Presentation Outline

- Placement data
- Stability
  - Compaction
  - Inspections
- Water level data
- Precipitation data
- Water quality at internal monitoring sites
- Snow sample results
- Sulfate Reduction Monitoring Program (SRMP) update
- Acid Base Accounting (ABA) data
- General site management
### Table 2.1 Tailings Placement Data

<table>
<thead>
<tr>
<th></th>
<th>All Materials</th>
<th>All Materials Cumulative</th>
<th>All Materials</th>
<th>All Materials Cumulative</th>
<th>Rock from Site 23</th>
<th>All Other Materials</th>
<th>Tailings</th>
</tr>
</thead>
<tbody>
<tr>
<td>yd³</td>
<td>yd³</td>
<td>tons</td>
<td>tons</td>
<td>tons</td>
<td>truck count</td>
<td>truck count</td>
<td>calculated</td>
</tr>
<tr>
<td>survey</td>
<td>survey</td>
<td>calculated</td>
<td>calculated</td>
<td>truck count</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>2009</td>
<td>227,817</td>
<td>3,078,657</td>
<td>412,736</td>
<td>5,577,603</td>
<td>16,117</td>
<td>90,584</td>
<td>306,035</td>
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<td>2010</td>
<td>222,363</td>
<td>3,301,020</td>
<td>402,855</td>
<td>5,980,458</td>
<td>30,796</td>
<td>105,076</td>
<td>266,983</td>
</tr>
</tbody>
</table>

Tons calculated at 134.2 pounds per cubic foot for tailings
Remaining capacity: 3.6 million tons
Tailings Facility Stability Compaction

- High degree of achieving >90% compaction
- Average dry density: 141 pcf
- Average Standard Proctor dry density: 146 pcf
- Average optimum percent moisture: 11.8%
- HGCMC on-site lab 1-point Proctors
  - Average dry density: 144 pcf
  - Average percent moisture: 11.8%
Tailings Facility Stability - Inspections

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

- Agency Inspections in 2010
  - USFS - 16
  - ADEC - 6
Tailings Facility Water Controls
(2003 EIS)
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 under drains
Figure 2.6 Water Level Data for Piezometer 50
PZ-T-00-02 and MW-T-00-05A Data
Figures 2.12 and 2.14

Top of Pile 210'

PZ-T-00-02

Bottom of well screen 145.7'

MW-T-00-05A

Bottom of well screen 135.2'
Figure 2.8 Water Level Data for Piezometer 74

Pile Surface 168'

Transducer Elevation 141.1' (base of pile)
### 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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</thead>
<tbody>
<tr>
<td>January</td>
<td>0.58</td>
<td>2.6</td>
</tr>
<tr>
<td>February</td>
<td>2.60</td>
<td>0.97</td>
</tr>
<tr>
<td>March</td>
<td>2.59</td>
<td>3.7</td>
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<tr>
<td>April</td>
<td>4.90</td>
<td>2.01</td>
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<tr>
<td>May</td>
<td>8.99</td>
<td>1.08</td>
</tr>
<tr>
<td>June</td>
<td>10.92</td>
<td>3.49</td>
</tr>
<tr>
<td>July</td>
<td>12.03</td>
<td>2.56</td>
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<td>August</td>
<td>13.04</td>
<td>3.26</td>
</tr>
<tr>
<td>September</td>
<td>10.54</td>
<td>5.34</td>
</tr>
<tr>
<td>October</td>
<td>6.46</td>
<td>6.34</td>
</tr>
<tr>
<td>November</td>
<td>2.27</td>
<td>4.94</td>
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<td>December</td>
<td>-2.18</td>
<td>0.06</td>
</tr>
<tr>
<td>2010</td>
<td>6.06</td>
<td>36.35</td>
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</table>
Tailings Facility Internal Monitoring Sites: Water Quality Data

- Internal site waters captured, treated, and discharged per NPDES/APDES permit
- pH between 6.0 and 8.5
- Alkalinity between 150 and 500 mg/L
- Conductivity in wet wells and tailings completion wells between 2000 and 4100 uS/cm
- Conductivity in suction lysimeters between 1400 and 5000 uS/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 Wet Well 3 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.
WET WELLS

Wet Well #2

Wet Well #3
Tailings Area Internal Sites
pH - Figure 2.20a
Tailings Area Internal Sites Conductivity - Figure 2.22a
Tailings Area  Internal Sites  
Zinc - Figure 2.26a
TAILINGS COMPLETION WELLS

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

TAILINGS COMPLETION WELLS
Tailings Area Internal Sites pH - Figure 2.20b
Tailings Area Internal Sites
Alkalinity - Figure 2.21b
Tailings Area Internal Sites Conductivity - Figure 2.22b
SUCTION LYSIMETERS

SL-02-04

SL-02-06

SL-02-05

SL-02-07
Tailings Area Internal Sites pH - Figure 2.20c
Tailings Area Internal Sites
Alkalinity - Figure 2.21c
Tailings Facility Additional Monitoring

- Most 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

Tailings Facility Additional Monitoring

- A complex history of disturbance poses challenges to identifying potential leakage from the facility

- Zinc in the drainage is an order of magnitude or more lower than contact water, suggesting that effects from seepage, if any, from the tailings pile are minimal

- Zinc at site 610 increased with construction and tailings placement activity

- Zinc at site 611 increased from 2004 to 2009 but decreased in 2010. The absence of manganese suggests the source of the increase is not tailings leachate

- Further Creek drainage is expected to improve. Some element concentrations may temporarily increase as the drainage returns to its naturally acidic, dilute condition
Tailings Facility Additional Monitoring

- Quarrying and construction of Pond 7 influenced Althea Creek chemistry and collection of foundation drainage caused a return toward pre-construction conditions.

- Comparison of zinc concentrations above and below the liner suggests that the liner is intact and functioning as designed. The lack of an increase in metals from Pond 7 suggests that the small increase in zinc and lead in 2010 at Site 60 is not from Pond 7.

- Background conditions typical of muskeg drainages preclude compliance with AWQS for pH, alkalinity, aluminum, and iron at sites 60 and 609.

- Pb, Zn, Cd, Hg, Mn are expected to exceed background levels and may not meet AWQS as pH and hardness decrease to background levels. The magnitude of the exceedance is expected to be small and temporary.
Figure 2.40 Site 609 Zinc

Graph showing the concentration of Zinc in Site 609 FCLR and AWQS from 2000 to 2011.
Figure 2.41 Site 609 Lead

Graph showing the levels of lead (Pb in μg/l) from 1/1/2000 to 1/3/2011. The graph compares two data sets: AWQS and Site 609 FCLR.
Figure 2.42 Site 60 Zinc
Figure 2.43 Site 60 Lead
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 relative to 2006. Variability due to location of active placement areas
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

Snow Survey Analysis - Lead Loading vs Distance from Pile Center

- Lead Loading (mg/m²)
- Distance from Pile Center (feet)
- Data points for different years and directions (e.g., 2007 South, 2007 West, 2008 South, 2008 West, 2009 South, 2009 West, 2011 South, 2011 West)
Figure 2.35 Snow Survey Analysis
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.

- Seven field test plots (5 carbon amendments; 2 controls) were constructed, instrumented (suction lysimeters, tensiometers, moisture access probes), and sampled.

- Laboratory batch and column test were performed to support field tests and constrain reaction rates.

- Analyses of enzymes related to cellulose degradation were performed in support of field and laboratory testing.
## Sulfate Reduction Monitoring Program (SRMP) Update

### 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>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell 1</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Unexcavated</td>
</tr>
<tr>
<td>Cell 2</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Excavated</td>
</tr>
<tr>
<td>Cell 3</td>
<td>95</td>
<td>5</td>
<td>0</td>
<td>0</td>
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<tr>
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<tr>
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<tr>
<td>Cell 7</td>
<td>90</td>
<td>5</td>
<td>2.5</td>
<td>2.5</td>
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</tbody>
</table>
Sulfate Reduction Monitoring Program (SRMP) Update

- Key findings 2004-2010
  - Microbially mediated sulfate reduction in cells 4-7
  - No significant sulfate reduction in control cells or peat-amended cell
  - Precipitation of metal sulfides contributes to a decrease in sulfate and metal concentrations. Thiosulfate reduction/disproportionation is also significant.
  - Increase in iron reducers, elevated dissolved Fe and As
  - Organic carbon from biosolids is rapidly consumed
  - Cells containing spent brewing grain show best performance
  - Laboratory batch and column test results support field results
  - Carbon amendment to oxidized tailings is not recommended
  - High concentrations of DOC should be avoided to minimize iron reduction and arsenic mobility
  - Laboratory analysis of enzymes related to cellulose degradation supports water chemistry and microbiology results
Future work planned
- Ongoing performance sampling
- Geotechnical evaluation
- Logistical considerations
Tailings Facility Acid Base Accounting (ABA) 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 (ABA) Data

Tails Monthly Composite ABA (tons CaCO₃/kton)

Acid Potential or Neutralization Potential

Net Neutralization Potential

Jan-01  Jan-02  Jan-03  Jan-04  Jan-05  Jan-06  Jan-07  Jan-08  Jan-09  Jan-10  Jan-11

NP  AP  NNIP
Tailings Facility General Site Management

- Operations per GPO Appendix 3 and Waste Management Permit
- Most placement occurred in northwest expansion area
- Tailings facility activities in 2010
  - Cleaned sediment from the lined degrit basins that were installed in 2009
  - Continued co-disposal of Site E rock and tailings
  - Replaced the geomembrane at the inlet to Pond 7 with concrete to create a permanent inlet channel
  - Expanded the sandpit in support of the planned East Ridge tailings expansion
  - Performed geotechnical investigation in the East Ridge area
Tailings Facility General Site Management

2011 Planned Tailings and Closure Planning Activities

- Geotechnical and environmental drilling program
- Continue Site E removal and co-disposal
- SRMP field program continues

- Stage III tailings preparation
- Cover monitoring continues
- Underground hydrology study continues