Installation & Operation of a Passive Treatment System to Treat Mining Influenced Water From the Magenta Drain Portal at Empire Mine State Historic Park, Grass Valley, CA

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Empire Mine State Historic Park

- Oldest, largest, and richest in California

- 1850 to 1956 produced 5.8 million ounces of gold (~$8.1 billion today)

- 367 miles of underground workings - mine pool

- 845 acre park with 12 miles of trails

- Magenta Drain portal drains portions of the underground workings – neutral pH
Historic Buildings, Mine Tours (2013), Hiking
Regulatory Agencies Involved

- Central Valley Regional Water Quality Control Board
- California Department of Toxic Substances Control
- Army Corp of Engineers
- California Department of Fish and Game
- Nevada County, California
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Design Influent Concentration</th>
<th>Design Effluent Target Concentration</th>
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<tr>
<td>pH</td>
<td>7</td>
<td>&gt;6.5, &lt;8.5</td>
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<tr>
<td>Arsenic (µg/L)</td>
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<td>10</td>
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<tr>
<td>Iron (µg/L)</td>
<td>10,500</td>
<td>300</td>
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<tr>
<td>Manganese (µg/L)</td>
<td>3,500</td>
<td>50</td>
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</table>
Passive Treatment Bench Testing

- Biochemical Reactor (BCR)
- Chitin Reactor
- Zero valent iron (ZVI)
- Aerobic Wetland
Passive Treatment Bench Test Conclusions

- Arsenic and iron concentrations variable
  - Iron >> arsenic, good for adsorption of arsenic (iron oxy-hydroxide)

- Settling pond and aerobic wetland lowest life-cycle cost

- Manganese loading rate is the limiting factor for design

- Designed to meet secondary standard for manganese for taste and odor as an annual average
Settling Pond Design Summary

- Design flow range of 30 to 1,200 gpm with average flow of 230 gpm

- 12 hours hydraulic retention time (same as bench) at upper flow range

- 1,000 cubic yards of iron oxyhydroxide precipitate storage – “adsorption media”
  - Estimate the settling pond will be cleaned out once every 4 to 5 years
Wetland Sizing Parameters

- Iron removal rate from bench test data
- Manganese removal rate from bench test data
- 12 inches of wetland soil (combination of soil and/or limestone rock)
- Up to 6 inches of standing water depth
- 2 feet of freeboard
- Interior concrete walls to control short circuiting
Final Passive Treatment System Concept

PORTAL EXITS ALONG SLOPE IN WOODPECKER RAVINE
PTS Schematic 1 of 3

TO WETLAND 1

REMOVAL OF SOLIDS AS NEEDED

INFLUENT MONITORING LOCATION INF-001

CONVEYANCE PIPING

MAGENTA DRAIN MINE PORTAL

EMERGENCY GENERATOR

PUMP VAULT

SETTLING POND

TO WETLAND 1
Passive Treatment System Design Layout

- Magenta Drain & Pump Station Intake Area
- Wetland No. 1
- Wetland No. 2
- Feed & Return Pipeline Corridor
- Pump Station
- Settling Pond

0-20 feet
Preliminary Work

- Survey – Site, EMSHP boundaries, residence property lines, and all trees greater than 12” caliper at breast height

- Geotechnical Study
  - Boring and Potholes
  - ReMi – Refraction Micro-tremor Survey

- Locate Settling Pond and Wetlands

- Vegetation Removal
Preliminary Work, Continued…

- Determine Conveyance Pipe Route
- Construction Storm Water Pollution Prevention Plan
- Nevada County Traffic Plan – detours
- Local Resident Notification
- Pacific Gas & Electric (PG&E) – Application for New Service
- DPR Avian Survey
- Coordination with DPR Archaeologist – Cultural Survey
Divert Water From Portal To Pump Station

Flange at Magenta Portal

Diversion and Bypass Valves

Valve Access Platform

Energy Dissipater
Remove, Screen, and Stockpile Topsoil
Shaping the Wetlands

Cut and fill balanced for entire site within 5%
Settling Pond Rock Excavation
And More Rock!..Wetland 2
Historical Finds - Riveted Pipe & Mule Shoes

20–inch riveted steel pipe parallel with center line of East Empire Street

Mule Shoes
Concrete Structures – Settling Pond Outlet
Concrete Structures – Wetland 2 Inlet
Concrete Structures – Pump Station
Clay Liner – Settling Pond and Wetland Berms
Settling Pond – Liner Installation

- 12 oz. Geotextile
- 60 mil Textured HDPE
Wetland 1 Liner Installation

- 12 oz. Geotextile, underlay
- 60 mil HDPE
- 12 oz. Geotextile, overlay
- 12 oz. 8 ft wide under wall
Wetland 2 Liner Installation

- 12 oz. Geotextile, underlay
- 60 mil HDPE
- 12 oz. Geotextile, overlay
- 12 oz. 8 ft wide under wall
Wetland Vegetation

- Wetland 1 – Arroyo willow (*Salix lasiolepsis*) is primary species and Narrow leaf willow (*Salix exigua*) is secondary species
- Wetland 1 - Common rush (*Juncus effuses*), and Baltic rush (*Juncus balticus*).
- Wetlands 1 & 2 – grass species included for erosion control on exposed soil
- Wetland 2 – No vegetation, limestone bed with natural colonization by manganese scavenging algae
- Wetland 2 – future colonization by moss
Flow Path – Pump Station to Wetland 1
Flow Path – Wetland 1 to Effluent Flume
Flow Path – Wetland 1 to Effluent Flume

- 24 Bottle Auto Sampler
- Effluent Flow Rate
- Temperature
- Dissolved Oxygen
  - Mg/L
  - ppm
  - % Saturation
- Golder Watch®
- Influent flow into PTS is calculated measurement
### Field Data

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<tr>
<th>Group</th>
<th>Name</th>
<th>Value</th>
<th>Sample Time</th>
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### Magenta Drain Passive Field Data - Field & Historical Data

#### Historical Data

**Options:** Filter By Alarm State  Maintain grouping when sorting.

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PTS Benefits

- Green technology minimizes long term carbon footprint; maximized use of gravity flow conveyance
- Sustainable technology
- Mature treatment facility will blend into the existing parkland habitat
- Little hiking trail disruption and less noise and visual impacts compared to alternatives
- Less impact to local infrastructure: roads, traffic, power, water, and sewer
- No chemical use typically associated with active treatment technologies
- Less waste generated compared to alternatives
Settling Pond
Outfall from Settling Pond
Wetland 1
Wetland 2
Treated MIW Discharge at Flume