

# WINTER PERFORMANCE OF BIOLOGICAL TREATMENT SYSTEMS

**9<sup>th</sup> Annual British Columbia ML/ARD  
Workshop**

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# Winter performance: the Achilles' Heel of Biological Treatment Systems?

- ☞ Passive treatment systems don't work during the winter
- ☞ Can't be used in a walk-away scenario

**GOOD NEWS! Recent research shows that this may not be true!**

Everything stops when water  
freezes, right?

**NO!**

- Idea not really tested!
- This presentation: summary of recent findings

# Presentation Outline

## ▣ 3 examples of winter zinc removal:

1. Galkeno (natural wetland)
2. Silver King (muskeg)
3. Silver Queen (natural wetland)

## ▣ Mechanics of winter metal removal:

1. Metal adsorption onto TOC (Bell Mine wetland)
2. SRB & sulphide precipitation (Calliope and ARCO bioreactors)

## ▣ Conclusions

# Keno Hill Mines

- ▣ Open pit and extensive underground mines
  - Some adits discharge Zn-contaminated water
- ▣ Investigated wetlands for mine closure
- ▣ Tested zinc removal during the winter

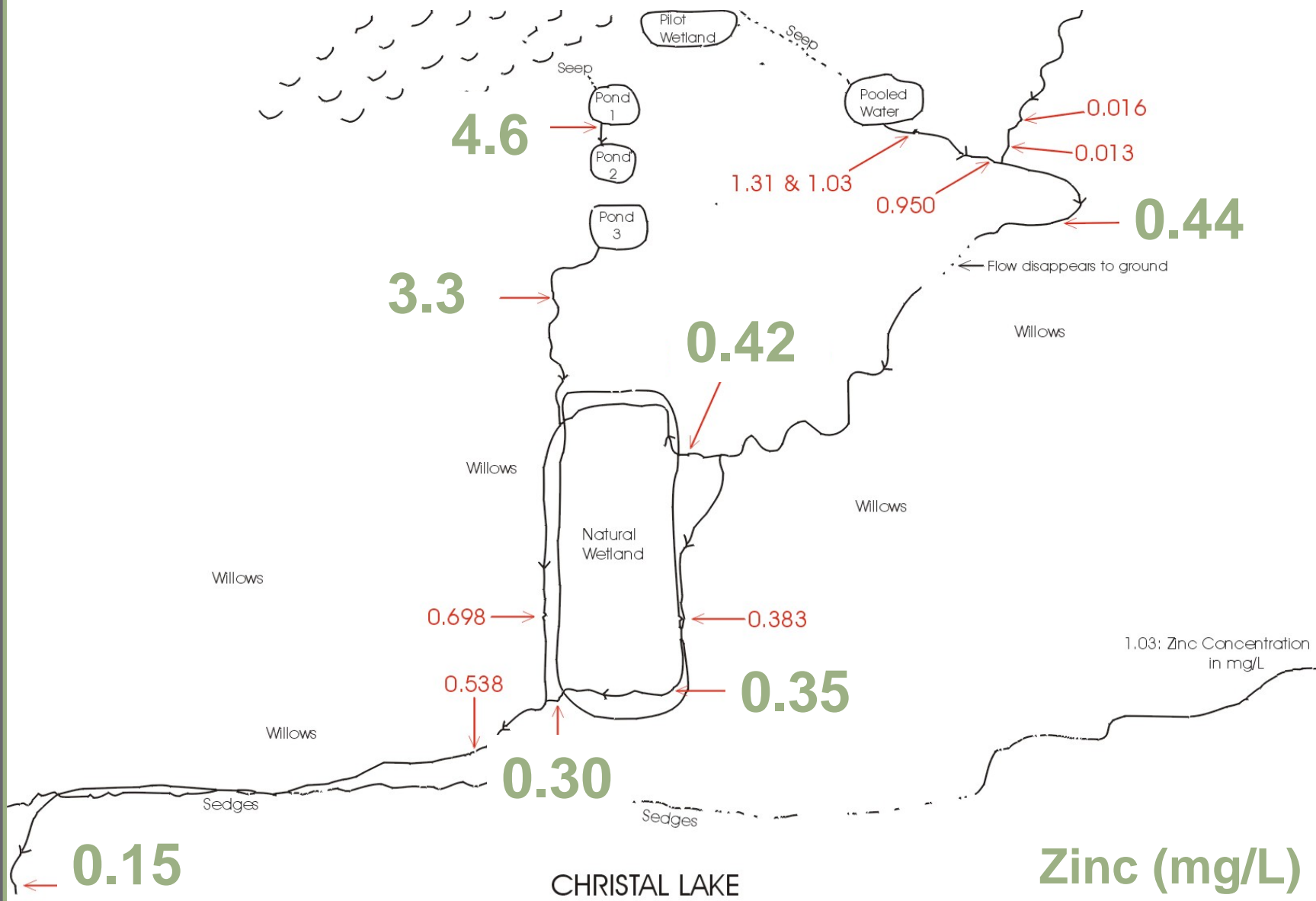
# Example #1: Galkeno natural wetland





# Galkeno natural wetland ctd..



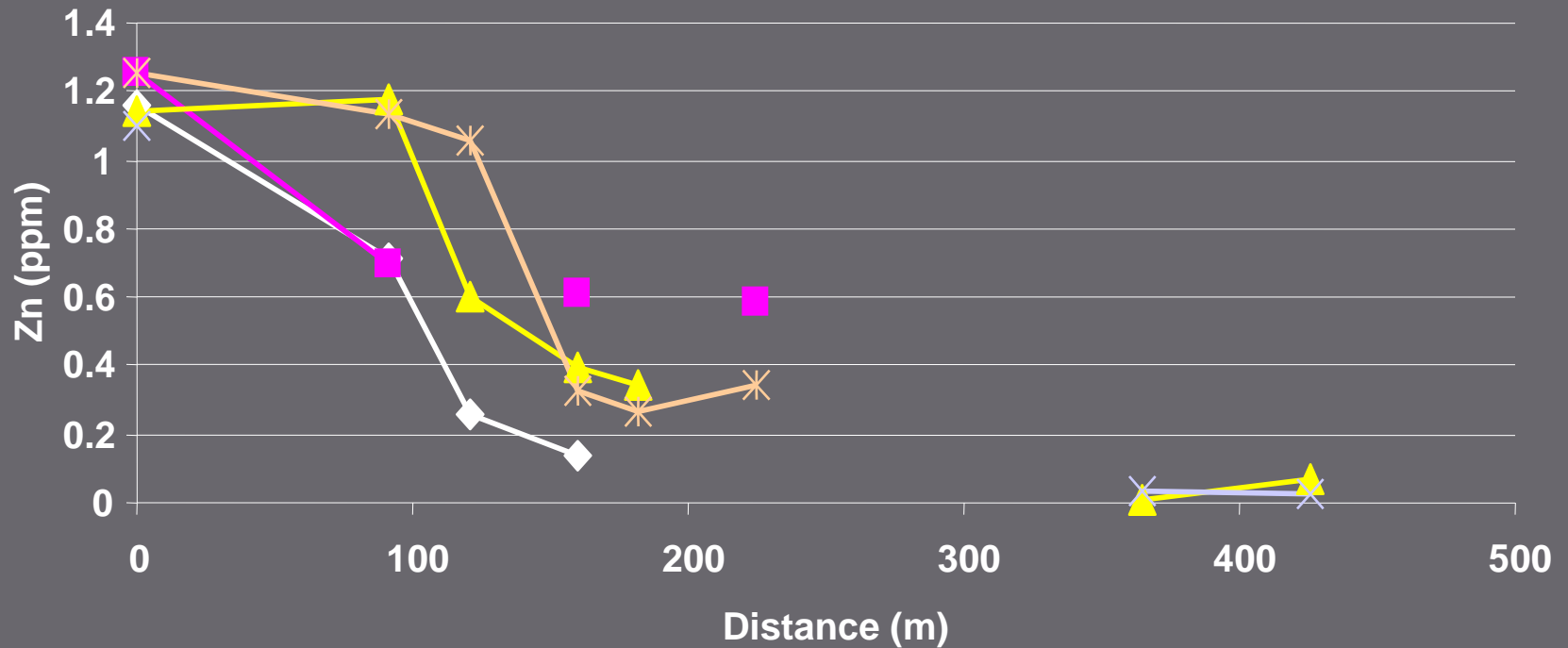




## Example #2: Silver King Mine

- ▣ Adit discharges 1.2 mg/L Zn at 2 L/sec
- ▣ Discharge over wetland/muskeg
- ▣ Measured zinc during the winter

# Silver King Mine, ctd



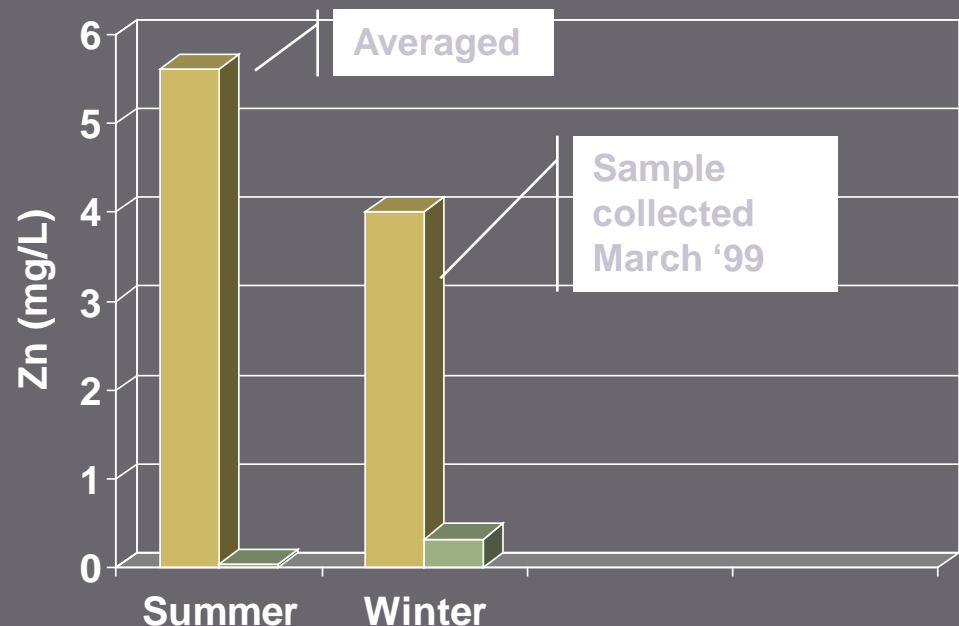
—◆— 2-Dec-2001 —■— 5-Jan-2002 —▲— 24-Jan-2002 —x— 1-Feb-2002 —\*— 26-Feb-2002

# Silver King Mine, ctd

Date	Temp	Zn (0 m)	Zn (160 m)	Zn (426 m)
Dec 2, 2001	NA	1.16	0.135	NA
Jan 5, 2002	-40's	1.25	0.606	NA
Jan 24, 2002	-35 °C	1.14	0.396	0.071
Feb 1, 2002	-39 – -49 °C	1.10	NA	0.026
Feb 26, 2002	-26 – -39 °C	1.25	0.327	NA

# Example #3: Silver Queen Mine

- ▣ Discharge flows (10-100 L/min) through tailings pond, then 1-2 hectare wetland
- Inlet and outlet Zn concentration were measured





# Outline of presentation

- ▣ A few examples:
  - Zinc removal in wetlands
- ▣ **Treatment processes:**
  - Metal adsorption onto organic matter
  - SRB & sulphide precipitation

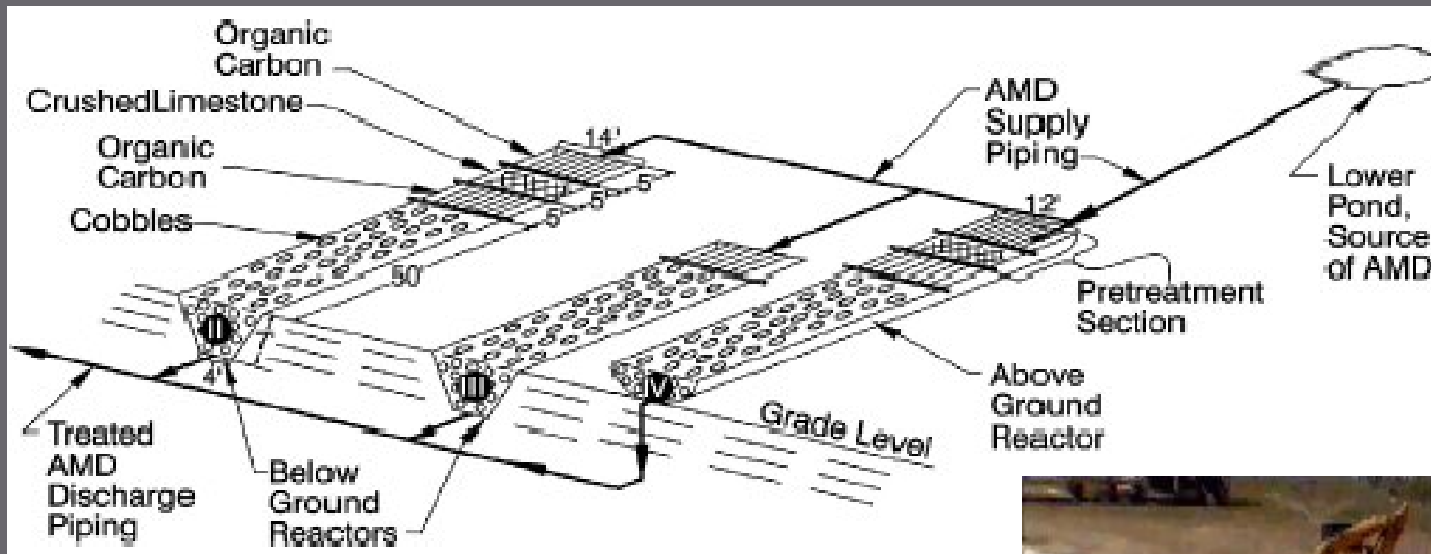
# Removal processes & design

- ▣ Three processes dominate metal removal:
  - Oxidative precipitation: e.g., Fe oxides
  - Adsorption onto organic matter
  - Sulphide precipitation : e.g., Zn sulphides

# Calliope Bioreactors

- ▣ SRB-based bioreactor treating ARD at abandoned Calliope Mine, Montana
- ▣ Bioreactors filled with organic carbon, cobble, and crushed limestone
- ▣ Operated to compare year-round performance

# Calliope Bioreactors



Bioreactor layout (above)

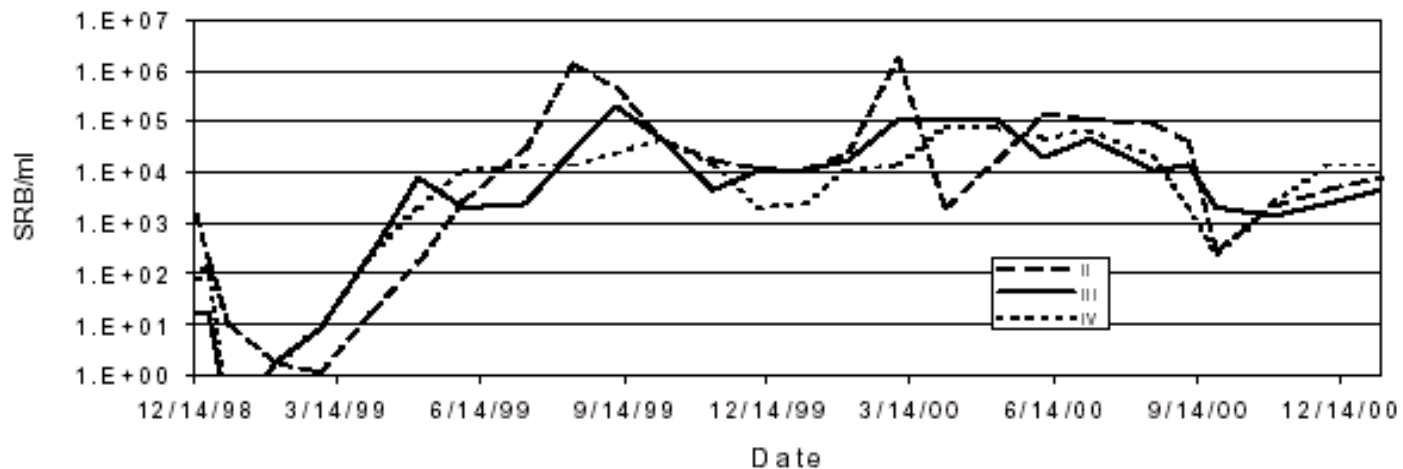
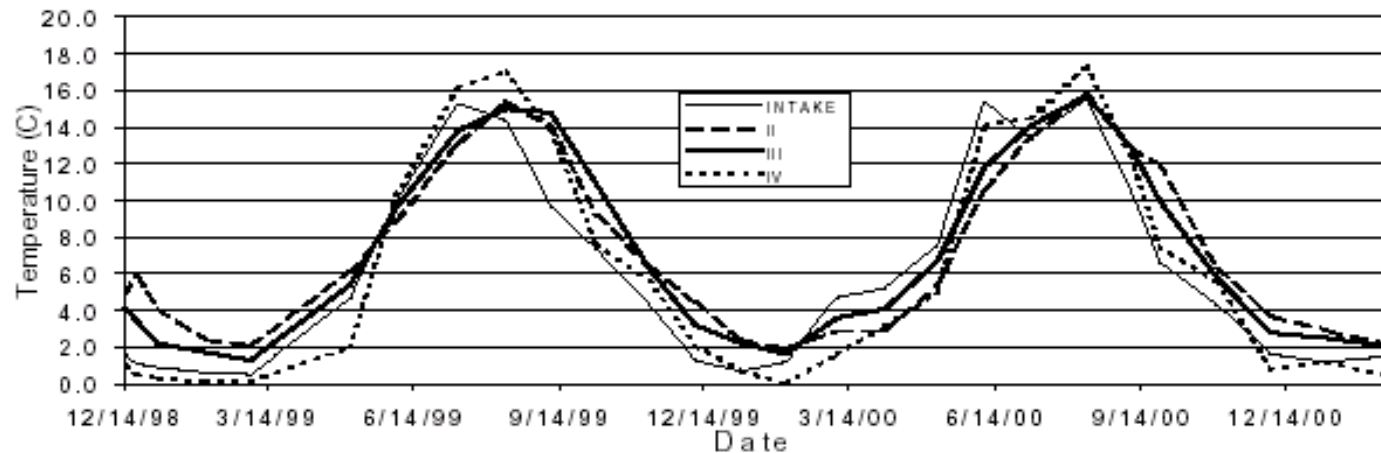
Construction (right), Fall '98

(MSE Technology Applications Inc.)

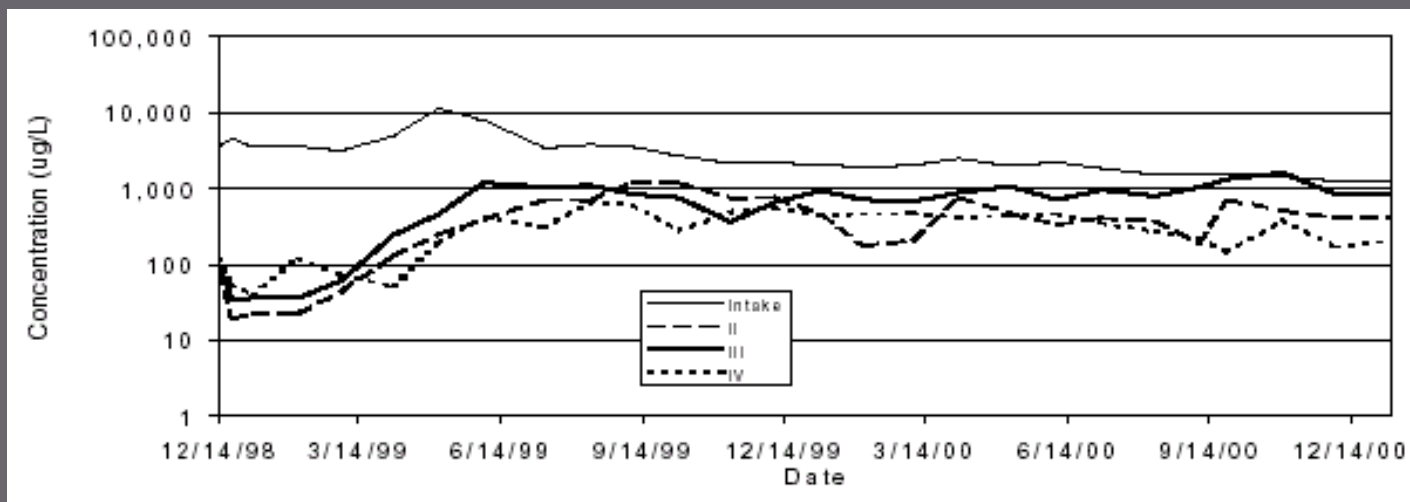
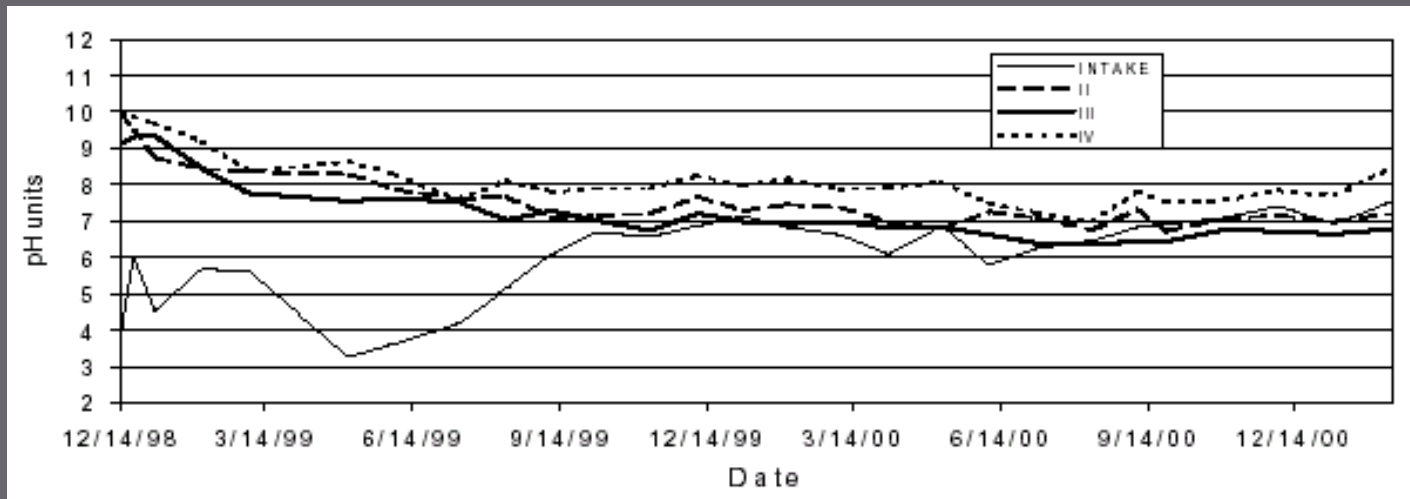




# Calliope Bioreactors: Temp, SRB



# Calliope Bioreactors: pH, Zn



# ARCO demonstration wetlands

- ▣ Wetland complex at ARCO site, Butte, Montana
- ▣ Aerobic wetlands and anaerobic bioreactors
- ▣ Retention times ranging from 4-9 days
- ▣ Year-round operation: summers hot ( $30^{\circ}\text{C}$ ) and winter cold (below  $-20^{\circ}\text{C}$ )
- ▣ Remove As, Cd, Cu effectively, Zn less well

# ARCO demonstration wetlands

- ▣ Winter 97-98, frost penetrated 75% of wetland depth. With reduced wetland volume, retention time was insufficient for full treatment
- ▣ SRB slower, but still active
- ▣ Alkalinity produced (ARD still can be treated)



# Conclusions

- ▣ Biological treatment system work during the winter
- ▣ Metals removed at reduced rate
- ▣ Adsorption onto OM and sulphide precipitation important processes
- ▣ Possibility of “walk-away” scenario at mine closure
- ▣ Design process is still in its infancy

# Work to be done

- ▣ Develop sizing parameters/criteria
- ▣ Develop designs that allow water flow after freeze-up
- ▣ Determine longevity
- ▣ Can winter activity be improved?
  - Alcohol feed to bacteria
  - Winter storage