Golden Sunlight Mine
Water Management

- During Operation
  - Use as makeup water for mill circuit
  - Major sources
    - Pit
    - Tailings Impoundment #1 containment wells
Water Management

- Closure
  - Pump – Treat - Discharge
  - Major sources
    - Pit
    - Tailings Impoundment #1 containment wells
    - Tailings Impoundment #2 drain-down
Water Types

- **Pit Water**
  - ARD signature
    - Low pH, sulfate, iron, trace metals, and TDS

- **Tailings Impoundment Waters**
  - Process water residuals
    - Cyanide, thiocyanate, nitrate, ammonia, and TDS
    - Slight signature of neutralized ARD
Treatment

- **Pit Water**
  - Active HDS type treatment (pH adjustment, metals precipitation), possibly polishing for TDS removal.

- **Tailings Impoundment Water**
  - Active biological treatment (aerobic and anaerobic), possibly followed by HDS and polishing for TDS removal.
**Biological Treatment**

- **Desired Reactions:**
  - **Aerobic**
    - $\text{CN} + \text{Bacteria} \rightarrow \text{HCO}_3 + \text{NH}_3$
    - $\text{SCN} + \text{OH} + \text{Bacteria} \rightarrow \text{SO}_4 + \text{HCO}_3 + \text{NH}_3$
    - $\text{NH}_3 + \text{Bacteria} \rightarrow \text{NO}_2 + \text{Bacteria} \rightarrow \text{NO}_3$ (nitrification)
  - **Anaerobic**
    - $\text{NO}_3 + \text{CH}_3\text{OH} + \text{Bacteria} \rightarrow \text{CO}_2 + \text{N}_2 (g) + \text{OH}$
      (denitrification)
  - **Adsorption and Absorption of Heavy Metals**
Passive Biological Treatment

- Acknowledgements
  - Jim Whitlock – Whitlock and Associates
  - Chris Nelson – Barrick Golden Sunlight Mine
  - Rory Tibbals and Shannon Dunlap
  - Rick Henderson and Tom Monfortan – Barrick Golden Sunlight Mine
  - Kathy Gallagher - SPSI
Pilot Plant Testing

- Down flow columns constructed in GSM mill facility - 42 inch diameter and 14 foot height
- Counter current air flow (convective)
- Inert rock media used (1/4 - 5/8 inch nominal size)
- Tailings Impoundment #2 reclaim water used for testing
- Flow rate - 3 gallons/day/ft²
- Inoculated
Pilot Test Results

- 96% removal of cyanide
- 98-99% removal of thiocyanate
- Nearly complete nitrification
- Anaerobic column used to effectively denitrify
- 98-99% removal of copper (19 ppm to 1 ppm)
- Slight decrease in TDS
- pH relatively unchanged at approximately 8 s.u.
Heap Treatment

- One acre limestone based pad on a synthetic liner
- Limestone - 20% > 1.5”, 50% > 1” and 70% < \(\frac{3}{4}\)”
- Buried drip line distribution system
- Counter current convection air in heap
- Flow rate - 3 gallons/day/ft\(^2\)
- Soda ash (alkalinity) and phosphate added to influent
- Source water - T1 containment well water
Heap Test Results

Heap Test - Thiocyanate

Thiocyanate (mg/L)

Influent  Effluent

Heap Test Results

Heap Test - Ammonia

Ammonia (mg/L - N)

Influent  Effluent
Heap Test Results

Heap Test - Arsenic

Arsenic (mg/L)


Influent
Effluent
Heap Test Results

- Heap treatment can significantly reduce cyanide and thiocyanate concentrations
- Heap treatment can reduce metal and metalloid concentrations
- A single stage heap did not demonstrate complete nitrification
- Short circuiting due to plugged drip line filters was a problem
- Temperature effects on small heap reduced performance, particularly for nitrification
- Single stage heap could not meet WQ standards
Heap Treatment

- Larger heaps could mitigate temperature effects
- A second stage heap could likely remove more cyanide and thiocyanate as wells have complete nitrification
- TDS is a problem – some sulfate could be removed in an anaerobic denitrification treatment step
- Heap treatment could reduce phytotoxicity for land application
- Heap treatment has the potential for a low capital and operating cost water management tool
Questions ?

(None – Thank You)
“A number of research people have tried to make this process(es) work without much success, probably because it is art as well as science.”

“If your audience wants to contact me with questions, that is fine as well.”