A REVIEW OF THE MANAGEMENT OF THE BRITANNIA MINE REMEDIATION PROJECT – COUNTING THE PENNIES

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ABSTRACT

The Province of British Columbia began planning and budgeting for the Britannia Mine Remediation Project in 1997, subsequent to the B.C. Contaminated Sites Regulation becoming effective. Remediation planning was conducted in significant consultation with stakeholders, and with the guidance of a technical advisory committee, which has proven a valuable approach. The Contaminated Sites Regulation provided a legal incentive for the former mine owners to reach a settlement with the Province. A settlement was reached between the Province and the former mine owners in April 2001. The settlement only provided a portion of the total estimated remediation cost and therefore required the Province to commit additional dollars to fully fund the plan. The Province subsequently reached an agreement with the new owner of the mine site in 2003 and took ownership of the vast majority of the Britannia Mine lands. The Province also received development levies from the privately held lands and other cash-in-kind considerations.

The original remediation plan and budget was developed with only limited site knowledge; however, the project budget has benefited from some early conservative assumptions, effective project management, and cost-effective WTP procurement and delivery. However, there remain substantial outstanding liabilities that may impact the budget in the future.

SITE LOCATION AND HISTORY

Britannia Mine (the Site) is located at Britannia Beach on the east shore of Howe Sound along the Sea-to-Sky Highway, approximately 50 km north of Vancouver, and 75 km south of Whistler. The primary mining area was at and beneath Jane Basin, located approximately 6 km east of Britannia Beach along Mineral Ridge between Britannia Creek and Furry Creek (see Figure 1). The massive sulphide ore bodies were mined through open pit, underground and glory hole developments. Approximately 80 km of underground workings, over a 1,700-metre vertical distance, including numerous stopes and five open pits, were developed over the life of the mine from 1904 to 1974. Over the 70-year history, approximately 47 million tonnes were mined and milled at the site producing copper, zinc, lead, cadmium, silver and gold. At its peak, prior to World War II, Britannia Mine was the largest copper producer in the British Commonwealth. The mine was closed in 1974 due to exhaustion of economically accessible ore bodies and low copper prices.
ENVIRONMENTAL LEGACY OF THE MINE

Figure 2 provides a snapshot of the environmental issues left behind after the mine closed. The mine operation left an open pit – glory hole complex at the top of Mineral Ridge with a catchment area of 1.19 km². All precipitation, including spring snowmelt, flows into the internal mine workings and prior to the remediation program, discharged into Britannia Creek from the 2200 Level portal and into Howe Sound directly from the 4100 Level portal, located as shown in Figure 1. The descriptions of the mining levels utilize the historical reference system used at Britannia Mine, which is based on the number of feet below the uppermost working of the mine.

The mine drainage is acidic (prior to the remediation actions started in 2001, the average pH was 3.5) with elevated copper, zinc, cadmium, iron, manganese, and aluminum. Prior to 2001, approximately 5 million cubic meters of acid rock drainage (ARD) flowed from the mine annually with a total metal loading estimated at 1,700 kg/day. Studies by the federal government and the provincial government during the 1980s and 1990s confirmed significant impact to the aquatic resources over a distance of several kilometers from Britannia Beach in Howe Sound. In addition to the ARD problem, the mine operation also left major waste rock dumps at several locations across the mine site, which contributes to contaminated groundwater and stormwater entering surface waters, including Howe Sound, Britannia Creek and Furry Creek.
The mine operation also generated approximately 44 million tonnes of tailings. Tailings were initially discharged to Britannia Creek and were later piped directly into Howe Sound, resulting in contamination of Howe Sound sediments. Contaminated tailing sediments are now observed extending kilometers away from Britannia Mine. Some tailings were used with waste rock to extend the Britannia Creek fan into Howe Sound for land reclamation purposes. Spilled concentrates and other wastes added to contamination of soil in the Britannia Creek alluvial fan area.

![Figure 2: The Environmental Legacy of the Britannia Mine](image)

**PROVINCIAL ENVIRONMENTAL REGULATION OF BRITANNIA MINE**

In 1970, the *Pollution Control Act* was amended to include all of B.C., including Britannia Mine. In 1973, the mine was ordered to obtain a permit and was directed to meet the criteria set in the B.C. Pollution Control Objectives for the Mining and Smelting Industries, which would have effectively required lime treatment of the ARD. However, the mine closed in 1974 and was again subject to an Order, but instead of maintaining the requirement to meet the Pollution Control Objectives, the mine was only ordered to maintain minimal pollution control works. In 1979, the mine property was sold to a real-estate developer (CBEL). Soon after, it was recognized that the pollution control works were not being maintained and that there were substantial environmental issues at the Site. Legal action against CBEL was considered, but due to a lack of definitive studies showing environmental impact, the uncertainty of the necessary solution and associated costs, and doubt whether CBEL had sufficient funds to provide any significant remediation, a long period of studies and monitoring by the provincial and federal governments ensued.
DEVELOPMENT OF A REMEDIATION PLAN AND COST ESTIMATE

In the early 1990s, a Technical Advisory Committee (TAC) was formed to help coordinate federal and provincial efforts to remediate the Site. The TAC has evolved over time but has generally had representation from all levels of government and the local community, as well as environmental non-governmental representation. Organizations represented on the TAC have included the B.C. Ministry of Environment (MOE), the B.C. Ministry of Energy, Mines and Petroleum Resources, Environment Canada, Department of Fisheries and Oceans Canada, Natural Resources Canada, Squamish Lillooet Regional District, BC Museum of Mining, local landowner (CBEL/BBPL), and the Environmental Mining Council of BC. The Squamish Nation was invited to participate on the TAC but advised that they would prefer their involvement be limited to being updated as the project progressed.

By 1996, once adequate information had been collected regarding environmental impact, and ARD quality and flow, the project evolved from one of government studies for the purpose of characterizing the severity of the problem, to one of defining the cost of the liability, so as to encourage and respond to prospective developers. The initial focus was selection of the appropriate treatment technology for the ARD and development of conceptual capital and operating costs. This initial work, which included ARD collection and assessment, high-density sludge lime pilot testing, biological sulphide pilot testing, alternative neutralization using pulp mill ash, and conceptual assessment of treatment technology, was jointly paid for by the provincial and federal governments.

By 2001, other major capital costs were identified, including fan remediation, Jane Basin Road upgrade (which assumed sludge and contaminated soil would be transported to Jane Basin) and limited remediation of Howe Sound sediment. From this conceptual assessment work, the total remediation project cost to 2026 was estimated at $99.3 million.

DEVELOPMENT OF FUNDING FOR PROJECT

In 1997, the newly effected Contaminated Sites Regulation (CSR), pursuant to the (then) Waste Management Act, allowed the Province to make historical mine owners/operators pay for present environmental problems. A 1998 historical corporate assessment identified several existing companies that were successors to the historical mine owners and operators. These parties were notified of their potential responsible party status under the CSR. Given the ‘joint and several’ aspect of the legislation, they provided legal responses which included naming other parties with potential responsibility. By 2001, the Province had a reasonably complete understanding of corporate ownership and historical liability for the mine. From the Province’s initial assessment and subsequent legal submissions, a corporate ownership successorship web was constructed as shown in Figure 3. The ownership figure has been updated to include developments to the year 2003.
Given the choice between a prompt settlement versus years of legal battles with the historical owners of the mine, and the uncertain outcome of the legal battles, in 2001, the Province agreed to a $30 million settlement in exchange for environmental indemnification. These funds were to be used solely towards the environmental remediation of the mine site, including technical studies, capital remediation works and long-term operation and maintenance of such works. This agreement was part of an overall funding plan involving the property owner (CBEL) and federal-provincial infrastructure funding that together with the settlement would fully cover the estimated remediation cost. However, since the infrastructure and CBEL funds were uncertain, the Province prudently set aside a contingency liability fund to make up the difference between the settlement amount and the projected cost estimate should this be needed. In the event, this was a wise move, as the CBEL and federal-provincial infrastructure funding were never realized.

Due to difficulties with the pre-2003 landowner and the property status, an agreement with the land owner was not finalized until 2003 when the secured creditor (BBPL) obtained ownership through foreclosure
on the property and an agreement was subsequently reached between the Province and BBPL. This agreement had a monetary value of $5 million to the Province, but more importantly also provided ownership of the required lands, which allowed the Province to proceed with remedial activities including construction of works. Figure 4 summarizes the agreements and financial sources for the project.

**Figure 4: Summary of Funding Sources**

### RESPONSIBILITY FOR PROJECT

In April 2003, in response to a report by the Office of the Auditor General of B.C., responsibility for undertaking the Britannia Mine Remediation Project was passed from the B.C. Ministry of Water, Land and Air Protection, now MOE, to the B.C. Ministry of Sustainable Resource Management, now the B.C. Ministry of Agriculture and Lands (MAL). The purpose of this move was to separate the role of the environmental regulator from the role of environmentally responsible party. As also recommended in the Auditor General report, the Province has also begun systematically addressing other Provincially owned contaminated sites, including mine sites, within the Crown Contaminated Sites Branch, Crown Land Administration Division of MAL.

### INITIATION AND PROGRESS OF REMEDIATION

Starting in 2001, utilizing the $30 million settlement, the Province, TAC, and project manager (Golder Associates) developed a detailed remediation plan that began with contracting for the necessary technical assessments to allow a feasibility design of the WTP. Associated studies included a mine hydrogeology/hydrology assessment, contaminated sites investigations, and flood risk assessment. The final design and construction of remedia works was not started until 2003 when access to the land had been resolved through the agreement with BBPL. The centerpiece of the remediation project is the
Britannia Mine Water Treatment Plant (WTP), which was procured via a design, build, finance, operate (DBFO) form of contract using a public-private partnership (P3) model. The P3 contract provides for operation and maintenance of the WTP for 20 years, until 2026. The open procurement process was won by EPCOR Water Services Inc. in early 2005. The WTP was constructed and operational by late 2005. Other remedial actions include limited removal and on-site management of contaminated soil, a contaminated groundwater recovery and treatment system, contaminated stormwater management, diversion of uncontaminated streams from entering the mine workings, and mine safety mitigation.

CURRENT EXPENDITURES AND BUDGET

The budget of $99.3 million for the Britannia Mine Remediation Project was set in 2001 based on a conceptual remediation plan and conceptual costs. Subsequent investigations further defined the remediation plan and costs, and by 2007, most of the major capital cost items have been constructed, such that there is greater confidence in the projected expenditures to 2026.

Table 1: Comparison of 2001 and 2007 Estimates of Project Costs to 2026

<table>
<thead>
<tr>
<th>Budget Item</th>
<th>2001 Cost Estimate to 2026</th>
<th>2007 Cost Estimate to 2026</th>
<th>Expenditures to April 2007</th>
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<tbody>
<tr>
<td>WTP Initial Studies and Capital</td>
<td>$11,569,964</td>
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<td>Fan Remediation</td>
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<td>JB Road Upgrade</td>
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<td>Marine Remediation</td>
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<td>Additional Area Remediation</td>
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<tr>
<td>Mine Inflow Diversions</td>
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<td>Mine Safety (non-WTP)</td>
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<td>Project Management</td>
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<td>O&amp;M - WTP (annual)</td>
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<td>O&amp;M - Fan GMS (annual)</td>
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<td>$16,852,556</td>
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<td>TOTAL TO 2026</td>
<td>$99,264,091</td>
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<td>$26,948,649</td>
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</table>

Note: all dollars to 2026 in inflated dollars (2% per year) except annual O&M values

Table 1 provides a comparison of the 2001 estimated costs and the 2007 actual and projected costs. The table shows that the 2007 projected expenditures to 2026 are within the budget although specific budget items have significantly changed from the 2001 estimates. The lower 2007 estimates for operating and maintenance costs for the WTP and groundwater management system, based on experience to date, and the re-assessment of the need for marine remediation based on marine studies, have offset the increases in costs associated with WTP initial studies and capital costs and the addition of other items that were not costed in 2001. The major items that were not included in the 2001 budget but were necessary to address as the remediation plan was implemented include:
• **WTP Initial Studies and Capital**: WTP feasibility assessment, flood assessment, site demolition, residential development impacts, access road, sludge filter plant, WTP site remediation, outfall location, building architecture, water supply, P3 financing charges (DBFO contract), profit.

• **Fan Remediation**: Contaminated soil excavation and disposal/on-site management.

• **Additional Areas Remediation**: Investigation and remediation.

• **Mine Inflow Diversions**: Upper Jane Creek Diversion, Bluff Creek Diversion, Victoria Inflow Diversion.

• **Mine Safety**: Mitigation of site hazards including open raises, 4100 wye, ore bin, mine manager.

• **Project Management**: Project management services including owner’s engineer, construction management and procurement management.

• **Administration**: Staff salaries and expenses.

• **Legal**: Legal services for property issues, agreements.

• **EEMRA**: Environmental effects monitoring and risk assessment.

The difference between the budget and the 2007 projected expenditures is maintained as contingency for the project. Project budgets are tracked monthly, and any excess allocated funds are returned to the contingency. The contingency will be used to address any emergency situations that may arise, and also to address any outstanding liabilities for which the need for expenditures is considered to have a low probability and are therefore not currently budgeted. These outstanding liabilities (many non-environmental related) include:

• Stability and hazard mitigation of five large abandoned water reservoir dams on Britannia Creek.

• Jane Basin Rock Block slope failure concern.

• Loss of hydraulic continuity between the mine ore body and the 4100 Level portal (resulting in ARD exiting at another location into Britannia Creek or Furry Creek.

• 3250 Level overflow into Mineral Creek despite mine storage and best reservoir-management efforts (resulting from extreme weather conditions and/or and potential mine working collapses).

• Additional mitigation of open portals, shafts, raises, derelict structures, fall hazards.

• Risk assessment determines additional remediation is necessary, such as at waste rock dumps at mine portals, portal seepages or for marine sediments.

• Outfall location instability results in need to replace outfall.

**SUMMARY**

Despite having set the budget for the project in 2001, using conceptual costs for a conceptual remediation plan, the project remains on budget in 2007 due to some early conservative assumptions, cost-effective WTP procurement and delivery, effective project management, and teamwork between the provincial and federal governments, contractors, consultants and stakeholders. Costs will continue to be carefully managed to ensure the project stays on budget and funds are allocated to provide optimal environmental benefit. It is recognized that there are outstanding liabilities that may result in substantial future cost impacts to the project, and contingency reserves are maintained for this purpose.
REFERENCES


