2007 Annual Reports

Tailings

July 8, 2008
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
### Table 2.1 Tailings Placement Data

<table>
<thead>
<tr>
<th></th>
<th>All Materials Annual</th>
<th>All Materials Cumulative</th>
<th>All Materials Annual</th>
<th>All Materials Cumulative</th>
<th>Prod Rock from Site 23</th>
<th>Other Materials</th>
<th>Tailings</th>
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<tbody>
<tr>
<td></td>
<td>yd³</td>
<td>yd³</td>
<td>Tons</td>
<td>Tons</td>
<td>Tons</td>
<td>Tons</td>
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<tr>
<td><strong>Survey</strong></td>
<td><strong>Survey</strong></td>
<td><strong>Calculated</strong></td>
<td><strong>Calculated</strong></td>
<td><strong>Truck Count</strong></td>
<td><strong>Truck Count</strong></td>
<td><strong>Calculated</strong></td>
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<tr>
<td><strong>Totals</strong></td>
<td></td>
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<td><strong>2006</strong></td>
<td>203,357</td>
<td>2,432,907</td>
<td>368,422</td>
<td>4,407,697</td>
<td>28,358</td>
<td>12,175</td>
<td>327,889</td>
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</table>

Tons calculated at 134.2 pounds per cubic foot for tailings.

Remaining capacity 4,335,890 tons
Tailings Facility Stability Compaction

- High degree of achieving greater than 90% compaction

- Average dry density: 138 pcf

- Average Standard Proctor dry density: 140 pcf

- Average optimum percent moisture: 12.5%

- HGCNMC on-site lab 1-point proctors
  - Average dry density: 146 pcf
  - Average percent moisture: 12.5%
Results of operator, engineering, environmental department and regulatory inspections revealed no signs of instability.

No issues of non-compliance were noted in 32 USFS and 1 ADEC/ADNR regulatory inspections.
• 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

Transducer Elevation 164.9'
Figure 2.14 Water Level Data for Well MW-T-00-05A

NOTE: Water level reading taken with a sonic indicator caused these erratic data points in 2002 and 2003.

Bottom of well screen elevation 135.17
Figure 2.12 Water Level Data for Piezometer PZ-T-00-02

[Graph showing water level data with dates and water elevation values.]

Bottom of well screen elevation 145.7
Figure 2.8 Water Level Data for Piezometer 74

Transducer Elevation 141.1'
<table>
<thead>
<tr>
<th>Month</th>
<th>Avg. Temp (°C)</th>
<th>Precipitation (inches)</th>
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<tr>
<td>January</td>
<td>-2.04</td>
<td>6.15</td>
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<tr>
<td>February</td>
<td>-4.32</td>
<td>2.74</td>
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<tr>
<td>March</td>
<td>-3.23</td>
<td>11.73</td>
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<td>April</td>
<td>2.19</td>
<td>8.24</td>
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<tr>
<td>May</td>
<td>6.01</td>
<td>3.33</td>
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<tr>
<td>June</td>
<td>10.43</td>
<td>2.64</td>
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<td>July</td>
<td>12.26</td>
<td>6.58</td>
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<td>August</td>
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<td>September</td>
<td>8.69</td>
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<td>2007</td>
<td>3.61</td>
<td>72.85</td>
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Tailings Facility Internal Monitoring
Sites: Water Quality Data

• 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 1446 to 3710 umho/cm

• Conductivity in suction lysimeters ranged from 1398 to 6610 umho/cm

• Sulfate and hardness correlate with conductivity
SUCTION LYSIMETERS
Figure 2.20a Tailings Area Internal Sites - pH

- pH values range from 6.00 to 7.40.
- Data points are plotted for Wet Well 2 and Wet Well 3 over a period from 1/5/98 to 1/5/08.
Figure 2.21a Tailings Area Internal Sites - Alkalinity

Alkalinity (mg/L CaCO3)

Wet Well 2
Wet Well 3

Date:
1/1/99 1/1/00 12/31/00 12/31/01 1/1/03 1/1/04 12/31/04 12/31/05 1/1/07 1/1/08
Figure 2.22b Tailings Area Internal Sites - Conductivity

The graph shows the conductivity levels at various sites from 1/1/02 to 1/1/08. The sites include PZ-T-00-01, PZ-T-00-02, PZ-T-00-03, MW-T-02-05, and MW-T-02-06. The conductivity values range from 0 to 7000 uS/cm.
Figure 2.22c Tailings Area Internal Sites - Conductivity

- SL-T-02-04
- SL-T-02-05
- SL-T-02-06
- SL-T-02-07
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.
Figure 2.26a Tailings Area Internal Sites - Zinc

- Wet Well 2
- Wet Well 3

(12/29/99, 13000)
Figure 2.26b Tailings Area Internal Sites - Zinc
Figure 2.26c Tailings Area Internal Sites - Zinc
• 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
Figure 2.35 Snow Survey Analysis

Lead Loading vs Distance from Pile Center

- **2007 South**
- **2007 West**
- **2008 South**
- **2008 West**
• Tailings Expansion EIS ROD required 30 month 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 and instrumented (suction lysimeters, tensiometers, moisture access probes)
## Field Test Cell Amendment Mixtures

<table>
<thead>
<tr>
<th>Cell</th>
<th>Tailings (vol %)</th>
<th>Peat (vol %)</th>
<th>Brewery Waste (vol %)</th>
<th>Sewage Sludge (vol %)</th>
<th>Condition</th>
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<td>0</td>
<td>0</td>
<td>Unexcavated</td>
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<tr>
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<td>95</td>
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<td>90</td>
<td>5</td>
<td>2.5</td>
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Sulfate Reduction Monitoring Program

- Lysimeter
- Moisture Probe Access
- Tensiometer
- Pore Gas Tube
- RPP Liner
- Organic Carbon Amended Tailings
- Unamended Tailings
• Initial Conditions (November 2004)

- Pore water chemistry

  - Near neutral pH (average 8.17)
  - Elevated dissolved SO₄ (211-2980 mg/L)
  - Thiosulfate (381-3510 mg/L)
  - Trace metals (Al, Ag, Cd, Cu, Mn, Mo, Ni, Pb, Se, Sb, Tl, V, Zn)

- Microbial enumeration of core samples

  - Presence of sulfate and iron reducing bacteria
  - Presence of sulfur oxidizing bacteria
• Suction Lysimeter Sampling Results (October 2005)

  - Conditions favorable to sulfate reduction have developed in some carbon amended test cells

  ➢ Populations of sulfate reducing bacteria have increased significantly – oxygen deficient conditions

  ➢ Increases in dissolved Mn, Fe and ammonia suggest reduction reactions are occurring

  ➢ Concentrations of dissolved Ag, Cd, Cu, Sb, Se, Pb and Tl generally decreased from November 2004 – 2005

  ➢ Concentrations of As, Ni and Zn increased

  ➢ Pore-water concentrations of SO$_4^-$ and thiosulfate decreased in some cells; however, additional investigation is required to determine controlling mechanisms
Sulfate Reduction Monitoring Program (SRMP) Update

• Performance report distributed Oct. 2007
  - Microbially mediated sulfate reduction in cells 4-7
    ➢ Lower sulfate: higher alkalinity, depletion of 13C in dissolved inorganic carbon, and enrichments of 34S in pore water sulfate
  - No evidence of reduction in control cells or peat-amended cell
  - Precipitation of metal sulfides also contributing
  - Increase in iron reducers
  - Pile characterization
  - Hydrology of pore water transport

• Future work planned
  - Laboratory test program and potential geotechnical study in 2008
  - Scheduled completion extended to 2008
  - Additional performance sampling beyond 2008
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

Neutralization Potential and Acid Potential (tons CaCO3/kt)

Net Neutralization Potential (tons CaCO3/kt)
Figure 2.33 Tailings Facility
AP vs NP (tCaCO3/kt)

NEUTRALIZATION POTENTIAL (tCaCO3/kt)

ACID POTENTIAL (tCaCO3/kt)

NNP = 0

Tailings 2005
Tailings and waste rock 2005
Tailings and road rock 2005
Tailings 2004
Tailings Facility General Site Management

• Operations per GPO Appendix 3 and Waste Disposal Permit

• Main placement areas were East and Southeast areas
  – Began placing in Northwest expansion area

• Tailings facility expansion project accomplishments in 2007
  – Pond 9 constructed and commissioned
  – Northwest tailings area excavation continued
  – 127,000 cy of material relocated to SE II and top of Tailings pile from northwest corner
Tailings Facility General Site Management

- Tailings and production rock co-disposal geotechnical studies complete

- Tailings and production rock co-disposal geochemical studies
  - Field weathering columns constructed
  - Sampling of columns in 2007