

Golden Sunlight Mine Bio-Treatment of Acid Producing Waste

By

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Operations Superintendent



Golden Sunlight Mine

- Gold Producing Mine
- 2.5 Million Ounces Produced
- 20 Year Operation
- Ore and All Waste High In Sulfides – Acid Producing
- Mitigating Factors
 - Semi Arid Environment
 - Summer Precipitation
 - Good Soil Characteristics
 - Little Arsenic, Mercury, Selenium etc.

Site Status

- **Mine Nearing Closure**
- **Sixteen Research and Technology Demonstration Projects**
- **Two-thirds of Disturbed Area Reclaimed – Over 1000 acres Restored to Wildlife Habitat**
- **Perpetual Water Treatment Planned and Bonded**

Reclaimed West Dump



Reclaimed Acreage



Deer on Reclamation



Some Problem Areas

- **Stepan and Midas Springs – Acid Drainage**
 - **Pit Water Quality**
- **Potential For Waste Rock Acid Drainage**
 - **Potential For Tailings Acid Drainage**
 - **Cyanide Contaminated Groundwater**

Project 16A

SRB-Driven Sulfide Precipitation Demonstration

Project Management

Dianna Bless - EPA

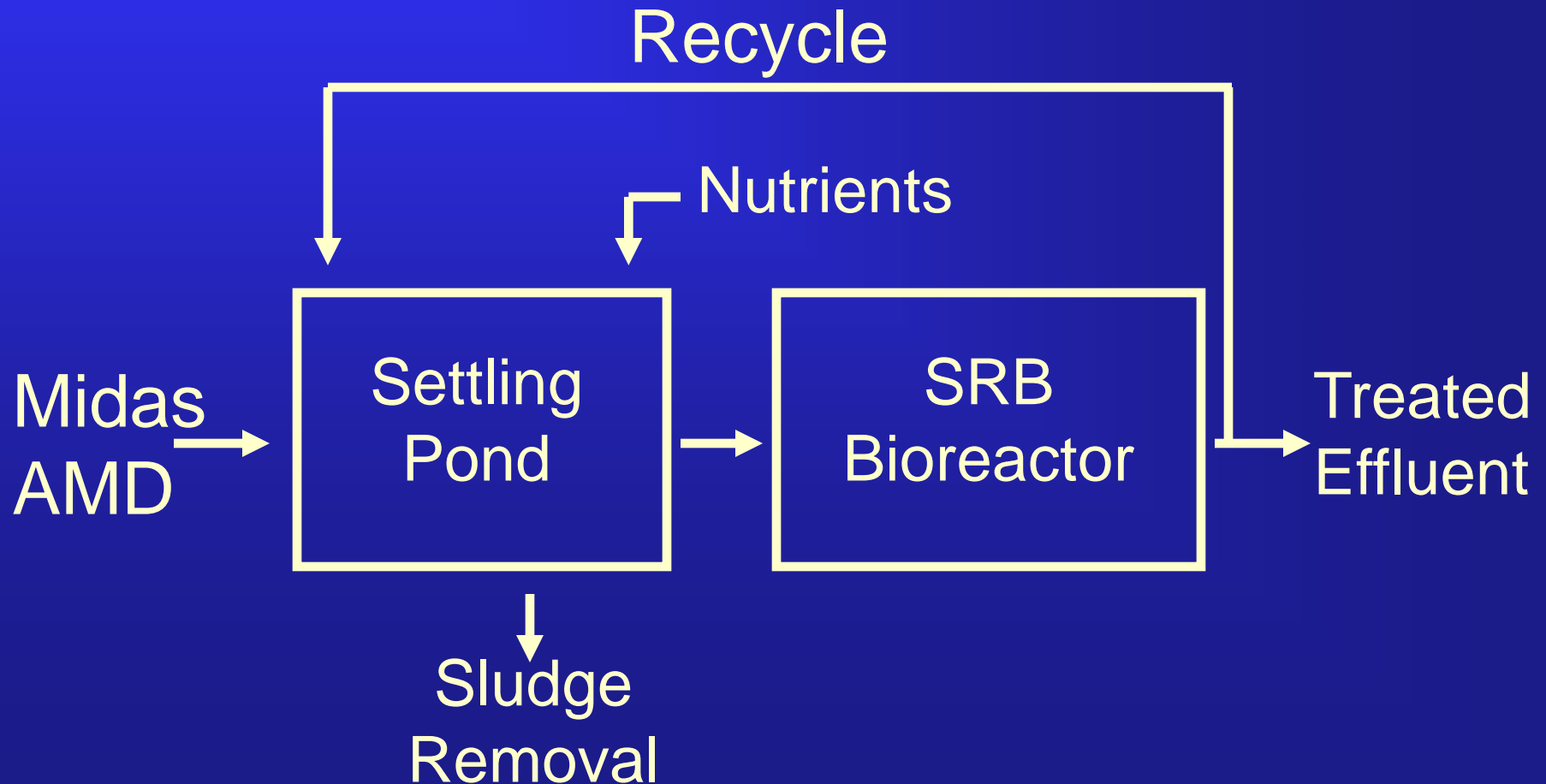
Garth James – MSE

Rory Tibbals – Golden Sunlight
Mine

SRB-Driven Sulfide Precipitation Demonstration Project

- Innovative design involves a two-step system
- Biological products (H_2S and HCO_3) generated in bioreactor by SRB
- Biological products in the bioreactor effluent are mixed with AMD
- Bench-scale testing completed at MSE
- Field-scale testing at Golden Sunlight Mines

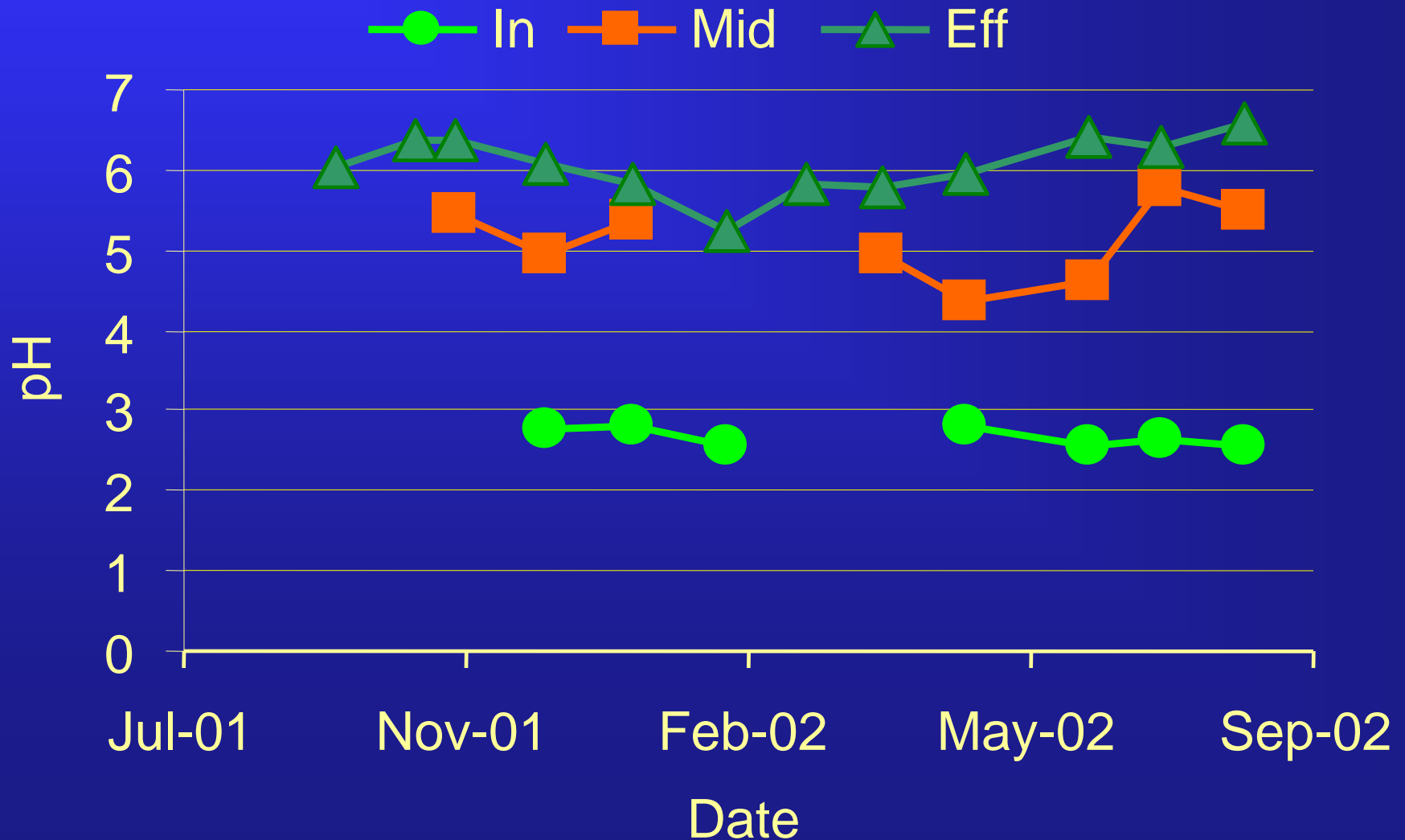
SRB-Driven Sulfide Precipitation Demonstration Project



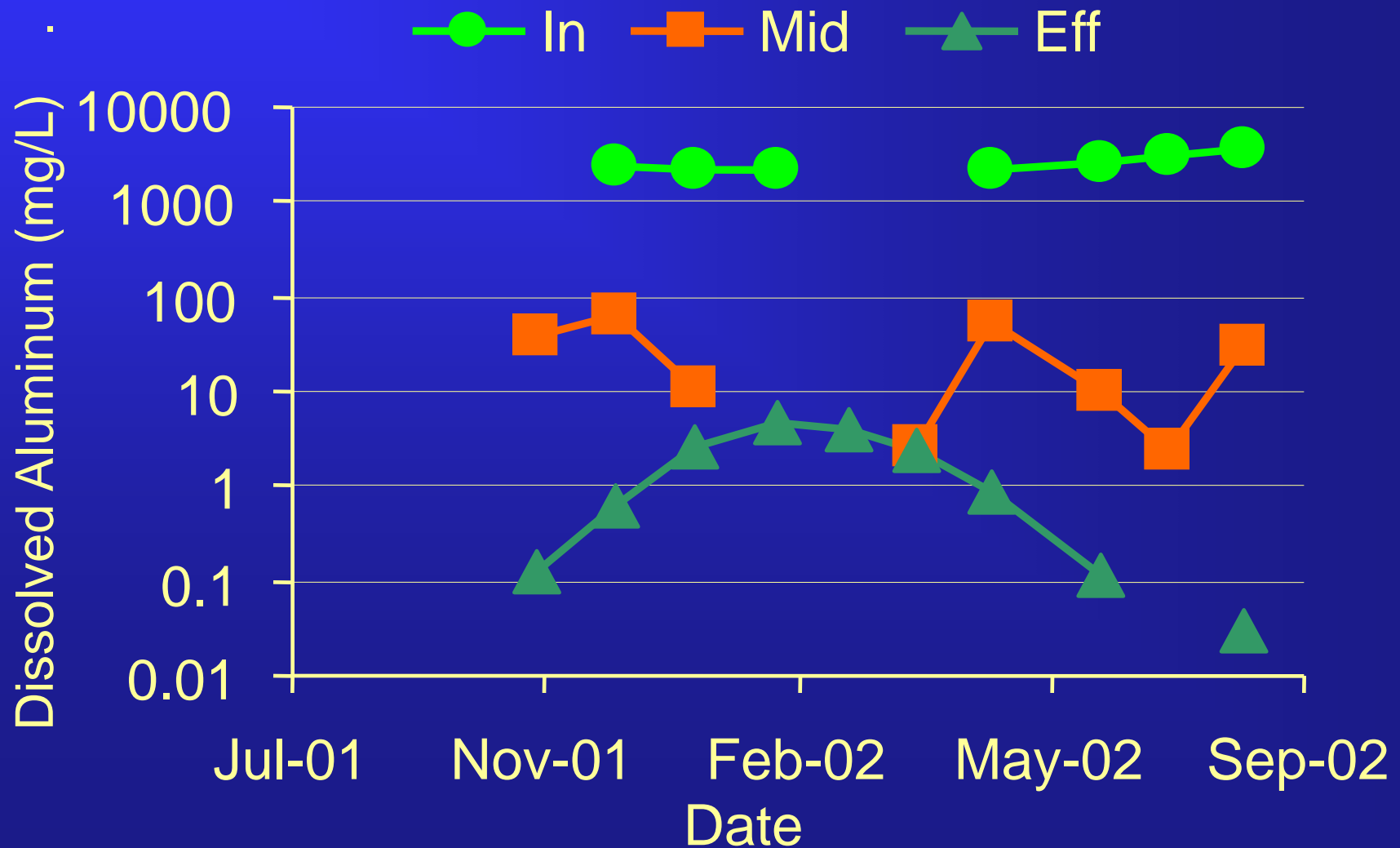
SRB-Driven Sulfide Precipitation Demonstration Project



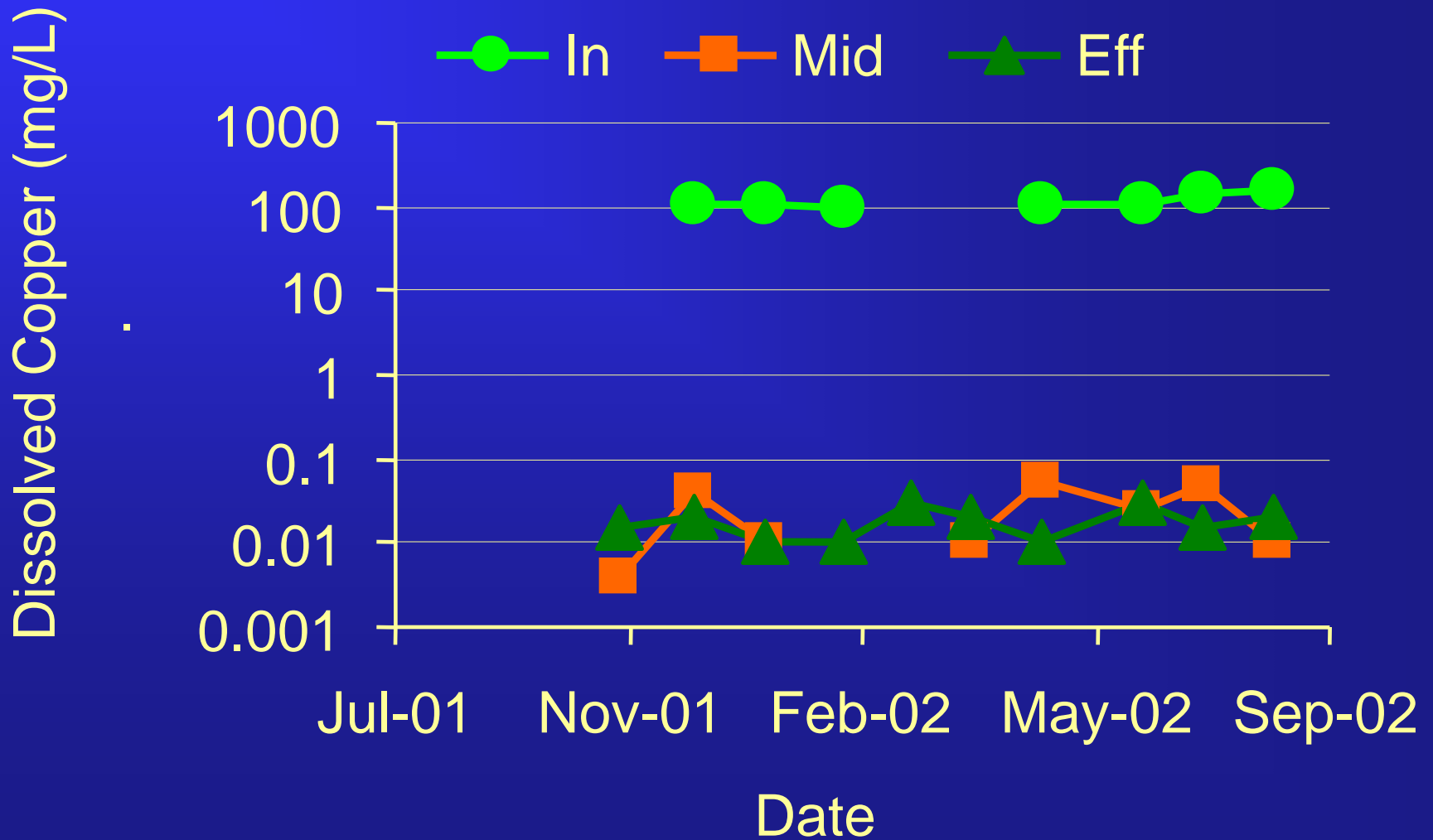
SRB-Driven Sulfide Precipitation Demonstration Project



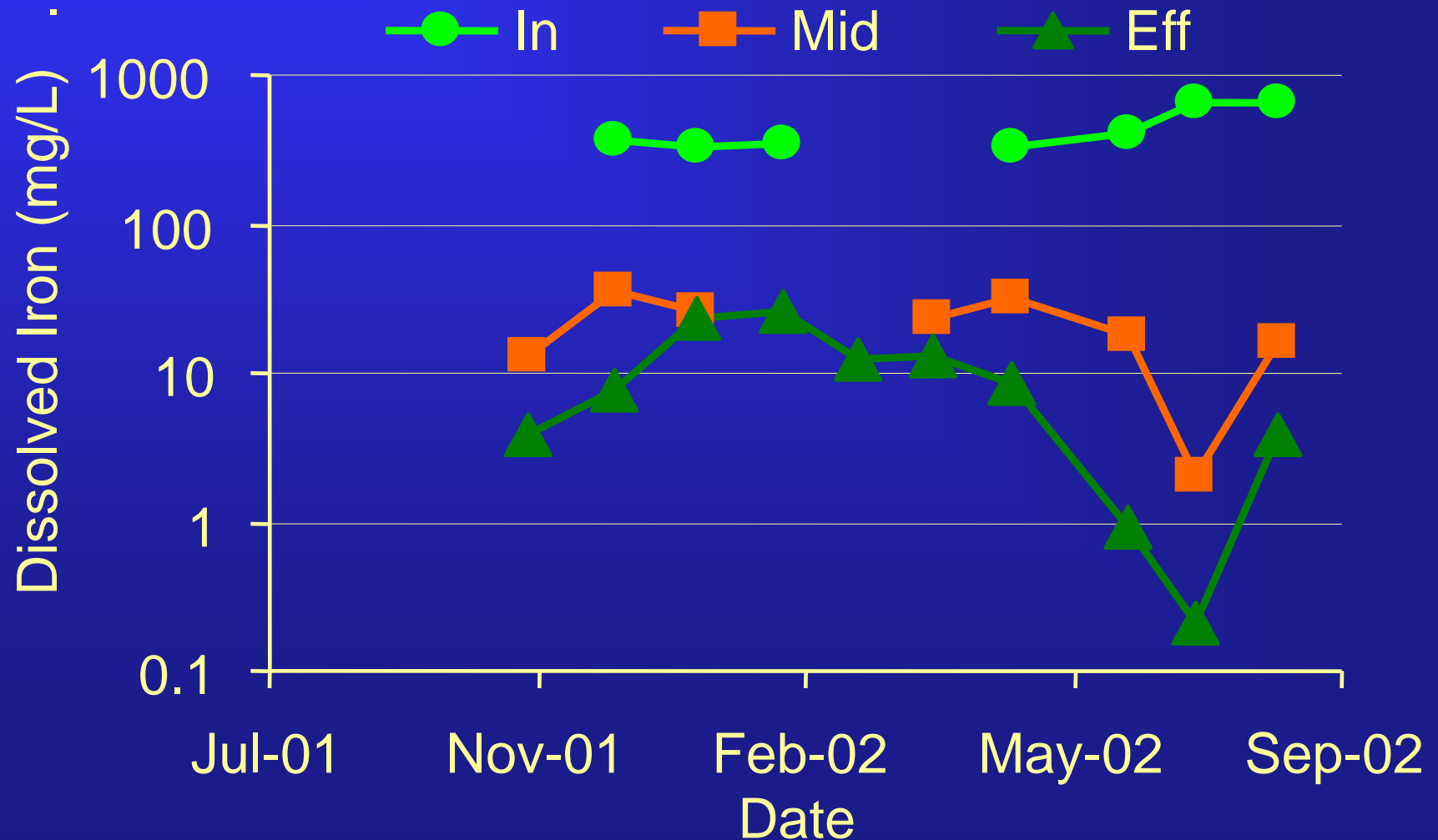
SRB-Driven Sulfide Precipitation Demonstration Project



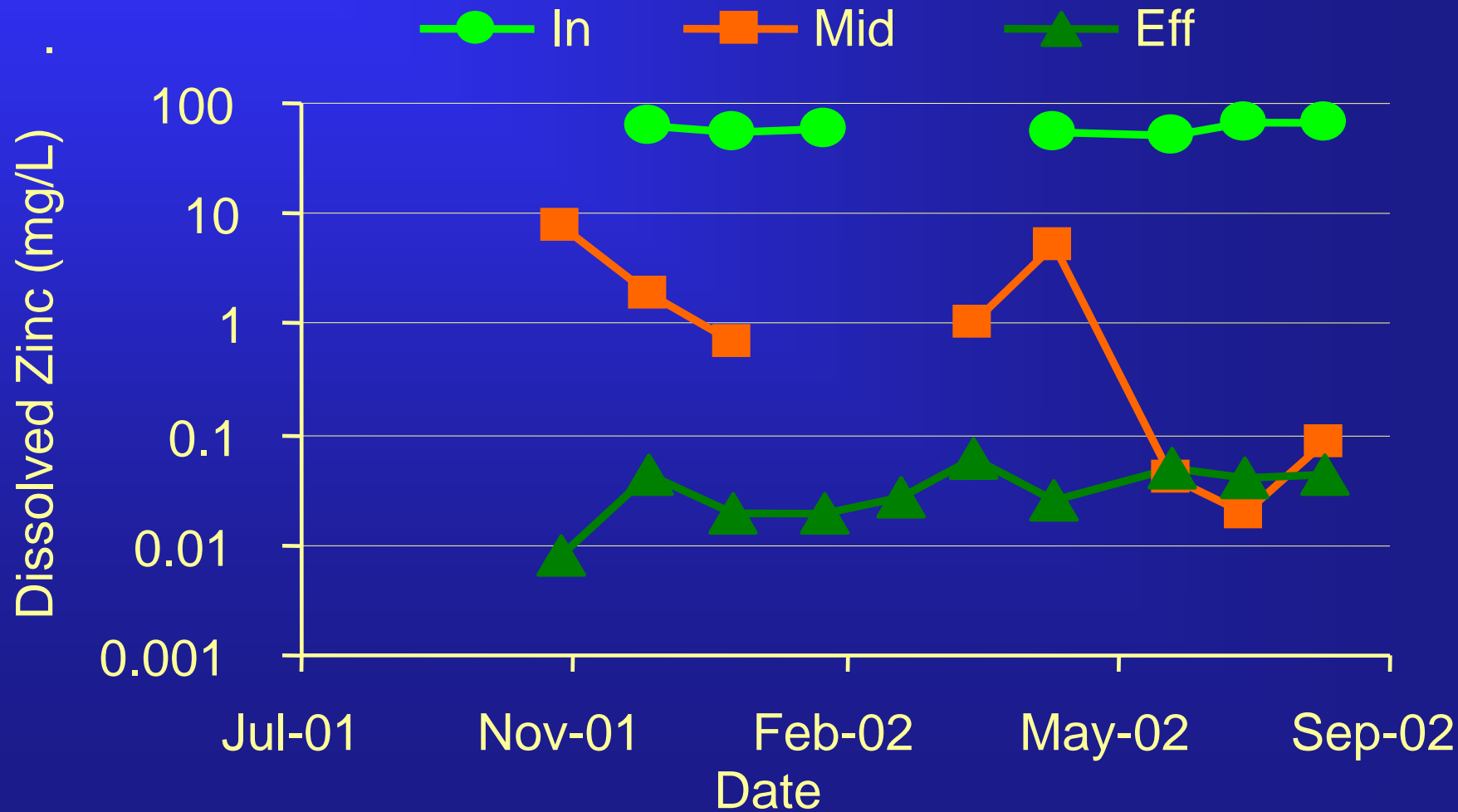
SRB-Driven Sulfide Precipitation Demonstration Project



SRB-Driven Sulfide Precipitation Demonstration Project



SRB-Driven Sulfide Precipitation Demonstration Project



SRB-Driven Sulfide Precipitation Demonstration Project

- Alkalinity and sulfide generation
- pH increase
- Removal of Al, Cu, Fe, Zn

SRB-Driven Sulfide Precipitation

Bioreactor Sludge Analyses		
Water		50%
Sulfur		13.7%
Sulfide		n.d.
Sulfate		n.d.
Carbonate		13.0%
Aluminum		6.1%
Arsenic		n.d.
Calcium		9.4%
Copper		0.4%
Iron		1.1%
Magnesium		2.1%
Manganese		0.2%
Potassium		0.4%
Silicon		2.2%
Sodium		0.3%
Zinc		0.2%

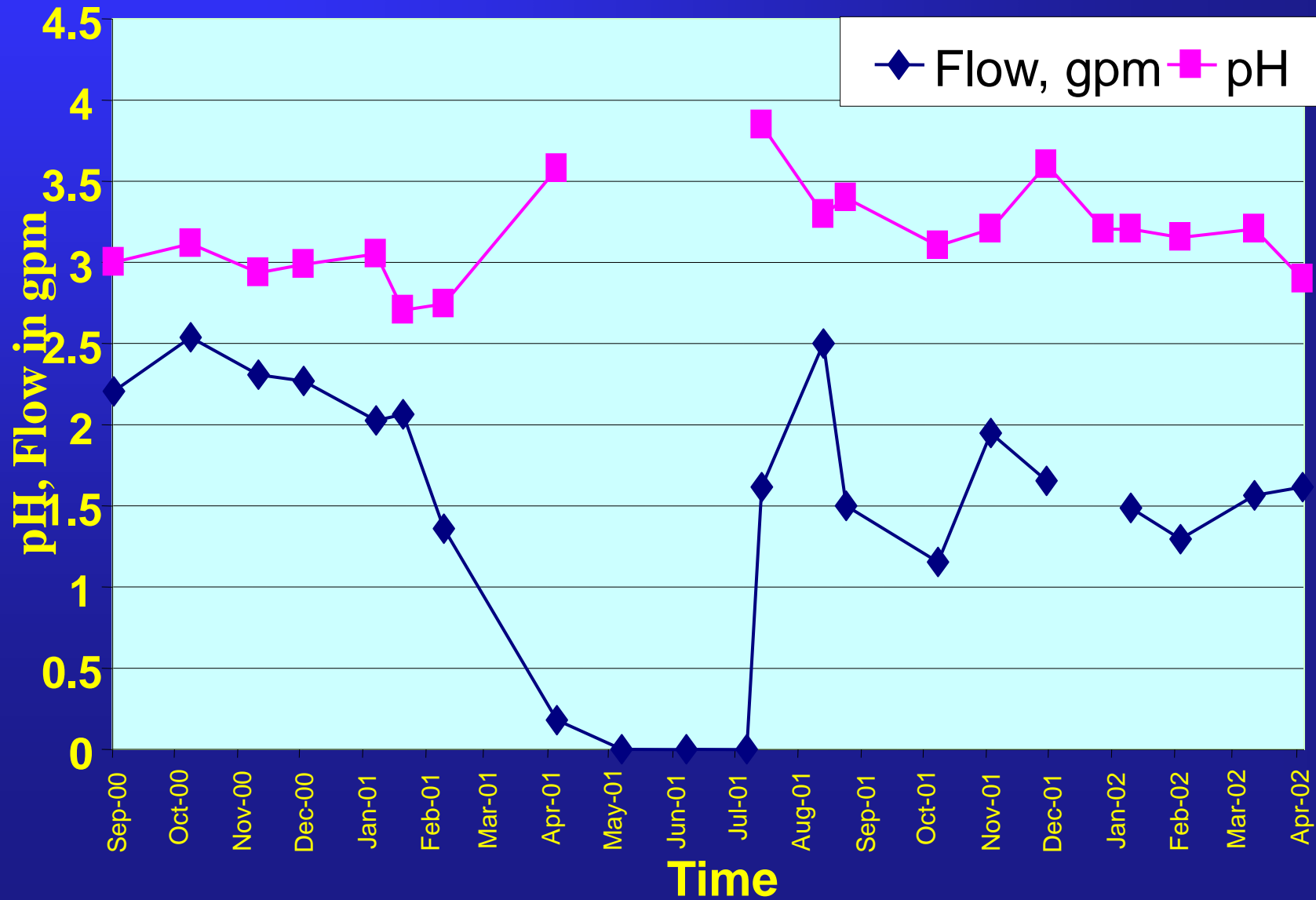
CONCLUSIONS

- The bioreactor worked very effectively at producing alkalinity sufficient to neutralize acid constituents.
- The bioreactor did not experience plugging.
- All lost sulfate was turned into sulfur via oxidation.
- Sulfate reduction was limited by the oxidation potential of the contained metals.
- Manganese, and to some extent iron reduction, was limited by oxidation state, reduced forms being more soluble.
- Ca, Mg reduction was limited by carbonate production and carbonate solubility.

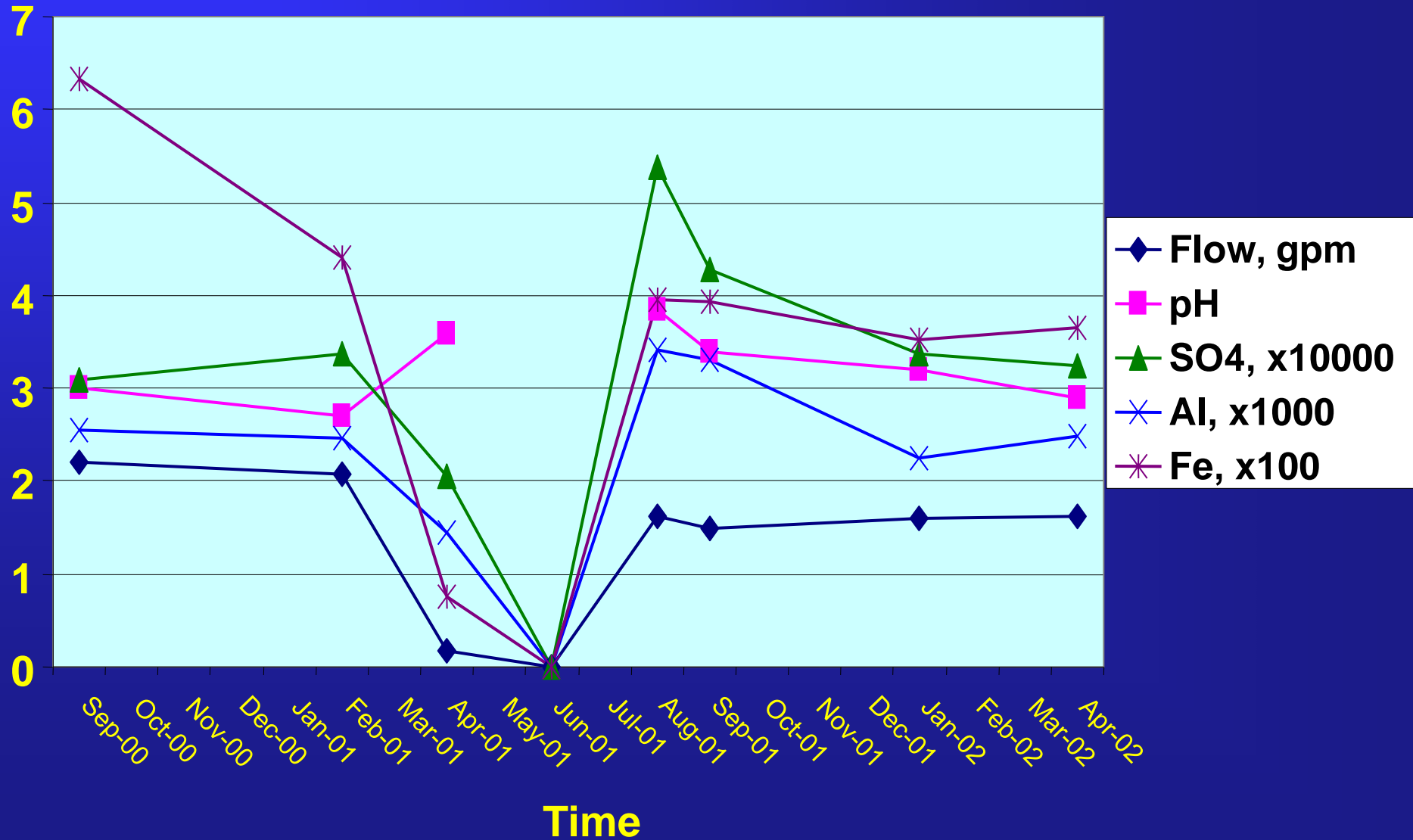
Midas Dump

- Midas Dump Built Over Spring
- Source of ARD
- Total Flow About 3 gpm
- Very Poor Quality Water
- Test Consisted of Adding Sugar/Alcohol To Well Placed Into Dump Above Spring
- Water Quality of ARD and Soil Gas Composition Was Monitored
- Question: Can Carbon Utilizing Bacteria Thrive in Acidic Environment and Affect Water Quality?

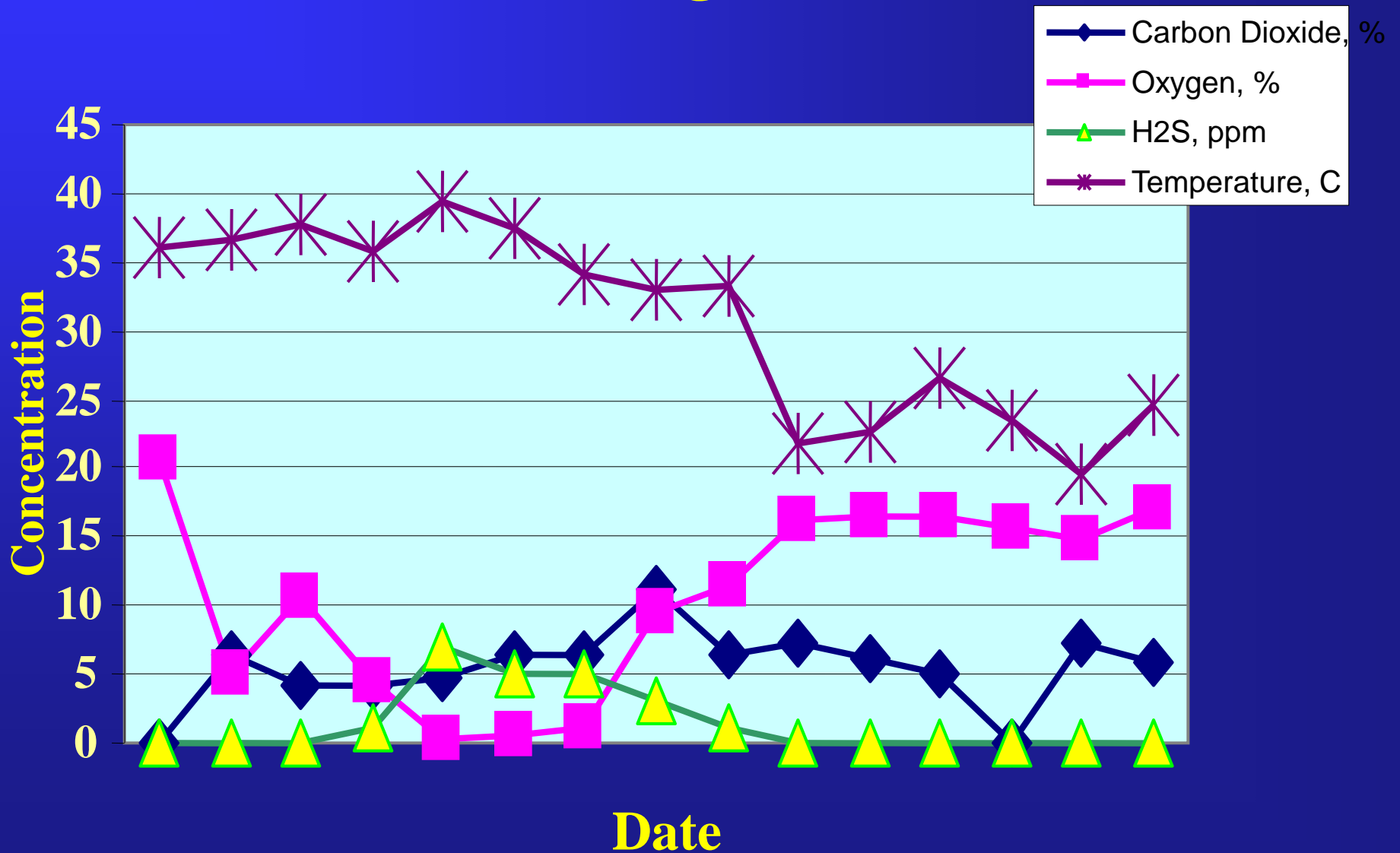
Midas Spring pH vs. Flow



Midas Spring - Water Quality



Soil Gas Monitoring Results



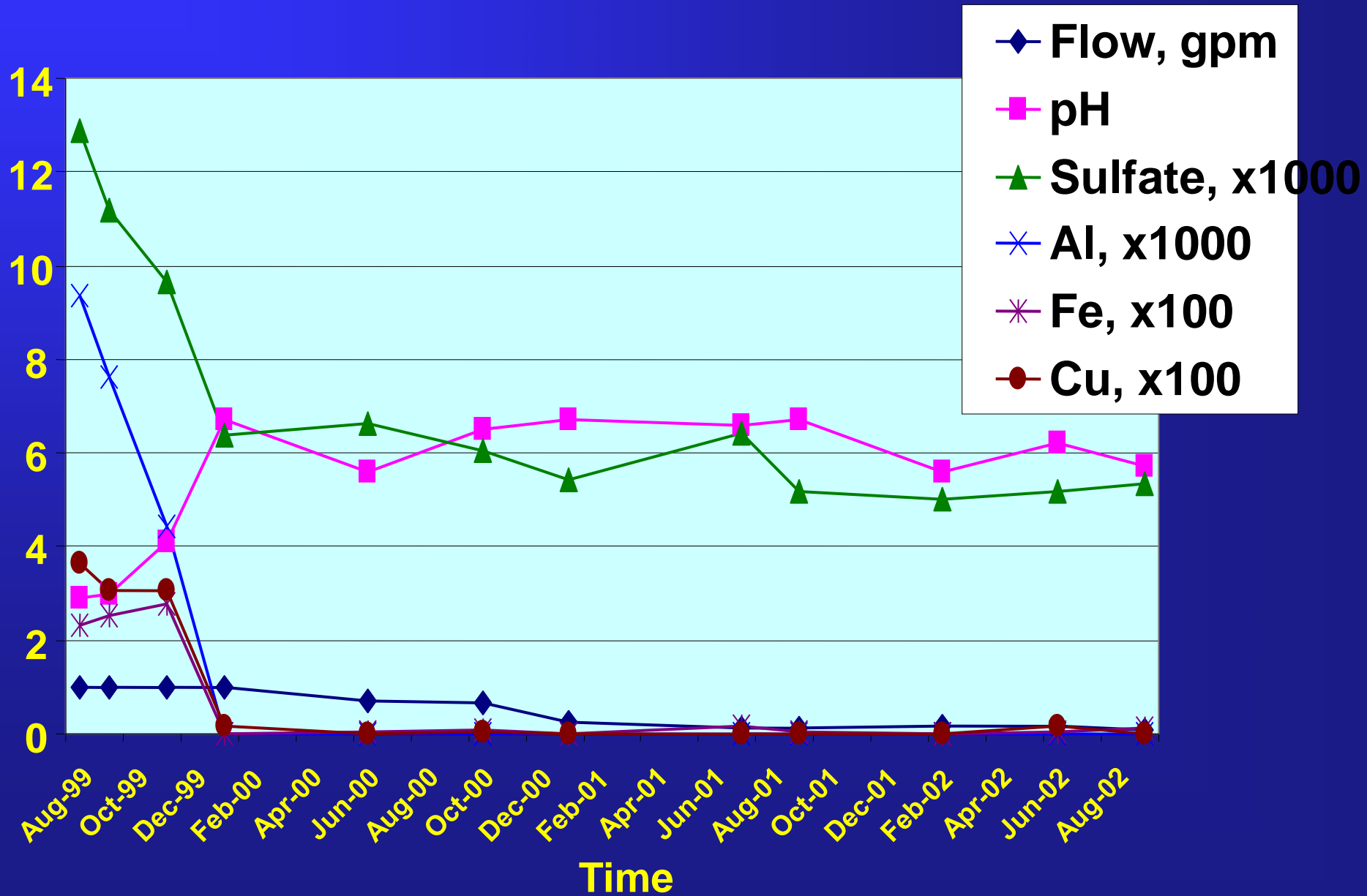
Stepan Spring Anoxic Drain

- Low Flow ARD Contained Within Ferrocete Canyon
- Canyon Filled with Manure/Limestone
- Anoxic Drain Planted with Vegetation
- Effective for pH control and Metal Removal for Three years
- Flow Diminishing
- No signs of Failure





Stepan Spring Water Quality

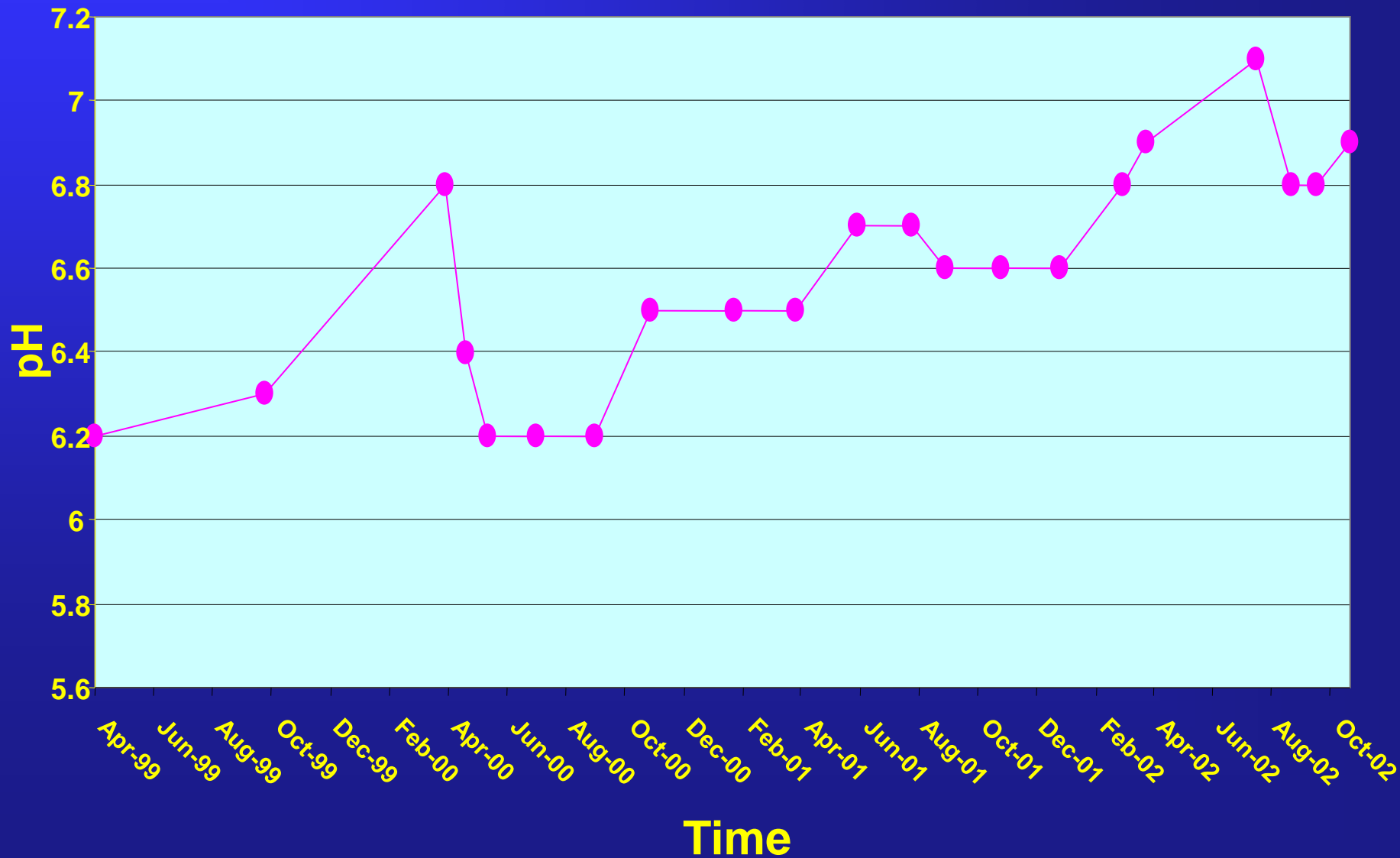


Tailing Dam Under Drain

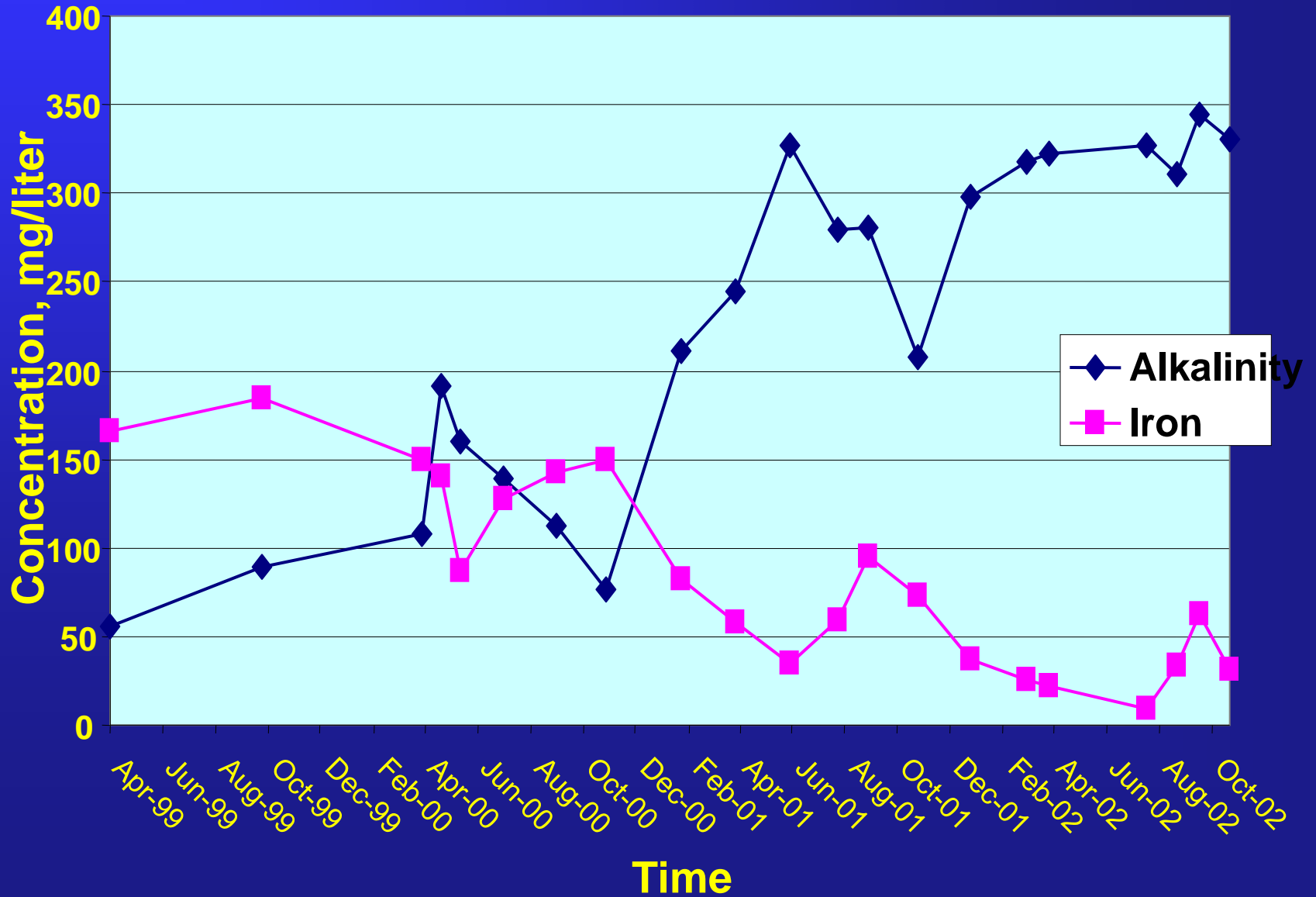
Problem:

- Apparent Acid Generation In Tailings
- Water Draining From Tailings Becoming More Acidic
 - Metals Becoming Soluble

Tailings Dam Underdrain pH



Water Quality Changes - Tailings Underdrain



Problem Solver – Water Trap



Water Trap

- Trap Prevents Oxygen Excursion Into Under-Drain System
 - Acid Generation Was Caused By Air
- When Air Was Excluded, Acid Generation Ended and The Water Quality Improved