Passive and Active Treatment of Arsenic and Antimony at a Remote Abandoned Mine Site in Idaho

Presented by

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Presentation Outline

Site Characterization

Project Overview

Identified Treatment Technologies

Bench Testing

Results

Conclusions

Path Forward

Site Characterization

Abandoned silver and antimony mine

No power

Limited access

Adit drainage

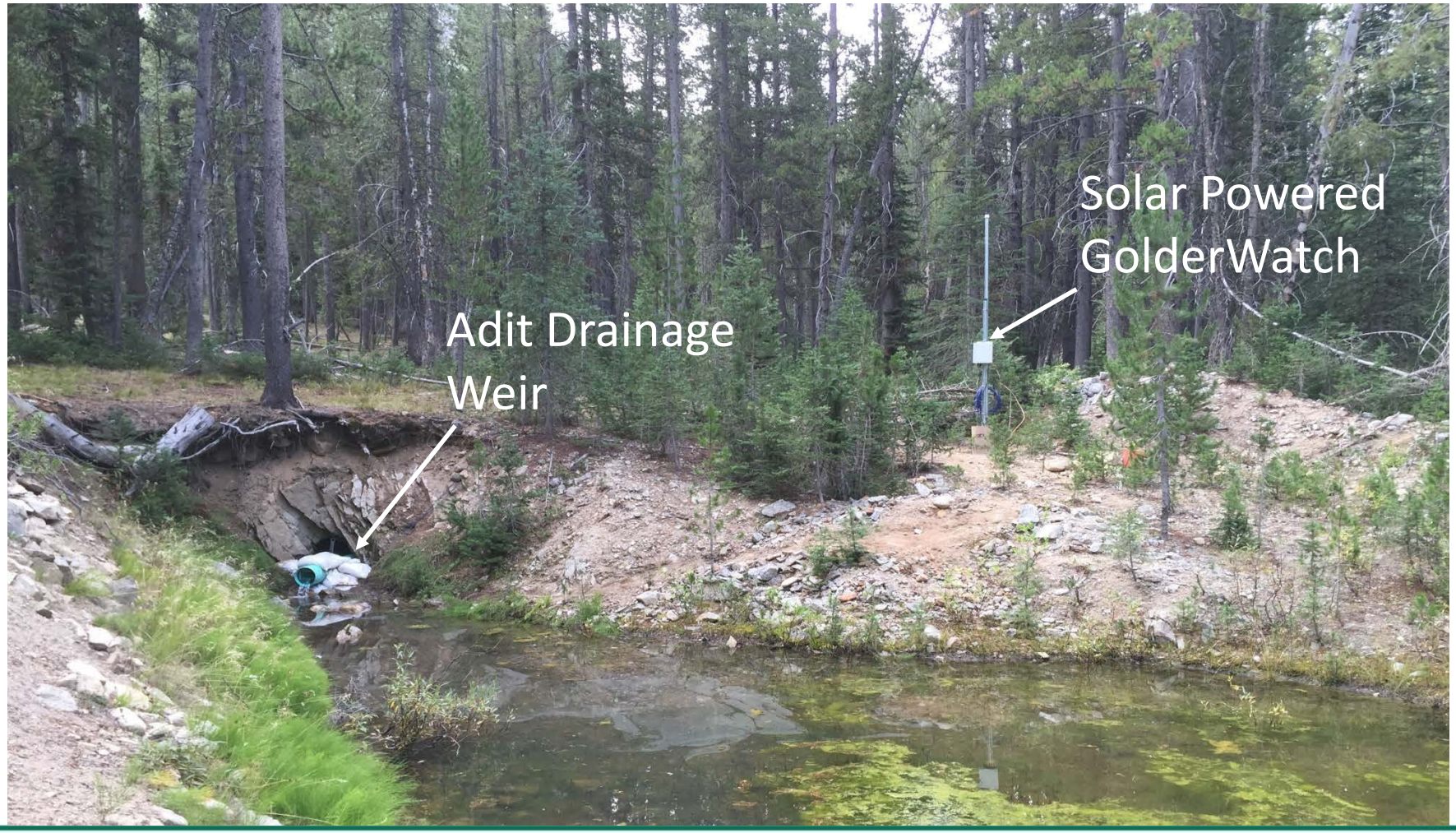
Remediation through the Idaho Department of Lands (IDL)

Adit Water Quality

- *Low metals*
  - Iron: 0.06 mg/L
  - Aluminum: 0.14 mg/L
- *Circumneutral pH, low alkalinity*
- *Low Flow: 4- 8 m3/hr (15-30 gpm)*
- *Constituents of concern include:*
  - Arsenic and Antimony

Parameter	Influent Concentration	Effluent Targets			
		EPA MCL	Required Removal, %	IDAPA	Required Removal, %
Antimony, total, mg/L	0.069	0.006	91%	NS	NA
Arsenic, total, mg/L	0.163	0.010	94%	0.150	8%

Site Monitoring Setup



Project Overview

Project Goals

- Meet IDAPA or EPA MCL standards
- Screen technologies based on efficiency in removing arsenic and antimony
- Narrow down implementation of effective technologies in a passive or semi-passive configuration

Treatment Technologies

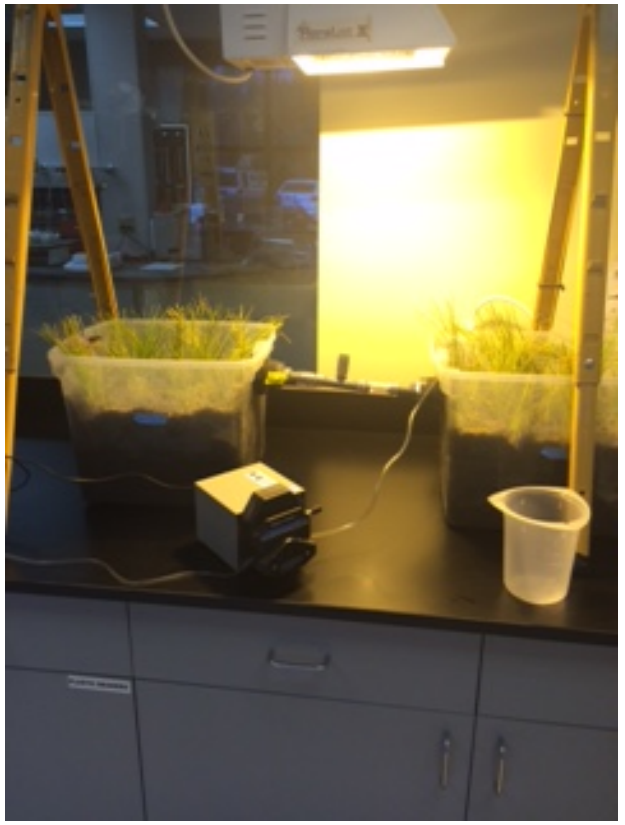
Passive

- Aerobic Wetland

Active

- Iron Co-precipitation
- Media Absorption

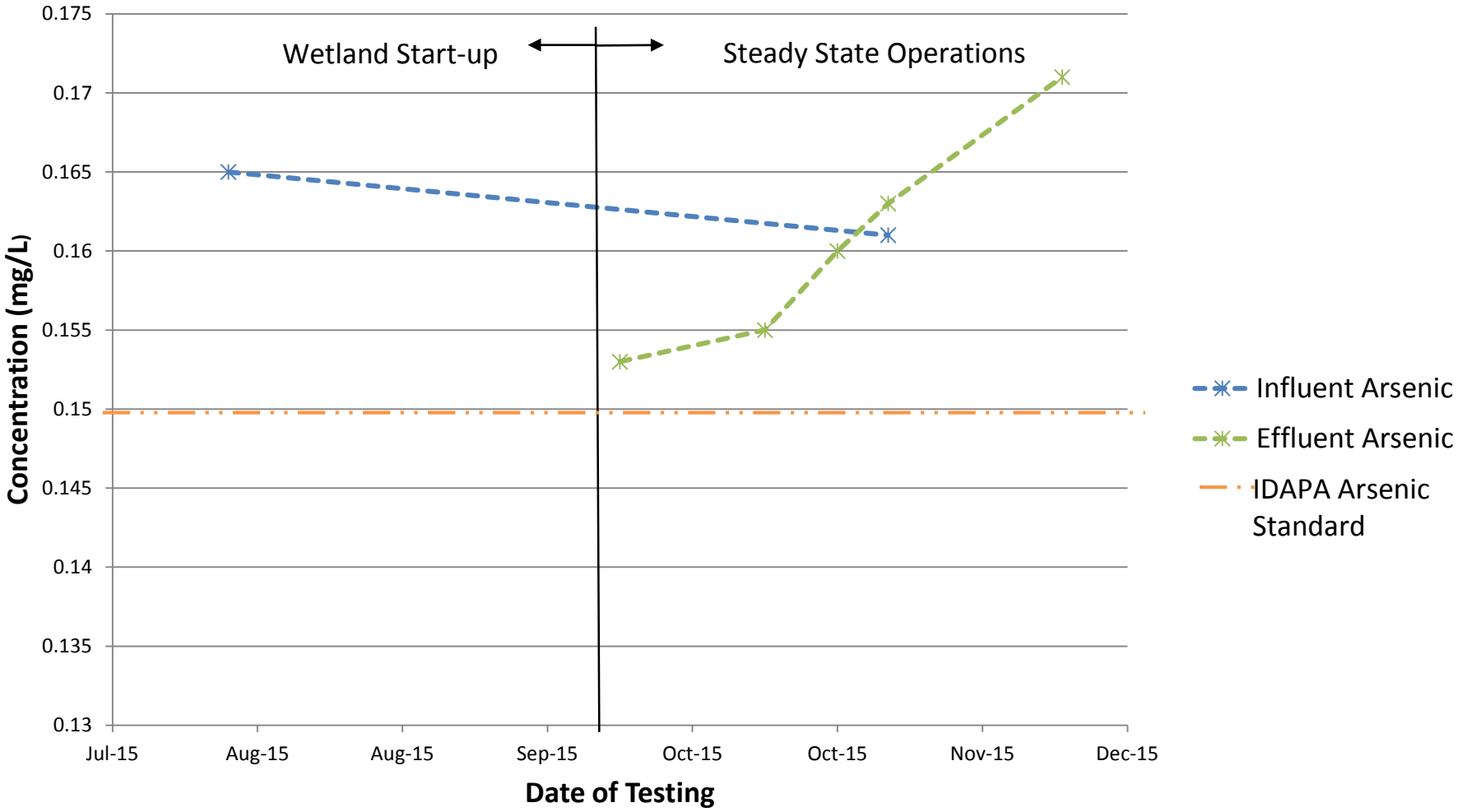
Bench Testing: Aerobic Wetlands



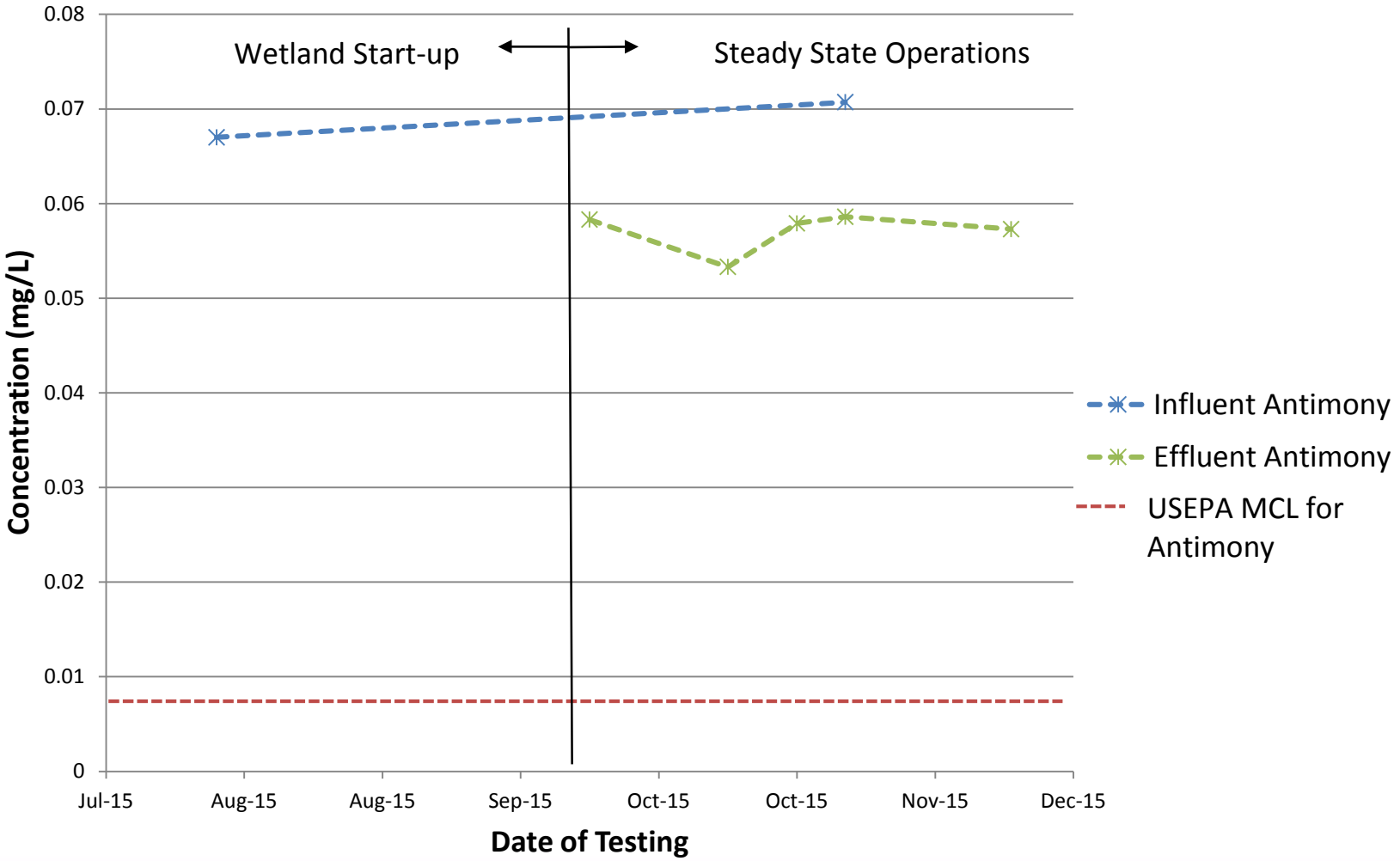
Bench Testing: Aerobic Wetlands

- Two wetlands in series
- 5 day Hydraulic Retention Time (HRT)
- Initial plant selection:
  - Hardstem Bullrush
  - Beaked Sedge
- Final plant selection:
  - Softstem Bullrush
  - Creeping Spikerush
- Top soil mixture for substrate

Results: Aerobic Wetlands



Results: Aerobic Wetlands



Results: Aerobic Wetlands

Wetlands were not effective for removal of Arsenic or Antimony based on water quality:

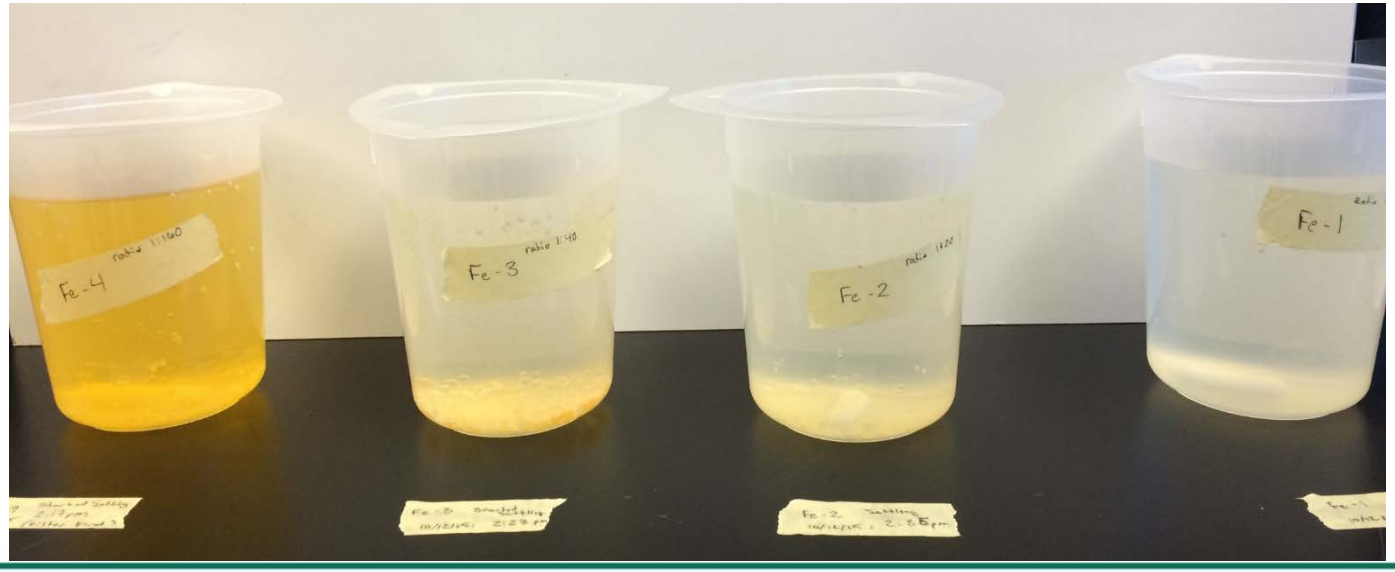
- Reducing conditions
- Not enough iron present for co-precipitation

Golder has observed arsenic removal down to 10 ppb in a full scale wetlands with iron present at higher concentrations (California)

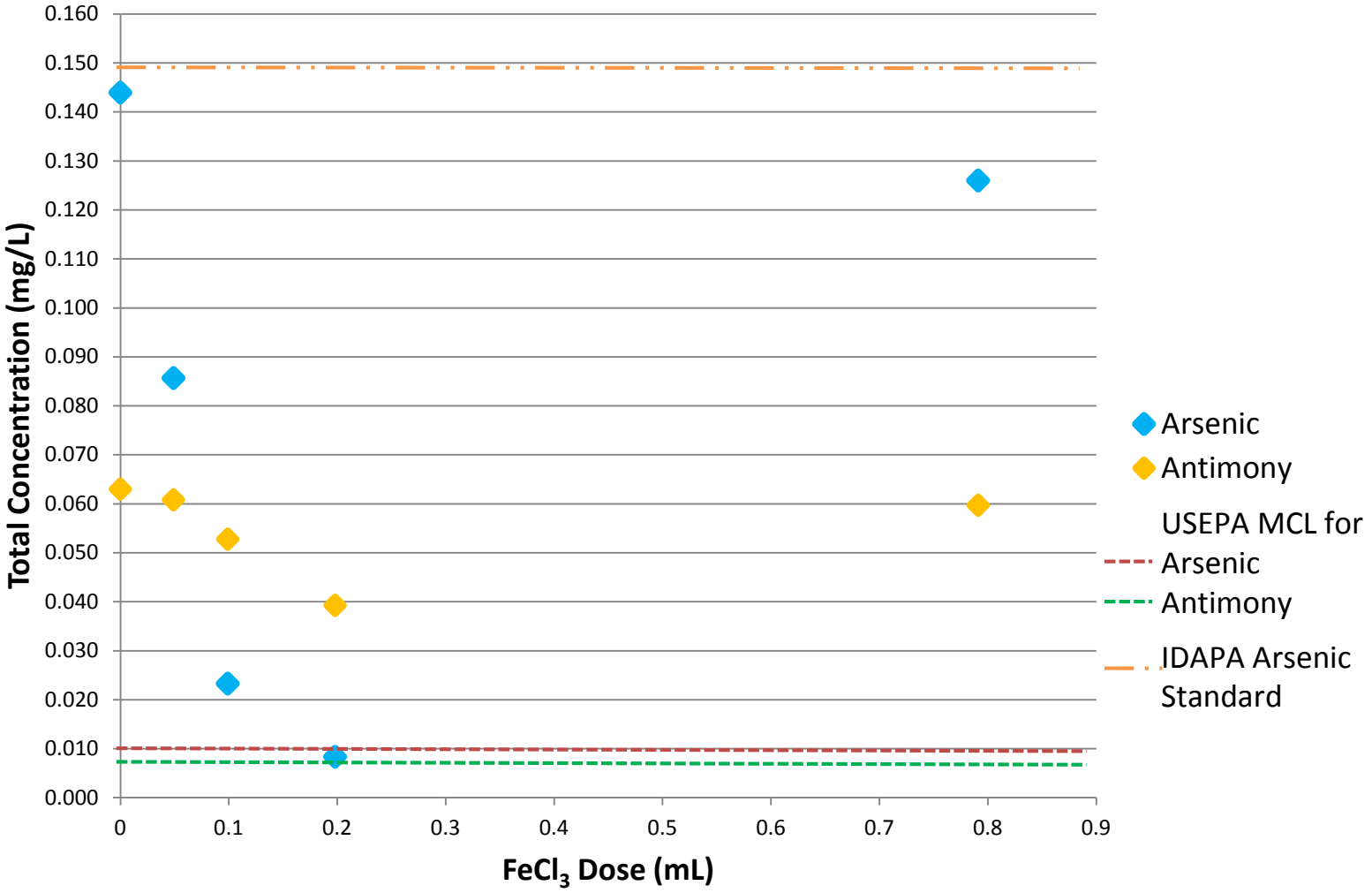
Bench Testing: Iron Co-precipitation

Test	FE-1	FE-2	FE-3	FE-4	FE-5
	Ratio 1 (10:1)	Ratio 2 (20:1)	Ratio 3 (40:1)	Ratio 4 (160:1)	Control

(moles Iron : moles Arsenic)



Results: Iron Co-precipitation



Results: Iron Co-precipitation

Test	FE-1		FE-2		FE-3		FE-4		FE-5
Constituent	Ratio 1 (10:1)	removal	Ratio 2 (20:1)	removal	Ratio 3 (40:1)	removal	Ratio 4 (160:1)	removal	Control
As (Dissolved)	<0.00027	99%	<0.00027	99%	<0.00027	99%	0.00423	78%	0.0188
Sb (Dissolved)	0.0584	11%	0.0493	25%	0.0247	63%	<0.00019	100%	0.0659

pH reduced

Implementation Requirements

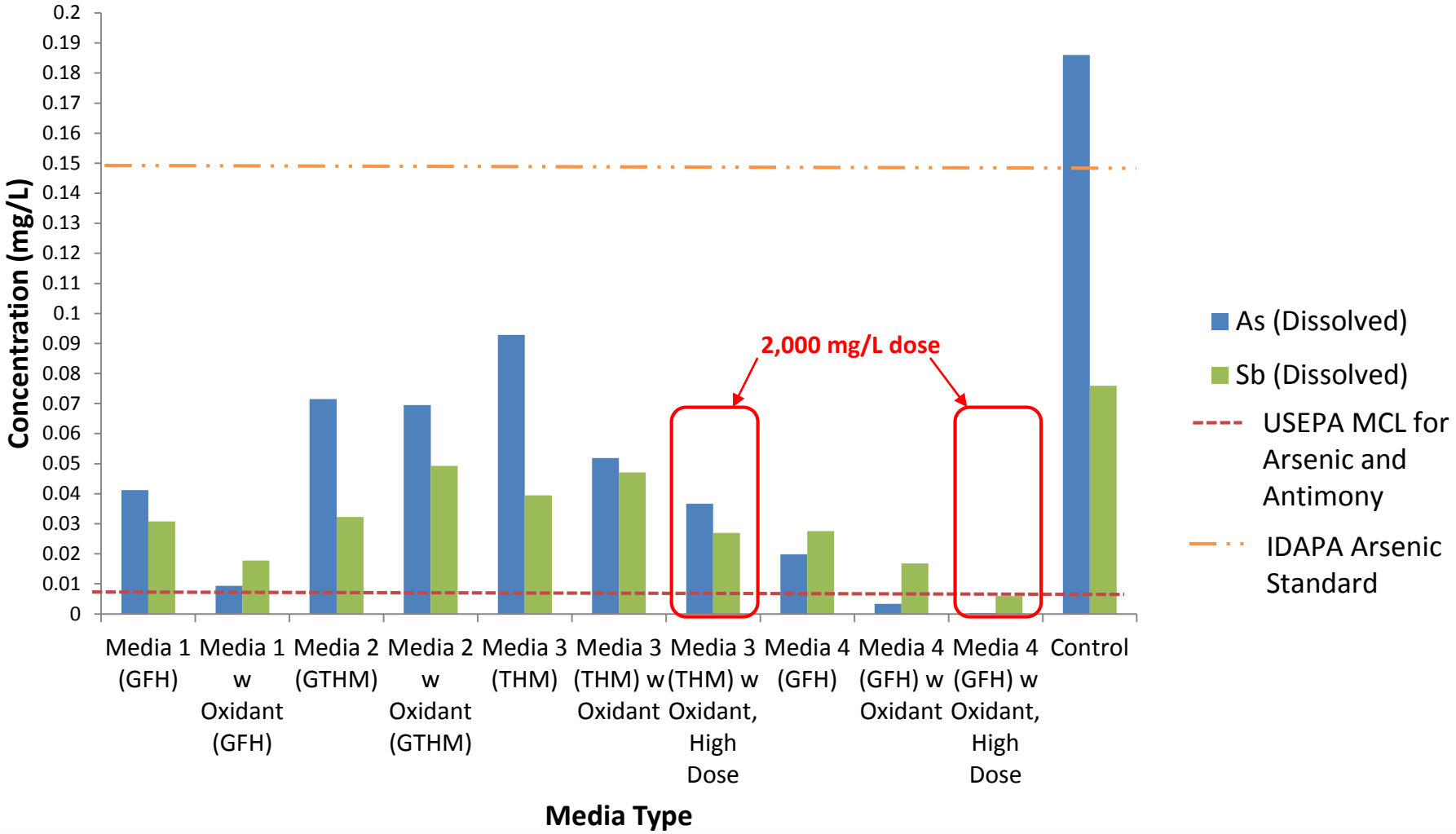
- pH Control
- Chemical Dosing
- Filtration

Bench Testing: Media Absorption

- 2 granular ferric hydroxide media
- 2 titanium based media
- 1 control

- Batch Testing
- Testing with and without Oxidation
- Theoretical dose
- Excess dose

Results: Media Absorption



Results: Media Absorption

Test	500mg/L of Media 4				2000mg/L of Media 4	
Constituent	without oxidation	removal	with oxidation	removal	with oxidation	removal
As (Dissolved)	0.0198	89%	0.00333	98%	<0.00027	100%
Sb (Dissolved)	0.0276	64%	0.0168	74%	0.00593	91%

- Pre-oxidation improves media function
- Iron based media has better removal than titanium based media
- When dosed in excess, removal was complete
- Removal is limited by dose/contact time

Conclusions

Aerobic Wetlands

- In-effective for treatment of the adit drainage water

Iron Co-precipitation

- Effective for treatment
- Requires fully active system

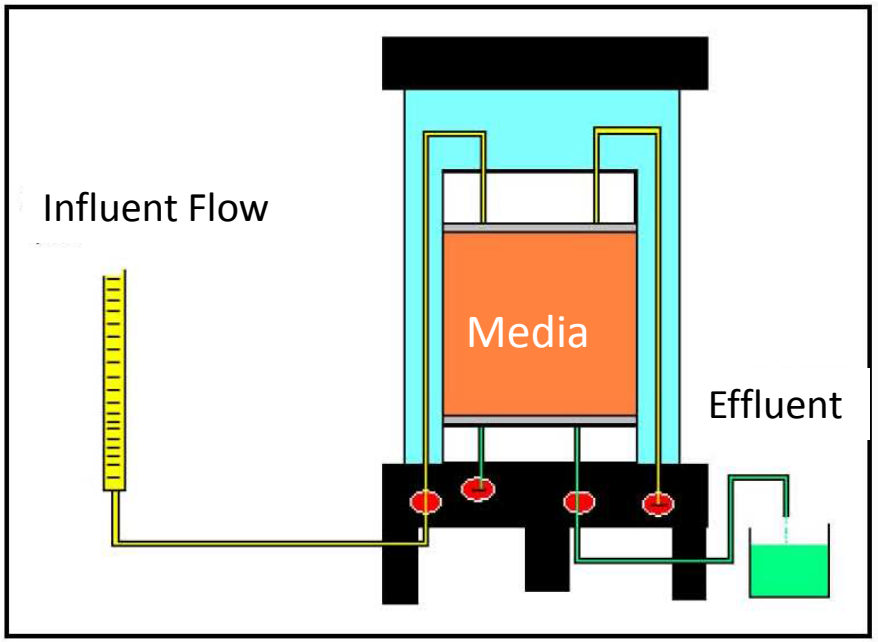
Media Absorption

- GFH media effective for treatment
- Able to be implemented in a passive/semi passive configuration
- Further testing required

Next Steps

Media Absorption with Oxidation

- Test in a passive configuration
- Establish a required contact time
- Conceptual design



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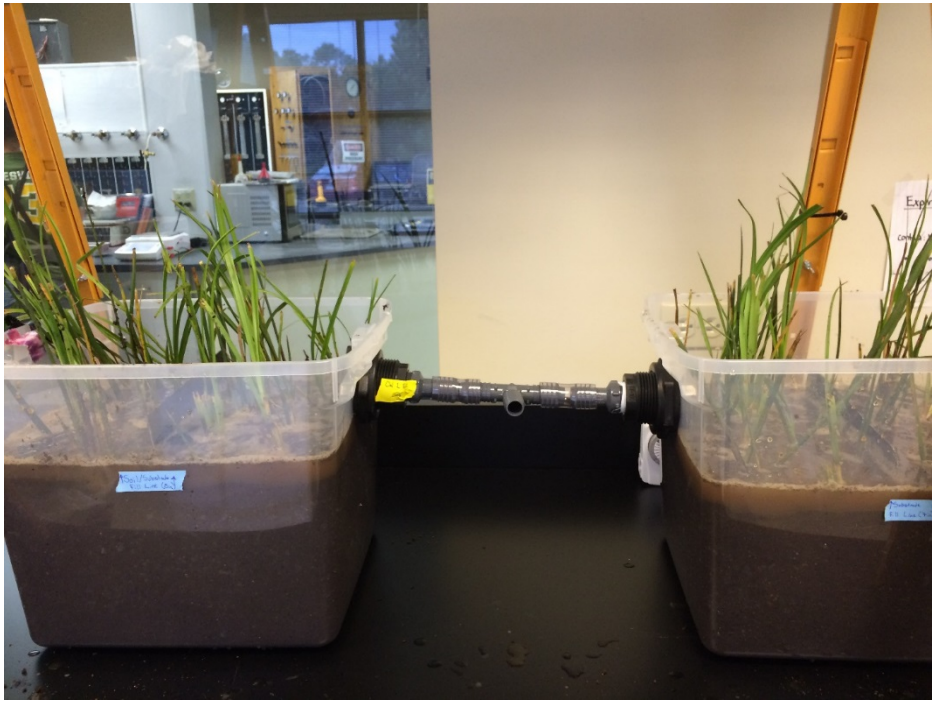

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Thank You!

Additional thanks to:

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