Removal of Arsenic from Mine Water Using an Adsorption-Based System

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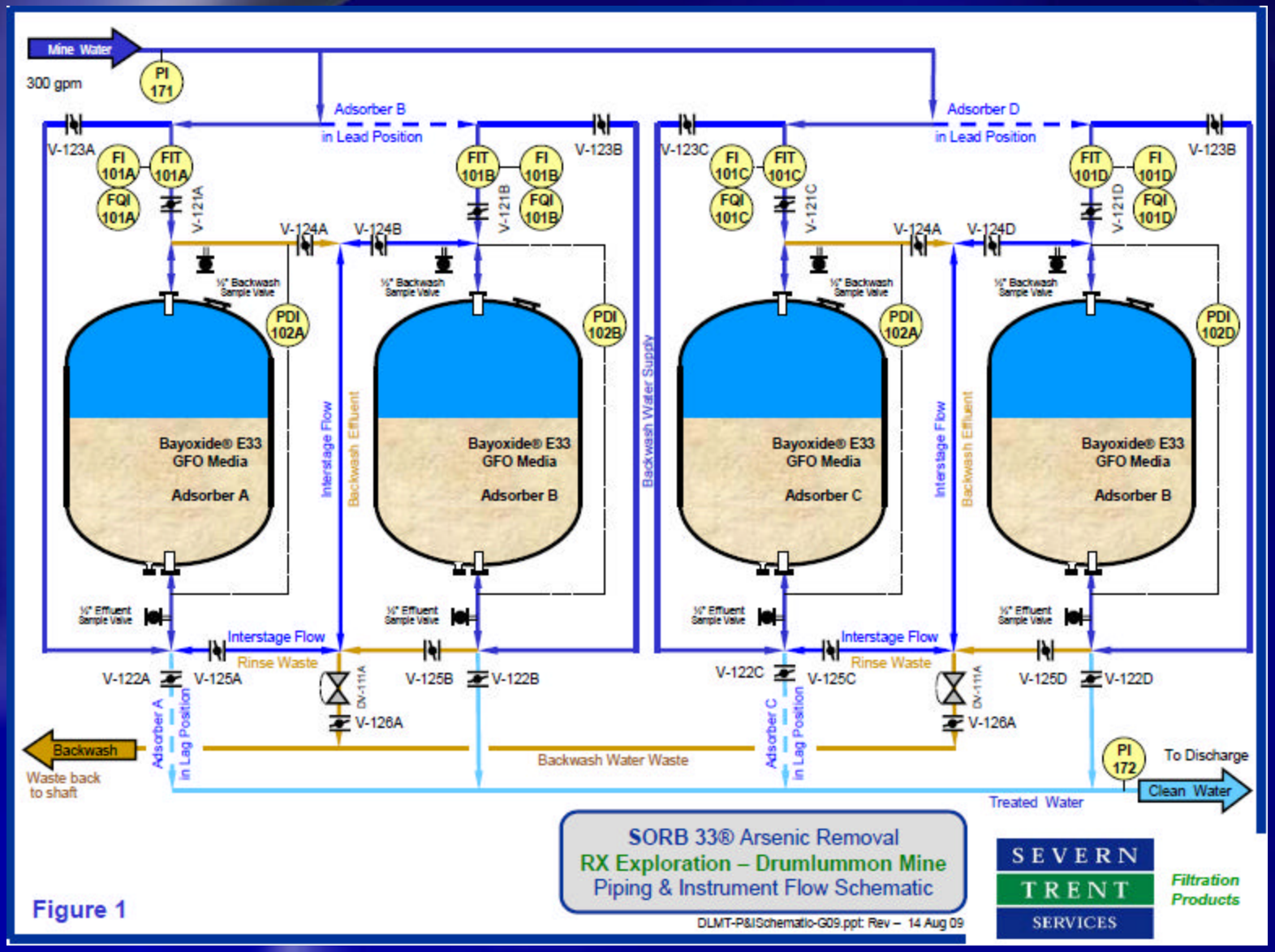
May, 2010

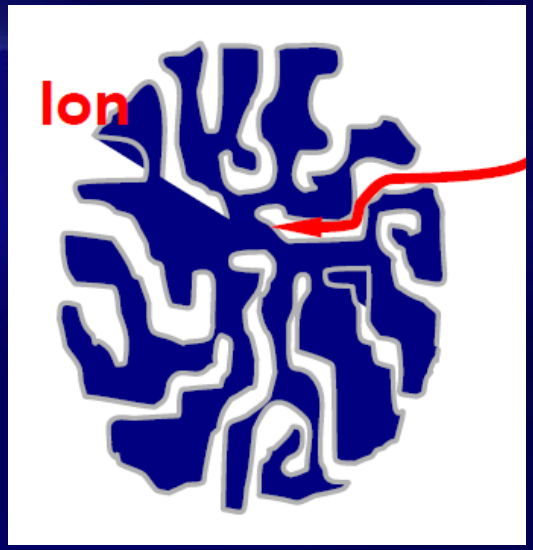
Mine Water Quality – November 2008

Parameter	Value
pH	7.7
Alkalinity	300 mg/L
TDS	306 mg/L
Arsenic	0.018 mg/L
Copper	0.003 mg/L
Iron	ND
Zinc	0.008 mg/L
Manganese	1.5 mg/L
Silicon	14.4 mg/L
Calcium	80 mg/L
Magnesium	24 mg/L

Severn Trent SORB33 System



SORB33 Media



- High surface area – 100-500 m^2/g
- Porous – 98% of surface area is within the particle
- Arsenic is removed from the water via adsorption onto the porous media
- Once the adsorption sites are consumed, the media is disposed of.

Factors Contributing to Media Performance

- pH - <7 is preferred
- Low levels of competing ions (Si, P, V, F, and SO_4)
- Low TSS – To prevent channeling
- No precipitation reactions within bed (media can become coated)

System Installation

Installed System

Media in Vessel

Completed Installation

Submersible Pump

System Performance

- Breakthrough occurred after only one month of operation (30 ppb in effluent)
- Non-degradation standard for arsenic is 3 ppb.
- Manufacturer predicted media life of ~0.5 yr.

Possible Reasons for Breakthrough

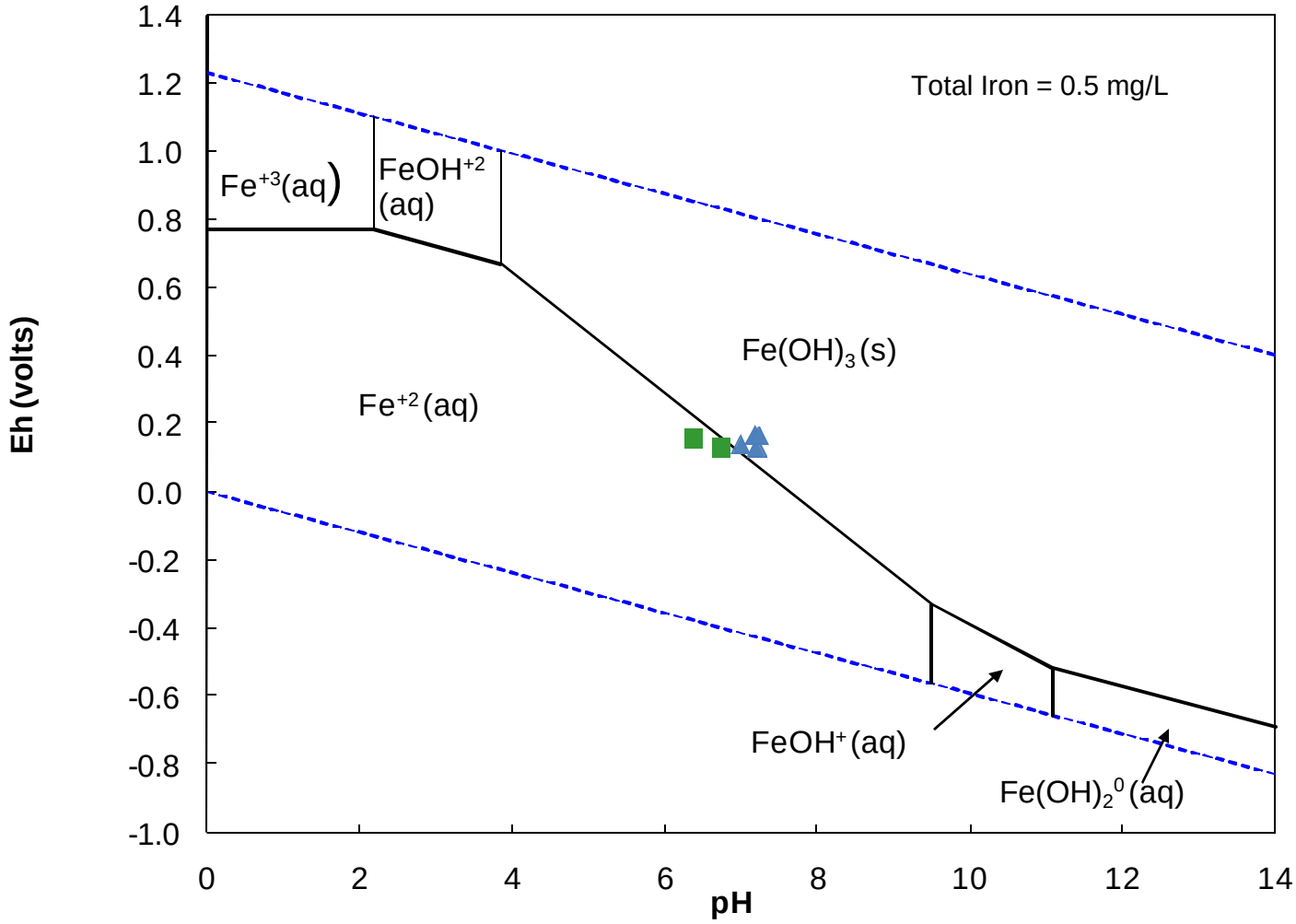
- Media Fouling by iron- or sulfate-reducing bacteria
- Presence of unexpected TSS and iron levels in the influent
- Precipitation of minerals onto and deactivation of the media

Bacteria

- Although TOC is low in the influent (~2 mg/L), significant organic material is present within the decaying mine timbers within the workings
- Addition of bleach to the spent media resulted in significant reaction, but did not regenerate the media. Routine addition has resulted in improved As removal.
- Addition of acid resulted in production of a gas with a hydrogen sulfide odor, suggesting that sulfate-reducing bacteria were active.

Bleach Addition

System Performance



TSS

- Bag filters were placed within the influent line to remove the TSS and the media was replaced.
- System performance was again short-lived.

Mineral Precipitation

- Analysis of the spent media suggested that manganese was being retained within the lead vessel
- PHREEQC modeling indicated that manganese carbonate and possibly calcium carbonate were precipitating within the media
- Regeneration procedures proved to be impractical, but did show that once the manganese was removed, arsenic exchange became possible.

Geochemical Modeling Results

Sample	Date	Saturation Index		
		Calcite	Rhodochrosite	Carbon Dioxide*
		$CaCO_3$	MnCO3	CO_2 (g)
Shaft #1 50 ft	2/12/2008	0.71	1.27	-2.54
Shaft #1	8/26/2008	0.21	0.83	-2.03
Shaft #1 8 ft	11/6/2008	0.48	1.04	-2.24
Shaft #1	12/16/2009	-0.12	0.52	-1.76

Regeneration Procedure

- Bleach – To oxidize sulfides
- pH 2 Oxalic Acid – To dissolve Manganese (6 EBVs)
- pH 12 Caustic – To remove arsenic (5 EBVs)
- pH 2.5 HCl – To regenerate media surfaces (15 EBVs)
- H_2O Rinse

Regeneration Results

Solution	As (mg/L)	Fe (mg/L)	Mn (mg/L)
Oxalic	0.096	677	172
Caustic	18.8	239	3.45
HCl	1.77	59.5	0.42

- **Oxalic removed large amounts of iron and manganese, but insignificant As**
- **Once the Fe and Mn were removed, the arsenic was successfully removed from the media**

Conclusions

- Iron and manganese precipitates, as either sulfides or carbonates are coating the media
- The production of sulfides appears to be due to the action of sulfate-reducing bacteria within microenvironments
- Disinfection and pre-treatment for iron and manganese appear to be necessary prior to treatment with SORB33 media

Questions?