2008 Annual Reports

Tailings

June 2, 2009
Presentation Outline

• Placement data
• Stability
  – Compaction
  – Inspections
• Water level data
• Precipitation and flow data
• Water quality at internal monitoring sites
• Snow sample results
• Sulfate Reduction Monitoring Program (SRMP) update
• ABA data
• General site management and co-disposal
2008 Pit 5 Looking South

Northwest Excavation

New Water Treatment Plant

Pit 5 Expansion
## Table 2.1 Tailings Placement Data

<table>
<thead>
<tr>
<th></th>
<th>All Materials</th>
<th>All Materials</th>
<th>All Materials</th>
<th>All Materials</th>
<th>Prod Rock from Site 23</th>
<th>Other Materials</th>
<th>Tailings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Annual</td>
<td>Cumulative</td>
<td>Annual</td>
<td>Cumulative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>yd³</td>
<td>yd³</td>
<td>Tons</td>
<td>Tons</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Survey</td>
<td>Survey</td>
<td>Calculated</td>
<td>Calculated</td>
<td>Truck Count</td>
<td>Truck Count</td>
<td>Calculated</td>
<td></td>
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<tr>
<td><strong>Totals</strong></td>
<td><strong>2007</strong></td>
<td><strong>2,648,842</strong></td>
<td><strong>390,557</strong></td>
<td><strong>4,798,255</strong></td>
<td><strong>39,425</strong></td>
<td><strong>16,285</strong></td>
<td><strong>334,847</strong></td>
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<td><strong>2008</strong></td>
<td><strong>201,658</strong></td>
<td><strong>2,850,140</strong></td>
<td><strong>365,344</strong></td>
<td><strong>5,163,598</strong></td>
<td><strong>25,679</strong></td>
<td><strong>62,395</strong></td>
<td><strong>277,270</strong></td>
</tr>
</tbody>
</table>

Tons calculated at 134.2 pounds per cubic foot for tailings.

Remaining capacity approx 4.4M tons
Tailings Facility Stability Compaction

- High degree of achieving >90% compaction

- Average dry density: 138 pcf

- Average Standard Proctor dry density: 143 pcf

- Average optimum percent moisture: 12.5%

- HGCMC on-site lab 1-point Proctors
  - Average dry density: 147 pcf
  - Average percent moisture: 12.5%
Tailings Facility Stability - Inspections

- Results of operator, engineering, environmental department and regulatory inspections revealed no signs of instability

- 2008 WMP Audit by SRK

- Agency Inspections
  - USFS - 21
  - ADEC - 4
  - DNR – 2
Tailings Facility Monitoring Well and Piezometer Water Level Data

- Maximum saturated thickness 35 feet
- Toe foundations are well drained
- Water perches approximately 12 feet above the unsaturated underdrains
Figure 2.6 Water Level Data for Piezometer 50

- Top of Pile Elevation: 280'
- Transducer Elevation: 165'

Date Range:
- 1/1/1995 to 12/31/2008
PZ-T-00-02 and MW-T-00-05A Data
Figures 2.12 and 2.14
Figure 2.8 Water Level Data for Piezometer 74
### Table 2.4 Monthly Summary of Tailings Area Climate Data

<table>
<thead>
<tr>
<th>Month</th>
<th>Avg Temp ( °C )</th>
<th>Precipitation (in)</th>
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<tbody>
<tr>
<td>January</td>
<td>-2.6</td>
<td>4.7</td>
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<tr>
<td>February</td>
<td>-2.3</td>
<td>4.9</td>
</tr>
<tr>
<td>March</td>
<td>1.7</td>
<td>3.9</td>
</tr>
<tr>
<td>April</td>
<td>3.3</td>
<td>4.6</td>
</tr>
<tr>
<td>May</td>
<td>7.9</td>
<td>3.2</td>
</tr>
<tr>
<td>June</td>
<td>9.7</td>
<td>2.8</td>
</tr>
<tr>
<td>July</td>
<td>11.6</td>
<td>5.9</td>
</tr>
<tr>
<td>August</td>
<td>12.0</td>
<td>3.8</td>
</tr>
<tr>
<td>September</td>
<td>9.8</td>
<td>8.2</td>
</tr>
<tr>
<td>October</td>
<td>5.1</td>
<td>9.9</td>
</tr>
<tr>
<td>November</td>
<td>2.5</td>
<td>5.0</td>
</tr>
<tr>
<td>December</td>
<td>-3.3</td>
<td>3.6</td>
</tr>
<tr>
<td>2008</td>
<td>4.6</td>
<td>60.5</td>
</tr>
</tbody>
</table>
• Internal site waters captured, treated and discharged per NPDES permit

• pH between 6.0 and 8.5: Alkalinity 250 to 600 mg/L

• Conductivity in wet wells and tailings completion wells ranged from 1400 to 3700 umho/cm

• Conductivity in suction lysimeters ranged from 1400 to 6600 umho/cm

• Sulfate and hardness correlate with conductivity
Tailings Facility Internal Monitoring Sites: Water Quality Data

- Fluctuations in saturated zone thickness and associated redox conditions influence arsenic and iron concentrations.
- Zinc is considerably more mobile than other metals.
- Microbial sulfate reduction and base metal sulfide precipitation produces low metal concentrations in most saturated zone wells.
- Shallow unsaturated zone and WW3 have higher metal concentrations.
- Iron and manganese concentrations are elevated in wet wells, groundwater, and most of the suction lysimeters due to oxidation/reduction and buffering reactions.
Tailings Area Internal Sites Conductivity - Figure 2.22a

- Wet Well 2
- Wet Well 3

µS/cm vs. Year

Jan-98 to Jan-10
Tailings Area Internal Sites
Zinc - Figure 2.26b

µg/l

1/1/01 1/1/02 1/1/03 1/1/04 1/1/05 1/1/06 1/1/07 1/1/08 1/1/09 1/1/10

PZ-T-00-01
PZ-T-00-02
PZ-T-00-03
MW-T-02-05
MW-T-02-06
SUCTION LYSIMETERS

SL-02-04
SL-02-05
SL-02-06
SL-02-07

SUCTION LYSIMETER
Tailings Area Internal Sites
pH - Figure 2.20c

The diagram shows the pH levels at different sites over time. The x-axis represents dates from January 1, 2002 to January 1, 2010, while the y-axis represents pH levels from 6.5 to 10.0. The sites are indicated by different markers and line styles:
- SL-T-02-04
- SL-T-02-05
- SL-T-02-06
- SL-T-02-07

The pH levels at each site vary over the years, with some sites showing an increase and others a decrease.
Tailings Area Internal Sites Conductivity - Figure 2.22c
Tailings Facility Additional Monitoring

- Perimeter wells exhibit chemistry comparable to background waters

- Pyritic rock used locally for access roads produced acidic drainage in two areas (The pyritic rock was removed from both locations)

  - Water quality shows improvement in response to remediation efforts

- Residual sulfate and metal concentrations are very low relative to contact waters but higher than background levels in localized areas

- Continued monitoring will determine the effects of other efforts to minimize loading (e.g. lined bedrock areas, improved truck wash, covering exposed slopes with rock and ditch sediments)
Tails Snow Dust Sampling

- Mitigation
  - Snow Fences
  - Eco Blocks
  - Snow removal only in active placement area

- Lead levels in water do not directly correlate to lead loading values

- Observable up to approximately 1700 feet away

- Significant decrease in lead load over the past three years
Figure 2.35 Snow Survey Analysis

- 1015 MW-T-00-04A
- 1014 MW-T-02-07
- 1013 Main Embkmnt Toe
- 1012 Lease Line South
- 1009 Wet Well 1 75' S
- 1007 MW 3S, Site 29
- 1010 MW 1S, Site 25
- 1011 MW 2S, Site 27
- 1008 MW 5, Site 32
Figure 2.35 Snow Survey Analysis

Distance from Pile Center (feet)

- 1049 MW-T-01-03B
- 1014 MW-T-02-07
- 1044 MW-T-00-03B
- 1007 MW 3S, Site 29
- 1009 Wet Well 175' S
- 1045 MW-T-00-02B
- 1015 MW-T-00-04A
- 1013 Main Embkmnt Toe
- 1008 MW 5, Site 32
- 1010 MW 1S, Site 25
- 1047 MW-T-95-5B
- 1046 MW-T-00-01B
- 1048 MW-T-05-04
- 1012 Lease Line South
- 1011 MW 2S, Site 27
Sulfate Reduction Monitoring Program (SRMP) Update

- Tailings Expansion EIS ROD required a study to determine if long term sulfate reduction is achievable and will meet closure needs; evaluate existing and additional carbon sources and application methods

- SRMP objectives and action plan developed and implemented: Project team includes GCMC, University of Waterloo, Environmental Design Engineering, Whitlock and Associates

- Seven field test plots (5 carbon amendments; 2 controls) constructed, instrumented (suction lysimeters, tensiometers, moisture access probes) and sampled
# Sulfate Reduction Monitoring Program

## Field Test Cell Amendment Mixtures

<table>
<thead>
<tr>
<th>Cell</th>
<th>Tailings (vol %)</th>
<th>Peat (vol %)</th>
<th>Brewery Grain (vol %)</th>
<th>Bio-Solids (vol %)</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell 1</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Unexcavated</td>
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<tr>
<td>Cell 2</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Excavated</td>
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<tr>
<td>Cell 3</td>
<td>95</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>Amended</td>
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<tr>
<td>Cell 4</td>
<td>95</td>
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<td>2.5</td>
<td>0</td>
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<tr>
<td>Cell 5</td>
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<td>Cell 7</td>
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</table>
Sulfate Reduction Monitoring Program
Sulfate Reduction Monitoring Program (SRMP) Update

- Performance as of spring 2009
  - Microbially mediated sulfate reduction in cells 4-7
    - Lower sulfate: higher alkalinity, depletion of $^{13}$C in dissolved inorganic carbon, and enrichment of $^{34}$S in pore water sulfate
  - No evidence of significant sulfate reduction in control cells or peat-amended cell
  - Precipitation of metal sulfides contributes to a decrease in sulfate and metal concentrations
  - Increase in iron reducers, elevated dissolved Fe and As
  - Sulfate reduction and calcite/metal-sulfide precipitation control compositions in Cells 4-7
  - Sulfide oxidation, carbonate dissolution and sulfate precipitation control compositions in Cells 1-3
  - Organic carbon from biosolids is rapidly consumed. Cells containing spent brewing grain show best performance
  - Laboratory batch and column test results support field results
Sulfate Reduction Monitoring Program (SRMP) Update

- Future work planned
  - Ongoing performance sampling
  - Final report from University of Waterloo
  - Geotechnical evaluation
  - Logistical considerations
  - Program completion and final report
Tailings Facility Acid Base Accounting Analyses

• Tailings have the potential to generate acidic drainage if the buffering capacity of the tailings is consumed

• High carbonate content supports a long lag time for depletion of buffering capacity

• Long lag time (decades) allows time for construction and closure of the facility, including construction of an oxygen-inhibiting composite soil cover
Figure 2.32 Monthly Tailings Acid Base Accounting Data

Acid Potential
Neutralization Potential
Net Neutralization Potential
Tailings Facility General Site Management

- Operations per GPO Appendix 3 and Waste Disposal Permit
- Most placement occurred in northwest expansion area
- Tailings facility activities in 2008
  - Completion of Pit 5 area
  - Relocation of Pond 6 sediments
  - Installation of Wet Well A
  - Placement of B Road pipeline excavation material
2009 Planned Tailings Activities

- Instrumentation at Pond 6 and Pit 5 area
- Construction of degrit basin
- Continued work at Pond 6
- Begin test pits on East Ridge
- Commence Site E removal and co-disposal
Co-Disposal Testing
Tailings Facility General Site Management

- Tailings and production rock co-disposal geotechnical and geochemical studies complete
  - A 3:2 (production rock:tailings) ratio is recommended
- Site E Drainage will improve following relocation
- Lower acid generation potential (higher NNP) than tailings alone, improved stability, decreased permeability
- Decreased oxidation and improved pore water compositions
- Lower metal content than tailings
Non-detection results are shown at the detection limit in a lighter shade.