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Upper Cement Creek and Sources of Metals Loading

Bonita Peak Mining District

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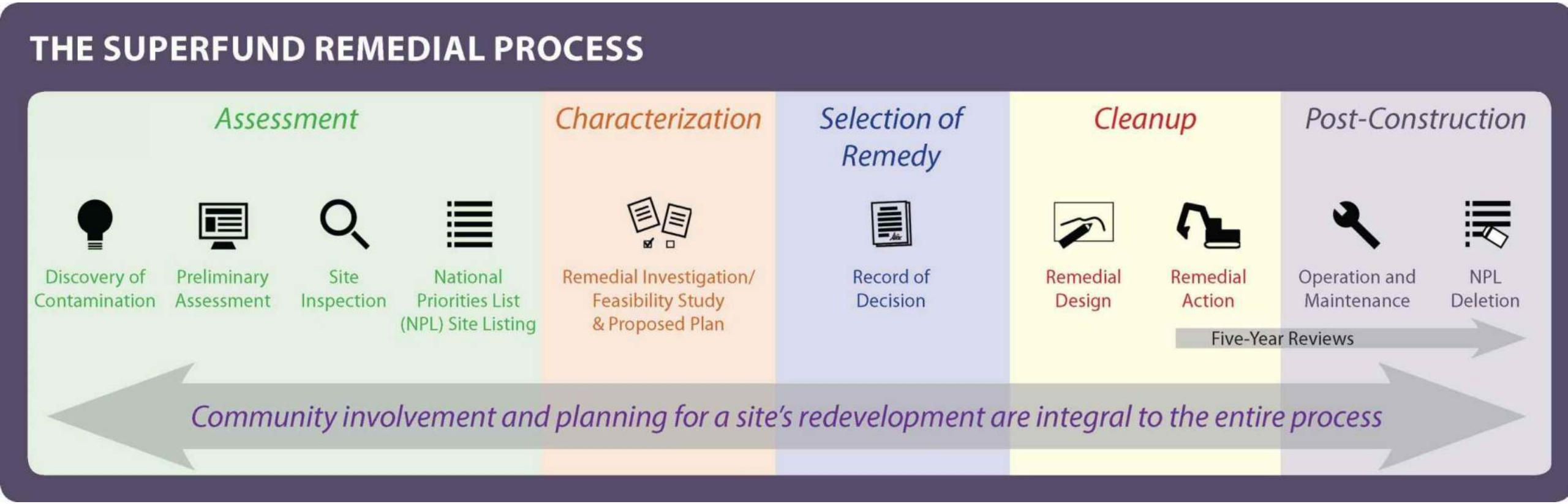
Outline

- Upper Cement Creek
- Sources in Upper Cement Creek
- Discharge and Water Quality
- Base Flows
- Comparison Location A72
- Source Water Management and Options
- Conveyance
- Treatment Options
- Feasibility Study Evaluations

EPA United States Environmental Protection Agency



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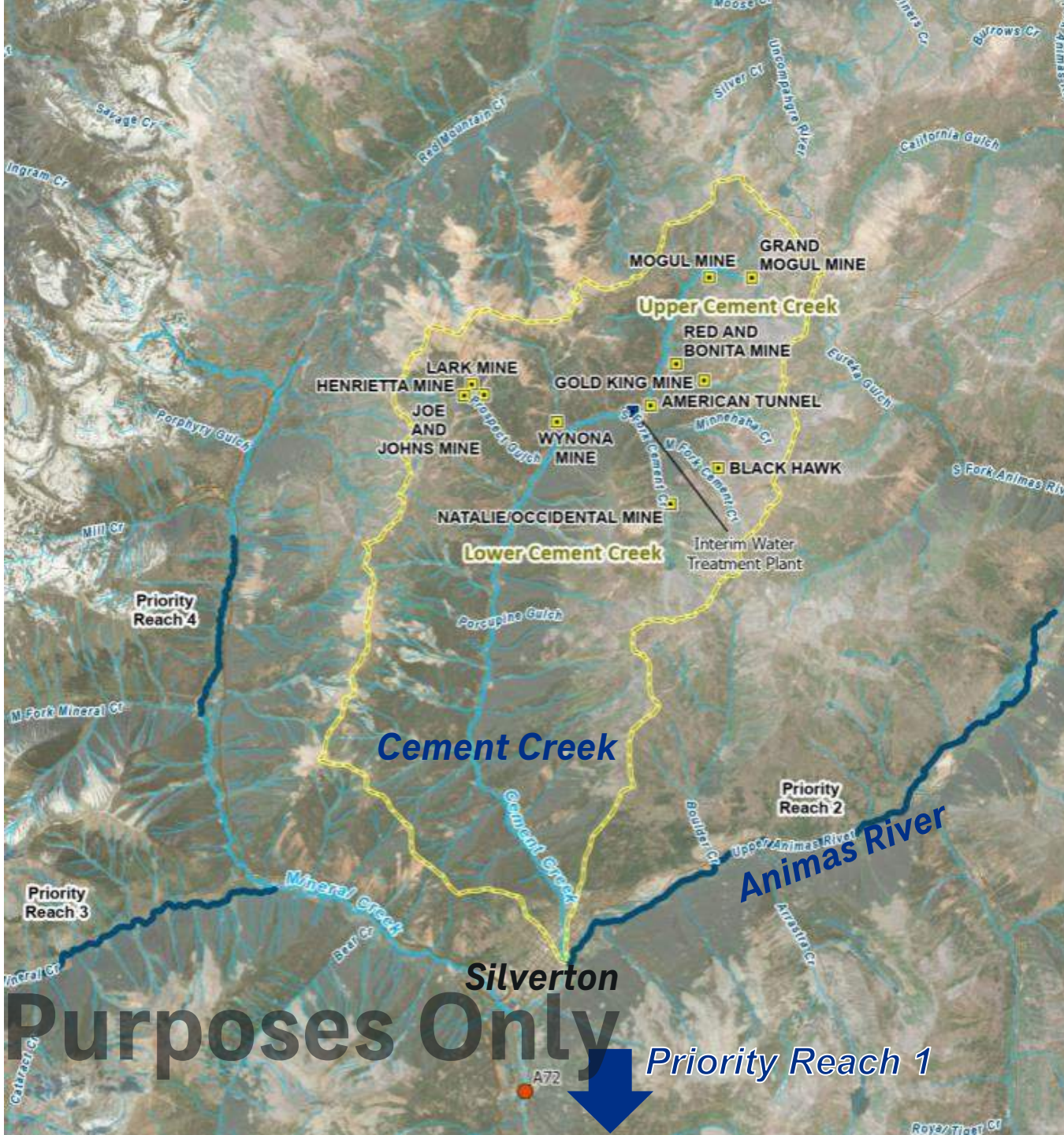
Data in this presentation were collected in the 2019 – 2020 time – for the months generally between June to October.

Monthly Water Quality and Flow Data

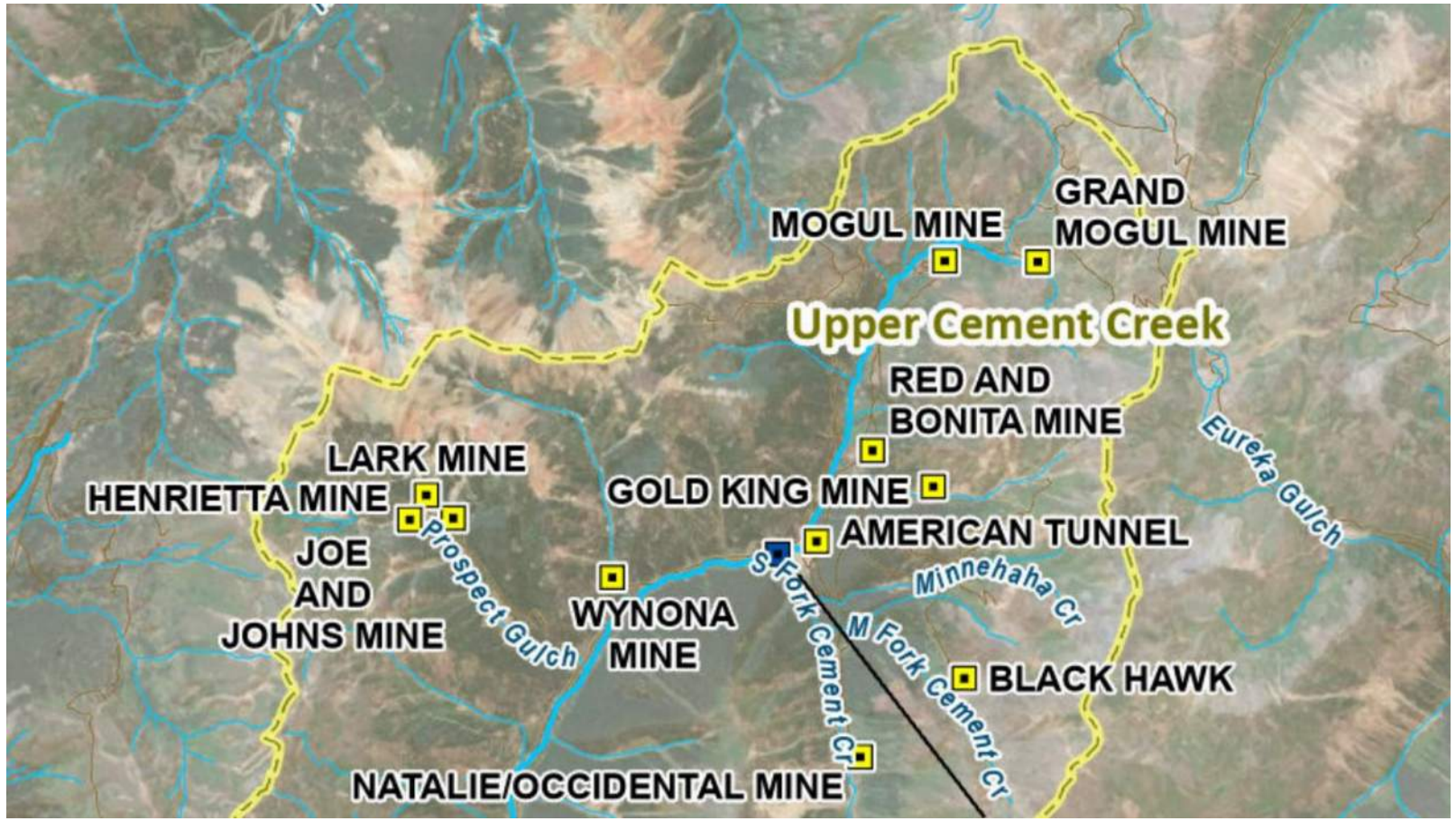
Upper Cement Creek

- Upper Cement Creek Watershed
- Source Area Mining Features
- Surface Water Inputs
  - Input from groundwater
  - Snowmelt and other surface runoff
  - Input from mine features (discharge from adits, run-on/run-off of surface features



Upper Cement Creek Source Areas

- Source areas are those that may be conveyed by gravity to the Gladstone Area
- Cement Creek and tributaries/Prospect Gulch



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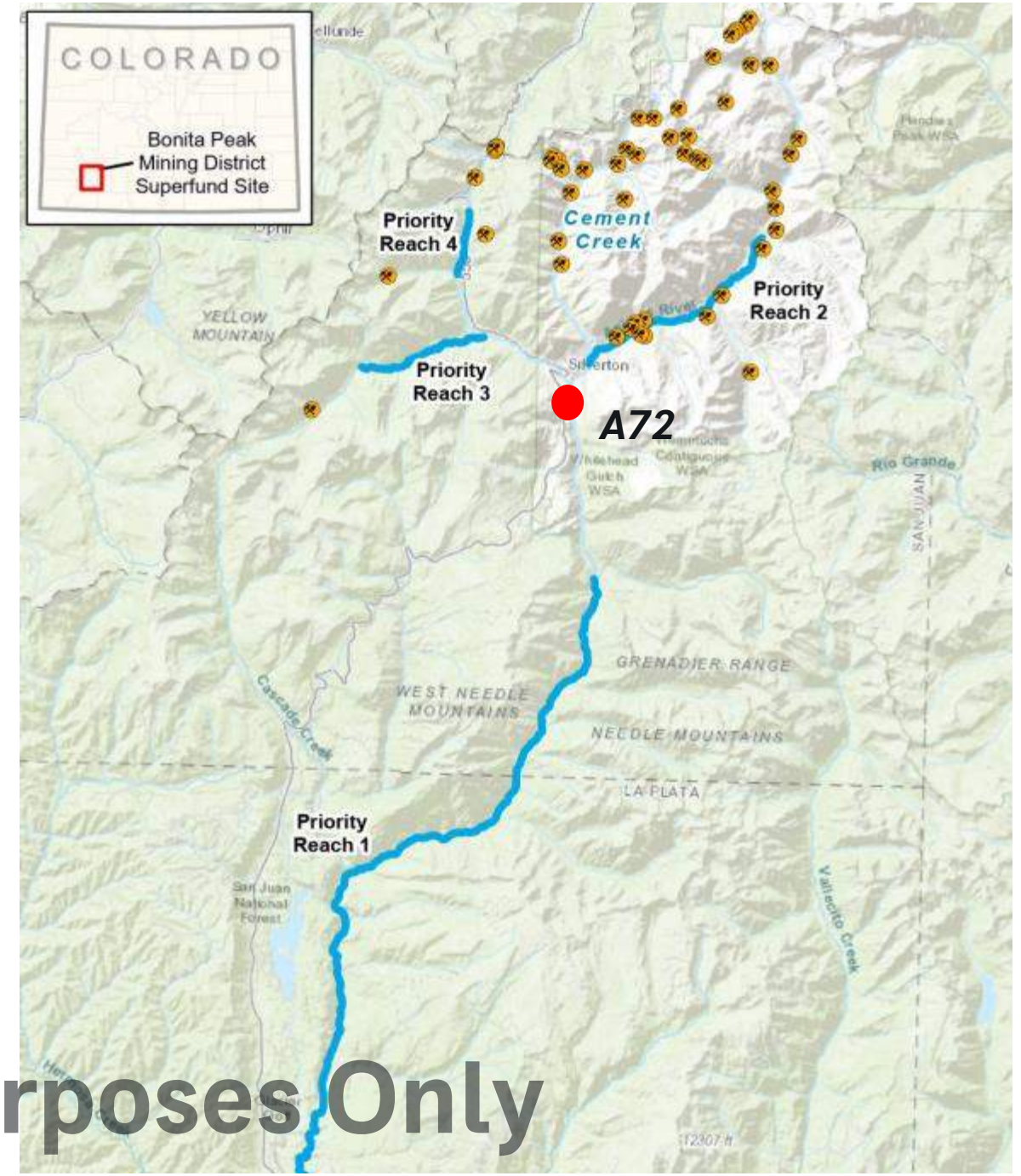
Location A72

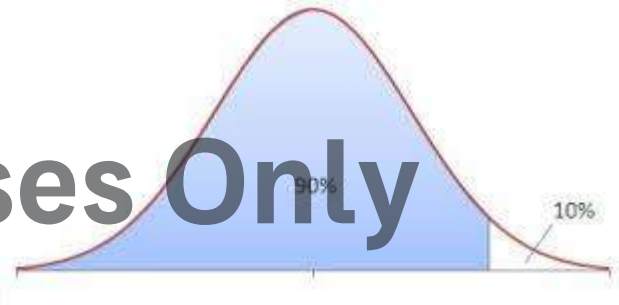
- Represents the Animas River below Silverton
- Can be used as a point of reference for consideration of load/concentrations of metals impacting Priority Reach 1
- Source metals concentrations and loading within Upper Cement Creek can be compared to concentrations and loading at A72
- Comparisons of load highlight sources that may most affect A72 (and Priority Reach 1)



Discharge and Water Quality – Load Calculation

- Discharge is a measure of volume per unit time – flow
- Load - Mass per unit time
  - Calculated using Discharge and Concentration data
- 90th percentile used where sufficient data is available
- Provides context for understanding the amount of metals mass conveyed independent of flow volumes from sources
- Water Quality (concentration) is influenced by flow volumes (dilution/concentration)

Source	Discharge	Total Zinc	
	gpm	mg/L	lb/day
Mogul	27	33	11
Grand Mogul	3	16	1.7
Red and Bonita	296	15	55
Gold King No. 7	430	16	82
Natalie Occidental	392	0.85	5.6
American Tunnel	81	20	19
Black Hawk	269	0.67	2.2
Lark	0.31	16	0.058
Henrietta No. 7	3.6	0.21	0.0060
Joe and Johns	4.2	13	0.66
Wynona	5.1	1.4	0.085
Cement Creek Base Flow	1321	8.4	122
Total	1511	132	177

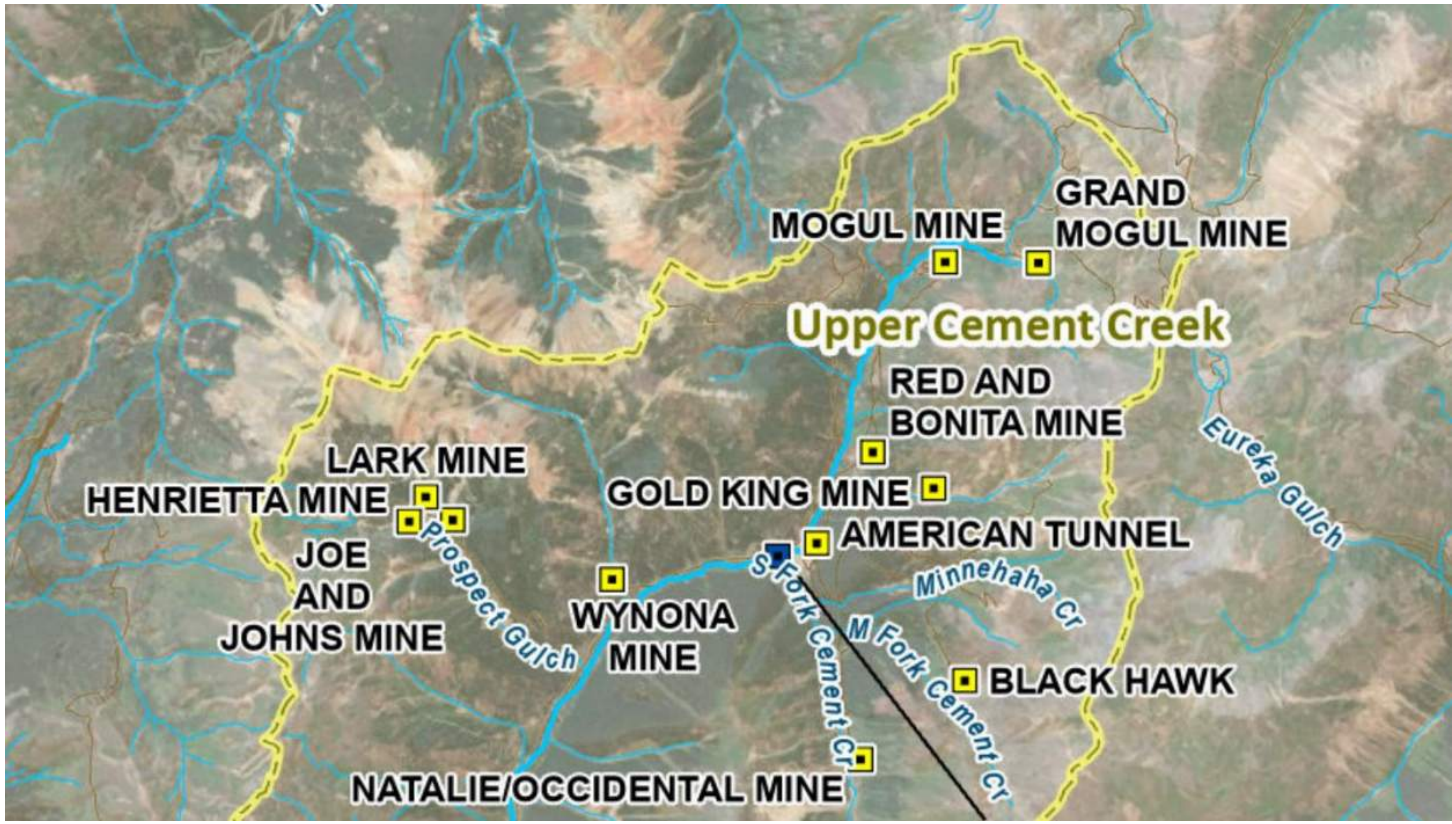


Upper Cement Creek - Base Flow

- Includes:
  - North Fork Cement Creek
  - Iron fen near Mogul
  - Base flows in Cement Creek between Mogul and American Tunnel
  - Middle Fork of Cement Creek
  - South Fork of Cement Creek
  - Minnehaha Creek

Base Flow Discharge – Source Summary

- Highest Discharges: Natalie/Occidental, Black Hawk, Gold King No. 7, and Red and Bonita
- Prospect Gulch areas have the lowest observed flows
- Cement Creek discharge - range 90 to 130 cfs during spring runoff. Typical flows are 4 – 6 cfs
- Natalie Occidental, Black Hawk Mine respond seasonally, other locations show a muted seasonal response



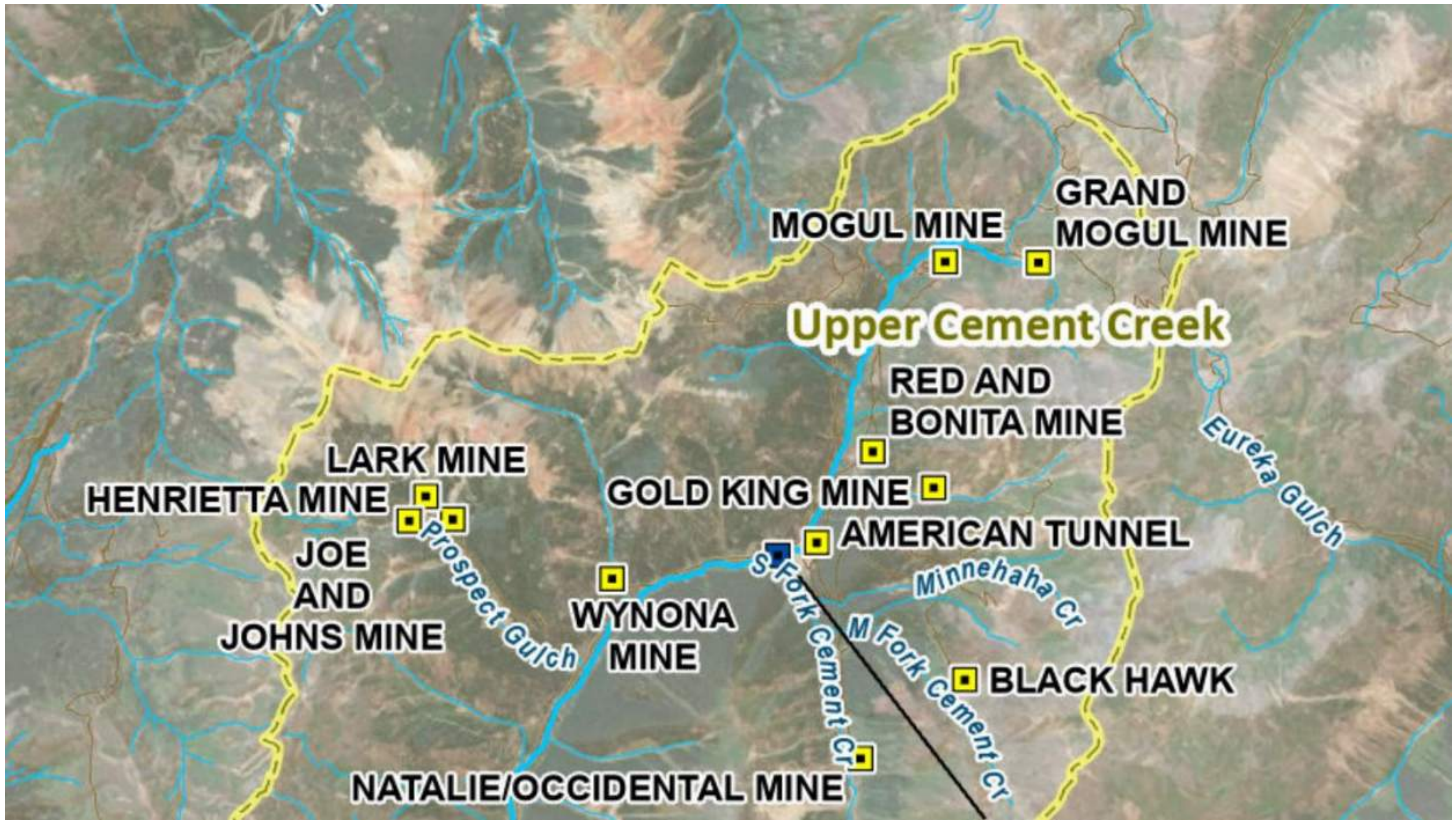
Source Areas and Cement Creek Base Flow - Discharge

- Total Discharge representing Cement Creek Base Flow downstream of tributary inputs.

Draining Mine	Statistic	Discharge, gpm	Percent of Total Discharge
Upper Cement Creek Base Flow	90th	1240	40%
Natalie Occidental	90th	476	15%
Gold King No. 7	90th	484	16%
Red and Bonita	90th	391	13%
Black Hawk	90th	328	11%
American Tunnel	90th	90	2.9%
Grand Mogul	90th	19	0.6%
Mogul	90th	37	1.2%
Wynona	Average	5.1	0.17%
Joe and Johns	Average	4.2	0.14%
Henrietta No. 7	Average	3.6	0.12%
Lark	Average	0.31	0.0101%
Total		3076	100%

Source Area Load Summary

- Zinc used for this analysis
- Other metals, including Arsenic, Cadmium, Copper, Iron, Manganese and Lead are also important
  - Typically these metals are proportionate
  - Some local variability
- The following summary assumes input from Gold King No. 7 – which is currently treated at the IWTP



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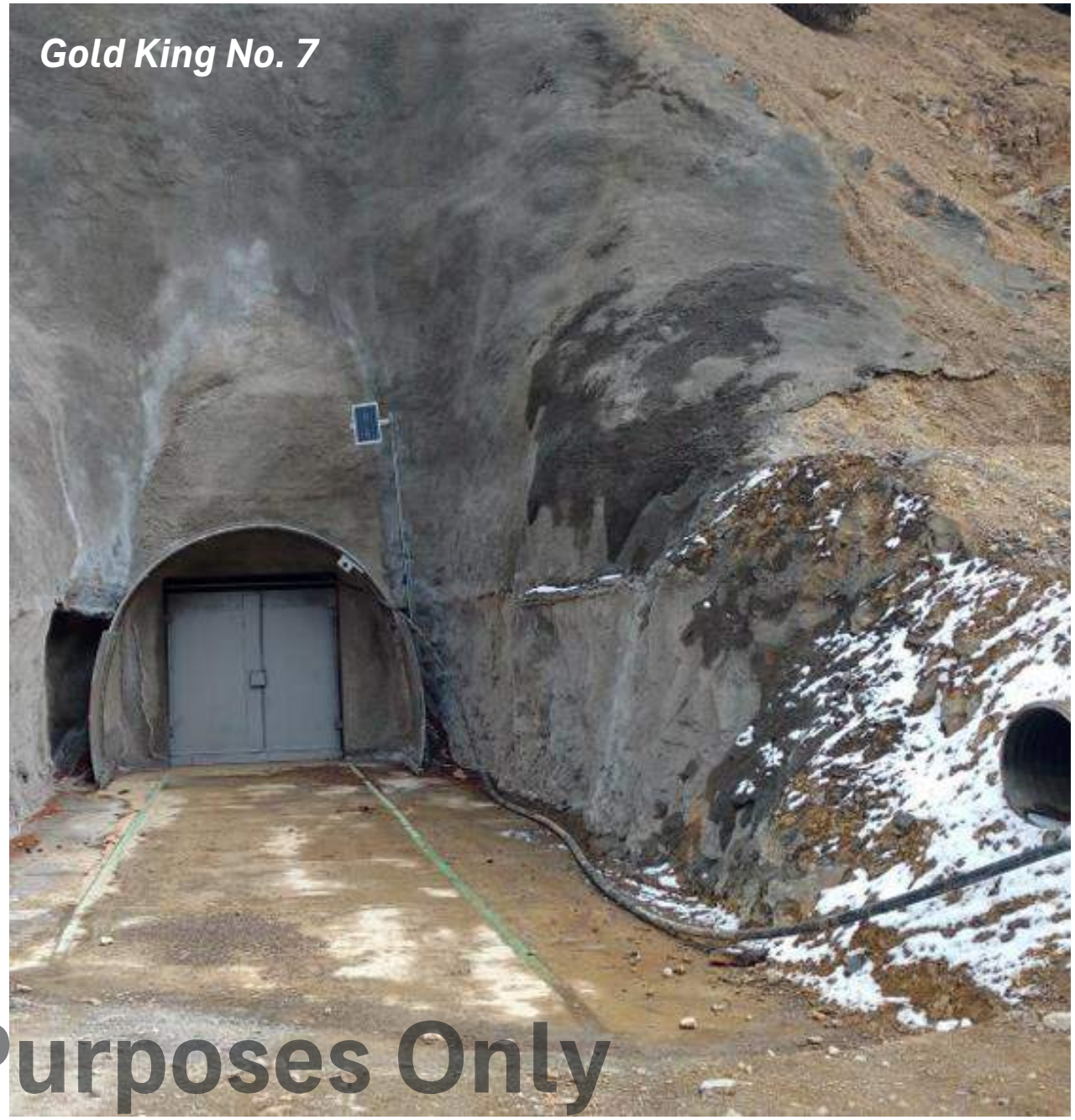
Source Area Loads and A72

- Gold King No. 7, Red and Bonita, and American Tunnel represent the largest load contribution to A72 from Upper Cement Creek
  - Provide Approximately 30% of the load observed At A72
  - Other Source locations provide 7 to 8% of the A72 load
  - Cement Creek Base Flow provides 6% of the A72 load



Source Areas - Loads

Source	Statistic	Discharge, gpm	Percent of Total Discharge	Zinc, lb/day	Source Cumulative Percent Load	Relative Percent Load at A72
Gold King No. 7	90th	484	21%	136	45%	19%
Red and Bonita	90th	391	17%	72	24%	10%
Upper Cement Creek Base Flow	90th	1240	55%	42	14%	6%
American Tunnel	90th	90	4%	22	7%	3%
Mogul	90th	37	2%	13	4.3%	2%
Natalie Occidental	90th	476	21%	12	4.0%	2%
Grand Mogul	90th	19	1%	3.2	1.04%	0.45%
Black Hawk	90th	328	14%	2.8	0.93%	0.40%
Joe and Johns	Average	4.2	0.19%	0.66	0.22%	0.09%
Wynona	Average	5.1	0.23%	0.085	0.028%	0.0121%
Lark	Average	0.31	0.014%	0.058	0.019%	0.0082%
Henrietta No. 7	Average	3.6	0.16%	0.0060	0.0020%	0.00086%
Total for Upper Cement Creek Sources		2260		305		
Calculated Load at A72		512110		702		

Source Water Management and Treatment Considerations

- Conveyance Options
- Discharge and Load
- Potential Treatment Options
- Feasibility Study

Conveyance Options for Identified Sources

- Pipelines – overland or buried. This already exists near the Gold King No. 7 mine and the Red and Bonita
- Using the American Tunnel as a centralized location for water management
- Cement Creek or its tributaries - sources currently drain to Cement Creek.
- Localized passive or limited active treatments (such as wetlands or flow-actuated/solar treatments at sources)

Identified Sources are generally available for conveyance by gravity – i.e., they are topographically higher than the Gladstone Area

Water Treatment Options

- Major Influences on Water Treatment and Source Management include the Influent Geochemistry, Flow Variability, and Sludge Management

Influent Geochemistry	Flow Variability	Sludge Management
▪ Metals (ratios and concentrations) ▪ pH ▪ Water temperature	▪ Treatment for a variation in flows ▪ Seasonal Extremes ▪ Treatment and/or Storage	▪ Spatial extents for storage and/or deposition ▪ Different treatment methods may generate different quantities, chemistries, and/or viscosities

Potential Treatment Options

Active

- Water Treatment Facilities
- Involves influent management – flows, pretreatments
- Several Different Technologies (Lime treatment, HDS, filtration, membrane, etc…)
- Effluent considerations; sludge management, outfall geochemistry

Ex-situ and some passive treatments work well for low flows (10s of gpm). Active treatments tend to favor larger flows.

Passive

- Source Control and/or Water Management
  - Bulkhead(s)
  - Routing.
- Biochemical reactors, wetlands – similar to the Mogul fen
- Alkalinity producing drainages and systems – e.g., limestone cascades
- Passive engineered (water or solar powered) treatments

Feasibility Study Evaluation Criteria

- Any option will need to be evaluated as part of the Feasibility Study
- There is a detailed planning criteria which involves:
  - Effectiveness
  - Implementation
  - Cost
  - And other criteria →