Mining Influenced Water Technology Demonstration Program

Case Studies and Lessons Learned

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Presentation Outline

- MIW Tech Demo Program Background and Introduction
- Overview of sites and technologies
- Focus on 2 Sites:
  - Site 1: Captain Jack Mill
  - Site 2: Elizabeth Mine
- Overall Program Lessons Learned

2020 Review: Data Gaps Identified

- Concentration associated with percent removal (rather than only average percent removals and ranges of concentrations treated)
- Measurements of constituents removed at each point in a treatment train
- Costs on a treated volume or mass removed basis
- Operation and maintenance requirements and challenges
- Lessons learned during development/testing/validation of the technology –it's beneficial to know all of what to expect
- Longevity of passive system components and driving factors

Mahoney, M. K., Butler, B. A., & Skeo Solutions Inc. 2021. Review of Peer-Reviewed Documents on Treatment Technologies Used at Mining Waste Sites. EPA 542-R-20-002. Office of Superfund Remediation and Technology Innovation, Washington, D.C.

MIW Tech Demo Program

IDENTIFY AND DEMONSTRATE PROMISING TREATMENT TECHNOLOGIES

GENERATE ENGINEERING DESIGN, PERFORMANCE, AND COST DATA

COLLECT DATA OF ADEQUATE QUANTITY & QUALITY FOR 3-5 YEARS

Currently Participating Sites

Site	Location	Technology	Tech Demo Status
Captain Jack Mill	R8: Ward, CO	In-tunnel treatment	Demonstration monitoring since 09/2020
Formosa Mine	R10: Riddle, OR	Passive bioreactor, chitinous substrate, biochar	Design phase, construction in 04/2024
Elizabeth Mine	R1: Strafford, VT	Passive treatment train	Demonstration monitoring since 03/2022
Nelson Tunnel	R8: Creede, CO	Electrocoagulation	Bench scale complete, planned field scale in 2024

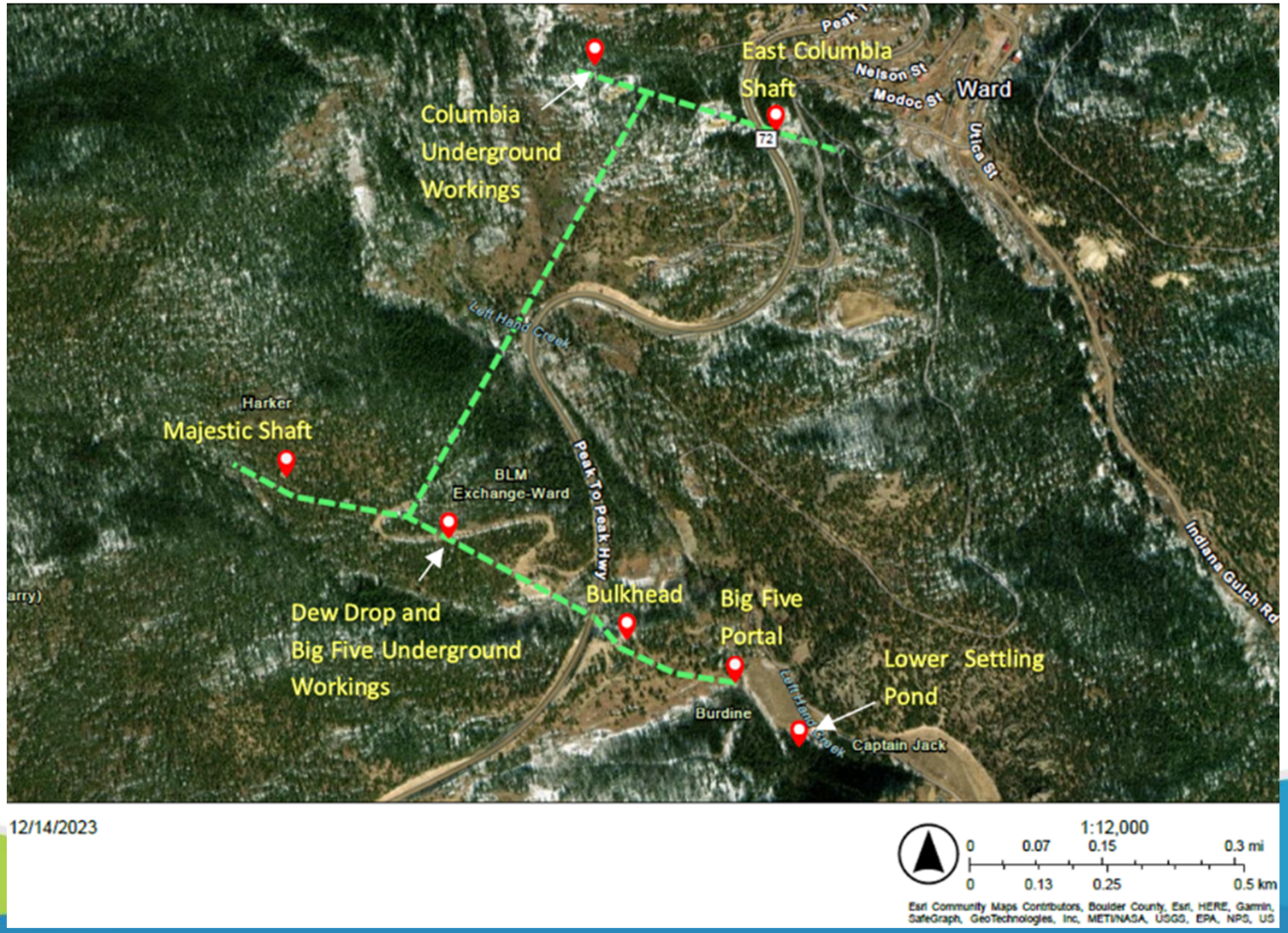
Site 1: Captain Jack Mill

Ward, Colorado

Captain Jack Mill Site Characteristics

- Colorado Mineral Belt (≈8,000 mines)
- Installed bulkhead in Big Five Adit, with flow-through 20-50 gpm
- Underground mine pool: depth = 100-120 ft; length = 900 ft
- Acidic, high iron (>10 mg/L), cadmium, copper, manganese, zinc, lead
- High altitude (≈9,000 ft), access difficult in winter, susceptible to power outages, limited flat expanse for construction
- In-tunnel demonstration underway before MIW Tech Demo (2018)

Map of Captain Jack Mill Mine



Why In-tunnel Technology?

Pros	Cons
◦ Addresses logistic challenges: limited access, cold, limited flat expanse sites ◦ Potential to provide source control, and alternative sludge disposal ◦ Dual usage of characterization infrastructure for monitoring and amendment addition (fewer wells need to be drilled)	◦ Requires an in-depth understanding of water flow in subsurface (to design retention time) ◦ More difficult to control chemistry and flow than an ex-situ system ◦ Visual inspection is generally not possible for in situ system

Some Lessons Learned in Demonstration at Captain Jack

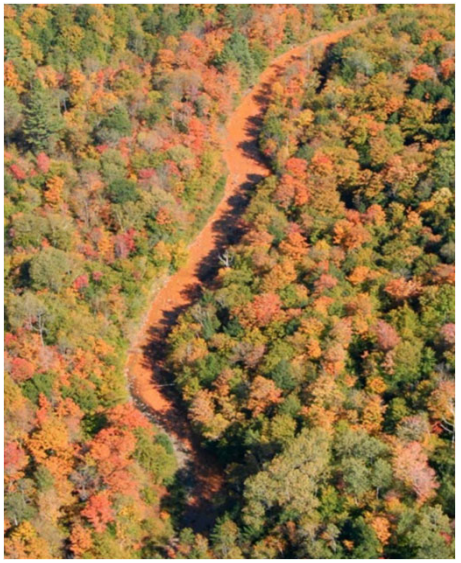
- Mapping and limiting influx of surface water/oxygen essential
  - Tracers seemed to be more effective than geophysics
- The mine pool level should be controlled
- Stratification in the mine pool caused issues for amendment mixing
- Sludge generation inside the tunnel requires long term monitoring and planning
- Remote field sensors had trouble with metal sulfide fouling
- Fixed volume problem: How to best determine success?
  - Some form of external polishing will be required at the site

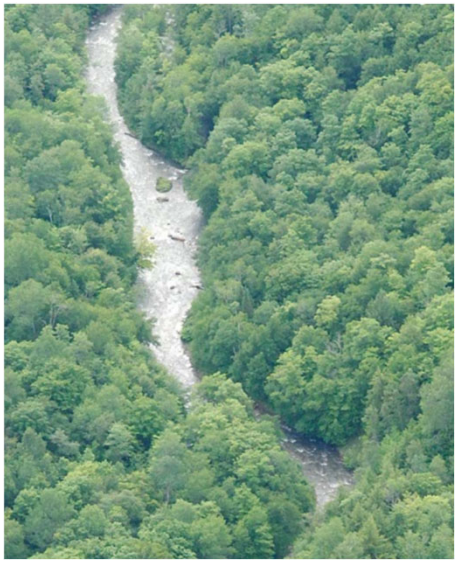
Site 2: Elizabeth Mine

Strafford, Vermont

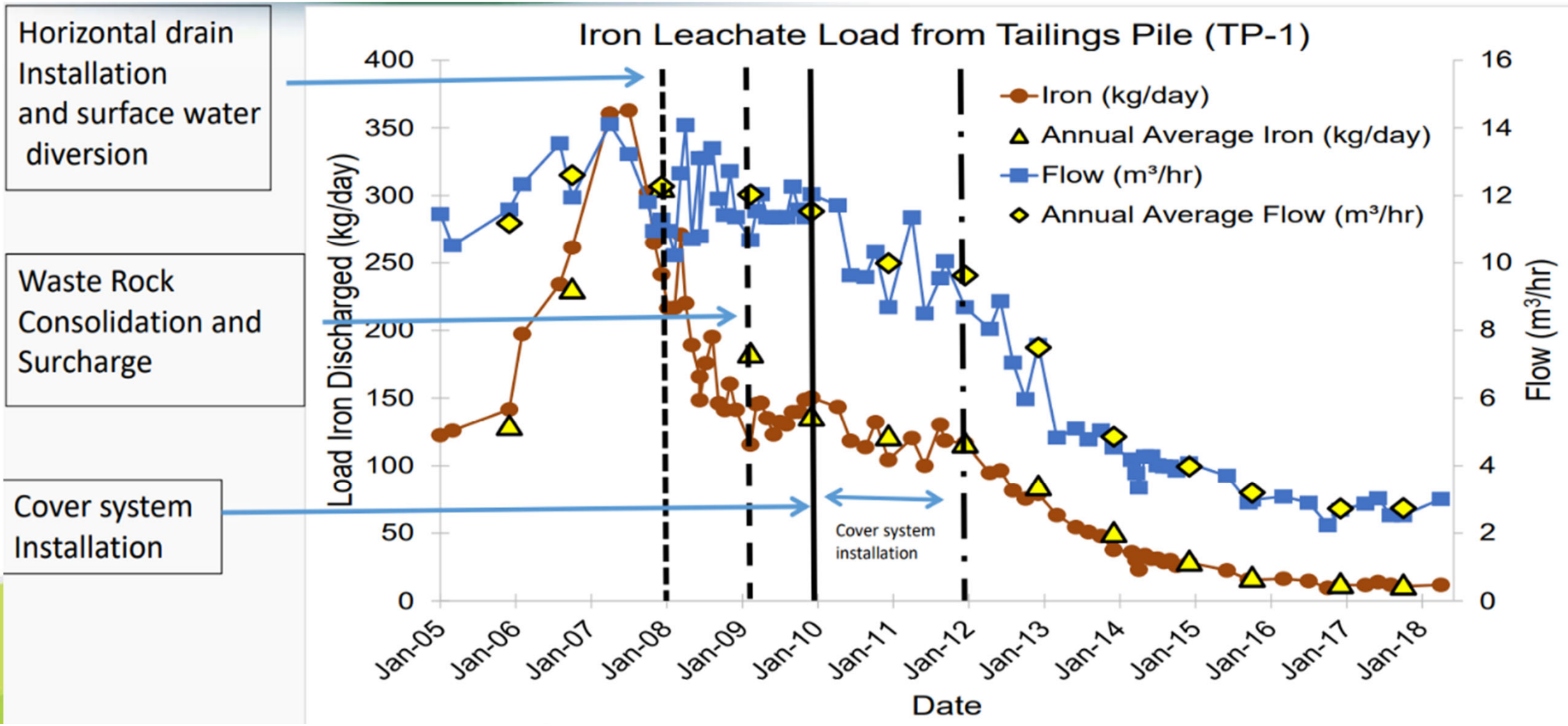
Elizabeth Mine Site Characteristics

- Vermont Copperas Mine
- Tailings cap and stormwater modifications around pile helped reduce flow and concentrations to levels that can be managed with passive treatment
- Tailings leachate flow is ≈10 gpm
- Iron is the contaminant of concern at 190 mg/L (down from 2,000 mg/L)

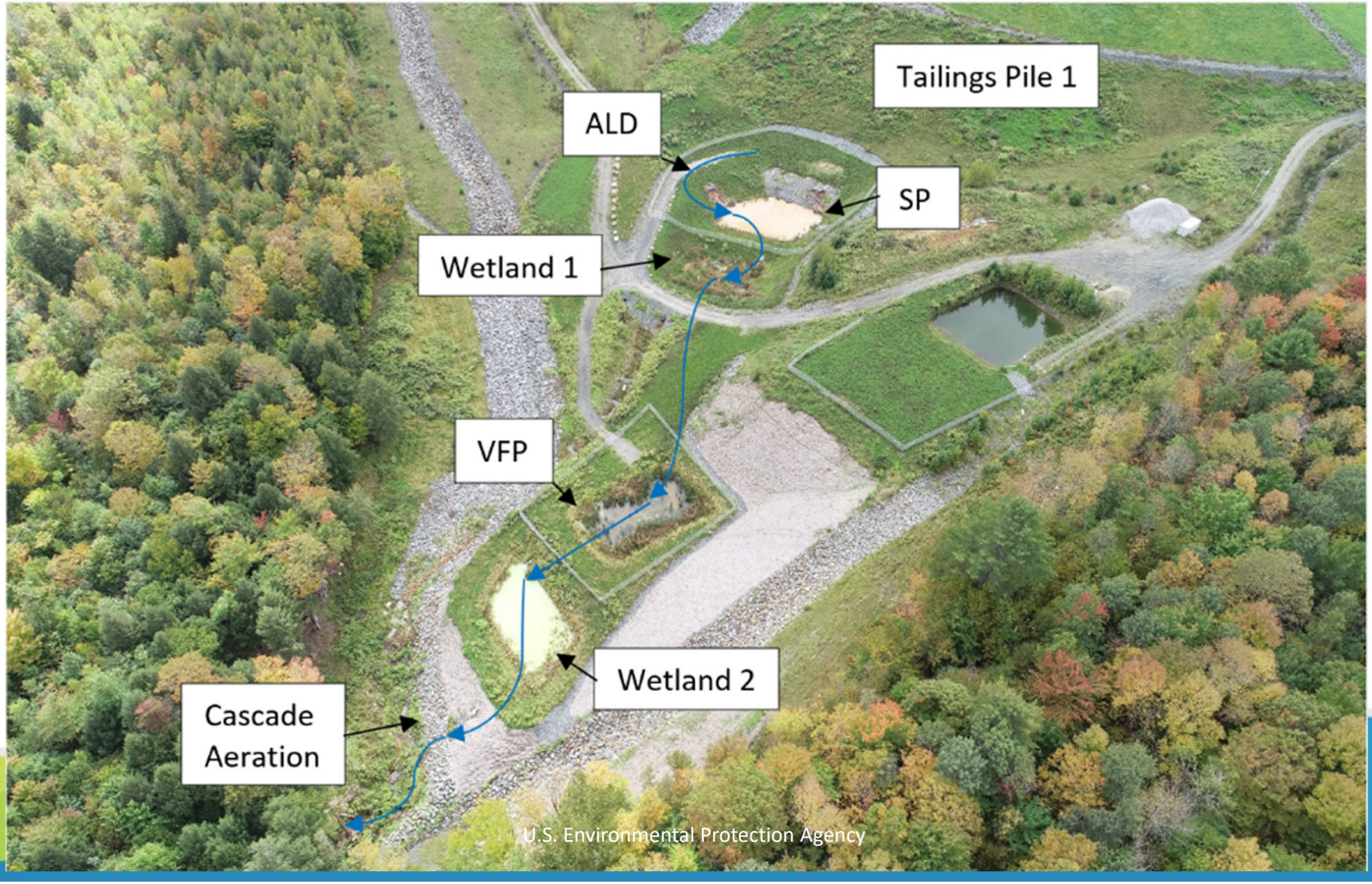




Iron Leachate Load from Tailings Pile graph



Aerial Map of Elizabeth Mine



Why passive treatment?

- Conventional mine water treatment can cost hundreds of thousands of dollars!
- **Active** treatment requires an energy source, frequent chemical addition and 24/7 operation and maintenance

- **Passive** treatment is low maintenance, low to no chemical input, and low to no electrical inputs!
- Passive treatment can also leverage local feedstocks like wood chips and mushroom compost
- Often though, passive treatment requires good hydraulic control and a large footprint

Some Lessons Learned in Demonstration at Elizabeth Mine

- Anoxic lime drain quickly passivated or clogged if dissolved oxygen present in water
- Variable flow measurements between components may be caused by either or both groundwater inflows and atmospheric precipitation (tracer study under development)
- Likely due to insulation from the ground, the vertical flow pond maintained efficiency in the winter when other components exposed to the cold lost efficiency
- The vertical flow pond requires mixing every 5 years to maintain uniform permeability (residence time)
- The passive treatment system has achieved the state's standard of 1 mg/L for 5 years without maintenance

Overall Programmatic Lessons Learned

- Challenging how to make information transferable to other sites
- What are the critical factors? Iron concentration, pH, flow, available footprint, underground working dimensions, access to electricity, site accessibility
- Remote monitoring systems to gather system data is often crucial- but not many rugged technology options
- Water control is essential for implementing passive treatment (combined technology)
- To date, the program has been effective in enabling regions to try innovative technologies at their sites and facilitated information sharing across regions

Questions and Discussion

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