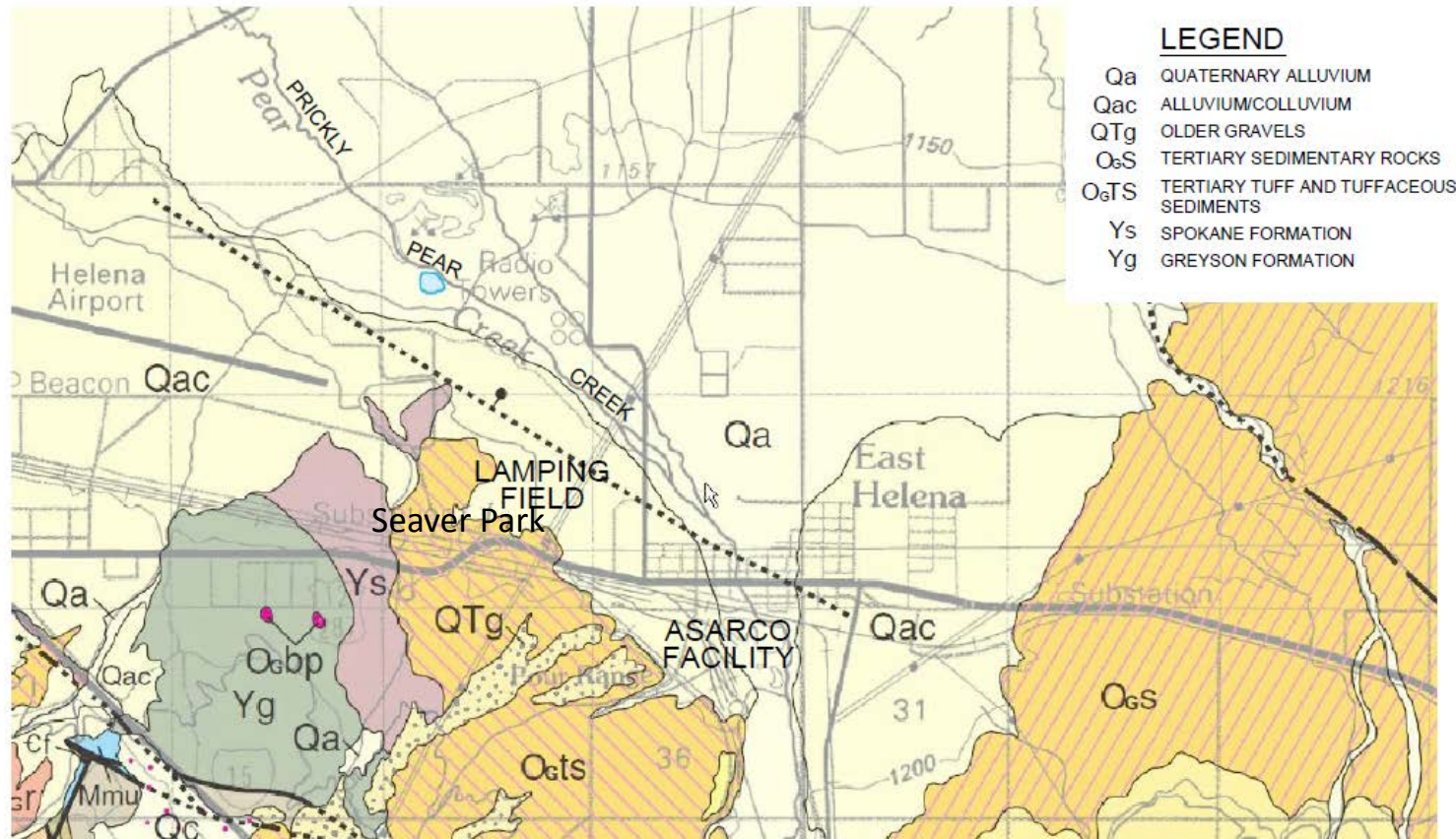


Site Geology



LEGEND

- Qa QUATERNARY ALLUVIUM
- Qac ALLUVIUM/COLLUVIUM
- QTg OLDER GRAVELS
- O_sS TERTIARY SEDIMENTARY ROCKS
- O_sTS TERTIARY TUFF AND TUFFACEOUS SEDIMENTS
- Ys SPOKANE FORMATION
- Yg GREYSON FORMATION

SCALE
0 (In Feet) 4000

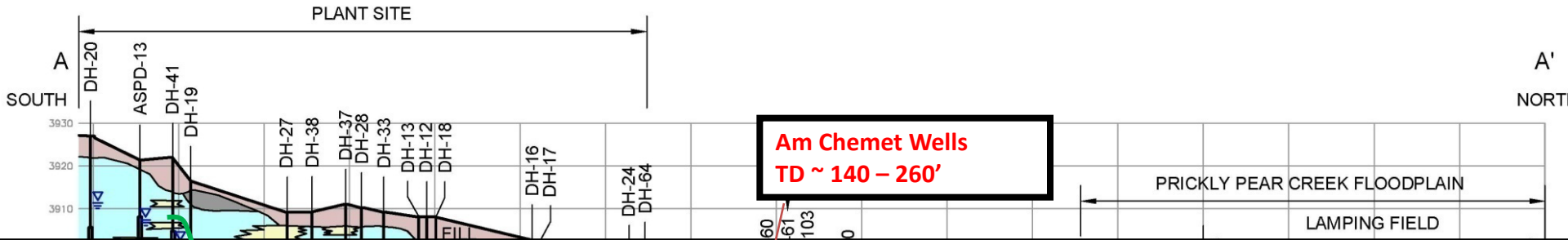


PHASE II RCRA FACILITY INVESTIGATION
SITE CHARACTERIZATION WORK PLAN
ASARCO EAST HELENA FACILITY

SURFICIAL GEOLOGY IN THE
EAST HELENA FACILITY AREA
(U.S.G.S., 2005)

FIGURE
2-3-2

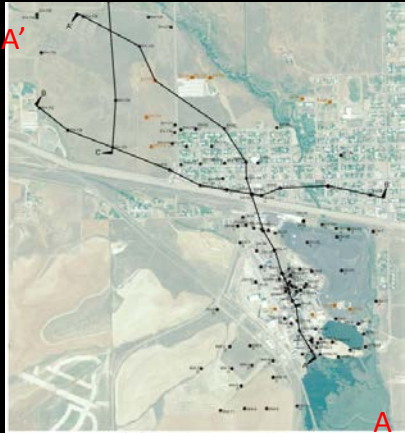
Hydrostratigraphy



Cemented
Older
Alluvium

Oligocene Tuffs and Tuffaceous
Sediments (OgTS)

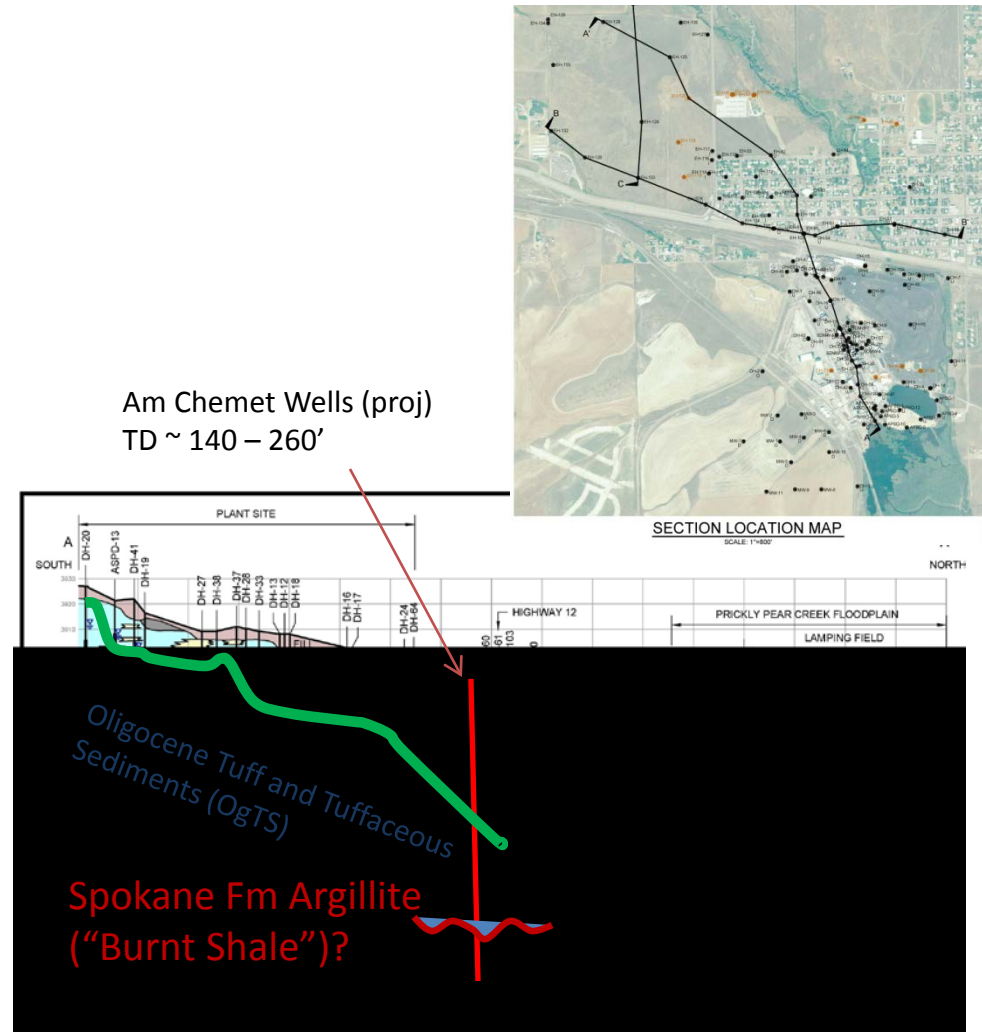
Spokane Fm Argillite
("Burnt Shale")?



SECTION LOCATION MAP
SCALE 1:4000

Tertiary Tuff and Tuffaceous Sediments Unit

- Unit thins towards valley - >40 feet beneath CAMU and <25 at Chemet wells
- Clay and silt with lenses of loose sand and gravel
- No detections of As or Se in limited data set (2 wells)



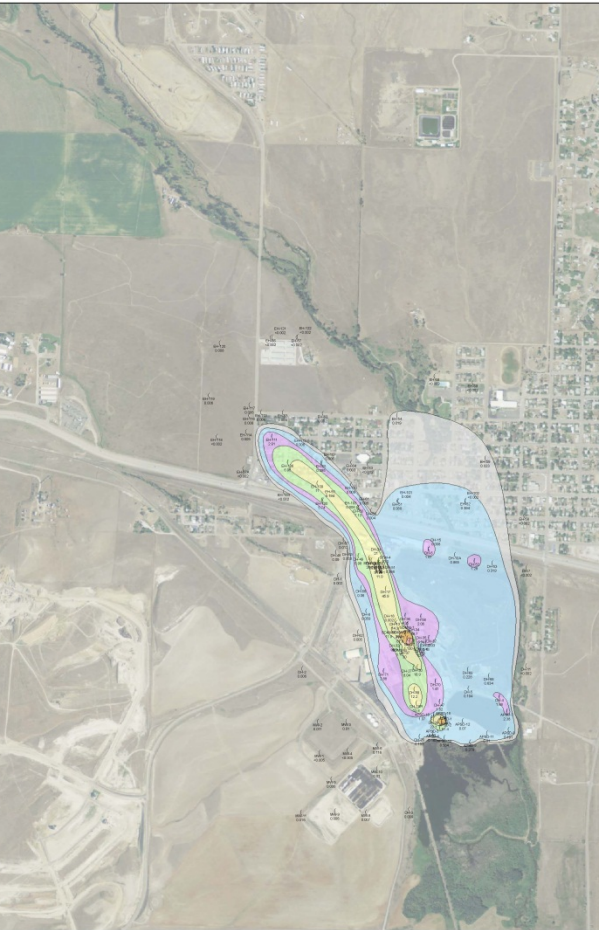
Hydrogeological Questions

- Containment Effectiveness - Is the Tertiary Tuff and Tuffaceous unit acting as a confining unit and are the slurry walled areas working?
- Will subsurface and smear-zone soils continue to act as a source?
- PRB and MNA effectiveness for Se and As

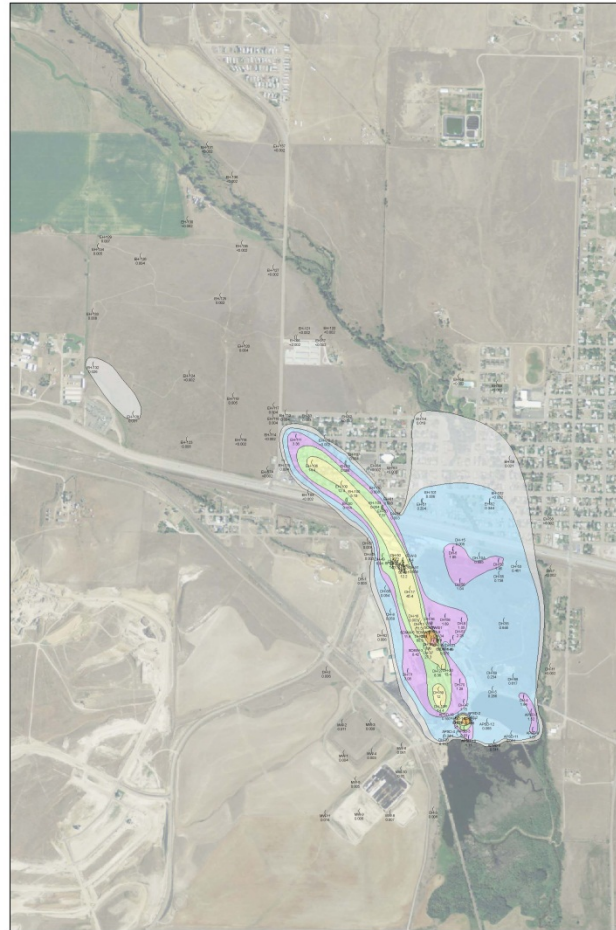
Contaminants of Concern

- Arsenic and Selenium exceed Primary MCLs onsite and offsite
- Sulfate/TDS and Manganese exceed Secondary MCLs onsite and offsite
- As, Se, and Sulfate Evaluated Further

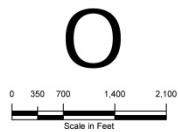
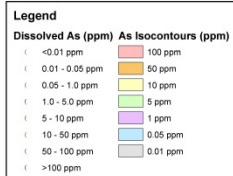
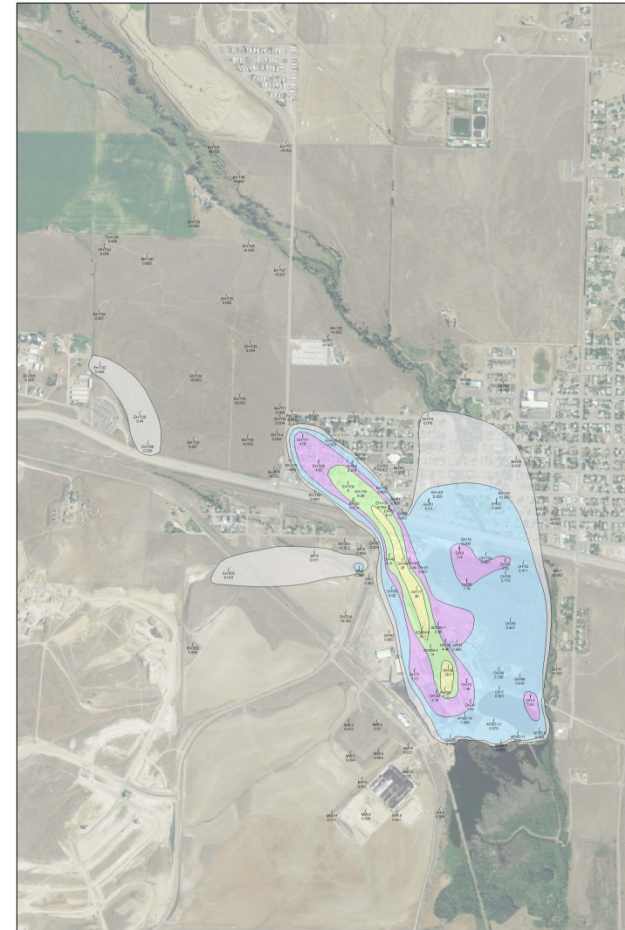
November 2008



November 2009

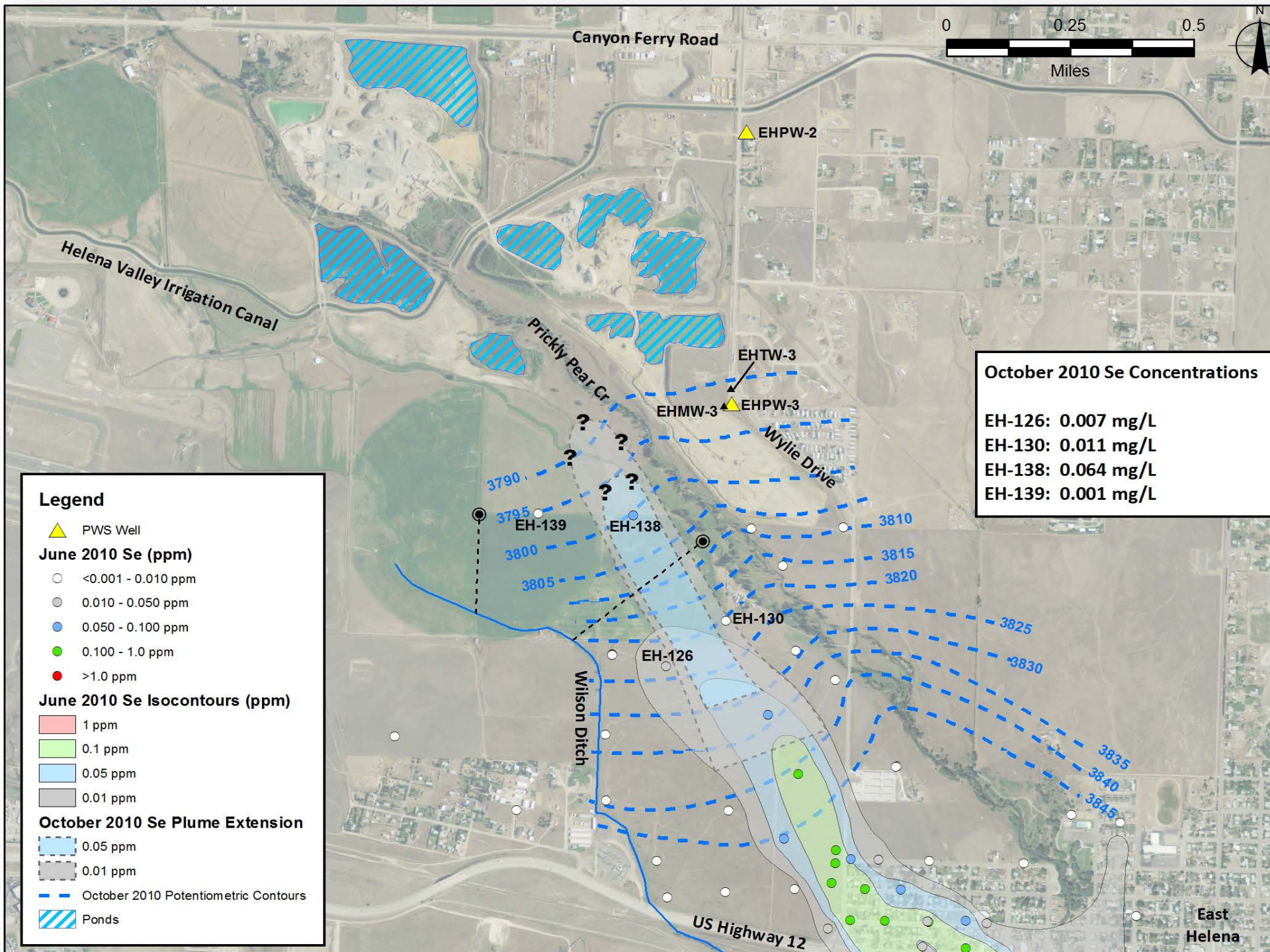


June 2010



Arsenic

- Some downgradient migration
- Onsite concentrations remain high
- Geochemistry indicates arsenic partitioned to soil acting as ongoing source to groundwater



Legend

- ▲ PWS Well
- June 2010 Se (ppm)**
- <0.001 - 0.010 ppm
- 0.010 - 0.050 ppm
- 0.050 - 0.100 ppm
- 0.100 - 1.0 ppm
- >1.0 ppm
- June 2010 Se Isocontours (ppm)**
- 1 ppm
- 0.1 ppm
- 0.05 ppm
- 0.01 ppm
- October 2010 Se Plume Extension**
- 0.05 ppm
- 0.01 ppm
- October 2010 Potentiometric Contours
- Ponds

October 2010 Se Concentrations

EH-126:	0.007 mg/L
EH-130:	0.011 mg/L
EH-138:	0.064 mg/L
EH-139:	0.001 mg/L

3790

3795

3800

3805

3810

3815

3820

3825

3830

3835

3840

3845

East Helena

Selenium

- High concentration plume migrating with process water (sulfate)
 - Geochemistry indicates mobile Se(VI) form
- Some offsite migration of Se(IV), which will partition to soil (similar to Arsenic)

COC Summary

- Arsenic and Selenium exceed Primary MCLs at site boundary and offsite areas
- Sulfate/TDS are tracers of site process waters

As/Se Sources:

- Primary historical source was smelter process water (now migrating offsite)
- Residual sources are COCs in smear zone and saturated soils
- Slag may or may not be an ongoing source

COC Summary (cont.)

Contaminant Plumes:

Arsenic

- Onsite concentrations may be decreasing in APSD area, but remain high
- Geochemistry indicates arsenic partitioned to solids are an ongoing source
- Central plume offsite migration is currently decreasing (as process water flushes off-site)

Selenium

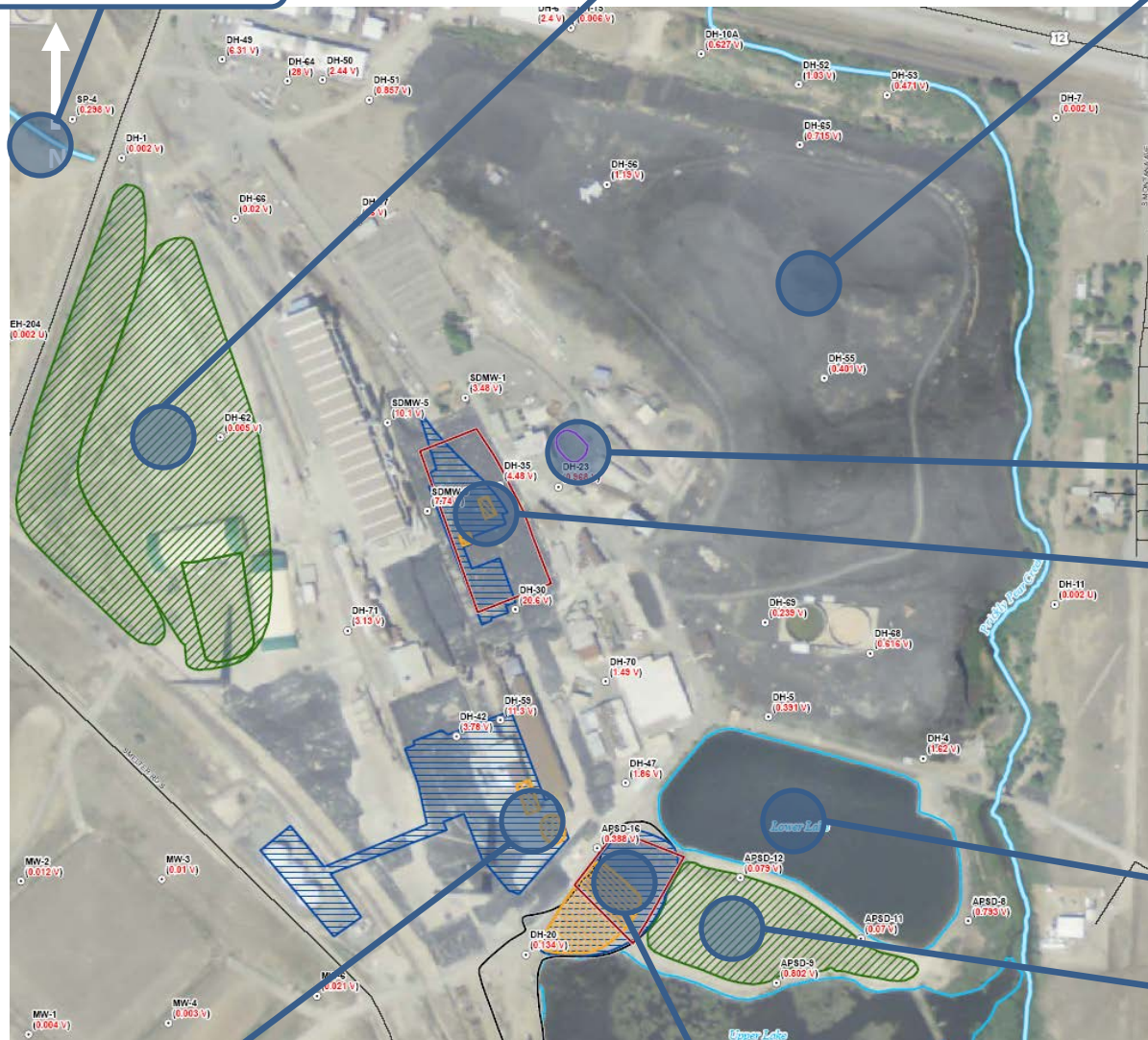
- Likely present in several forms with different mobilities (Se(0), Se(IV), Se(VI))
- Se(VI) may be migrating with sulfate (i.e. process water plume)
- Selenium in soil likely includes insoluble Se(0) and adsorbed Se(IV)
- Data insufficient to determine long-term fate

Source Areas

Wilson Ditch

Lower Ore Storage

Slag Pile



Thornock Lake

Speiss Area

Lower Lake

Upper Ore Storage

Acid Plant

Acid Plant Sediment
Drying Area

Current Solid Waste Sources

<u>Source Material</u>	<u>Source Location</u>	<u>Current Source</u>	<u>Comments</u>
Ore Concentrate; Dredged Sediment	Lower Ore Storage Area	No (As); Maybe (Se)	LOSA As in soil (<20 ft); Groundwater (40 ft)
Ore Concentrate	Upper Ore Storage Area	Yes (As); Maybe (Se)	Groundwater is shallow
Acid Plant Sediment	APSD Area	No?	2006 slurry wall effectiveness?
Slag	Slag Pile	Maybe	Leachate – As: 0.02-0.59 mg/L Se: 0.002-0.05 mg/L

Background Soils:
As: 1-47 (9 avg.) mg/kg
Se: <0.1-1.7 (0.43) mg/kg

Process Water Sources

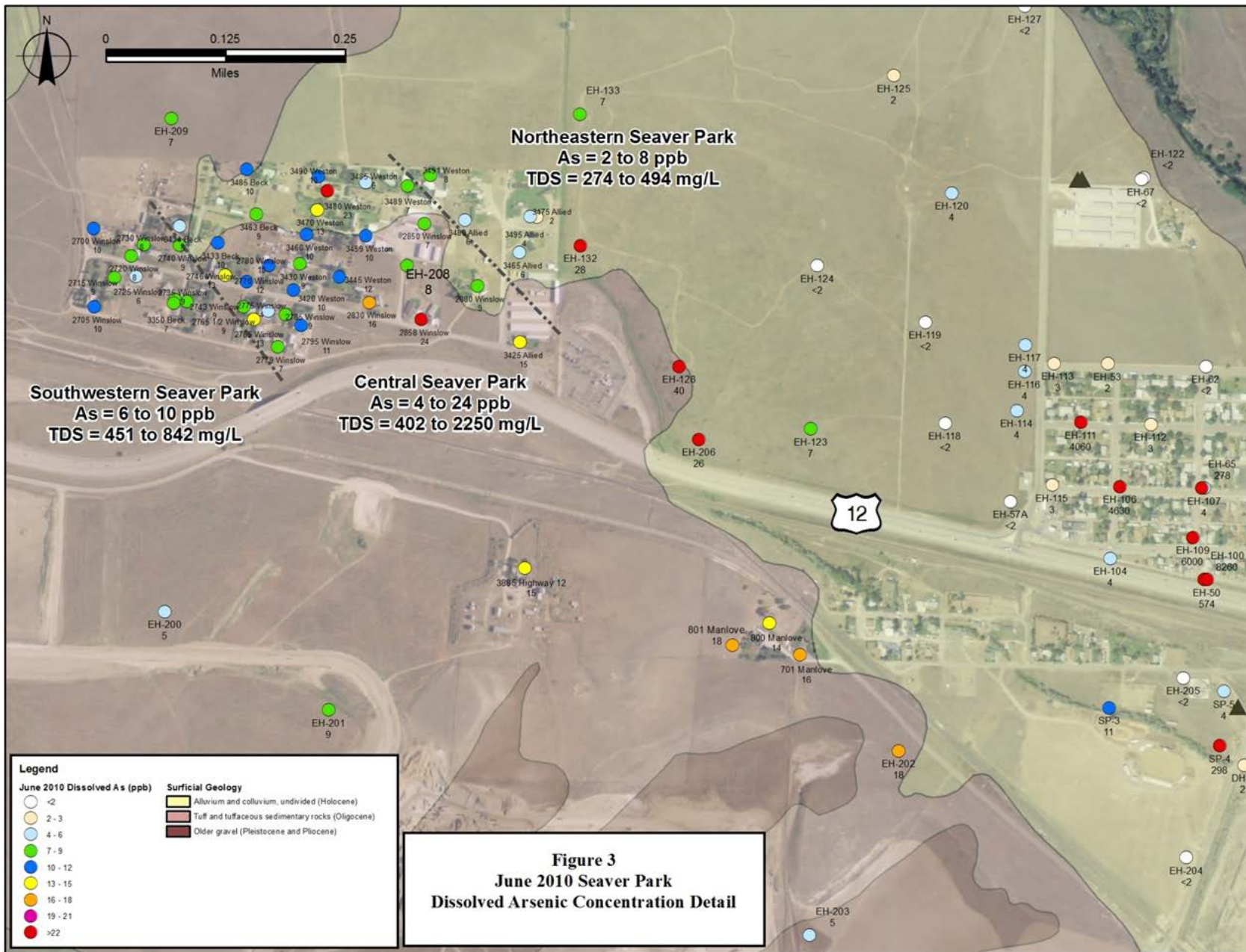
<u>Source Material</u>	<u>Source Location</u>	<u>Current Source</u>	<u>Comments</u>
Main Process Water	Lower Lake	Yes	Process Water As – 18 mg/L (pre-1996); 0.05-0.4 mg/L (2001)
Main Process Water	Thornock Lake	No	1991 Removal
Scrubber Fluid	Acid Plant	No	1993 Pond Removal
Speiss Process Water	Speiss Area	No?	1993-95 removals; '07 slurry wall effective?

Background Water:
As: 0.002-0.021 mg/L
Se: <0.001-0.007 mg/L

Summary of Sources

- **Arsenic:**
 - Upper Ore Storage Area (high levels in saturated soil)
 - Migrating process water from Lower Lake
 - Soil contaminated from historical process waters
 - Possibly Speiss area & APSDA saturated soils, slag, Lower Lake sediment
- **Selenium:**
 - Migrating process water from Lower Lake
 - Soil contaminated from historical process waters
 - Possibly slag, other solid waste storage/disposal areas
 - Additional characterization needed

Seaver Park Residential Wells



Selenium Plume Delineation

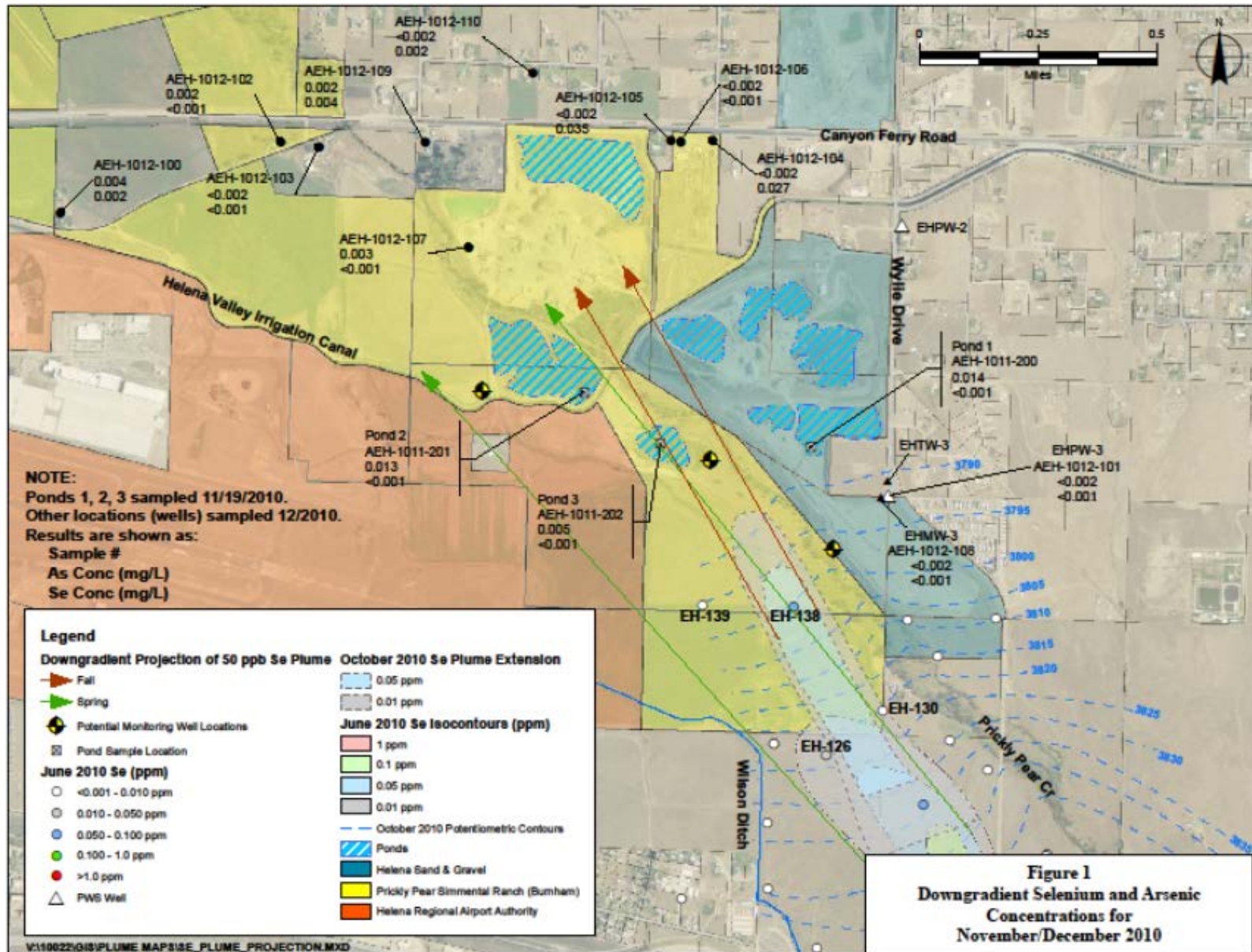


Figure 1
Downgradient Selenium and Arsenic
Concentrations for
November/December 2010