ENVIRONMENTAL CONTROL AND RECLAMATION AT WESTMIN, MYRA FALLS OPERATIONS

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The Myra Falls Operations; at the south end of Buttle Lake date back to 1918 when the first claims were staked and prospected. The properties were sold to Western Mines Limited in 1961.

The Lynx Mine was developed first arid began production to a concentrator at the rate of about 950 tonnes per day of copper -lead - zinc ore with gold and silver values as well.

Mining at the Lynx Mine site started with the development of an open pit on surface. The pit was operated until 1973 and mining was continued underground. The Lynx Mine remains an active producer today.

The Myra Mine was developed in 1970 and produced until mid-1985.

Declining ore reserves prompted an aggressive exploration program which resulted in the discovery of the massive H-W deposit. Access to this orebody is from a 2350 foot shaft with levels spaced every 150 feet.

A new mill/concentrator was built to allow an increase in mill feed to 3000 metric tonnes per day.

The new mill came on stream in May of 1985. Up to this point, tailings disposal from the Lynx/Myra operations had been to Buttle Lake. With the development of the H-W Mine and the new concentrator, tailings disposal had to be moved on land.

Copper and zinc concentrates are shipped by truck to a deep sea port facility in Campbell River. The copper goes to Japan and zinc goes to Japan and to Trail, B.C. Lead concentrate has not been produced since August, 1985.

All power required is generated on site. In the past the Tennent Lake hydro plant provided a peak supply of 3.0 MW which was augmented by a number of diesel-generating units with a maximum output of 5.4 MW.

A second hydro plant was built during 1984/1985 with a total capacity of 8.0 MW. Ten permanent diesel generating units provide power during times of higher power consumption or low water levels in the lakes. The present power consumption is about 14.0 MW,

The orebodies in this area occur in a 1500 foot thick stratigraphie sequence of volcanic rock of Permian age in which three rhyolitic horizons are found. Rhyolite is an acidic light coloured rock often altered to a light grey, foliated rock called sericite schist, particularly in the vicinity of the orebodies. The major minerals encountered are sphalerite, chalcopyrite, and galena, but also pyrite. The Lynx, Myra and Price orebodies outcropped above the valley floor and belong to the middle rhyolitic horizon. Here the many individual ore lenses occurred disseminated throughout the sericite schist. The H-W orebody was found in the lower horizon and is a finegrained massive deposit.

The remaining reserves at the Lynx and Price Mines total 500,000 tonnes while the H-W reserves known to date are in excess of 15,000,000 tonnes with a combined average grade of 0.007 oz/tonne gold, 1.1 oz/tonne silver, 2.2% copper, 0.3% lead and 5.3% zinc.

There are presently 570 people employed at the Myra Falls mine site. Most people are transported daily to and from the mine from the Campbell River and Courtenay areas. Usually two shifts work underground five days a week. But the mill operates seven days a week on a 24-hour a day, 12-hour shift basis. Mill employees! and some mechanical trades stay at the mine site for four day periods.

ENVIRONMENTAL OPERATIONS

Environmental operations at the mine have two major components: 1) Tailings Disposal and 2) Water Treatment

TAILINGS DISPOSAL

Tailings disposal from the old Lynx/Myra operations used to be to Buttle Lake. Tailings flowed by gravity through a 10" 0 HDPE pipe laid on a specially constructed road to where Myra Falls enters the Lake. The pipeline crossed Myra Creek and the falls on two bridges and then ran on a tressle along the mountainside on the north shore of the Lake to a raft where tailings were deposited below surface in about 100 feet of water. This was a relatively simple and trouble-free operation. An emergency tailings pond near the mill was used whenever tailings flow to the lake was interrupted. Little manpower was needed for operation and maintenance although some addition of flocculant and water sprays to suppress floating material were required which demanded periodic attention. With the construction of the new (H-W) mine and concentrator, tailings disposal had to be moved to an on-land facility. This presented an interesting problem; the Myra valley is fairly narrow with little usable room and very few flat areas. Being situated inside a Provincial Park also put certain restrictions on the location. In addition, tailings from the H-W ore are highly reactive due to higher pyrite content in this ore. (30% vs 15% in Lynx/Myra ores).

It was decided to use *an* area below the waste rock dump and the tailings line road, an area of approximately 55 hectares. The area was developed in two stages. Area I was cleared of virgin timber and topsoil down to the underlying alluvial gravels. A starter embankment was built along Myra Creek and a filter consisting of a geotextile and sand placed on the toe of the waste rock dump. Water collection drains were placed in the gravels under the outer embankment and at the toe *of* the waste rock dump to intercept contaminated groundwater flowing from the waste dumps and to assist in the initial draining of the tailings deposit. The outer embankment was rip rapped on the creek side to protect against a 1 in 200 year flood of Myra Creek. The drains were terminated in a pumphouse which pumped the water to treatment facilities for the removal of metals. This area was first used in July, 1984 when disposal of tailings to Buttle Lake ceased.

Development of Area II required the relocation of about 900 meters of Myra Creek. After completion of the creek diversion, the outer embankment, water collection drain, sloping filter and creek protection were extended and an additional pumphouse installed. Area II became available in 1985.

Approximately 50% of the tailings produced, the coarse fraction, is removed by cyclones and used as backfill underground. This fill can be pumped directly to the backfill plants at the Lynx and H-W Mines or it can be temporarily stored in a small area adjacent to Area I. Recovery from this area is by submersible pump and high pressure water jet to reliquify the sand. A bulldozer is used to push tailings sand towards the pump. Cyclone overflow thickened in the tailings thickener. Thickener underflow is pumped to the tailings areas for deposition using the subaerial technique. In this technique the thickened slimes slurry, approximately *50%* solids, is distributed through spray bars along the outer embankment. Under the spray bars rapid settlement of the coarser particles takes place while finer material travels some distance further along thus forming a sloping beach. Water "rolls" off the beach and collects in a pond beyond the beach from where it is drawn off through decant pipes connected to the pumphouse. After a thin layer, 1" to 2", of tailings has been deposited another set of spray bars is used and the deposit allowed to drain and air-dry before the next layer is laid down. This allows thin, virtually impervious layers to be deposited which results in the formation of an unsaturated, stable deposit.

Piezometers, electric and pneumatic, installed under the tailings and in the tailings mass monitor groundwater levels and pore water pressures. The negative pore pressures observed in the tailings mass indicate proper air drying and low saturation and thus no infiltration of rain water. Test work has also indicated that design permeability levels of 1.0 x 10.9 m/sec are being achieved.

The subaerial technique was chosen in order to minimize the total area required for tailings disposal, to obtain a seismically stable deposit, and to minimize acid generation within the tailings mass. Although the tailings have a net acid generating potential, no evidence of acid formation has been detected to date.

As deposition progresses, raising of the embankment is done by constructing successive lifts on top of the tailings, each lift approximately 3 meters high, thus obtaining an inward sloping series of berms. Eventually, the tailings deposit will reach partway up the waste rock dump. It is hoped that the lower portion of the dump when covered by tailings will be sealed sufficiently to minimize or eliminate transport of oxygen and/or water into the dump so that artificial sealants would not be required on that portion of the dump.

WATER TREATMENT

Much of the water originating from, or flowing through the mine site becomes contaminated by heavy metals as a result of acid mine drainage. Depending on the source this water may contain Al, Zn, Cu, Fe and to a lesser extent Pb and Cd.

To minimize the amount of water entering disturbed areas from the mountainsides to the north of the property, a ditch was dug along the northern boundary which catches most of the surface runoff, rain and snow melt, and discharges it to Myra Creek. The ditch is lined with shotcrete in the area above our active waste dump and tailings areas where leakage from the ditch would add significant quantities of water to be intercepted and treated. Water discharged from the Diversion Ditch remains clean and free from metals.

Sub-surface water flowing through the waste dump flows toward the tailings areas and charges the underlying alluvial gravels. To prevent this water from reaching Myra Creek, intercepting drains were placed in the gravels under the tailings area, one at the toe of the waste dump (inner drain) and one under the tailings embankment adjacent to the Creek (outer drain). The inner drain collects much of the contaminated water as it enters the sub-surface gravels while the outer drain collects excess groundwater during high runoff periods. Since its elevation is just below creek bed level, the outer drain also collects a certain amount of creek water thus ensuring an inflow into the drain rather than to the creek. Perforated lines collecting the water are terminated in chambers. Inside the chambers the collection lines are connected to a conveyance line by flexible hose. A valve allows for flow control. Lowering or raising the flexible portion of the line controls the elevation from which water is collected thus allowing for some control over the amount of creek water collected. To keep the amount of water to be treated to a minimum adjustment of elevation with changing creek water levels will prevent too much creek water from entering the system. There are 14 chambers giving access to the outer drain.

The inner drain consists of two pairs of perforated pipes, at different elevations, upper drain and lower drain, connected to two conveyance lines. There is no access to the underground portion of this drain.

The inner and outer drains are terminated in a pumphouse. Valves allow for flow control into the pumphouse wet well. Four Aurora pumps (two, 60 HP, two, 100 HP) are level activated and cycle as required to accommodate the incoming flow. Water is discharged through H.D.P.E. lines to a surge basin. The surge basin also collects runoff water from the Lynx open pit and from old waste dumps.

The surge basin's function is to mix water from different sources and to allow for some surge capacity during high runoff periods. Lime is added to the water leaving the basin to raise the pH to 10.5. The original pH may vary from less than 4.0 to 6.5. The lower pH values usually occur after the first rainfall events in the fall.

The water next enters the first of five settling ponds» Myra Ponds, where metal hydroxide sludges are allowed to settle. These sludges, about *1%* solids, are pumped to the tailings area for disposal along with tailings.

Normal effluent quality from these ponds is less than 0.01 mg/l dissolved zinc, up to 0.20 mg/l total zinc, less than 0.01 mg/l copper and lead and cadmium levels usually below detection limits. Iron and aluminum are not normally monitored for. The effluent is consistently non-toxic in a 96-hour LC50 bioassay test.

The system is presently able to handle a maximum of 1400 l/second but is to be upgraded to handle at least 2000 l/second.

In addition to contaminated groundwater, water from the Myra and H-W mines as well as discharge from a rotating biological contact sewage treatment plant are also handled by this system.

A second treatment system, the Lynx Ponds, collects water from the Lynx Mine and effluent from the concentrator. The mine water pH may vary from about 4.0 to 7.0 This water is mixed in the four series ponds with high pH mill effluent. No lime is required for pH control or metal removal. The effluent pH is generally 11.0 or more. These ponds differ from the Myra ponds also in the sludge they accumulate. The sludge contains a high level of tailings type solids contained in mill effluent and settles to about 30 to 35% solids. This sludge, like that from the Myra system, is pumped periodically for disposal with the tailings. A second sewage treatment plant and yard drainage are also discharged to these ponds.

Since the curtailment of lead concentrate production, cyanide and chlorine are no longer used in the milling circuit and are, therefore, no longer present in mill effluent or pond discharge.

Water from this system is recycled to the mill on a demand basis. The excess is decanted to Myra Creek. During low precipitation periods, July to October, fully 100% of the water is recycled.

IMPROVEMENT PLANS

Plans are underway to increase the mill feed rate from 3000 metric tonnes per day to 4000 tonnes per day. The tailings disposal facilities are being upgraded to improve thickener performance, to improve backfill consistency and supply, and to minimize the need for disposal of bulk tailings.

The Myra Water Treatment System is to be upgraded to increase its capacity. This will include expansion of the surge basin, addition of a new pond and pipelines. The objective is to be able to treat about 2000 l/second and to further improve effluent quality during high rainfall events when higher than normal amounts of water need to be treated.

Although Lynx Ponds effluent is non-toxic it does at times contain elevated levels of dissolved lead when the pH is in excess of IB.O. Work is in progress to divert all mill effluent to the tailings thickener for improved solids removal. A CO_2 injection system is to be installed on the thickener overflow for pH control and removal of lead. Pond sludges will also be diverted to the thickener to increase sludge density and to obtain easier mixing with tailings for disposal.

RECLAMATION

Since completion of the new mine/mill construction in 1985 the reclamation emphasis has been on the removal of installations and facilities no longer required. Some work has also been done to enhance the appearance of the site for the benefit of tourists and park visitors who frequently visit the mine site during the summer months. Two public tours per day are normally scheduled to show visitors around.

Hydroseeding and landscaping were undertaken around the mine site following completion of construction activities in 1985. Unfortunately, a prolonged dry summer and heavy frost during the early winter took their toll of some of the new shrubs. These areas are normally fertilized in the spring and tended to by a crew of summer students from May until September.

All former tailings disposal facilities and equipment used to experiment with subaerial techniques were removed from the emergency tailings pond. The berm around this pond was raised to prevent surface runoff from the pond to Myra Creek. This pond was also used to conduct vegetation research on tailings.

A number of plots were established on the tailings using varying thicknesses of topsoil, lime and fertilizer applications to study the growth potential of a number of species of grasses, legumes and ground covers. Tensiometers were installed to monitor migration of moisture into or from the tailings under these plots. Reid, Collins Nurseries Ltd. conducted most of the work. More recently, test plots were established to investigate the effectiveness of sealants such as bentonite and latex based asphalt as potential sealing materials for the reclamation of our tailings deposit. Further research is being planned and aimed at finding effective ways to seal and revegetate waste rock. Since available till materials and topsoil are scarce in this area, other materials such as artificial sealants may have to be considered in order to minimize soil requirements while still maintaining an effective air and water barrier to prevent acid mine drainage.

Most of the former tailings disposal facilities to Buttle Lake were removed during 1985 and 1986 including the pipeline, disposal raft, associated floats and catwalks on the lake, portions of the tressle and bridge over Myra Creek.

Remaining portions of the tressle are to be removed this year. Also ongoing is the removal of the road built to carry the tailings line to the Lake. The material used to build the road was predominantly waste rock from the open pit. Since much of this rock is acid-generating, sections of the road were used to add to the metal loading in Myra Creek during high runoff periods.

The road will be excavated down to original ground involving the removal of some 170,000 cubic yards of material. The project may take up to 1989 to complete. Maintenance of the road for use by haul trucks during the winter months has been difficult. Hauling will, therefore, be continued during dryer periods only.

Mining activities adjacent to and underneath the open pit have to date precluded backfilling of the pit for reclamation purposes. Backfilling is considered unsafe at the present time given the conditions of the pit bottom. However, work is in progress to determine the hydrology of the general pit area which collects significant quantities of surface as well as subsurface runoff. Work required underground in preparation for backfilling is also being investigated.

CONCLUSION

Being situated in the middle of a Provincial Park, on a drinking water reservoir that also forms the headwaters of a significant commercial fishing industry have all helped to give environmental operations at the mine an important profile.

While it was discovered in the late 70's that metal concentrations in Buttle Lake, particularly zinc, were rising, facilities installed during the early 80's have had a dramatic impact in turning this trend around.

In September of 1986, the Ministry of Environment, Waste Management Branch, reported that the zooplankton population had recovered to the point where they had sampled all species of zooplankton previously reported to be in Buttle Lake. Also the phytoplankton had been found in numbers expected for an oligotrophic lake. Analyses of fish livers taken from the lake also showed that levels of metals in the water are not harmful to fish.

Planned additional improvements and reclamation are aimed at fine tuning the operation to better cope with major rainfall and snow melt events as well as to minimize or eliminate the impact of potential pollution sources.