

# CLEARING THE WATER AT BRITANNIA MINE

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*View of the Britannia Beach town site, including Howe Sound and the Coastal Mountains*

# Clearing the water at Britannia Mine

Mine water is one of the biggest environmental challenges facing mining today. Although this may be an issue during a mine's productive life, the need to protect the environment from metals, salts, acid and other contaminants continues for many years after closure.



*Britannia Beach Townsite, early 20<sup>th</sup> Century*

For a look at some of the trends in mine water management today, consider Britannia Mine on Canada's West Coast. Operational from the early 1900s until 1974, in its heyday Britannia was the largest copper mine in the British Empire. While much of the ore was processed at the mill located close to the ocean shore, mining was done at higher levels and deep underground, from mine settlements located high up in the Coast Range Mountains. About 80 km of underground workings, numerous stopes, four open pits and glory holes were developed to extract the ore.

The last mining company to own the property closed the mine in 1974 generally in accordance with the then-current requirements of the Province of British Columbia. With ownership of the mine property, including the Britannia Beach townsite, transferred to a succession of property-development companies, little was done to manage the effects of some five million cubic metres of mine water that pour through the mine each year and into nearby Howe Sound on the Pacific Ocean.

Copper in the water flowing from the mine's upper levels stained the rocks lining nearby Britannia Creek dark red and the mine's outflows made Britannia one of the biggest point-sources of metal pollution in North America.

The mine water discharge typically has a pH of about 3.5.

While the volume of water flowing through the mine varies significantly by season, typical concentrations in the discharge water are 25 mg/L copper, 25 mg/L zinc and 0.1 mg/L cadmium. Prior to the recent installation of treatment systems,

an average of 300 kg/day each of copper and zinc flowed into Howe Sound.

## Working towards a solution

A step towards managing the mine-water problem was taken as the Province's remediation work began in 2001, through a concrete plug being installed at one of the upper adits, this being constructed as part of a research project by the University of British Columbia. This plug ensured that almost all the drainage would subsequently exit through a single lower-level of the mine at the 4100 Level.

However, this was only the first step in the Province of British Columbia closure concept for the mine. Working under the legal principle of joint and several liability, the Province researched the vast web of prior ownership for Britannia Mine over the previous century, and approached the modern descendants of each company. A settlement was reached that would absolve the mining companies of any future liability, in exchange for C\$30 million (about £15 million). This money would fund part of the

remediation works and long-term operating cost.

One of the first steps was to reduce the scope of the problem. Much of the water in the mine enters through the open pits at one of the highest parts of the mine property - the open pits and associated glory holes linking to the underground workings within the Jane Basin area. Filling in the open pits and glory holes was assessed as being unfeasible, so instead, three surface water diversions were installed to reduce the flow of water entering the mine by this route and becoming contaminated. This system, involving collection structures, ditches and pipes is expected to divert about ten to fifteen percent of the mine water when it is fully optimized.

## Treating the mine water



The water treatment plant removes metals from the mine water so it can be safely released into Howe Sound.

The biggest challenge yet remained – treating the mine water so that it could be safely discharged into Howe Sound. With the upper-level plug installed to prevent water from flowing into Britannia Creek, the mine voids can be used as a storage reservoir to balance outflows from the mine. This is important because of the fluctuations in mine water production – high in the spring with snow-melt, and again in the fall with the onset of the heavy fall rains (the site is located in coastal temperate rainforest) before the

rain turns to snow at higher elevations.

Beginning in 2001, the environmental and geotechnical firm Golder Associates Ltd. took the role of Project Manager, in charge of the overall remediation project, which included the cleanup of mine waste and other closure aspects beyond the mine-water issue, eg. safety of mine entries.

The Province decided on a Design-Build-Finance-Operate form of contract for procuring the water treatment plant and its operation, in a Public-Private Partnership in which the Province pays a pro-rated fee when the plant's discharge is within permitted limits. The initial contract called for the contracting company to operate the facility for 20 years. The technology was left to the proponents to choose, however, all proposals received adopted the accepted approach to Acid Rock Drainage (ARD) water treatment, ie. high density sludge (HDS) technology developed in the mid-1970s. This technology adds lime to the ARD water, which precipitates dissolved metals by pH adjustment. The water is then clarified before being discharged as treated effluent. The denser sludge is partly recycled into the inflowing water to seed crystal growth and make the clarification process more efficient. Surplus sludge, a stable metal hydroxide at 25 to 50 percent solids, is disposed of, or in some cases re-used in cement manufacturing.

The winning company, EPCOR Utilities Inc. of Edmonton, Alberta, began construction in March 2005, and the first water treated over a 24-hour cycle was in October 2005; official opening of the treatment facility was in May 2006.

Mine water flow figures over the previous 25 years were used to determine the size of the plant, which will treat an average of 97 percent of mine water. The three percent of mine water that is untreated will be discharged during by-pass events and will be neutralized by lime addition prior to being blended with the treated water stream, thus mitigating its

impact to the environment. Four by-pass events are likely to occur in a 25 year period, particularly in years with high snowpack and high temperatures in late spring. One of the most important design criteria is to not overtop the mine reservoir. The system is designed and is being managed such that no overtopping will occur within a one-in-200-year mine discharge event.

One of the "sustainability" aspects to the operation is that about half of the electrical power needed to operate the mine-water treatment facility is generated on-site through two hydro-electric generators. These use the head of water developed inside the mine to power the generators, with backup on the electrical grid.

The treated effluent enters Howe Sound through a new Deep Outfall pipeline that carries the effluent past the environmentally-vulnerable shoreline. The previous pipeline terminated at a depth of 26 metres and was on unstable sub-sea terrain, and therefore subject to breakage and blockage. To meet environmental regulations, the new outfall was repositioned to be at a 50-metre level with a diffuser.

The sludge from the treatment plant is pressed into a 'filter cake', which is temporarily stored in a covered shed on-site. This material is then carried up a newly-refurbished 11 km back-country road to Jane Basin, high up in the mountains, and disposed of in the existing open pits and glory holes. Any contaminated runoff from the filter cake drains into the internal mine workings and is directed to the treatment plant. Because Jane Basin is high enough to have snow much of the year, the six-axle Volvo mine haulers used for the job only do it twice a year – once in the spring after enough snow has melted, and then again just before the snows of autumn make the road again impassable.

To further protect the waters of Howe Sound, steps have been taken to treat the flow of groundwater contaminated through remnant and largely inaccessible mine waste on and under the surface, before it enters the

Sound. This meant installing near the shoreline seven pumping wells in a carefully designed array. The groundwater is then pumped up to the mine-water treatment facility so it can be released into Howe Sound as treated effluent.

## A part of the overall solution

Treating the Britannia Mine water is part of a revitalization of the area that has seen significant progress on other environmental issues such as the cleanup of mine-waste dumps and the remains of mine processing equipment. The lower-level mine facilities have been utilized to form the British Columbia Museum of Mining, including the recently-refurbished gravity-feed mill building – itself an historic landmark and icon of mining in BC. Part of the attraction is an interactive display at the water-treatment plant, to help visitors including school children understand the treatment process.

Facilities in the town of Britannia Beach have been much improved, including new roads, power distribution, water and sanitary systems. In addition over 100 building lots have been sold by a property developer.

There is work to do in cleaning up the environmental legacy of a century of mining at Britannia, but the mine-water issue is now well in hand.



*The location of the town, overlooking Howe Sound, is a major attraction for purchasers.*



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Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in enduring relationships and long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. This enables us to help clients achieve their short- and long-term financial, social and environmental goals.

The success of Golder's approach can be seen through our steady growth. We now operate from offices located throughout Africa, Asia, Australasia, Europe, North America and South America. Our knowledge of local cultures, languages and regulatory requirements, combined with our global resources, makes it possible for us to help our clients achieve their business objectives around the world and at home.

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