How Many Hydrogeologist Can Dance on the Head of a Pin?

Joe Griffin, MTech James Madison, MBMG

Butte Superfund Groundwater-Surface Water Interaction

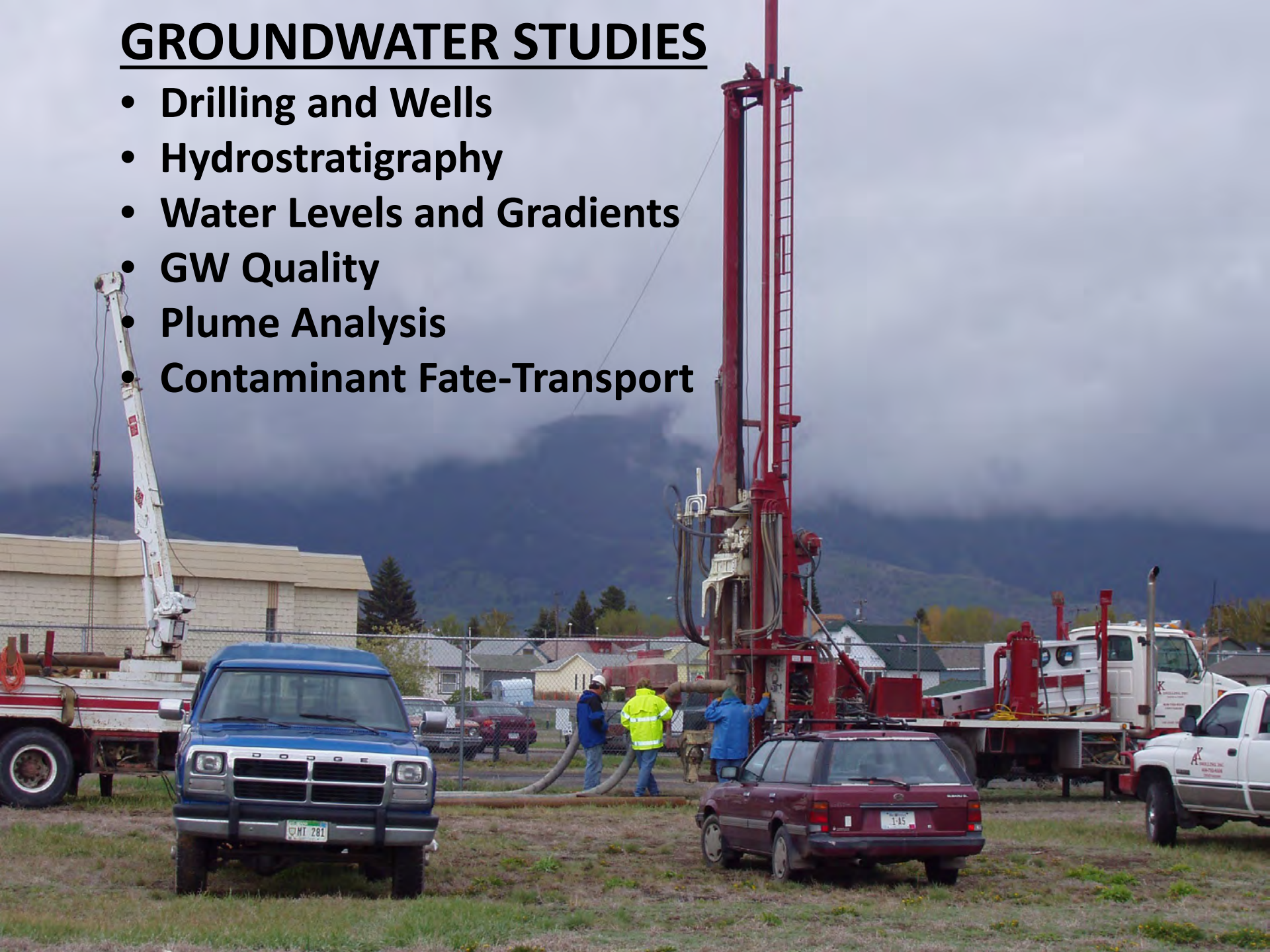
-EPA Decision 2006-
Alluvial Aquifer
Can’t Be Restored

But It Can Be Managed

Two Ways of Lookiing

GROUNDWATER STUDIES

- Drilling and Wells
- Hydrostratigraphy
- Water Levels and Gradients
- GW Quality
- Plume Analysis
- Contaminant Fate-Transport



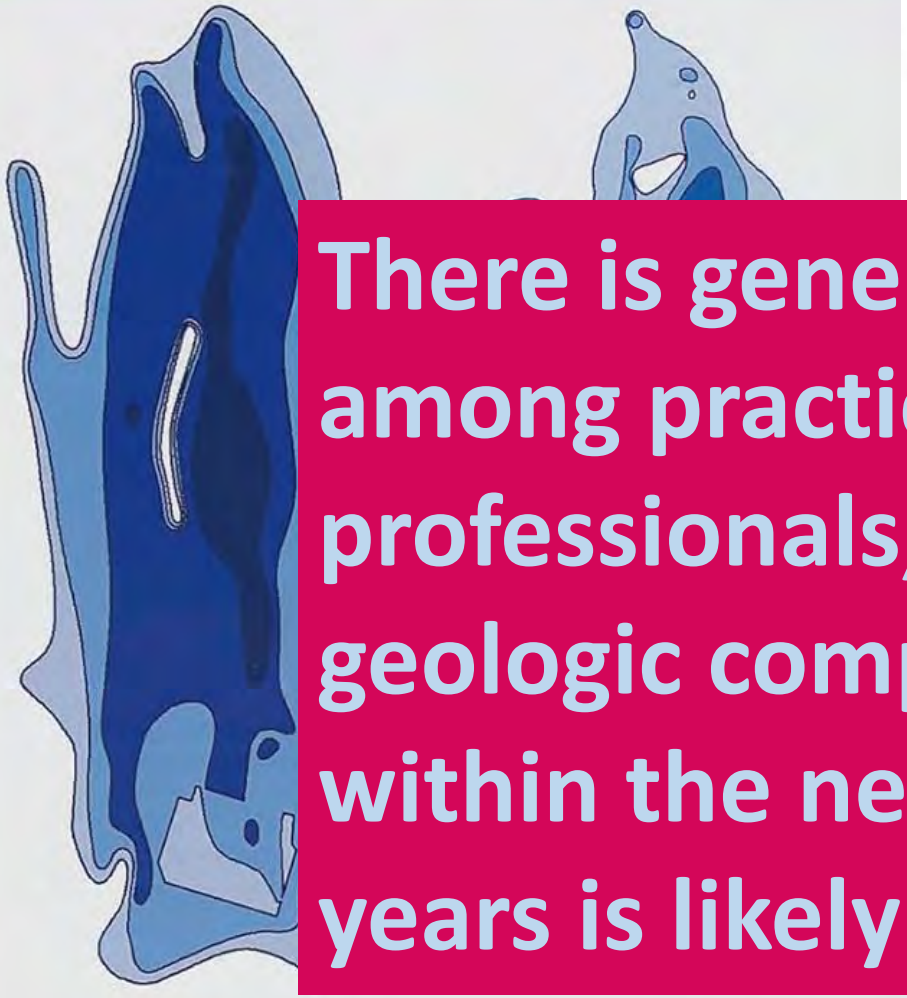
SILVER BOW CREEK STUDIES

- Monthly Synoptic Water Quality Sampling
- Look for patterns in data

EPA Decision for Groundwater 2006

NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES

ALTERNATIVES FOR MANAGING THE NATION'S COMPLEX CONTAMINATED GROUNDWATER SITES



Groundwater

Technical Commentary/

On the Effectiveness of Remediating Groundwater Contamination: Waiting for the *Black Swan*

by Donald I. Siegel

in each class of things just so far as the nature of the subject admits; it is evidently equally foolish to accept probable reasoning from a mathematician and to demand from a rhetorician scientific proofs.

profoundly difficult and meet long-term drinking water standards. Yet, many still seem to buy into the continued regulatory demand that it needs to be done. We could instead try to show why it can't be done yet, which might

There is general agreement among practicing remediation professionals, that due to inherent geologic complexities, restoration within the next 50 to 100 years is likely not achievable.

Butte Decision
Technically Impracticable

1. *Aquifer Heterogeneity/Preferential Flow Pathways*
2. *Primary Sources Extensive*
3. *Secondary Sources to Depth (100ft)*
4. *Urban Infrastructure*

EPA Remedy MUST *Protect Human Health*

1. *Controlled GW Area*
2. *BSB County Ordinance*
3. *Licensed Well Drillers*

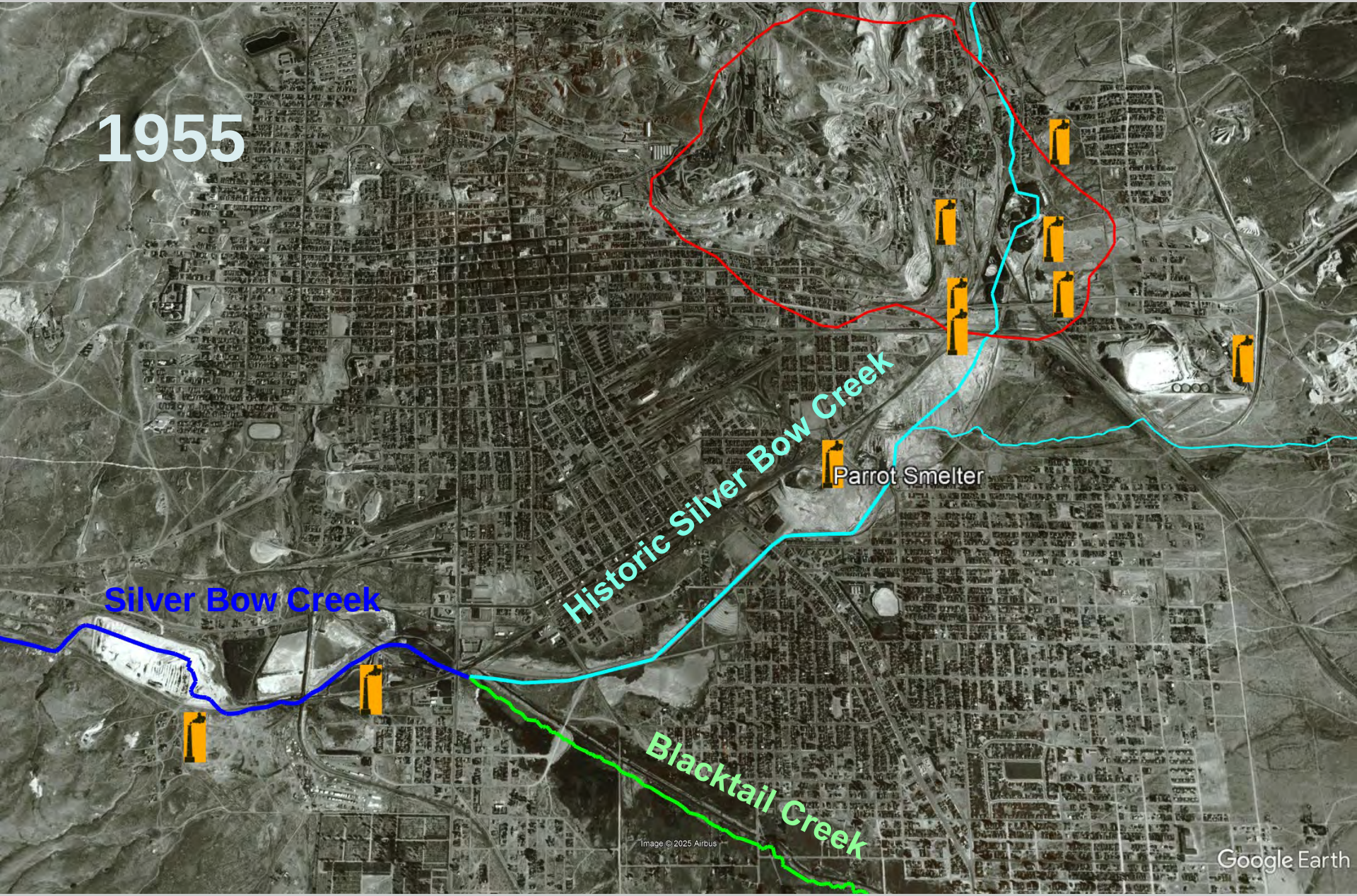
EPA Remedy MUST *Protect Ecosystem Health*

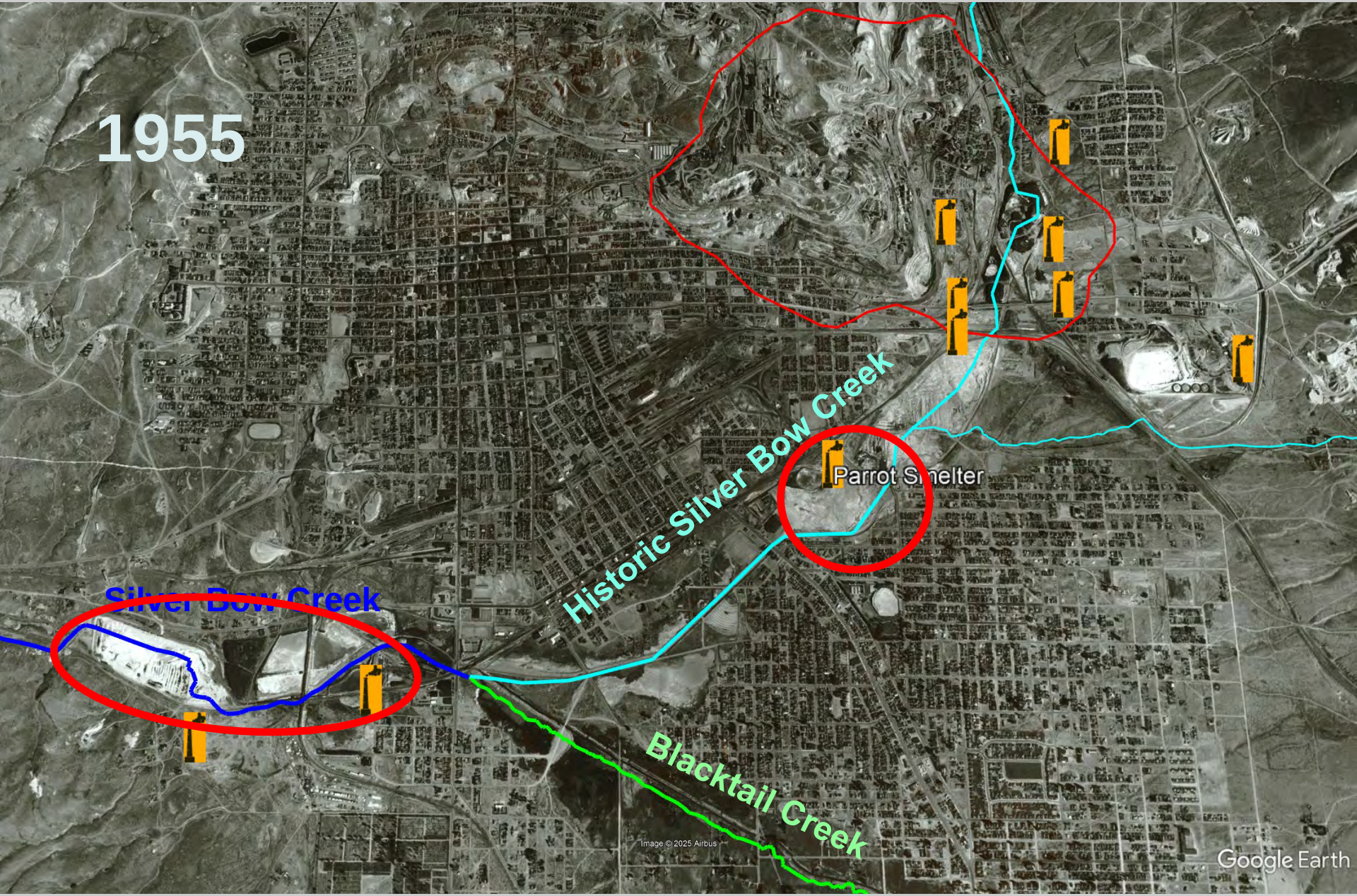
1. *GW Plumes - No Expansion*
2. *GW Plumes – Not Affect Creek*
3. *GW Managed – Pump and Treat (in perpetuity)*


EPA Mine Flooding
Bedrock TI Waiver
10,000 Miles
SS-07
Google Earth


SS-07
EPA TI Waiver
Alluvial Aquifer
Google Earth

The Problem
Tailings and AMD


1955
Historic Silver Bow Creek
Parrot Smelter
Silver Bow Creek
Blacktail Creek
Image © 2025 Airbus
Google Earth


1955
Historic Silver Bow Creek
Parrot Smelter
Silver Bow Creek
Blacktail Creek
Image © 2025 Airbus
Google Earth


Currently
HCC
MSD
Google Earth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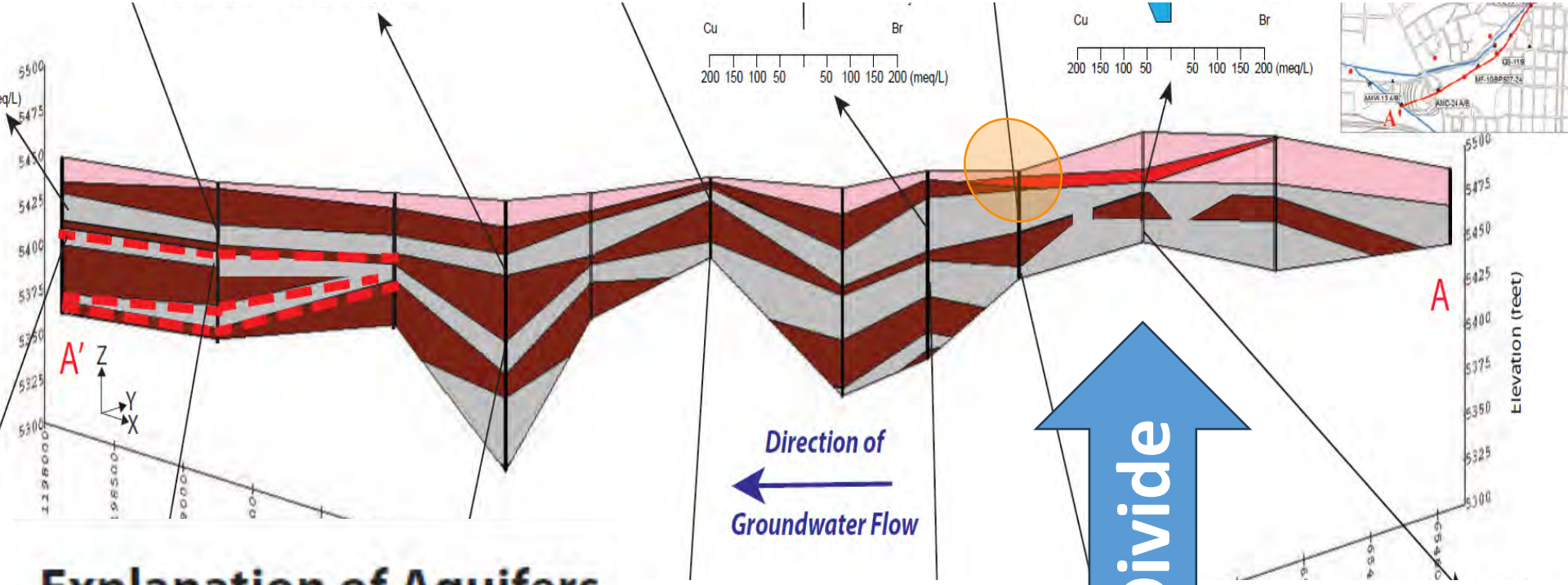
Longitudinal Profile



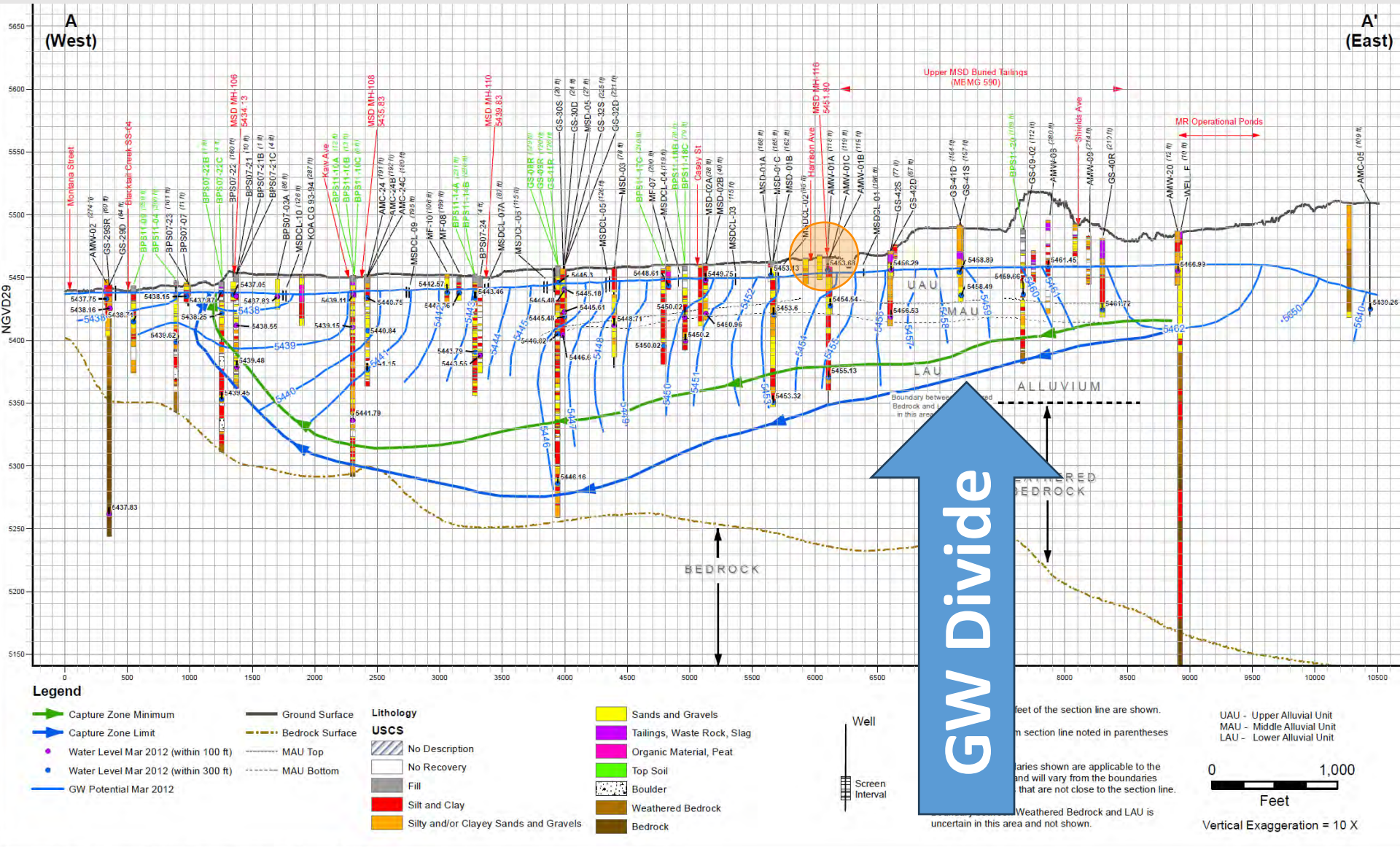
Explanation of Aquifers

Shallow Alluvial Aquifer

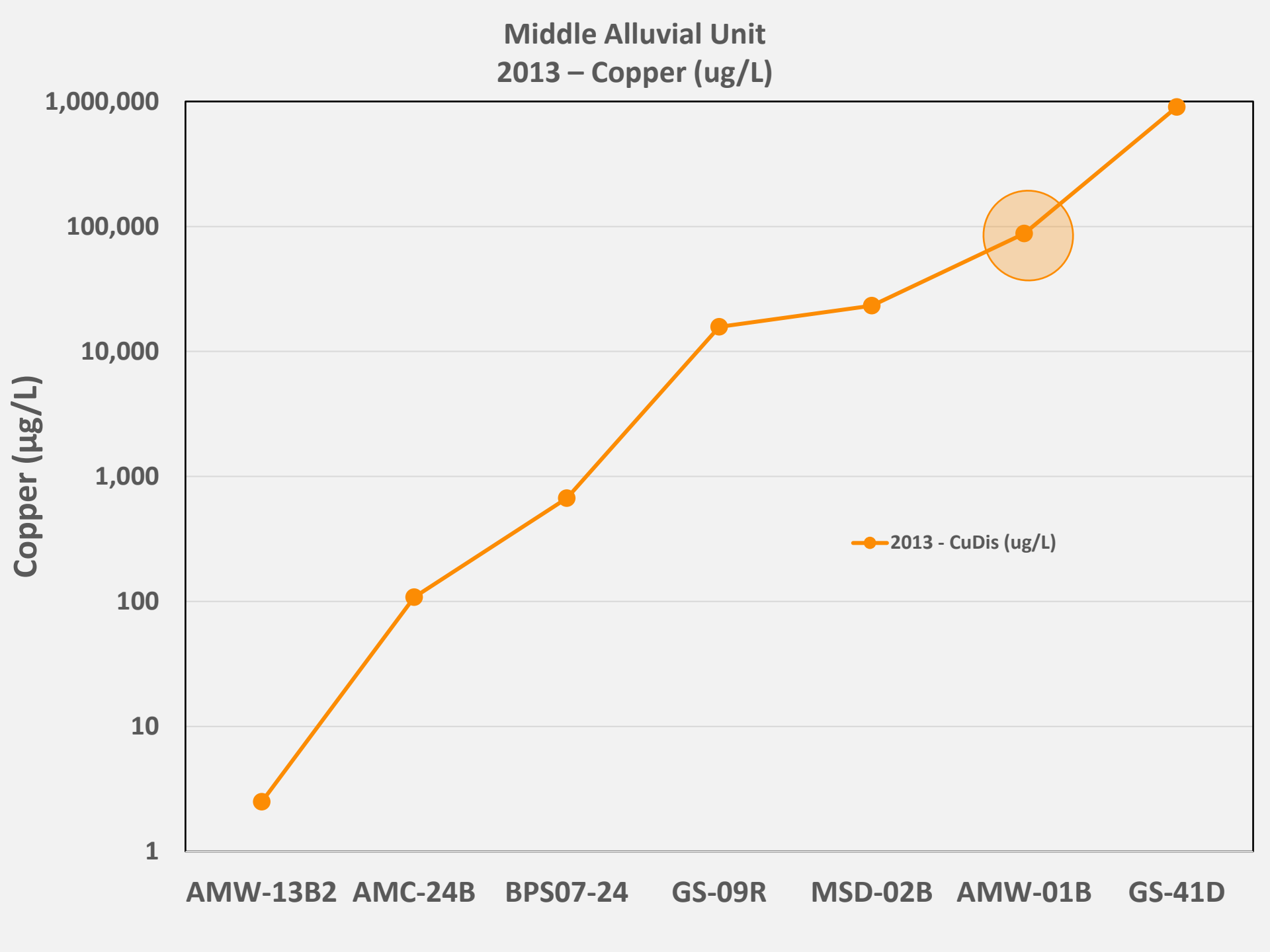
Middle Alluvial Aquifer

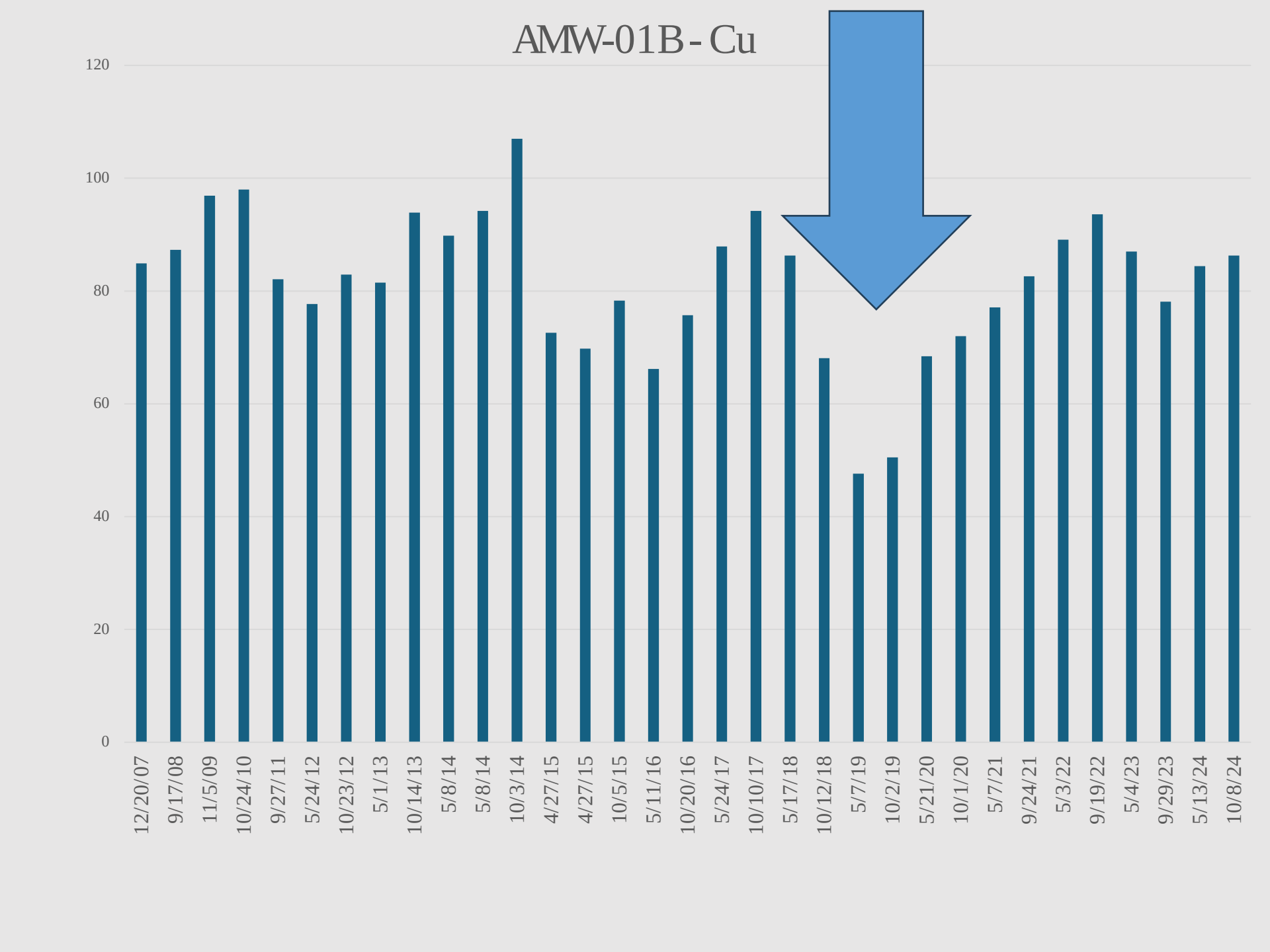
Deep Alluvial Aquifer

LUMPER


A
(West)
A'
(East)
NGVD29
Upper MSD Buried Tailings
(MEMG 590)
MR Operational Ponds
Harrison Ave
Shields Ave
Casey St
Montana Street
Kaw Ave
Blackcat Creek SS-04
UAU
MAU
LAU
ALLUVIUM
BEDROCK
GW Divide
Legend
Capture Zone Minimum
Capture Zone Limit
Water Level Mar 2012 (within 100 ft)
Water Level Mar 2012 (within 300 ft)
GW Potential Mar 2012
Ground Surface
Bedrock Surface
MAU Top
MAU Bottom
Lithology
USCS
No Description
No Recovery
Fill
Silt and Clay
Silty and/or Clayey Sands and Gravels
Sands and Gravels
Tailings, Waste Rock, Slag
Organic Material, Peat
Top Soil
Boulder
Weathered Bedrock
Bedrock
Well
Screen Interval
feet of the section line are shown.
n section line noted in parentheses
aries shown are applicable to the
and will vary from the boundaries
that are not close to the section line.
Weathered Bedrock and LAU is
uncertain in this area and not shown.
UAU - Upper Alluvial Unit
MAU - Middle Alluvial Unit
LAU - Lower Alluvial Unit
0
1,000
Feet
Vertical Exaggeration = 10 X

SPLITTER


Middle Alluvial Unit
2013 – Copper (ug/L)
1,000,000
100,000
10,000
1,000
100
10
1
Copper (µg/L)
2013 - CuDis (ug/L)
AMW-13B2
AMC-24B
BPS07-24
GS-09R
MSD-02B
AMW-01B
GS-41D

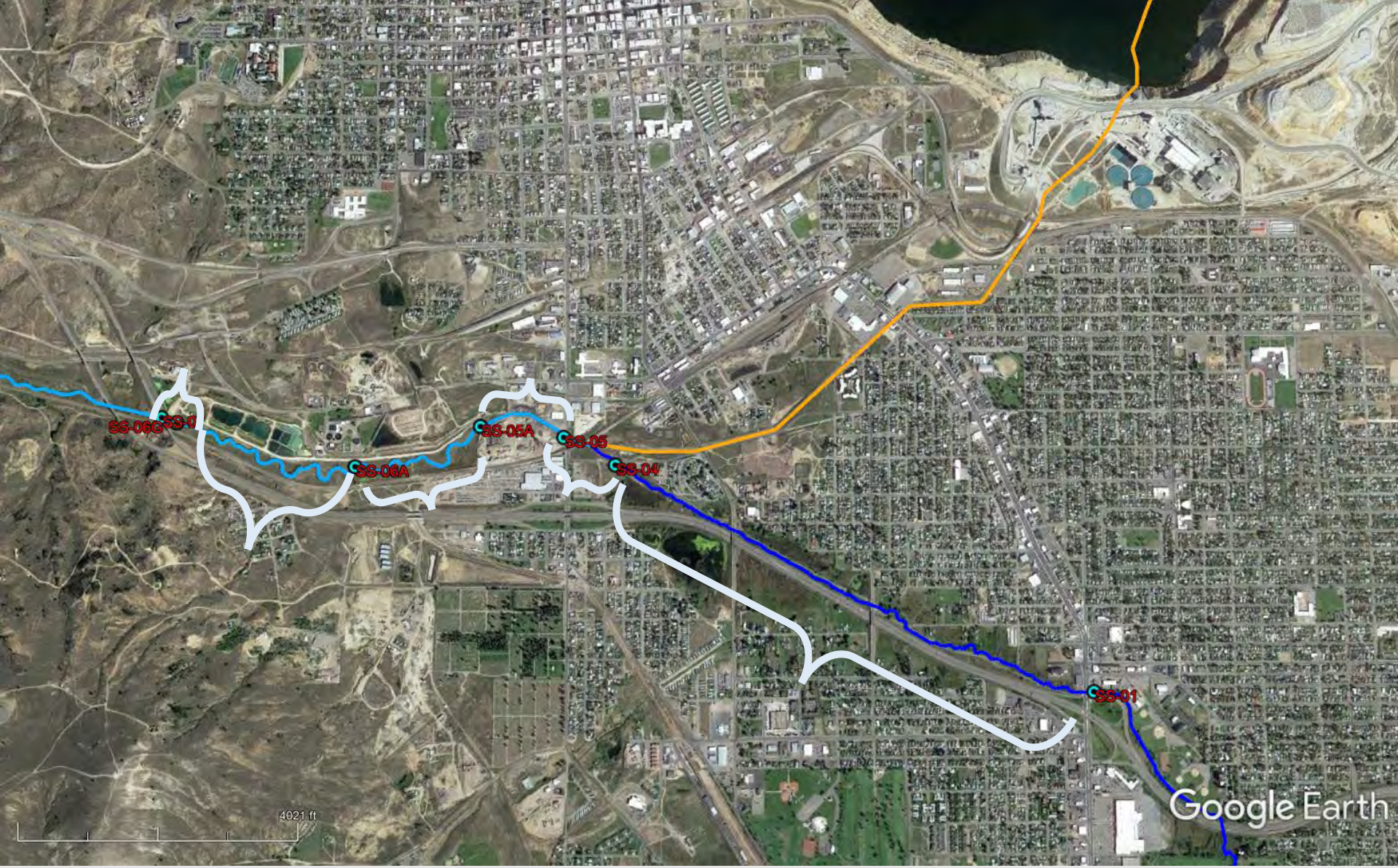

AMW-01B - Cu
120
100
80
60
40
20
0
12/20/07
9/17/08
11/5/09
10/24/10
9/27/11
5/24/12
10/23/12
5/1/13
10/14/13
5/8/14
5/8/14
10/3/14
4/27/15
4/27/15
10/5/15
5/11/16
10/20/16
5/24/17
10/10/17
5/17/18
10/12/18
5/7/19
10/2/19
5/21/20
10/1/20
5/7/21
9/24/21
5/3/22
9/19/22
5/4/23
9/29/23
5/13/24
10/8/24


2014
HCC
MSD
Google Earth

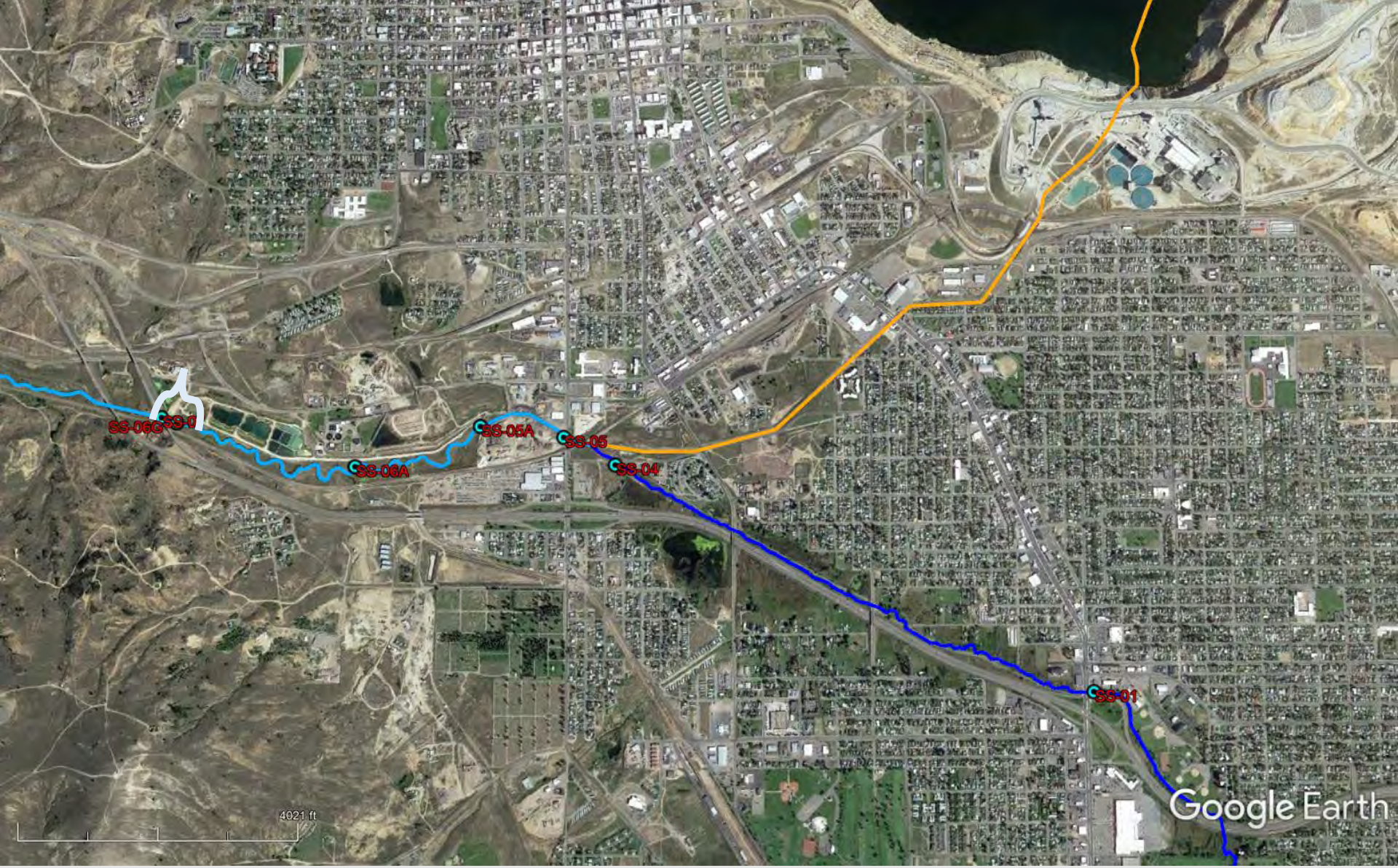

SS-07
TAILINGS
Montana St
1995


Currently

MONTHLY SYNOPTIC – 7 STATIONS

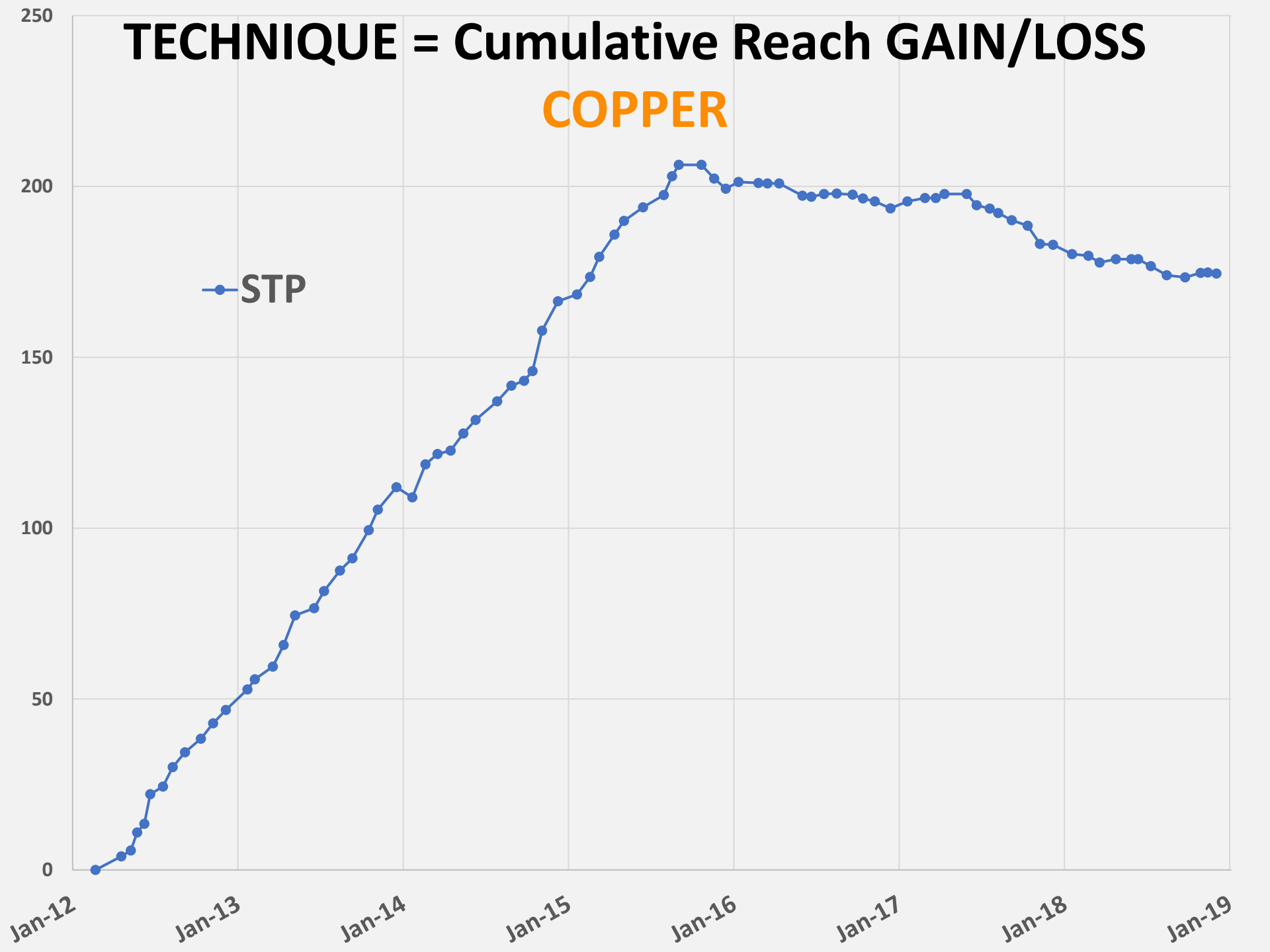


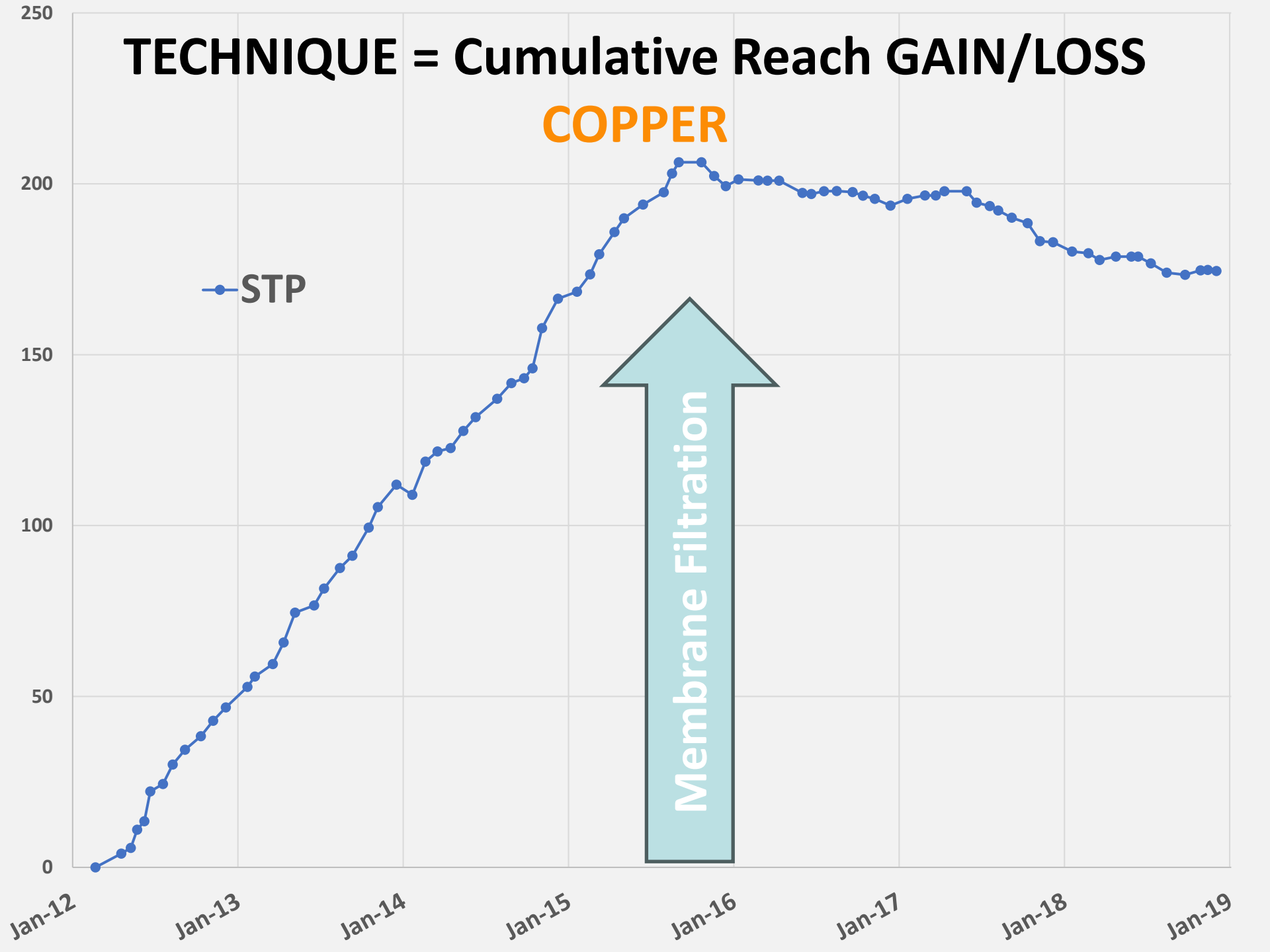
6 Stream Reaches
Monthly

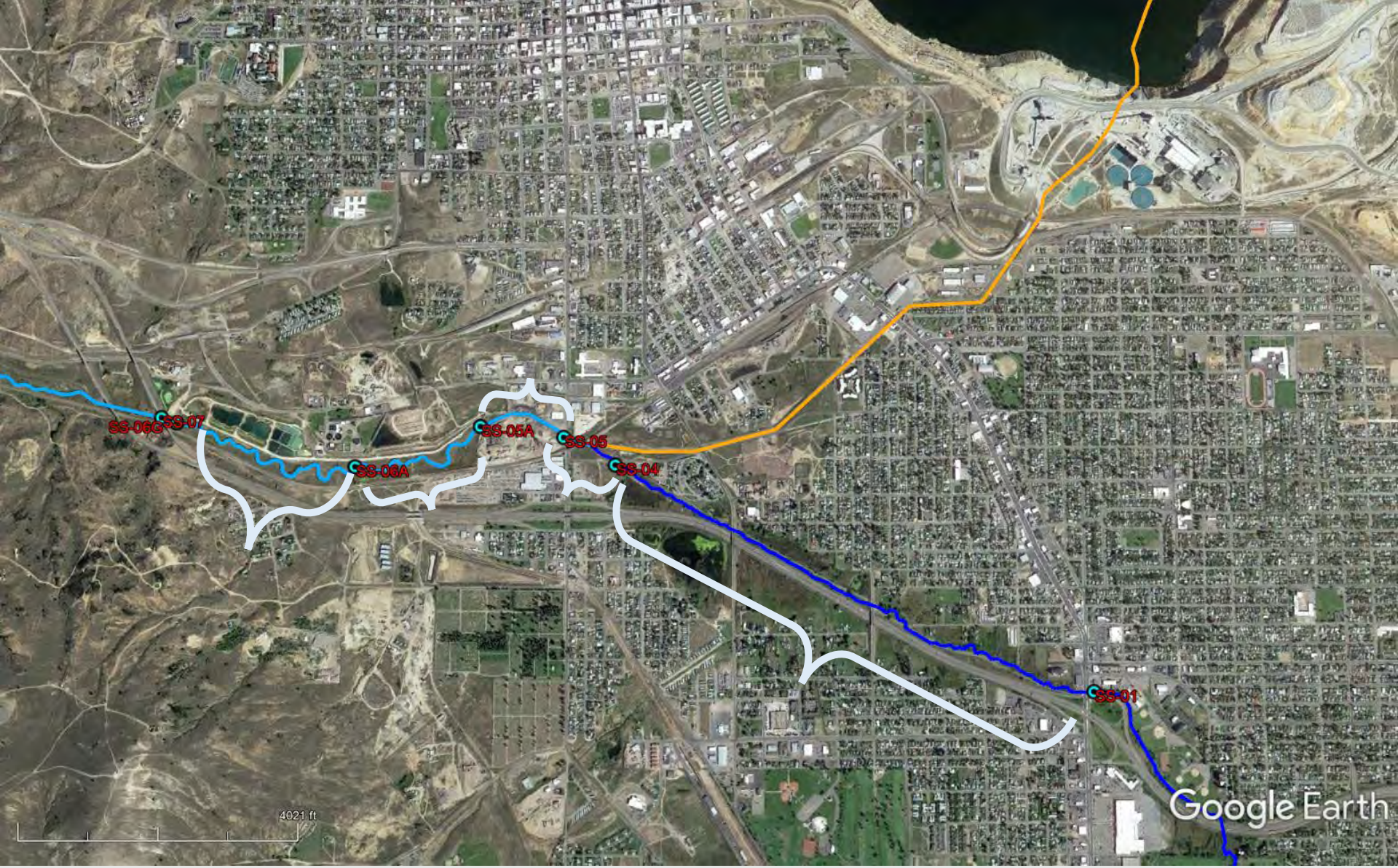


Sewage Treatment Plant


Google Earth

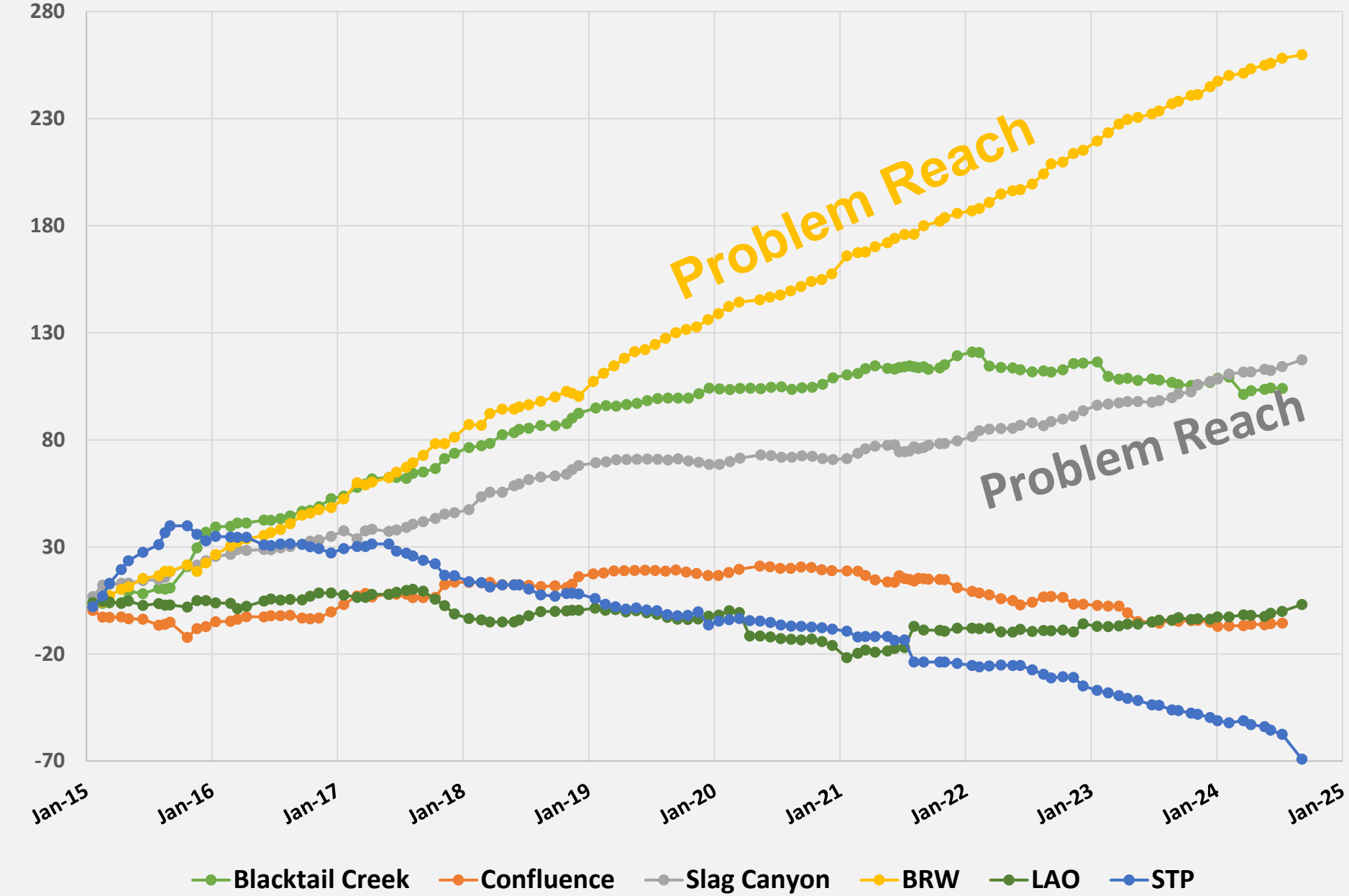

TECHNIQUE = Cumulative Reach GAIN/LOSS
COPPER
STP
250
200
150
100
50
0
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19

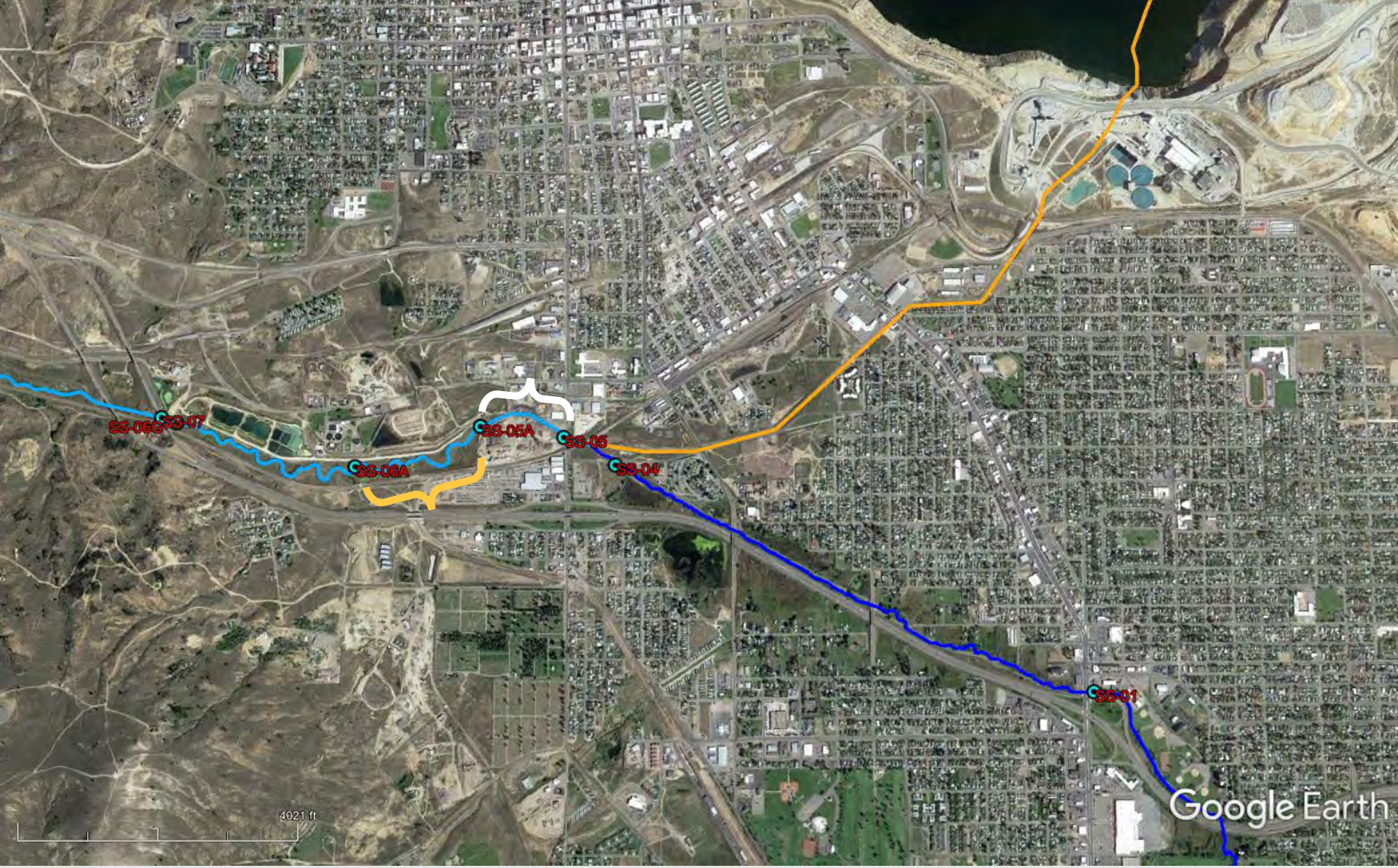

TECHNIQUE = Cumulative Reach GAIN/LOSS
COPPER
STP
Membrane Filtration
250
200
150
100
50
0
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19



Other 5 Stream Reaches

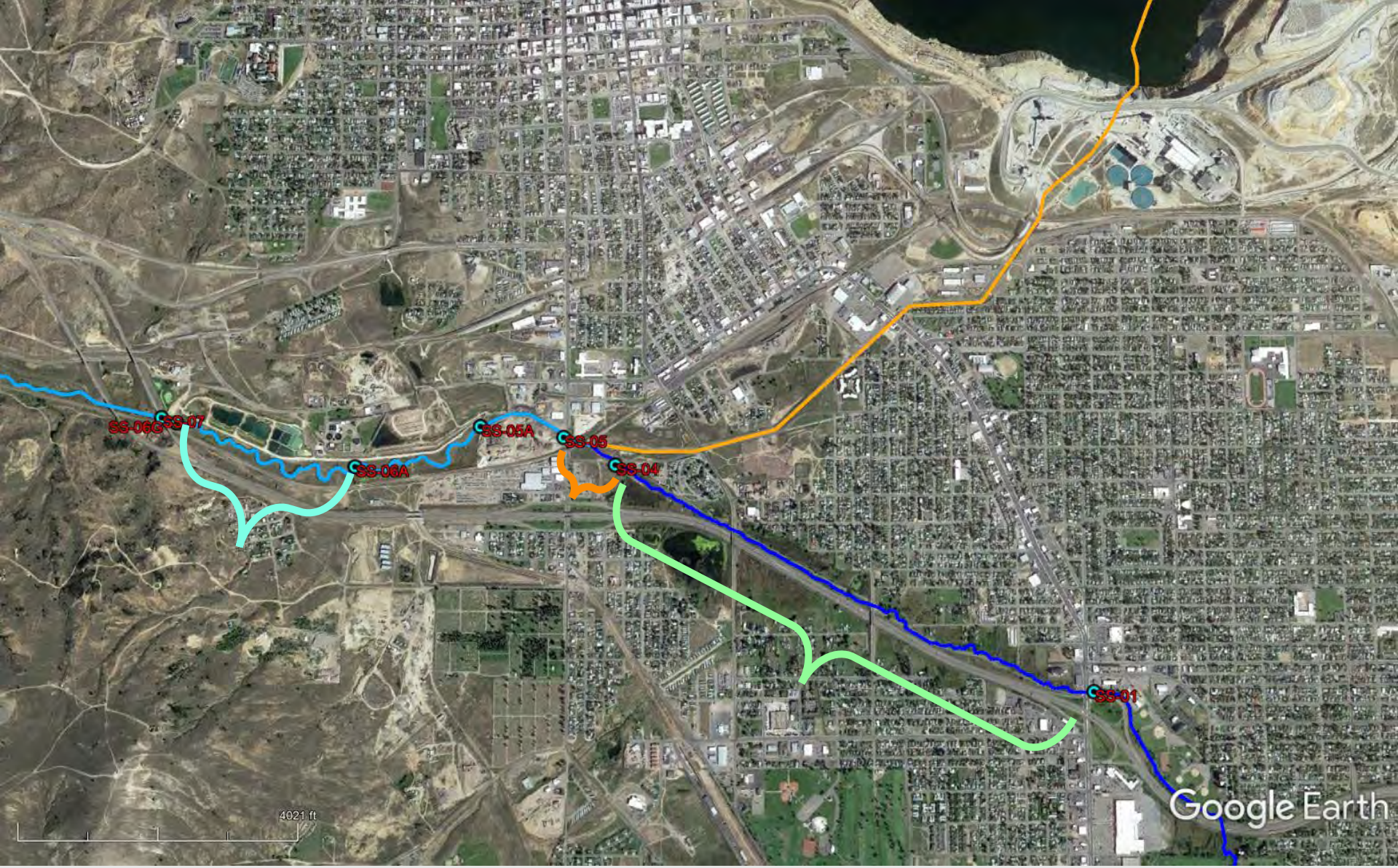
Cumulative Reach Gain
Total Recoverable Copper



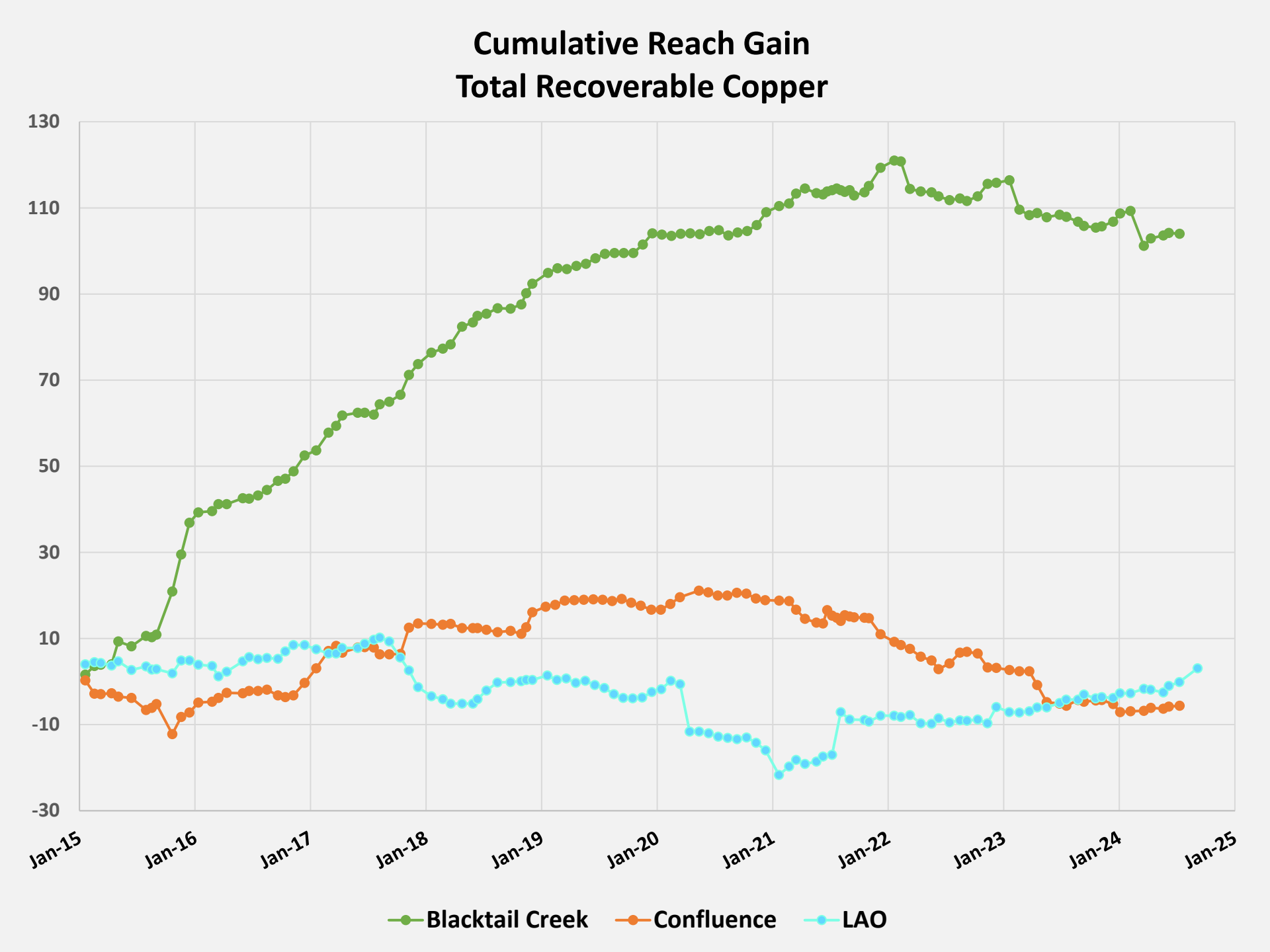


Reaches Outside of GW Capture

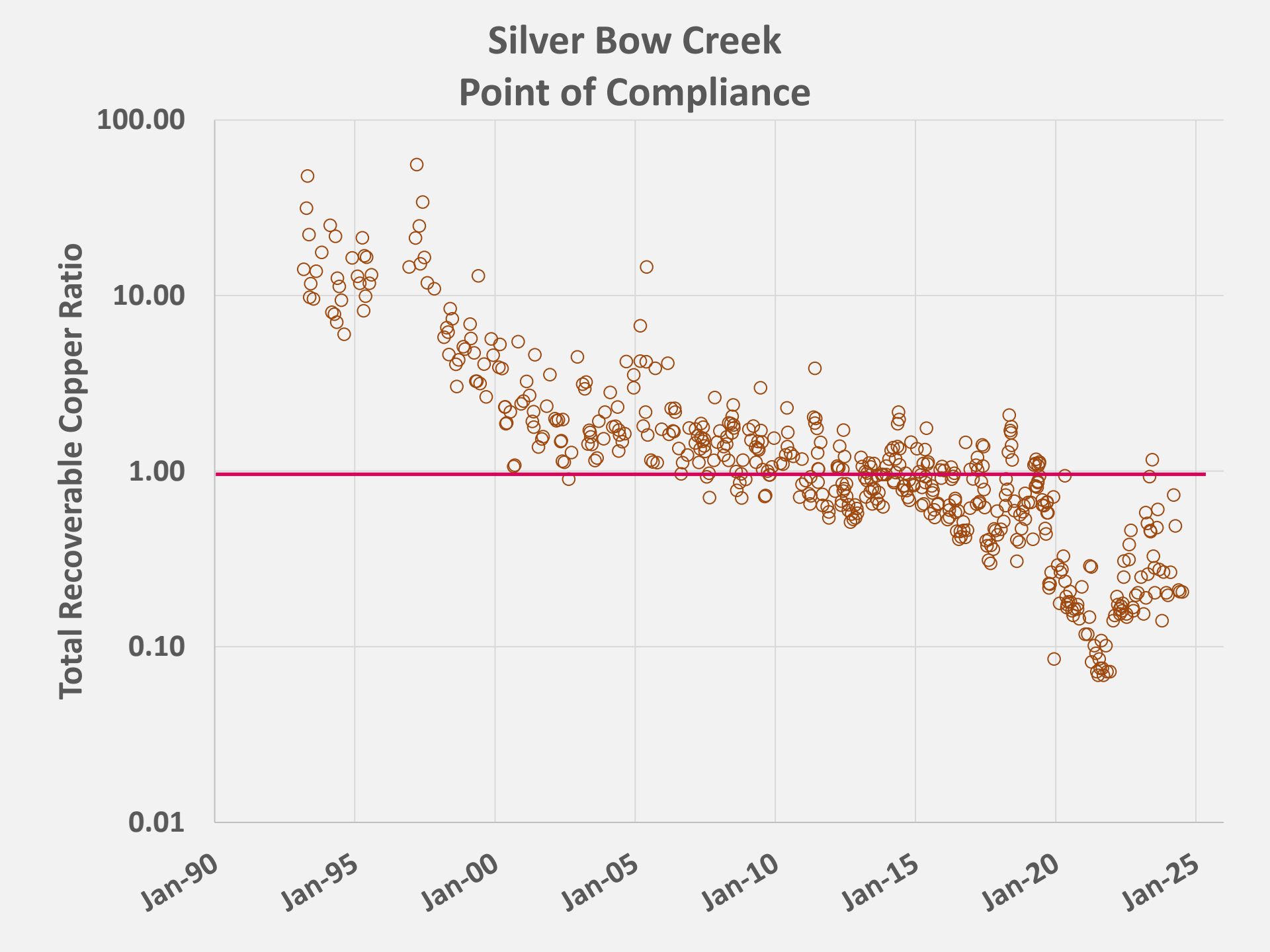

HCC
MSD
Google Earth



Reaches Affected By GW Capture


Cumulative Reach Gain
Total Recoverable Copper
130
110
90
70
50
30
10
-10
-30
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
Jan-23
Jan-24
Jan-25
Blacktail Creek
Confluence
LAO

Silver Bow Creek – Point of Compliance


Silver Bow Creek
Point of Compliance
Total Recoverable Copper Ratio
100.00
10.00
1.00
0.10
0.01
Jan-90
Jan-95
Jan-00
Jan-05
Jan-10
Jan-15
Jan-20
Jan-25

CONCLUSIONS:

- GW TI Warranted (So Far)
- Capture Treat Effective
- Wait and See for Area Between GW Capture

Questions?

How many hydrogeologists can dance on the head of a pin: Examining the controversial history of groundwater management at the Butte Superfund Site using more than 35 years of stream and groundwater data.

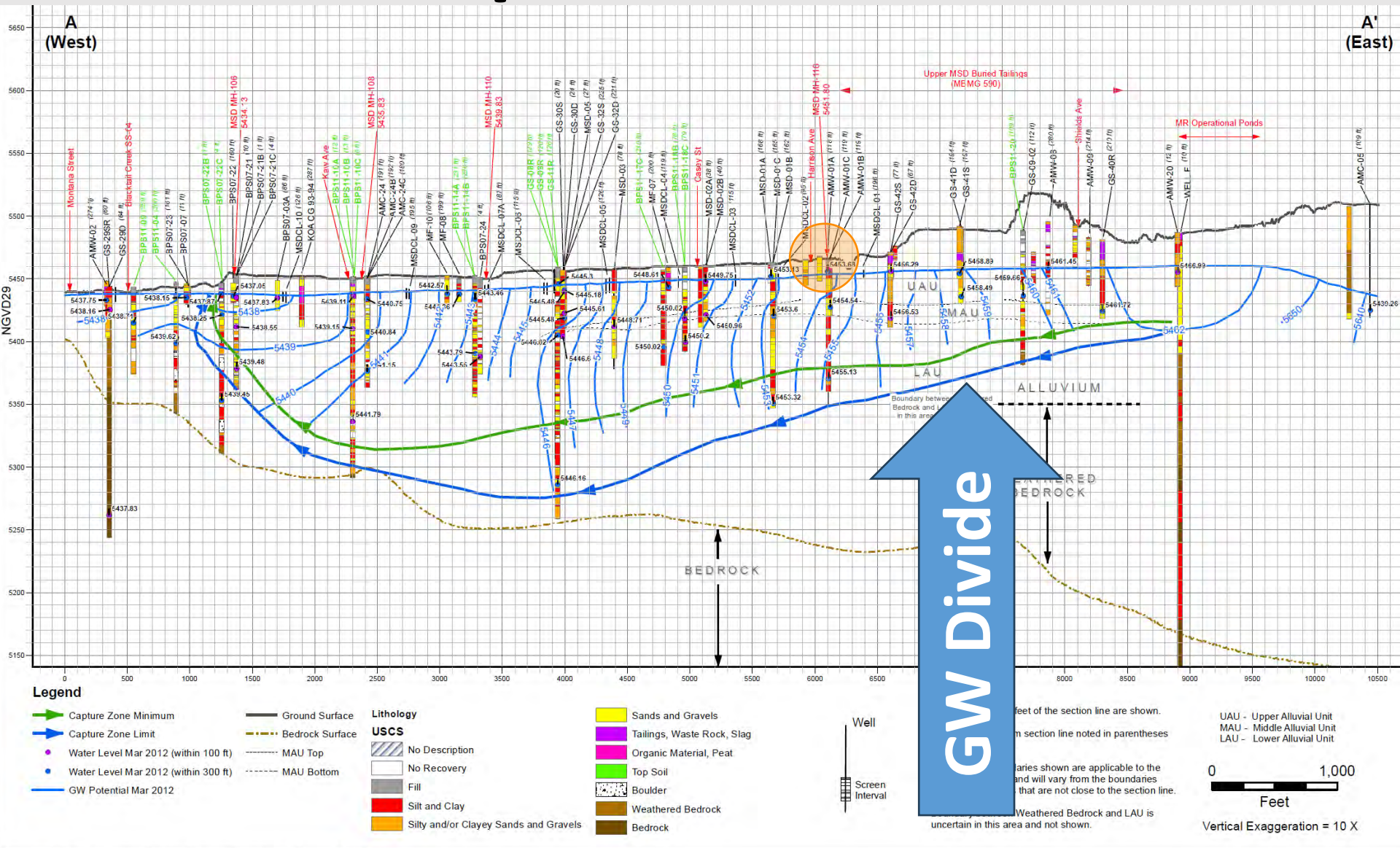
Joe Griffin, Montana Technological University, Affiliated Faculty
James Madison, Montana Bureau of Mines and Geology, Associate Professor

Nearly two decades ago, the U.S. EPA implemented a remedial strategy for the contaminated alluvial aquifer at the Butte Priority Soils Superfund Site. Exercising its federal authority, the EPA designated the alluvial aquifer along Silver Bow Creek as *technically impracticable* (TI) to restore to drinking water standards due to persistent secondary contamination sources and aquifer heterogeneity. In compliance with Superfund law, the remedy prioritizes human health through institutional controls and protects aquatic life by continuously capturing and treating contaminated groundwater (*in perpetuity*) before it reaches Silver Bow Creek.

The remedy has involved multiple components, including removing the Colorado Smelter tailings—a major source of stream contamination **directly** impacting the creek. However, EPA controversially chose not to remove the Parrot Tailings, despite their role in generating a severe groundwater contamination plume (copper 1,000 ppm), because the tailings and the resultant plume were located far from the creek.

Using over 35 years of comprehensive groundwater and surface water-quality data, we apply a novel cumulative gain-loss analysis to evaluate the interaction between aquifer and stream systems to critically assess whether EPA made the right decision to leave waste in place and rely on capture and treatment to manage surface water/groundwater interaction at this large and complex Superfund site.

Too Complex To Model?



SPLITTER

Cumulative Reach Gain
Total Recoverable Copper