Acid Mine Drainage Source Control Program Design Investigation
Upper Tenmile Creek Mining Area Site

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Overview

- Tenmile Creek Superfund Background
- Adit Discharge Source Control Program
- Susie/Upper Valley Forge and Lee Mountain Source Control Findings
- Upcoming Work
Site Background

- Over 150 abandoned mines
- About 40 discharging adits
- Primarily gold, lead, and zinc
- 70-80 percent of the municipal water supply for Helena
- EPA – Fund Lead – no PRPs
Tenmile Creek in Rimini

- Low flows due to city water diversions
- Elevated Arsenic, Cadmium, Lead, and Zinc
Overall Goals of Selected Remedy:

- Protect watershed which serves City of Helena
- Remove mine wastes from 70 abandoned sites to repository
- Remove contaminated residential yard soils to repository
- **Adit discharge source control and treatment**
Tenmille ROD Requirements for Adit Discharge

• “Four-Phase” Source Control Program to reduce contaminant loading from discharging adits to the watershed.
• Three adit discharges qualify as “Principle-Threat Wastes”
  1. Lee Mountain
  2. Susie
  3. Red Water

  “…source materials considered to be highly toxic or highly mobile that generally cannot be contained in a reliable manner or that would present a significant risk to human health or the environment should exposure occur”
• Expectation of treatment under the NCP
Site Wide Mass Load Ranking

Percentage = Average Load/Total of Average Loads

Combined Average Load (As+Cd+Pb+Zn), pounds/day

Mine Site

- Lee Mountain
- Stake
- Red Water
- National Extension
- Bunker Hill (Adit 2 lower)
- Bunker Hill (upper)
- No Name/Crown Point
- Peerless King
- Monitor Creek Mill
- Evergreen
- Bunker Hill (Adit 3 lower)
- Justice
- Other 23 Adits

Seasonal High Flows

Seasonal Low Flows
Source Control Program

• Phase 1 – Initial Design Investigations
  – Site Prioritization
  – Figure out the unique hydrology/geochemistry of the mine
  – Tracers, historic workings maps, flow measurements

• Phase 2 – Source Control and Flow Reduction Design Studies
  – Pilot scale - regrading, rerouting drainages, plugging, grouting, flooding, dewatering

• Phase 3 – Source Control and Flow Reduction Implementation
  – Implement full scale if successful

• Phase 4 – Design and Construction of Treatment Facilities
  – Passive or Active
Phase I Design Investigations on the Susie and Lee Mountain Adits

- Two discharging adits on opposite sides of the canyon
- Within the Community of Rimini
- Less than 1,500 feet apart
- Understanding the internal workings is critical to reducing flows and contaminant loading
- Results – these two adits require different source control strategies
Susie Adit

- Drains Upper Valley Forge
- 5-10 gpm
- pH 3.5-4.3
- As = 10-20 mg/L
- Fe = 150-200 mg/L
- Al ~ 1 mg/L
- Cd ~ 200 ug/L
- Zn ~ 30 mg/L
- These are several orders of magnitude above water quality standards

Adit reopening in 2005
2010 Susie Discharge

No immediate response to precipitation
Susie Adit Drains the Upper Valley Forge Mine Workings
⇐ 1 mile!
Can we reduce infiltration from the surface to the workings?
2010 Site Reconnaissance

- Identify possible areas of recharge
- Plan Tracer Study
2011 Tracer Study

• Determine if hydraulic connection between surface water bodies and the adit discharge.
• Presence/Absence
• Three injection points dosed with three different dyes:
  – Two small ponds
  – Losing reach of Moore’s Spring Creek
• From a remediation standpoint, the two ponds and the creek are the features that could most easily be altered to limit infiltration to the mine workings
2011 Tracer Study

• 5 pounds of Eosine introduced in Moore’s Spring Creek
• 6 pounds of Fluorescein introduced into Pond 2
• 5 pounds Rhodamine WT introduced into BMP Pond
• Activated carbon sample points:
  – Susie Adit
  – Two residential wells upgradient and downgradient of the adit
  – Mouth of Moore’s Spring Creek
  – Residential springs upgradient and downgradient of Moore’s Spring Creek
Tracer Study
Tracer Results

• Dye tracer detected at mouth of Moore’s Spring Creek
  – Expected
• No detections in Susie adit, springs, or groundwater wells
  – Travel time?
  – Insufficient tracer mass?
  – No connection?
• Still sampling once per month
Susie - Next Steps

- Bulkhead evaluation
  - Would the water discharge somewhere else?
  - Any other unmapped connected workings?
- Stability and safety going underground
- Safety of Rimini residents
Lee Mountain Adit

- 2-8 gpm
- pH <3 (2.5-3)
- As ~ 25-30 mg/L
- Fe ~ 250 mg/L (dissolved)
- Al ~ 20 mg/L (dissolved)
- Cd ~ 0.5-1 mg/L
- Zn ~ 50-80 mg/L
- Pb ~ 0.3-0.6 mg/L
- Orders of magnitude above standards

Adit reopening in 2005
Lee Mountain – Waste Piles
Lee Mountain

- Waste removals occurred incrementally
2010 Lee Mountain Discharge

Increased flows after precipitation events
Unusually high flow observed prior to regular monitoring
Lee Mountain Cross Section - 1918

LONGITUDINAL PROJECTION OF
LEE MOUNTAIN MINE

Scale 1 in = 100 ft

LEGEND

--- Estimated Limits of Ore Bodies
Known " " "

Notes from Map of A.E. Hollingsworth, E.M., July 1918

Adit
700-Level Workings and Reconnaissance
2010 Reconnaissance

- Adits and shafts and waste rock farther up very steep hill
- Previously unknown discharging adit – “Caplice” mine
- Shaft with snow inside
- Deep exploration trenches
- Minimal connection with nearest creek
2011 Flow Measurements

- Install continuous recorder prior to spring runoff to capture the peak and to determine flow variation
- Tenmile Creek reached over 600 cfs on June 7, 2011
Cutthroat Flume and Stage Recorder
Lee Mountain Discharge - 2011

- Confirmed flows increase after precipitation
- Daily snowmelt signature
Lee Mountain - Next Steps

• Bulkhead ruled out due to interconnected workings and adits higher on the mountainside
• Can we drill horizontal wells to dewater the mountain away from the mine workings?
Upcoming Work and Tough Questions

• Scoping for bulkhead feasibility (Susie) and horizontal drilling (Lee Mountain)
• Red Water adit investigation
• Evaluate further source control costs versus long-term water treatment costs – is it worth chasing these source control measures for these two adits?
  • Good access and existing infrastructure
  • Success of source control uncertain – if 75% reduction is achieved, are we still killing fish? Will we still need treatment?
• Each mine site is unique!!