SOVEREIGN CONSULTING INC.
AN ENVIRONMENTAL SERVICES FIRM

Replacing an Active AMD Treatment System with Semi-Passive Techniques

- ❑Background Information
- ❑Site Characterization
- ❑Conceptual Site Model
- ❑Water Treatment Approach

Presented by:

Tyler Chatriand, PE

Sovereign Consulting Inc

Active Mining - 1993

Existing ARD Treatment

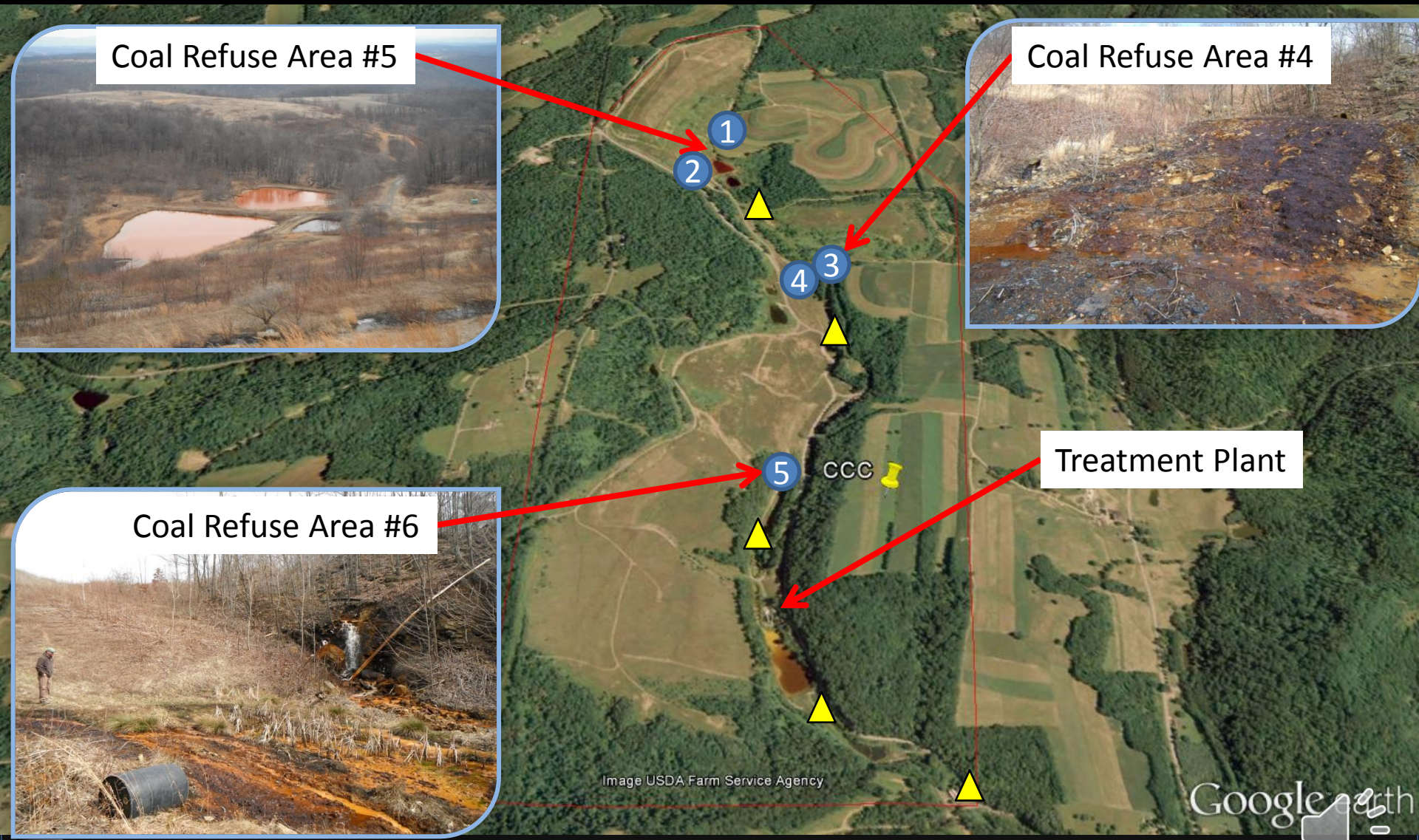
- Hydrated Lime Feed Plant
  - Mix alkaline media to neutralize pH and precipitate metals
- 25+ yrs old
- Weak structural integrity
- Inadequate pump system
- Remote – Power Outages
- Single stage treatment
  - Insufficient Mn/Al removal

- Treatment Alternatives Analysis
  - Identify and Characterize the source

Site Characterization

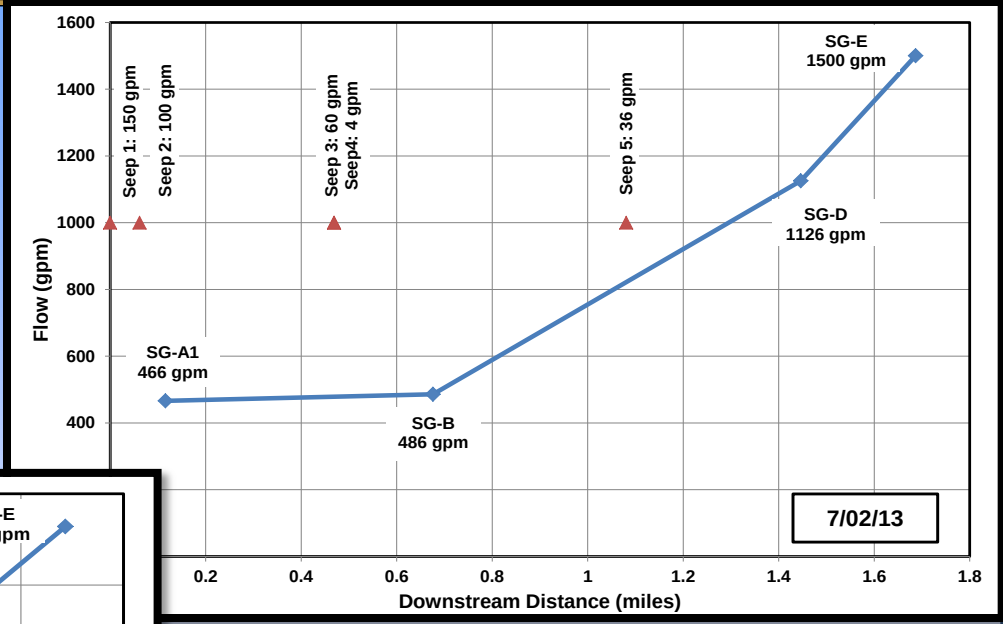
- Review Historical Data
- Inventory ARD Sources
- Establish Monitoring and Gaging Stations
- Evaluate Water Chemistry and Contaminant Loadings
- Identify Treatment Alternatives

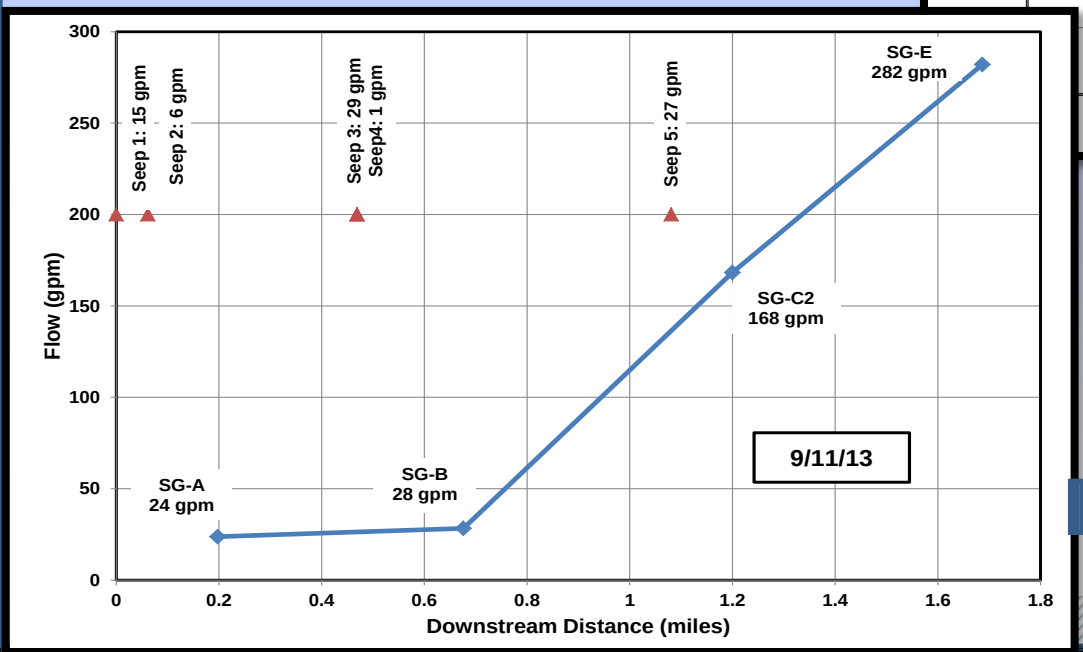
Post Mining - 2013



Data Analysis – Surface Water Flow

- Upper creek base flow is due primarily to Seeps 1 & 2 (at SG-A) and Seep 3 (at SG-B)

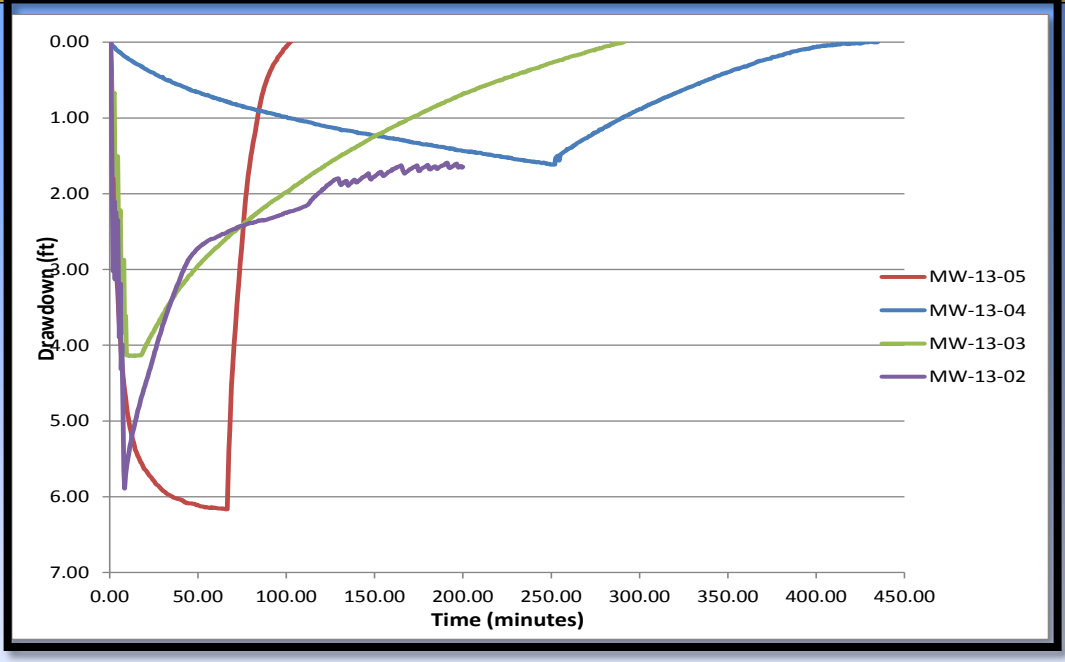




- Flow increases at SG-C much greater than Seep 5 input.

→ Suggests groundwater influx

Groundwater Influence

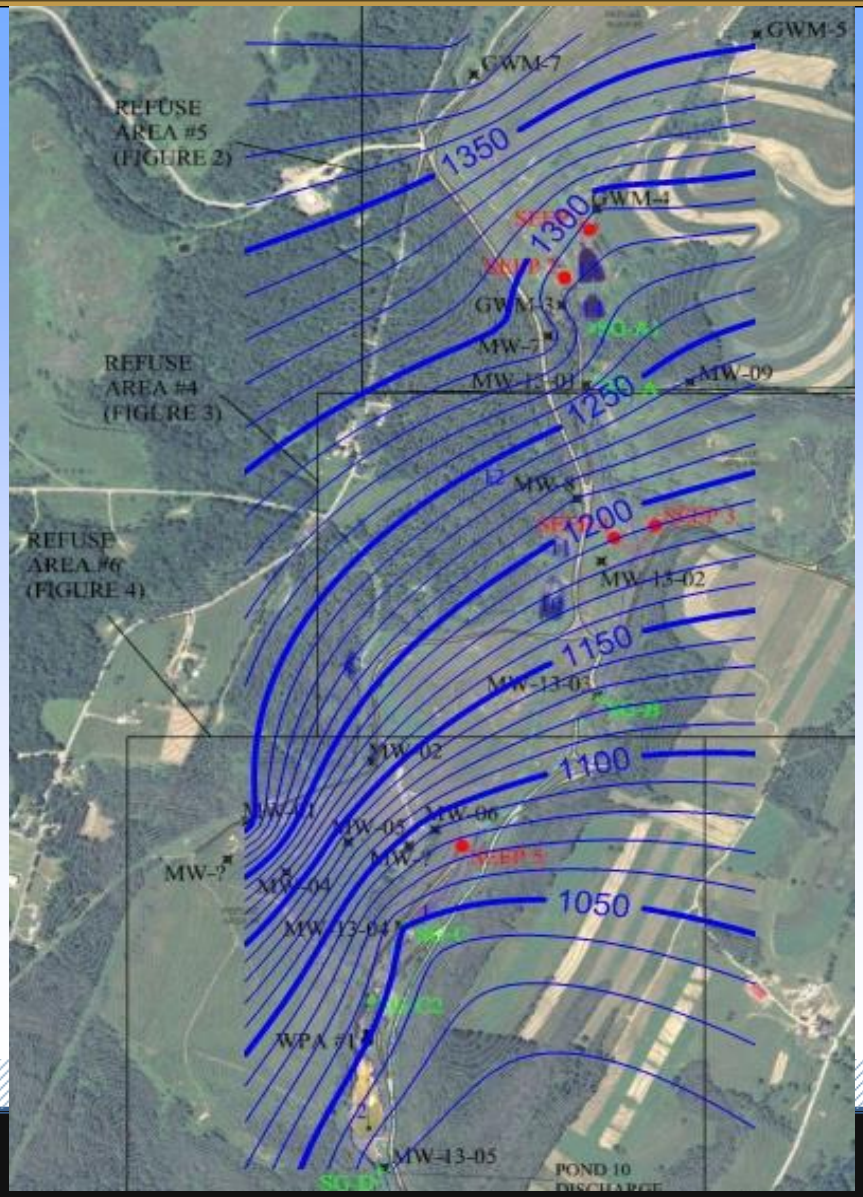


- Pumping tests: low K (0.07-0.14 f/d) in upper reaches; higher K (0.6-1.8 f/d) in lower
- Strong GW-SW interaction in lower valley (MW-13-04)

WELL	METHOD OF ANALYSIS	TRANSMISSIVITY (ft^2/day)	LENGTH OF SATURATED SCREEN INTERVAL (ft)	HYDRAULIC CONDUCTIVITY (ft/day)
MW-13-05	Neuman	4.17	7.35	0.57
	Theis - Recovery	13.3		1.81
MW-13-04	Theis	461	7.89	58.4*
	Theis - Recovery	367		46.5*
MW-13-03	Theis - Recovery	0.671	4.9	0.14
MW-13-02	Theis - Recovery	0.446	6.65	0.07

* Hydraulic conductivity is not considered highly accurate due to insufficient pumping rate and length of test

Groundwater Influence



- GW Flow rate 0.02 f/d (upper) and 0.4 f/d (lower)

- GW quality is generally good
  - Neutral pH
  - Iron < 10 ppm
- Flow increase and WQ improvement downstream due to GW influx

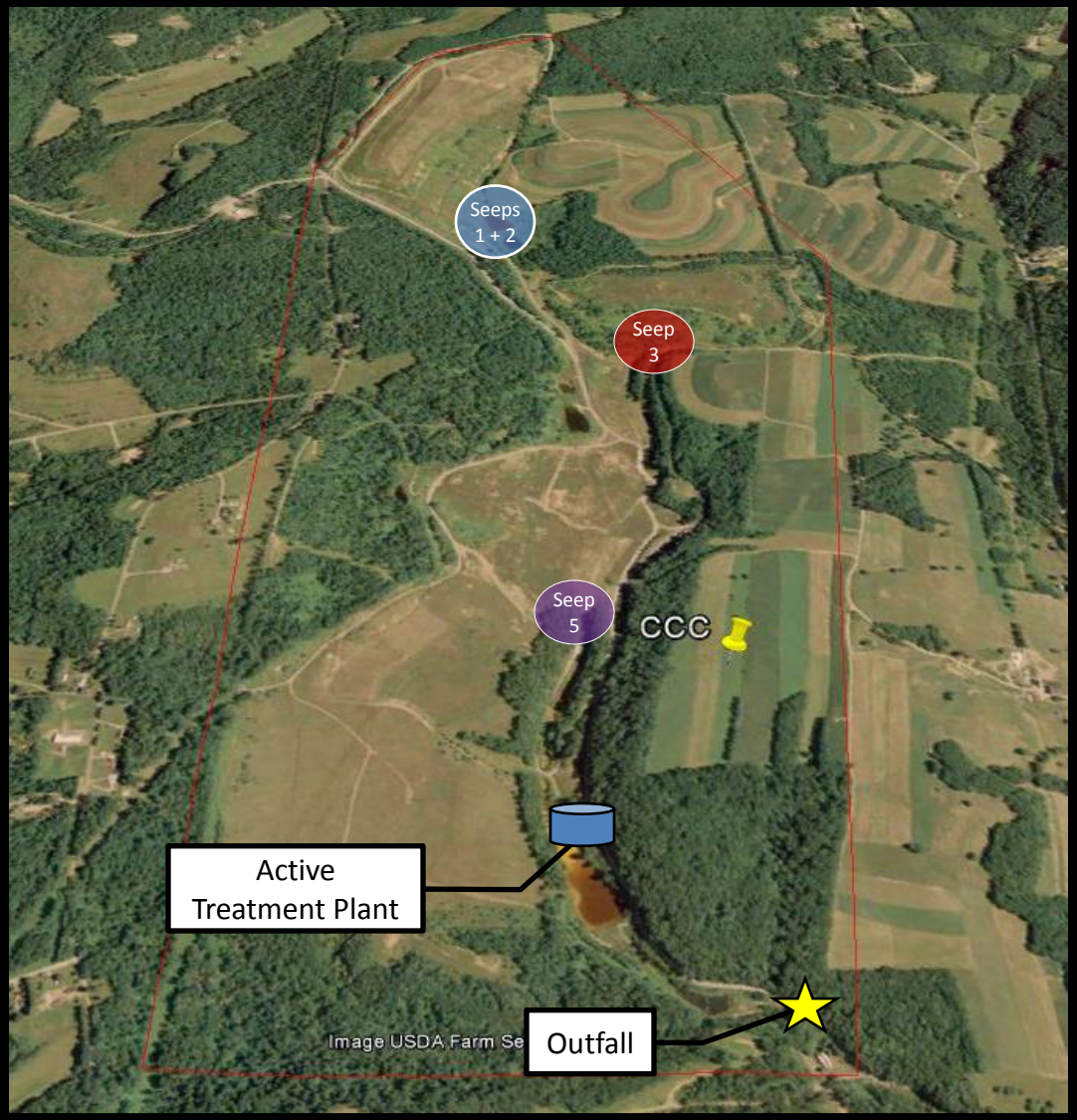
SOVEREIGN CONSULTING

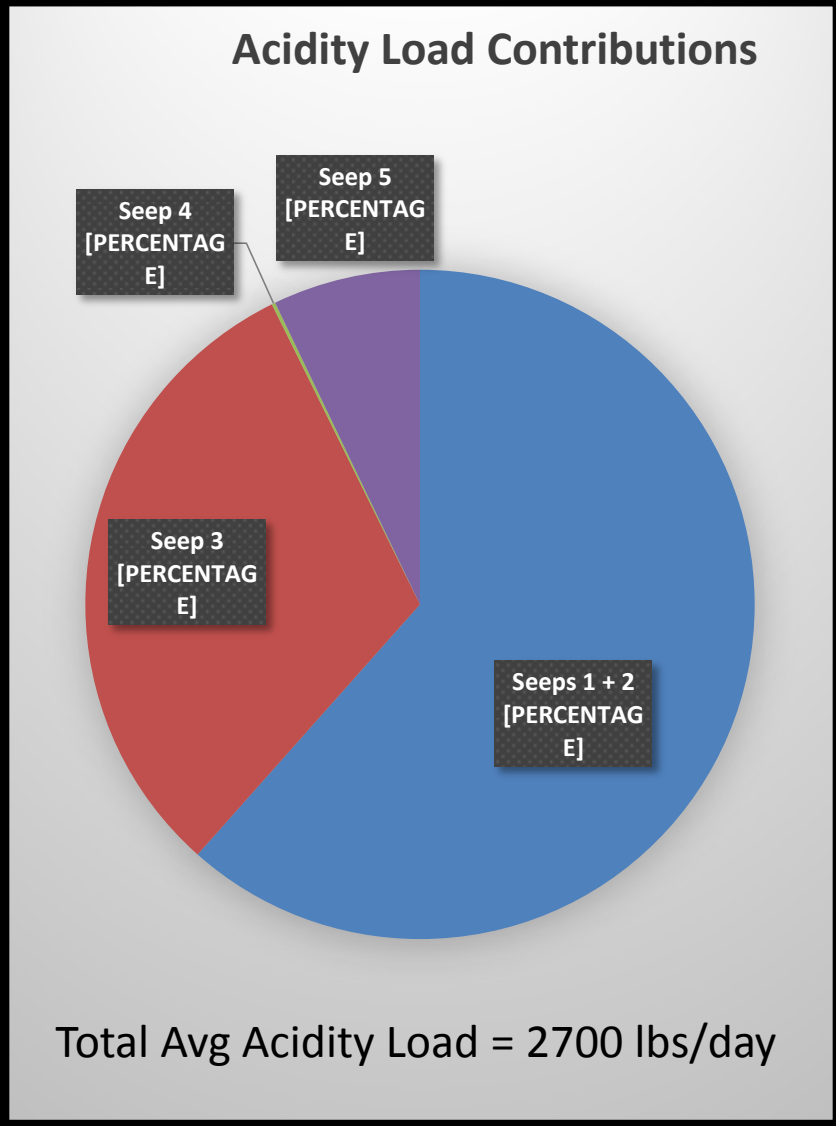
Data Analyses – Acidity Loadings

- Conceptual Site Model –
  - Acidity Loadings (pH, Fe, Al, Mn, flow rate)

- Compare acidity loadings from each source to the total acidity load observed at the treatment plant (as a percentage of the total loading at the site)
  - Identify data gaps
  - Prioritize treatment areas

Acidity Loadings Comparison





Total Avg Acidity Load = 2700 lbs/day

Water Treatment Alternatives

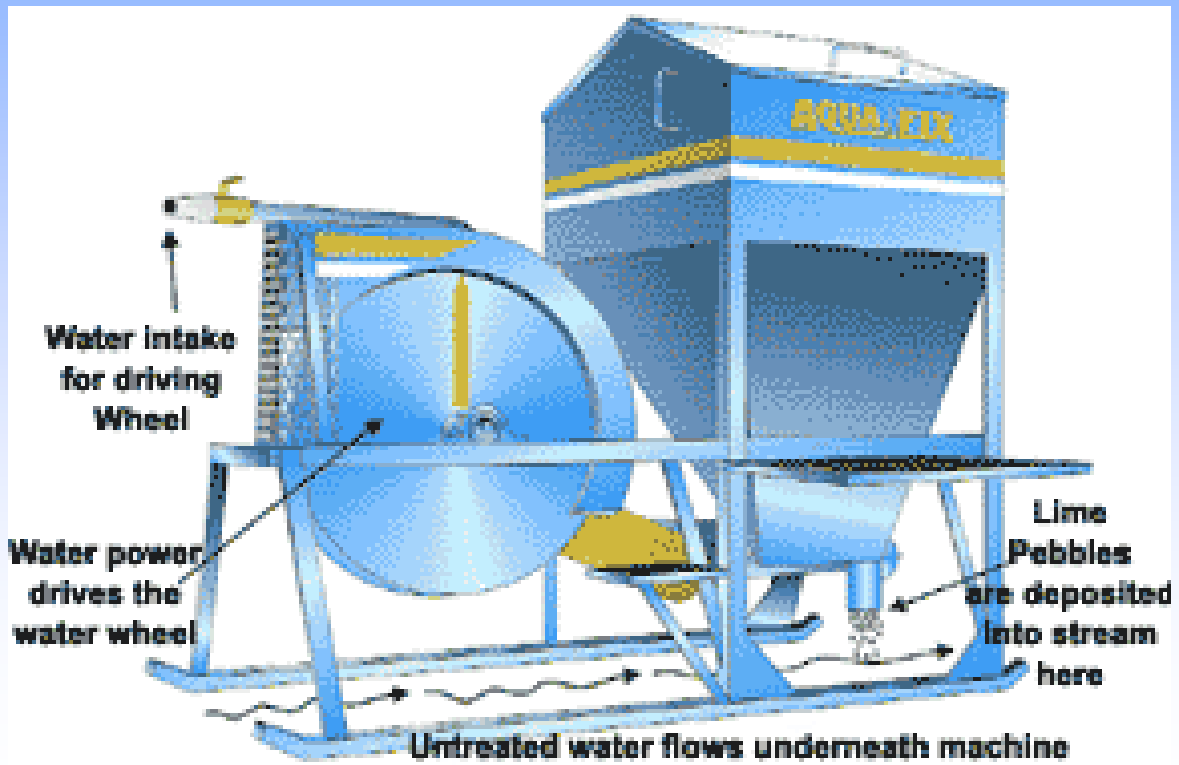
- Active Treatment
  - Uses chemicals, energy, labor, and infrastructure (high O&M)
  - Shortest HRT and smallest possible footprint

- Passive Treatment
  - Low-energy dynamics employed in natural biological and geochemical processes at ambient temperatures
    - No moving parts or power requirements
    - Low O&M
    - Long HRT and large footprint

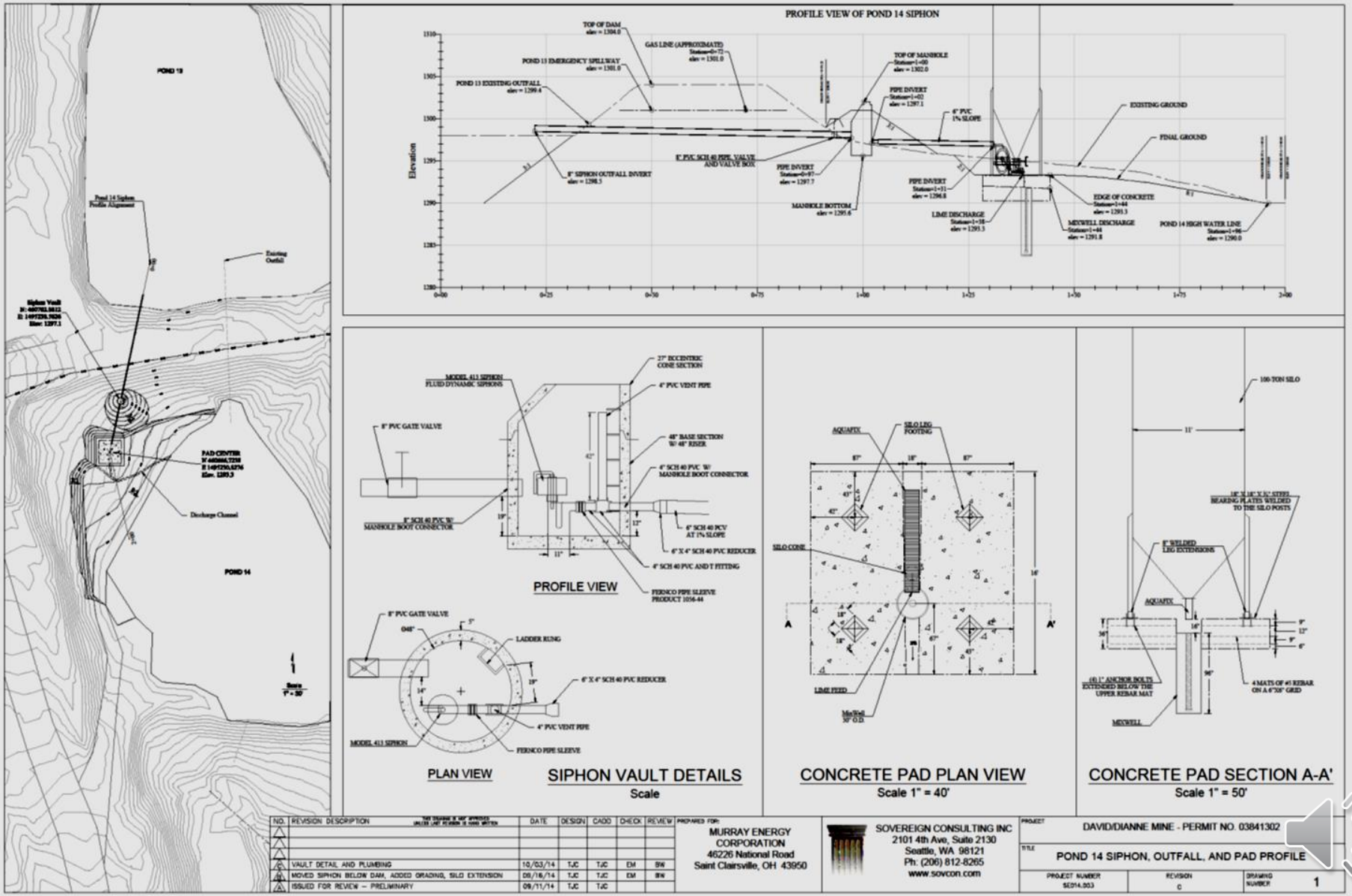
- **Semi-Passive Treatment**
  - Utilizes moving parts and chemicals WITHOUT continuous power and labor required for active systems.
  - Treat at the source

Pebble Quicklime at ARD Source

- Aquafix – water wheel driven chemical feed system



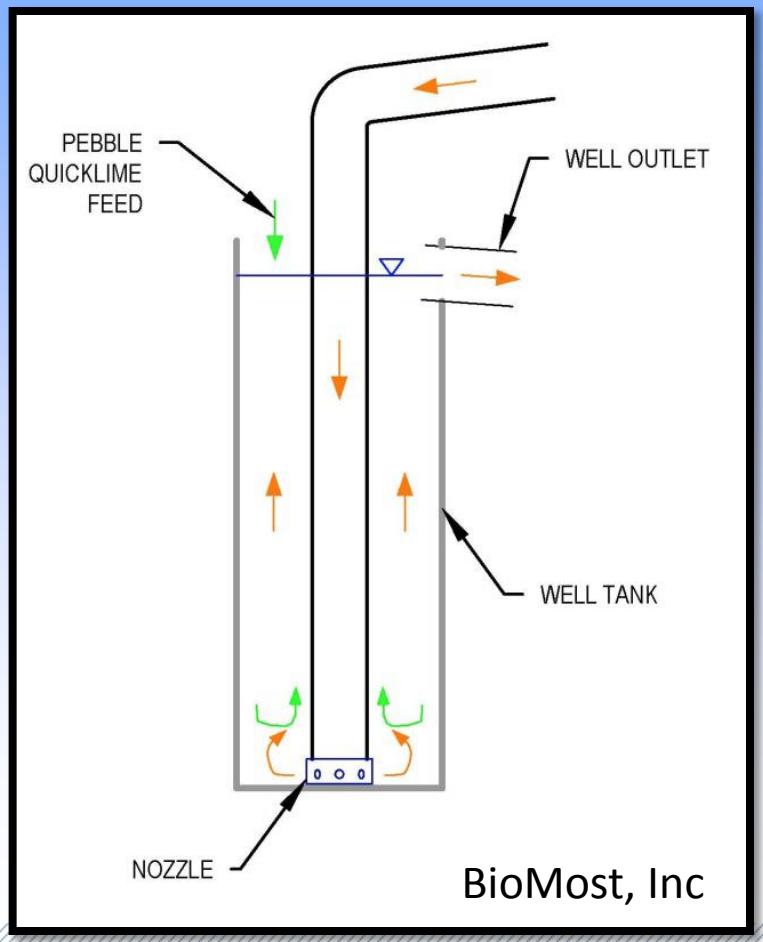
Pebble Quicklime at ARD Source



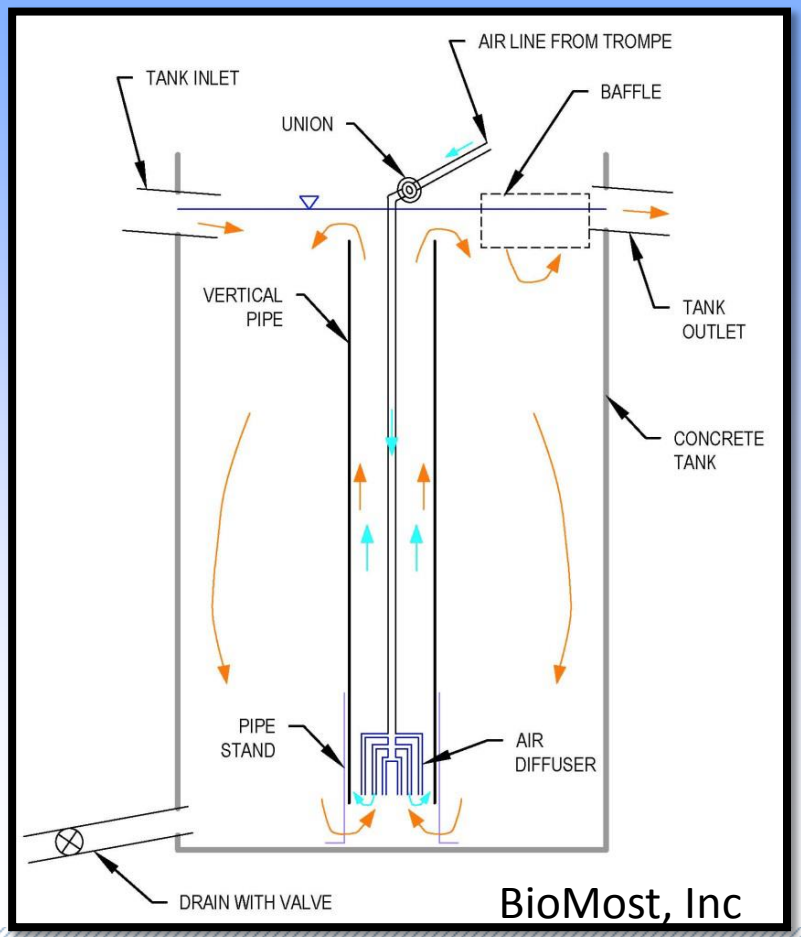
Pond 14 Lime Dosing Footprint

Passive Mixing/Aeration – BioMost, Inc

MixWell

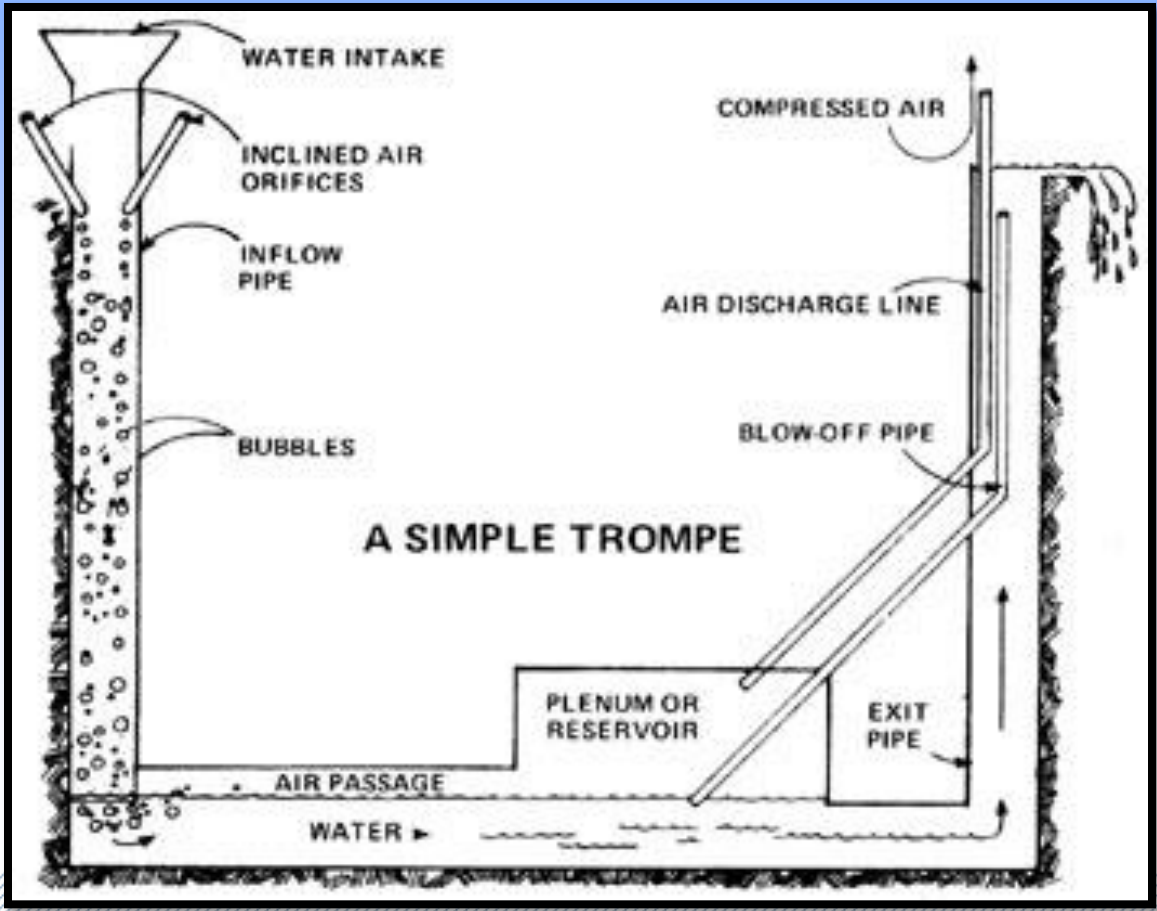


A-Mixer



Passive Aeration - Trompe

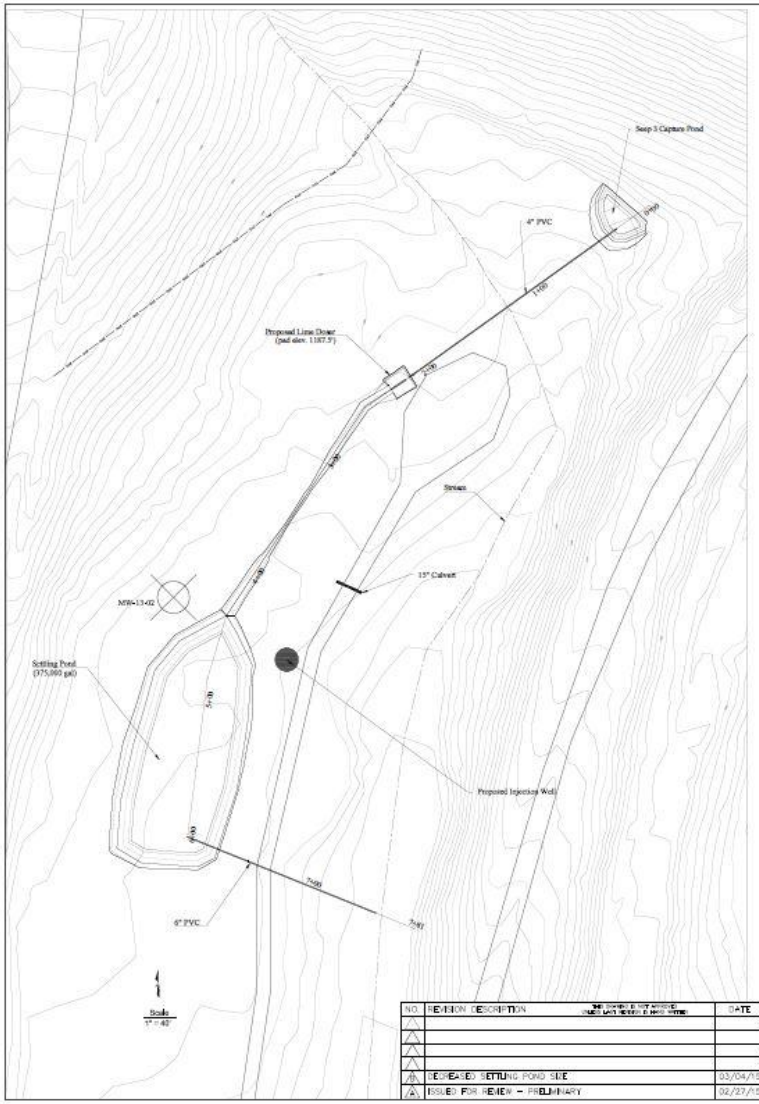
- Water-powered air compressor

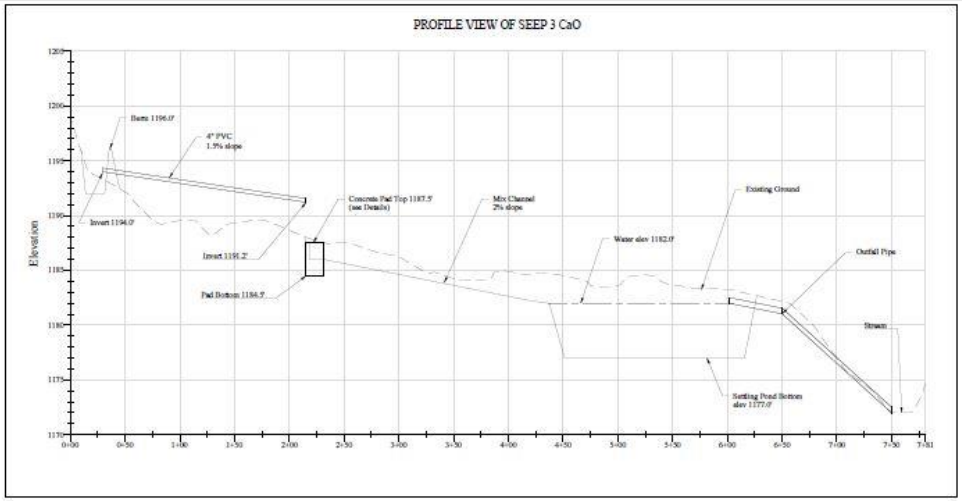


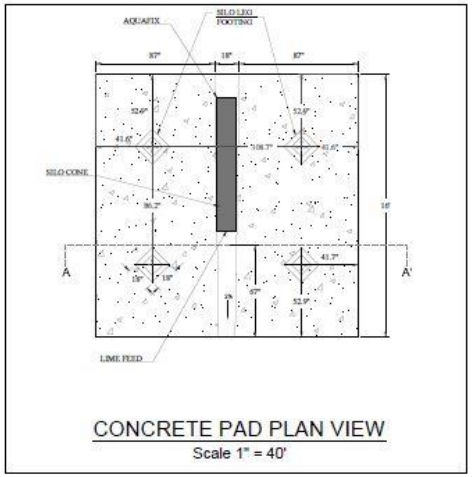
- For every 4' TDH,
  = 1 cfm/25 gpm
- Pond 14 Outfall = 13'
- 3 Trompes in series
  = 4 CFM at base flow

Pond 14 Construction

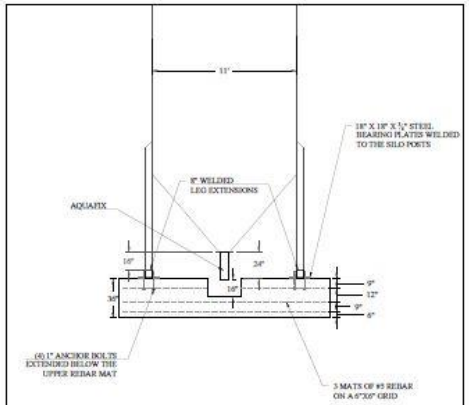
Seep 3 Lime Dosing







CONCRETE PAD PLAN VIEW
Scale 1" = 40'



CONCRETE PAD SECTION A-A'
Scale 1" = 50'

NO.	REVISION DESCRIPTION	DATE	DESIGN	CADD	CHECK	REVIEW
3						
2						
1						
B	DECREASED SETTLING POND SIZE	03/04/15	TJC	TJC		
A	ISSUED FOR REVIEW – PRELIMINARY	02/27/15	TJC	TJC		

PREPARED FOR:
MURRAY ENERGY CORPORATION
46226 National Road
Saint Clairsville, OH 43950

SOVEREIGN CONSULTING INC
2101 4th Ave, Suite 2130
Seattle, WA 98121
Ph: (206) 812-8265
www.sovcon.com

PROJECT: DAVID/DIANNE MINE - PERMIT NO. 03841302

TITLE: SEEP 3 LIME DOSING & SETTLING POND

PROJECT NUMBER: SE014.003 | REVISION: B | DRAWING NUMBER: 1

Seep 5 Passive Treatment

- Added alkalinity from upper lime dosing systems
- “Clean” groundwater influx
- Controlled releases of stormwater ponds above the site
  - Currently piped to below permitted outfall
- Constructed Wetlands

Semi-Passive Treatment

- Capital costs << Completely Passive System
- Annual O&M costs << Active System
- No power = reliable treatment
- Treating at the source allows passive polishing systems to be installed downstream
  - Manganese removal beds
  - Open Limestone Channels
- Cost-effective bandage approach
  - Buys time to explore source control efforts

Questions?

Tyler Chatriand, PE, CFM

Environmental Engineer | email: tchatriand@sovcon.com

Bill Walker, PhD

Sr. Geochemist| email: bwalker@sovcon.com

Sovereign Consulting Inc.

2101 Fourth Ave, Suite 2130

Seattle, WA 98121

www.sovcon.com

Phone: 206-812-8265