Inventory of Mine Tailings and Ponds in the Salmo Watershed

SALMO WATERSHED Streamkeepers SOCIETY

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November 2000

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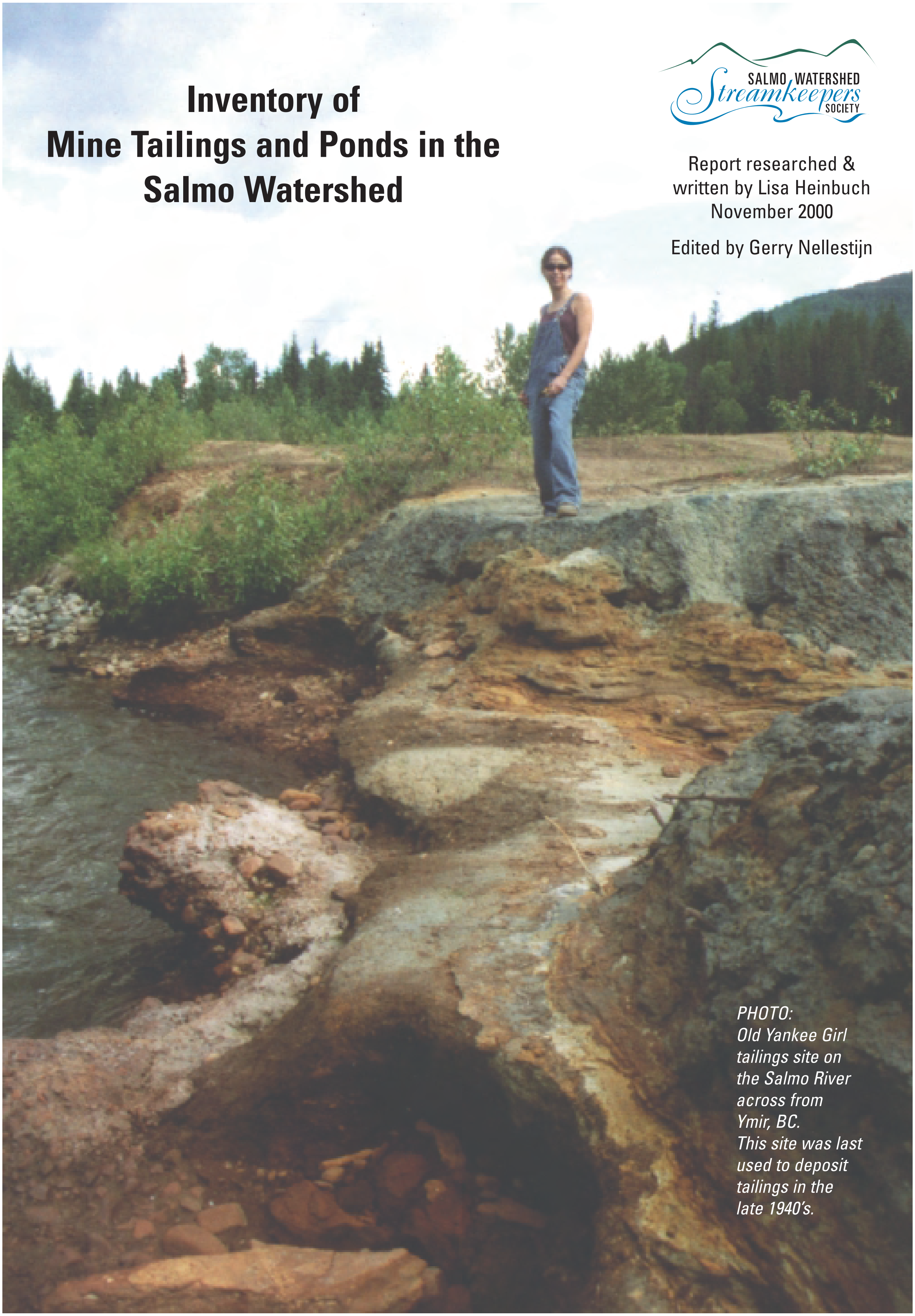

*PHOTO:
Old Yankee Girl tailings site on the Salmo River across from Ymir, BC.
This site was last used to deposit tailings in the late 1940's.*

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Acknowledgements

The Salmo Watershed Streamkeepers Society would like to thank everyone who made this project possible. We would like to express our appreciation to the following specialists and individuals who shared their knowledge, time, and guidance to help us explore and understand the history of our Watershed. We are a community based group and without our community none of this would have been possible.

Ministry of Environment Lands and Parks, Nelson
- Sylvie Mass for doing the water and sediment sampling
- Carl Johnson for information regarding the Second Relief Mine

Ministry of Forests, Nelson
Ministry of Energy and Mines, Cranbrook

Chamber of Mines, Nelson

Salmo Public Library
Nelson Public Library
HRDC for the funding of this project

Tim Robinson and Keith Davies for their assistance with traverse notes,
Belinda from the Palace in Ymir who lent us her historical documents,
and Alice Nellestijn for time and assistance with photo scanning and formatting of this report.

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BC Archives

Executive Summary

The purpose of this report is to compile a general inventory and brief history of the historical mines, tailing piles, and ponds in the Salmo River Watershed. We have broken the watershed down into specific areas in which there was dense mine development. Each area is discussed and the major producing mines and mills and significant tailing piles are located. These areas include some of the tributaries of the Salmo River as well as the river itself.
We have prepared maps in order to give a visual perspective of the density of mines in each area. It is necessary to say that these maps are in no way exhaustive, there were at one time in this valley, around the turn of the last century, some 600 operating mines. The Salmo Watershed Tailings and Mine Locations map on the next page illustrates all of the mines and tailings that we could look at in yellow and the tailing piles of priority concern to the health of the Salmo River, in red.

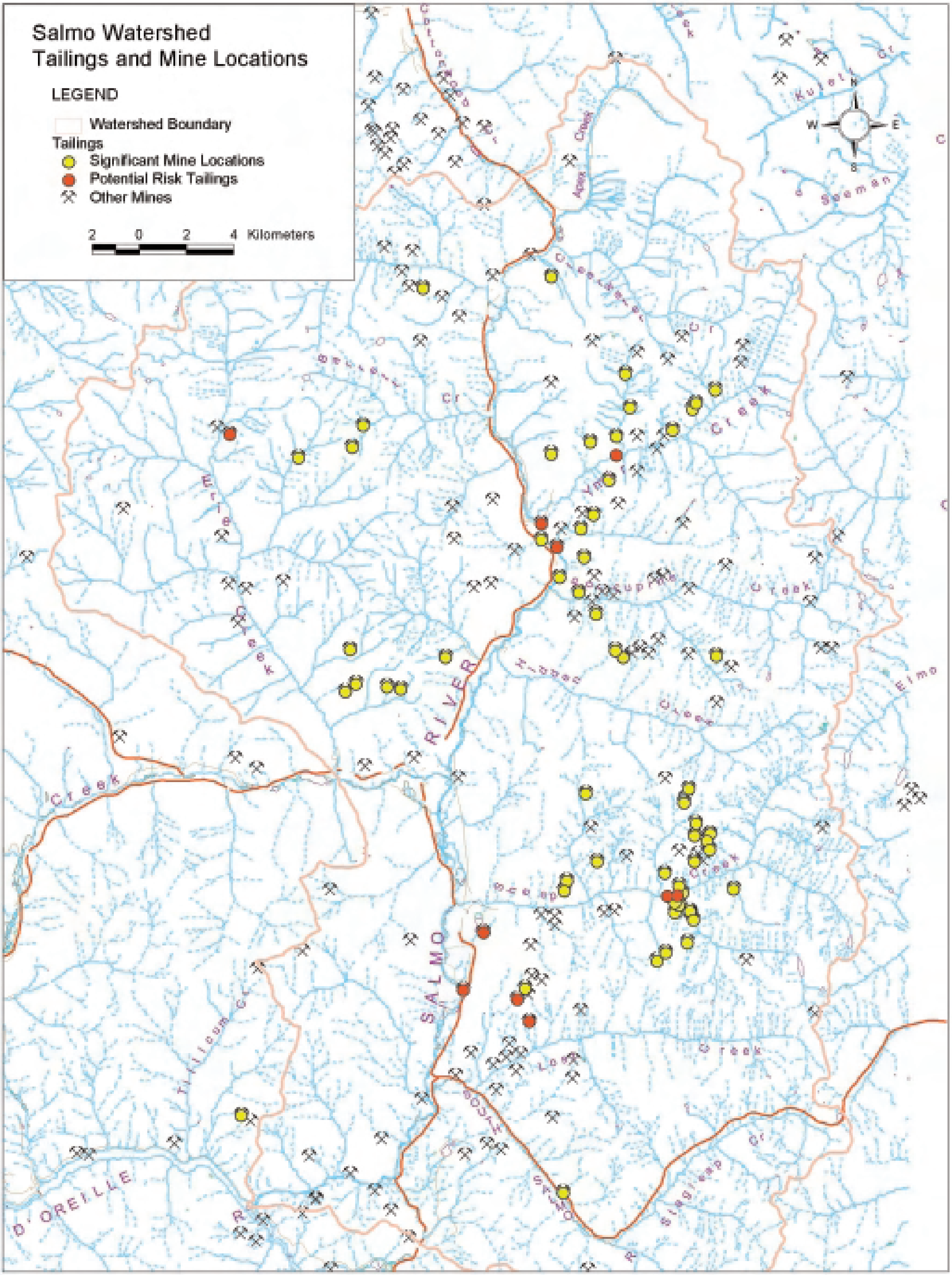
The tailing piles were prioritized by their visual size and proximity to water courses. The tailings of priority concern are significantly large and directly adjacent to the Salmo River. The other tailings that we looked at were visible by helicopter or by vehicle when exploring these old mining roads.

We would like to stress that it is probable that the tailings these mines have produced may continue to have significant impact on our precious waterways. It is for this reason we are trying to identify areas of concern. We hope that each one of these areas will recieve further attention in order to recruit them back toward naturally functioning ecosystems.

An explanation of the milling processes includes flow charts to show which part of the mineral extraction process the mine waste comes from and why. Common environmental hazards due to the mineral extraction process such as acid mine drainage and metal toxicity are also discussed.

The two main areas of concern, that we were able to identify are the Yankee Girl Tailings located at the tributary of the Salmo River and Wildhorse Creek , and the Wesko tailings from the Center Star mine located near the confluence of the Salmo River and Ocsar Creek. These two tailings locations are by no means the only locations that we hope community action can help deal with in the near future. Other locations in the Sheep and Wildhorse Creek watersheds deserve our consideration.

In partnership with the Ministry of Environment, water and sediment sampling were accomplished on the Yankee Girl Tailings. Due to the negative visual impact, the possibility of sulphurose summer dust clouds, and results that exceeded BC criteria for aquatic life and drinking water quality we feel that it is extremely important to carry out a reclamation project along the banks of the Salmo River at this site.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Preamble

The following report is a compilation of research done on the history of mining, with a focus on the legacy of mining waste in the Salmo River Watershed. Throughout the summer of 2000 the Salmo Watershed Streamkeepers Society (SWSS) have focused on finding out what has been left by the mines and mills that have created the framework of our existing communities. Within our time frame and budget we have been able to prepare a general inventory of abandoned mines and their waste dumps that remain along the mainstem of the Salmo River, its tributaries and riparian areas. Due to time restraints and lack of funding we have been unable to undertake complete environmental assessments on any of these sites but do hope to illustrate the need for further assessment in certain areas. Potential contaminants are discussed in this report as well as milling processes and recommendations for further investigation.

Our ultimate goal is to negate any detrimental effects of tailings on the environment, especially those that may effect the river's health. In this case we feel that mine reclamation and watershed restoration are essential to maintaining a healthy and functioning ecosystem.

Due to results received from the Ministry of Environments water quality sampling on and around the Yankee Girl tailing pile, we are in the process of preparing a reclamation prescription for this site. We hope to contain any further leaching of elements that exceed provincial water quality standards for aquatic life and drinking water. We are a community group who deeply cares about our watershed and the life that it supports and we are simply interested in finding out exactly what state it is in. This report was not in any way conducted to blame the mining industry for inadequate environmental practices in the past. We are aware that things are different now. SWSS realizes that proponents of the mining industry are also aware of past inadequacies. We are also aware that they have considerable insight and knowledge that we hope to engage in the restoration of these historical sites.

Introduction

Mining is responsible for life, as we know it, in the Kootenays today. It has created the framework of our economic and social systems. It has also become a topic of great controversy. On one hand, it is or was, a mainstay of regional economies that provides jobs, tax revenue, and a range of economic benefits. On the other hand mining activities pose challenges to the rich ecological values of the region.

There has been a growing awareness of the environmental legacy of mining activities that have been undertaken with little respect or care for the environment. Recent changes in laws, technologies and attitudes have begun to address some of the threats posed by mining production. It is important to note that in the 'early days' technology was limited and we were in the initial stages of impacting the earth. Mining was in its preliminary stages and its impacts on the environment were not known, understood or acknowledged until recently. These days we are learning from our mistakes and realize the crucial need to take action on some of these mine related issues due to ore processing and its waste that pollute our precious water ways.

What We're Doing

During the summer of 2000 the Salmo Watershed Streamkeepers Society have been collecting research about the mining history in the Salmo River Watershed. The goal of this project is to find out "what is out there, " along the Salmo River and it's tributaries. We have prepared an inventory of mines, tailings, and waste rock piles and ponds within our watershed. The direction of this report has led us to the concept of mine reclamation. Our ultimate goal is to become aware of and begin to prescribe ways to negate detrimental effects, if any, of mine tailings on the surrounding environment, especially ones that may effect the health of our river system. We

hope to contain any potentially damaging agents such as heavy metal leaching and acid mine drainage that may be harmful to humans and other organisms within our functioning environment.
Due to the abundance of mines, both large and small, within our region we have decided to focus in on a few significant "hot spots."
These areas were selected because of the density of mines, mills and tailings that are found there. Specific mines were chosen because of their significance. Meaning they were once main producers in the district. Due to this high production, the waste from their mills have been placed along waterways or are of significant size and located within a major drainage area. The areas of focus are; Ymir or Wildhorse Creek, Sheep Creek, Erie Creek and the Mainstem of the Salmo River.

A Short History

Current settlement patterns in the Salmo River Watershed are due to the great mining boom that began in the late 1800's. In order to understand the ecology of our river system it is important to gain an understanding of its history.

The early history of mining in the Salmo River valley dates back to the first discovery of placer gold. This discovery is credited to men of the Hudson's Bay Company who in 1865 discovered gold at the mouth of the Pend d'Oreille. From there they began edging their way north up the Salmon River in a constant search for new placer creeks (creeks that contain gold). Their quest brought them to some of the tributaries like Erie, Sheep, Hall, Wildhorse and Quartz creeks that carried placer gold. These areas were exploited throughout the late 1800's, but as the placer gold began to dwindle attention was turned to lode mining for the great hard rock.

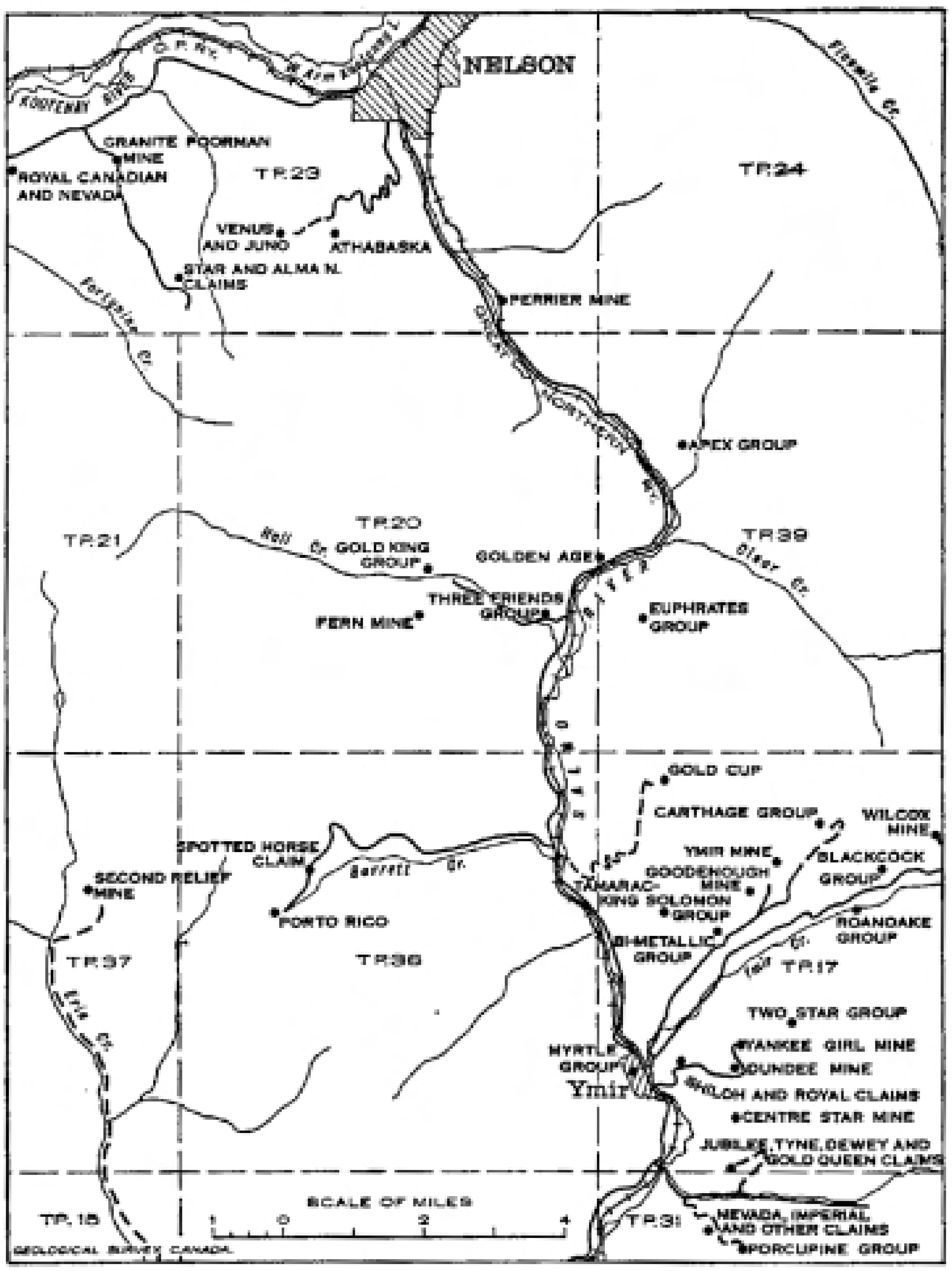
Numerous claims and developments were worked intermittently throughout the 20th century with some of the richest mining country in the west being opened up. In the vicinity of the Salmo River Valley gold was the primary lure with an added abundance of silver. As these primary resources were extracted and exhausted the focus shifted to lead, zinc, tungsten and copper.

The first lode claims were staked in 1886 when the Hall brothers and their party from Colville, Washington discovered a rich outcrop of silver ore on Toad Mountain. This claim became known as the Silver King Mine. Interestingly enough this discovery did not spark further prospecting for lode deposits in the area for another 10 years.
The construction of the Nelson and Fort Sheppard Railway in 1893 made the district accessible, but it wasn't until 1895 that prospectors spread out from the great Rossland boom.

In 1896 mining commenced in the Salmon River valley near the small settlement of Quartz Creek, later to be known as Ymir. Gold was the lure to this camp which quickly became a supply point on the trail as prospectors streamed north through the valley searching for new finds. Several promising claims were staked at this time including the Ymir, Dundee, Elise, Summit, Blackcock, Good Hope, Tamarac, Foghorn, Wilcox, and Porto Rico. In 1897 the Fern Mill was installed, on Hall Creek, and the Ymir and Porto Rico properties were being energetically opened up. Development was also being done on the Dundee, Wilcox, Porcupine, Union Jack and Tamarac as well as many other small properties. By 1898 the camp of Quartz Creek was attracting widespread attention and the population of the town reached 1,100.

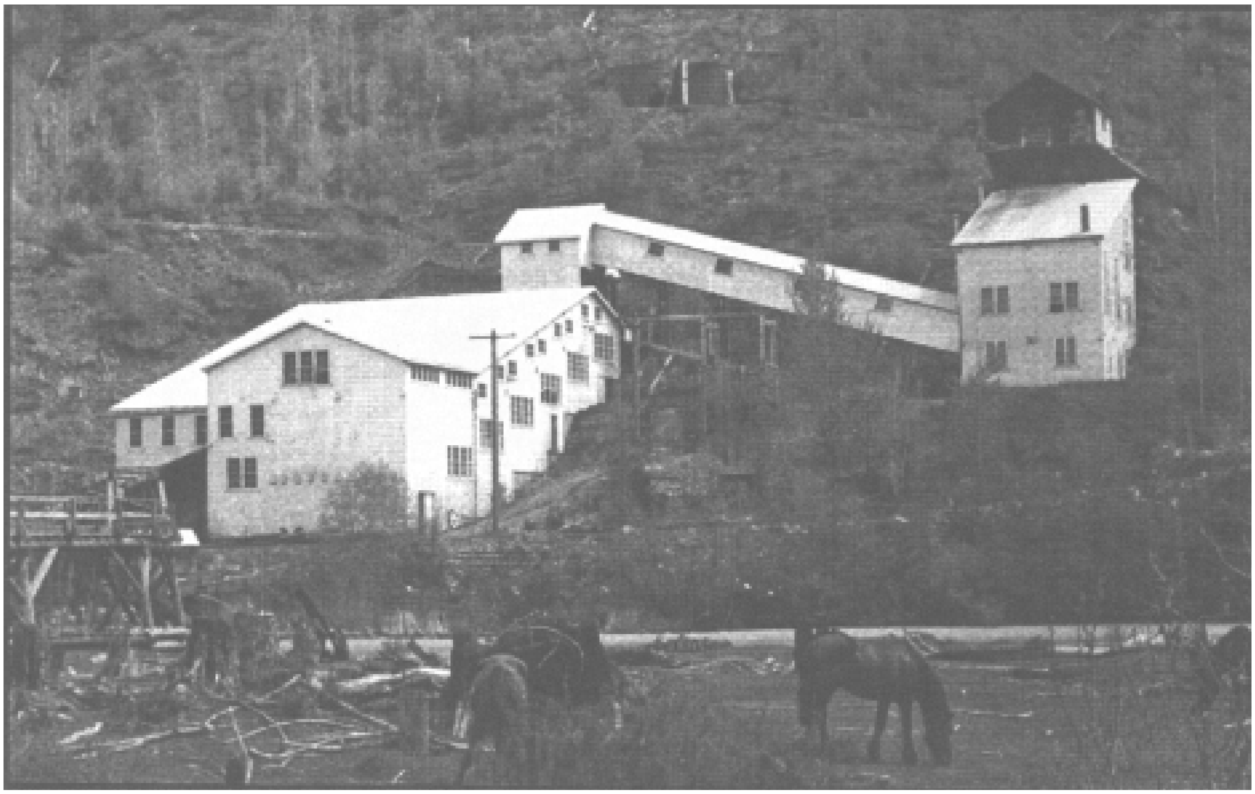
Not only was the township of Quartz Creek booming at this time but camps were being set up all over nearby valleys. About 4 kilometers up Wildhorse Creek a small settlement by the name of Petersburg was in full bloom. This made it feasible for miners from the Ymir and Goodenough mines to remain on the mountain for months at a time. It has been said that Petersburg was named after a local Ymir man known as Pete the Packer. He was around in the very early days and was well known for his string of packhorses that he engaged in transporting supplies over the Dewdney trail (N.L. Barlee).

The main producers in the region quickly became known as the Ymir, Dundee and Fern mines while several concentrating plants and small stamp mills were being constructed throughout the district. In 1900 mine development was impeded for various reasons and conditions did not improve until 1902 when the Ymir, Yellowstone, Wilcox, Arlington, Fern, Tamarac, and Spotted Horse properties began producing high quality ore. The total production from these mines by 1902 was approximately 80,000 tons (Memoir 94). Most of this ore was treated in local stamp mills of which there were 5 in operation by 1917.



Historical Map of Ymir, taken from page 4 Memoir 191. Printed in 1936

The majority of these mills were located along side the waterways of the Salmo River valley. A local miner recalls the view, "From 1903 to 1905 we lived at the Hunter V. mine at Ymir. The mine was at about 5000 feet elevation and connected to the railway by tram. From here an excellent view was obtained of the Salmon River Valley, and I still remember seeing the Great Northern trains looking like tiny toys working their way up and down the valley. Also the Ymir mill, Wilcox mill, Porto Rico and Fern mills were all operating and the tailings entering the river had the result that it appeared as a white ribbon in the distance (D.H. Norcross)."



The Yankee Girl Mill site across the river from Ymir in 1934.

Water and timber were plentiful in the region for generating power to the mines and mills. Pelton wheels and wood burning furnaces were used and high elevation mines were powered by gas or diesel generators. The region was easily accessible for the transport of goods by the Nelson and Fort Sheppard railway. It provided good transportation facilities to the nearest smelters in Nelson, Trail and Northport, Washington.

By 1904 gold developments in the neighboring Sheep Creek camp had overshadowed mining operations around Ymir. The setting in Salmo was of busy hotels full of rollicking miners who had come to make their fortune. A winding one way wagon road led out of town and split as one set of tracks led to the Yellowstone mine, up Sheep Creek, and the other to the Second Relief and Arlington mines that are located in the Erie drainage. When the Queen, Motherlode, Kootenay Belle, Reno and Emerald mines opened up the Salmo area became busier than it ever has and probably ever will be. Real activity began in the Sheep Creek camp in 1899 with the opening of the Yellowstone vein and the staking of claims that were later to be known as the H.B and Aspen groups. In 1900 work began on the Queen property that was staked in 1896. By this time work was well advanced on the Arlington property, out of the Erie camp, producing both gold and silver. Mining continued at Sheep Creek until 1916, when production declined suddenly because of fixed gold prices and high costs of production as well as the over working of easily-mined ore shoots.

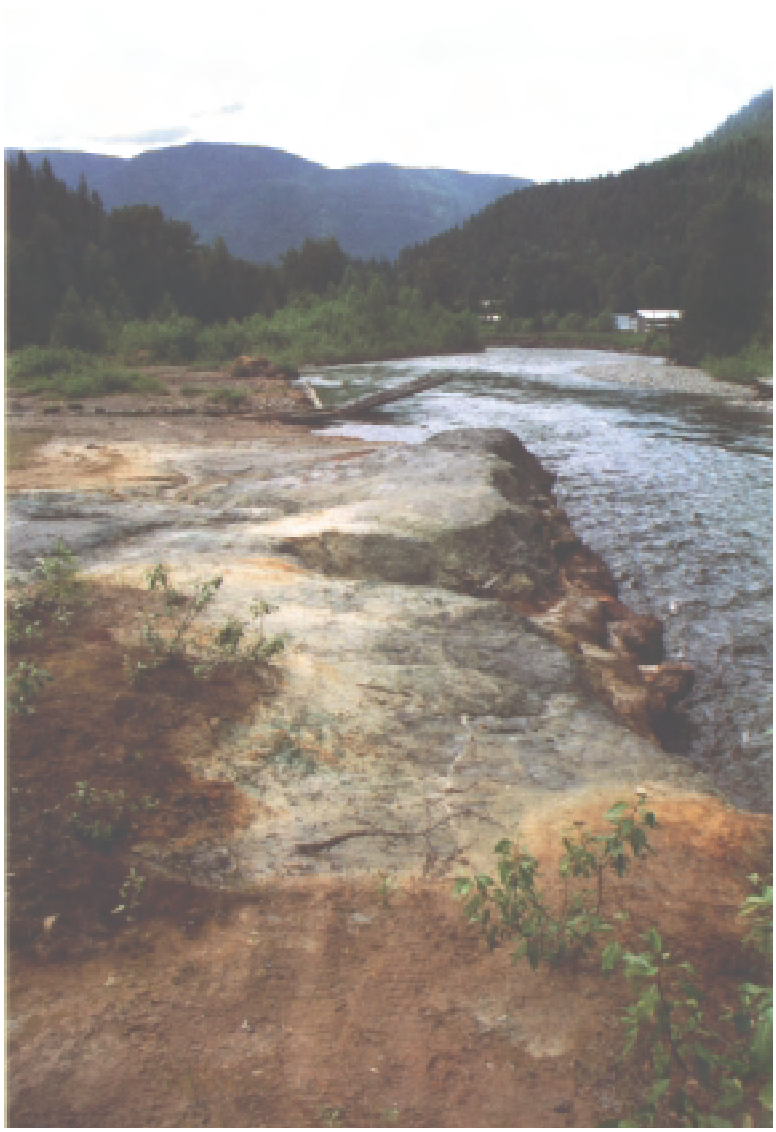
Milling and concentrating operations fluctuated with these conditions and are somewhat responsible for a number of placer claims on Sheep Creek during 1914. Placer miners had the objective of recovering gold lost in the tailings from the Queen mine that were deposited directly into the creek from the Yellowstone mill (Memoir 172).

The first lead ore in the area was mined in 1906 at the old Emerald Mine, with production from high-grade ore shoots of galena continuing until 1926. A renewed interest in gold revived the camp in 1928 and production continued until 1951, when the last gold mine closed. Since World War II the production of gold has declined greatly due to an economic squeeze between rising production costs and fixed selling prices.
Around this time, though, the discovery of tungsten and a renewed interest in lead-zinc ores kept the area profitable with the new developments at the H.B. camp. In 1951 construction had started on a 1000 ton per day concentrator that was being built at the confluence of Sheep and Aspen Creeks. A new 4000 foot tunnel was also being driven into the mountainside to access a newly developed sulphide orebody that contains zinc, lead and silver. The opening of this tunnel and the new developments around the mine brought new prosperity to not only the Salmo district, but to the entire Kootenays. This lasted until August 17, 1978 when the mine finally closed leaving over 100 people out of work.

Due to the heavy extraction of gold throughout the Salmo River Watershed the mills and their concentrating and cyanide plants have left prominent waste piles of tailings along side the river and its tributaries. In the early decades of this century it was common procedure for the mine tailings to be dumped directly into the waterways causing the water to run opaque at high production times (Norcross). The significance of the impacts of these waste piles is currently unknown.

In 1994 controversy arose over potential mercury contamination at the Second Relief mine. Accordingly, a full environmental impact assessment was done by Klohn-Crippen for Almforest, a logging company that now owns this property. The purpose of the assessment was to provide a professional opinion of the potential for contamination of the property arising from historical activities at and adjacent to the site.
Through this investigation Klohn-Crippen concluded that there is indeed heavy metal and arsenic contamination present, at different levels, on site as well as two types of mercury contamination that represent different types of environmental risk (Klohn-Crippen Phase II). These conclusions, as well as how these issues were dealt with are discussed in the following section under the Second Relief Mine.

In the Phase II Environmental Site Investigation Final Report by Klohn-Crippen they state that "the contamination conditions present on the Second Relief Mine site are likely to be typical of abandoned mine sites throughout the Kootenay region, where milling operations were performed. "



Yankee Girl Tailing Pile, River Side.

Finding this information led us to pursue our uncertainties about possible contamination coming off of the Yankee Girl tailing pile in Ymir. This site resembles a vast wasteland on the Salmo River across from the Ymir townsite. It has been of some concern to citizens for quite a while, but never has anyone taken the initiative to do any actual testing to find out exactly what we are looking at. So we did. This past summer, of 2000, the Ministry of Environment came out to take some water and sediment samples. The results showed that several parameters for the water samples taken in the Salmo River and in the pond directly on the tailings were found to exceed provincial water quality guidelines set for aquatic life and drinking water. To view these results see appendix A.

Yankee Girl Tailing Pile West side of Salmo River

The Mines and Mills

Erie Creek Drainage:
Erie Creek is located approximately 5km west of Salmo on the Crowsnest Highway (#3). It is home to the historical Arlington and Second Relief mines. In 1899 a small settlement was born at Erie Lake, complete with homes, schools, hotels and general stores. Throughout the early 1900's this settlement grew to a population of almost 200. During these high production periods, many people settled up stream at the Second Relief Mine.

Second Relief Mine:
References: Little, H.W. 1960. Geological Survey of Canada, Memoir 308. Nelson Map-Area , West-Half. Pp. 205. Cockfield, W.E. 1936. Geological Survey of Canada, Bureau of Economic Geology, Memoir 191. Lode Gold Deposits of Ymir-Nelson Area, British Columbia. Pp 7-12. Ann. Repts., Minister of Mines, B.C.: 1904, 1919, 1927-30, 1933, 1934, 1935-1948.

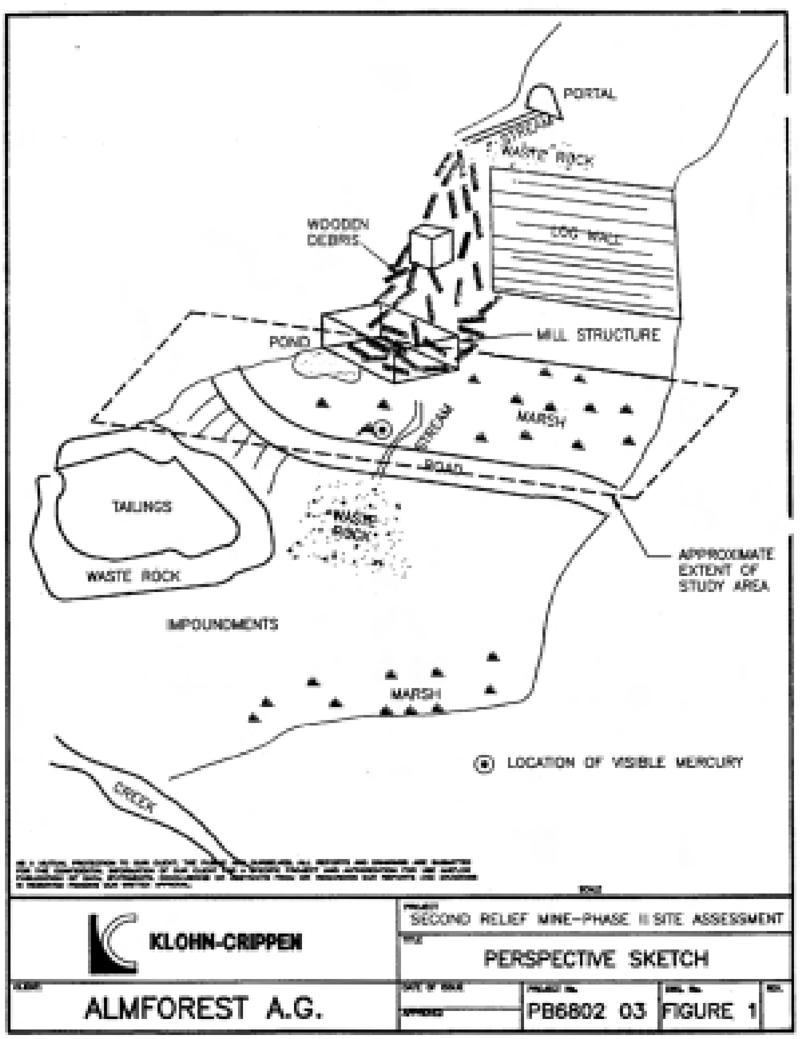
The Second Relief Mine site is located 20 km north of the junction of Erie Creek road and Highway 3. It sits on the southwest slope of Dominion Mountain and overlooks Erie Creek. The property sits on a steep heavily timbered hillside on which at least 11 mine portals exist. Full descriptions of the mine workings can be found in the Minister of Mines Reports suggested above.
The Second Relief was one of the main gold producing mines in the Nelson District. The claim was staked in 1901 and started production in 1902. Ore was treated on site at a 40 ton stamp mill and flotation plant that burned down, along with the camp, in 1919. The mine was then left undeveloped until 1927 when Oscarson Mining Company from Erie took it over. A new 75 ton mill was then built that used elemental mercury in an amalgamation gold extraction process. By

1935 a new cyanide plant was added onto the mill and a cyanide based Merril-Crowe process was operated until 1948. According to the Phase 1 site assessment by Klohn-Crippen, these processes imply a potential for contamination around the mill site with mercury and other heavy metals. The tailings deposit is also likely to contain some potential for acid generation that will, in turn, solubilize heavy metals.

Due to these presumptions, a Phase II environmental site investigation was necessary. Informative charts and graphs illustrate the results of mercury and metal analysis and show concentration levels and distribution. Tests and lab procedures are described and numbers have been compared to the BC criteria for Management of Contaminated sites.

The results of this analysis conclude that the following contaminants exist on site and exceed BC criteria (Klohn-Crippen Phase II 33):

– Two types of mercury contamination exist; one is widespread, at a relatively low concentration in the inorganic form, the other is very localized, at high concentration, and contains significant elemental content.
– arsenic contamination is widespread within the study area and exists at levels greater than BC Special Waste criteria.
– Heavy metal contamination, other than mercury, seems to be associated with tailings deposits and is likely to be in a mineralized form.
– Copper, lead and zinc exist at levels greater than BC CMCS Level "C".
– The above conditions are likely to be typical of abandoned mine sites throughout the Kootenays where milling operations have been performed.

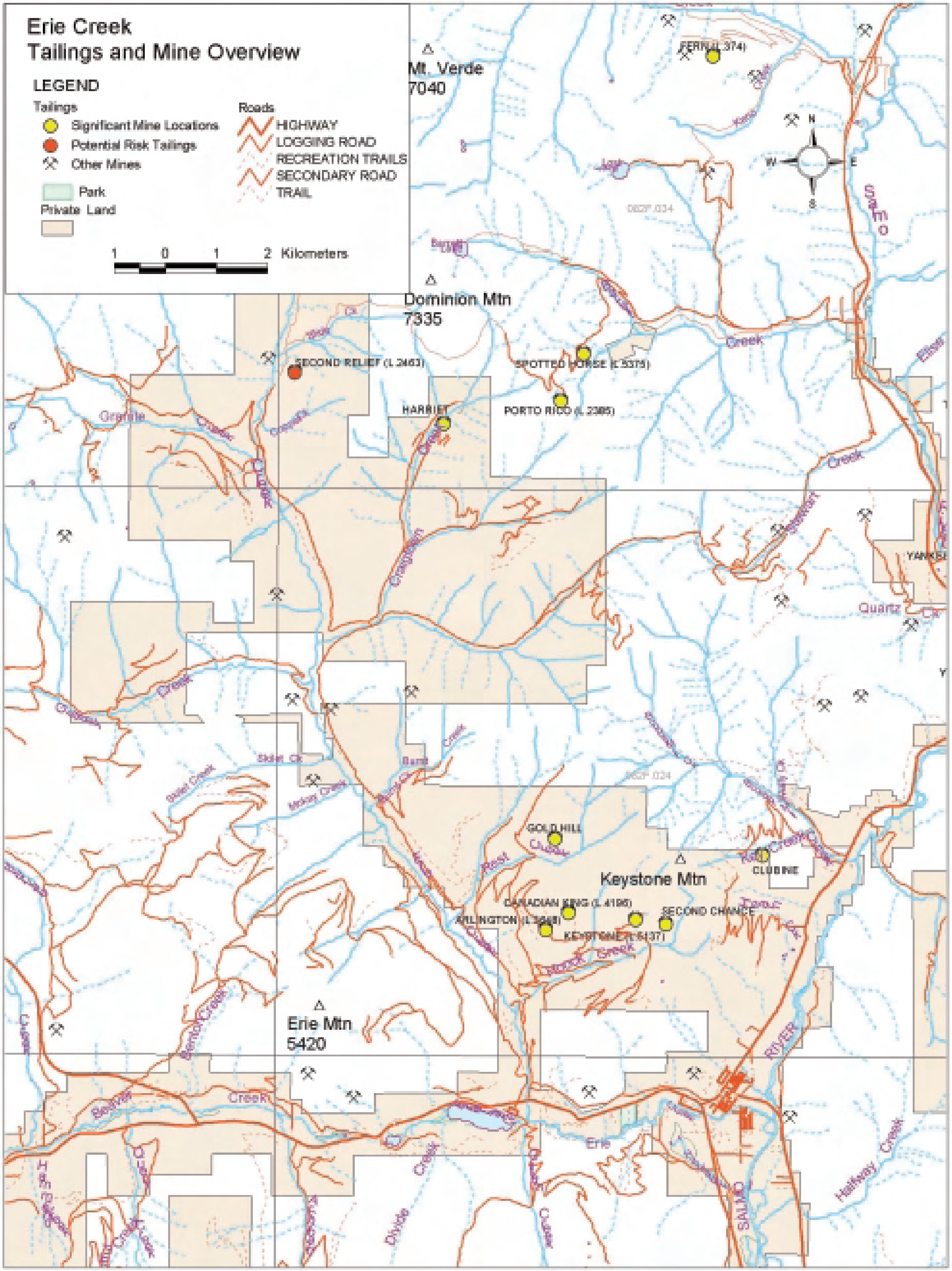


Second Relief Mine

Arlington Mine:

References: Walker, J.F. 1934. Geological Survey of Canada, Memoir 172. Geology and Ore Deposits of Salmo Map-area. pp. 75

See appendix B for mine location, history of site use, geology and production figures.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Sheep Creek Drainage:

Sheep Creek is located about 3 km south of Salmo off of Airport Road. The valley was once densely populated with miners and their families, in the late 1930's there was said to be about 111 houses. The townsite of Sheep Creek sat at the confluence of Sheep and Waldie Creeks. It was well equipped with a general store, hotel, pool hall, post office and school. In the winter an ice skating rink was built on top of a tailing pile from the old Yellowstone mill.

The Sheep Creek camp ranks sixth in B.C. for its lode gold production, the most important producer being the Queen mine (Minfile Trail-082FSW). Many quality ore bodies are present in this area and along with an abundance of water and timber have created prime mining conditions.

In the winter time ore was transported from the mines to the Yellowstone wagon road by rawhiding. According to local miner and historian Don Endersby, horses were equipped with snowshoes and would drag a rawhide full of ore to the wagon road where another team waited to take it to the railroad. Conditions for transport in the Sheep Creek drainage from the higher elevation mines were steep and avalanches were of grave concern in the winter and spring months.

Many mills have operated in this drainage since the turn of the century. The highest producers were the Queen and the Motherlode whose tailing piles are still visible along the Sheep and Waldie Creeks. The waste piles in this valley were extremely prominent until the 1970's when many tailings were excavated and shipped to the Trail Smelter due to an increase in the price of silica. (Silica is a byproduct from the milling of gold.)

Today much of the foundations and the Sheep Creek townsite are being overgrown with streamside vegetation. The deep mining history is still evident as waste rock piles cascade out of portals on the steep hillsides of Mt. Waldie and Reno Mountain.

References: References for all properties within the Sheep Creek mining camp can be found in: Walker, J.F. 1934. Geological Survey of Canada, Memoir 172. Geology and Ore Deposits of Salmo Map-area. Or, the Geological Survey of Canada, Memoir 308. Minister of Mines Production Reports, 1905-1960. The Ministry of Energy and Mines, Minfile Capsule Geology and Bibliography.

The Yellowstone:
See Appendix C for location, history of site use, geology and production figures.

The Yellowstone mill is was one of the first mills in the valley. Its foundation is no longer visible due to fire and revegetation. Most of the Yellowstone tailings were hauled out for silica, but some remain near the old Sheep Creek townsite, west of Waldie Creek. The community used this tailing pile as a skating rink that was active as recently as the late 1960's.

Queen Mine:
See appendix D for mine location, history of site use, geology and production figures.

The Queen mine was an important producer of gold in the Sheep Creek camp. Production began in about 1900 and ore was treated by amalgamation at the Yellowstone mill. In 1908 a 20 stamp mill was built on the Queen property that crushed about 60 tons of ore per day. Amalgamation was used to treat the gold of which about 60 percent was recovered.

Foundation of historic Queen Mill

In 1935 a new 50 ton mill was put into operation. The foundation of this mill is still visible as are some of the tailings that have been left along side Waldie Creek. The tailing piles consist of rust colored rock piles that sit on a steep angle directly adjacent to Waldie Creek.

Tailings from the Queen Mill adjacent to Waldie Creek.

Motherlode Mine:
References: Ministry of Energy and Mines, Minfile Capsule Geology and Bibliography: #082FSW041.

The Motherlode mine is located on the north side of Sheep Creek, one mile east of the junction with Waldie Creek. The mine sits on a steep hillside between 5,400 and 5,900 feet. This places it about 1,900 to 2,400 feet above Sheep Creek.
The Motherlode began production in 1906 and ran steady until 1915 producing 61,336 tons of ore. In 1911 a 100-ton stamp cyanide mill was erected on Sheep Creek and was connected to the mine by tram. This cyanide plant was the first of its kind in British Columbia and processed up to 125 tons of ore per day. In 1920 the mill was reconditioned when the Motherlode and Nugget workings were connected. In 1932 it was reconditioned again and changed into a ball mill so it could efficiently treat Reno ore. By this time the mill was treating ore from the Bluestone, Nugget, Motherlode, Reno and Gold Belt properties.

The mill foundation and some equipment, such as compressors, are still standing at the site. Wires from the old tramway to the Reno mine are still hanging over the Sheep Creek Forest Service road. No tailing piles are evident due to the fact that they washed into Sheep Creek.

The historic Motherlode Mill

Nugget Mine:
References: Ministry of Energy and Mines, Minfile Capsule Geology and Bibliography: #082FSW040.

The Nugget mine made its first shipment of crude ore in 1907 and continued to produce until 1911. In 1908, a small mill with 4 stamps and two Frue vanners was constructed. Gold was recovered through amalgamation and the tailings loss was approximated at about $5 a ton. Production from 1907-1922 amounted in 36,665 tons of ore, yielding 21,409 ounces of gold and 4,836 ounces of silver. In 1919 the Nugget and Motherlode enterprises united and the workings were connected. All Nugget ore was then shipped to the Motherlode mill.

Reno Mine:
References: Ministry of Energy and Mines, Minfile Capsule Geology and Bibliography: #082FSW036.

The Reno workings are located at the head of Reno (Fawn) Creek, on the west facing slope of Reno Mountain. A road connects the mine with Sheep Creek road at 3,100 feet and climbs to the mine office, cook house, bunk houses and buildings at 6,240 feet. The top portal of the Reno mine is located at the summit of Reno Mountain.
The Reno property was prospected in 1914. Active development commenced in 1928 when a group of English investors rebuilt the camp. In 1929 a 25 ton cyanide mill was constructed and by 1931 it was said to have produced about $400,000 worth of ore. In February 1932 the mill was

destroyed by fire. This caused production to be suspended until the Motherlode mill was put back into operation in 1933. At this time a 12,800 foot long aerial tram was built to move Reno ore to the Nugget-Motherlode property. The elevation difference was 2,413 feet between start and end points.

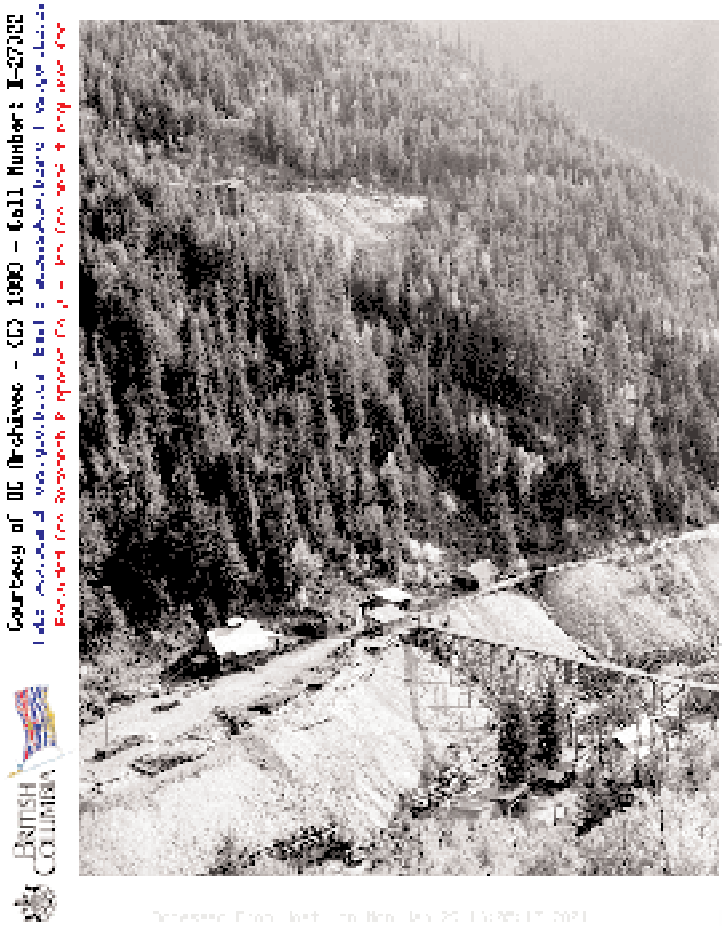
Sheep Creek, Reno Mine

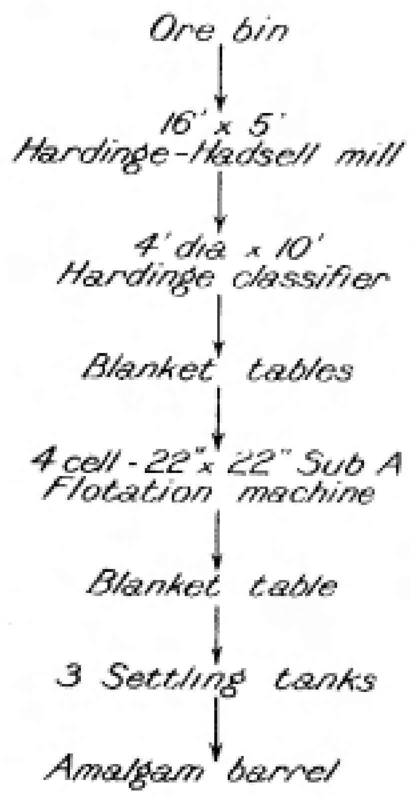
Considerable piles of waste rock are evident on the upper west slopes of Reno Mountain. Piles from the number four and five tunnels are very large and still contain some valuable ore. In the early 1980's some of this rock was hauled to the Trail Smelter by the Endersby family. According to Don Endersby, this mine still contains a considerable amount of valuable ore. Due to fixed gold prices, though, it is uneconomical to mine.

Reno tailings

Kootenay Belle Mine:
See appendix E for history of site use, geology, and production figures.

The Kootenay Belle is located just above the junction of Waldie and Sheep Creeks just east of the Yellowstone property. In 1908 a small 4 stamp mill was installed that processed gold by amalgamation. By 1916 it was in poor condition. It wasn't until 1934 that a new 50-ton mill was put into operation. During its production period, tailings were piled in large dumps all along Sheep Creek. None of these piles are visible now due to their excavation and shipment for silica.



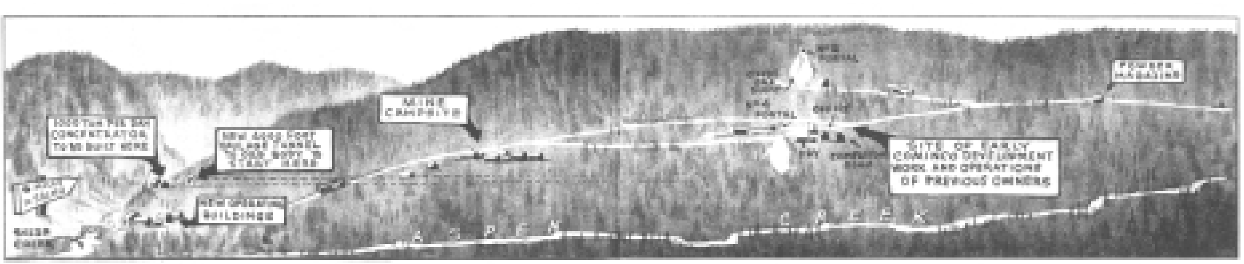


Outline flow-sheet, Kootenay Belle mill, Sheep Creek, B.C.

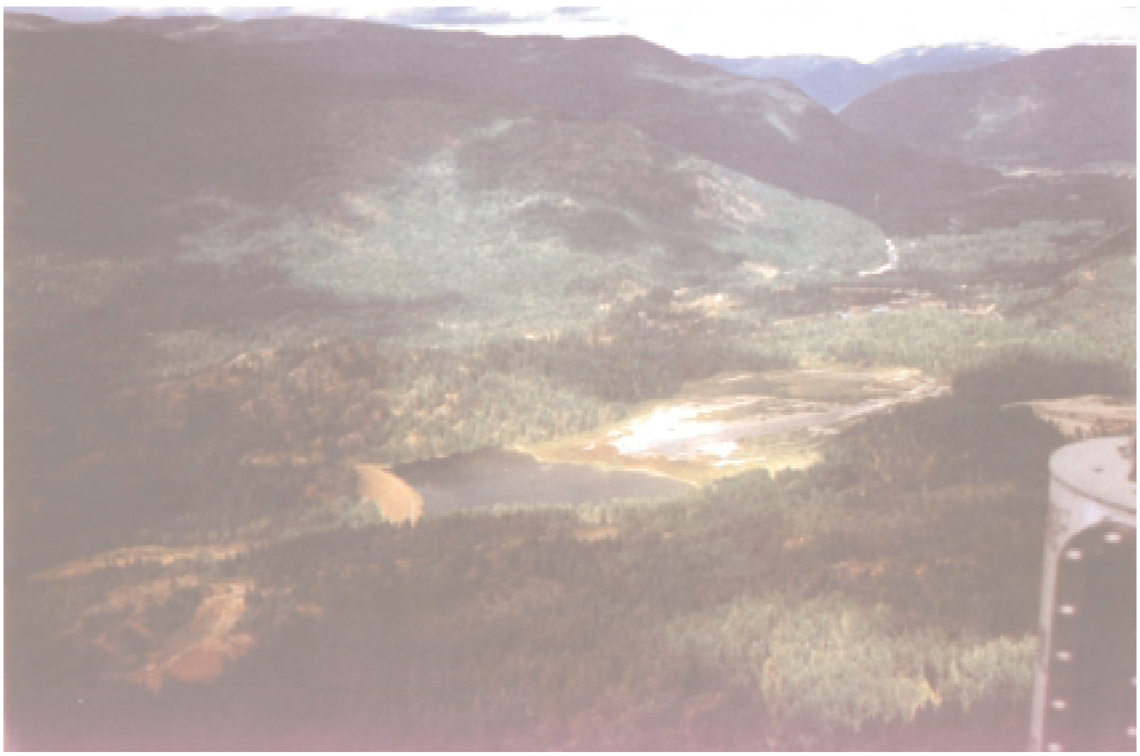
Sheep Creek, Kootenay Belle Mine

H.B.:
References: The Cominco Magazine, June, 1951; page 8-10. The Nelson Daily News, June 30, 1955 and February 3, 1954.

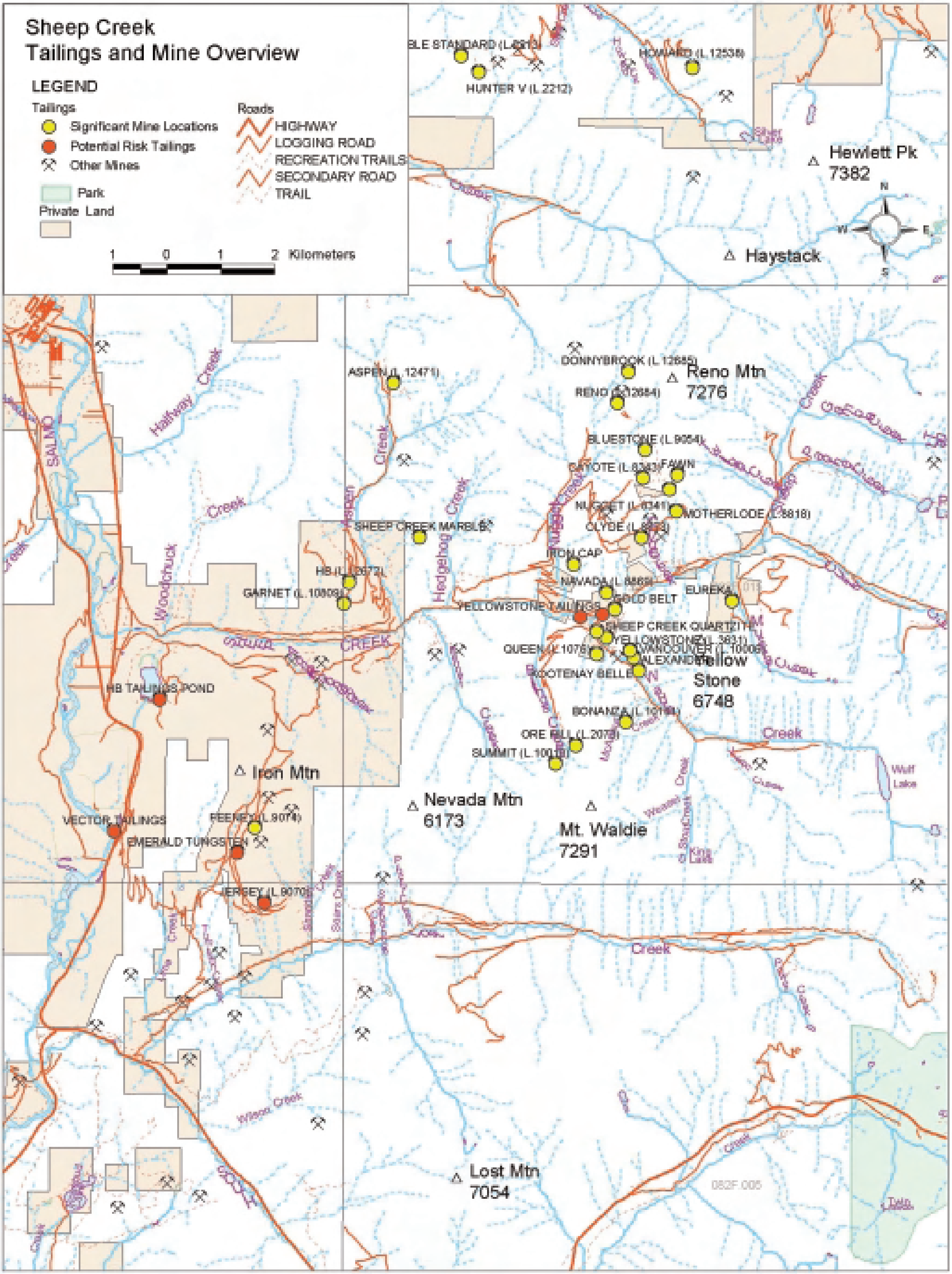
See appendix F for location, history of site use, geology and production figures.



The H.B. claims were staked in 1899 and recovered again in 1907 by Horton and Billings. The development of a large tonnage of sulphide ore after World War II is what has made this claim pay off. Previously the property had been handling a high grade zinc-lead oxide ore, but because of the change in character the newly discovered ore could not be treated at Cominco's existing plant. A program was then developed to build new surface buildings and a 4,000 foot haulage tunnel at the 2800-foot level to haul the ore to the new 1000 ton per day concentrating plant. The new plant employed up to 150 people, and was the first mine in the area to hire women. Tailings from this plant were relocated to the south side of Sheep Creek by a 16-inch pipeline. They were deposited in a tailing pond that was developed in order to stop any acid generating potential from this sulphide ore. Although Cominco no longer owns this property, they still hold mineral rights and are therefore obligated to maintain and monitor the tailing pond. They are currently doing work on the damn that restricts the contaminated waters in the pond from flowing into the Salmo River.



H.B. Tailing Pond


Sheep Creek
Tailings and Mine Overview
LEGEND
Tailings
Significant Mine Locations
Potential Risk Tailings
Other Mines
Park
Private Land
Roads
HIGHWAY
LOGGING ROAD
RECREATION TRAILS
SECONDARY ROAD
TRAIL
1 0 1 2 Kilometers
HUNTER V (L.2212)
HOWARD (L.12538)
Hewlett Pk
7382
Haystack
DONNYBROOK (L.12885)
Reno Mtn
7276
ASPEN (L.12471)
BLUESTONE (L.9054)
MOTHERLODE (L.8818)
SHEEP CREEK MARBLE
IRON CAP
GARNET (L.10808)
GOLD BELT
EUREKA
YELLOWSTONE TAILINGS
SHEEP CREEK QUARTZITE
KOOTENAY BELLE
Yellow
Stone
6748
ORE HILL (L.2078)
HB TAILINGS POND
Iron Mtn
Nevada Mtn
6173
Mt. Waldie
7291
VECTOR TAILINGS
EMERALD TUNGSTEN
JERSEY (L.9070)
Lost Mtn
7054
Creek
Wolf
Lake

Iron Mountain:
Iron Mountain is located between Sheep and Lost Creeks and is home to the Emerald and Jersey lead-zinc mines, and the Emerald, Feeney and Dodger tungsten mines. The name Iron Mountain came from the occurrence of rusty outcrops that were exposed when the mountain was burned over. During production from the 1940's until closure in 1970 a small townsite existed on Iron Mountain. It was just south of the main camp where offices, residences and cook houses were located.
The first shipment of lead ore from Iron Mountain was made in 1906. Ore was shipped regularly until 1919 when a small concentrator was built but was destroyed by fire in 1934.

References: References for Iron Mountain workings are as follows:
Geological Survey of Canada, Memoir 172, p. 57. Geological Survey of Canada, Memoir 308 p.111-192. British Columbia Department of Mines Bulletin No. 41: Stratigraphy and Structure of the Salmo Lead-Zinc Area.
Ministry of Energy and Mines, Capsule Geology and Bibliography.

Tailings on Iron Mountain

Emerald-Jersey Mines:
See appendix G for location, history of site use, geology and production figures.

The Emerald Mine was a steady producer of lead ore, and later tungsten, throughout many decades in the Salmo Area. It has a diverse history of exploration and developments that have led to a number of Emerald mineral claims. In 1943, a 300 ton concentrating plant was built in the Salmo Valley to treat Emerald tungsten for the war effort. It was put into production on August 1st at a rate of 200 tons per day, but was closed down that September. In 1947, under new ownership, milling commenced at 260 tons a day. The last tungsten was milled on January 12th, 1949 due to the discovery of a lead-zinc vein. Immediate steps were then made to convert the mill and by March it was handling over 300 tons per day.

Drilling in 1951 indicated that the lead-zinc mineralization extended north from the Jersey more than 6,000 feet. Operations expanded enormously to attain a production of 800 tons per day by 1951 and 950 tons per day by the end of 1952. In 1954 the mill capacity was 2,200 tons per day and until mineral exhaustion in 1970 production was maintained at about half of that capacity.
Early in 1951 there was a renewed interest in tungsten that led the Canadian government to buy two blocks of ground from Canadian Exploration Limited. A new mill was built by the company on the west side of Lime Creek at the 3800 portal. During this time new reserves were found near the Dodger zone and the company bought back the blocks. In 1952 the mill was treating 650 tons of ore per day. The rate of milling of tungsten ore, mostly from the Emerald mine, gradually increased from 9,000 tons per month in 1953 to 12,500 tons per month in 1955. In 1956, ore from the Dodger mine was being milled at a rate of 17,300 tons per month.
The Can Ex tailings from these major milling operations are sometimes referred to as the "Vector" tailing piles and are located on the west side of the Nelson-Nelway highway #3. Efforts have been made to retain these large dumps on which at least three houses now sit. Tailings and waste rock are also evident at the mine sites up on Iron Mountain.

Wildhorse Creek Drainage:

The town of Ymir is one of the oldest lode mining camps in British Columbia. It forms the center of what is known as the Ymir District. Located 20 miles south of Nelson this town quickly became a central point for the various migrants that came to work in the rich gold bearing creeks and mines of the area.
By 1905, what was once a booming town quickly began to dwindle due to low ore prices and the exhaustion of easily accessible ore. It was the continued existence of the Ymir and Dundee mines that kept the area somewhat profitable, although, they too were almost exhausted by the end of World War II.

References: References for all workings within the Ymir camp can be found in: Drysdale, C.W. 1917. Geological Survey of Canada, Memoir 94. Ymir Mining Camp. Cockfield, W.E. 1936. Geological Survey of Canada, Memoir 191. Lode Gold Deposits of Ymir-Nelson Area, British Columbia. Minister of Mines Annual Reports. Ministry of Energy and Mines, Capsule Geology and Bibliography.

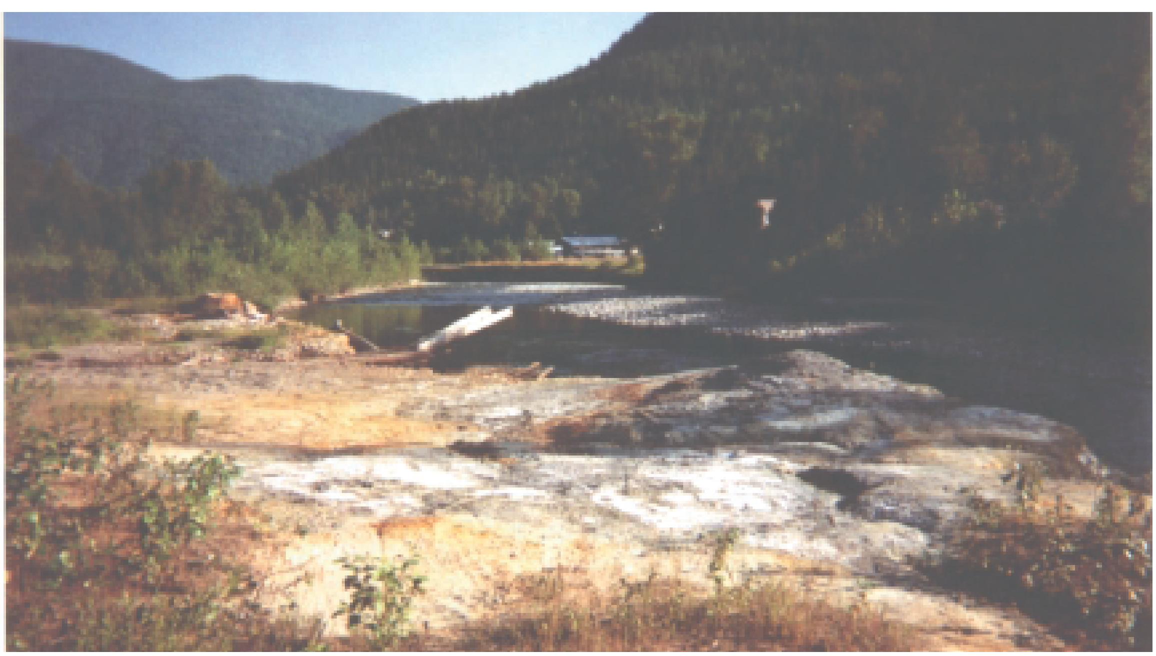
The Yankee Girl/Dundee Mines:
References: Ann. Repts., Minister of Mines, B.C.: 1919, pp. 132-133; 1920, pp 129-131; 1926, pp. 275-276; 1927, pp. 277-301; 1928, pp. 327-330; 1929, p. 349; 1932, pp. 186-187; 1933, p. 224; 1934, pp. E 6

See appendix H for location, history of site use, geology and production figures.

The Dundee Gold Company was incorporated in December, 1896 and was one of the two companies to which Ymir owes it existence. The great promise of this mine, along with the Ymir claim, were the main causes for the rush of prospectors and miners to the area. Prior to its amalgamation with Yankee Girl mines in 1940 Dundee ore was treated at a 50 ton concentrator located at approximately 1000 meters on the north side of Oscar Creek. The remnants of this mill are still visible today.
There is an estimated 360,000 tons of waste material left on the dumps at the mine sites (Minfile number 082FSW067). This waste consists of large coarse rock debris that is highly oxidized, being very red and rusty in color. There is a minor drainage running out of the dumps that follows the access road for half a kilometer before entering Oscar Creek. The drainage is bright orange and devoid of life. The dumps are on the south-east facing slopes of Mount Dundee and can be seen from the highway driving north towards Ymir.

Waste dumps and runoff on Mt. Dundee

There are also tailings left at the Yankee Girl mill site located at the toe of Mount Dundee across the Salmo River from the Ymir townsite.



Ymir Mine:
See appendix I for location, history of site use, geology and production figures.

Historic Ymir Mill

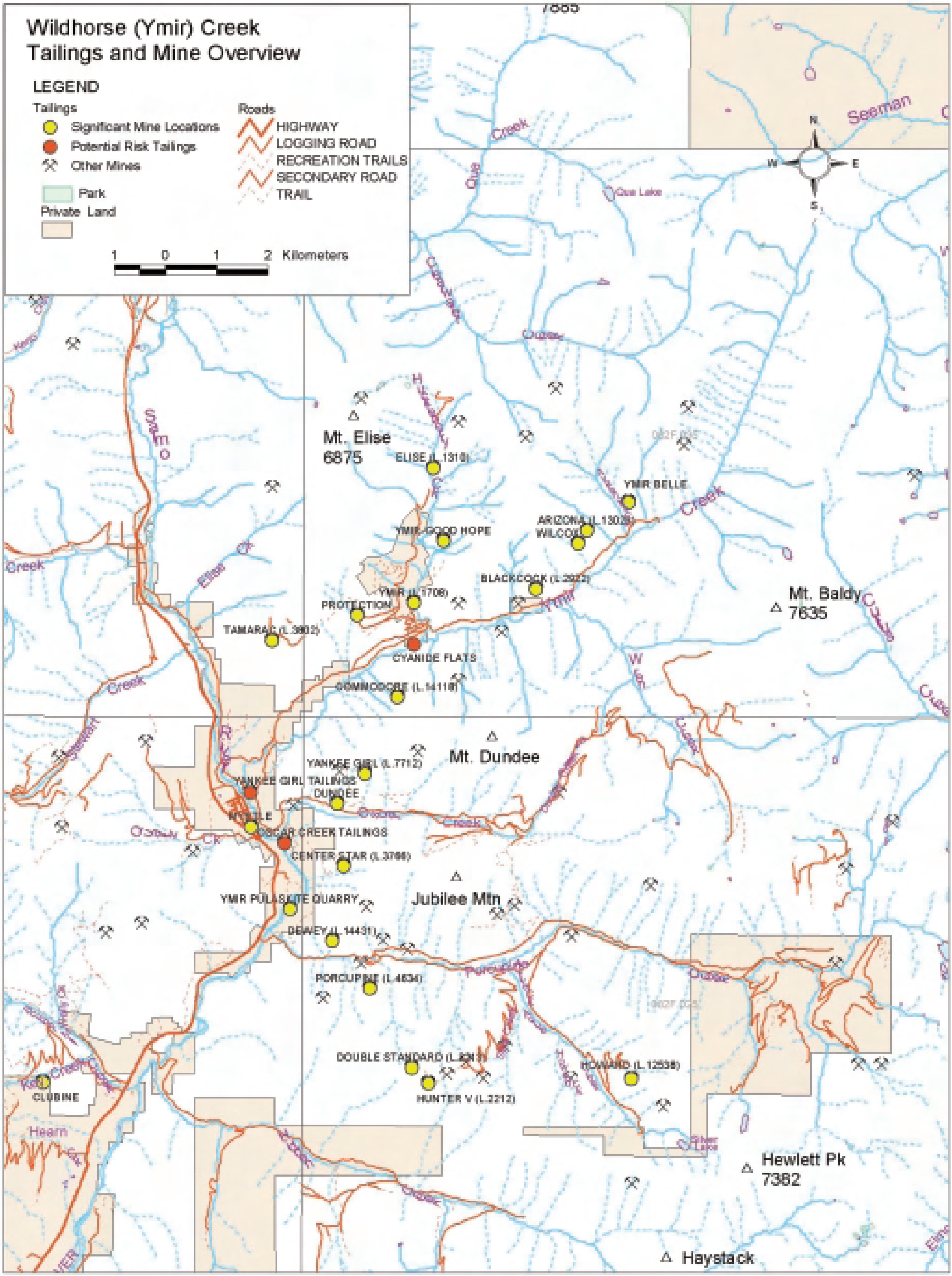
In 1885 the Ymir, Mugwump, and Rockland claims were located. These claims soon became the most productive area of the Ymir Gold Mines property and in 1898 they made up the largest gold mining operation in Canada.
The Ymir mill consisted of 80 stamps, and was equipped with amalgamation plates, concentrate tables, and a state of the art sand leaching cyanide plant. The cyanide plant was capable of treating 200 tons of ore per day and was powered by wood, steam, and water.
At today's prices gold production from the Ymir mill totaled about four and a half million dollars, (130,000 ounces) with at least another half a million from silver and lead concentrates. A decrease in gold values at only 700 feet in depth brought an end to the operation in 1907.
Tailings from the Ymir mine sit directly on the northwest bank of Wildhorse Creek. These tailings have been reworked numerous times since the closure of the mine and are currently being assessed by Miracle Mountain Gold Corporation.

Center Star Mine:
Memoir 191, pg. 20-24.
Annual Reports, Minister of Mines, B.C., 1934.

See appendix J for location, history of site use, geology, and production figures.

Today the tailing pile left by the mill is still very apparent, as is its strong sulpher smell. It covers approximately 2 hectares not including the waste rock around the old mill site. There is also about 2-10 meters of revegetated tailings around the circumference of the pile that we did not include. The rest of the tailings have no vegetation besides the odd Lodgepole pine or small Cottonwood. The tailing dams are still in place and chemical as well as physical weathering are evident. Waste Rock piles are obvious on the upper slopes of Jubilee Mountain at the mouth of the mine portals. They can be seen from the highway heading North into Ymir.

Center Star tailings


Wildhorse (Ymir) Creek
Tailings and Mine Overview
LEGEND
Tailings
Significant Mine Locations
Potential Risk Tailings
Other Mines
Park
Private Land
Roads
HIGHWAY
LOGGING ROAD
RECREATION TRAILS
SECONDARY ROAD
TRAIL
1 0 1 2 Kilometers
N
S
E
W
Mt. Elise
6875
ELISE (L.1310)
YMIR BELLE
ARIZONA (L.13028)
WILCOX
YMIR-GOOD HOPE
BLACKCOCK (L.2922)
YMIR (L.1708)
PROTECTION
TAMARAC (L.3802)
CYANIDE FLATS
COMMODORE (L.14118)
Mt. Baldy
7635
Mt. Dundee
YANKEE GIRL (L.7712)
YANKEE GIRL TAILINGS
DUNDEE
MYRTLE
OSCAR CREEK TAILINGS
CENTER STAR (L.3766)
Jubilee Mtn
YMIR PULASKITE QUARRY
DEWEY (L.14431)
PORCUPINE (L.4634)
DOUBLE STANDARD (L.2913)
HUNTER V (L.2212)
HOWARD (L.12538)
CLUBINE
Hewlett Pk
7382
Haystack
Seeman
Creek
Qua Lake
Ymir
Hearn

Wilcox Mine:
The Wilcox Mine located at the end of Wildhorse Creek wagon road began operations in 1897 with a 10 stamp mill. From 1932 to 1938 the mill was operated by D.H. Noreross and three partners who milled about 20,000 tons of ore during this time. They made a clean-up each month with a gold brick that went to the Royal Canadian Mint and gold bearing concentrates that were shipped to the Trail Smelter. By 1938 they had exhausted their known ore and shut down.

Hall Creek:
The Fern mine, located on Hall Creek, was quite productive for a few years with its 10 stamp mill and cyanide plant that produced an average monthly production of about 750 tons in 1902. The grade of ore was excellent, however they lost the ore shoot against a dyke and all attempts to locate a continuation failed (Norecross).

Barrett Creek:
South of Hall on Barret Creek the Porto Rico mine made some production of gold. On site there was a 10 stamp amalgam mill that was powered by wood fired boilers. The wood for these boilers was cut below the high elevation mill and was hauled by horses up to the site. This proved to be an extremely costly operation and quickly went out of business (Norecross).

Dominion Mountain Mill, Barret Creek

Mines and Mills Summary

Prior to 1969 there were no environmental laws or regulations in place to protect the lands, waterways, and organisms from any potentially damaging effects of mining and milling operations. Most of the mills discussed here were in production in the first half of the 19th century and therefore ran unregulated. Tailings were distributed straight into the creeks such as Ymir, Sheep and Erie that eventually flow into the Salmo River. Most of these tailings have long since been washed away, and in certain cases, such as Sheep Creek much of the tailings were removed due to a market for silica.
At some sites, though, such as the Yankee Girl, Center Star and Second Relief, large tailing piles still remain. The potential contaminants within these tailings are discussed later on.

The Milling Process

The extraction of valuable metals from ore has posed the most significant challenges to the historical mining industry. Valuable minerals are interspersed within worthless mineral rock called gangue. In order to separate these minerals the rock must go through extensive crushing and grinding procedures before being exposed to chemical solutions from which each metal is liberated.
The milling and concentrating of ore is the most significant source of any potentially contaminating activities related to mining. These historic mills used a variety of milling procedures that were responsible for the output of tailings and waste rock that arise as waste materials from the crushing and mineral extraction process.
Many types of mills and concentrating practices have been used at different mines throughout history. It is difficult to generalize the procedures of milling for gold and base metal recovery, but for the purpose of this report we will concentrate on stamp mill concentration by flotation, amalgamation and cyanidation that were common procedures of the mills in our area.

Primary Crushing
Ore is shipped from the mine to the mill often by tram line with buckets. The mills were usually located at lower elevations along creeks or rivers for power purposes. The buckets are then dumped into a coarse ore bin that holds the ore until it is ready to be fed through a grizzly. The grizzly separates and holds the small chunks of ore that don't need to go through the primary crusher, usually a jaw crusher. This machine breaks the ore between a fixed metal plate and a moveable jaw that crushes the rock by rapid forward movements.

Bob Burley operates jaw crusher that removes metal objects from chunks of ore

From the jaw crusher, the crushed ore is reunited with the smaller pieces from the grizzly and put through a vibrating screen. Oversize pieces are returned for further crushing while belt conveyors move the ore to the fine ore bin. This is the final step in the crusher house. In larger milling operations the ore would go through a secondary crusher before moving on to the mill. Ore from these fine ore bins is fed together with water to the next grinding units, either a stamp mill or a ball/Hardinge mill. A stamp mill consists of a giant mortar and pestles that have a series of heads that are lifted by cams and dropped by gravity to crush the ore. A ball mill consists of a cylindrical shell that is full of steel balls. As the ore enters through one side the mill revolves creating a cascading effect as the steel balls roll over each other to crush and grind the ore.

The crushing and grinding stage of the process reduces the ore in size until the best possible liberation has been attained. The product from this stage becomes the feed for a number of recovery processes that are used to obtain valuable metals. Gold can be obtained through amalgamation or cyanidation and base metals can be obtained through a flotation process.

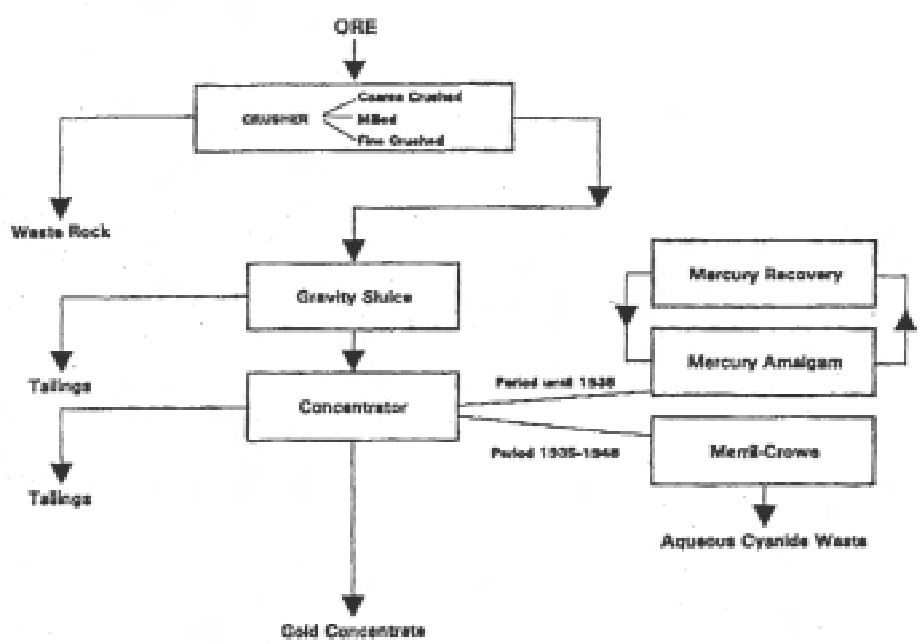
Gold Recovery

Milling methods for the treatment of gold ores are selected by studying and taking into consideration the natural characteristics of the metal. Gold differs from base metals such as lead, zinc and iron, because it can be found as a native metal. This means that it can be found naturally occuring in its metal form. Therefore, its recovery processes are somewhat simpler than those of base metals.

Historically, there were three types of gold mills commonly used at small mines; amalgamation and gravity concentration, amalgamation and flotation and cyanidation (Parsons, 438). See flow sheet for an example outline of these processes.

Eris Creek
Phase I Site Assessment

September 29, 1994



Ore Processing Flow Sheet

Amalgamation

Throughout the earlier part of the century gold was extracted through a process called amalgamation. The mercury amalgamation process involves rolling finely milled free gold with elemental mercury to produce a gold/mercury amalgam. This amalgam is then separated from the waste by either gravity, filtration, or panning processes. Excess mercury is then recovered and the gold concentrated by a variety of processes. These processes may include; mercury recovery through a retort, which involves direct condensation and collection through a "vaporisation" process, the use of buckskin, where mercury is forced through porous buckskin leaving the gold/mercury concentrate behind, or the amalgam may be treated with nitric acid to solubilize the mercury and leave the gold. Mercury is then recovered from this mercuric nitrate solution by retort, recondensation and collection.

According to the Phase 1 Site Assessment of the Second Relief Mine at Erie Creek, the potential contaminants from the above processes are; mercury (elemental or solubilized as mercuric nitrate), nitric acid, and mercury contaminated tailings (there is usually a very low mercury loss).

Cyanidation

Cyanide is a very poisonous white chemical in which gold can be dissolved. Cyanidation begins with the crushing of rock in a cyanide solution. Fortunately, a weak cyanide solution has been found to attack gold particles faster than a strong solution in the presence of oxygen. Most importantly it is necessary to liberate the gold from the worthless gangue rock in order for the cyanide to react, as it will not attack the surrounding rock. This is an expensive and time consuming problem considering that it takes three tons of rock to produce enough gold for one gold ring (Dobb, 40).

Lime and cyanide are added to the grinding circuit in the mill. The lime performs various functions such as protecting the cyanide from being destroyed by naturally occuring chemicals called cyanicides, as well as improving the settlement of pulp in the thickeners. From 30-70% of the gold is dissolved during this grinding period. This is due to fresh solutions interacting with the newly freed gold particles. From here the gold bearing "pulp" is pumped into large mixing tanks called agitators where it is exposed to air before being placed in a thickener.

It is very important at this stage to separate the valuable solution from the worthless waste rock. As the feed enters the thickening tanks the finely ground rock sinks to the bottom and is raked to the center and discarded through a pipe in the bottom of the tank. This discharge is thick and still contains too much valuable material to be discarded so it is then filtered through a large drum.

As the drum rotates, a vacuum causes the thick pulp to stick to the drum while the remaining solution is sucked out by another vacuum. Water is then used to wash any remaining solution out of the drum. The end product, the "filter cake" makes up the rejected material or tailing and resembles soupy clay. It is then dropped into a box, mixed with more water and pumped into the tailing pond where it dries and hardens.

The gold bearing solutions are then pumped through canvas sheets to remove any remaining clay particles and then put through a precipitation process where a fine zinc dust is added. The gold precipitate is then caught between leaves of canvas in a filter press where it remains for a number of days. This combination forms an impure precipitate that resembles mud because it is still concentrated with other minerals such as iron, copper and zinc.

The last step in the cyanidation process is refining the precipitate. Silica, borax and soda ash are added to the dried precipitate that is then heated in an oval shaped tilting furnace. When the solution has turned completely fluid, the furnace is tilted and the molten contents are poured into a mold. According to local miners the sight of the molten gold is something never to be forgotten.

Possible contaminants from the cyanidation process are discussed in the Phase 1 Site Assessment of the Second Relief Mine. These possible contaminants include; lime and insoluble ferrocyanide complexes that are produced during the gold extraction reaction and are likely to be precipitated in the tailings. Other metal cyanide complexes that have a minor capacity for the slow release of cyanide complexes could also be present in the tailing ponds.

Extraction of Base Metals

Base metals are usually found associated with sulpher,in this form they are known as sulphides. These sulphides require a more complex treatment for liberation. The milling of base metals differs from gold in that the finished product is not produced at the mill but is shipped to a smelter and then a refinery for further fabrication.

The goal of the base metal mine is to locally remove as much waste rock as possible from the ore. The process of separating valuable sulphides and removing waste is called concentrating. The mill is a concentrator, and the product is a concentrate (Northern Miner, 158).

Synthetic chemicals and oils are added to the water in which the grinding of base metal ores is done. The product is a pulp that is swirled around in a series of tanks called flotation machines. Air is added to form bubbles in the pulp and flotation reagents (chemicals) are added to coat the sulphides, but not the waste particles, which causes them to stick to the bubbles that carry the sulphides to the top of the tanks. These sulphide carrying bubbles are scraped from the top of the flotation machine while the fine waste rock particles sink to the bottom and are discharged as tailing waste. Water is then removed from the mineral bearing bubbles, that now form a concentrate, that is ready to be shipped to the smelter.
To extract certain minerals different flotation reagents are used and different kinds of sulphides can be floated or separated one at a time.

This flotation process is occasionally used in the extraction of gold ores. A gold flotation concentrate is made and then cyanided. This method works especially when the metal is fine and very intimately associated with sulphide or arsenide minerals (Northern Miner Press, 162).

The sink-float process is another method of concentrating ore metals. In this plant, crushed ore is fed into a suspension of finely ground ferrosilicon, magnetite or other heavy minerals in water. Suspension is carefully maintained at a specific gravity between the desired product and the waste rock. In a simplistic motion the heavier material sinks and the lighter floats. The latter being the waste and the fore being the concentrate. Obviously, the waste gets left on site while the concentrates get shipped to the smelter.

All of the above milling techniques and procedures vary greatly between different mills or concentrators. Different machines and various procedures are used accordingly for each mill. In some cases waste rock is returned through the mill various times in order to assure that all valuable metals have been obtained. For more information on milling processes consult the references sited, ministry of mines or lend an ear to a local miner.

Tailings and Waste Rock

Coarse waste rock is stored above ground at the mine and/or mill site in large free draining piles. It is a byproduct from mining that never made the trip to the mill. The coarse debris left on most of the piles within the Salmo River Watershed is bright red and orange in color. Depending on the geology of the area, this rock often contains acid-generating sulfides, heavy metals and other contaminants such as iron oxides (Environmental Mining Council).
The finely ground mill tailings are stored in either ponds or piles that are usually surrounded by dykes or dams of waste rock that create a barrier for these contaminated materials. These tailings contain traces of chemical agents used in the mineral extraction process such as cyanide or sulpheric acid. They also can contain heavy metals and acid forming minerals depending on the processes used and the constituents of the rock.
If these tailings are not secured by dykes or dams than the contaminants in the mine waste can

leach into water systems causing pollution that could last for many generations (Environmental Mining Council). The major potential contaminates from these sources are discussed in further detail.

Metal Leaching and Acid Rock/Mine Drainage

Acid mine drainage (AMD) is one of the greatest environmental challenges facing the mining industry in British Columbia. It is a significant issue that causes challenging impacts throughout BC. When sulfide-bearing minerals are exposed to air (oxygen) and water through disturbances such as mining, a reaction could take place that produces sulphuric acid. Due to high metal solubility and sulphide weathering rates under acidic conditions, this acid in turn leaches heavy metals out of materials in waste rock, tailings and underground workings. Once acid mine drainage is sparked, it is extremely hard to stop and will, in most cases, require treatment interminably (East Kootenay Mining Profile).

Metal leaching (ML) and acid generation are naturally occuring processes that could have negative impacts on the receiving environment. An acid generating mine has the potential for long-term impacts on rivers, streams and aquatic life. The environmental impact of AMD/ML depends on the magnitude, the sensitivity of the receiving environment and the degree of neutralization, dilution or attenuation. Certain factors may enhance leaching activities such as rapidly weathering metal-containing minerals, drainage conditions that increase solubility and high flow rates through contaminated materials (Price and Errington, 3).

Under most environmental conditions metal leaching will only happen when the drainage pH drops below 5.5 or 6, although, a neutral pH does not necessarily prevent metal leaching from happening. In a neutral pH, the solubility of aluminum, iron and copper is greatly reduced while elements such as antimony, arsenic, cadmium, molybdenum, selenium and zinc can occur in significantly high concentrations and will remain soluble (Price and Errington, 4).

Acid rock drainage differs from acid mine drainage in that it is found naturally in watercourses and outcrops of sulphide-bearing rock. The rusty color of these rocks is a sign of the weathering and oxidation of sulphide minerals, primarily pyrite. Just because the rocks are rusty does not necessarily mean that they are acid producing. In many cases, neutralizing minerals are present in local soils that create a buffer for acid generation. In this situation acidity will continue only if the acid generation is faster than the rate of neutralization or outlives the available neutralizing buffers.

These rates are quite complex and involve a large number of site specific mining, geological and environmental factors.

The BC Mininstry of Energy and Mines, together with local industry and environmental groups have developed a set of guidelines to outline the potential, limits and mitigation of acid mine drainage. They have developed a set of "static" and "kinetic" tests that use processes such as Acid Base Accounting to measure bulk amounts of acid generating and acid neutralizing materials on mine sites. Although this science is far from complete, the guiding principles and prediction principles through a phased approach provided in this manual should allow mines to gain understanding in order to meet receiving environment objectives and minimize the risks and costs of acid mine drainage and metal leaching. The Metal Leaching and Acid Rock Drainage Guidelines by William A. Price and John C. Errington was updated in 1998 with the most current research. Please refer to this manual for a complete outline of the above procedures.

Effects of Metal Toxicity

The excessive conentrations of metals found in mine waste are toxic not only to aquatic life but plant life as well. Metals such as iron, aluminum, manganese, zinc, and heavy metals such as cadmium, lead and copper that are known to occur in mine tailings make the establishment of vegetation difficult. The waste rock piles and tailings in the Salmo River drainage are pretty much devoid of vegetation. Some of these piles have been around for a hundred years and have still not revegetated. These sites resemble small deserts within a forested landscape. This fact alone causes major concern that there are in fact contaminants left on site that have effected the decomposition and nutrient mineralization needed for a healthy ecosystem.

Plants vary widely in their uptake and requirements for various macro-and micronutrients. Although high metal concentrations make plant establishment difficult, methods for surface improvement with inert materials such as the application of top soil and organic amendments have been proven to increase survivorship and plant establishment (Smyth, 102).

Recommendations

Throughout this discussion we have explored historical mining and milling processes that imply some potential for contamination. Considering the fact that every mine site has a completely unique set of geological and environmental conditions that vary widely, it is very important to explore each site on an individual basis. The character and structure of waste rock, tailing piles and ponds can vary considerably even when side by side. It is therefore important to identify and characterize the geological materials that are located within each site and to recover the exact milling processes that were used for mineral extraction.

Drainage patterns and flow rates at each concerned site should be observed as well as soil profiles within each contaminated area.

As there are a great number of abandon mines within our watershed I stress the need to focus on areas that are of the greatest concern; those closest to water and sites with heavy drainage. Preliminary soil and water samples are crucial for assessing the impacts tailings are having on surrounding soils and waterways in order to avoid unnecessary work on sites whose impacts are insignificant.

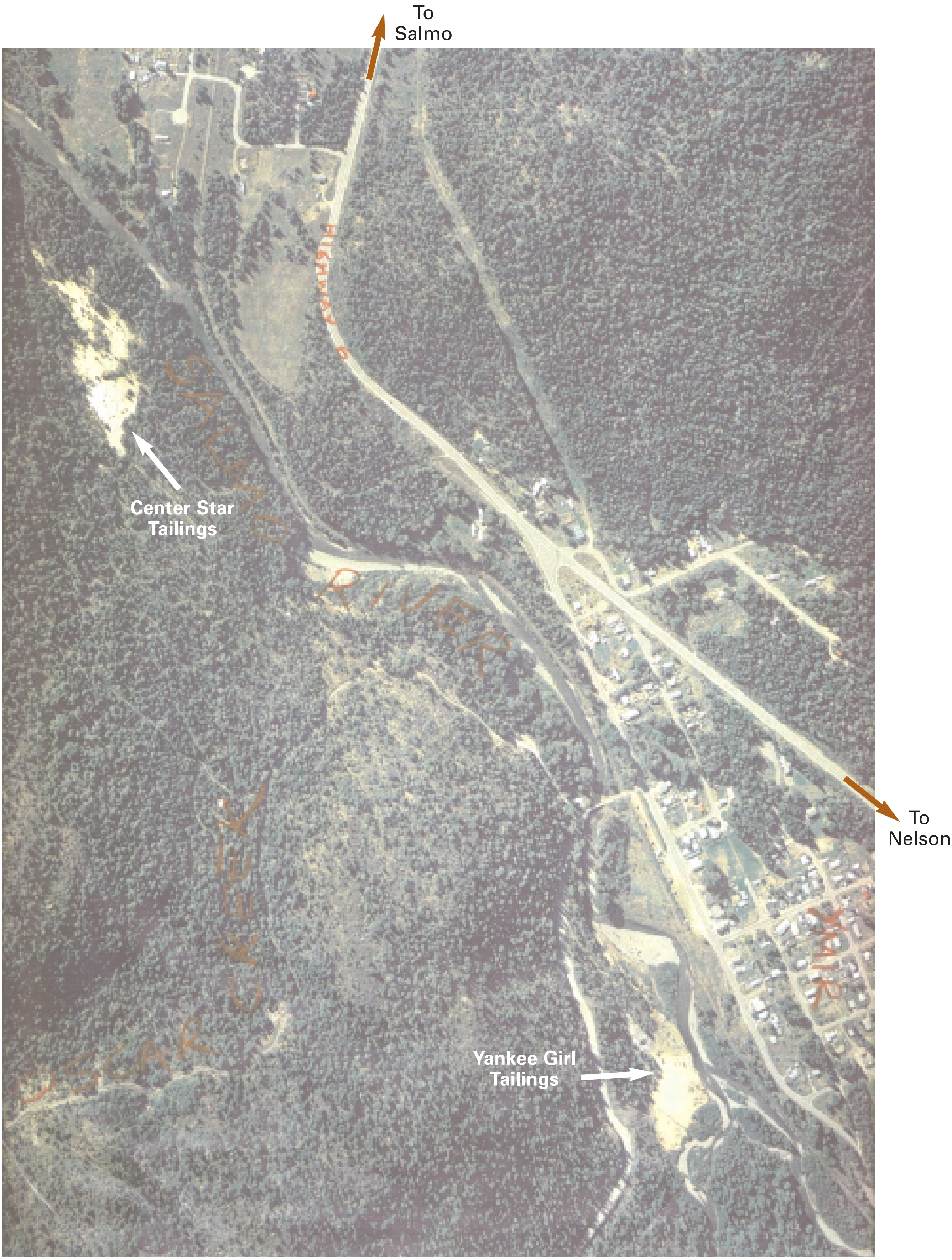
Once the materials have been identified and described it is then possible to further characterize each pile for its ML/ARD potential. If this predicted ML/ARD potential is positive it is then neccessary to develop a mitigation plan. These prediction strategies and mitigation programs are discussed in the Guidelines for Metal Leaching and Acid Rock Drainage.

Mine Reclamation

Reclamation is the process of returning the land to a condition and productivity level that moves toward a balanced ecological state. It does not contribute to any further environmental deterioration and is consistent with local aesthetic values. The primary objective of mine reclamation is to ensure that mined land will be returned to a state in which plant and animal life can be supported or be otherwise productive or useful to man.

Example of coal mine reclamation in the East Kootenays

While end land uses envisioned for reclamation sites vary, the principle reasons for reclamation are: erosion control, safety, and the improvement of water, soil, and air quality in the area. This involves various processes such as the stabilization of metal contaminants through vegetative uptake, the application of glacial tills, top soil and organic matter to create a cover system as well as the recontouring of disturbed land, in certain situations.



Arial view of Yankee Girl and Center Star tailings – future reclamation sites?

Our Future Vision

The next step for the Salmo Watershed Streamkeepers Society is to prepare a reclamation plan for the Yankee Girl Tailing pile. Throughout the duration of this report we have come to realize that the reclamation of this site is not as unrealistic as we may have first thought. We have had members of the community as well as the ministries show interest on this issue. Our ultimate goal is to negate any detrimental effects of mine tailings on the surrounding environment, especially ones that may effect the health of our river system. We hope to contain any potentially damaging agents such as heavy metal leaching and acid mine drainage that may be harmful to humans and other organisms within our functioning environment.

We feel that through community involvement as well as time, planning and effort on our part that this site could one day be cleaned up. We plan to take action, along with the Ministry of Environment to carry out further sampling on the site spring.of 2001. Periphyton and sediments will be collected and the periphyton (algae growing on the stream bottom) species composition will be assessed to show distribution patterns around the source of the contaminants.

We appreciate any questions, comments, or concerns as to the direction of our project.

Please call the Salmo Watershed Streamkeepers Society at 250.357.2630.

Conclusion

Government agencies are extremely reluctant to conduct further environmental assessments to these sites because of the high cost, research, time and number of old sites. Current legislation states that any assessment or reclamation work done to any mine site is the responsibility of the current owner, whether they are responsible for the damage or not. In the case of many historical sites though, the owners or businesses are no longer existent. Responsibility and funding for any reclamation or clean up is then placed on the province, or tax payers. This can become a very lengthy process and is the major reason the ministries have not been able to deal with many small scale mine sites.

We depend on the rivers now for the health of our communities just as much as we did then for the success of our economy. That is why we believe that it is important to carry out comprehensive assessments of the possible impacts of these historical sites on the river's health, no matter what it takes.

References Cited

Barlee, N.L. 1970. Old Kootenay Mining Town. Canada West.

Dobb, Edwin. October, 1996. Pennies From Hell. Harper's Magazine.

Environmental Mining Council of BC website: www.miningwatch.org.
Klohn-Crippen Consultants Ltd. 1994. Phase 1-Environmental Site Assessment: Second Relief Mine, Erie Creek.

Minfile Trail – 082FSW. Minfile/pc NTS map index.

Ministry of Energy and Mines, Minfile Capsule Geology and Bibliography, website: www.em.gov.bc.ca/mining/geosurv/minfile/default

Norcross, D.H. Early Mining History. Personal paper. Date Unknown.

East Kootenay Mining Profile: From Environmental Mining Council of BC website: www.miningwatch.org

Northern Miner Press Ltd. 1968. Mining Explained. Northern Miner Press Ltd. Toronto.

Parsons, C.S. 1935. Milling Practice for Small Gold Mines. Annual Western Meeting, Vancouver, B.C. November, 1935. Department of Mines, Ottawa.

Price, W.A. and Errington, John C. August 1998. Guidelines for Metal Leaching and Acid Rock Drainage at Minesites in British Columbia. BC Ministry of Energy and Mines.

Smyth, Clynt. 2000. Ecological Restoration 329 Course Readings for Mine Reclamation. University of Victoria, School of Environmental Studies and the Division of Continuing Studies.

Appendix

APPENDIX A

Table 1. Chemical analysis of the tailings at the Yankee Girl mine site.

Parameters	Units	Site 2a Iron colour deposit	Site 2b Bluish deposit	Site 2c Mineral looking deposit
Cyanide	ug/g	0.8	26.2	2.7
Aluminum	ug/g	8700	24000	7330
Antimony	ug/g	<8	81	195
arsenic	ug/g	1680	1030	1950
Barium	ug/g	116	286	101
Berylium	ug/g	0.5	0.9	0.5
Boron	ug/g	238	133	594
Cadmium	ug/g	<0.8	14.8	<800
Calcium	ug/g	694	2000	388
Chromium	ug/g	59.2	65.7	29.6
Cobalt	ug/g	<0.8	1.6	36
Copper	ug/g	17	125	187
Iron	ug/g	120000	59200	323000
Lead	ug/g	1120	51100	13000
Magnesium	ug/g	1060	2010	503
Manganese	ug/g	<0.2	30.2	<0.2
Molybdenum	ug/g	<2	<2	<2
Nickel	ug/g	<3	4	77
Phosphorus	ug/g	562	548	<20
Potassium	ug/g	5210	13300	4020
Selenium	ug/g	<8	<8	<8
Silicon	ug/g	522	352	283
silver	ug/g	<2	124	39
Sodium	ug/g	239	585	45
Strontium	ug/g	113	132	32.7
Sulfur	ug/g	11000	27300	36200
Tin	ug/g	35	21	60
Titanium	ug/g	148	766	72
Vanadium	ug/g	64	74	74
Zinc	ug/g	2880	1390	1070
Mercury	ug/g	0.025	0.92	0.66

APPENDIX A

Table 2. Water analysis at the Yankee Girl mine site.						
Parameters	**Units**	**Water Quality Criteria (AL)**	**Water Quality Criteria (DW)**	**Site 1 Salmo River***	**Site 2 Pond on Tailings**	**Site 3 Ymir Creek (Control)**
Cyanide	mg/L		0.2	<0.03	<0.03	<0.03
Chloride	mg/L			0.5	1.1	0.3
Fluoride	mg/L	0.2	1.5	0.09	***0.26***	0.06
Sulphate	mg/L	100	500	*59.2*	***203***	6.6
Bromide	mg/L			<0.05	<0.05	<0.05
Nitrate	mg/L	40	10	0.005	<0.002	0.019
Nitrite	mg/L	0.06	1	<0.005	<0.005	<0.005
Phosphorus	mg/L		0.01	<0.05	<0.05	<0.05
Conductivity	uS/cm			*225*	*439*	95
Aluminum	mg/L	0.1	0.2	***1.6***	0.06	<0.06
Antimony	mg/L	0.02	0.006	<0.06	<0.06	<0.06
Arsenic	mg/L	0.005	0.025	<0.06	<0.06	<0.06
Barium	mg/L	5	1	*0.064*	*0.042*	0.012
Berylium	mg/L	0.0053		<0.001	0.001	<0.001
Boron	mg/L		5	0.08	0.01	<0.01
Cadmium	mg/L	0.00003	0.005	***0.016***	***0.086***	<0.006
Calcium	mg/L			*42.3*	*60.8*	14.5
Chromium	mg/L	0.001	0.05	**0.01**	<0.006	**0.011**
Cobalt	mg/L	0.0009		<0.006	**0.011**	**0.015**
Copper	mg/L	0.002	1	<0.006	<0.006	<0.006
Iron	mg/L	0.3	0.3	***32.341***	***1.805***	0.017
Lead	mg/L	0.005	0.01	***0.15***	<0.06	<0.06
Magnesium	mg/L		100	*6.7*	*10.1*	1.7
Manganese	mg/L	0.1-1	0.05	***0.447***	***0.488***	<0.001
Molybdenum	mg/L	1	0.25	<0.01	<0.01	<0.01
Nickel	mg/L	0.025		<0.02	0.03	<0.02
Phosphorus	mg/L			0.5	<0.1	<0.1
Potassium	mg/L	20		*1.8*	*2.1*	0.6
Selenium	mg/L	0.001	0.01	<0.06	<0.06	<0.06
Silicon	mg/L			*7.56*	*5.39*	3.5
Silver	mg/L	0.0001		<0.01	<0.01	<0.01
Sodium	mg/L		200	1	2.1	0.9
Strontium	mg/L			*0.223*	*0.333*	0.096
Sulfur	mg/L	?		***26.28***	***70.62***	2.41
Tin	mg/L			<0.06	<0.06	<0.06
Titanium	mg/L	0.1		*0.092*	<0.002	0.003
Vanadium	mg/L	0.1		<0.01	<0.01	<0.01
Zinc	mg/L	0.03	5	***1.989***	***3.537***	0.015
bold: exceeding water quality criteria						
italic: exceeding background levels (control)						
AL: aquatic life						
DW: drinking water						
* Salmo River near tailings						

APPENDIX B

Capsule Geology and Bibliography

082FSW205 Production Report Inventory Report

Name	ARLINGTON (L.3648)	**Mining Division**	Nelson
Status	Past Producer	**NTS**	082F03W NAD 27
Latitude **Longitude**	49 13 27 N 117 19 39 W	**UTM**	11 5452208 476152
Commodities	Gold Silver Lead Zinc	**Deposit Types**	I05 : Polymetallic veins Ag-Pb-Zn±Au.
Tectonic Belt	Omineca	**Terranes**	Quesnel. Plutonic Rocks.

Capsule Geology	This property, consisting of 9 Crown-granted claims and fractions, is located between Rest and Hooch Creeks about 4.8 kilometres northwest of Salmo. The Arlington claim (Lot 3648) was Crown-granted to the Hastings (British Columbia) Exploration Syndicate Ltd. in 1899. The mine was in continuous operation from 1900 until June 1912; leasers kept the mine operating until November 1913. No further work was done until 1927 when the Arlington Mining Company reopened the mine and installed a 15 stamp mill; the company operated intermittently through 1928. In 1929 the property was acquired by Relief-Arlington Mines Ltd.; the company was subsequently controlled by the W.N. O'Neil Company Ltd. and in the 1940's by Premier Cold Mining Company. The mine was operated under lease by R. Oscarson from 1932 to 1942. Messrs. Schrieves and R. & K. Golac optioned the property in 1943 and acquired title to it in 1945. Intermittent operations were carried on by the owners or by leasers until October 1948 when F.C. Buckland optioned the property. Subsequent operations were carried on under an agreement by Kenville Gold Mines Limited until May 31, 1950, when the property reverted to the former owners. New Arlington Mines Limited was formed in December 1951 to work the property. The mill capacity was increased from 50 to 125 tons per day and milling operations, mainly of dump material, continued into 1954. Subsequent operations were carried on intermittently by leasers. In about 1961 the property was acquired by J. Russell of Borrega Springs, California. Development work totals over 5182 metres of drift, crosscuts and raises. The vein has been explored and largely mined out for 457 metres along the strike. Lower to Middle Jurassic argillites and argillaceous quartzites of the Hall Formation (Rossland Group) are gently folded and intruded by a granite-porphyry sill of the Middle to Late Jurassic Nelson Intrusions. Pyrite, galena, and sphalerite mineralization is hosted by quartz in a 0.6 metre thick vein which closely follows the granite- sediment contact but which locally occurs as a footwall or hanging wall to the intrusive sill. The vein lies in strata which exhibits gentle "rolls" or folds downdip and these structures may have had some controlling influence on mineralization. The vein has been explored and largely mined out for 460 metres along strike. The mine was in production from 1900 to 1913 and again from 1932 to 1970. The total amount of ore mined for these years was 69,823 tonnes. Recovered from the ore was 1,700,339 grams of gold, 4,334,578 grams of silver, 520,420 kilograms of lead and 456,920 kilograms of zinc. In 1969, G.D. Fox and Associates of Trail, hauled material from the old dumps to the Trail smelter. These operations ceased in 1970. It is possible that Shalman Resources Limited held

	the property in 1975. In 1982, the property was owned by Chutine Resources Ltd. They estimate that there are about 113,000 tonnes of dump material from which samples assayed between 3 and 53.5 grams of gold per tonne (Northern Miner, October 28, 1982, page 6). In 1983, a soil geochemistry survey was carried out. About 3084 tonnes were mined producing about 7400 grams of gold. In 1985, Ryan Exploration Company Ltd. acquired the Chutine's interest. Chutine dropped its option in 1988.

Bibliography	EMPR AR 1899-842; 1900-847,982; 1902-161; 1903-148; 1904-129,135, 142; 1905-168; 1906-150,248; 1907-103,213; 1908-108,246; 1909-119,272; 1910-107; 1911-159,284; 1912-155,322; 1913-131,419; 1927-313; 1928-338; 1932-159,195; 1933-199,236; 1934-A26; 1935-E29,A27,G50; 1936-E47; 1937-A38,A39,E27; 1938-A35,E40; 1939-39,42,84; 1940-25,69; 1941-26,68; 1942-A27,A64; 1943-65; 1944-40,62; 1945-43,100; 1946-35,145; 1947-162; 1948-133; 1949-167; 1950-123; 1951-41,138; 1952-43,146; 1953-45,116; 1954-49, 126; 1957-A46; 1958-A45,38; 1960-A54; 1961-A49,68; 1962-A49,74; 1963-A49,70; 1964-A55,115; 1965-181; 1966-212; 1967-244; 1968-242 EMPR ASS RPT *11542, 12075 EMPR BC METAL MM00953 EMPR FIELDWORK 1987, pp. 19-30; 1988, pp. 33-43; 1989, pp. 11-27; 1990, pp. 9-31 EMPR GEM 1969, p. 318 EMPR INDEX 3-188; 4-119 EMPR OF 1988-1; 1989-11; 1990-8; 1990-9; 1991-2; 1991-16 EMPR PF (*1:720 Scale Map of Arlington Mine, unknown author; also Miscellaneous clippings; Relief-Arlington Mines, Limited, Annual Report for 1938) EMR MP CORPFILE (Relief Arlington Mines Ltd.; New Arlington Mines Ltd.; Chutine Resources Ltd.) GSC MAP 299A; 1090A; 1091A; 1145A GSC MEM *172, p. 75; 308, p. 174 GSC OF 1195 CANMET IR 1935, 771, p. 134-141, #653 CANMET RPT Investigation No. MD2599 (1949); Concentration and Cyanidation Tests on a Sample of Low Grade Dump Material, containing Gold, Silver, Lead and Zinc from Arlington Mine, Ymir Area, Nelson District, British Columbia GCNL #209,#246, 1975; #197, 1979; #74, 1984; #114,#174,#200,#217, 1985 IPDM Mar/Apr 1983 N MINER Oct.28, 1982; Sept.22, 1983; Jan. 24, 1985

APPENDIX C

Capsule Geology and Bibliography

082FSW052 Production Report

Name	YELLOWSTONE (L.3631)	**Mining Division**	Nelson
Status	Past Producer	**NTS**	082F03E NAD 27
Latitude Longitude	49 08 35 N 117 08 00 W	**UTM**	11 5443148 490275
Commodities	Gold Silver Lead Zinc Silica	**Deposit Types**	I01 : Au-quartz veins.
Tectonic Belt	Omineca	**Terranes**	Ancestral North America. Plutonic Rocks.

Capsule Geology	This property is located on Waldie creek near its junction with Sheep Creek. The Kootenay Belle (082FSW046) property adjoins on the northeast. Other associated properties are Queen, Vancouver, Midnight and Alexander (082FSW048-051, respectively). The Yellowstone claim was staked in 1896 by T. Bennett. Development of the property commenced late in the summer of that year by Yellowstone Mines Limited and in the three succeeding years all its own ore had been developed. Leasers began development work on the Queen property (082FSW048) in about 1900; the Holmes Syndicate carried on development work during part of 1902; the Queen claim (Lot 1076) was Crown-granted to Messrs. Turner and Scully that same year. In 1903 W. Waldie, one of the owners, began development of the property and also obtained a lease on the Yellowstone mill. Waldie completed purchase of the property in 1905, acquired the Yellowstone group in 1907, and sold the combined property to Queen Mines Incorporated in 1908. The company operated the mine until 1916. Except for a brief period of operation by leasers in 1918 the property was idle until acquired by the Yellowstone Mining Company Limited in 1922, however, the company carried on operations for only about a year. Messrs. Lavigne, Stayner & associates acquired the property in 1928 and in 1930 formed Queen Mines Limited, however, operations ceased later in the year. In 1933 Sheep Creek Gold Mines Limited was formed by a consolidation of the Queen Mining & Milling Company and the Midnight Gold Mining Syndicate, owners of the Midnight and Vancouver claims. A new 50 ton mill was put into operation in May 1935 and operated more or less continuously until the mine was closed in 1951. The company name was changed in 1956 to Sheep Creek Mines Limited. Beginning in 1961 leasers made intermittent shipments of silica ore from the dumps, the ore being in demand as a silica flux. The company name was changed in September 1965 to Aetna Investment Corporation Ltd. The Yellowstone is one of four east-west trending quartz-sheer veins identified in some references as part of the Queen property. The Yellowstone lies on the east limb of the western anticline of the Sheep Creek Camp. It is within quartzites and argillites of the Lower Cambrian Reno Formation (correlative with rocks of the Hamill Group) which are in contact to the east with quartzites of the Lower Cambrian Quartzite Range Formation argillites of the Lower Cambrian Laib formations argillites. Along the Laib-Reno formation contact is an intrusive sill (?) of quartz-porphyry which extends along a north-south trend through most of the Sheep Creek camp. Mineralization consists of brown iron oxides (limonite?) with pyrite, free gold and some

	sphalerite and galena in a quartz gangue. The vein is less than a metre wide and is normally very narrow. It commonly splits into several fissures. Almost all recorded production was achieved in 1900 and 1901 when an ore shoot about 40 metres long produced about 15,400 tonnes of ore containing 169 kilograms gold and 86 kilograms silver. The north wall of the shoot was quartzite and the south wall was argillite. The eastern extension of the shoot was marked by a change from quartzite to argillite in the north wall. Refer to the Queen mine (082FSW048) for a summary of the Sheep Creek mining camp. Arakis Mining Corporation drilled 10 holes (257 metres) in 1988. Nugget Mines Ltd. conducted geophysical and geochemical surveys in 1998 and 1999.

Bibliography	EMPR AR 1899-692,847; 1900-843,847; 1904-130,144; 1905-169; 1907-103; 1909-122; 1910-108; 1915-156; 1922-205; 1923-218; 1932-193; 1933-230; 1934-E17,E19; 1937-E47; 1947-162 EMPR ASS RPT 14, 82, 83, 6421, 6975, 11444, 11662, 14027, 16861, /cf/aris/search/search.cfm?mode=repsum&rep_no=00000 18029, 25469, 26023 EMPR BC METAL MM01094 EMPR BULL 10, p. 93; *31, pp. 42,45,51,54 EMPR EXPL 1977-E63; 1980-53 EMPR FIELDWORK 1987, pp. 19-30; 1988, pp. 33-43; 1989, pp. 11-27; 1990, pp. 9-31 EMPR GEM 1970-442; 1971-400; 1972-42; 1974-82 EMPR INDEX 3-219 EMPR OF 1988-1; 1989-11; 1990-8; 1990-9; 1991-2 EMPR PF (Starr, C.C. (1929): Report of Preliminary Examination of the Queen Mine, 12 p. (in 082FSW048); Longitudinal Section and Plan of Yellowstone Mine) EMR MP CORPFILE (Queen Mines Inc.; Aetna Investment Corporation Ltd.) GSC MAP 50-19A; 299A; 1068; 1090A; 1091A; *1145A GSC MEM *172, p. 42; 308, p. 175 GSC OF 1195 CANMET IR #748(1934), pp. 53-61 N MINER May, 1941, pp. 26,29

APPENDIX D

Capsule Geology and Bibliography

082FSW048 Production Report

Name	QUEEN (L.1076)	**Mining Division**	Nelson
Status	Past Producer	**NTS**	082F03E NAD 27
Latitude **Longitude**	49 08 25 N 117 08 09 W	**UTM**	11 5442839 490092
Commodities	Gold Silver Lead Zinc Silica	**Deposit Types**	I01 : Au-quartz veins.
Tectonic Belt	Omineca	**Terranes**	Ancestral North America.

Capsule Geology	This property is located on Waldie creek near its junction with Sheep Creek. The Kootenay Belle (082FSW046) property adjoins on the northeast. Other associated properties are Yellowstone, Vancouver, Midnight and Alexander (082FSW052, 049, 050 and 051). Leasers began development work on the Queen property in about 1900; the Holmes Syndicate carried on development work during part of 1902; the Queen claim (Lot 1076) was Crown-granted to Messrs. Turner and Scully that same year. In 1903 W. Waldie, one of the owners, began development of the property and also obtained a lease on the Yellowstone mill. Waldie completed purchase of the property in 1905, acquired the Yellowstone group in 1907, and sold the combined property to Queen Mines Incorporated in 1908. The company operated the mine until 1916. Except for a brief period of operation by leasers in 1918 the property was idle until acquired by the Yellowstone Mining Company Limited in 1922, however, the company carried on operations for only about a year. Messrs. Lavigne, Stayner & associates acquired the property in 1928 and in 1930 formed Queen Mines Limited, however, operations ceased later in the year. In 1933 Sheep Creek Gold Mines Limited was formed by a consolidation of the Queen Mining & Milling Company and the Midnight Gold Mining Syndicate, owners of the Midnight and Vancouver claims. A new 50 ton mill was put into operation in May 1935 and operated more or less continuously until the mine was closed in 1951. The company name was changed in 1956 to Sheep Creek Mines Limited. Beginning in 1961 leasers made intermittent shipments of silica ore from the dumps, the ore being in demand as a silica flux. The company name was changed in September 1965 to Aetna Investment Corporation Ltd. The Sheep Creek mining camp consists of auriferous sulphide mineralization within a regional system of quartz veins controlled by faults. The camp hosts four distinct fault/fracture systems. All productive veins are associated with faults trending northeast and dipping southeast. The veins are particularly productive where they cross the axis of the two regional, northerly trending anticlines which dominate the geology of the camp. In addition there are a few northwest trending strike slip faults, north trending normal faults and flat faults, on which the hanging wall has been thrust westwards. Ore occurs in shoots and is almost without exception confined to parts of fault zones in which one or both walls are quartzite. Other parts of the veins are either too narrow or low grade to be economic. The ore shoots are found at the intersection of northeast faults with quartzite stratigraphy, particularly the Upper Nugget and Upper Navada members of the Quartzite Range Formation (correlative with rocks of the Hamill Group). The underlying Motherlode Member quartzite is, without obvious reason, almost completely barren of economic gold mineralization. The veins contain a quartz gangue containing pyrite with

	lesser amounts of pyrrhotite, chalcopyrite, galena, sphalerite and rare visible gold. Precious metal grades are exceedingly variable and zones of high grade appear to be distributed randomly. Such zones or ore shoots are rarely greater than a few of tens metres in size. Throughout the camp, economic mineralization is found within a vertical range of less than 500 metres in any given vein and from north to south in the camp this vertical range occurs at progressively lower elevations. At the north end of the camp near Reno Mountain the economic zone lies at about 1675 to 2150 metres elevation and at the south end near Mount Waldie the zone is entirely below 915 metres above sea level. The veins may occur above the economic zone but are generally too narrow and below the zone the veins usually persist but are commonly wider and of lower grade. Higher grades of greater than 150 grams per tonne are generally restricted to the top of the zone. The Queen property includes four east trending veins which are north to south the Yellowstone (082FSW052), Queen, Midnight (082FSW050) and Alexandra (082FSW51) veins. The Queen vein crosscuts the western anticline and the mine shaft is within the Nugget and Navada Members of the Quartzite Range Formation. To the west, the quartzites are in contact with Lower Cambrian Laib Formation limestones and the vein dies out in the softer sediments. To the east, the vein crosscuts argillites and quartzites of the Lower Cambrian Reno Formation (correlative with rocks of the Hamill Group). The ore shoots are within quartz gangue carrying free gold, pyrite and some sphalerite and galena. Wall rocks are predominantly quartzite. The vein is crosscut by two lamprophyre dykes intruded along fault zones. Several ore shoots were developed on the Queen property which produced 653,165 tonnes of ore intermittently from 1902 to 1970. It has been reported that from 1900 to 1938 production was from the Queen vein; thereafter it includes production from other veins mined by Sheep Creek Gold Mines. From the total tonnage mined 9,453,383 grams of gold, 3,121,527 grams of silver, 7,769 kilograms of lead and 3,063 kilograms of zinc were recovered.

APPENDIX E

Capsule Geology and Bibliography

082FSW046 Production Report

Name	KOOTENAY BELLE	**Mining Division**	Nelson
Status	Past Producer	**NTS**	082F03E NAD 27
Latitude Longitude	49 08 23 N 117 07 35 W	**UTM**	11 5442776 490781
Commodities	Gold Silver Lead Zinc Tungsten Silica	**Deposit Types**	I01 : Au-quartz veins. I02 : Intrusion-related Au pyrrhotite veins.
Tectonic Belt	Omineca	**Terranes**	Ancestral North America.

Capsule Geology	This property, consisting of the Posadena, Rio Tinto, Sultana, Yosemite, Yosemite Fraction and Batt Fraction Crown-granted claims, is located on the south side of Sheep Creek about 0.4 of a kilometre above the junction with Waldie Creek. The nucleus of the property was located in about 1899 but no work was reported until leasers began operations in about 1904; subsequent production was treated at a small customs mill. The Kootenay Belle and Motherlode (082FSW041) properties were bonded to J.L. Warner & associates in 1908; the Rogers Syndicate purchased the property in 1910. Intermittent small scale operations were carried on by the owners or by leasers until 1928. Kootenay Belle Gold Mines Limited was incorporated in February 1933 to take over the property. A 50-ton mill was put into operation in November 1934 and operated until June 1943 when the mine was closed and the equipment removed. Leasers R. Thompson & associates worked the property from 1944 through 1948. From 1961 through 1964 the property was leased from M. Arishenkoff of Shoreacres and intermittent shipments were made from the mine dumps, the material being in demand as a silica flux. Around 1982, the property was acquired by Amore Resources Inc. from Crow Equities. They carried out geological mapping, sampling, geochemical surveys, re-established access to the mine and rebuilt surface roads. The Sheep Creek Mining Camp consists of auriferous sulphide mineralization within a regional system of quartz veins controlled by faults. The camp hosts four distinct fault/fracture systems. All productive veins are associated with faults trending northeast and dipping southeast. The veins are particularly productive where they cross the axis of the two regional, northerly trending anticlines which dominate the geology of the camp. In addition there are a few northwest trending strike slip faults, north trending normal faults and flat faults, on which the hanging wall has been thrust westwards. Ore occurs in shoots and is almost without exception confined to parts of fault zones in which one or both walls are quartzite. Other parts of the veins are either too narrow or low grade to be economic. The ore shoots are found at the intersection of northeast faults with quartzite stratigraphy, particularly the Upper Nugget and Upper Navada Members of the Lower Cambrian Quartzite Range Formation (correlative with rocks of the Hamill Group). The underlying Motherlode quartzite is, without obvious reason, almost completely barren of economic gold mineralization. The veins contain a quartz gangue containing pyrite with lesser amounts of pyrrhotite, chalcopyrite, galena, sphalerite and rare visible gold. Precious metal grades are exceedingly variable and zones of high grade appear to be distributed randomly. Such zones or ore shoots are rarely greater than a few tens of metres in size. Throughout the camp, economic mineralization is found within a vertical range of less than

	500 metres in any given vein and from north to south in the camp this vertical range occurs at progressively lower elevations. At the north end of the camp near Reno Mountain the economic zone lies at about 1675 to 2150 metres elevation and at the south end near Mount Waldie the zone is entirely below 915 metres above sea level. Above the economic zone the veins may occur but are generally too narrow and below the zone the veins usually persist but are commonly wider and of lower grade. Higher grades of greater than 150 grams per tonne are restricted generally to the top of the zone. The Kootenay Belle deposit lies south of Sheep Creek within quartzites, argillites and argillaceous quartzites of the Navada and Nugget Members of the Quartzite Range Formation. The sediments strike 0 to 15 degrees with a dip of 50 to 75 degrees east and they lie on the west limb of the eastern anticline. Production from the deposit was from the #1 and #2 fissure which contained two ore shoots each. The fissures each dipped 64 to 76 degrees south and intersected along strike. The ore shoots were in the order of 20 to 40 metres long and about 30 centimetres wide. The veins contained quartz and crushed country rock mineralized with pyrite and some galena and sphalerite. A quartz-porphyry sill intrudes along the contact of the Lower Cambrian Reno and Laib formations and is exposed at surface between the 2 and 3 level adits. Wolframite and scheelite are reported locally in the vein quartz. The quartz-porphyry intrusive extends the length of the Sheep Creek gold camp from Reno Mountain to Mount Waldie. Its influence on the gold mineralization is undetermined. Between 1904 and 1967, the Kootenay Belle mine produced a total of 305,610 tonnes of ore. From this ore 3,507,079 grams of gold, 1,306,232 grams of silver, 52,517 kilograms of lead and 59,335 kilograms of zinc were recovered. Locke Goldsmith drilled 8 holes (1115 metres) in 1988 and conducted a geochemical survey in 1992.

Bibliography	EM OF 1999-3 EMPR AR 1900-987; 1904-144; 1905-169; 1906-148,248; 1907-103,213; 1908-110,246; 1909-119,120,123,124; 1910-110; 1911-160,284; 1912-155; 1913-131; 1915-156,159; 1916-517; 1917-448,452; 1918-197; 1922-205; 1923-218; 1927-312; 1928-346; 1932-159,193; 1933-200,231; 1934-A27,29,E19,E22; 1935-A27,E29,G50; 1936-E47; 1937-A39,41,E47; 1938-A36,E3,39; 1939-39,83; 1940-26,68; 1941-26,66; 1942-27,63; 1943-71; 1944-40,62; 1945-101,104; 1946-35,145; 1947-163; 1948-134; 1949-168; 1950-1240; 1958-A45; 1959-A48; 1960-A54; 1961-A49,68; 1962-A49,74; 1963-A49,70; 1964-A55,116; 1965-A55 EMPR ASS RPT 14, 82, 83, 6421, 6975, 11444, 11589, 11662, 14027, /cf/aris/search/search.cfm?mode=repsum&rep_no=00000 17667, 22789 EMPR BC METAL MM01026 EMPR BULL 10(1941), p. 93; 10 (Rev.), p. 155; *31, pp. 54,57,59,62 EMPR FIELDWORK 1987, pp. 19-30; 1988, pp. 33-43; 1989, pp. 11-27; 1990, pp. 9-31; 1999, p. 214 EMPR INDEX 3-202 EMPR OF 1988-1; 1989-11; 1990-8; 1990-9; 1991-2; 1991-17, 1999-3 EMR MP CORPFILE (Kootenay Belle Gold Mines Limited; Amore Resources Inc.) GSC MAP 50-19A; 299A; 1090A; 1091A; *1145A GSC MEM *172, p. 38; 308, p. 175 GSC OF 1195 CANMET IR #494; #743(1933), pp. 74-76

APPENDIX F

Capsule Geology and Bibliography

082FSW004 Production Report Inventory Report

Name	HB (L.12672)	**Mining Division**	Nelson
Status	Past Producer	**NTS**	082F03E NAD 27
Latitude Longitude	49 09 08 N 117 11 55 W	**UTM**	11 5444177 485516
Commodities	Lead Zinc Silver Cadmium Copper Gold Talc	**Deposit Types**	E13 : Irish-type carbonate-hosted Zn-Pb. E12 : Mississippi Valley-type Pb-Zn. J01 : Polymetallic manto Ag-Pb-Zn.
Tectonic Belt	Omineca	**Terranes**	Kootenay.

Capsule Geology	The HB property is located on Aspen Creek, a tributary of Sheep Creek, 8 kilometres southeast of Salmo. The north end of the No. 1 orebody outcropped at an elevation of 1219 metres, west of Aspen Creek and almost a 1.6 kilometres north of Sheep Creek. The heavily oxidized outcrop was staked in 1907 by P.F. Horton, H.M. Billings, J.A. Benson, and S.N. Ross. The property and one of the claims was called the H.B. The Consolidated Mining and Smelting Company of Canada (Limited) optioned the claims in 1911. The No. 2 level crosscut was driven during the winter but results were disappointing and the option was dropped in 1912. W.R. Salisbury & associates, of Salmo, in 1913 leased the area containing the workings and small amounts of carbonate ore were mined until the lease expired in August 1915. During this period the owners, Horton & Billings, drove the Zincton crosscut to explore the adjacent Zincton claim. On the expiry of the above lease the entire property was optioned to a Spokane syndicate operating under the name Hudson Bay Zinc Company. The low level No. 7 crosscut (3,100 level) was started in 1915 and reached a length of 579 metres on completion in 1916. Diamond drilling (473 metres) from the crosscut failed to find ore and the option was given up in 1917. Crown-grants were issued to P.F. Horton and Agnes Billings on the Garnet (Lot 10809) and Zincton (Lot 10810) claims in 1919 and on the H.B. (Lot 12672) and 10 other claims and fractions (Lots 12668-12671 and 12673-12678) in 1921. The Victoria Syndicate, Limited, optioned the property in 1925 and began driving the No. 4 level (3,500 level) crosscut. This was completed at a length of 335 metres and from it drifting north and south in the orebody continued into 1926. The option was subsequently given up and P.F. Horton one of the owners, carried out some work on the property in 1927. Exploration work to that date was all done in the heavily oxidized zone at the north and on No. 1 orebody where the flat-plunging ore was exposed on surface. Oxidation here extended to the full depth of the ore zone, about 91 metres below surface. The Consolidated Mining and Smelting Company returned in 1927 to purchase the 18 Crown-granted claims and fractions, but the property remained idle until 1948. Starting about 1946, the company began geological investigations that led to an intensive diamond drilling program beginning in 1948. Large bodies of 9, low-grade disseminated sulphides plunging gently south from the oxidized orebody were indicated by this drilling. In June, 1949 an underground program began to investigate the drill results. The No. 4 level was rehabilitated and from the face the adit was extended south for nearly 457 metres. A parallel drive was subsequently made about 70 metres to the west and connected to the main drive by 3 crosscuts at 61-metre intervals. Diamond drilling from these two drives and from exploration

raises in 1950 partly delimited two orebodies - the No. I and No. 2 - and work until 1953 was aimed at developing these orebodies for production. In 1951 construction of a 1,000 ton per day concentrator began and a new adit level (No. 8) was driven 823 metres north from the Sheep Creek valley millsite to the ore zone. The concentrator was completed early in 1953 but due to low lead and zinc prices, was not put into operation. All work ceased on March 31 and was not resumed until April 1955; milling began in May.

The Garnet (082FSW249) zone outcrops on the Garnet and Legal Tender claims between elevations of 1067 and 1158 metres on the Sheep Creek slope about 0.5 kilometre north of the concentrator. The Legal Tender claim (Lot 10823) was staked on this showing in about 1899. In 1912 the claim was Crown-granted to George Klavano. Development work at that time apparently consisted of a few short adits. In 1926 the claim was part of the Black Jack group of 4 claims. This group was optioned by P.F. Horton & associates in 1926 and late in the year exploration work was done in about a dozen trenches crosscutting the zone. The Legal Tender was part of the group sold to Cominco in 1927; the Black Jack claims, lying to the west of the Legal Tender, were apparently abandoned. Diamond drilling by the company in 1948-49 in more than 30 holes delimited a more or less continuous mineralized zone 15 metres wide lying 46 to 61 metres west of the Garnet fault. Mining of the Garnet zone began in 1965 as an open pit operation and was later incorporated with the underground operation. The mine and mill closed on November 1, 1966. The company name was changed in 1966 to Cominco Ltd. Plans to re-open the mine were announced late in 1972. The mill and under ground workings were rehabilitated and production resumed in February 1973. Mining and milling operations continued until August 1978 when the mine closed. Measured and indicated reserves, as of December 31, 1978, were reported at 409000 tons, at 0.1 per cent lead and 4.1 per cent zinc (Canadian Pacific Limited, Form 10-K, December 31, 1978).

David Minerals Ltd. by an agreement dated May 8, 1981 purchased the mine, mill and adjacent properties from Cominco Ltd. for $750,000; a 20 acre parcel was subsequently sold to Goldbelt Mines Inc. for a millsite. Renovation of the H.B. mill was carried out to prepare a flotation circuit to custom mill gold-bearing sulphide ores, and a second circuit to treat molybdenite-gold ore from the company's Rossland properties (82 F/4, Mo 2 and 3). The gold circuit was put into operation on ore from the Gold Belt property in December 1981.

The HB orebodies are currently thought to be Kootenay Arc-type carbonate hosted sedimentary exhalative (sedex) deposits. The orebodies are located within dolomitized limestone of the Lower Cambrian Laib Formation, Reeves Member (correlative with limestone of the Badshot Formation). The east boundary of the Laib Formation is in contact with argillites of the Lower to Middle Ordovician Active Formation, on a fault contact, with the Active rocks overthrust from the east over the Reeves rocks.

Two distinct calcareous layers of the Reeves Member can be recognized in the area, an upper one about 110 metres thick separated from a lower 12-metre member by 15 to 30 metres of micaceous brown limey argillite. The HB orebodies occur within a hundred metres or so to the west of the thrust fault. It is thought that the mineralization is related to the intrusion of granitic stocks of the Middle to Late Jurassic Nelson Intrusions with the nearest outcrop about 1 kilometre away from the mine. The only intrusives present in the mine are post-ore diabase dykes up to 3 metres thick.

In the vicinity of the HB mine, the beds are folded into a broad synclinorium, and the limestone layers in the mine are on the west limb of this structure. There is evidence of much isoclinal folding within the trough of the synclinorium, with axial planes steeply inclined to the east and folds plunging 20 degrees to the south. There may be similar folding along the west limb within the mine area, but the portions of the folded beds revealed by the mine workings indicate that here the limestone has only formed thickened wrinkles. Within these wrinkles the beds are highly distorted by complex folding. In the central portion of the structures there is cleavage banding which strikes north and dips steeply. The primary folding is disturbed by major crossfolding in at least two places, one at the north end of the mine, the other just south of the main orebodies. The crossfolds plunge steeply to the north and resemble "S" type dragfolds.

The principal ore zones consist of three steeply dipping, parallel zones lying approximately

	side by side and extending as pencil-like shoots for about 900 metres along the gentle south plunge of the controlling structures. The largest and most easterly ore zone has a maximum height of about 140 metres and a maximum width of 30 metres. Within these zones are steeply dipping discontinuous ore stringers with a lead to zinc ratio of 1:5. In addition to the steep stringer lodes there is a second type consisting of flat lying, slightly brecciated zones with a lead to zinc ratio of about 1:2.5. These zones plunge at 20 degrees to the south, in general agreement with the plunge of the other orebodies. There are several separate ore zones of the flat lying variety. The layers of ore range from a few metres to 12 metres in thickness, but are generally from 3 to 5 metres thick. The sulphide mineralization within these layers is fairly regular and resembles bedding. There is evidence to indicate ore deposition was controlled by shear zones within the folded limestone; the best ore concentrations occurring at the junctions between steeply dipping shears (the pencil-like ore bodies) and flat lying shears (the flat-lying brecciated orebodies). The mineralogy of the ore is relatively simple with pyrite, sphalerite and galena in order of abundance and minor pyrrhotite found locally. The northern portion of these bodies is exposed at surface, near the original HB claim, and are oxidized to a depth of about 100 metres at that point. Where the ore is protected by enclosing dolomite relatively little oxidation has occurred. Other secondary minerals include calamine, smithsonite, anglesite, and the rare zinc phosphate, spencerite. Wallrock alteration is typical of lead-zinc deposits in the area. The ore zones are enveloped by a broad zone of dolomitization which is bordered along its contact with the limestone by a narrow zone in which limestone is replaced by fine-grained silica. Talc and tremolite alteration, thought to be pre-ore, is concentrated near the silica-rich zone resulting from the silicification of dolomite. An appreciable amount of talc is found locally within the ore zone. A smaller zone, located to the southwest of the main HB mine, is known as the Garnet orebody (082FSW249). The Garnet zone was mined from the surface from a small open pit, whereas the main mine is entirely underground. The HB mine produced a total of 6,656,101 tonnes of ore in 29 years between 1912 and 1978. Recovered from this ore were 29,425,521 grams of silver, 49,511,536 kilograms of lead, 260,431,646 kilograms of zinc, 2,019,586 kilograms of cadmium, 105,412 kilograms of copper and 6,159 grams of gold. Measured and indicated reserves published December 31, 1978 by Canadian Pacific Limited were given as approximately 36,287 tonnes grading 0.1 per cent lead and 4.1 per cent zinc (Energy, Mines and Resources Canada Mineral Bulletin MR 198, page 209).

Bibliography	EMPR AR 1911-157,160,161; 1912-155,322; 1913-131,419; 1914-327, 510; 1915-135,160,445; 1916-K205; 1917-448; 1919-370; 1921-G347; 1925-A248; 1926-A278; 1927-C309; 1933-224; 1934-E5; 1948-134; 1949-168; 1950-124; 1951-A139; 1952-147; 1953-117,220; 1955-A48, 52; 1956-A50,83; 1957-A46; 1958-A45,39,63; 1959-A48,61; 1960-A54, 68; 1961-A49,68; 1962-A49,74; 1963-A49,70; 1964-A55,116; 1965-181; 1966-213 EMPR BC METAL MM01014 EMPR BULL 41, p. 101 EMPR FIELDWORK 1987, pp. 19-30; 1988, pp. 33-43; 1989, pp. 11-27; 1990, pp. 9-31 EMPR GEM 1972-48; 1973-57; 1974-67 EMPR MINING Vol. I, 1975, p. 18 EMPR OF 1988-1; 1989-11; 1990-8; 1990-9; 1991-2; 2000-22 EMPR PF (*Warning, G.F. (1960): Geology of the HB Mine; Also see other reports, unidentified authors, on HB Mine; *Irvine, W.T. (1957): The HB Mine; *1:1200 Scale Map of General Mine and Section, 1961; Miscellaneous sketches of Drill Core and Underground Faces) EMR MIN BULL MR #166/Res.; *198, p. 209

	EMR MP CORPFILE (Cominco Ltd.; Canadian Pacific Limited; David Minerals Ltd.) GSC BULL *29, p. 20 GSC MAP 3-1956, #18; 50-19A; 299A; 1090A GSC MEM 94; *172, p. 47; 308 GSC OF 1195 GSC P 50-19 CIM Trans. Vol. 2, pp. 124-131 (*Irvine, W.T., The H.B. Mine in Canadian Ore Deposits, 1957); Vol. LXIII, 1960, pp. 520-523 (*Warning, G.F., Geology of the H.B. Mine) CIM Vol. LXIII, pp. 520-523 CMJ *May, 1954, Vol.75, Ch. 14, p. 202 GCNL #150, 1981; #171, 1983 W MINER May, 1979, p. 60

APPENDIX G

Capsule Geology and Bibliography

082FSW009 Production Report

Name	JERSEY (L.9070)	**Mining Division**	Nelson
Status	Past Producer	**NTS**	082F03E NAD 27
Latitude Longitude	49 05 55 N 117 13 12 W	**UTM**	11 5438222 483939
Commodities	Lead Zinc Silver Cadmium Tungsten Molybdenum Gold Bismuth	**Deposit Types**	E13 : Irish-type carbonate-hosted Zn-Pb. E12 : Mississippi Valley-type Pb-Zn.
Tectonic Belt	Omineca	**Terranes**	Kootenay.

Capsule Geology	This property lies on the summit between Sheep & Lost Creeks, about 11 kilometres southeast of Salmo. Although the Emerald has in recent years been a tungsten producer (082FSW010), its early history as a lead-zinc producer is mentioned here because the Jersey workings were later extended into Emerald ground (082FSW310) and production figures for the two have not been recorded separately. Production of lead-zinc ore from the Emerald was begun in 1906 by the owner, J. Waldbesen. In 1917 Iron Mountain Ltd. was formed to operate the mine and a 25 ton mill was put into operation. The Emerald was a small but steady producer of lead- zinc ore from 1906 to 1925. A small amount of shallow development work was done on the Jersey claim from 1916 to 1919 and some ore was shipped, however the main ore deposit was not discovered at this time. Canadian Exploration Ltd., while operating the Emerald tungsten mine, carried out an extensive diamond drilling program on the Jersey during 1948 and a large tonnage of lead-zinc ore was outlined. During 1948-49 the Emerald tungsten operation was closed down and the mill, beside the Nelson-Nelway Highway, was converted to a lead-zinc operation and production from the Jersey began in March 1949. The mine has operated continuously since that time, development work being done on all seven ore zones. Track mining has been used in A, C, and D zones and trackless mining in A, D, E, F, and G zones. The A zone has been developed from the south end of the Jersey zone to a point north of the Emerald, a distance of 1524 metres. Ore reserves as of April 1, 1965 are reported at 671,075 tonnes grading 1.2 per cent lead and 4.1 per cent zinc. The Jersey mine is a Kootenay Arc-type sedimentary exhalative deposit that occurs in the Kootenay Arc within what is called the Mine Belt, an area of carbonate hosted lead-zinc deposits associated with Lower Cambrian limestones of the Reeves Member (Laib Formation) and its equivalent, the Badshot Formation. The dominant structure of the Mine Belt is the north trending Jersey anticline, an isoclinal fold whose axial plane dips 45 degrees to the east. The Jersey orebodies are gently dipping tabular or lenticular bands of sulphide which lie on the normal limb of the anticline parallel to the banding in the sediments. The orebodies trend 015 degrees and plunge 10 degrees southerly over a distances up to 1800 metres. The maximum east-west width is 600 metres. The Reeves limestone is 120 to 150 metres thick in the mine area. Lead-zinc mineralization,

	occurring mainly in dolomite near the base of the Reeves Member, varies from 8 to 30 metres in thickness. The limestone and dolomite varies from a blue-green banded type to a white massive type. The dolomites are typically finer grained than the limestones. The Truman Member of the Laib Formation conformably underlies the Reeves Member, and forms the mine footwall rocks. This member consist of hard, dense, reddish green skarn and a brown argillite. The skarn is characterized by tungsten and minor molybdenum mineralization. The mine is bound on the east side by the Argillite (Iron Mountain) fault which down faults younger beds on the east side. The Dodger and Emerald stocks of the Middle to Late Jurassic Nelson Intrusions underlie the mine area. Secondary, symmetrical anticlinal and synclinal fold structures along the normal limb of the anticline have been used to delineate ten ore zones (A to J) within the deposit. Mineralization occurs more strongly in the fold troughs relative to the fold crests. The amplitude of these folds rarely exceeds 15 metres and their axis trends slightly east of north. Numerous post-ore faults and lamprophyre dykes crosscut the stratigraphy. Five ore bands, ranging in thickness from 0.3 to 9 metres are recognized in the mine. These bands in order of stratigraphic sequence are: 1) Upper Lead Band; 2) Upper Zinc Band; 3) Middle Zinc Band; 4) Lower Zinc Band; and 5) Lower Lead Band. Ore mineralization consists of fine-grained sphalerite and galena with pyrite, pyrrhotite and minor arsenopyrite. Cadmium is associated with sphalerite, silver with galena. Iron content of the sphalerite is low (about 6 per cent). The overall grade of the deposit is about 3.7 per cent zinc and 1.2 per cent lead. In the A zone the ore bands are very close together and frequently have been mined as a unit up to 24 metres thick. Throughout the remainder of the mine these bands have been mined separately or in combinations. The Lower Jersey zone is a zinc and lead enriched dolomite horizon located about 60 metres below the previously mined Jersey orebody. The zone was recognized in 1996 when a new mine model was prepared on the basis of surface and underground geology as well as two underground drillholes drilled prior to the mine's closure. Within the area previously tested, the widest mineralized intercept is 9 metres and the best single intersection graded 8.1 per cent zinc and 3.8 per cent lead across 1 metre (George Cross News Letter No. 27, February 7, 1997). The Bismuth Gold zone is a flat lying, gold-enriched horizon which overlies and trends parallel to the east limb of the former Jersey deposit. Two holes drilled into this zone in 1996 intersected a flat lying, 9-metre thick, pyrrhotitic horizon with gold grades ranging from 2.0 to 8.3 grams per tonne. A review of the mine records for drilling completed in the 1940s and 1950s indicates this gold-rich sulphide zone was intersected in surface and underground drillholes over a north-south distance of 1000 metres. These records suggest the body ranges from 1 to 18 metres in thickness (George Cross News Letter No.27, February 7, 1997). The Jersey mine commenced milling of lead-zinc ores in 1949 and continued until 1970 when operations ceased due to depletion of ore reserves. The mine produced about 6.4 million tonnes of ore from which 115 thousand tonnes of lead, 263 thousand tonnes of zinc and 21.5 thousand kilograms of silver were recovered. Sultan Minerals Inc. explored and drilled the area in 1996 (1700 metres in 16 holes) and 1997 (1204 metres in 16 holes underground). The best intersection was 2.65 per cent zinc and 4.62 per cent lead over a 5-metre core length (4 metres true thickness). Sultan had plans for more work in 1999.

Bibliography	EM EXPL 1996-E3; 1997-47 EMPR AR 1917-195; 1918-195; 1919-159; 1949-168; 1950-126; 1951-140; 1952-A147; 1953-117; 1954-A127; *1956-82; 1957-45; 1958-A45,38; 1959-A48,62; 1960-A54,69; 1961-A49,69; 1962-A49,75; 1963-A49,71; 1964-A55,117; 1965-A55,182; 1966-214; 1967-A53,245; 1968-A53,241 EMPR ASS RPT 8130, 23384, 23486, 23883, 24531, 24910, 25349 EMPR BC METAL MM00989 EMPR BULL 10 (Rev); *41, pp. 84,106,113-119

	EMPR FIELDWORK 1987, pp. 19-30; 1988, pp. 33-43; 1989, pp. 11-27; 1990, pp. 9-31; *1999, pp. 214-219 EMPR GEM 1969-319; 1970-442,443 EMPR OF 1988-1; 1989-11; 1990-8; 1990-9; 1991-2; 1991-17; 2000-22 EMPR P 1991-4, pp. 71-88 EMPR PF (in *082FSW010 - Property Photos; *Bradley, O.E., (1968): Geology of the Jersey Lead-Zinc Mine; Sultan Minerals Inc. Website (May 1999): Jersey-Emerald Property, 3 p.) EMR MP CORPFILE (The Iron Mountain Ltd.; Canadian Exploration Ltd.; Placer Development Ltd.) GSC BULL 29, p. 17 GSC MAP 1145A GSC MEM 172, p. 57; 308, pp. 111,184,192 GSC OF 1195 GSC P 50-19 CIM Struct. Geol. Vol. II, pp. 116-123 CIM TRANS Vol. 56, pp. 228-236 ECON GEOL *Vol. 49, #5, p. 521 GCNL *#27(Feb.7), #223(Nov.20), #240(Dec.31), 1997 PR REL Sultan Minerals Inc., May 7, 1997; Apr.6, July 22, 1999 WWW http://www.langmining.com/sultan/main.htm Sinclair, (1960): Ph.D. Thesis, University of British Columbia, Vancouver, British Columbia

APPENDIX H

MINFILE Capsule Geology & Bibliography Report

082FSW067 DUNDEE:YANKEE-DUNDEE:YANKEE GIRL-DUNDEE:BLUE:OLD BILL (L.1863):PARKER (L.1861):LIGHTHEART (L.1862):ANNIE FR. (L.3849):WHITE PINE (L.4004)

	Status: Past Producer
Commodities: AU AG PB ZN	Deposit Type: I05
Latitude/Longitude: 49 17 12 N 117 11 31 W	Mining Division: Nelson
UTM: 11 5459342 N 486041 E	NTS: 082F06E

The property is located at approximately 914 metres elevation on the north side of Oscar Creek, 0.8 kilometre east of Ymir. Dundee Gold Mining Company, Limited Liability, was incorporated in December 1896 by Charles Dundee and associates of Rossland to develop the property, one of the first to be worked in the Ymir area. The Parker, Old Bill, and Lighthart claims (Lots 1861-1863) were Crown-granted to the company in 1897, and the Annie Fraction (Lot 3849) and White Pine (Lot 4004) in 1902. Intermittent development work comprising a 79-metre shaft and some 126 metres of crosscuts and drifts was carried out from 1897 to 1902. In 1898 a concentrator and tram line were erected and put into operation but were destroyed by fire in April 1899. Vancouver interests were negotiating for the property in 1903. Dundee Cold Mine, Limited was incorporated in Vancouver in July 1904 to acquire the property. Some rehabilitation work was done in 1903 and lessees worked for a short period in 1905. The Dundee, Dundee Fraction, and M.S. claims (Lots 7241- were Crown-granted to Dundee Cold Mining and Milling Company, of Everett, Washington, which was registered in British Columbia in 1905. The location of these claims relative to the Dundee propery is not known. Work resumed in June 1910 when an adit "Dundee adit" was begun on the Old Bill claim some 274 metres below the collar of the shaft. By 1915 when work ceased the adit had been driven as a crosscut for 568 metres, and for 333 metres of drifting on the vein. The Mining Corporation of Canada, Limited optioned the property late in 1919 and some exploration work was carried out in 1920. The option was dropped in 1921. Ymir Dundee Gold Mining Company, Limited, incorporated June 1934, acquired the property under agreement from Dundee Gold Mine, Limited adn development work was begun in driving a raise. Operations continued until mid 1935. Ymir Yankee Girl Gold Mined, Limited, owner of the adjacent Yankee Girl mine, aquired a lease and bond on the property early in 1940. A crosscut was begun from the Yankee Girl main (376 metres) level to connect with the raise from the Dundee adit. Some 660 metres of raising on the Dundee supplied most or the ore milled during 1941 and to the and of 1942 when the mine closed. Lessees owned pillar and stope remnants in 1950. The workings to date comprised 8 levels over a vertical range of 305 metres. Yankee Dundee Mines Limited was incorporated in November 1952 by Ralph Sostad and associates to develop the Yankee Girl and Dundee mines, however no work was reported on the Dundee. The company name was changed in 1963 to Dundee Mines Limited. Burlington Mines Ltd., (of which Ralph Sostad was a director) acquired 36 claims comprising the Dundee and Yankee Girl properties from Dundee Mines Limited by an agreement dated July 1966. No work was reported on the Dundee. The Dundee mine is located on the north side of Oscar Creek, 3 kilometres east-northeast of Ymir. This property was one of the first to be developed in the Ymir area; gold was initially discovered on the Dundee in 1896. The Dundee and Yankee Girl (082FSW068) mines were amalgamated in 1940. A crosscut was developed from the Yankee Girl 1235 level to connect with the raise from the Dundee adit. The Dundee mine closed in 1942 and no further work has been reported. The Yankee Girl vein occurs 300 metres to the north. The area is underlain by Jurassic Ymir Group slate, argillite and argillaceous quartzites intruded by granodiorite of the Middle to Late Jurassic Nelson Intrusions. The contact with a southern tongue of the Nelson batholith occurs about 400 metres to the east. The area is strongly faulted with the faults forming a conjugate set. One set, striking 290 degrees and dipping 60 to 70 degrees north, hosts mineralized veins. The Dundee vein, a strong fault-fissure striking 060 to 070 degrees east and dipping 60 to 70 degrees northwest, cuts both the sediments and intrusive. The zone has well-defined walls and varies from 2 to 6 metres in width. On the hanging wall, 30 to 60 centimetres of fault gouge is present and the footwall is granite. The vein hosts sheared country rock fragments in a quartz gangue containing pyrite, galena, and sphalerite, in order of abundance. The vein, parallel to the Yankee Girl vein, has been traced on surface for many hundreds of metres. At surface, the vein is 4 metres wide and increases with depth. The vein is offset and intersected by lamprophyre dykes.

Production at the Dundee was principally from a 33-metre long ore shoot in the vein where it crosscuts a tongue of granodiorite. The ore bearing sections of the vein are up to 4 metres wide. Sulphide mineralization is less abundant where the vein crosscuts sediments. The Dundee vein is paralleled by the Blue vein which generally hosts less gold and dips less steeply. Production from the Dundee has been included with the Yankee Girl, however, this property had only a limited production of 2717 tonnes with grades in the order of 10 grams per tonne gold and 170 grams per tonne silver. Inferred reserves are 872,000 tonnes at approximately the same grade as the material mined (George Cross News Letter No. 215, 1983). There are 360,000 tonnes of reported material left on the dumps (George Cross News Letter No. 212, 1983). Kingsvale Resources Ltd. optioned the property in 1988 and conducted trenching and sampling; they dropped the option in 1989.

EMPR AR 1897-529,531,564,572; 1899-597,691,7 13; 1900-846; 1902-296,302; 1903-147; 1904-125; 1905-166; 1906-251; 1910-106; 1911-157,159; 1912-154; 1913-132; 1914-329; *1915-135,149,151,445; 1916-204; 1921-172; 1934-A26,E7; 1935-A27,E28; 1940-67; 1942-62; 1949-165; 1950-120; 1951-41,136; 1952-144; 1953-115; 1954-125; 1956-78
EMPR ASS RPT 7196, *9021, *14719
EMPR BC METAL MM00986
EMPR BULL 1, p. 104; 41
EMPR EXPL 1975-34; 1980-68; 1986-C53
EMPR FIELDWORK 1980, pp. 149-158; 1981, pp. 28-32, pp. 176-186; 1987, pp. 19-30; 1988, pp. 33-43; 1989, pp. 247-249; 1990, pp. 291-300
EMPR MAP 7685G; RGS 1977; 8480G
EMPR OF 1988-1; *1989-11; 1991-16
EMPR PF (See Yankee Girl 082FSW068)
EMR MP CORPFILE (Ymir Dundee Gold Mining Company, Limited; Ymir Yankee Girl Gold Mines Limited; Yankee Dundee Mines Limited; The Mining Corporation of Canada, Limited; Burlington Gold Mines Ltd.; Dundee Mines Limited)
GSC ANN RPT 1897, p. 32A
GSC MAP 51-4A; 175A; 1091A; 1144A
GSC MEM *94, pp. 109,111; 191, p. 25; 308, pp. 184,192
GSC OF 1195
GSC P 51-4
GCNL #212,#215, 1983

APPENDIX I

Capsule Geology and Bibliography

082FSW074 Production Report

Name	YMIR (L.1708)	**Mining Division**	Nelson
Status	Past Producer	**NTS**	082F06E NAD 27
Latitude Longitude	49 19 19 N 117 10 13 W	**UTM**	11 5463040 487625
Commodities	Gold Silver Lead Zinc	**Deposit Types**	I05 : Polymetallic veins Ag-Pb-Zn±Au.
Tectonic Belt	Omineca	**Terranes**	Quesnel.

Capsule Geology	The property is located at the 1372 metres elevation on the west side of Huckleberry (north fork of Wild Horse) Creek, 5.6 kilometres northeast of Ymir. The Ymir, Rockland, and Mugwump claims, staked in July and August 1895 by Joseph and Jerome Petrie and Oliver Blair, were in May 1897. The Golden Horn and Robertson and Nora Fractions were staked in 1896 by Petrie, Wood, and Robertson and Crown-granted (Lots 1711, 1712, 2301, respectively) in 1897 and 1898. The Poutney and Lawrence Fractions were staked by the operating company in 1897 and Crown-granted (Lots 2302 and 2303) in 1898. The property was acquired in November 1896 by The London and British Columbia Goldfields Limited. A program of extensive underground development was begun. A mill was built at the 1036-metre elevation, with a 732-metre tramway to No. 3 adit. A subsidiary company, The Ymir Gold Mines, Limited, was incorporated in London, England, in August 1898 to be the operating company. An 80-stamp mill was put into operation in 1900 and a cyanide plant for treating the tailings was installed in 1901. The No. 10 level crosscut was collared just above the mill and by 1902 had been driven 657 metres to intersect the vein 305 metres below the outcrop. Development work in the upper levels was done in Nos. 2 and 3 adits, and on Nos. 4 and 5 levels from a winze from No. 3 adit. No. 10 level was connected by a raise to the winze from No. 3 adit. Little ore was found below the 7th level. By 1904 the milling operation was reduced to 40 stamps. Production gradually decreased until the mine closed in 1908. During 1907-08 considerable surface exploration was carried out in search for the source of mineralized float occurring further up the mountain. On No. 2 level a crosscut was driven 244 metres into the hill in search for a parallel vein. On No. 10 level the vein was drifted on for 335 metres to the east. Ymir Gold Mines, Limited, a private company incorporated in February 1933 by J.F. Coats and associates of Vancouver to acquire the adjacent Goodenough property (082FSW073), acquired an option on the Ymir mine but no work was reported under this agreement. Ymir Consolidated Gold Mines, Limited, was incorporated in September 1934 to acquire and operate the Ymir, and Goodenough properties. Some high-grade ore was known to occur in the Goodenough, and sampling in the Ymir reportedly indicated large blocks of low-grade ore. On the basis of this the company installed a 125 ton-per-day mill at the Ymir property in 1935. The Goodenough ore had to be trucked to the mill. The mill operated from July 18th to November 30, 1935, mainly on Goodenough ore. Exploration in the east end of the upper Ymir workings located a small ore shoot and the mill resumed operating in June 1937 at 30 tons-per-day; milling operations continued into May 1938 when the company ceased operations. Lessees worked the property intermittently from 1937 to 1944, mining from pillars, stops remnants, and dumps. Americonda Mines Limited, incorporated October 1956s held options on the Ymir and

	Goodenough properties. Only limited work on the Goodenough was reported during 1956. Silver Dawn Mines Ltd. apparently held the Ymir and Goodenough properties in 1970. Some adits were rehabilitated and the workings prospected for scheelite. The Ymir property was owned in 1973 by Murray Zulps and associates, of Vancouver. Some rehabilitation work was reported and a small amount of ore shipped. Issa Fahel optioned the 7 Crown-granted claims of the Ymir group from Zulps and associates in July 1975. This agreement to purchase was assigned to Junex Resources Ltd. in September 1975. The deposit is hosted by Lower Jurassic Ymir Group schist, argillite and quartzite. Felsic dykes (up to 1 metre wide) strike 030 degrees and dip 74 degrees northwest crosscutting the host rocks. Augite basalt flows and flow breccias of the Lower Jurassic Elise Formation (Unit Je1), Rossland Group occur just to the west and the contact with the Middle to Late Jurassic Nelson batholith is about 1 kilometre to the east. Pyrite is disseminated in quartz veins and throughout the sedimentary rock. Mineralization is confined to a shear zone trending northeast at 065 degrees with a 60 to 70 degree dip to the northwest. The shear crosscuts the sedimentary stratigraphy which strikes 035 degrees with a 70 degree northwest dip. Economic mineralization occurs as lenses with an easterly pitch and frequently contains narrow bands or inclusions of argillite. The main ore zone, the Bonanza shoot, was about 146 metres long by 3 to 12 metres wide, averaging 4 metres in width. This zone was mined to a vertical depth of about 153 metres. Ore minerals consisted of pyrite, galena, and sphalerite and, near the surface where the vein is oxidized, cerussite and free gold are common. Below 150 metres depth quartz became more prominent and at about 300 metres ore mineralization is confined to streaks within the quartz. Ore material gradually decreased along strike to the east but to the west the vein was terminated by a fault. The Protection (082FSW073) occurrence may be the western extension of the Ymir vein but the latter is much wider although other characteristics are similar. The host rocks are crosscut by lamprophyre dykes, numerous faults and are complexly folded. However, there is no evidence of granitic intrusives associated with the ore zone as is common at some nearby deposits. The Tamarac (082FSW072), Protection (082FSW073), Ymir, and Good Hope (082FSW075) all appear to be located along the same shear related vein system although the same vein or shear may not be continuous through all properties. The best assay from drilling in 1986 (DDH Y86-1) was from a 2-metre intersection (68 to 69 metres) from a drill hole east of the main shaft and below the No. 7 level workings. This assay was 6.5 grams per tonne gold, 38.05 grams per tonne silver, 1.33 per cent lead and 0.70 per cent zinc (Assessment Report 15524). It is suggested that 85,500 tonnes of ore remains in the old stopes. Total production from 1895 to 1970 is 327,646 tonnes with a grade of about 10 grams per tonne gold and 34 grams per tonne silver. Combined lead and zinc content was about 1.7 per cent.

Bibliography	EMPR AR 1897-529,575; 1898-1158; 1899-556,598,692,713,815; 1900-838,844; 1901-1032; 1902-158; 1903-28,145; 1904-26,122,135, 269; 1905-25,167; 1906-148,248; 1907-102,213; 1908-246; 1910-106; 1915-135; 1917-168; 1922-209; 1923-214; 1924-192; 1925-248; 1926-275; 1927-301; 1928-330-331; 1929-239; 1930-269-270; 1931-136; 1932-187; 1933-227; 1934-E12-13; 1935-A28,E28,G50; 1936-E45,E64; 1937-E45; 1938-E37; 1939-82; 1940-67; 1941-65; 1942-62; 1943-64; 1944-A40,A60-61; 1949-164; 1951-136; 1952-144; 1957-43; 1958-37; 1959-61; 1960-A54,A67; 1964-115 EMPR ASS RPT *12562, 12993, *15524 EMPR BULL *1, pp. 102-104; 20, Part II, p. 10; 41 EMPR FIELDWORK 1980, pp. 149-158; 1981, pp. 28-32, pp. 176-186; 1987, pp. 19-30; 1988, pp. 33-43; 1989, pp. 247-249; 1990, pp. 291-300 EMPR GEM 1970-A40; 1973-64 EMPR MAP 7685G; RGS 1977; 8480G

	EMPR OF 1988-1; *1989-11; 1991-16 EMPR PF (Plan of the Ymir Group, 1900; Ymir Mine - Plan and Projection, 1926; Ymir Consolidated Gold Mines Ltd., Vertical Projection through Ymir Mine, 1935; Ymir Consolidated Gold Mines Ltd., Report of the Managing Director, 1939) GSC ANN RPT 1897, pp. 10,31A-32A GSC MAP 51-4A; 1090A; 1091A; 1144A GSC MEM *94, pp. 100-107; 191, pp. 32-37; 308, pp. 111,155,157,173 GSC OF 1195 GSC P 49-22; 50-19; *51-4; 52-13 GSC SUM RPT 1908, pp. 13-15; 1911, pp. 139-157 AIME TRANS 397, 1938 CIM TRANS 1900, pp. 3-10 (Fowler, S.S.: Notes on the Ymir Mine & its Mill Practice); #30, 1902; 1937, pp. 59-74 (McClelland, W.P.: Laboratory tests and Milling Practice on British Columbia Ores) CMJ 1933, Jul., pp. 259-264 GCNL #87; #120; #134; #154, 1984 N MINER Feb. 7, Jun. 4, 18, Aug. 29, Sept. 19, Oct. 3, Nov. 2, 21, 28, Dec. 19, 1935; Jan. 9, 16, Mar. 26, May 21, Dec. 31, 1936; Feb. 18, Mar. 11, Apr. 8, Aug. 24, Sept. 2, 30, Dec. 16, 30, 1937; Apr. 7, 1938; Feb. 2, Oct. 26, 1939; Jan. 25, 1940; Jun. 18, Dec. 24, 31, 1942; Dec. 2, 1943; Jan. 10, 1985

APPENDIX J

Capsule Geology and Bibliography

082FSW066 Production Report

Name	CENTER STAR (L.3766)	**Mining Division**	Nelson
Status	Past Producer	**NTS**	082F06E NAD 27
Latitude Longitude	49 16 32 N 117 11 21 W	**UTM**	11 5457900 486250
Commodities	Gold Silver Lead Zinc	**Deposit Types**	I05 : Polymetallic veins Ag-Pb-Zn±Au.
Tectonic Belt	Omineca	**Terranes**	Quesnel. Plutonic Rocks.

Capsule Geology	This property is located at 1067 metres elevation on the west slope of Jubilee Mountain about 1.6 kilometres southeast of Ymir. The Centre Star claim was located in 1900 and Crown-granted to J.S.C. Fraser & associates in 1905. No further activity was reported from the property until 1934. At this time Wesko Exploration and Development Company, Limited, acquired the Centre Star group consisting of the Centre Star, Redman, Twilight, Cold Island, Crowfoot, and Blind Canyon Crown-granted claims, and ten adjoining claims held by location. Exploration and development work was carried on through 1935 and in 1936 a 100 ton per day concentrator was put into operation. During 1936 the company name was changed to Wesko Mines, Limited. The concentrator operated until August 1938 at which time the ore reserves were exhausted. A very limited diamond drilling program failed to locate additional ore and the mine closed late in the year. Lessees carried on small scale intermittent salvage operations from 1940 until 1950. The mine has been developed by over 2012 metres of drifts, crosscuts and raises on 5 main levels and several subsidiary levels. The Centre Star mine is located on the west slope of Jubilee Mountain, about 1.6 kilometres northeast of Ymir. The mine has been developed by over 2000 metres of drifts, crosscuts, and raises on 5 main levels and several secondary levels. Mining operations started in 1936 and by 1938 reserves were exhausted; intermittent salvage operations were carried on from 1940 to 1950. The area is underlain by Jurassic Ymir Group sediments. The sheared and altered argillites and quartzites are intruded by the Nelson batholith comprising granite and granodiorite of the Middle to Late Jurassic Nelson Intrusions. Prominent shear zones, 5 to 10 metres wide, trending 30 to 55 degrees east with vertical or steep southeast dips, crosscut the host rocks. On the property, two such parallel shear zones occur about 122 metres apart. Mineralization occurs in a broad contact zone consisting of sheared and altered argillites and quartzite intruded by granite. Ore shoots occur in veins, up to 8 metres wide, along fault fissures striking 280 to 300 degrees and dipping steeply northwest. The deposit comprises a 152 metre long mineralized vein, dipping steeply northwest, occurs within a 1 to 2-metre wide fracture. The vein strikes 60 to 80 degrees east, diagonally between the two major northeast trending shear zones, and is terminated by shears. Ore shoots with an easterly pitch are developed at the intersection of the vein with northwest trending fractures. The fractures also host sulphides but they contain negligible to zero gold. Tongues of intrusive granite are close to the ore shoots. Gangue consists of quartz and brecciated, siliceous country rock fragments, with pyrite,

	galena, sphalerite and pyrrhotite. Pyrrhotite is less common in the upper levels. Near surface, the vein is oxidized with limonite, manganite and pyromorphite stained by cerussite. The average grades from 51,458 tonnes of production were 7.5 grams per tonne gold, 57.3 grams per tonne silver, 1.88 per cent lead and 0.93 per cent zinc (Assessment Report 11753).

Bibliography	EMPR AR 1905-251; *1934-E9; 1935-E28; 1936-E46; 1937-A39,A41,E46; 1938-A36,E3; 1940-25,67; 1941-26,66; 1942-27,63; 1944-40,61; 1946-35,144; 1947-16; 1948-133; 1949-165; 1950-121 EMPR ASS RPT 11753, 19587 EMPR BULL 41 EMPR FIELDWORK 1980, pp. 149-158; 1981, pp. 28-32, pp. 176-186; 1987, pp. 19-30; 1988, pp. 33-43; 1989, pp. 247-249; 1990, pp. 291-300 EMPR MAP 7685G; RGS 1977; 8480G EMPR OF 1988-1; *1989-11; 1991-16 EMR MP CORPFILE (Wesko Mines Ltd.) GSC MAP 51-4A; 175A; 1090A; 1144A GSC MEM *191, pp. 3,5,17-20; 308, p. 155 GSC OF 1195 GSC P *51-4 CANMET RPT 771, INVEST 642, Jul.-Dec., 1935, pp. 42-55