Implementing Source Control at the Pennsylvania Mine, Summit County, Colorado

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Pennsylvania Mine

- Penn Mine setting, geology and history
- Watershed and site remedial history
- Source control investigation
- Remedy implementation
Setting

- Located in Upper reaches of Peru Creek, a tributary to the Snake River.
- Pennsylvania Mine - single largest manmade metals contributor to the Snake River (~40,000lbs Zn/yr).
Geology

- Geology dominated by Montezuma Stock.

- Majority of mining along stock margins.

- Significant hydrothermal alteration throughout Peru Creek and Snake River watersheds.
History

- Vein originally discovered in 1879.
- Mined for gold and silver through 1950’s.
- Six main levels, A – F.
- Production:
  - > 3,500 ounces gold
  - > 895,000 ounces silver
- All portals into mine workings are collapsed.
Remedial History

- Investigated in mid 1980’s for wetland remediation.
- Passive treatment system constructed in mid 1990’s...never operated.
- Numerous non-point source projects completed in watershed.
Site Characterization

• Conduct site wide water sampling to establish baseline conditions.
• Use dye tracing and stable water isotopes to establish underground flowpaths.
• Conduct subsurface drilling to locate and establish condition of mine workings.
Portal Rehab
Underground Rehab
Underground Characterization

Underground water sampling locations

Pretty Good Water

Very Bad water
Data Evaluation

Investigations indicated:

- Bulkheads are viable source control option.
- Multiple bulkhead approach.
- Possible opportunity for inflow reduction on Level C and in mine treatment.

Implement as phased approach.
Bulkheads

- Flow reduction up to 90%;
- Steady state reached quickly;
- Peak flow controlled.
Bulkhead Results – pH and Zn

Data compiled by USGS
Effect of Penn Mine Bulkheads

- % Load reduction compared to 2009 baseline, downstream in Peru Creek.
- Small improvements after first bulkhead (2014).
- Larger improvements following second bulkhead.

<table>
<thead>
<tr>
<th>Year</th>
<th>Al</th>
<th>Cd</th>
<th>Cu</th>
<th>Fe</th>
<th>Mn</th>
<th>Pb</th>
<th>Zn</th>
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<td>-83%</td>
<td>-16%</td>
<td>5%</td>
<td>-76%</td>
<td>-24%</td>
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<td>-21%</td>
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<tr>
<td>2015</td>
<td>-14%</td>
<td>37%</td>
<td>50%</td>
<td>76%</td>
<td>22%</td>
<td>51%</td>
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<tr>
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<td>38%</td>
<td>57%</td>
<td>83%</td>
<td>35%</td>
<td>66%</td>
<td>33%</td>
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Penn Mine Accomplishments

- Eliminated portal blowout events.
- Reduced chronic loading to Snake River.
- Increased survivability of fish in the Snake River.
- Reduced long term O&M.
- Investigation, implementation and operation of bulkheads ~ $2 million.
- Maintained existing land use and character of Peru Creek Watershed.
Questions?