Britannia Mine Remediation Project

Project Overview

9th Annual ML/ARD Workshop
December 4, 2002
Gerry O’Hara, Project Manager
Golder Associates Ltd
Britannia Mine Remediation Project Overview - Presentation Outline

• Environmental problems at Britannia
• Province’s remedial concept
• Summary of work completed/ongoing
• Project status and schedule
Site Location

Mine extends 10km east

Vancouver 45km
Britannia Mine Background

- Britannia Mine often cited as the largest point source metal pollution source in North America discharging to a marine environment
- Impact to aquatic life in Howe Sound and local waterways (e.g., Britannia Creek, Jane Creek)
- Naturally occurring metal sulphide orebody which has been exposed to air and water during (and subsequent to) seventy years of mining
Mine History

• 1905 – mine began production
• 1920s – largest producing copper mine in the British Commonwealth
• 1974 – Mine owners ordered to collect and treat ARD discharge
• 1974 – Anaconda Canada Ltd. closed mine
• Post 1974:
  • Plug installed in 4100 Level – flow control
  • Dam installed in 2200 Level (later failed)
  • ARD discharge via ‘deep outfall’
  • Plug installed in 2200 Level – divert flow to 4100 Level
Why Now?

- On April 12, 2001 the Province and historical PRPs reach agreement indemnifying the historical PRPs in exchange for $30 million
- The settlement requires the $30 million be maintained in a trust fund
- Fund may only be spent on environmental remediation at the mine
- Funds to be committed within 5 years
Mine Levels defined in feet measured downwards from highest elevation in mine.
Summary of Environmental Problems

• Metals contaminated acidic (pH ~3) mine water from:
  – 2200 Level portal (now diverted to 4100 Level)
  – 4100 Level portal (deep discharge to Howe Sound via 4150 sub-level)
  – Other (minor discharges, e.g. seeps and other portals)

• Other contamination sources:
  – Mine infrastructure (‘Fan Area & ‘Additional Areas’) e.g.
    • Processing/storage areas
    • Waste rock piles, launders, sediment ponds
  – Metals contaminated sediments in Howe Sound
Howe Sound contaminated sediments

4100 portal ARD

Fan Area' - contaminated fill and groundwater

2200 portal ARD

Mill

Metal sulphide ore body

Additional Areas' – contaminated Waste rock and groundwater

Post-Mining Conditions

Britannia Creek

Howe Sound

‘Fan Area’ - contaminated fill and groundwater

contaminated sediments
Estimated Daily Metals Loading

- **South Alluvial Fan (Mill):**
  - Up to 48 kg/day Copper, 77 kg/day Zinc

- **North Alluvial Fan:**
  - Up to 0.5 kg/day Copper, 1 kg/day Zinc

**Mine Workings Total:**
Copper and Zinc average around 300 kg/day each via outfall at 26m depth in Howe Sound

- **From additional areas – minor contribution**
- **Groundwater flow**
- **Mine water flow**
- **4100 Level**
- **Howe Sound**

**Contaminated sediments (tailings)**

**Bedrock**

**Alluvium and Fill**
South ‘Fan Area’, Britannia Beach
Remediation Project Objectives

- “Reduce environmental impact to fisheries….resulting from water and sediments originating from the mine site, by meeting site-specific risk-based provincial and federal requirements,
- Construct a water treatment plant and other works to treat drainages to meet site-specific provincial and federal requirements,
- Reduce contamination-related human health risks on, and emanating from, the mine site by meeting site-specific risk-based provincial requirements, and
- Consider future sustainable development, compatible with land use designations in SLRD’s OCP”
Province’s Remedial Concept

1. Collecting all ARD
2. Treating the ARD
3. Controlling the discharge of contaminated groundwater
4. Prevention: diversion and/or cap
5. Risk assessment/in-situ management is anticipated for contaminated sediments and soils at certain locations

Assessment of contaminated waste rock and groundwater

(1) Collection:
Plug 2200 portal

(2) Treatment: mine drainage and groundwater

(3) Control of contaminated groundwater

Assessment of contaminated Sediments (Environment Canada)

Howe Sound

Mill
Project Components

• Golder Associates hired by Province in August, 2001 as Remediation Project Manager
• Technical contractors hired in fall, 2001:
  – Mining & Hydrogeology (SRK)
  – Water Treatment Plant (CH2MHill, AMEC & CEMI)
  – Contaminated Sites (URS)
  – Flood Risk Assessment (WMC)
Management Structure

Steering Committee
Province (chair),
EC, BCMEM, BCMFin

Legal Counsel
Ministry of Attorney General

Project Manager
Golder Associates

Technical Consultants
SRK, URS, AMEC, WMC

Technical Advisory Committee
BCMWLAP (chair),
EC, BCMEM, BCMA

Ministry of Attorney General
Remediation Process

Project Management (Golder)

Mine Hydrogeology - mine drainage investigations (SRK)

Flood Risk Assessment (WMC)

Contaminated Sites Investigations - remediation plan (URS)

Water Treatment Plant - feasibility study for HDS lime plant (AMEC)

Drainage diversions and equalization

Plant final design, procurement, and construction

Soil and Groundwater Remediation works
Evaluate mine as storage reservoir:
- Safety assessment & rehabilitation program
- Hydrology & hydrogeology studies\(^1\)
- Stability assessment of 4100 Level plug
- Tests to assess storage capacity of Mine
  - Assessment of mine water chemistry\(^2\)
  - Determine elevation v. volume relationship
  - Evaluate mine hydraulics

\(^1\) Patrick Bryan & Graham Parkinson, 8:45
\(^2\) Kelly Sexsmith & Stephen Day, 9:15
Mining and Hydrogeology Study - SRK

- 4100 Level Plug test completed
- Mine reservoir simulation model developed
- Jane Basin diversion study in progress
- Jane Basin stability assessment nearing completion
- Structural geology study completed

Legend:
- Main Flow (l/s)
- Metres Water above Plug
- Piezometer Pressure (m)
- Plug Displacement (mm*10)
- Seepage Flow (cc/s)
- Main Flow (l/s - Right Axis)
- Turbidity (NTU - Right Axis)
- 12 per. Mov. Avg. (Seepage Flow (cc/s))

Date (Valves Closed 08:50 March 26th)
Flood Risk Assessment - WMC

Flood risk study required:

- Long history of flood and debris torrent events associated with Britannia Creek
- Dilapidated dams in watershed
- Some remedial works for Fan Area possibly located in flood plain

Tunnel Dam

Hwy99 Bridge
Flood Risk Assessment - WMC

Determine flood risk and mitigation:

- Site surveys
- Maximum probable flood
- Debris flow analysis
- Sedimentation analysis
- Dam breach analysis
- Flood flow routing
- Modelling

Tunnel Dam
Contaminated Sites Investigation - URS

Assessment of secondary contamination sources by:

− Site Investigations in Fan Area and Additional Areas, including:
  • historical information review
  • risk assessments*
  • boreholes, test pits, surficial sampling
  • groundwater pumping tests & modelling
  • storm water runoff sampling
  • sediment & biota sampling

− Development of remediation plans

*Cindy Ott & Steve Sibbick, 9:45
Contaminated Sites Investigation - URS

- Reports completed:
  - Fan Area PSI & DSI reports
  - Fan Area ecological risk assessment
  - Fan Area human health risk assessment
  - Fan Area remediation planning document

- Additional Areas - PSI and DSI fieldwork complete, investigation, risk assessment and remedial planning reports in preparation
Determine Optimum Treatment Plant Design by:

- Pilot treatment program (CEMI):
  - High Density Sludge (HDS) program (lime addition)
  - Consider upstream metals removal (UMR)

- Plant feasibility study
  - Conceptual plant design
  - Plant siting and access
  - Sludge disposal study(s)
  - Outfall feasibility study
Water Treatment - AMEC

- Treatment plant pilot study report - completed
- Plant location stakeholder workshop held
- Site selection report - completed
- Preliminary sludge disposal option study/report – completed. Second phase study in progress
- Geotechnical investigation – completed
- Plant feasibility study issued (draft)*
- Outfall study in progress

*Doug Lee & Tom Higgs, 10:45
Water Treatment – Plant Sizing

Plant sizing considerations:

– Nominal 1050m³/hr plant selected for feasibility study
  • Desktop hydrological/hydrology studies
  • Previous mine flooding records
  • Results of phase 1 of the 4100 Level Plug test
– SRK daily reservoir simulation model developed from plug test data - basis of assessing ability of plant to accommodate range of flows for previous 25 years
– Extension of the SRK model allows effects of operator decision rules to be simulated
– Will be used as input into permitting process
## Water Treatment

### Plant Flow Modelling

#### Input

<table>
<thead>
<tr>
<th>Type</th>
<th>Capacity</th>
<th>Flow Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Capacity</td>
<td>1050 m³/hr</td>
<td>292 L/s</td>
</tr>
<tr>
<td>Hydraulic Capacity</td>
<td>1400 m³/hr</td>
<td>389 L/s</td>
</tr>
<tr>
<td>Plug Capacity</td>
<td>4000 m³/hr</td>
<td>1111 L/s</td>
</tr>
</tbody>
</table>

#### Level I Criteria: Controlled discharge of untreated water

<table>
<thead>
<tr>
<th>Condition</th>
<th>Flow Rate</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase flow of untreated water by a further 50 L/s</td>
<td>50 L/s</td>
<td>≥150 m</td>
</tr>
<tr>
<td>Increase flow of untreated water by a further 25 L/s</td>
<td>25 L/s</td>
<td>≤1 m/day</td>
</tr>
</tbody>
</table>

#### Level II Criteria: At high values of estimated Snowpack Water Equivalent (SWE)

<table>
<thead>
<tr>
<th>Condition</th>
<th>Flow Rate</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase the WTC flow by a further 50 m³/hr in April</td>
<td>50 m³/hr</td>
<td>≥21 m</td>
</tr>
<tr>
<td>Increase the WTC flow by a further 50 m³/hr in April</td>
<td>50 m³/hr</td>
<td>≥2 m/day</td>
</tr>
<tr>
<td>Decrease the WTC flow by a further 50 m³/hr in April</td>
<td>50 m³/hr</td>
<td>≤-1 m/day</td>
</tr>
</tbody>
</table>

#### Output

Example: 1050 m³/hr design capacity plant

**Percentage of water treated = 97.38266**
Estimated Total Inflows to Mine (including flows that reported to 2200 level)
Other Activities

• Site-Wide Monitoring Program:
  – integrates with scopes of Mining & Hydrogeology and Contaminated Sites investigations:

• Project Scheduling and Cost Control
• Permitting
• Database construction and maintenance
• Websites:
  • britannia.golder.com
  • wlapwww.gov.bc.ca/sry/p2/britannia/index.htm
• Newsletters, Reporting & Public Meetings
Project Schedule: Implementation

- Qtr. 4 02: WTP Feasibility Study Review
- Qtr. 2 03: Design-Build Specifications
- Qtr. 4 03: Tender & Award
- Qtr. 1 04: Detailed Design
- Qtr. 4 02: Procurement
- Qtr. 2 03: Construction
- Sludge Disposal Preparation
- Contaminated Sites Remediation

Ministry of Water, Land and Air Protection
Golder Associates