DECOMMISSIONING AND REMEDIATION OF THE PINCHI LAKE MINE

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ABSTRACT

The Pinchi Lake Mine was owned and operated by Cominco Ltd. which was the predecessor of Teck Metals Ltd. (Teck) from 1940 to 1944, and again between 1968 and 1975. The property is located approximately 25 km northwest of Fort St James, British Columbia. After 1975, the mine was under care and maintenance with the surface facilities remaining intact. Beginning in 1996 Teck undertook a series of aquatic and terrestrial studies to determine potential impacts to the ecology of Pinchi Lake, upland portions of the mine site, and surrounding lands. In 2004 a Technical Working Group was formed, consisting of representatives from Teck, the Tl'azt'en Nations, and the Nak'azdli Band, which reviewed the studies and commissioned additional studies. Results from the environmental studies assisted in developing the Pinchi Lake Closure Plan and finalizing remediation activities. This paper discusses the scope of the reclamation plan, schedule and activities completed at the Pinchi Mine site.

In 2010 the site still had all of the surface facilities intact from the 1970s operations including a surface crusher, a mill with conventional grinding and flotation circuits, a mercury roaster, and a tailings impoundment facility. The paper discusses the works undertaken to decommission and reclaim the site. The primary objectives of the site were to physically and chemically stabilize the site, and to restore it to a state where there are no unacceptable risks to the wildlife or people using the site and surrounding areas.

Key words: Mercury, methyl mercury, First Nations, closure plan, cap

INTRODUCTION AND SITE HISTORY

The Pinchi Lake Mine is located on the north shore of Pinchi Lake, British Columbia approximately 25 km northwest of Fort St James, British Columbia. The mine site is located on property owned and operated by the Consolidated Mining and Smelting Company which subsequently was renamed Cominco Ltd. and is a predecessor of Teck Metals Ltd. (Teck). The mine was initially operated from 1940 to 1944 with much of the production supporting the Second World War efforts. Ore production rates were initially 50 t/d and increased to 1100 t/d by 1943. During this period, cinnabar ore was processed from both surface glory hole and underground mining methods with the ore being coarse crushed and roasted to recover the mercury. All of the roaster wastes ("calcines") were deposited on the shoreline and into Pinchi Lake. Subsequent to these operations closing, all structures were demolished. Later, the mine was redeveloped with a "modern" processing plant designed to process 800 t/d of ore using both crushing/grinding and froth flotation circuits. Fine grinding of the ore allowed separation of the cinnabar from other gangue minerals which was done in the flotation circuits. The gangue materials (tailings) were separated prior to roasting the concentrates, unlike the 1940's operations. The coarse fractions of tailings

Figure 1 –
Pinchi Lake Mill Site

from this process were deposited underground for backfill purposes and the finer fractions were deposited into an impermeable tailings impoundment area (TIA). The modern plant operated from 1968 to 1975 (Figure 1), at which time the facility closed due to declining mercury prices. As mineral reserves remained, the processing plant was placed under care and maintenance and remained intact until permanent decommissioning began in 2010. The 1940s processing practices occurred before the environmental dangers of mercury were well known and resulted in the release of mercury into Pinchi Lake. The impact of these releases was not known until 1970 when the elevated mercury content of lake trout was reported, resulting in a fish consumption advisory. Although fish tissue mercury concentrations have diminished considerably (Azimuth, 2012), the consumption advisory is still in effect. In the 1990s a series of studies were commissioned by Teck to gain a better understanding of the relative importance of various mercury and methyl mercury sources to Pinchi Lake to support environmental planning and management of the site. Between 2000 and 2004, several targeted reclamation projects were undertaken to improve the physical stability of the site, including resloping, armoring and capping of the calcine waste dumps; and the capping of the former sewage and spills lagoons. Between 2010 and 2012, the Pinchi Lake mercury mine underwent decommissioning, remediation, and reclamation of all the mine facilities as outlined in the Closure Plan titled "Pinchi Lake Decommissioning and Reclamation Plan" (Marsland Environmental Associates, 2009), and the site is now in the post-reclamation monitoring and risk management phase.

This paper is one of four papers prepared on the work and studies associated with the closure activities at the Pinchi Lake Mine. The other papers include "Use of Ecological Risk Assessment to Guide Remediation at The Teck Pinchi Lake Mine (Allard, *et al.*, 2013), "Pinchi Mine Closure – Demolition Debris Disposal" (Marsland, *et al.*, 2013), and "The Long Term Post Reclamation Management of the Pinchi Lake Mine" (Unger, *et al.*, 2013).

BACKGROUND STUDIES

Between 1970 and 1985 several published aquatic studies indicated elevated, but declining mercury concentrations in Pinchi Lake fish (Peterson *et al.*, 1970; Reid and Morley, 1975; Martin *et al.*, 1995). More comprehensive fish studies commissioned by Teck in 1995, 2000, 2005, and most recently in 2011.

These studies indicate that fish mercury concentrations have continued to decline gradually since mining ceased in 1976 but recovery to 'regional' fish mercury concentrations may take several decades or longer.

Between 1993 and 1998 Teck commissioned a series of investigations to examine the mine site and its relationship with Pinchi Lake with respect to mercury. The studies resulted in two summary reports titled "Pinchi Lake Mine Site and Lake Investigation Data Report" (EVS, *et al.*, 1999), and "Pinchi Lake Mine Site and Lake Investigation Environmental Assessment Report (EVS, *et al.*, 1999).

Beginning in 2000 a number of short term site maintenance projects were undertaken to stabilize the site while more detailed site studies continued to support the longer term development of a site decommissioning and remedial plan. Fundamental to this was the "Pinchi Mine Ecological Risk Assessment (Azimuth Consulting Group Inc., 2009). The information contained within these studies was used to design and implement many of the site remedial works that were undertaken between 2010 and 2012.

The number of technical studies and their scope are too extensive to detail here but are listed in the Bibliography section.

REGULATORY AND FIRST NATIONS CONSULTATION PROCESSES

The Pinchi Lake Mine was first permitted by the Ministry of Energy and Mines (MEM) in 1979 under Mine Reclamation permit M-5. The original permit being one of the first ones issued in the province is brief and has little detail. This permit had four amendments, with the latest amendment to authorize the implementation of the Closure Plan. Development of the Closure Plan began in 2006 and it took almost three years of effort to consider various options, to include information from previous and ongoing technical studies, and to receive and respond to input from First Nations.

Integral to the development of the Closure Plan was a comprehensive consultation process with the Tl'azt'en First Nations and the Nak'azdli Band (First Nations) that began in earnest in 2005. In 2006, a formal "Pinchi Mine Protocol Agreement" (Agreement) was signed between the Tl'azt'en Nation, the Nak'azdli Band Council, and Teck. This Agreement was the result of over a year of discussions between the parties. The Agreement is to guide the parties in future dealings with respect to the mine including conducting reviews and studies related to the mine, and to accommodate First Nations regarding reclamation and future work at the mine. As part of the Agreement, a Technical Working Group (TWG) was formed including representatives from Teck, the Tl'azt'en First Nation and the Nak'azdli Band. The role of the TWG was to develop the Closure Plan for the site by reviewing previous environmental and human health studies; to identify data gaps, to jointly agree to the scope and to direct additional studies to be undertaken; and to consult with the First Nation's communities that use the areas surrounding the site. Throughout the development of the Closure Plan, the TWG met thirteen times, held four community tours of the site (including community members, affected Keyoh Holders, and Elders), and had three community meetings. Newsletters were circulated to several communities and numerous other less formal meetings and discussions were held with the community. A site tour for nearby neighbours was held, as well as an open house in Fort St. James for other interested community members. In November

2008 the draft Closure Plan was formally approved in a letter to Teck by the Chief and Councils of both the Tl'azt'en First Nations and the Nak'azdli Band.
With First Nations formal support for the Closure Plan, Teck applied for an amendment to the site's Reclamation Permit in May 2009 to approve the work program contained in the Closure Plan. MEM established a Mine Development Review Committee who reviewed the Closure Plan and the supporting technical studies. The review committee invited representatives from MEM, Ministry of Environment, Environmental Protection Division and Contaminated Sites Divisions (MoE), Environment Canada, Department of Fisheries and Oceans, Northern Health, Ministry of Transportation, Ministry of Forests, Regional District of Bulkley-Nechako, and 3 First Nations (of which the Tl'azt'en First Nation and the Nak'azdli Band participated). A meeting was held to present the Closure Plan and introduce all of the supporting documents to the Development Review Committee. The following day was set aside for a site tour for interested Committee members. Copies of the Closure Plan and supporting studies were distributed on an as requested basis by the participants. Teck received and responded to 110 questions and comments on the Closure Plan. MEM approval of the amended Reclamation Permit was issued on July 12, 2010.

The approved Reclamation Permit included requirements for additional studies and approvals to be obtained as part of the implementation of the Closure Plan. The Closure Plan included the establishment of an on-site landfill for the process plant demolition debris rather than removing debris from the site for resale or disposal. This required Approval for the on-site landfill and included the requirement for a "Mercury Removal and Debris Management Plan" for materials being disposed of in the landfill. This was conducted as a separate process with the MoE, Environmental Protection Branch. The Approval required the development of a site specific testing protocol and a cleaning protocol for debris being landfilled on-site. Details on this aspect of the closure process are contained in the paper entitled "Pinchi Mine Closure – Demolition Debris Disposal" (Marsland, *et al.*, 2013).

In accordance with the conditions in the Reclamation Permit and as a requirement of Independent Remediation, a contaminated sites review of non-core areas of the site is required by MoE related to the Contaminated Sites Regulations (CSR). Teck will continue to own the land and manage the site for the long term and as such will not require a Certificate of Compliance. However since the site is classified as a "high risk" under the CSR, the MoE will be reviewing the site assessment and remediation reports to ensure that site conditions are acceptable and adequately risk managed in the long term. This process began during the reclamation phase of the project and is on-going at the current time.

A requirement in the Reclamation Permit amendment was for Teck to develop a long term monitoring plan. A comprehensive draft monitoring and risk management plan has been developed and is still in the process of being reviewed by regulators. This plan is a fundamental document to guide monitoring and risk management of the site going forward. The paper entitled "The Long Term Post-Reclamation Management of the Pinchi Lake Mine" (Unger, *et al*., 2013) discusses the development and details of this monitoring and management plan.

Separate from the Reclamation Permit, Teck is in discussion with MoE, Environmental Protection Division regarding updating Teck's surface water effluent permit to reflect the current status of the closed

and reclaimed mine. The amended permit will focus on the two primary sources of effluent discharge which includes the tailings impoundment area and the underground mine workings from the 750 Level Portal.

IMPLEMENTATION OF THE DECOMMISSIONING AND REMEDIATION PLAN

Reclamation Objectives

The primary objectives of the Closure Plan were to ensure for the long term; that:

1. The site will be physically stable to ensure migration of mercury and other potential contaminants of concern do not pose unacceptable risks to either the aquatic or terrestrial environments;
2. Through the use of risk management and physical protection measures, the site does not present unacceptable risks to either human health or safety, or to wildlife populations utilizing the site;
3. Site reclamation complements adjacent wildlife habitat so that the entire area will continue to support viable wildlife populations; and
4. The traditional use of the areas surrounding the Pinchi Mine site by First Nations is safe and can be facilitated, consistent with ensuring public safety and adherence to Mines Act requirements.

Scope of the Closure Plan

The scope of the Closure Plan is consistent with decommissioning and reclamation activities that would occur at most small scale metal mine sites. Decommissioning and reclamation included the removal of hazardous materials from site, demolition of all structures and buildings, remediation of special waste spills, the sealing of mine portals, decommissioning the tailings impoundment area, re-contouring and/or partial filling of open pits, closure of landfills, decommissioning of roads, and re-vegetation of the site.

A number of the less conventional aspects of the activities undertaken included:

- Dismantling of the mercury contaminated process facilities which had a number of challenges including the health and safety issues associated with the potential for workers to be exposed to mercury; the development and approval for landfilling the process facilities debris onsite; and the shipping of substantial quantities of mercury contaminated residues off site for disposal and recycling; and
- Decommissioning of the tailings impoundment area included constructing an active spillway to maintain a dry tailings facility for geotechnical and ecological reasons, as well as capping the tailings to improve re-vegetation success and for ecological risk management reasons. Capping of the tailings utilized winter conditions to facilitate working on top of the low strength tailings.
- Each of these aspects is discussed below.

Dismantling and disposal of the process facilities

In preparation for decommissioning the process facilities (including the primary crushing and conveying structures, the concentrator and the roaster facilities) all underwent a detailed hazardous materials survey. Typical of industrial facilities constructed in the late 1960s, the mill contained a range of hazardous chemicals, friable and non-friable asbestos materials, lead paints, mercury containing lights, and polychlorinated biphenyl (PCB) contaminated electrical transformers (PCB oils had been previously removed). In addition, the building, and equipment had substantial mercury sulphide (cinnabar), mercury

oxides, and metallic mercury contamination. The hazardous chemicals, friable asbestos, and PCB contaminated transformers were removed in the conventional manner and shipped off site for disposal at licensed facilities. Mercury vapours in the mill were a function of location within the facility (i.e. roaster areas had the highest concentrations), outside air temperatures, and interior building temperatures (due to the mass of equipment and concrete, interior temperatures were different from exterior temperatures). Mercury vapour pressures are very temperature dependent. It is also known that mercury residues tend to form a protective coating that limits release of vapour from liquid mercury until its surface is disturbed. Once building materials or equipment were agitated during work activities, vapour levels in the work area would increase. From the planning stage, it was recognized that work within the more contaminated areas of the mill should be scheduled for early winter months when temperatures were cooler. Work later in the winter (January to March) was minimized or suspended to avoid the much colder temperatures and deep snow.

As worker health and safety was the primary consideration, standardized, protective work procedures were established. Personnel working in the process facilities were trained in comprehensive safety protocols; wore protective clothing, filter masks, and personal dosimeter badges; had separate change and wash facilities; and underwent weekly urine testing to check for mercury exposure. Mercury vapour concentrations were tested frequently with a Gerome mercury sampler during each shift.

Before demolition of the building could commence, the range of hazardous materials were removed and cleaning of building structures and equipment from mercury containing materials was conducted. Work removing hazardous materials began in October in service buildings and then progressed to the crusher area where mercury vapours were low, as mercury contamination in these areas primarily consisted of mine run ore and dust (containing cinnabar). Small quantities of metallic mercury were located within some of the crushing and ventilation equipment. By November, the cleaning activities progressed towards the conventional grinding and froth flotation areas of the mill where most of the mercury contamination continued to be cinnabar as expected. Demolition work was done using an excavator with a wrecking ball and other excavators with hydraulic shearers. The demolition crews could not start on a building until the decontamination crew had finished their work and signed off the area as being ready for demolition. Demolition of the roaster and associated equipment was the last to be done.

There was an elaborate procedure to dismantle the roaster after the building had been removed from around it. The roaster was contained before being laid on its side, cut open, and manually emptied of its contents (Figure 2) to minimize spreading of contaminants. This occurred in mid to late December so it was conducted under winter temperature conditions. Demolition of the facilities was essentially completed by December 23rd 2010 with final cleanup of demolition debris occurring in January 2011. During the demolition process there were no loss time accidents and no workers had unacceptable mercury exposures as monitored through the urine tests.

Figure 2
Preparing roaster soot & brickwork
for off-site disposal

The majority of the building debris was able to be placed into an on-site landfill after being cleaned and tested. The site specific testing, cleaning, and environmental protection requirements were a significant challenge. The paper entitled "Pinchi Mercury Mine Closure – Demolition Debris Disposal" (Marsland, *et al.*, 2013) discusses the methods and intensity of characterizing mercury contamination, the evaluation of disposal options, the permitting and design of the onsite landfill, and the monitoring to verify that drainage from the base of landfill was not affected by the disposal of the process facility materials.

Another significant challenge was encountered when trying to dispose of the liquid mercury and other mercury contaminated debris responsibly in a manner acceptable to Teck's Product Stewardship Committee. There was approximately 47,000 kg of mercury contaminated residues and debris that required off-site disposal. Much of this material was from the site's mercury roaster and building. Recycling facilities and disposal locations for mercury within Canada are very limited. After carefully considering a number of options, the preferred option was to ship the materials to Clean Harbour's facility in Quebec for recovery of the mercury from the residuals. The cleaned residues were stabilized and then landfilled at the Clean Harbour's Lambton facility in Ontario. An environmental audit of the Clean Habour's facility was done prior to shipping the residues to them. The liquid mercury separated from the residues was shipped to the Bethlehem Apparatus Co. in the US where the mercury was further purified by roasting and then sold as a marketable product. Bethlehem sells their mercury to reputable manufacturing companies to produce mercury containing products such as fluorescent light bulbs. It was important to ensure that the mercury was not inadvertently getting into the black market, which is then commonly used to mine gold in developing countries. It took more than a year to verify the preferred disposal option, obtain adequate contractual documents, and to dispose of the residues.

Decommissioning of the tailings impoundment area

The tailings impoundment area (TIA) consists of a dam which retains approximately 22 ha of exposed tailings of which a portion was covered by a ponded area. The tailings are contained on three sides by the dam which varied in height between 3m and 15m. While the tailings dam was evaluated to be able to withstand a 1 in 10,000 year seismic event for both static and pseudostatic conditions, the geotechnical stability was improved during the site reclamation program by lowering the phreatic surface within the dam and tailings impoundment area by installing an active spillway. The spillway invert is at the same elevation as the surface of the tailings to eliminate ponding of water within the TIA. The tailings are not acid generating, so there was no benefit to maintain a water cover. However the ERA studies "Use of Ecological Risk Assessment to Guide Remediation at The Teck Pinchi Lake Mine", (Allard, P., *et al.*)

identified the tailings pond area as the area of highest ecological risk on the site due to the methylating environment created by the tailings pond in combination with an abundant aquatic habitat. The edge of the pond had marshy habitat for aquatic organisms and a range of wildlife species. The uptake of methyl mercury through the food chain by insects and benthic organisms to birds and other small mammals, and to carnivorous mammals and birds from small mammals were determined to be of potential concern. Elimination of the aquatic environment within TIA effectively breaks these food chain pathways

The exposed dry tailings area was less important from a mercury methylation perspective, but posed moderate to high risks to browsing or burrowing animals from exposure to inorganic mercury, arsenic and antimony. Evaluating the range of species of both the large and small mammals using the area, the applicable food sources and burrowing habits, it was determined that a minimum 0.5m thick cover would provide a sufficient barrier to ensure acceptable exposure risk levels. In the former pond area with high concentrations of methyl mercury, First Nation's and the TWG had concerns that capping plans weren't being conservative enough. In response, the minimum cap thickness for the pond area was agreed to be 1.0m. In addition, based on recommendations from one of First Nation's consultants, a layer of chemically stable iron sulphate sludge from Teck's former Sullivan Mine site was spread over the pond sediments. The intent of the sludge is to act as a chemical barrier to sequester the methyl mercury in the sediments. With respect to the cap thickness, it is important to note that mercury uptake in vegetation is not a concern at this site as plants do not take up mercury through their root system. Sampling of plants growing directly on the tailings was done to confirm this.

When planning the capping of tailings, previous experience placing till into the tailings impoundment area demonstrated that heavy construction equipment could only work in limited locations due to the weak structural nature of wet tailings. Finely ground tailings retain pore water which results in the wet tailings having similar properties to quick sand. Additionally, while surface water had been removed from the impoundment area, the tailings are very fine (over 93% passing 250 μ) and have a very low hydraulic conductivity; so the tailings are not easily dewatered. There were two options to cap the tailings from a practical perspective; the first was to increase the thickness of capping up to 1m to 2m thick (and potentially augmented by using synthetic liners/mats to improve the load bearing capacity), or do the capping during winter when the top of the tailings could be frozen due to local cold climatic conditions. Temperatures of -20^{o}C to -25^{o}C are not uncommon in the Pinchi Lake region during winter. The latter method was chosen and in the early winter of 2011, efforts to drive the frost into the tailings were undertaken. Once the tailings surface was verified to have adequate bearing capacity, the till capping of the tailings began at the end of January of 2011 and was completed by March 22nd 2011, with approximately 150,000 cu.m. of till placed on the tailings. The contractor worked 24 hours per day to ensure the borrow pits did not freeze up and to complete the work before spring temperatures started to increase. Snow removal issues complicated the work but it was still easier than to try and cap the tailings during the snow free periods of the year. The following summer, some areas had settled (primarily under snow piles left from snow clearing efforts) and minor maintenance filling of the tailings cap was required. It is expected that additional touchup work may be required in 2014 if further localized settling occurs. The cap was subsequently re-vegetated with a mix of grasses, shrubs and trees.

CURRENT SITE STATUS

Reclamation of the site was completed in September 2012. Due to the climate and the quantities of till at the site, the re-vegetation efforts are showing rapid progress. Regular biannual surface water quality monitoring has shown some surface water quality improvements since closure however frequent sampling will continue for another two years to confirm the status of the site before sampling frequencies begin to decrease. In 2016 the next fish mercury study will be undertaken which includes a comprehensive ecological sampling program of the adjacent Stuart and Tezzeron Lakes in addition to Pinchi Lake. As previously indicated, trends of methyl mercury concentrations in fish are being considered the bellwether species to monitor the health and progress of recovery for the aquatic environment. For the terrestrial environment, the first post-reclamation terrestrial ecological risk assessment review is not scheduled until 2022. This recognizes that it will take time for vegetation to initially re-establish along with the stabilization of insect and wildlife populations use of the site so that the results of the reclamation work can be adequately monitored. Groundwater monitoring and sampling is also occurring three times a year to get a good understanding of seasonality trends as part of the CSR investigations. Pending the results in 2013, the data will be re-evaluated to determine if the sampling frequency could be reduced.

The site is being risk managed and so periodic and on-going monitoring of environmental conditions will be necessary to demonstrate that the Closure Plan actions continue to meet the original objectives of the plan. The monitoring must be sufficient to identify if there are any issues of concern over time so that management actions can be developed to address them. To support this, a formal risk management plan has been developed. The plan includes environmental as well as geotechnical aspects. It is a detailed document to ensure that the knowledge used to remediate and reclaim the site and to develop the risk assessment process is not lost over time. Much effort has been put into developing a prescriptive plan which describes the frequencies, locations, types and numbers of samples required, and the protocols for taking and analyzing those samples. Long term trends are key to monitoring the health of the site and the collection of comparable data sets is needed to give confidence when reviewing data trends. The long term risk management plan also allows for the calculation of long term monitoring costs for the site which will be used by the Ministry of Mines to review the site's reclamation security requirements. Refer to the paper entitled "The Long Term Post Reclamation Management of the Pinchi Lake Mine" (Unger, *et al.*, 2013) for additional information.

Teck continues to work with First Nations with regard to the site and have been discussing updating the formal Protocol Agreement for the site to reflect long term post-reclamation monitoring activities. As discussed earlier, CSR investigations at the site continue which currently includes groundwater investigations and future aquatic sediment investigations are planned. Teck is also supporting an independent study related to minks and otters in Pinchi Lake which will be completed by the John Prince Research Forest.

Although the site as remediated poses no unacceptable risks to resident caretakers or authorized visitors, trespassing is discouraged, in part to ensure that disturbance of areas managed by capping or other containment systems does not occur.

REFERENCES:

Allard, P., Baker, R., and Mackintosh, C. 2013. Use of ecological risk assessment to guide remediation at the Teck Pinchi Lake mine. Prepared for the 2013 Mine Reclamation Symposium, Vancouver B.C.

Azimuth Consulting Group (Azimuth). 2009. Pinchi mine ecological risk assessment. Prepared for: Teck Metals Ltd., Bag 2000, Kimberley BC by Azimuth Consulting Group, Vancouver. June 2009.

Marsland Environmental Associates. 2009. Pinchi Lake decommissioning and reclamation plan 2009. Prepared for Teck Cominco Metals Ltd.

Marsland, R., Unger, M., Donald, B. 2013. Pinchi Lake Mine Closure – Demolition debris disposal. Prepared for the 2013 Mine Reclamation Symposium, Vancouver B.C.

Unger, M., Donald, B., and Marsland, R. 2013. The long term post reclamation management of the Pinchi Lake mine. Prepared for the 2013 Mine Reclamation Symposium, Vancouver B.C.

BIBLIOGRAPHY:

Baker, R.F. and G.S. Mann. 2002. Assessment of sediment mercury contamination, Pinchi Lake, BC. Report prepared by EVS Environment Consultants and Azimuth Consulting Group for Teck Cominco Metals Ltd.

Baker, R.F., G.S. Mann and M. McConnell. 2013. Pinchi Lake mercury mine – fish mercury study 2011. Prepared for Teck Metals, Kimberley BC by Azimuth Consulting Group Partnership. Vancouver BC.

Baker, R.F. 2001. Regional survey of fish mercury concentrations, Pinchi Lake, BC. Report prepared by EVS Environment Consultants for Cominco Ltd.

EVS Environment Consultants. 2000. Fish mercury survey Pinchi Lake region B.C.

EVS Environmental Consultants Ltd., Azimuth Consulting Group Inc. 2000. Assessment of sediment mercury contamination, Pinchi Lake, BC.

EVS Environment Consultants, Norecol Dames and Moore, and Frontier Geosciences. 1999. Pinchi Lake mine: mine site and lake investigation – environmental assessment report. AND Mine site and lake investigation data report for Cominco Ltd.

Mann, G.S., R.F. Baker, McConnell, M and Gould, R. 2008. 2006 Regional fish mercury and Pinchi Lake ecology report. Prepared for Teck Cominco Metals, Kimberley BC by Azimuth Consulting Group Inc., Vancouver BC.

Marsland Environmental Associates Ltd. 2009. Pinchi mine geochemical assessment of waste rock and tailings.

Martin, J.W., W.F.A. Duncan and M.N.M. Masselink. 1995. Mercury concentrations in fish tissue and sediment from Pinchi Lake, B.C. draft report. B.C. Environment, Environmental Protection, Prince George, B.C.

Peterson, G.R., H.V. Warren, R.E. Delavault and K. Fletcher. 1970. Heavy metal content of some fresh water fishes in British Columbia. Fisheries Technical Circular. No. 2. British Columbia Fish and Wildlife Branch. 33 p.

Plouffe, A. 1995. Glacial dispersal of mercury from bedrock mineralization along Pinchi fault, north central British Columbia. Water, Air and Soil Poll. 80: 1109-1112.

Przeczek, J. 2012. Pinchi Lake mine 2012 planting and 1st growing season seedling survival assessment.

Reid, D.S. and R.L. Morley. 1975 Mercury contamination of fish from Pinchi Lake. BC Habitat Protection Service, Fish and Wildlife Branch, Department of Recreation and Conservation, Victoria BC.

RT Geosciences Inc. 2004. Results of July 2004 ambient air monitoring Pinchi Lake mine site, Pinchi Lake, British Columbia.

Siegel, S., Siegel, B. Lipp, C., Kruckeberg, A., Towers, G., Warren, H. 1984. Indicator plant-soil mercury patterns in a Mercury-rich mining area of British Columbia.

URS, Vancouver, BC. 2008. Environmental site assessment Pinchi Lake mine site Pinchi Lake, BC.

Weech, S., Scheuhammer, A., Elliott, J. 2005. Mercury exposure and reproduction in fish-eating birds breeding in the Pinchi Lake region, British Columbia, Canada.

Wilson W. 2010, Human health risk assessment of the Pinchi mine and Pinchi Lake Are.