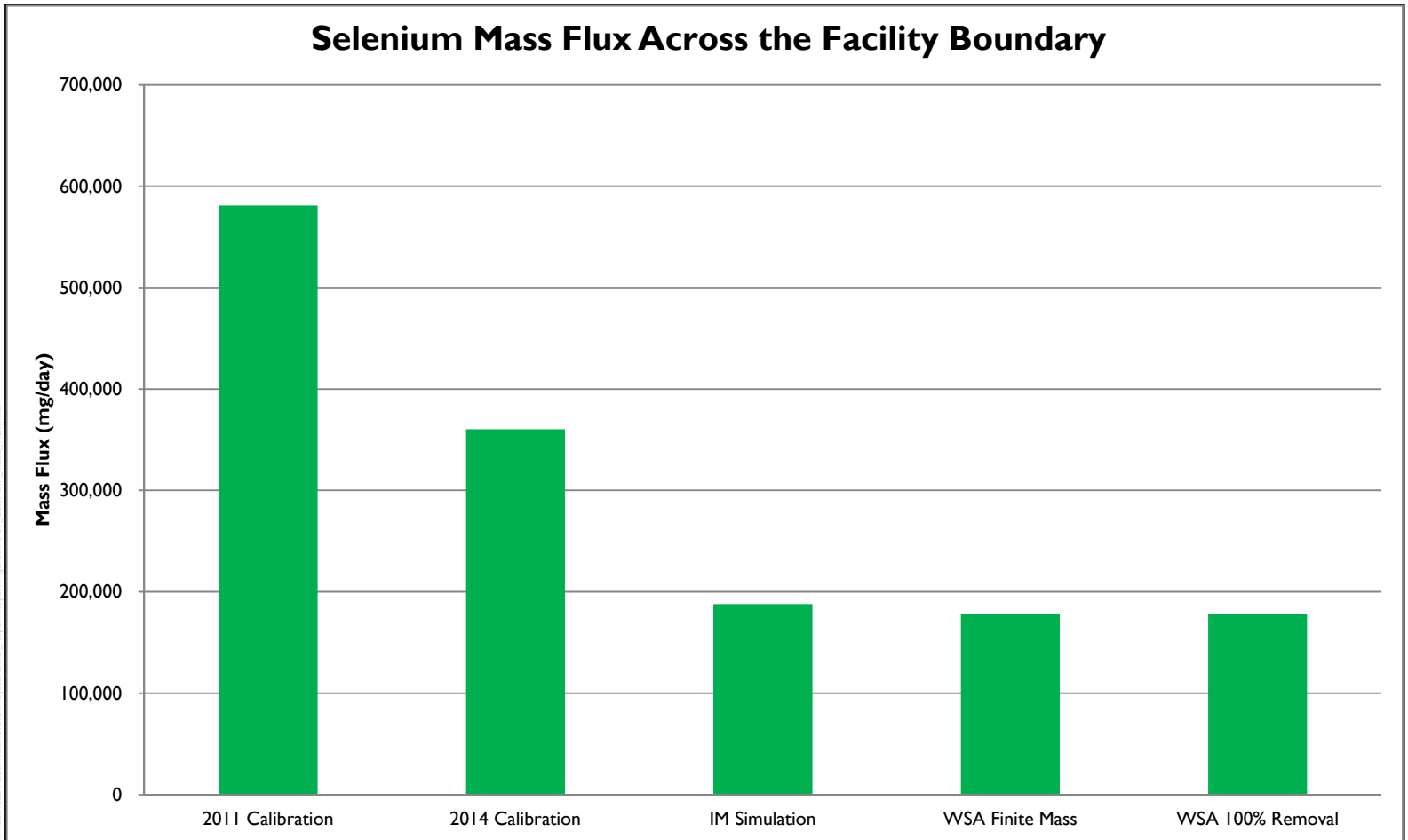


Figure 5-5
Predicted Change in Selenium Volume/Mass
for Source Control Measures
Former ASARCO East Helena Facility
Corrective Measures Study Report
East Helena, Montana

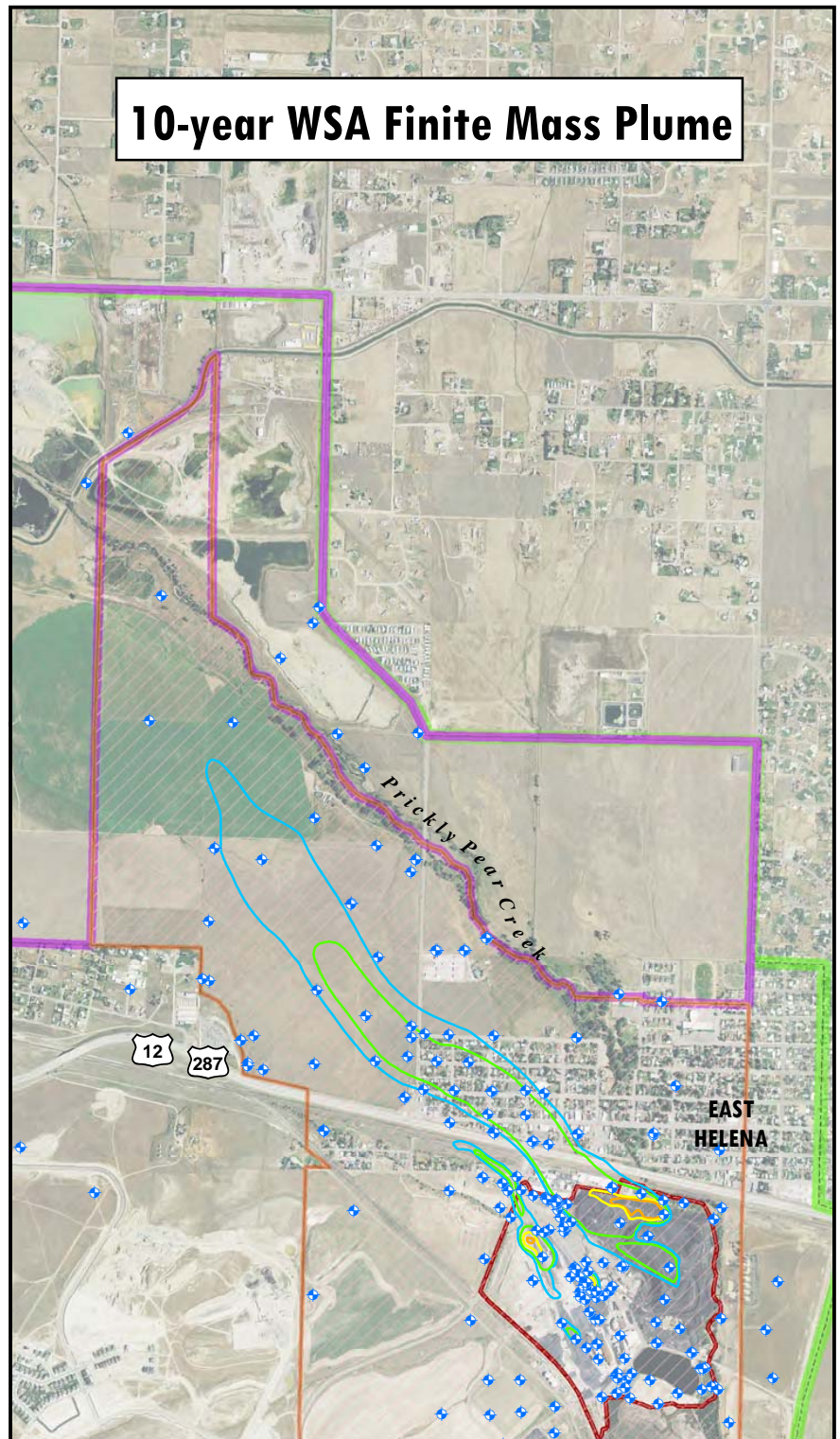
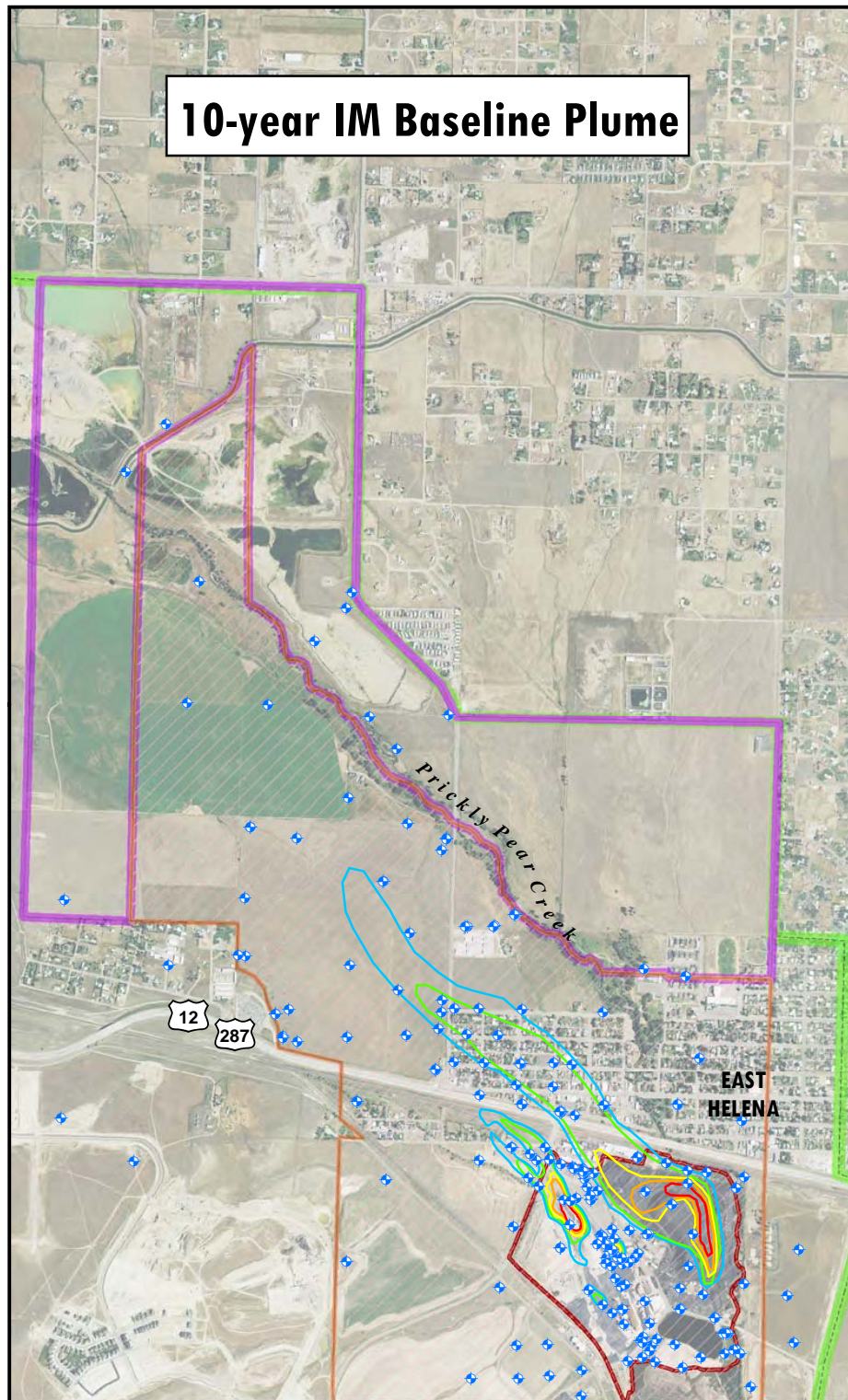
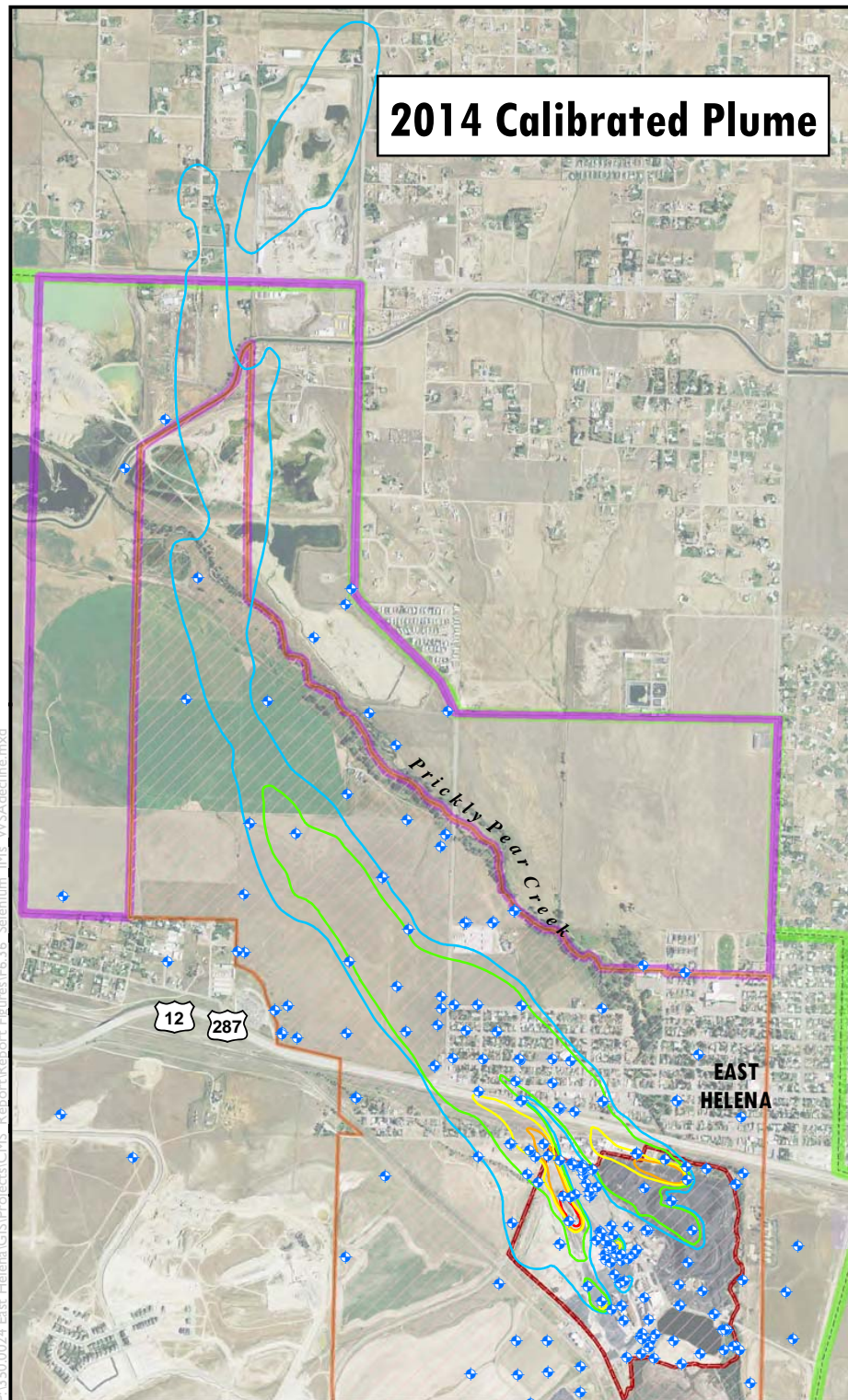
- Notes:
- 1) See Appendix B for detailed information regarding model operations and predictions
 - 2) WSA = West Selenium Area.
 - 3) Results are from NewFields (2016a).



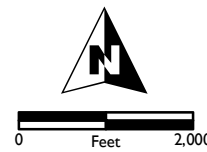
D:\2016_2017_EH_HealthImpact\Projects\EHIS\05_05\Report\Report\Figures\Fig 5-6_Selenium_Mass_Flow.mxd

Figure 5-6
Predicted Change in Selenium Mass Flux
Across the Facility Boundary
Former ASARCO East Helena Facility
Corrective Measures Study Report
East Helena, Montana

- Notes:
- 1) See Appendix B for detailed information regarding model operations and predictions
 - 2) mg/day = milligrams per day; WSA = West Selenium Area.
 - 3) Results are from NewFields (2016a).



Source: NAIR, 2013; METG, 2011



Notes:

- 1) Simulated plumes represent a composite of model layers 1, 2, 3, and 4.
- 2) Predictive results depict concentrations in stress period 66, after model has reached steady-state.
- 3) mg/L = milligram per liter; CGWA = Controlled Groundwater Area.
- 4) Results are from NewFields (2016a).
- 5) Refer to Appendix B for further details of model operations and predictions

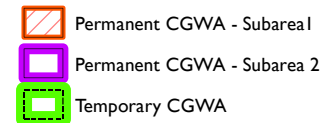
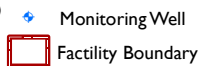
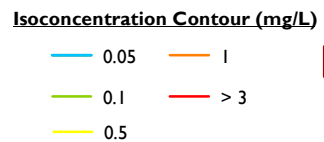


Figure 5-7
Transient Flow and Transport Predicted Isoconcentration Contours
Selenium Interim Measure Baseline and West Selenium Source
Area Finite Mass Simulations
Former ASARCO East Helena Facility
Corrective Measures Study Report
East Helena, Montana

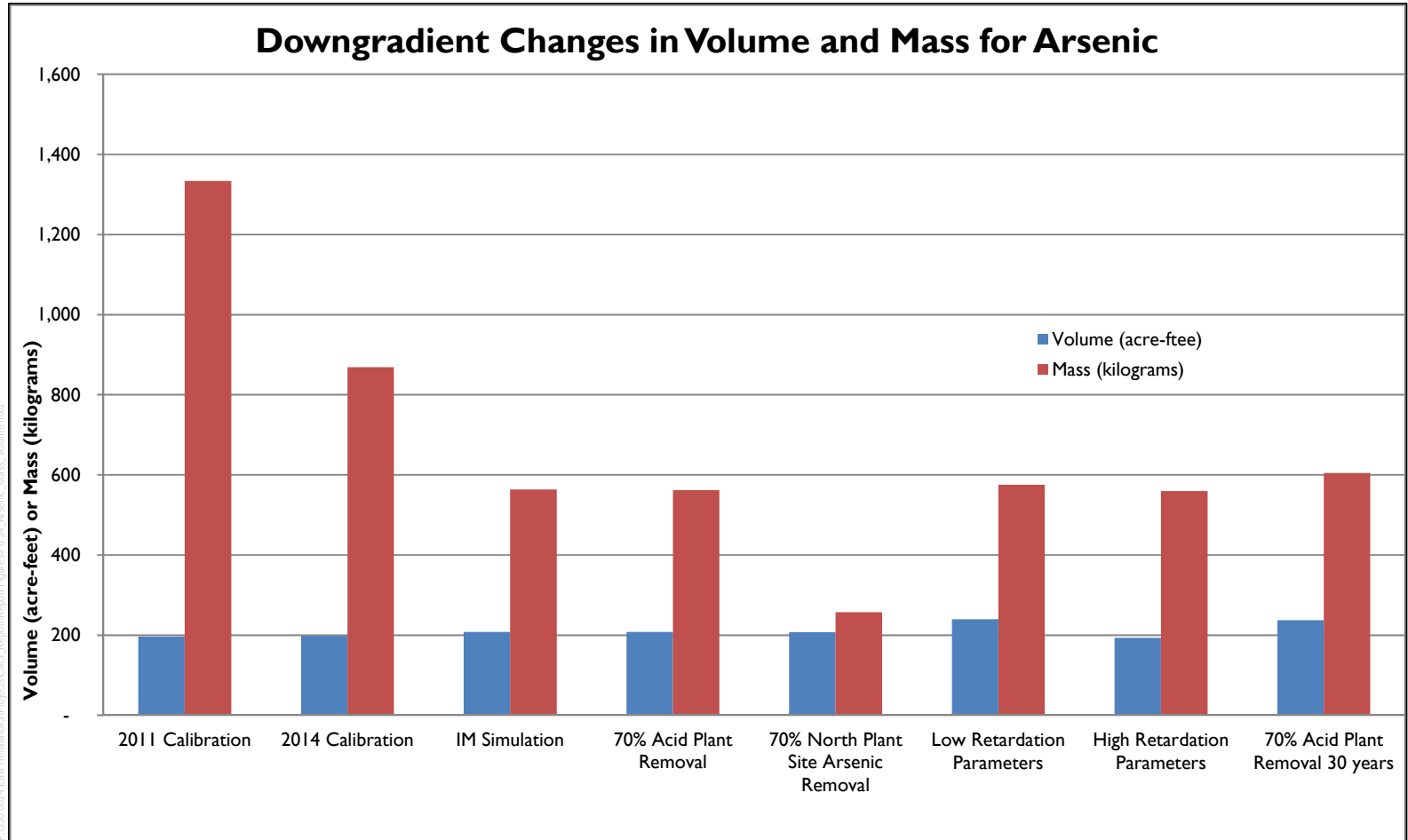


Figure 5-8
Transient Flow and Transport Predicted Change in Arsenic Volume/Mass for Source Control Measures
Former ASARCO East Helena Facility
Corrective Measures Study Report
East Helena, Montana

- Notes:
- 1) See Appendix B for detailed information regarding model operations and predictions
 - 2) Results are from NewFields (2016a).

Created by:



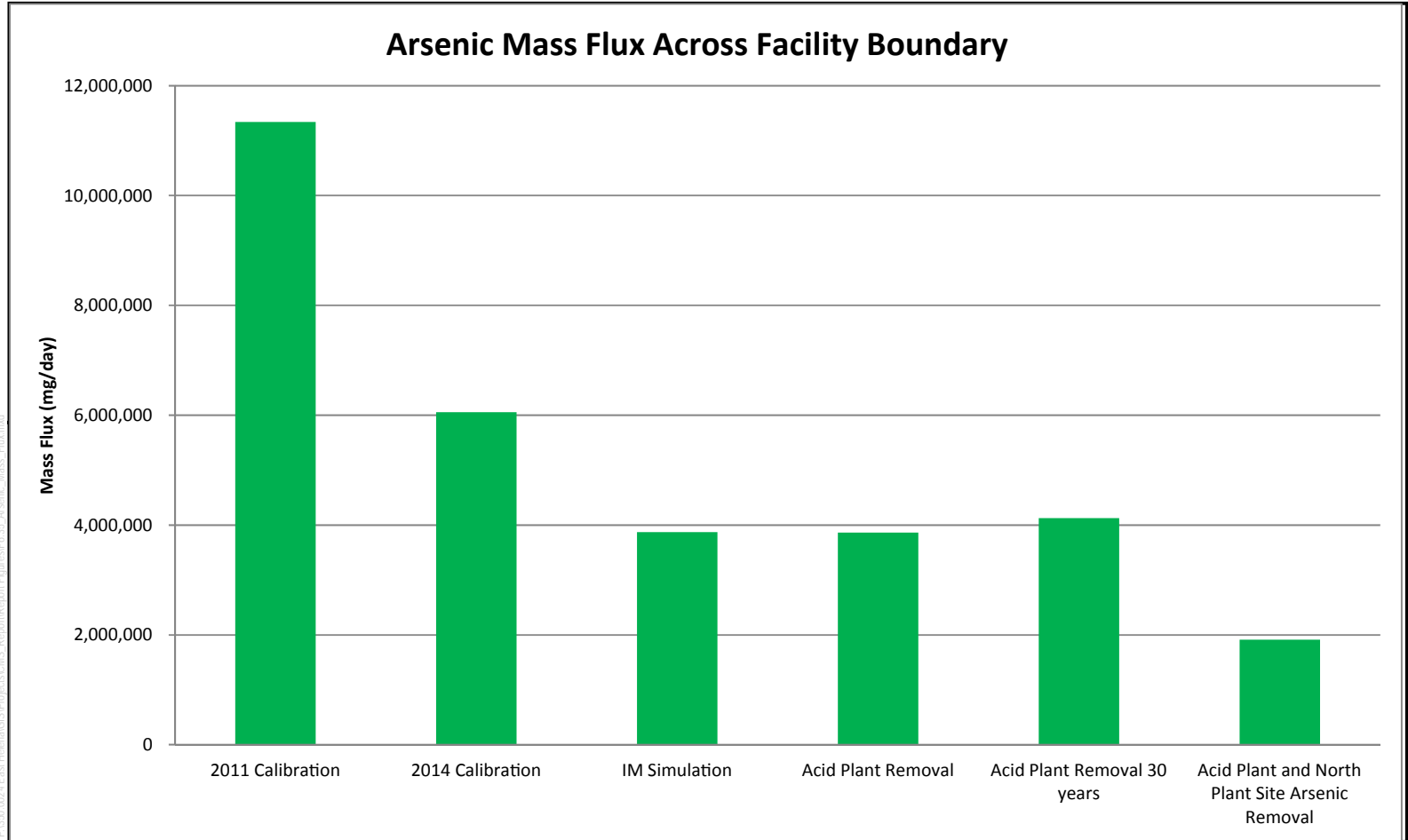


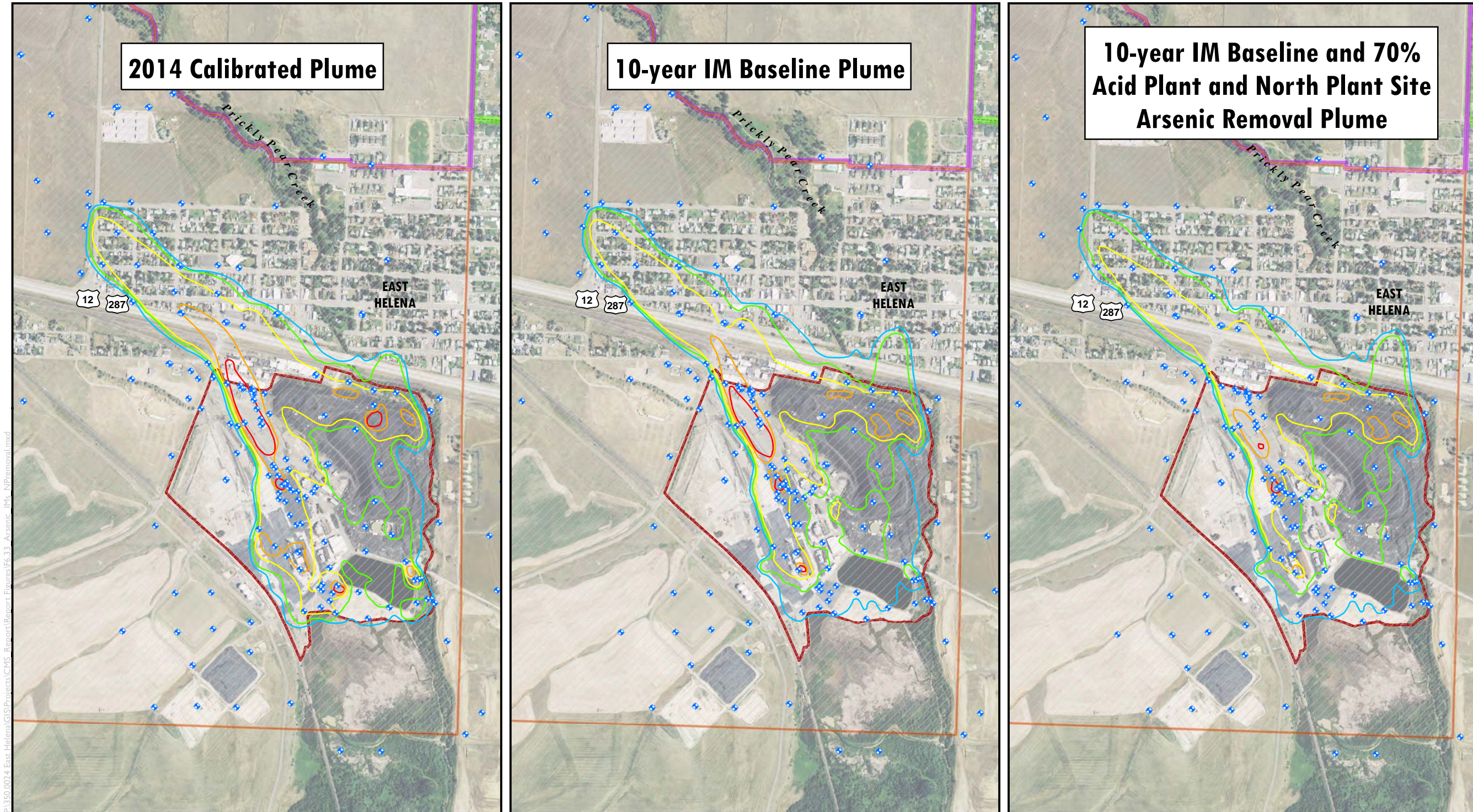
Figure 5-9
Transient Flow and Transport Predicted Change
in Arsenic Mass Flux Across the Facility Boundary

*Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana*

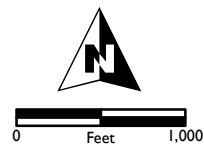
- Notes:
- 1) mg/day = milligram per day.
 - 2) Results are from NewFields (2016a).

Created by:





Source: NAIP, 2013; METG, 2011



- Notes:
- 1) Simulated plumes represent a composite of model layers 1, 2, 3, and 4.
 - 2) Predictive results depict concentrations in stress period 66, after model has reached steady-state.
 - 3) mg/L = milligram per liter; CGWA = Controlled Groundwater Area.
 - 4) Results are from NewFields (2016a).

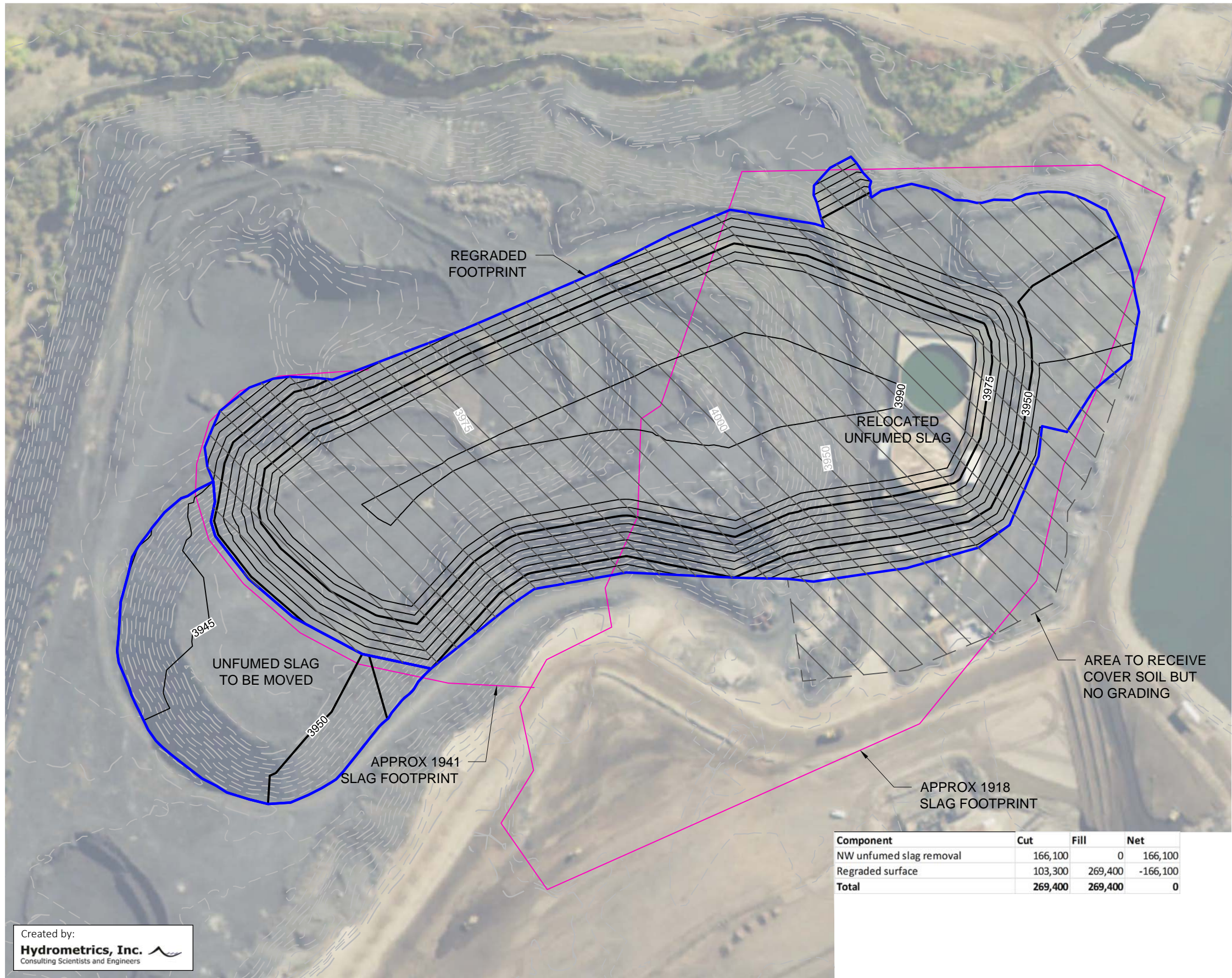
Isoconcentration Contour (mg/L)

0.01	10
0.1	> 20
1	

- Monitoring Well
- Facility Boundary

- Permanent CGWA - Subarea 1
- Permanent CGWA - Subarea 2
- Temporary CGWA

Figure 5-10
Transient Flow and Transport
Predicted Isoconcentration Contours
Arsenic IM Baseline and Acid Plant/North
Plant Site Arsenic Removal Simulations
Former ASARCO East Helena Facility
Corrective Measures Study Report
East Helena, Montana



SCALE
(In Feet)
0 150

LEGEND

- 1-FOOT SOIL COVER
- NO HATCH: NO SOIL COVER
- GRADING LIMITS

- CONTOURS**
- EXISTING (5' & 25')
- PROPOSED (5' & 25')

SOIL COVER:
SOIL COVER SURFACE AREA:
762,000 SF
REQD SOIL VOLUME, 1-FT COVER:
28,200 CY

ADDITIONAL NOTES:
2.5:1 SLOPES ALONG GRADED SLOPES
2% - 5% SLOPES FOR DRAINAGE

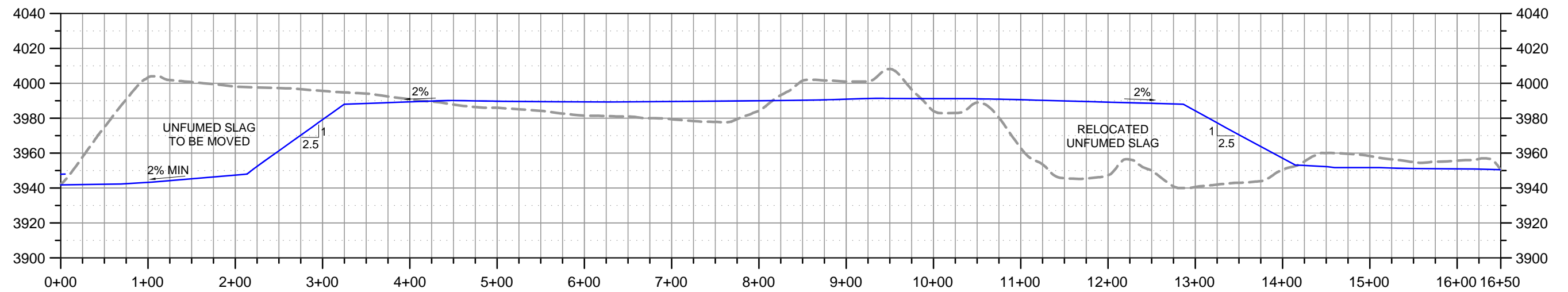
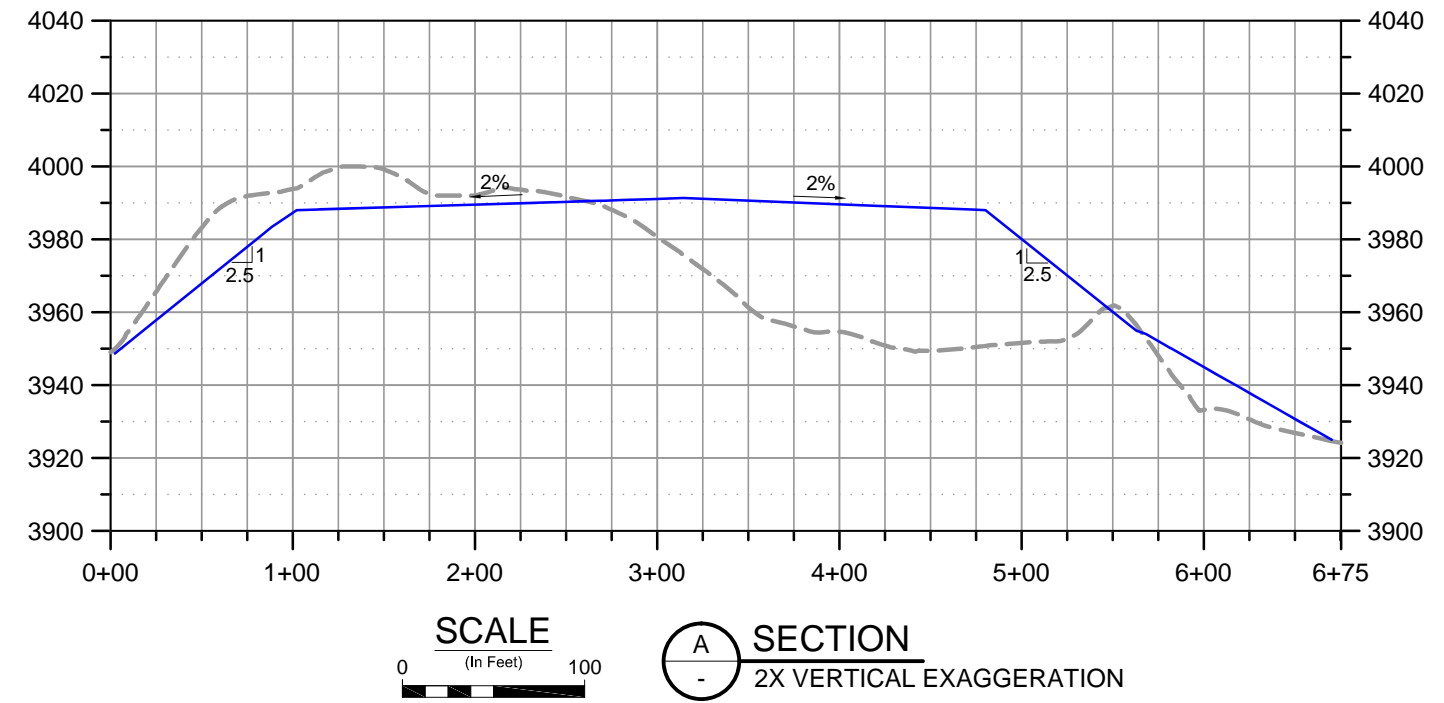
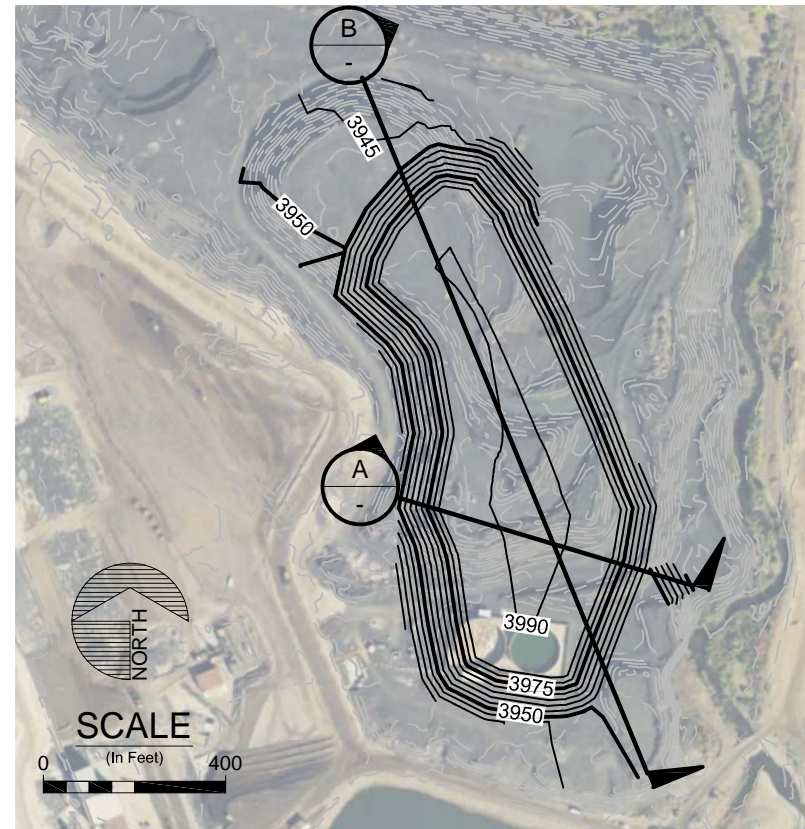
MOUND GRADED TO MATCH EXISTING ELEVATIONS ALONG WEST AND SOUTH EDGES; SOME CUT/FILL ALONG EAST AND NORTH EDGES ASSUMING SMOOTHING OF ADJACENT SLAG

Component	Cut	Fill	Net
NW unfumed slag removal	166,100	0	166,100
Regraded surface	103,300	269,400	-166,100
Total	269,400	269,400	0

Created by:
Hydrometrics, Inc.
Consulting Scientists and Engineers

Figure 5-11
Slag Pile Conceptual Grading Plan -
Minimum Alternative Plan View
Former ASARCO East Helena Facility
Corrective Measures Study Report
East Helena, Montana





LEGEND

- EXISTING SURFACE
- PROPOSED TOP OF SLAG

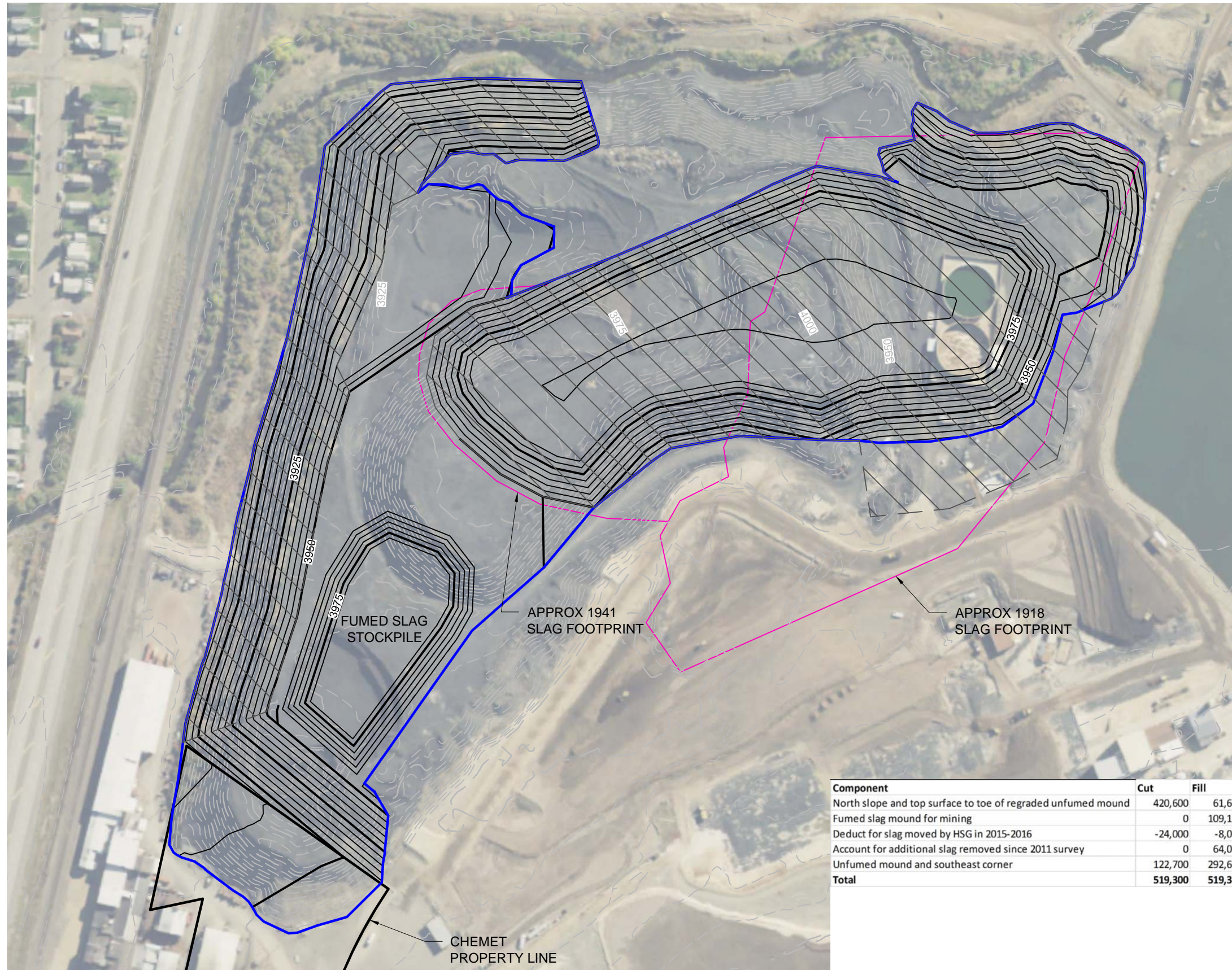


B SECTION
2X VERTICAL EXAGGERATION

Figure 5-12
Slag Pile Conceptual Grading Plan -
Minimum Alternative Cross-sectional View
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana





Created by:
Hydrometrics, Inc.
 Consulting Scientists and Engineers





SCALE
 0 (In Feet) 200

LEGEND

-  1-FOOT SOIL COVER
- NO HATCH: NO SOIL COVER
-  GRADING LIMITS
- CONTOURS**
-  EXISTING (5' & 25')
-  PROPOSED (5' & 25')

SOIL COVER:
 UNFUMED SLAG SURFACE AREA:
 801,000 SF
 REQD SOIL VOLUME, 1-FT COVER:
 29,700 CY

REMAINDER OF COVERED AREA
 276,000 SF
 REQD SOIL VOLUME, 1-FT COVER:
 10,200 CY

ADDITIONAL NOTES:
 2.5:1 SLOPES ALONG GRADED SLOPES
 3.5:1 NEAR NORTHEAST CORNER
 2:1 SLOPES ON FUMED SLAG MOUND
 2% - 5% SLOPES FOR DRAINAGE

APPROX 144,000 CY CUT FROM CHEMET
 PROPERTY LINE AND ADJACENT SLOPE

Component	Cut	Fill	Net
North slope and top surface to toe of regraded unfumed mound	420,600	61,600	359,000
Fumed slag mound for mining	0	109,100	-109,100
Deduct for slag moved by HSG in 2015-2016	-24,000	-8,000	-16,000
Account for additional slag removed since 2011 survey	0	64,000	-64,000
Unfumed mound and southeast corner	122,700	292,600	-169,900
Total	519,300	519,300	0

Figure 5-13
Slag Pile Conceptual Grading Plan -
Intermediate Alternative Plan View
Former ASARCO East Helena Facility
Corrective Measures Study Report
East Helena, Montana

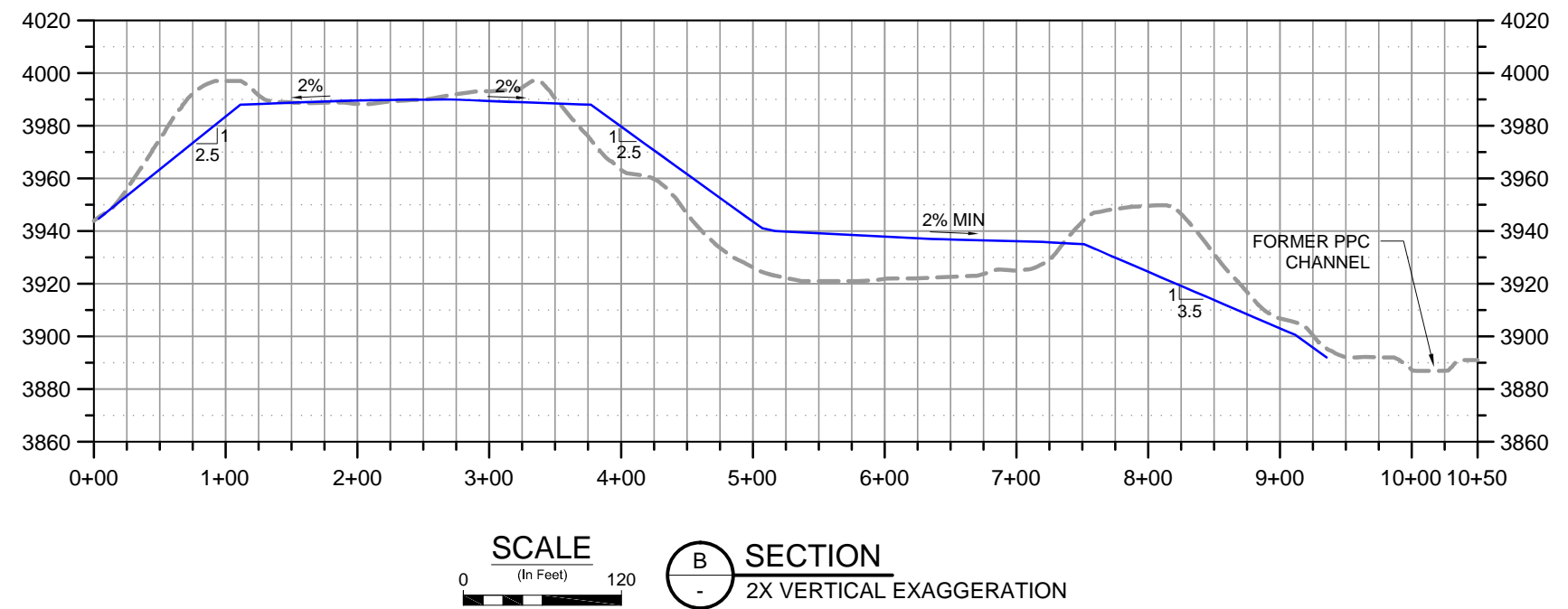
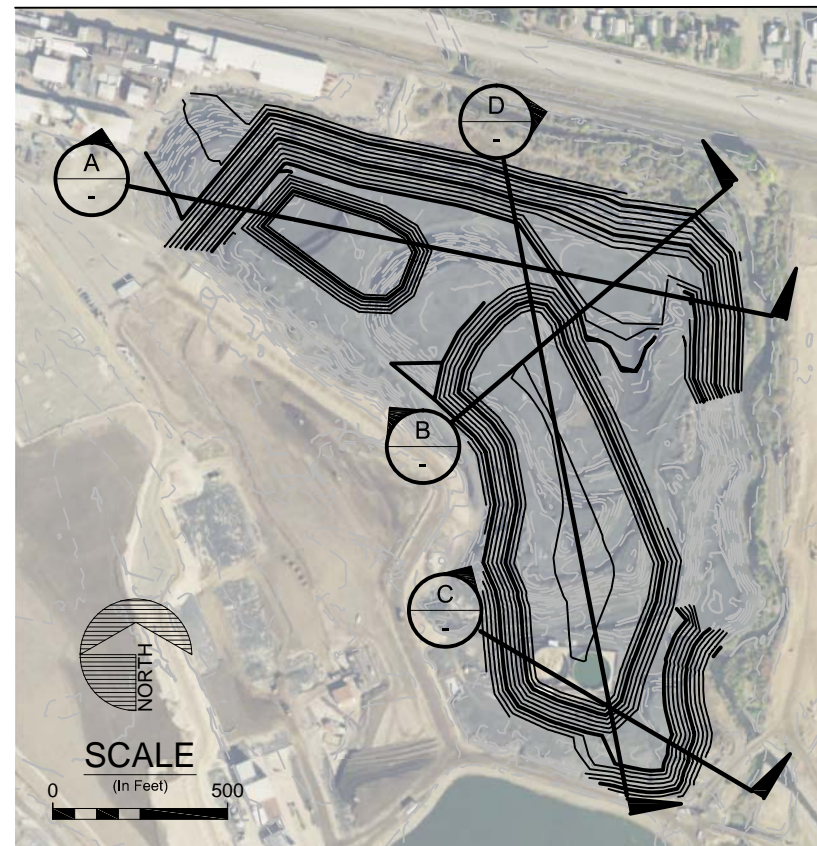
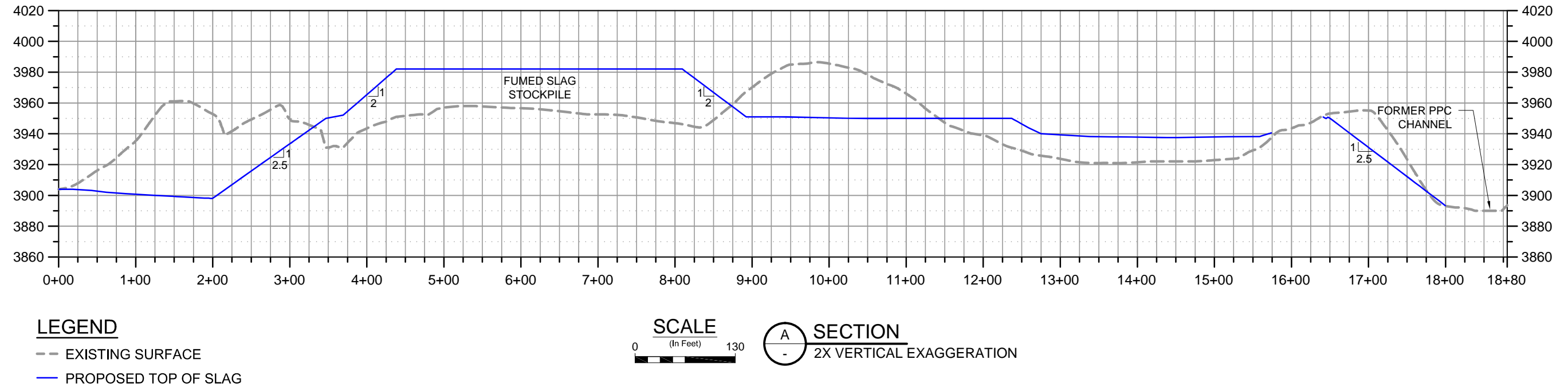
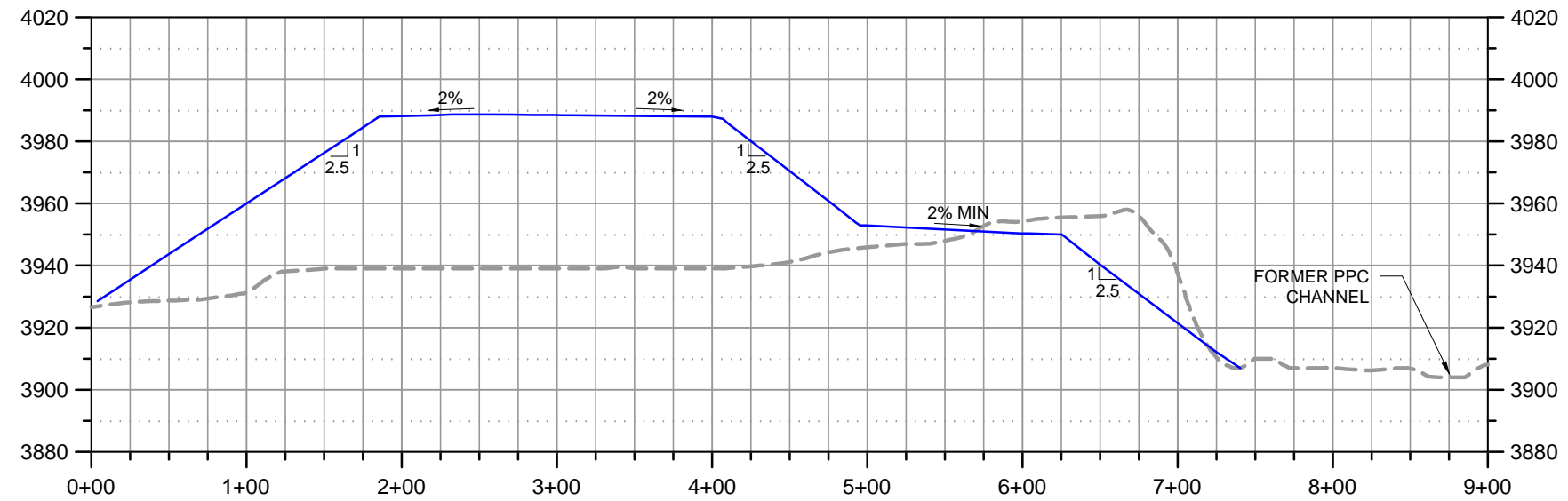


Figure 5-14
Slag Pile Conceptual Grading Plan -
Intermediate Alternative Cross-sections A and B
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana



LEGEND

- EXISTING SURFACE
- PROPOSED TOP OF SLAG

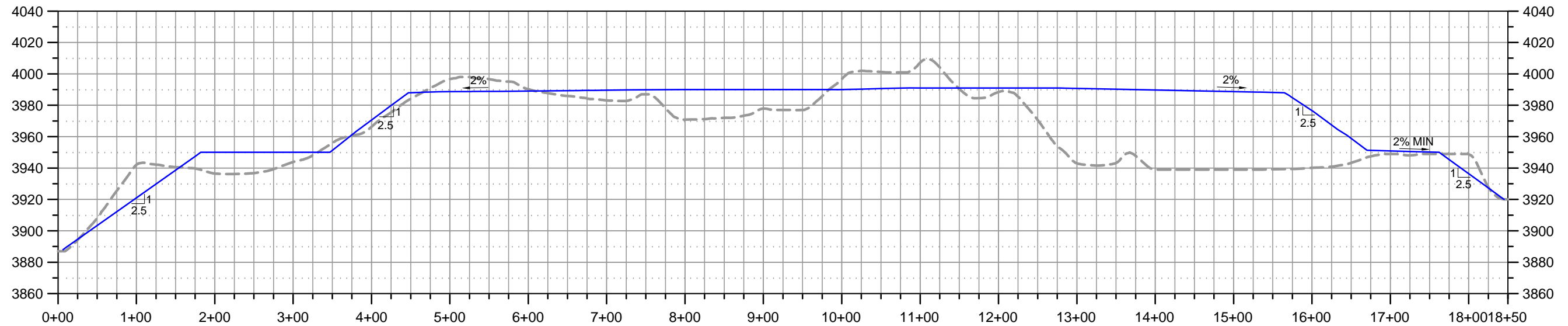
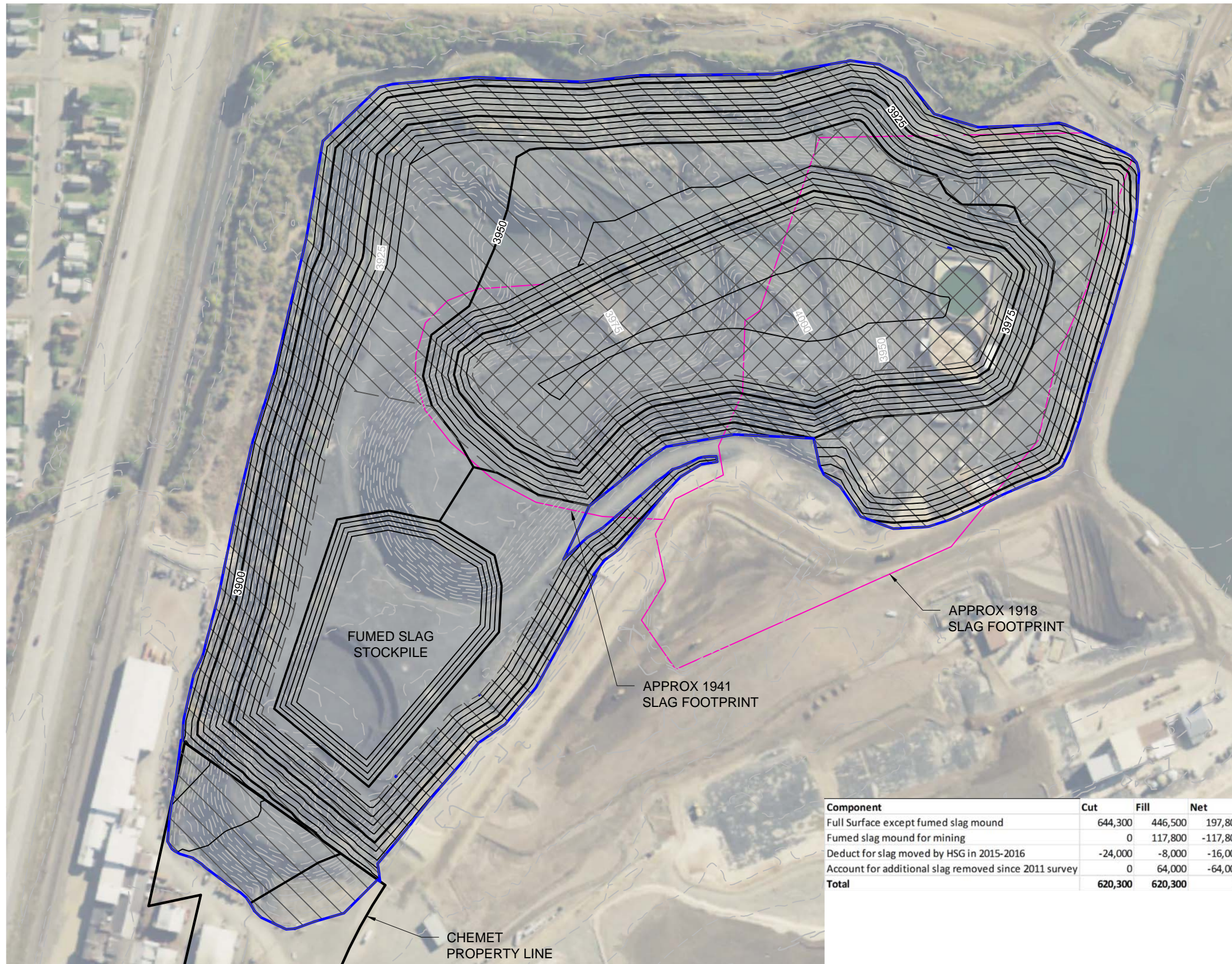


Figure 5-15
Slag Pile Conceptual Grading Plan -
Intermediate Alternative Cross-sections C and D
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana



SCALE
(In Feet)
0 200

LEGEND

- 3-FOOT ET COVER
- 1-FOOT SOIL COVER
- NO HATCH: NO SOIL COVER
- GRADING LIMITS

CONTOURS

- EXISTING (5' & 25')
- PROPOSED (5' & 25')

SOIL COVER:
ET COVER SURFACE AREA:
405,000 SF
REQD SOIL VOLUME ASSUMING 3-FT ET COVER:
45,000 CY

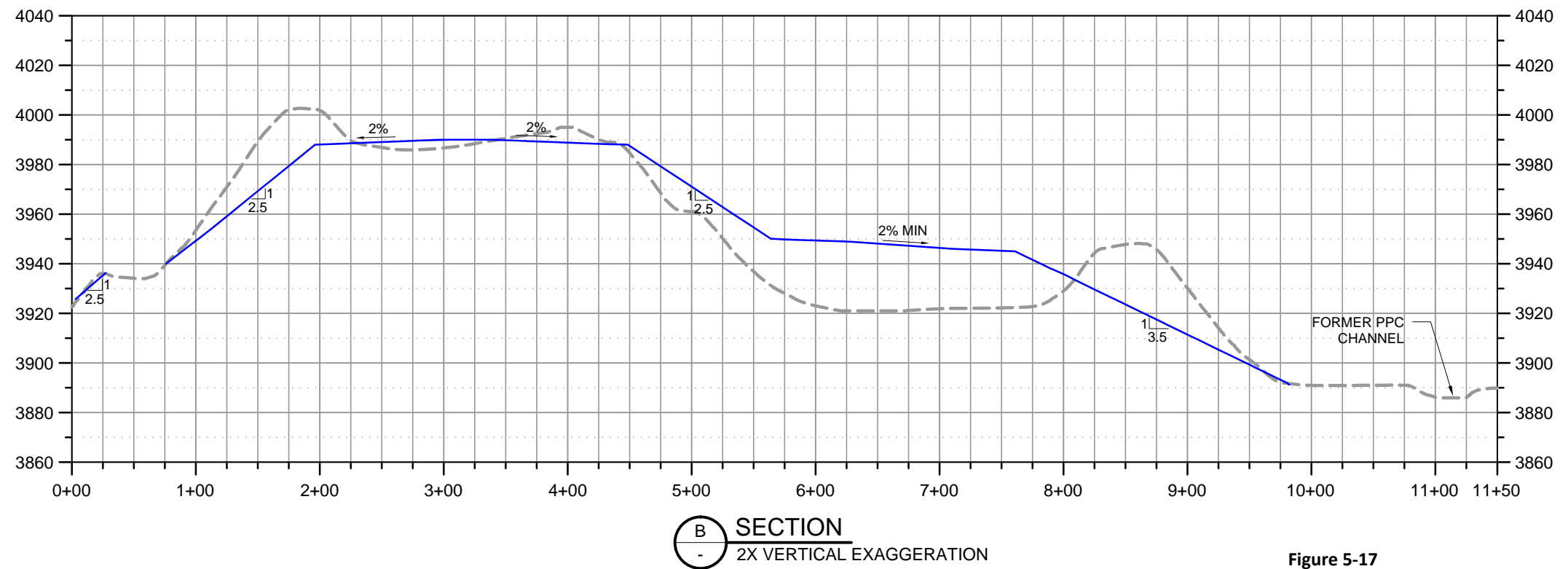
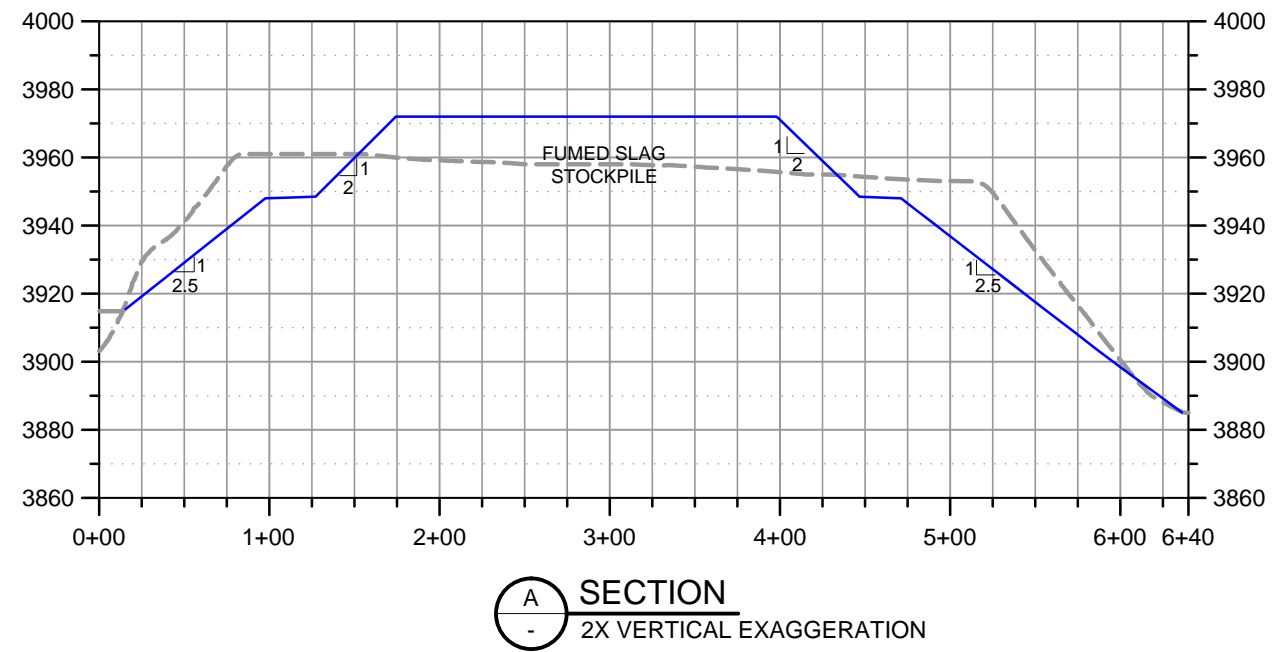
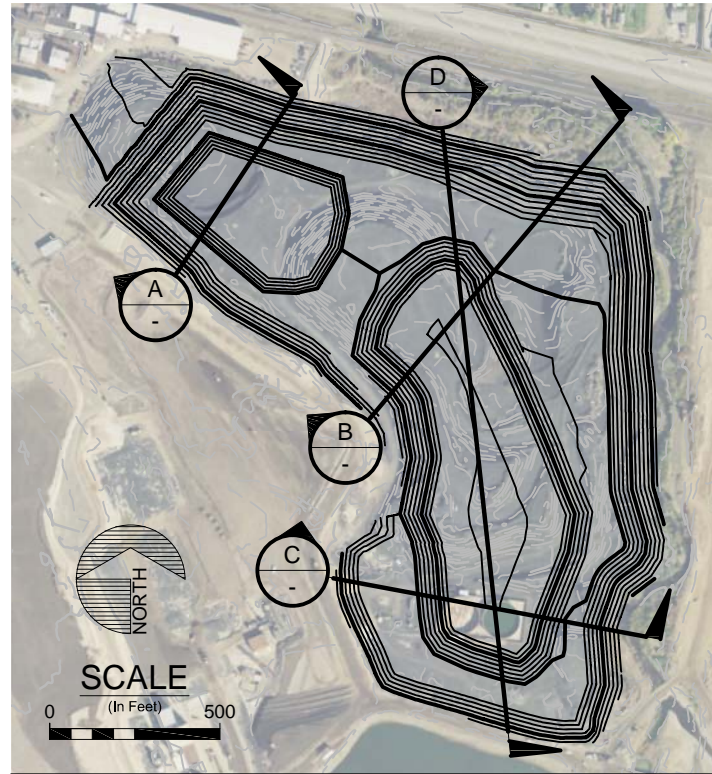
REMAINDER OF COVERED AREA
1,277,000 SF
REQD SOIL VOLUME ASSUMING 1-FT COVER
47,300 CY

ADDITIONAL NOTES:
2.5:1 SLOPES ALONG GRADED SLOPES
3.5:1 NEAR NORTHEAST CORNER
2:1 SLOPES ON FUMED SLAG MOUND
2% - 5% SLOPES FOR DRAINAGE

APPROX 144,000 CY CUT FROM CHEMET
PROPERTY LINE AND ADJACENT SLOPE

Component	Cut	Fill	Net
Full Surface except fumed slag mound	644,300	446,500	197,800
Fumed slag mound for mining	0	117,800	-117,800
Deduct for slag moved by HSG in 2015-2016	-24,000	-8,000	-16,000
Account for additional slag removed since 2011 survey	0	64,000	-64,000
Total	620,300	620,300	0

Figure 5-16
Slag Pile Conceptual Grading Plan -
Maximum Alternative Plan View
Former ASARCO East Helena Facility
Corrective Measures Study Report
East Helena, Montana



LEGEND

- EXISTING SURFACE
- PROPOSED TOP OF SLAG

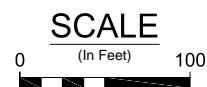
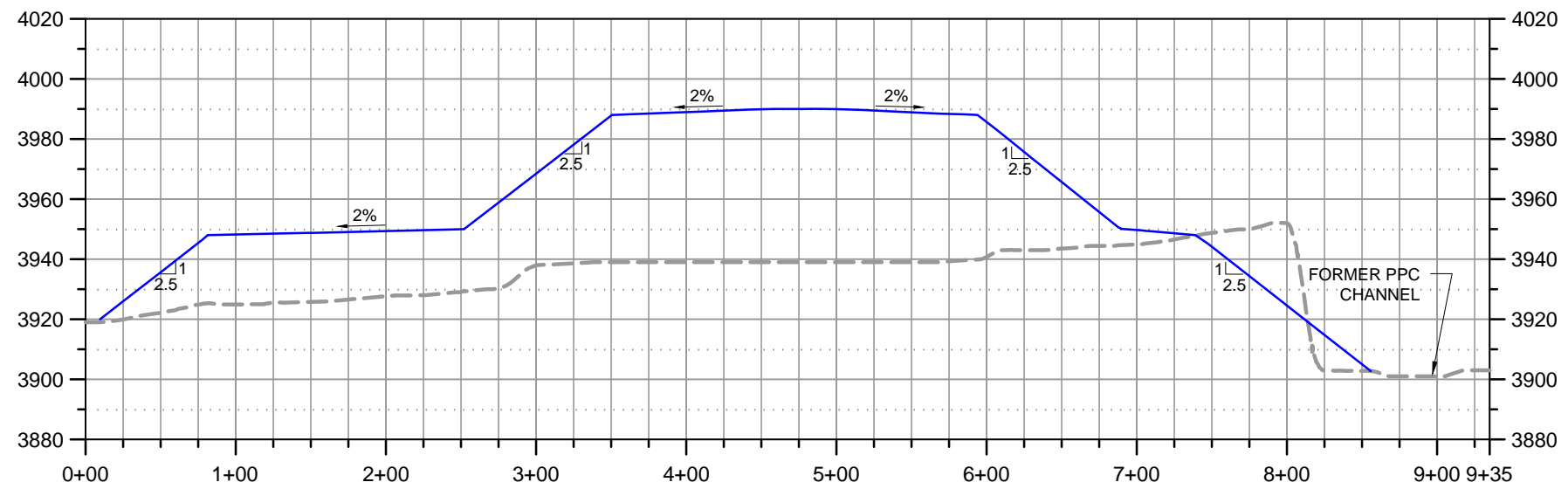


Figure 5-17
Slag Pile Conceptual Grading Plan -
Maximum Alternative Cross-sections A and B
Former ASARCO East Helena Facility
Corrective Measures Study Report
East Helena, Montana

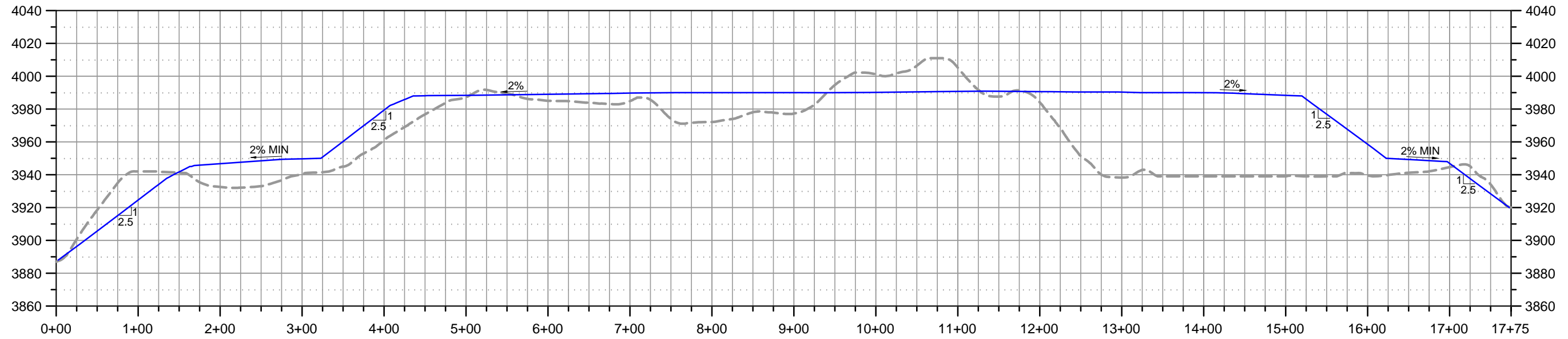


LEGEND

- EXISTING SURFACE
- PROPOSED TOP OF SLAG

SCALE
(In Feet)
0 100

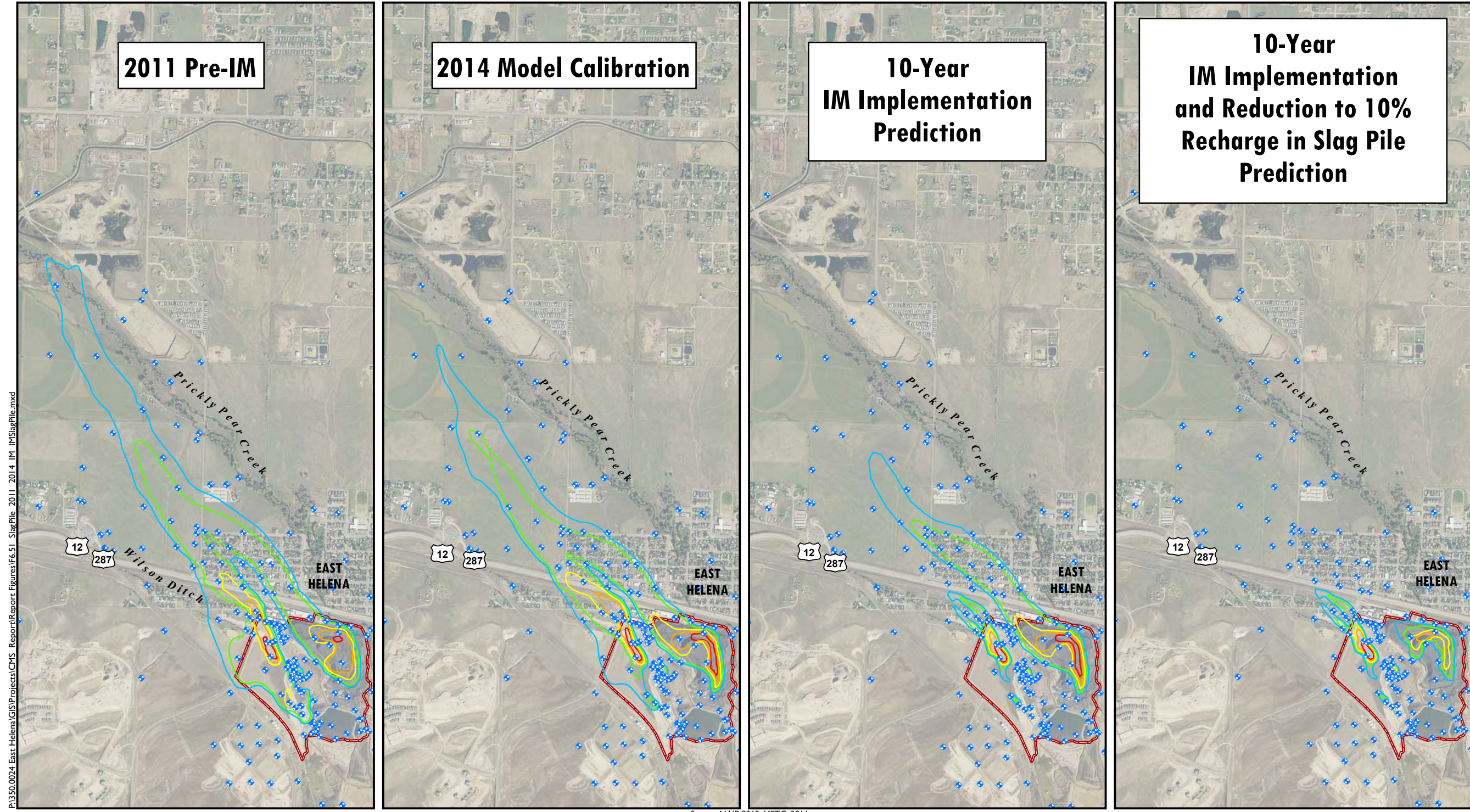
C SECTION
2X VERTICAL EXAGGERATION



SCALE
(In Feet)
0 120

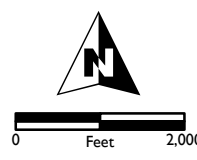
D SECTION
2X VERTICAL EXAGGERATION

Figure 5-18
Slag Pile Conceptual Grading Plan -
Maximum Alternative Cross-sections C and D
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana



PA\350,0024 East Helena\GIS\Projects\CMS_Report\Report\Figures\F6.51_SlagPile_2011_2014_IM_10%SlagPile.mxd

Source: NAIP, 2015; METG, 2011



- Notes:
- 1) Simulated plumes represents a composite of model layers 1, 2, 3, and 4.
 - 2) IM and 10% Slag Pile Recharge results show are predicted after 10 years.
 - 3) Results are from NewFields (2016b).
 - 4) Refer to Appendix B for further details of model operations and predictions

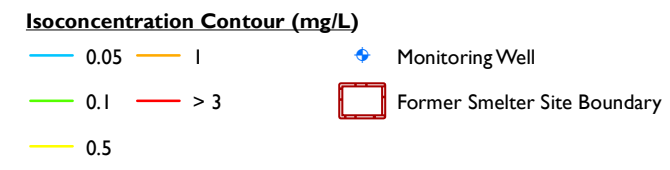
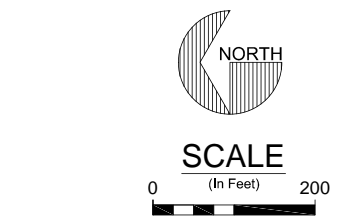
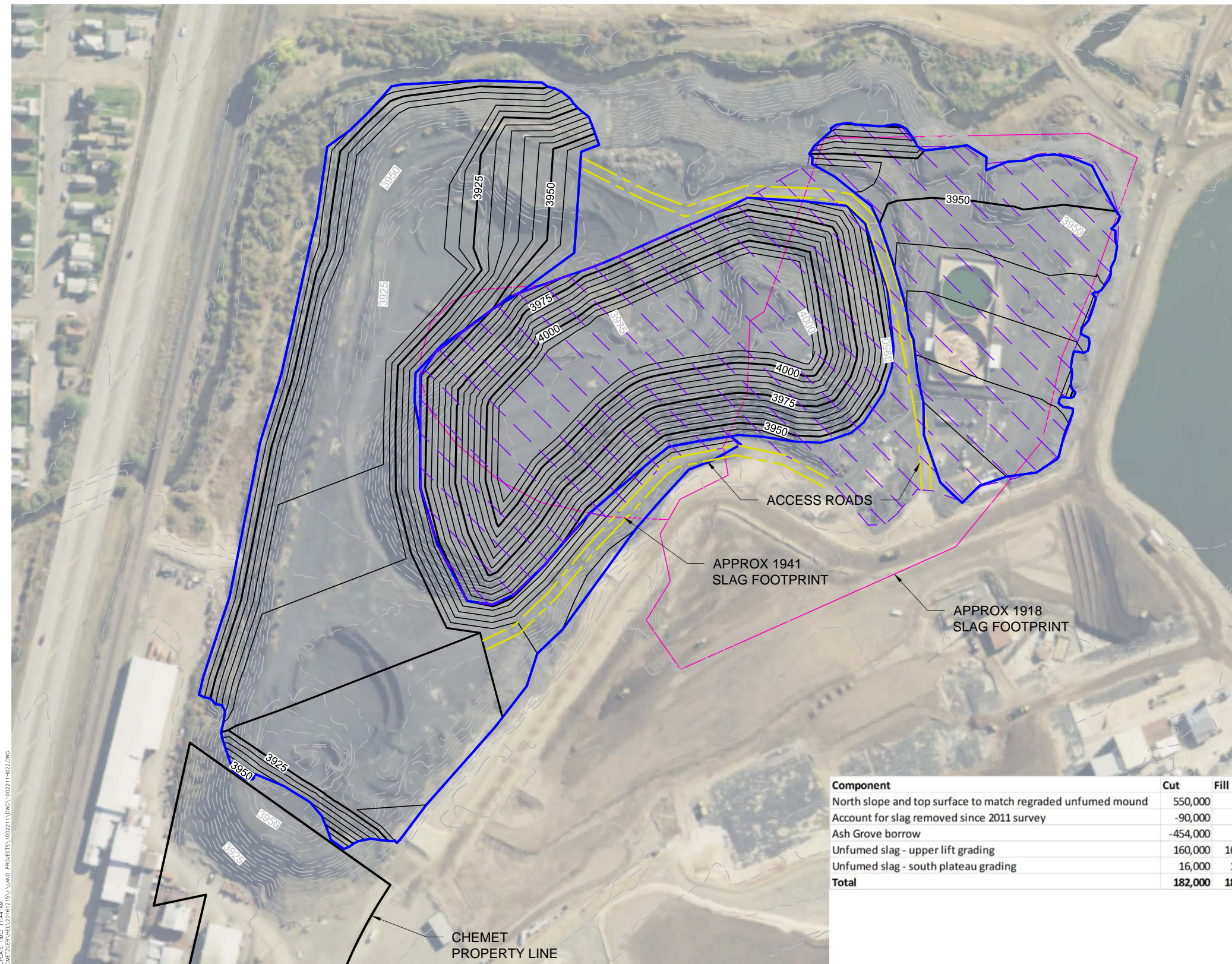


Figure 5-19
Predicted Selenium Isoconcentration Contours
IM and 10% Recharge in Slag Pile Simulations
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana



- LEGEND**
- SOIL COVER
 - NO HATCH: NO SOIL COVER
 - GRADING LIMITS
 - CONTOURS**
 - EXISTING (5' & 25')
 - PROPOSED (5' & 25')

SOIL COVER:
 UNFUMED MOUND SURFACE AREA:
 506,000 SF
 REMAINING SOIL COVER AREA:
 364,000
 REQD SOIL VOLUME, 3-FT ET COVER:
 96,700 CY

ADDITIONAL NOTES:
 2.5:1 SLOPES ALONG REGRADED SLOPES
 3:1 TO 3.5:1 NEAR NORTHEAST CORNER
 6:1 SLOPE ON EAST RAMP
 2% - 5% SLOPES FOR DRAINAGE

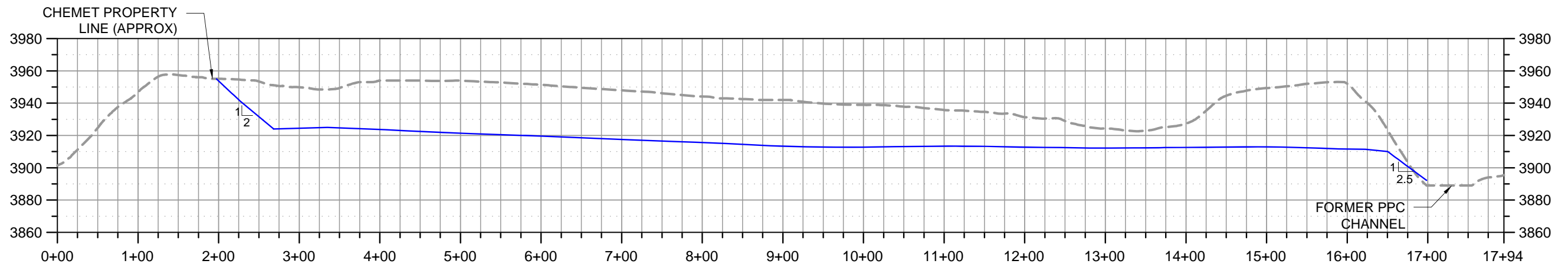
Component	Cut	Fill	Net
North slope and top surface to match regraded unfumed mound	550,000	6,000	544,000
Account for slag removed since 2011 survey	-90,000	0	-90,000
Ash Grove borrow	-454,000	0	-454,000
Unfumed slag - upper lift grading	160,000	160,000	0
Unfumed slag - south plateau grading	16,000	16,000	0
Total	182,000	182,000	0

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 Consulting Scientists and Engineers

Figure 6-1
Slag Pile Grading Plan
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana





LEGEND

- EXISTING SURFACE
- PROPOSED TOP OF FUMED SLAG
- - - PROPOSED TOP OF UNFUMED SLAG

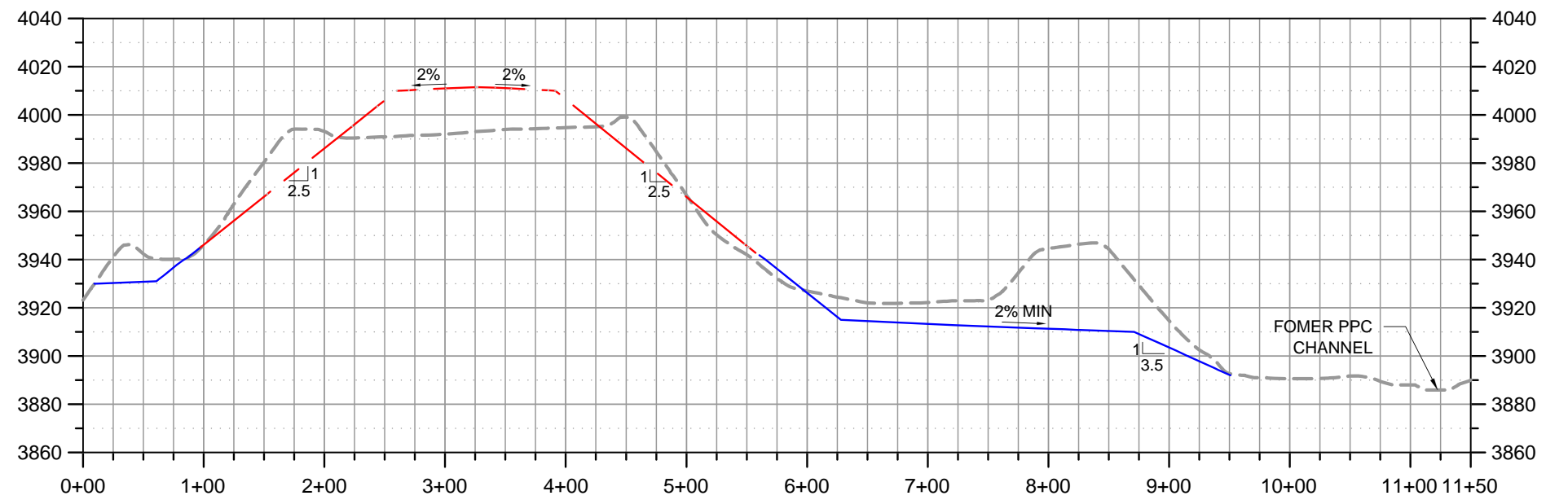
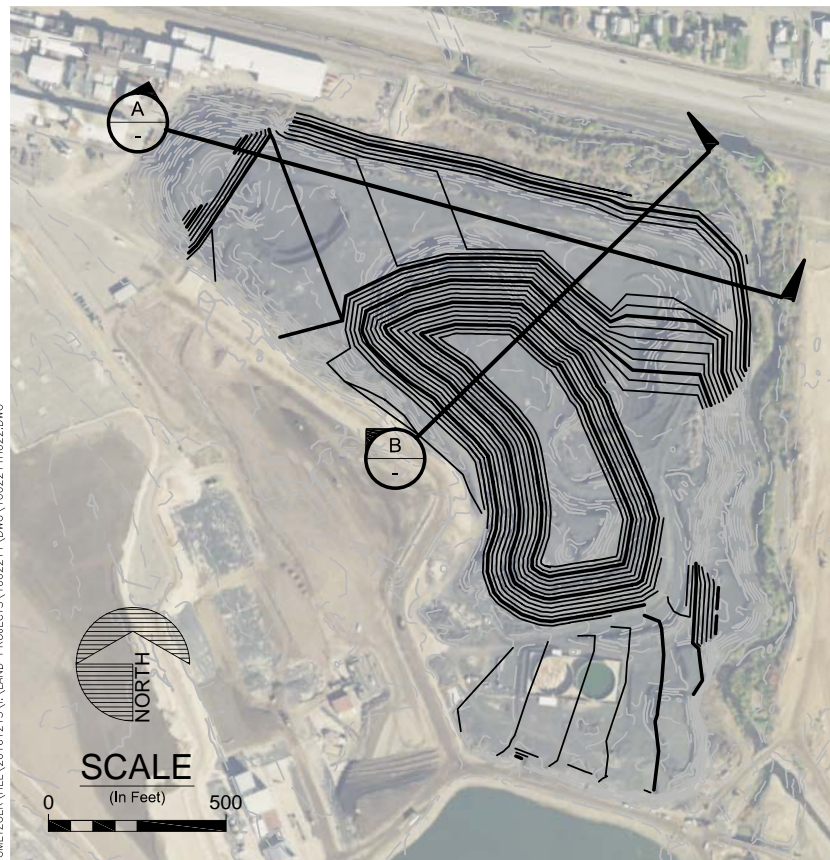


Figure 6-2
Slag Pile Grading Plan
(Cross-sections A and B)
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana

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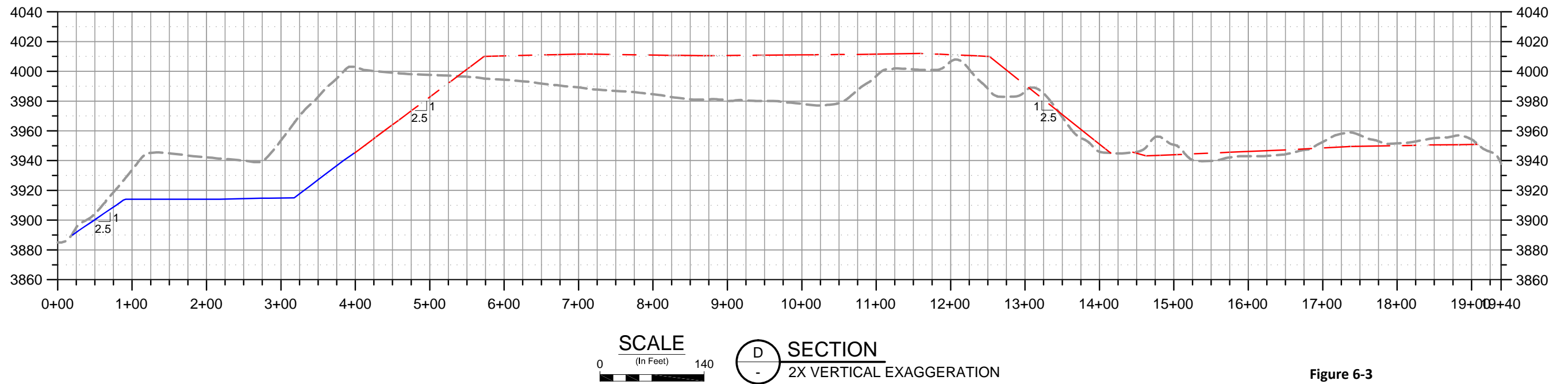
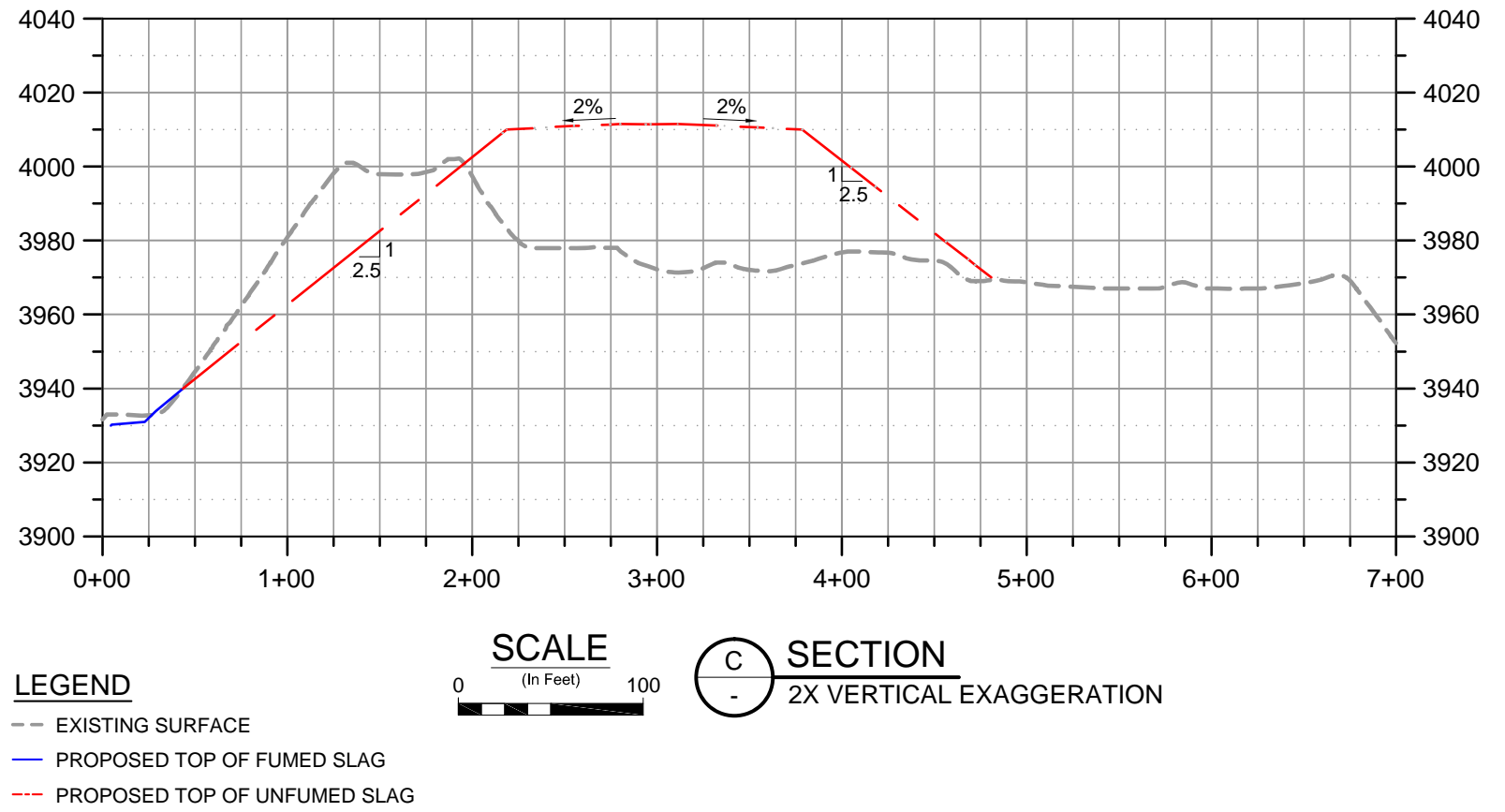
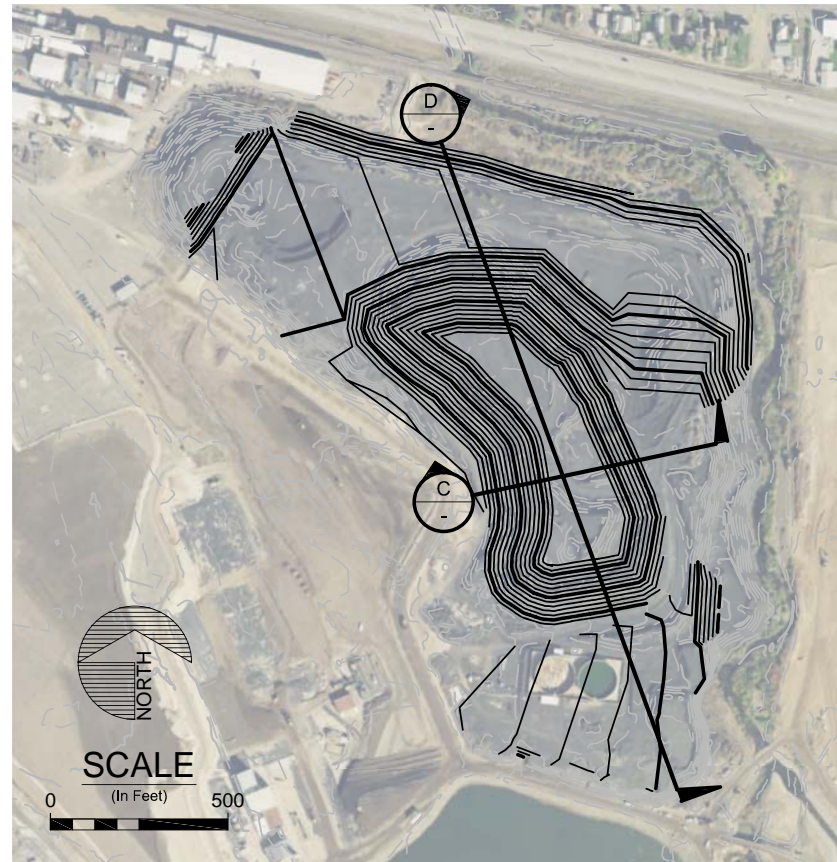


Figure 6-3
Slag Pile Grading Plan
(Cross-sections C and D)
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana

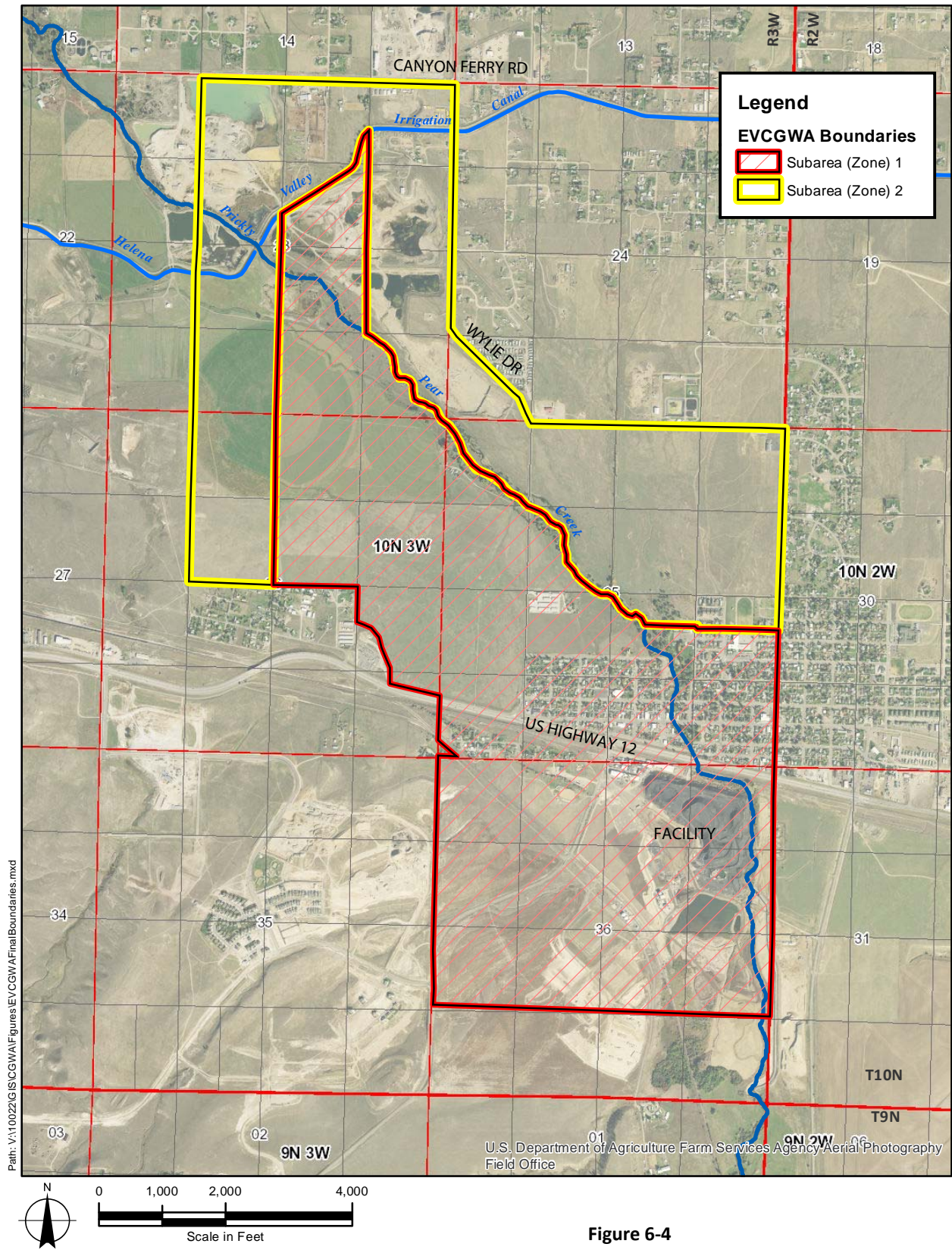


Figure 6-4
East Valley Controlled Groundwater Area
 Former ASARCO East Helena Facility
 Corrective Measures Study Report
 East Helena, Montana

Created by Hydrometrics, Inc.: 11/18/2016 11:50:08 AM

