Tsolum River Partnership

Mt Washington Mine Remediation Executive Summary

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Tsolum River Partnership

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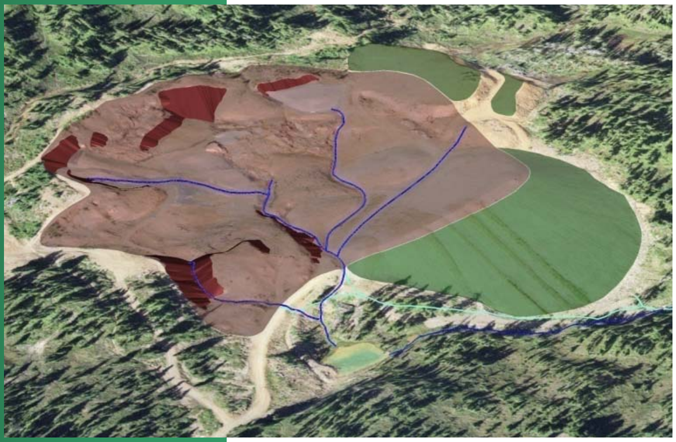

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Executive Summary

Introduction

The Tsolum River Partnership retained SRK Consulting (Canada) Inc. (SRK) to develop an Acid Rock Drainage (ARD) remediation plan for the abandoned copper mine on Mt Washington, Vancouver Island. Detailed design features of the reclamation plan were presented in a design report submitted to the Partnership on December 21, 2007. Current plans call for the project to be staged over a period of three years. Subject to the acquisition of project funding, final construction drawings would be prepared in early 2008 in preparation for mobilization to the site by June 2008. A photograph of the site in its current condition is shown in Figure 1.

Figure 1: North Pit of the abandoned copper mine below the Mt Washington Ski Field on Vancouver Island

The Problem

Historically, the Tsolum River had large salmon runs. In the late 1940's, runs of up to 200,000 pink salmon, 15,000 coho, 11,000 chum and 3,500 steelhead were reported. Since that time, several factors are believed to have affected the river and its aquatic life, reducing the salmon runs. While these factors include development and logging along the banks of the Tsolum, the dominant impact has been copper leaching from the abandoned mining operation from the mid-sixties.

Although the community was aware of the decline of fish in the river, it was not until 1982 that the severity of the problem was discovered. After operating for four years with very low returns, the Headquarters Creek Hatchery released 2.5 million pink fry into the Tsolum River and none returned. Subsequent water monitoring in 1983 revealed high copper levels originating from the mine.

Several community members, concerned about watershed issues in the Comox Valley, began a campaign of letter writing, media outreach, and working with federal and provincial ministries to bring community attention to the mine problem. This helped to bring about partial remediation of the mine site between 1988 and 1993.

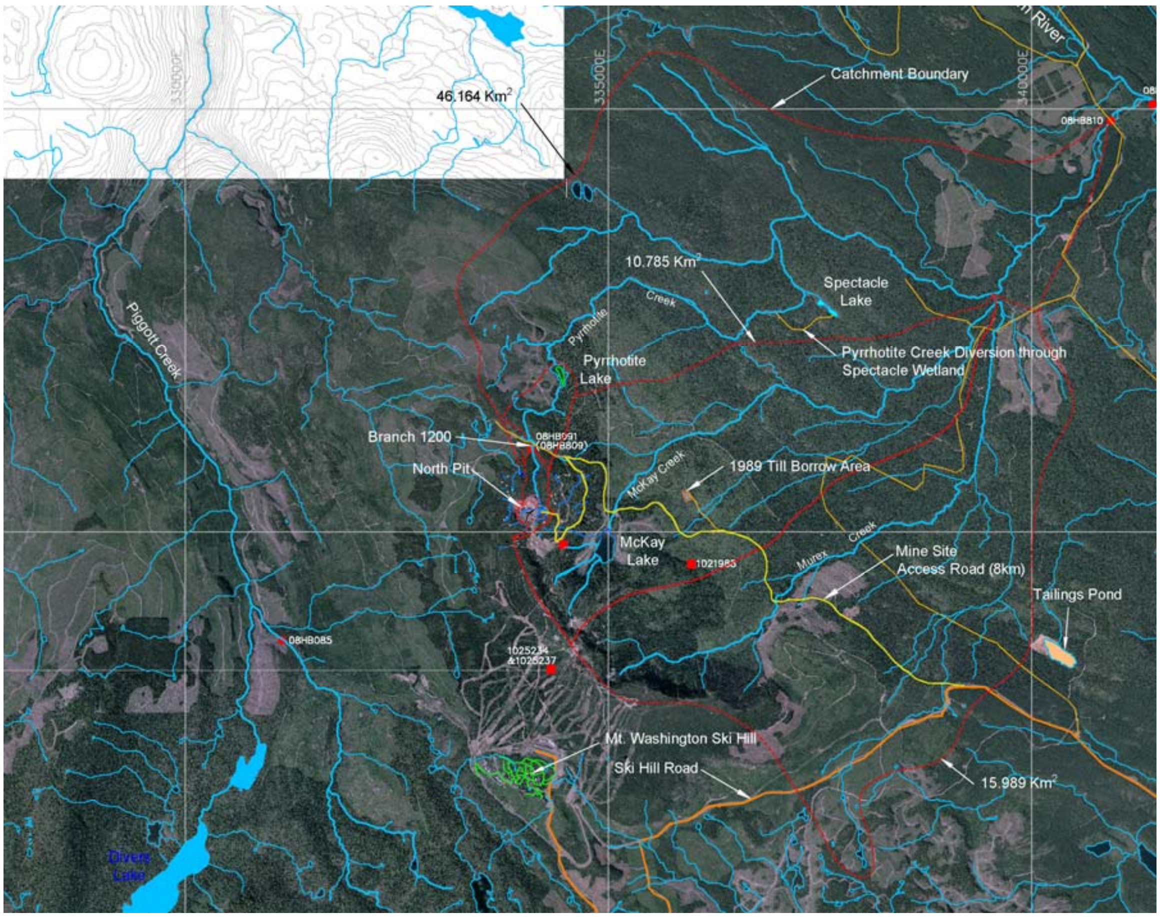

Figure 2: Location Map

Background

Beginning in 1987, federal and provincial agencies funded studies, monitoring and on-site works to address the ARD problem. Between 1988 and 1992, the Ministry of Energy, Mines and Petroleum Resources (MEMPR) put $1.5 million into remediation at the site. Steffen Robertson and Kirsten (Canada) Ltd. (SRK) was hired to design and install a till cover, the primary focus of the remediation work at that time. The cover was placed over waste rock in the East Dump. The purpose of this till cover was to prevent the ingress of oxygen and infiltration of water to the waste rock. Other smaller scale MEMPR activities included the application and testing of an experimental asphalt emulsion/geotextile cover, and the application of calcium hydroxide to the pit walls and floor to attempt to raise the pH and reduce metal loading. Since the initial work done by SRK in 1988 and 1989, the site has been the subject of numerous government, consultant and academic reports and assessments.

Water monitoring results from 1993 to 1996 revealed little reduction in copper levels. However, since 1998, water quality monitoring has shown sustained reductions, approximately 50%, in the copper loading from the mine, which is believed to be the result of the on-site works.

To address continuing toxicity issues, the Tsolum River Partnership was formed. The Partnership initially included:

- B.C. Ministry of Environment;
- Environment Canada;
- Fisheries and Oceans Canada;
- Pacific Salmon Foundation;
- TimberWest; and
- Tsolum River Restoration Society.

In 2003, this Partnership developed the Spectacle Lake Wetland Project to achieve water quality which was no longer acutely toxic at the compliance point downstream of the triple confluence of Pyrrhotite, McKay and Murex Creeks that drain the upper watershed. The wetland has been successful in achieving this goal to date, as copper levels in the Tsolum have been reduced by a further 40%. The concern is that this form of passive treatment is time limited and the wetland will become less effective at reducing copper over time.

With the improved water quality in the Tsolum River, the health of the fishery has gradually improved, but a longer-term solution was required. In 2005, the Tsolum River Partnership was expanded to include the Mining Association of British Columbia and the B.C. Ministry of Energy, Mines and Petroleum Resources as the focus shifted back to remediation of the major copper sources at the mine site. Recently, Natural Resources Canada has also joined the partnership.

In 2006, the Partnership initiated a process with SRK Consulting to develop a long term remediation plan for the site, which would incorporate remedial measures to sufficiently reduce the Cu loading from the mine site, so that the water quality objectives for Pyrrhotite Creek and the Tsolum River would be achieved.

Geochemical Assessment

The primary purpose of the remediation plan is to reduce copper loadings from the site that impact water quality in the Tsolum River. A geochemical assessment of the mine site was carried out by SRK in 2007 to support development of the final remediation plan. The assessment included the collection of field and water quality data from three weirs during the freshet starting in April and ending in July, by representatives of the Tsolum River Restoration Society and the B.C. Ministry of Environment (BCMoE).

The North Pit, which is considered to be the main source of ARD, typically has pH levels below 4 and contains typical copper concentrations of 10 mg/L. The ARD originates as runoff from the shallow pit floor and waste rock on the pit floor, as well as the two waste rock dumps in the North Pit. The majority of the drainage from the North Pit flows northwards, feeding the headwaters of Pyrrhotite Creek. Part of the West Dump also contributes, but flows in a northwesterly direction towards Piggott Creek (Figure 2). The South Pit in contrast has non-acidic drainage containing lower copper concentrations (1 mg/L), and flows towards McKay Lake and McKay Creek, eventually reaching the Tsolum River via Murex Creek (Figure 2).

In addition to the above, a detailed water quality sampling was completed on July 9, 2007 by representatives from SRK, the Tsolum River Restoration Society and Environment Canada. SRK inspected the site and identified 23 potential surface water sampling locations and four groundwater monitoring locations.

The following is concluded from this work:

- Copper loads originate mainly from the pit floor and more specifically in the eastern part of the pit, including the bench of highly fractured rock on the eastern edge of the pit;
- Distribution of loads, shown by weir monitoring and pit area sampling in 2007 were consistent with load distribution calculated in 2000;
- Reduction of water contact with the pit floor is not expected to result in a directly proportional decrease in loads because copper concentrations in water beneath a cover will increase due to a predicted decrease in pH. A 90% reduction in load will require roughly a 95% reduction in flow.

Remediation Alternatives

One of the key remediation alternatives considered during the planning stages of the project was the concept of a flow equalization reservoir located at Pyrrhotite Lake. This lake is already affected by ARD from the mine site and therefore it was considered to be suitable for storage of contaminated water. We know that the highest copper loads are released from the site when dilution capacity in the Tsolum River is low. The concept would involve storage of snow melt water containing high copper load in the spring. The stored water would then be released into the river the following winter when flows in the river peaked due to rainfall.

However, during the evaluation of the option, it was found that even if the load could be perfectly optimized to make use of dilution in the river, the water quality objectives would not be met because the site produces more copper load than can be assimilated by the river.

Calculations showed that the water quality objectives could be met if the copper load from the mine was reduced by 60% and the storage capacity of Pyrrhotite Lake was increased to 500,000 m^3 with an embankment averaging 9 m high. Several variants were considered, including construction of surface water diversions around Pyrrhotite Lake and piping of contaminated seepage from the pit to the flow equalization reservoir at Pyrrhotite Lake.

For technical reasons and the high cost resulting from a combination of this method with source control measures, the flow equalization concept was not pursued and attention was focused on source control using pit covers.

A number of alternative pit cover options were considered to reduce contact of water with the oxidized pit floor and waste rock. Table 1 summarizes benefits and disadvantages for each option. The Bituminous geomembrane was selected as the preferred cover option.

Table 1: Cover Options Benefits vs. Disadvantages

Option	Pros	Cons
Till Cover	• Long term durability • Ease of construction, require no special technicians or equipment for installation • Minimum subgrade requirements	• Relative high permeability with soil available on site • Long haul distance, hence increase cost • Volume of suitable material maybe difficult to find
Bituminous Liner	• Long term durability • Ease of installation • Very low permeability • Cheaper unit cost relative to till	• Requires subgrade preparation • Relatively higher material cost than GCL • Susceptible to long term traffic if left exposed
GCL Liner	• Ease of installation • Low permeability • Cheapest material unit cost	• Requires confining stress to perform • Susceptible to weather if exposed • Requires relatively more subgrade preparation compared to Bituminous Liner • Might require an extra layer of geogrid for poor subgrade condition • Strict construction weather conditions
Concrete Liner	• Very low permeability • Long term durability	• Expensive material unit cost • Requires extensive subgrade preparation and installation process • Susceptible to long term cracking and settlement • Strict construction weather conditions

Geotechnical Field Investigation

A borrow source investigation was completed at the site in August 2007 to identify the quality and quantity of material available for construction within a 10 km radius from the site. The investigation was carried out by SRK and Chatterton Geosciences Ltd. The investigation identified a potential borrow area as a source for general fill material (glacial till). No ideal or high potential sites were found for granular sources. A number of potential sites were also identified for road fill and riprap. These borrow areas contribute to TimberWest's productive forest land base and every effort will be made to ensure production of a second crop of commercially viable trees following the work.

Final Design

The planned remediation work is designed in three phases. The first phase will include all the major earthworks involving installation of underdrains, placement of the till buttresses against the pit high walls, installation of the bituminous geomembrane, placement of the 1m thick till cover over the geomembrane, construction of surface drainage channels in the till cover and the work associated with an uphill diversion of runoff. The second phase would involve placement of the 0.5 m till cover on the flat areas of the west dump, site revegetation, reclamation of the borrow areas and instrumentation installation. The need for amendment of the till cover to encourage the vegetative growth is currently under review. The third phase of the project is subject to the need for a water treatment system. The current design includes a provision for treatment but a decision on whether it is required will be made in the spring of Year 3 subject to the results of the monitoring program. If water treatment is required, Phase 3 would involve final design and procurement of the lime addition water treatment system, the installation of the pipeline to Branch 1200, construction of the settling ponds and the Pyrrhotite diversion at Branch 1200.

Figure 3 is a rendering of the proposed cover to be placed over the North Pit. The overall project remediation measures are shown in Figure 4.

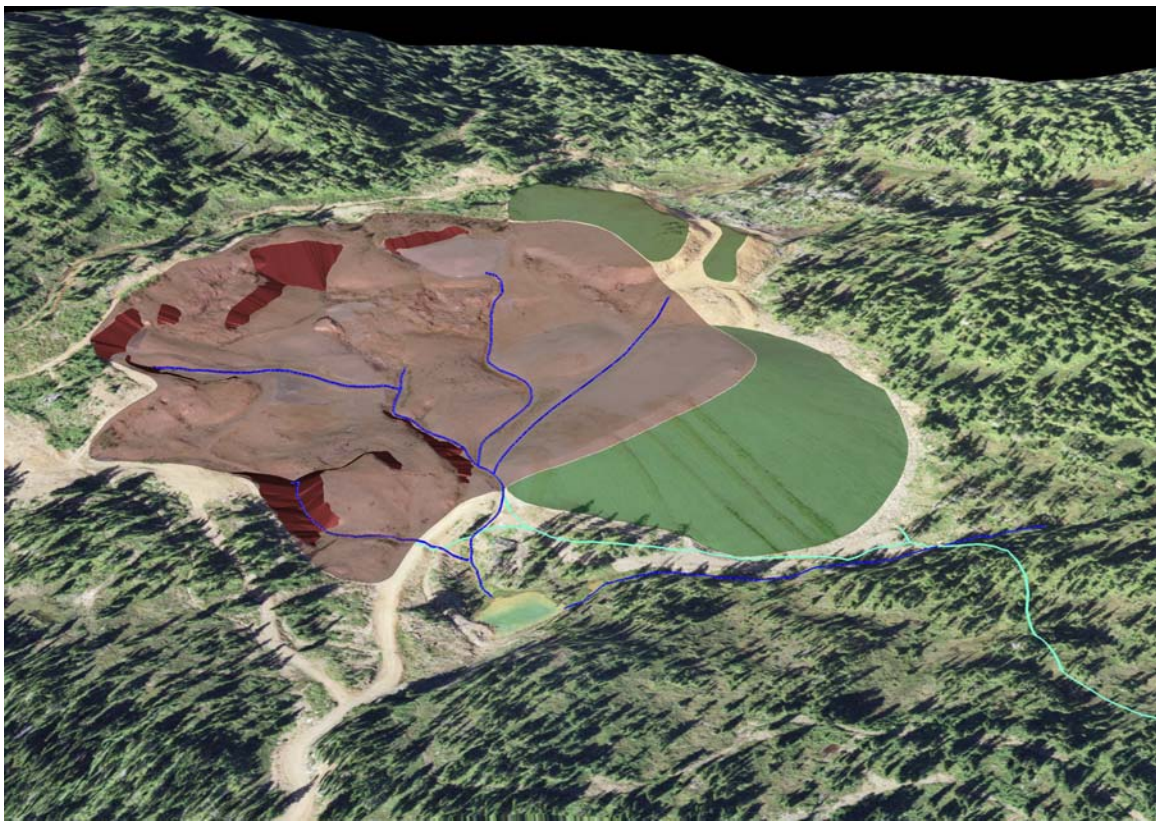

Figure 3: Rendering of the proposed bituminous geomembrane, surface drains and revegetation

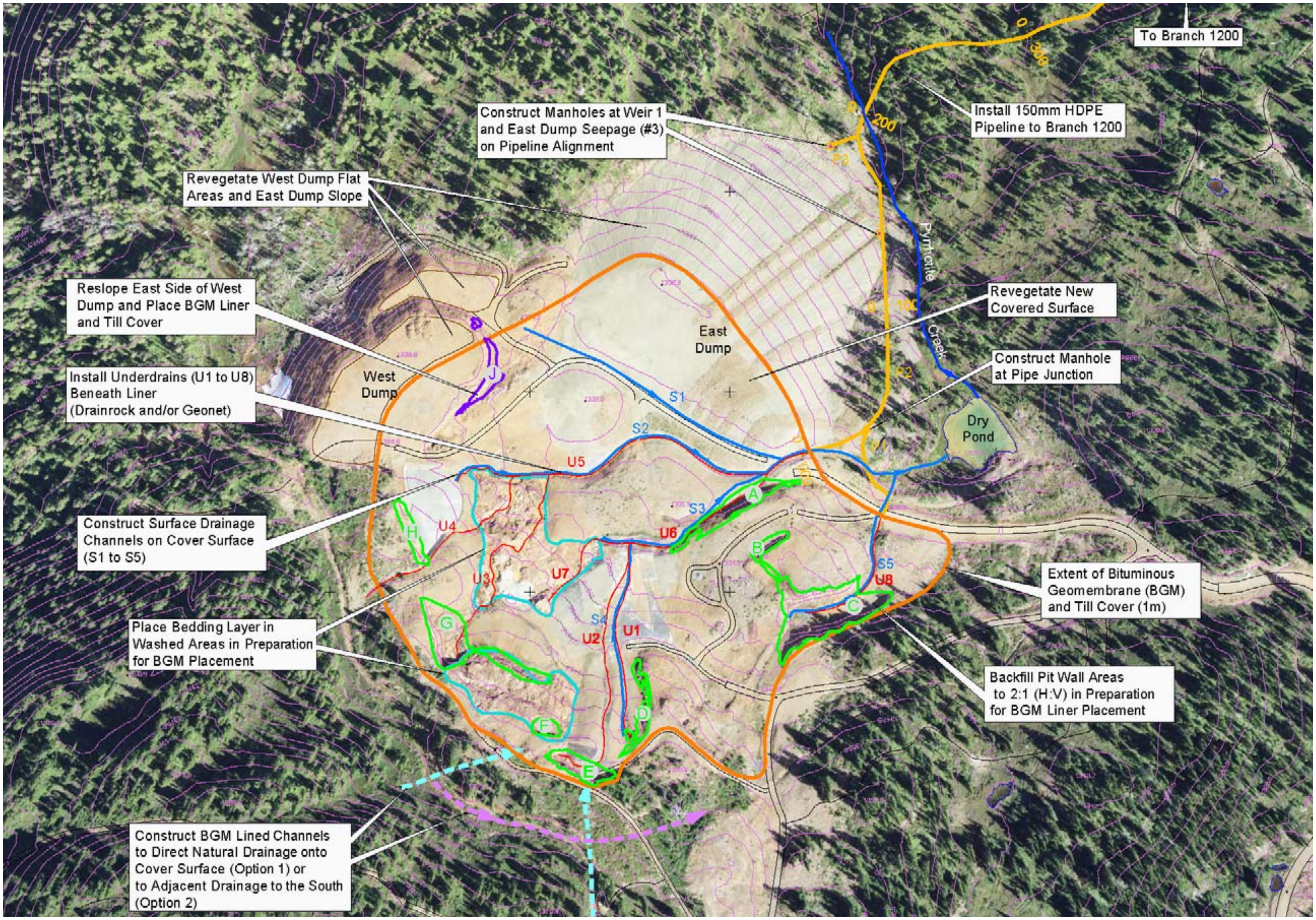

Figure 4: Proposed Remediation Measures

Water Treatment

The current plan includes a provision for short-term treatment of the underdrain flow from beneath the cover. A schematic of the treatment concept is shown on Figure 5. The underdrain flow would be collected and transported via a pipeline to Branch 1200 for treatment. An alignment of the proposed pipeline is shown on Figure 6. At Branch 1200, the flow would be treated with lime and discharged into sludge settling ponds. Clean water in Pyrrhotite Creek would be diverted around the ponds and over to Pyrrhotite Lake.

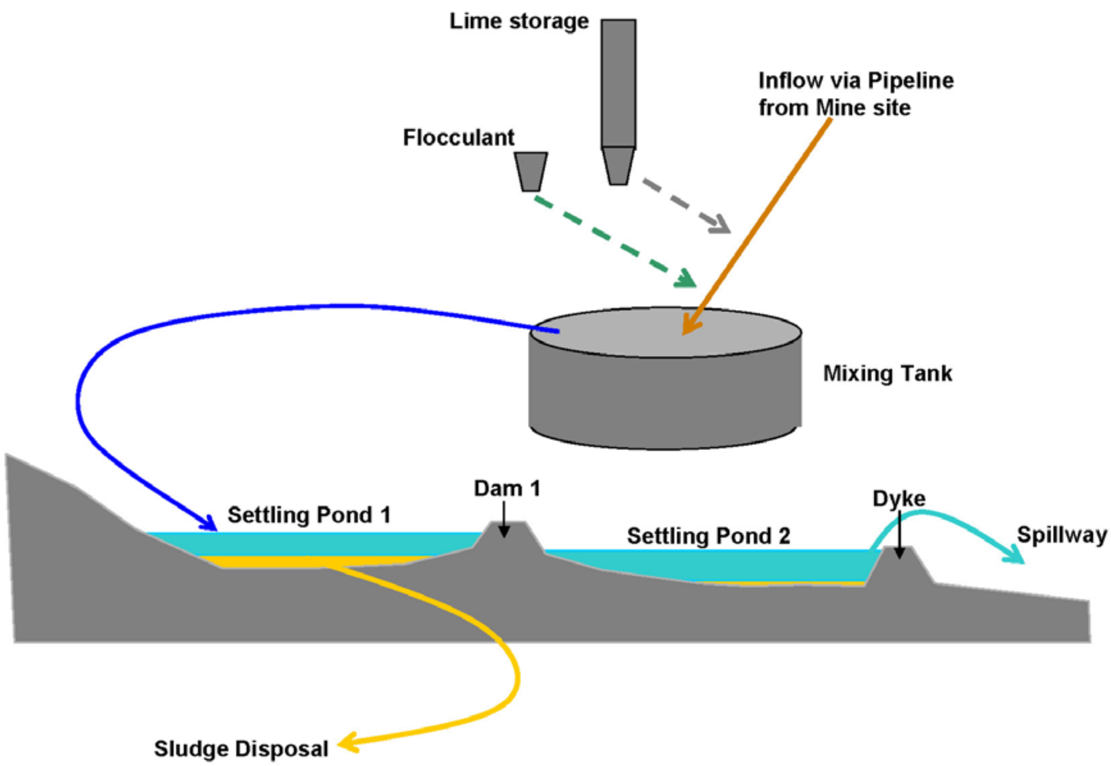

Figure 5: Schematic of the Water Treatment System

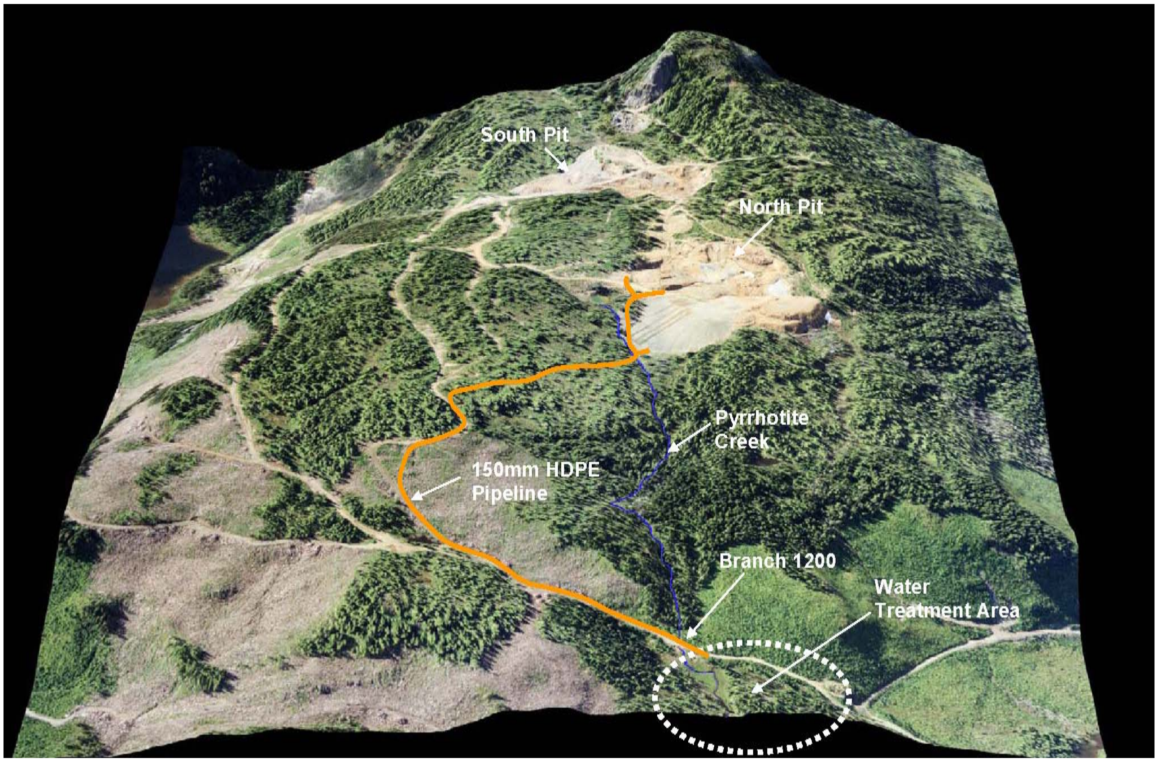

Figure 6: Proposed Pipeline Alignment from Minesite to Branch 1200

The treatment system would be based on hydrated lime addition operating 90 days per year. It is expected that about 5 tonnes of lime would be consumed each year and would produce about 60 tonnes of sludge.

A water quality monitoring program would be initiated following the construction of the cover in Year 1. The results of the monitoring program will be collated and in the spring of Year 3, a decision will be made as to the need for pipeline construction and lime treatment. This decision will be based on the establishment of copper loadings and concentration “triggers”.

Site Revegetation

The reclamation of the mine site areas will include the entire area of the covered pit and the capped areas of the East and West Dumps. The capping material will consist of locally available silt loam soil or glacial till.

Once the sites are capped, they will be seeded with a grass/legume seed mix to establish a fast growing ground cover that will provide erosion control. Consideration will be given to commercially available non-palatable (for ungulates) legume species with an assortment of bunchgrass and creeping grasses (erosion control) and possibly “pockets” of organic soil for site diversification and aesthetics. A shrub based cover will also be considered for the medium term.

Staging

The construction season for Mt Washington is normally mid June to late October. It is currently planned to complete the remediation over a three year period with placement of the cover, water quality monitoring and associated works in Year 1. The work in Year 2 would involve revegetation of the site; borrow area reclamations and instrumentation installation. If required, final design and procurement of the lime addition water treatment system, the installation of the pipeline to Branch 1200, construction of the settling ponds and the Pyrrhotite diversion at Branch 1200 would be carried out in Year 3.

Cost Estimate

Table 2 presents an engineering cost estimate in 2007 dollars for the implementation of the remediation measures spread over the proposed three year project schedule.

Table 2: Cost Estimate

Activity	Year 1	Year 2	Year 3	Total
Direct Costs				
Preconstruction	$190,427			$190,427
North Pit Drains and Cover	$1,903,375			$1,903,375
Uphill Diversion	$65,701			$65,701
Water Treatment				
Pipeline to Treatment System at Branch 1200			$88,228	$88,228
Settlement Ponds			$80,160	$80,160
Pyrrhotite Creek Diversion			$75,959	$75,959
Construct lime addition system			$199,500	$199,500
Borrow Area Reclamation		$12,475		$12,475
Site Revegetation		$205,195		$205,195
Instrumentation		$41,600		$41,600
Cover Repairs		$100,000		$100,000
Subtotal Directs	**$2,159,503**	**$359,269**	**$443,847**	**$2,962,619**
Indirect Costs				
Site Office	$40,000			$40,000
Survey	$20,000	$20,000		$40,000
Field Supervision	$18,000	$18,000	$9,000	$45,000
Contractor profit and home office overhead	$215,950	$35,927	$44,385	$296,262
Insurance	$10,798	$1,796	$2,219	$14,813
Bonding	$10,798	$1,796	$2,219	$14,813
Final Design Engineering, Technical Specs and Contract Doc	$129,570	$21,556	$26,631	$177,757
Field Engineering and QA	$107,975	$17,963	$22,192	$148,131
Mob - Demob	$60,000	$60,000	$30,000	$150,000
Living out allowances	$9,600	$9,600	$4,800	$24,000
Taxes	$164,521	$33,184	$34,757	$232,461
Subtotal Indirects	**$787,211**	**$219,823**	**$176,203**	**$1,183,237**
Total	**$2,946,714**	**$579,092**	**$620,050**	**$4,145,856**