Britannia Mine Water Treatment Plant: Environmental Compliance and Risk Transfer in a Collaborative Partnership

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EPCOR BC/Pacific Northwest
Britannia Mine Remediation Project – 1905 to 2005

- 1905 – mine begins production
- 1920s-1930s – largest producing copper mine in Commonwealth; metal recovery from mine drainage initiated
- 1970 – Pollution Control Act becomes effective at Britannia
- 1973 – mine owners ordered to obtain permit (lime treatment)
- 1974 – mine closes;
- 1981 to 1997 – studies to characterize impact, liability, and develop solutions
- 1997 – [Contaminated Sites Regulation becomes effective](#)
- September 2003 – Acquisition of land for remedial actions.
- January 2004 - RFEOI posted on BC Bid.
- March 2004 - Six EOIs received.
- May 2004 - Three RFPs issued to short-listed Proponents.
- November 2004 - Province announces that EPCOR has been selected to design, build, finance and operate WTP
- October 2005 – EPCOR starts WTP 3 months ahead of schedule
3D Cutaway of Mine with Remedial Actions

- Britannia Creek
- WTP
- June Basin
- Mine Inflow Diversions
- 2200 Plug (UBC 2001)
- 4100 Plug
- Fan Remediation
Post-Mining Conditions

1) AMD from mine portals (300kg Cu/d, 300kg Zn/d)

2) contaminated waste rock, groundwater & stormwater (30 kg Cu/d, 40kg Zn/d)

3) contaminated sediments
Province’s Conceptual Remediation Plan

1. Plug 2200 portal (UBC)
2. Prevention: Inflow diversion
3. Water Treatment Plant and new deep outfall
4. Management of contaminated soil and groundwater
5. Management of contaminated groundwater
6. Assessment of contaminated sediments (EC/DFO)

Use of mine void as storage reservoir to optimize water treatment plant size and
Britannia Mine Successorship

parties indemnified by Province: ARCO, BP/Dome, Canzinco, Intalco, Alcoa, Alumax, Howmet, Pechiney

current site owners: BBPL, BBHS, Makin, Tanac, BCR, BC Crown
Project Background

• Mine water treatment plant integral part of Ministry of Agriculture & Lands (MAL) environmental remediation plan for entire Britannia area site

• Left untreated, contaminated mine water would deposit 600 kg/day of heavy metals into Howe Sound (7 million pennies annually)

• New plant will treat up to 500 million litres of contaminated water annually

• Project first of its kind in BC (P3 DBFO)

• MOE issued permit to MAL which formed performance requirements for RFP (quality and schedule)
Risk Analysis and Procurement Method

- Risk Analysis Matrix
  - Procurement Risks
  - Design Risks
  - Construction Risks
  - Financial Risks
  - Operational Risks
- Risk varies with procurement method
- 2003 – Government selects DBFO procurement for WTP based on value for money with strong consideration to risk transfer
- Concern regarding lack of contractor interest in necessary large investment in P3 proposal, leads to procurement undertaken in two steps (RFEOI & RFP)
BMWTP Province Procurement Organization

Steering Committee (Province, PBC)

- Conflict of Interest Adjudicator
- Fairness Auditor
- Technical Evaluation Team
- Technical Advisory Committee

Financial Evaluation Team
Procurement Steps

- RFEOI – Ability of Proponent Team to do the job: experience of team, financial capacity, and demonstrable technology
- RFP – Cost in terms of 20 year NPV cost based on: specified treatment capacity, influent water quality range, required discharge quality, and preferred discharge quality.
From Key Objectives to Evaluation Criteria

**Key Objectives**

- Provide suitable treatment for mine water and suitable disposal of sludge
- Conform to all regulatory requirements
- Design, build & operate to provide best value to Province
- Provide flexible process to allow future upgrading

**RFEOI Evaluation Criteria**

- Use of Demonstrated Technology (P/F)
- Financial Capacity (P/F)
- Proponent Organization
- Technical Expertise
- Project Understanding

**RFP Evaluation Criteria**

- Risk Adjusted NPV 20 Year Cost (60 pts)
- Financial Sensitivity
- Ability to Comply with Permit Discharge Criteria
- Financial Guarantees
- Process Flexibility
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Assignment of Risk

<table>
<thead>
<tr>
<th>Risk Description</th>
<th>EPCOR</th>
<th>Province</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations, maintenance and repair costs</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Construction costs/inflation and schedules</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Water treatment plant discharge compliance</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Water treatment plant efficiency</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Project financing</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Catastrophic events</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Internal mine working collapse</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Volume of water treated</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Liability of disposed sludge</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Operating cost inflation</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Influent water chemistry within 10/90 percentile</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Influent water chemistry beyond 10/90 percentile</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Plant site geotechnical risk</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Marine outfall geotechnical risk</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
The Monthly Periodic Payment Equation

(Base Payment + Variable Payment)

**Province Risk**
- consumer price index
- labour inflation index
- chemical unit costs
- utility unit costs
- sludge disposal unit costs
- volume of water treated

Capital Repayment + Replacement + Labour + Chemicals + Utilities + Sludge Disposal

**EPCOR Risk**
- R/R overruns
- operating labour overruns
- chemical use efficiency
- sludge generation efficiency
- energy use/generation efficiency

- WTP startup date
- construction cost overruns
Operational Performance Requirements Non-Compliance Penalties and Quality Bonuses

Operational Performance Requirements are:
- stated in the Contract
- specify indicators
- specify Contractor rectification
- specify consequences (9 major, 5 minor, and 1 bonus)
- include compliance with discharge quality criteria, maximizing treatment of water, monitoring, and reporting

Major Event Consequence – is a deduction in Monthly Payment of 1/30th of Monthly Payment for each day that a Major Event occurred.

Minor Event Consequence – is a deduction in Monthly Payment of 1/3000th of Monthly Payment for each day that a Minor Event occurred.

Quality Event Bonus – is a bonus awarded at end of each year if the annual average preferred discharge levels are achieved. Bonus equals 1/250th of average monthly payment for the year.
## The Primary Operational Performance Requirement – OPR2

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Discharge Criteria/Permit</th>
<th>Provincial Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>dissolved copper</td>
<td>≤ 0.1 mg/L</td>
<td>≤ 0.02 mg/L</td>
</tr>
<tr>
<td>dissolved iron</td>
<td>≤ 0.1 mg/L</td>
<td>≤ 0.01 mg/L</td>
</tr>
<tr>
<td>dissolved zinc</td>
<td>≤ 0.2 mg/L</td>
<td>≤ 0.03 mg/L</td>
</tr>
<tr>
<td>dissolved aluminum</td>
<td>≤ 1 mg/L</td>
<td>≤ 0.5 mg/L</td>
</tr>
<tr>
<td>dissolved manganese</td>
<td>≤ 0.4 mg/L</td>
<td>≤ 0.2 mg/L</td>
</tr>
<tr>
<td>dissolved cadmium</td>
<td>≤ 0.01 mg/L</td>
<td>≤ 0.001 mg/L</td>
</tr>
<tr>
<td>total suspended solids (TSS)</td>
<td>≤ 30 mg/L</td>
<td>≤ 10 mg/L</td>
</tr>
<tr>
<td>pH range</td>
<td>6.5 to 9.5</td>
<td>6.5 to 9.5</td>
</tr>
<tr>
<td>96HRLC50 fish bioassay</td>
<td>≥100% survival (non-acutely toxic)</td>
<td>≥100%</td>
</tr>
</tbody>
</table>
Objectives of the Britannia Mine WTP

- Provide suitable treatment for mine water, and environmentally-acceptable disposal of sludge or treatment of by-products
- Conform to all applicable requirements of authorities having jurisdiction with respect to design, construction, operations, maintenance and oversight
- Minimize Provincial liability (risk transfer)
- Design, built, financed and operated in a manner that provides the best overall value to the Province
- Sufficiently flexible to be able to allow upgrading in response to changes in environmental regulation.
Project Sensitivities

- High profile project
- Treatment plant integral part of the overall mine rehabilitation
- Large and diverse group of stakeholders with different visions and value sets
- Alternate Project delivery method could be sensitive
- Project constructed in and around a residential neighborhood
Terms of Agreement

- EPCOR to build plant within 1 year and operate for 20 years
- EPCOR will finance, design, construct, operate and maintain treatment plant
- MAL to provide performance-based payments to EPCOR
- Performance payments begin once plant in operation
- Must meet 12 Operational Performance Requirements (OPR’s)
- EPCOR to assume risk for plant construction & operation
Performance – Schedule

- Award Contract – Dec 2004
- Design Dec 2004 – Mar 2005
- Site Grading – Feb 2005
- Foundation – Mar 2005
- Outfall – May/June 2005
- **Groundwater Pumpstation Complete** – May 31, 2005
- Building Erection – Jun 2005
- Controls/Lime System Installation – Aug 2005
- Clarifier Mechanism Installation – Sep 2005
- Start up – October 21, 2005
Performance – Value for Money

<table>
<thead>
<tr>
<th></th>
<th>Capital Cost</th>
<th>Operating Cost</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPCOR</td>
<td>$15.5 million</td>
<td>$11.6 million</td>
<td>$27.2 million</td>
</tr>
<tr>
<td>Traditional Delivery</td>
<td>$18.2 million</td>
<td>$21.5 million</td>
<td>$39.7 million</td>
</tr>
</tbody>
</table>

Partnerships BC – Britannia Mine Water Treatment Plant Value for Money Report
Performance – Environmental

- Algae growing in sensitive inter-tidal zone
- Micro-turbine producing 40% of plant power needs
- Water re-use for process systems (<1 m$^3$ per day of fresh water for domestic use)
- Completed pilot project for metal recovery and sludge re-use
- Discovery Centre Completed (environmental education)
ACID ROCK DRAINAGE

The Jar Test

A jar test is a test to determine if a soil is alkaline or acidic. If the soil is acidic, it will turn blue or green in color. If the soil is alkaline, it will turn red or orange in color.

The Acid Test

A jar test is a test to determine if a soil is alkaline or acidic. If the soil is acidic, it will turn blue or green in color. If the soil is alkaline, it will turn red or orange in color.

What is an acid?

An acid is a substance that has a low pH level. It is a substance that can react with metals or other substances to form a new substance.

The jar test is a simple test to determine if a soil is acidic or alkaline. If the soil is acidic, it will turn blue or green in color. If the soil is alkaline, it will turn red or orange in color.

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Performance – Water Quality

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<thead>
<tr>
<th>Parameter</th>
<th>Permit</th>
<th>Guideline</th>
<th>Value</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>≤ 0.1</td>
<td>≤ 0.02</td>
<td>0.007</td>
<td>Meets Permit and Guideline</td>
</tr>
<tr>
<td>Iron</td>
<td>≤ 0.1</td>
<td>≤ 0.01</td>
<td>≤0.005</td>
<td>Meets Permit and Guideline</td>
</tr>
<tr>
<td>Zinc</td>
<td>≤ 0.2</td>
<td>≤ 0.03</td>
<td>0.023</td>
<td>Meets Permit and Guideline</td>
</tr>
<tr>
<td>Aluminum</td>
<td>≤ 1.0</td>
<td>≤ 0.5</td>
<td>0.44</td>
<td>Meets Permit and Guideline</td>
</tr>
<tr>
<td>Manganese</td>
<td>≤ 0.4</td>
<td>≤ 0.2</td>
<td>0.14</td>
<td>Meets Permit and Guideline</td>
</tr>
<tr>
<td>Cadmium</td>
<td>≤ 0.01</td>
<td>≤ 0.001</td>
<td>≤ 0.002</td>
<td>Meets Permit and Guideline</td>
</tr>
<tr>
<td>pH</td>
<td>6.5-9.5</td>
<td>≤ 6.5-9.5</td>
<td>8.0</td>
<td>Meets Permit and Guideline</td>
</tr>
<tr>
<td>TSS</td>
<td>≤ 30</td>
<td>≤ 10</td>
<td>6</td>
<td>Meets Permit and Guideline</td>
</tr>
<tr>
<td>96hrLC50</td>
<td>≥100%</td>
<td>≥ 100%</td>
<td>≥ 100%</td>
<td>Meets Permit and Guideline</td>
</tr>
</tbody>
</table>
Performance – Successful Risk Transfer

- **OPR’s and Payment Mechanism**
  - Non-compliance events (mostly manganese, several TSS) have totalled seventeen resulting in a deduction total of $132,606. There has been no non-compliance events since December 2006.

- **Schedule and Construction Risk**
  - Construction inflation during period 1-2% per month

- **Environmental Compliance**

- **Sludge Storage Facility and Management**
  - Added sludge storage cover

- **Site Security**
  - Additional security measures added
Performance – Why It Worked

- Well Defined Scope of Work
- Linked Payment Mechanism and Key Performance Indicators
- Solid, Experienced Teams
- Shared Values – Everyone “Owned” and was Committed to the Project
Next Steps

• Ongoing testing and optimization of the plant to maximize throughput and metal reduction
• Review pilot results and determine approach (Objective – nothing leaves the site save treated water and useable products)
• Assess new smaller turbine to increase number of days power can be generated
• Stormwater system installation
• Groundwater system optimization (with Golder)