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ENVIRONMENTAL STATEMENT

Volume 1

Prepared for

AFTON MINES LIMITED (N.P.L.)

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AFTON MINES LIMITED (N.P.L.)

Prepared by

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INTRODUCTION

B. C. Research has been commissioned by Afton Mines Limited (N.P.L.) to compile this Environmental Statement relating to the proposed mine-mill operation located approximately 8 miles west of Kamloops.

Data collection involved on-site visits, one air flight, air photo interpretation, interviews with a number of Provincial and Federal resource departments, as well as a former property owner, extractions from all available Canada Land Inventory mapping, other consultants reports, and from available publications and literature.

The project was formally initiated on November 16, 1973 and completed February 28, 1974. It has been carried out by an interdisciplinary research team drawn from the Divisions of Applied Biology and Management Services, of B. C. Research.

A. DESCRIPTION OF THE PROJECT

Afton Mines Limited proposed to surface mine 7000 tons of copper ore daily for processing in an on-site mill seven miles west of the junction of the Trans-Canada Highway 1/97 and the Merritt Highway 5 (Figure 1). Afton's plan is to mine the ore body by conventional open pit techniques utilizing electric shovels, drills, and diesel trucks. Processing of the ore will be by crushing, semi-autogenous grinding, jigs, conventional flotation, filtering and drying. Tailings waste is pumped to a tailings pond where water is recovered for reuse in the milling process. Water supply for the project would originate from Kamloops Lake through a 20-inch pipeline (Figure 1).

Waste rock, which occurs in the open pit zone in a ratio of 4.2 to 1 of copper ore, would be used for construction of the tailings dam structure and the remainder would be disposed of on the land surface set aside for that purpose.

Current ore reserves established through a number of years of exploration drilling are set at 34,000,000 tons grading 1% copper, to a depth of 900 ft(1).

The proposed locations of the open pit, plant site, waste rock disposal area, tailings dam and tailings pond, are shown in Figure 1. Initial construction would involve a projected temporary work force of 400, about half of whom will be located in an on-site construction camp. An estimated 270 people will be permanently employed in the production phase.

Since the northern portion of the projected open pit lies beneath a portion of Highway 1/97, a B. C. Hydro 25-kv transmission line and B. C. Telephone lines, these would all require relocation to permit safe mining operation with minimum disruption of services. Relocation of the adjoining gas line may also be required.

To ensure stability and to avoid contamination, several diversions of runoff water will be necessary as will the diversion of Alkali Creek to Cherry Creek, south of the proposed tailings dam.

REFERENCES

1. Afton Mines Limited (N.P.L.) Annual Report, 1973.

B. DESCRIPTION OF THE ENVIRONMENT

1. Climate

The property is located in the Interior Plateau, in the lee of the Coast Mountains. The mean annual precipitation in the area increases with elevations, and ranges from less than 10 inches in the vicinity of Ashcroft to 50 inches on the flanks of the Columbia Mountains east of Kamloops. Generally, about one-third of the annual precipitation falls during January to March. The average precipitation at three stations north and west of Kamloops(1), April to October during the years 1959 to 1961 was measured as follows:

Elevation (ft)	Precipitation (inches)
1160	5.34
1700	5.26
2275	5.89
2925	7.09
3125	7.41

In comparison, the average total annual precipitation at Kamloops, at 1243 ft elevation, from 1962 to 1971, was 10.57 inches. At Cherry Creek, at 1825 ft elevation, the 1971 average was 14.56 inches.

Within the property, the approximate ground elevations range from 2100 ft to 2600 ft, suggesting a mean annual precipitation of approximately 14 inches to 16 inches.

Wind velocities from 1955 to 1966, measured at a Kamloops station, are illustrated in the wind rose in Figure 5. The station was situated on the valley floor, where the surrounding topography tends to funnel the winds in an easterly or westerly direction. The average annual wind velocities ranged from 4.2 mph from the north to 9.0 mph from the northwest(2).

The prevailing air movement across the Interior Plateau is eastward from the Pacific Ocean. These air masses bring mild temperatures during all seasons, and are the cause of most precipitation in the area. Occasional intrusions of Arctic air during the winter months may lower the temperatures for a few days to -20°F to -30°F.

During the summer, hot and dry desert air from the western United States may penetrate north into the interior of British Columbia for short periods, and be responsible for high summer extreme temperatures exceeding 100°F.

The frost-free period at Kamloops is greater than 150 days. The last spring frost normally is in late April or early May, and the first autumn frost is in early October.

REFERENCES

1. van Ryswyck, A. L., Alastair McLean and L. S. Marchand, 1966. The climate, native vegetation, and soils of some grasslands at different elevations in British Columbia. Can. J. Plant Sci. Vol. 46:35-50.

2. Climatic Normals, Volume 5, Canada Department of Transport, Meteorological Branch, Toronto, 1968.

2. Topography

The Interior Plateau between the Cascade and Columbia Mountains occupies many thousands of square miles of the B. C. interior. In the past, through part of the plateau at elevations of 4000 - 4500 ft, the Thompson River and its major tributaries have carved valleys 2500 - 3000 ft deep, reducing the topography to its present series of broad, gently rounded hills.

The Afton Mines claims area (Figure 1) is situated on undulating to rolling ground at an elevation of 2100 ft with localized peaks and drumlins extending up to 500 ft above this level. Slopes are relatively gentle, permitting cattle grazing throughout.

Figures 2 and 3 illustrate the general topography of the claims area. The topographic profile from the proposed pit due north to Kamloops Lake is shown in Figure 4.

Through a parallel drainage pattern, the Alkali-Cherry Creek system, draining the mine claims area, drops from about 2100 ft to 1124 ft (975 ft) over the 7 1/2 miles northeast to Kamloops Lake.

3. Geology and Seismology

The Afton deposits are located at the western end of the Ironmask batholith--an intrusive rock comprised of a coarse grained gabbro-diorite phase and a fine-grained microdiorite-micromonzonite phase. The batholith is associated with two intrusives--the Cherry Creek and Sugarloaf intrusives--both of which are porphyritic and of later age than the Ironmask batholith. The mineralization is mainly associated with the Sugarloaf and Cherry Creek intrusives and occurs as veins, stockworks and disseminations.

The batholith is intruded into a volcanic series called the Nicola group, which are, in turn, overlain by volcanics and sediments of the Kamloops group. The area has been glaciated and deposits of glacial origin abound. The Kamloops series are basaltic and all are badly weathered and crumbly. The Lake Zone of the Afton deposits appears to be localized at the junctions of two major fault systems. One system comprises a set of overlapping or en-echelon faults, trending east to northeast with a dip of 60 to 70 degrees south. These faults are probably an important ore control. The Main Fault is a major part of this system.

A second series of faults running generally north-south (northeast to northwest) are found. These are indicated by two topographical lineaments. Post-ore transverse faults are found towards the western end of the ore deposit and apparently dip steeply to the east and west.

Massive native copper occurs in joints, fractures and faults and is a striking feature of the deposits. Copper minerals, in order of abundance are native copper, chalcocite, bornite, chalcopyrite, cuprite, covellite, malachite and azurite. Within the oxidized zone, the minerals are found together in the following relationship; outwards from the center of the deposit:

native copper
native copper and chalcocite
chalcocite, bornite and chalcopyrite
bornite and chalcopyrite
chalcopyrite
chalcopyrite and pyrite
pyrite

The zone shows evidence of weathering, leaching and oxidation, in places to a considerable depth. Malachite is common to depths of 10 ft. Malachite and azurite are rarely observed in the drill core but have been noted at a depth of 800 ft.

There is also mineralization in the Pothook Zone just west of Pothook Lake (Figure 1), consisting mainly of chalcopyrite with some native copper. Secondary malachite, azurite and chalcocite are also present. Other minerals present in the area are magnetite and hematite.

The property is located in Zone 2 area where "damage would be moderate in the event of an earthquake".

REFERENCES

1. Cockfield, W. E. Geology and Mineral Deposits of Nicola Map-Area, British Columbia, Memoir 249, Geological Survey of Canada.

2. Millar, C. F. The Afton discovery. Western Miner, February, 1973.

3. McIntosh, G. Geological Report on the Afton Ore Deposit, November, 1973.

4. Canadian Exploration, "Geology of Afton Mines Limited Property". Internal report to Afton Mines.

5. Department of Mines and Technical Surveys 1957 "Atlas of Canada" Earthquake Probability.

4. Hydrology, Water Use and Water Quality

Cherry Creek and its tributary Alkali Creek drain essentially the whole area adjoining and south of the mine site and flow into Kamloops Lake at a point about seven miles northwest of the proposed mine (Figure 1). Flow records for these creeks were discontinued after 1928 and data are considered unreliable.

Two water bodies, Hughes Lake (about 28 acres in surface area) and Pothook Lake (an intermittent lake of about 7 acres) exist on the property as well as several small potholes which often dry up completely in the summer.

Groundwater has not been fully investigated on the mine property but on Cherry Creek, between two and seven miles below the property, at least 16 wells exist(1) and are utilized for domestic or irrigation purposes, or both. On the mine property, a pumping test was done on the old Pothook shaft, which indicated there was not sufficient recovery to consider it a source of potable water. Pumping test was also conducted on a deep rotary drill hole located about 500 ft east of the proposed plant site. It also indicated insufficient recovery.

Surface water licenses exist for the diversion of Alkali Creek into Hughes Lake and for storage in Hughes Lake in the mine claims area. Water is used for stock watering and irrigation. Below the mine property surface water licenses, including all of Cherry Creek, total 26. The combined groundwater and surface water licenses are 42 in total, between the mine property and Kamloops Lake.

Water Quality

Cherry Creek has been sampled at six intervals from April 24, 1972 to June 14, 1973 inclusive(2), and results of analyses are given in

Table 1.

A single B. C. Research sample from Hughes Lake taken November 7, 1973 indicated that impounded waters were considerably harder, more alkaline, higher in dissolved solids and slightly more turbid than samples obtained from three locations on Cherry Creek (Table 2).

On December 1, 1973 a B. C. Research sample from Cherry Creek below the Alkali Creek confluence yielded 9200 MPN/100 confirmed coliforms and 70 MPN/100 fecal coliforms--higher than is desirable for untreated drinking water, but probably considerably lower than might be expected during warmer periods of the year.

Water quality data for Kamloops Lake can be found in Tables 3 and 4 from IPSFC Bulletin XVI[3]. There appears to be no barrier to lake waters being used for irrigation purposes (personal communication, Department of Agriculture, Kamloops Experiment Station).

B. C. Research analysis of a filtered sample of supernatant tailings water, supplied by Lakefield Research of Canada Ltd., Lakefield Ontario, from their laboratory-scale separation of Afton ore, gave the following results:

Parameter	ppm	Parameter	ppm
Aluminum	< 0.5	Lead	< .005
Ammonia	0.202	Magnesium	0.80
Arsenic	0.046	Manganese	< 0.05
Cadmium	0.0007	Mercury	0.00011
Chromium	< 0.05	Molybdenum	< 0.05
Cobalt	< 0.05	Nickel	< 0.05
Copper	< 0.05	Silver	< 0.02
Fluoride	3.75	Sulfate	125.4
Iron	< 0.05	Zinc	0.15

REFERENCES

1. Data courtesy D. E. Smuin, P.Eng., District Engineer Water Rights Branch, Kamloops.

2. Data courtesy of Pollution Control Branch, Kamloops.

3. Ward, F. I. 1964. "Limnology of Kamloops Lake", Bulletin XVI, IPSFC

5. Soils

The predominant soils in the property area are Brown and Dark Brown Chernozemic soils of the Tranquille and Trapp series. These are grassland soils and are characteristic at low levels in the semi-arid climate of the Kamloops area. The soils are moderately to strongly saline and are well adapted to grazing use. Irrigation is required in order to ensure optimum crop yields. In the claims area, timothy and alfalfa have been grown, with flood irrigation, near the west end of Hughes Lake.

A preliminary investigation of the foundation for the proposed tailings dam disclosed bedrock, either exposed or at shallow depths, with thin, silty topsoil over silt-like glacial deposits. (Verbal communication, Mr. J. M. Anderson, Teck Corporation, December, 1973).

6. Fish and Wildlife

a. Potential Wildlife

The capability of the mining property for waterfowl production is limited. Table 5 summarizes the acreage per capability class. Roughly five and a half percent of the property lands, including Hughes Lake and other, minor water bodies, have some capability for waterfowl production. The remainder of the land is semi-arid, and the limitations to the production of waterfowl are severe.

The potential for ungulate production in the entire claim area is moderately high. The Canada Land Inventory rates the area as winter range for deer and moose, with moderately high productivity, limited mostly by moisture deficiency.

b. Present Wildlife

Information provided by the Department of Forestry and the Fish and Wildlife Branch, Kamloops, indicate that sharptail grouse range west from Ironmask Hill, north of Sugarloaf Hill to the south boundary of the mine's surface property at the city limits. According to the former property owner, sharptail grouse winter in the drainageway plant community of Alkali Creek near the southwest end of the property adjoining Hughes Lake.

During his 23 years of residence, the former owner(1) has not seen broods of waterfowl on Hughes Lake but has, during the spring, early and late fall, observed adult waterfowl (unidentified). It may be likely, therefore, that Hughes Lake, like the seasonal ponds on the property, may be used by waterfowl for resting and staging. Pheasant populations have decreased markedly over the past few years whereas ravens and magpies

using the area have apparently increased in numbers.

The deer population, formerly a nuisance around haystacks, has decreased over past years[1]. However, a herd of seven mule deer were observed north of Highway 1/97 by company personnel in the fall of 1973. The former owner has seen three moose on the property in 23 years.

Muskrat are present on Hughes Lake as evidenced by four "pushups" (cone-like protrusions above the water surface and used by the animal for shelter and a dry feeding platform internally) seen in November, 1973.

Other mammals either observed or reported by personnel on site include coyote, chipmunk, and pocket gopher.

Fish have not been reported in Hughes Lake either by the former owner or by the Fish and Wildlife Branch, Kamloops. Cherry Creek produced a small native trout fishery near the highway crossing, above Kamloops Lake a number of years ago; it is not known if fish populations exist there today.

Kamloops Lake serves as a rearing area for juvenile coho, chinook, and sockeye salmon and lies on an important migration route for the abundant Adams Lake society stock (F. I. Ward 1964 "Limnology and Kamloops Lake" Bulletin XVI IPSFC).

REFERENCES

1. Mr. A. A. Bowers, Box. 545 Kamloops (personal communication).

7. Vegetation and Present Land Use

Table 6 illustrates the approximate acreages of the different vegetation communities in the Afton property.

A number of vegetation communities exist on the approximate 2500 acres owned or under grazing leases. In decreasing order of magnitude, these are presented by simplified potential or climax vegetation units, together with their present vegetation.

a. Big Sagebrush-Bluebunch Wheatgrass Range

i Present Vegetation

Overgrazed seral range--this grazing-induced community comprising roughly 1914 acres includes big sagebrush and rabbitbrush as the predominant increaser species, with pasture sage, junegrass, Sandberg bluegrass, needle-and-thread, and western wheatgrass present in very minor amounts. Bluebunch wheatgrass was not observed and range condition is poor with 60 - 70% bare ground observed between plants.

In the Ironmask Area, bordering the eastern boundary of grazing leases, Canada Department of Agriculture, Research Station range test plots in areas of fair- to poor-condition range at approximately the same altitude contain the following species:

GRASSES AND SEDGES

Needle and thread	Sandberg bluegrass
Downy Brome	Columbia needlegrass
Sand dropseed	

FORBS

Yarrow	Lambs quarter (extra species)
Dwarf pussytoes	Fleabane species
Rockcress	Brittle pricklypear
Plaintain	Russian thistle

SHRUBS

Pasture sage
Big sagebrush
Rabbitbrush

Cultivated Fields--Two small fields, comprising roughly 31 acres, within the seral range area to the south of Hughes Lake, have been seeded with an alfalfa-timothy mixture. The established stand is apparently productive with floor irrigation. Another 10 acres near the southwest land boundary has been used to cultivate alfalfa.

b. Drainageway Community

This is possibly an edaphic climax of unit c below, but differs in being highly dependent upon surface or near-surface water supply. Plant species include Douglas maple, ponderosa pine, juniper, cherry, rose, buckbrush, willow and birch. The total area is approximately 33 acres.

i Present Vegetation

Aspen occurs in groves, with scattered individuals of juniper, willow, cherry, rose, buckbrush, Douglas maple, clover and pinegrass. This community is represented primarily in the bed of Alkali Creek which is free-flowing only during runoff but probably flows underground through much of the year.

c. Ponderosa Pine-Bunchgrass Range

This community is represented by approximately 267 acres of forested range in the ecotone between the ponderosa pine zone and the Douglas fir zone. The B. C. Forest Service classifies the area as a "poor" site, in terms of forest production, with immature ponderosa pine and small numbers of Douglas fir on the south and southwest exposed portion of the unit and Douglas fir with some pine on the east and northeast exposed slopes. The majority of the trees are small and immature, ranging in height from 36 to 65 ft and in age from 81 to 100 years. There are a few mature fir and pine present, veterans from past fires.

In the climax condition, bluebunch wheatgrass should dominate as understory vegetation and abundant rough fescue and Idaho fescue should be present.

i Present Vegetation

This poor-condition range contains big sage as an invader species, rabbitbrush, pasture sage, needle-and-thread Sandberg bluegrass, junegrass, wheatgrass species and an assortment of forbs.

d. Salt Grass Community

This is possibly an edaphic condition of the big sagebrush wheatgrass zone and occurs in a few small areas of salt flats to the east of Hughes Lake, at and near the proposed pit site, and near the plant site. Dominant vegetation is salt grass, (of little forage value) with a bordering cover of foxtail barley, also of little value for forage. The total acreage comprises approximately 151 acres.

e. Bulrush Community

This 19-acre lake-side community is dominated by soft stem bulrush bordering Hughes Lake, a water body which has been dammed to provide water storage near the southwest corner of the property.

The present land use categories compiled from the Canada Land Inventory data are presented in Table 7. Of the total 2500 acres, 2163 acres (86.5%) are classified as open grassland, 94 acres (3.8%) are classified as immature productive woodland, 75 acres (3.0%) are classified as water surfaces, 112 acres (4.5%) are classified as nonproductive woodland on a productive site, 50 acres (2.0%) are classified as improved pasture and forage crops and the remaining six acres (< 1%) are classified as swamp marsh and bog.

Information supplied by the Provincial Lands Branch, Kamloops, indicates that grazing leases on the mineral claims are held by three ranches, and that range condition is classified as fair to poor. The largest lease is for approximately 1500 acres, permitting maximum grazing of 165 head of cattle from April 1 to May 15 and from November 1 to December 30, a total of 3 1/2 months during the year.

REFERENCES

Grassland ranges in the southern interior of British Columbia. Can. Dept. of Agric., Publ. 1319, 1968.

McLean, Alastair, Canada Department of Agriculture, Kamloops (personal communication).

8. Socio-Economic Factors

The City of Kamloops is one of the Province's fastest growing cities. The urban area has a population of about 55,000, most of which is now encompassed by the May 1, 1973 enlargement of the City boundaries. This is about double the population of a decade earlier, reflecting the considerable industrial and trade expansion of the area, and the importance of Kamloops as a regional center.

The proposed Afton open pit lies 1 1/2 miles west of the new city boundary (see Figure 1). The small portion of Afton optioned grazing leases shown as actually lying within the city will not be part of the area affected. Electoral District J, a subdivision of the Thompson-Nicola Regional District is sparsely settled, and at the 1971 census contained only 1000 people in its entire 1377 square miles. Since the Afton claims cover approximately 3.4 square miles, and the proposed development only 1 1/2 square miles, the conflicts with existing settlement patterns are minimal. Exceptions are a trailer court and a ranch residence about 1 1/2 miles west of the proposed pit, and another ranch residence about 1 1/2 miles southwest. There are also a few other properties in the Cherry Creek area which runs generally northwest of the mine site for a distance of about 7 1/2 miles.

The 1972 manufacturing payroll in the Kamloops area was $15.6 million, and gross income of the population exceeded $215 million. Major forest products employers are Weyerhaeuser and Balco, with about 600 employees each. The major copper mining area of Highland Valley is not far away (Lornex is 47 miles from the city), and a cement plant and other industries are complemented by a large service industry payroll. The city's strategic location with respect to rail, road, and air networks has accounted for much of the impetus to growth. In the light of industry and government interest and study of the situation, there would appear to be good prospects for establishment of a copper smelter somewhere in the general area tributary to Kamloops. Government policy, environmental factors,

technical process considerations, and economics will be prominent among the factors governing its construction.

Average daily traffic on the Trans-Canada Highway west of the intersection with Route 5 was measured at 10,000 vehicles per day in 1972, and for 1962 it was only 1875. Although 1973 data are not yet available at the time of writing, it is expected to show a further increase to nearly 11,000.

9. Archaeology and History

The earliest record of settlement in the vicinity of the Afton property area dates back to 1860 at the mouth of Cherry Creek at Kamloops Lake. The Hudson's Bay Company, a year earlier, had rejected Cherry Creek as a suitable site for their proposed farm, although early fur traders had found the valley to provide good pasture for their horses.

The chief crops grown during the 1860's and 1870's were potatoes and barley. An orchard was also planted during the period. One of the finest ranches in the interior of B. C. (Cherry Creek Ranch) was developed during the following years. Hughes Lake was named after a retired sailor who settled at Cherry Creek in 1880 in the vicinity of the lake, on the lands where the Afton Mine claims are now located.

Early mining records date back to 1890, when the Glen Iron Mine was developed at the mouth of Cherry Creek. The mine later became unprofitable and was closed by 1900.

Gold-copper ore was discovered in 1896. Several small mining operations had short life spans, the most endurable being the Python, near Python Lake which was active at intervals for 10 years. At Roper Hill, the Copper King had shipped ore for a brief period. However, the Ironmask, later as Kamloops Copper Company, was the only mine in the area to achieve steady production. In 1913, 75 men were employed before a fire caused a serious setback. The enterprise never fully recovered.

Mr. Bjorn O. Simonsen, Provincial Archaeologist, advises that no known sites of archaeological value exist on the claims area (Appendix I).

REFERENCES

Balf, Mary. 1969. Kamloops--a History of the District up to 1914. Kamloops Museum.

10. Recreation

The recreational capability of the Afton property lands by Canada Land Inventory maps is rated moderate throughout (Class 4).

In the vicinity of Hughes Lake and in the area adjacent to the other small water bodies, recreational features include opportunity for viewing wetland and upland wildlife. For the remainder of the property, the recreational capability of the lands is associated with vegetation, wildlife and topographic features.

C. ENVIRONMENTAL IMPACTS AND MITIGATIONS

Possible environmental impacts are placed in the following five categories:

1. Direct effects on vegetation, animal habitat and land use.
2. Changing topography by mining
3. Physical pollutants
4. Chemical pollutants
5. The human environment

Mitigations refer to those measures recommended to be undertaken to avoid, reduce, or compensate for environmental changes and include monitoring, special studies, research and planned reclamation.

1. Direct Effects on Vegetation, Animal Habitat and Land Use

Of the 2500 acres of mine property, 1075 acres or 43% will be removed from present productivity through construction of the ultimate pit (139 acres), tailings area (472 acres) waste dump (368 acres), plant site (52 acres), highway relocation (37 acres), and gas pipeline relocation (7 acres) (Table 5). Another 34 acres for the freshwater pipelines will be disturbed outside the mine property. Only the water supply pipeline and gas pipeline relocation, a combined total of 41 acres are immediately amenable to reclamation, which should be undertaken as soon as possible after installation.

Potential waterfowl habitat to be removed by the proposed operation would be 65 acres of a total of 121 acres of Class 4 lands, having moderate limitations to the production of waterfowl. The remainder of the property is virtually valueless for the production of waterfowl, mainly Class 7.

With the removal of Hughes Lake as a tailing disposal site, the small muskrat population will be displaced or eliminated.

Potential deer and moose winter range (Class 3--moderately high productivity, limited mostly by water deficiency) totalling 1031 acres will be removed by the project. The actual populations which might be displaced are not presently known. On-site observations during the winter months should be carried out to establish present big game use of the area.

Distribution of vegetation communities on the Afton Mines property is given in Table 6. Of the 2500 total acres, 1914 (76.6%) are classified by B. C. Research as sagebrush-grassland. About 779 acres of this will be taken up by the mining projects. Combining the grasslands with cultivated fields, the drainage way community and the forested areas, all of which provide cattle support, the project would, in effect, reduce by half both the number of cattle and the acreage of the present grazing permit. Presumably, cattle could utilize the range which is not taken up by the project and it is recommended that the company investigate the possibility of range improvement practices. On suitable areas, a range drill can be used to remove undesirable sagebrush and seed simultaneously. With irrigation and possible fertilization, chances are excellent to produce more than three or four times the amount of forage now produced. Costs for range improvement by range drill are from $6 - $10 per acre. To ensure a healthy stand, the improved range should not be grazed for 3 to 5 years.

Reclamation of disturbed areas should be carried out progressively as the project develops using plant species adapted to the specific sites. Crested wheatgrass has been used successfully in the Kamloops area(1). Topsoil and sufficiently fine overburden materials should be stockpiled for use in reclamation. It is recommended that a relatively detailed soil survey be carried out to delineate those materials which should be saved and those with phyto-toxic constituents which should be buried.

Removal of 55 acres of the drainageway community through tailings pond construction will reduce by half the area available on the property for wintering populations of sharptailed grouse. It may be possible that reclamation planting will compensate for this habitat reduction, or even improve the area. The major area occupied by sharptail grouse will not be affected by the operation.

Although exact acreages differ with classification, there is a general agreement between losses of vegetation (Table 6) and present land use (Table 7). The major net result will be 50% reduction (to approximately 80) of cattle permitted on the 1500-acre grazing lease, and with the removal of the 31 acres of improved pasture by the tailings dam, the possibility that extra hay feeding of the remaining cattle will be necessary, should range improvement practices not offset this.

Construction of the mining/milling facilities is not expected to jeopardize any known site of historical or archaeological value. However, the area has never been subject to a systematic search for historical values, and should be inspected by a qualified archaeologist prior to industrial development being implemented.

Available water supply will be dealt with in the following section.

REFERENCES

1. Alastair McLean and A. H. Bawtree, 1971. "Seeding Grassland Ranges in the Interior of British Columbia", Canada Dept. of Agriculture Publication 1444.

2. Changing Topography by Mining

Construction of the tailings dam will produce a major change in topographic relief. With a projected maximum height of approximately 300 feet above existing ground level at the western end of the property, the dam will be visible and aesthetically displeasing to some, from the highway. The company should carry out progressive reclamation of the dam face and consider an earthen or tree barrier to screen the view from the highway. The possibility of constructing turn outs and view points should also be considered. The tailings dam structure may further serve to create a barrier to big game--notably deer migration. It is not known at this time whether this area is important to game movement or whether sufficient alternate routes exist. This should be investigated and any records of deer killed on the highway near the property should be collected. To insure structural stability and avoid water borne contamination, several runoff watercourses and Alkali Creek would be diverted to Cherry Creek in the region of the southwest property boundary. Water chemistry likely would not be changed, since Alkali Creek already joins Cherry Creek less than one mile from the western property boundary (Figure 1). Design and construction should incorporate safeguards to all existing water licenses.

It should be stressed that the mine-mill water supply originating in Kamloops Lake will be utilized for irrigation purposes as well as for milling. Corresponding volumes are 1000 U.S.G.M. (irrigation) and 3300 U.S.G.M. for milling. Figure 4 shows the topographic profile at cessation of mining.

Another major topographic change will be created by construction of the ultimate pit, the depth of which may be 900 feet and the area at the surface, 139 acres.

3. Physical Pollutants

The major physical pollutant is likely to be wind-aggravated fugitive dust through surface clearning, mining, blasting, transport of ore, overburden and soil, initial reclamation activity and, possibly, ore crushing and processing. Clouds of dust offer a safety hazard to personnel through inhalation and decreased visibility. Available wind data (Figure 4) indicate flow is predominantly east-west, although the most intense winds are northwesterly. Dust can also coat any adjacent vegetation, limiting its usefulness to cattle and wildlife. Good general mining practice and compliance with the Mines Regulation Act should insure adequate dust control through closed product storage, plant dust control practise, road wetting and area sprinkling. Water for this purpose should not be obtained from sources where high levels of dissolved salts might be toxic to plants used for subsequent reclamation.

Reclamation of disturbed surfaces should be started as soon as possible to provide a more permanent dust control surface. Monitoring is required by the Pollution Control Branch[1] for total suspended particulate matter. To determine changes over background levels, it is recommended that a baseline, air quality survey be carried out and that an on-site weather station, including anemometer, be established.

The possibility of using tree cover on a dyke-like embankment adjoining the diverted highway should be investigated as a means of partial dust control, to reduce noise and to screen the view of the project. Tree species which might be used include juniper, lombardy poplar, silver maple, and ponderosa pine.

Noise from operating machinery, blasting, and vibrations can result in structural damage, irritation to people within earshot and fright, causing avoidance of the area by cattle and wildlife. From the mine pit, the nearest dwellings are 1.5 miles west, and 1.5 miles southwest. Noise levels are not expected to be harmful to residents but may be variably irritating, depending upon wind direction, barometric pressure, humidity, and obstructions such as trees and topographic features.

Seismic tests by an independent consultant[2] have given the assurance that, by implication, structural damage will not occur from blasting at the mine, particularly with respect to the adjoining gas and oil pipelines. It should be noted that the concentrator is located within 1000 ft of the pit. It is understood that Afton Mines has been in consultation with the technical staff of the owners of the oil and gas pipelines.

Cattle have been reported to graze with apparent unconcern within one-quarter of a mile of the coal pits at Big Sky Mine (just south of Colstrip, Montana[3]). The stress effect of blasting on big game is not completely known at this time, but attempts to use explosive noise in Alberta to scare mule deer produced the same result as for cattle. After an initial "startle" effect, the noise was subsequently ignored. In any event, for the Afton Mines property, the choice of explosives and detonating devices should be investigated with a view to minimizing noise effects.

Complete or partial structural failure of the tailings dam located at an elevation above the Alkali Creek-Cherry Creek confluence could contribute heavy loads of fine material to the drainage system leading to Kamloops Lake. It should be stressed that the rock-based tailings dam design is being undertaken by consultants with a wide competence in this field and that design must be approved by engineers of the Department of Mines, and the Provincial Water Resources Service, including the Pollution Control Branch.

Water-borne products of erosion of the disturbed land surface, particularly during periods of short intense rainfall, could enter

the Cherry Creek drainage to Kamloops Lake. Drainage system design should incorporate suitable runoff control measures to avoid the possibility of erosion products entering Cherry Creek.

The possibility of smoke and particulate matter from fire being a major problem is relatively remote, but any slash disposal from the limited forest cover is governed by B. C. Forest Service Regulations. Once the freshwater pipeline is completed, fire fighting water supply will be assured.

The water intake structure in Kamloops Lake could have a deleterious effect on fish, particularly salmon fry. Design of the intake system will incorporate screening measures approved by the Federal Department of the Environment, Fisheries Service, to avoid any harmful effects to fish.

REFERENCES

1. "Pollution Control Objectives for the Mining, Mine-Milling and Smelting Industries of British Columbia", December, 1973. Department of Lands, Forests and Water Resources, Water Resources Service, Victoria,

2. "Memo re Blast Vibration Assessment, Bethlehem Copper Mine, Highland Valley", August 23 - 30, 1973. R. M. Hardy and Associates, Geo-technical Division.

3. Environmental Report, Sarpy Creek, Montana, 1973. Westmoreland Resources.

4. Chemical Pollutants

a. Tailings

With regard to the proposed tailings disposal area, the contamination of groundwater by percolation of mill water or precipitation is much less probable than for the waste dump area. The permeability of settled tailings is normally low, so the volume of water passing through the bed of tailings into the groundwater will be small. Also, since air will not pass through the settled solids, potential oxidation is limited to that from dissolved oxygen. An exception to this statement would occur in the case of settled tailings exposed to the atmosphere. Milling solutions are normally basic (pH 8.5 - 11) so oxidation products of sulfide minerals are expected to be precipitated by the alkaline solutions (or by alkaline components of gangue rock).

Preliminary experimental tailings supernatant water quality (Section B) indicates, for the parameters listed, that Level A, Pollution Control Branch guidelines[1] for discharge to fresh water, are met with the exception of fluoride, which exceeds the 2.5 ppm limit by 0.75 ppm, and sulfate at 125.4 ppm (limit 50 ppm).

The company plans to incorporate a closed water system, whereby any seepage from the tailings pond is collected in a below-dam seepage pond for pump return and reuse in the milling process. To provide the necessary baseline data, from which any change can be determined, the company should institute a program of water quality sampling and analysis of those parameters which will be required by the Pollution Control Branch during the operation phase. Any fish or fish food organisms should also be investigated.

b. Waste Dump

The projected waste disposal area at the Afton Mine site (Map Figure 1) overlies brecciated fault zones. Thus, it is possible that water (precipitation and drainage) which has penetrated through broken mine waste will pass into and mix with the groundwater of the underlying formation. From the topography and drainage pattern of the area, it is reasonable to assume that this groundwater will eventually merge with surface water.

Drainage from development waste could potentially become significantly contaminated with heavy metals (in this case, copper and iron) since, in a waste dump, the presence of moisture and oxygen will result in oxidation of sulfide minerals to soluble metal sulphates. Leaching of sulfides in broken waste can occur by two mechanisms--chemical or biological. In the presence of air and moisture, exposed sulfides are oxidized slowly to soluble sulfates. In the presence of sulfide oxidizing bacteria, the leaching process can be greatly accelerated. In some cases, leaching of waste rock is sufficiently rapid that commercial recovery of copper from drainage is feasible. The arid climate of the area may be expected to result in slow leaching rates, but large volumes of water are not required for leaching reactions to occur. Experience has shown that leaching reactions continue as long as 100% humidity is maintained (i.e. as long as some liquid is present). The mineralization on the Afton property includes pyrite, chalcopyrite, bornite, covellite, chalcocite, malachite and native copper. If chemical or biological oxidation of the sulfide minerals (particularly pyrite and chalcopyrite) occurs to the extent that water percolating through the waste dump becomes acidic (pH $\leq$3.5) the substantial amounts of copper will be solubilized. In the presence of dilute acid and oxygen (air) a large proportion of the copper present as native metal, malachite, chalcocite and bornite will dissolve readily and, in the presence of bacteria, practically all of the exposed copper minerals may dissolve. Thus, it would appear that there is a risk of solubilizing environmentally significant amounts of copper into the ground water underlying the waste dump. If, as seems probable, this ground water conforms to the general drainage pattern of the area, then the dissolved copper may eventually appear in downstream areas. In the downstream areas it may

appear in groundwater (detectable in wells), in surface water (via risings, pipes, etc.) or eventually in Kamloops Lake. Such contamination is not an acceptable consequence of development and measures should be taken to avoid this problem.

In this regard, test programs are recommended to investigate the potential amount of copper leachable from waste rock, the probability of acid drainage occurring, and the course of the drainage from the area of the proposed mine waste dump.

A test program has been developed by B. C. Research (for the Department of the Environment) to determine the amount of heavy metals which may be solubilized in a leaching environment, and the probability of acidic drainages occurring. Representative samples of waste material should be tested according to this program. If the tests show that significant leaching may occur, then it will be necessary to plan for segregation and chemical treatment of drainage from the waste dump area. (The test program will also indicate whether or not there is any possibility of economic leaching of the waste as practiced in other areas).

It is also considered essential that a groundwater hydrological survey be done to determine the course of the groundwater from the proposed waste dump area. Without this information, it is not possible to predict the potential impact of contamination of this water by heavy metals.

During preparation for mining and construction, soils may be required to be stockpiled for subsequent reclamation. Elements toxic to plants may exist in some soils in saltgrass communities and possibly as a high calcium layer beneath other soils. To ensure the success of reclamation, it is recommended that a soil survey be carried out to delineate those toxic soils which should be buried rather than saved.

Undesirable materials originating from refuse and garbage will be disposed of in accordinace with recommended solid waste management guidelines[1] and the required Pollution Control Branch permit. Sanitary wastes during the life of the project will be handled in a manner acceptable to the Pollution Control Branch. Monitoring of pertinent watercourses for fecal coliforms, a prime contaminant of drinking water, should be included in the sampling program. An unspecified amount of discharge to ambient air will result from diesel and gasoline-burning mining equipment. The impact of these emissions on air quality is, at present, undetermined but could be relatively minimal.

Plant safety regulations enforced by the Mines Act and Workman's Compensation Act will be strictly adhered to by the company to insure safety of personnel from any chemical hazards in the operation and every effort will be made to avoid losses of copper concentrate during processing, storage, and shipment.

REFERENCES

1. "Pollution Control Objectives for the Mining, Mine-Milling and Smelting Industries of British Columbia", December, 1973. Department of Lands, Forests and Water Resources, Water Resources Service, Victoria.

5. Human Environment

The Afton project is expected to create employment for 400 workers during construction, with mining operations (subsequent to, but overlapping construction) creating another 270 jobs. It is anticipated that there will be a construction camp on-site for about 200 people. The remainder, and the permanent employees will reside in the environs of Kamloops and commute to work at the site. There will be a continuing annual payroll of about $3.5 million. Capital cost of the project will be $40 million. There has already been a sizeable investment in exploration (of the order of $1,500,000). The relocation of a highway in the immediate area of the mine may result in about $500,000 in construction. The natural gas, telephone and the 25-kvs Hydro lines now crossing the property will also have to be relocated. There will be minimal inconvenience to the public, since construction of new highway and utility routes can be carried out prior to removal of any sections. Once in operation, the economic multiplying effect of the primary industrial jobs provided by Afton will show up in such areas as transportation, repair services, personal services, retail trade, etc. This should more than double the direct payroll value to the Kamloops economy.

In the latest of a series of annual studies for the Mining Association of B. C.[1] it was determined that for each direct employee of a mining company in B. C., there were 2.3 other workers in the Province in jobs based on the mining industry. It was also determined that the mining industry in B. C. supported six other workers in Canada for each worker directly employed. On the basis of 270 employees at Afton, a further 621 persons might be expected to be employed in British Columbia, and a further 1620 in Canada.

The increase in assessment base and tax revenue will benefit all levels of government in differing ways, both directly and indirectly--i.e. through the operation itself and thorugh the jobs it creates. No specific calculation of this effect has been made as part of this study, but analogy could be made with the effect of projects elsewhere. The mine would be of considerable added value to the provincial economy and could provide an encouraging lift to mining development which has been suffering a decline in B. C. An ongoing beneficial effect of the project will be the presence of an assured water supply by the pipeline from Kamloops Lake after the mine is exhausted (see Figure 1).

In the case of the nearby trailer court (1 1/2 miles west) it seems likely that any possible unfavorable environmental developments will be offset by a considerable increase in potential business.

Studies elsewhere suggest that no structural damage from blasting will be caused to any existing structures. Noise from both blasting and operating equipment will be heard in varying degree by the few residents in the general area and by passers-by on the highway.

With respect to traffic, the factors to consider are the added impact of commuting workers vehicles, the entry of trucks onto the highway, and the visual impact of the site on passing motorists. As a percentage of existing traffic, the increase induced by the Afton operation will not be very large. Entry and exit facilities and the proposed highway relocation have been discussed with the Department of Highways and will conform with their reccommendations. The relocation of about two miles of the Trans Canada Highway in the immediate vicinity of the mine is not expected to be a major construction task, but could provide $1/2 million worth of contract work, depending upon final design and costs at that time. Its location on a stretch of the route noted for its high incidence of accidents will warrant careful attention to both design and regulation.

The visual impact of the project on passing traffic will no doubt be considered unsatisfactory by some people. Conversely, however, the tourist attraction value of an operating open-pit copper mine will be considerable--people now drive 25 miles out of their way to view the Highland Valley workings, whereas this one is handily adjacent to a major travel route.

REFERENCES

1. "The British Columbia Mining Industry in 1972", Price Waterhouse & Co. August 1973, p. 50.

D. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Copper ore, a nonrenewable resource, will be mined at the proposed rate of 7000 tons per day up to at least the known open pit reserves of 34,000,000 tons.

Energy, labor, and some of the materials and equipment used in construction and operation will be irretrievably consumed.

There will be considerable topographic change in the specific areas of the pit (139 acres), the tailings pond (394 acres), and the waste dump (392 acres) which cannot be practically reclaimed to former topography. This will include permanent loss of at least some of grazing capability but some reclaimed land is likely to exceed the existing productivity.

E. RELATIONSHIP BETWEEN SHORT-TERM USE OF THE ENVIRONMENT AND LONG-TERM PRODUCTIVITY

Assuming a minimum open pit mine-life of 14 years, land actually occupied by the pit, plant and, to a lesser extent, the waste dump and tailings site, will be removed from present productivity which involves cattle grazing and, in a minor part, forage production.

Depending upon the success of reclamation efforts, some limited cattle and wildlife use may be made of plant species established on the tailings area and waste dump, but the lag period is indeterminate. Should range improvement practices be feasible on property areas not directly involved in mining, productivity of wildlife and cattle forage could compensate considerably in terms of present values of the mined area.

After completion of mining, a number of years will be required to complete reclamation of reclaimable areas. Conceivably, with proper plant selection and contouring, part of the mining area could be returned to at least its present, and probably an improved productivity. The pit area will likely be permanently withdrawn from productivity.

When mining is completed, presumably there could be no further requirement for the freshwater pipeline and pumping system and this would be available for alternate use such as a quality domestic and irrigation water supply for the relatively water-short area.

Table 1

WATER SAMPLE TEST RECORD*

Sample point: Cherry Creek at Cherry Creek mouth PCB Station 0600057

Date	Apr. 24/72	Jun. 19/72	Sept. 6/72	Dec. 7/72	Mar. 7/73	June 14/73
Time	2:00	2:05	3:00	1:30	3:50	9:20
Alkalinity, total (as $CaCO_3$)	357	166	291	534	300	355
Calcium	-	-	-	-	82.5	82.6
Color (units)	10	25	20	15	5	20
Conductance Micromhos/cm	1000	460	730	1345	830	-
Copper	0.02	0.02	0.007	0.001	0.006	0.004
Hardness (as $CaCO_3$)	-	-	-	-	354	428
Lead unfiltered	< 0.003	<0.003	<0.003	<0.003	<0.001	<0.001
Magnesium dissolved	-	-	-	-	-	54.0
unfiltered	-	15.0	34.0	82.5	37.5	53.5
Manganese unfiltered	0.06	0.07	0.08	0.28	0.06	0.09
Nitrate nitrogen (N)	] 0.22	0.20	0.30	0.53	0.28	0.18
Nitrite nitrogen (N)				0.007	0.007	<0.005
Ammonia nitrogen (N)	] 0.27	0.56	0.43	0.47	0.10	0.37
Organic nitrogen (N)						
Total nitrogen (N)	0.49	0.76	0.73	1.01	1.39	0.55
pH	8.0	8.0	8.5	8.0	8.2	-
Phosphate, total (P)	0.050	0.018	0.103	0.114	0.070	0.076
Solids, dissolved	718	277	508	934	582	626
Solids, suspended	1.7	61	4	14	18	2
Solids, total	720	338	512	948	600	628
Sulfate	243	50	131	264	181	161
Temperature (°C)	9	14.5	15	0.0	3	-
Turbidity (Jackson units)	1.3	16	4.1	13	3.3	1.0
Zinc	0.02	0.040	<0.005	< 0.005	< 0.005	<0.005

* Data courtesy Pollution Control Branch, Kamloops

Table 2

VALUES FOR SELECTED WATER QUALITY PARAMETERS

AFTON MINES, NOVEMBER 7, 1973

B. C. Research

Parameter	Hughes Lake	CHERRY CREEK		
		Above confluence with Alkali Creek	Below confluence with Alkali Creek	At CPR tracks
Copper	0.0035	0.0016	0.0025	0.0018
Hardness	760	245	405	245
Iron	0.013	0.004	0.004	0.007
Lead	<0.002	< 0.002	< 0.002	< 0.002
Nitrate	0.140	0.065	0.100	0.065
Nitrite	0.0016	< 0.001	< 0.001	0.0030
pH	9.6	8.3	8.1	8.0
Total phosphate	0.067	0.027	0.053	0.014
Total dissolved solids	2440	363	646	372
Turbidity	0.96	0.46	0.53	0.33
Zinc	0.0045	0.003	0.001	0.007

Table 3

RESULTS OF ANALYSES OF WATER SAMPLES FROM KAMLOOPS LAKE AND THE THOMPSON RIVER AT TRANQUILLE.
VALUES ARE GIVEN AS PPM*

Factor	MARCH 19-22					JULY 16-20					OCTOBER 16-18				
	A	C-2 10 feet	C-2 400 feet	D-2 10 feet	D-2 300 feet	A	C-2 10 feet	C-2 400 feet	D-2 10 feet	D-2 300 feet	A	C-2 10 feet	C-2 400 feet	D-2 10 feet	D-2 300 feet
Total Dissolved Solids	68.8	63.4	62.8	61.0	59.8	38.1	43.7	60.0	43.0	49.6	52.4	50.8	55.4	40.1	56.8
Volatile Solids	27.3	26.3	26.8	27.0	22.2	18.6	20.9	26.0	20.2	28.8	20.4	19.8	17.9	13.8	21.8
Fixed Solids	41.5	37.1	36.0	34.0	37.6	19.5	22.8	34.0	22.8	21.9	32.0	31.0	37.5	26.3	35.0
Silica (SiO_2)	2.6	2.3	2.3	2.2	2.1	2.8	3.7	3.5	4.7	3.9	0.4	0.5	0.4	0.4	0.5
Total Iron	0.1	0.1	0.1	0.1	0.1	1.0	0.6	0.8	0.7	1.0	4.5	1.8	2.0	1.6	1.8
Calcium	15.7	13.9	13.8	13.3	13.3	9.0	10.4	13.1	10.3	10.9	12.0	12.0	13.5	11.1	13.1
Sodium	2.4	2.3	2.4	2.0	2.0	1.2	1.2	2.1	1.9	1.7	1.7	1.3	1.3	0.8	1.3
Magnesium	2.5	2.1	2.2	2.0	2.2	1.3	1.5	2.3	1.5	1.8	2.0	2.0	2.5	1.9	2.5
Sulphate (SO_4)	7.7	7.1	7.9	6.4	6.4	6.6	6.9	11.0	6.5	7.0	7.9	7.3	7.9	7.4	8.1
Potassium	<1.0	<1.0	<1.0	<1.0	<1.0	0.9	0.8	1.1	0.8	1.0	0.9	0.8	0.9	0.8	0.8
Chloride	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Lead							< 0.002								
Zinc			< 0.001												
Copper			0.001												

From p. 28 "Limnology of Kamloops Lake" F. J. Ward, Bulletin XVI IPSFC, 1964.

Table 4

LEVELS (IN PPM) OF PHOSPHORUS AND NITROGEN IN KAMLOOPS LAKE IN 1963*

Date	C-2 10 FT					C-2 400 FEET					D-2 10 FT					D-2 300 FT				
	N	NH_3	N^1	PO_4^2	PO_4^2	N	NH_3	N^1	PO_4^2	PO_4^2	N	NH_3	N^1	PO_4^3	PO_4^3	N	NH_3	N^1	PO_4^2	PO_4^3
March	0.44	0.012	0.07	<0.003		0.40	0.012	0.06	<0.003		0.44	0.018	0.07	<0.003		0.44	0.012	0.06	<0.003	0.
April	0 34	<0.04	0.10	< 0.004		0.35	<0.02	0.07	<0.001		0.35	<0.01	0.07	<0.001		0.35	<0.02	0.07	<0.003	
May	0.27	0.02	0.11	0.006	0.020	0.18	0.02	0.11		0.007	0.18	0.01	0.14		0.020	0.18	0.010	0.09		0.007
June	0.34	< 0.01	0.10	<0.003	0.023	0.47	< 0.01	0.08	<0.003	0.018	0.42	<0.01	0.10	<0.003	0.023	0.42	0.020	0.09	<0.003	0.030
July	0.18	<0.01	0.07	<0.002	0.012	0.35	<0.02	0.07	< 0.002	0.013	0.18	<0.01	0.09	<0.002	0.013	0.31	<0.02	0.06	<0.002	0.012
August	0.18	0.03	0.11	<0.002	0.015	0.35	0.05	0.07	<0.002	0.019	0.18	< 0.02	0.10	<0.002	0.018	0.27	<0.02	0.08	<0.002	0.016
September	0.09	<0.01	0.09	<0.002	0.019	0.35	<0.02	0.09	<0.002	0.023	0.09	<0.01	0.09	<0.002	0.017	0.27	<0.02	0.08	<0.002	0.022
October	0.35	<0.02	0.08	0.007	0.026	0.61	< 0.01	0.07	0,009	0.084	0.26	< 0.01	0.07	0.009	0.053	0.61	<0.01	0.07	0.006	0.040
November	0.28	0.01	0.07	0.007	0.011	0.44	<0.02	0.05	0.007	0.011	0.30	<0.01	0.09	0.007	0.010	0.44	<0.02	0.06	0.007	0.011

1. Total nitrogen other than nitrates
2. Inorganic phosphate
3. Total phosphate

* From Page 29 "Limnology of Kamloops Lake" F. J. Ward Bulletin XVI IPSFC, 1964

Table 5

CAPABILITY OF LANDS FOR WATERFOWL PRODUCTION
IN THE AFTON MINING PROPERTY AT CHERRY CREEK, B.C.

	TOTAL	ACREAGE PER CAPABILITY CLASS		
	Acreage	Class 4	Class 5	Class 7
Total property	2500	121	6	2373
Ultimate pit	139	20	-	119
Tailings pond	472	42	-	330
Tailings dam				
Waste dump	368	-	-	368
Plant site	52	-	-	52
Highway relocation	37	3	-	34
Freshwater pipe	34	-	-	34
Trans.pipe relocation	7	n.a.	n.a.	n.a.

Legend

Class 4 — Lands having moderate limitations to the production of waterfowl

Class 5 — Lands having moderately severe limitations to the production of waterfowl

Class 7 — Lands having such severe limitations that almost no waterfowl are produced

Table 6

VEGETATION COMMUNITIES IN THE AFTON MINING PROPERTY
AT CHERRY CREEK, B. C.

	Total approximate acreage	APPROXIMATE ACREAGE PER VEGETATION COMMUNITY						
		1	2	3	4	5	6	7
Total property	2500	1914	41	33	267	151	19	75
Total occupied by mine operation	1031	-	-	-	-	-	-	-
Ultimate pit	139	118	-	-	-	6	1	14
Tailings pond and dam	472	305	34	22	57	12	7	35
Waste dump	368	307	-	-	27	34	-	-
Plant site	52	49	-	-	1	2	-	-

Legend

1. Sagebrush grassland
2. Cultivated fields
3. Drainageway
4. Forested areas
5. Saltgrass community
6. Bulrush community
7. Waterbodies

Table 7

PRESENT LAND USE IN THE AFTON MINING PROPERTY
AT CHERRY CREEK, B. C.

	Total approximate acreage	ACREAGE PER LAND USE CLASS					
		1	2	3	4	5	6
Total property	2500	2163	50	6	112	94	75
Total occupied by mine operation	1031	-	-	-	-	-	-
Ultimate pit	139	125	-	-	-	-	14
Tailings pond and dam	472	309	50	-	72	6	35
Waste dump	368	365	-	-	-	3	-
Plant site	52	52	-	-	-	-	-
Highway relocation	37	30	-	-	-	1	2
Fresh water pipe	34	24	-	-	-	10	-
Gas pipe relocation	7	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Legend

1. Open grassland
2. Improved pasture and forage crops
3. Swamp, marsh and bog
4. Nonproductive woodland on a productive site. Evidence of grazing on the forest range.
5. Immature productive woodland. Evidence of grazing on the forest range.
6. Water surfaces

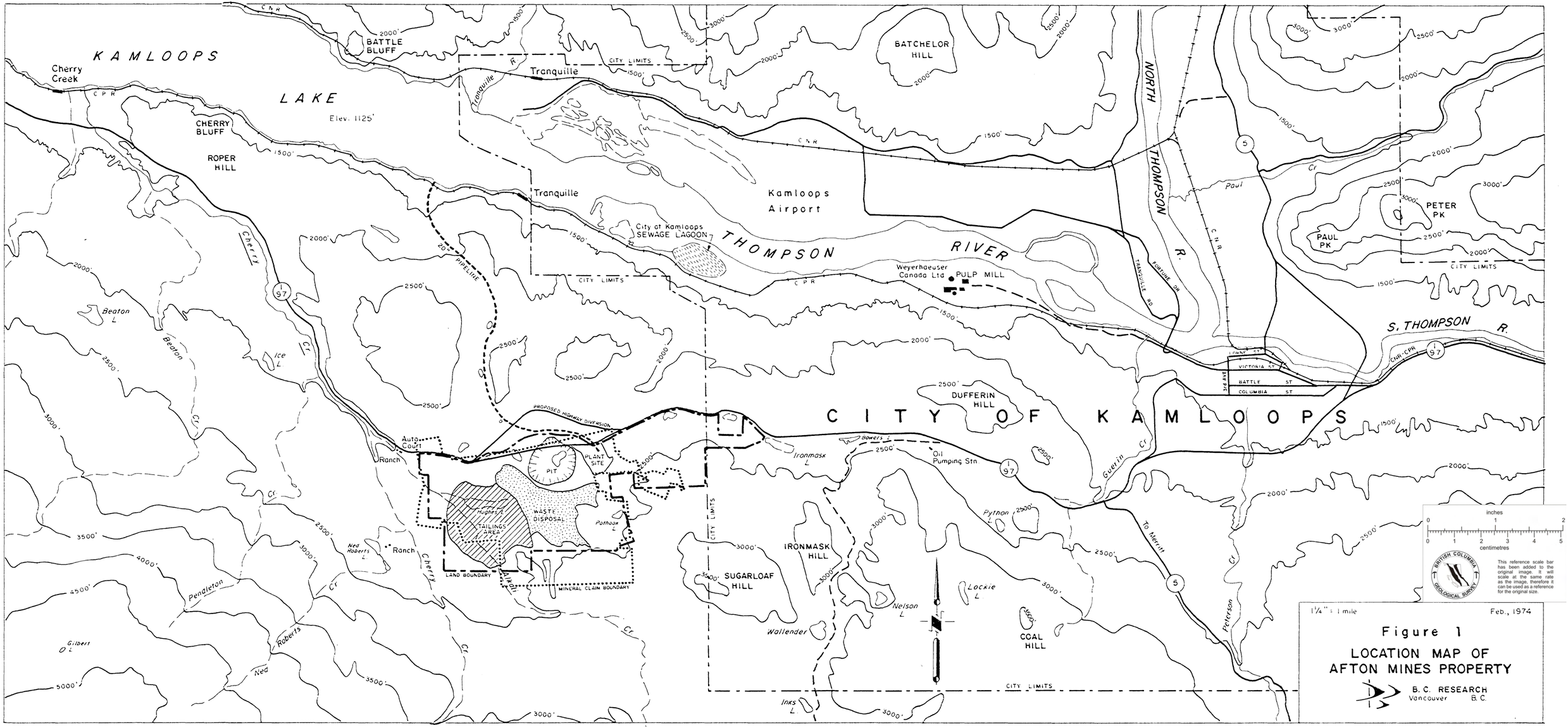

KAMLOOPS LAKE
Elev. 1125'
Cherry Creek
BATTLE BLUFF
CHERRY BLUFF
ROPER HILL
Tranquille
CITY LIMITS
BATCHELOR HILL
NORTH THOMPSON R.
Kamloops Airport
City of Kamloops SEWAGE LAGOON
THOMPSON RIVER
Weyerhaeuser Canada Ltd
PULP MILL
TRANQUILLE RD
FORTUNE DR
PETER PK
PAUL PK
Paul Cr
S. THOMPSON R.
CNR-CPR
LOUNE ST
VICTORIA ST
BATTLE ST
COLUMBIA ST
3rd AVE
CITY OF KAMLOOPS
DUFFERIN HILL
Beaton L
Beaton Cr
Ice L
Cherry Cr
20" PIPELINE
PROPOSED HIGHWAY DIVERSION
Auto Court
Ranch
PLANT SITE
PIT
WASTE DISPOSAL
TAILINGS AREA
Hughes L
Pothook L
LAND BOUNDARY
MINERAL CLAIM BOUNDARY
Ned Roberts L
Ranch
Cherry Cr
Pendleton Cr
Roberts Cr
Ned Cr
Gilbert L
Bowers L
Ironmask L
Oil Pumping Stn
Guerin Cr
Python L
IRONMASK HILL
SUGARLOAF HILL
Nelson L
Lockie L
Wallender
COAL HILL
To Merritt
Peterson Cr
Inks L
inches
centimetres
BRITISH COLUMBIA GEOLOGICAL SURVEY
This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.
1¼" = 1 mile
Feb., 1974
Figure 1
LOCATION MAP OF AFTON MINES PROPERTY
B. C. RESEARCH
Vancouver B. C.

Figure 2

Western end of Afton property showing Hughes Lake and area of proposed tailings dam. November, 1973 (21731-34A)

Figure 3

Area of proposed open pit; Highway No. 1/97 in background. Location is shown by arrow in Figure 2, November, 1973 (21730-21).

Figure 4
TOPOGRAPHIC PROFILE NE - SW THROUGH AFTON MINE PROPERTY

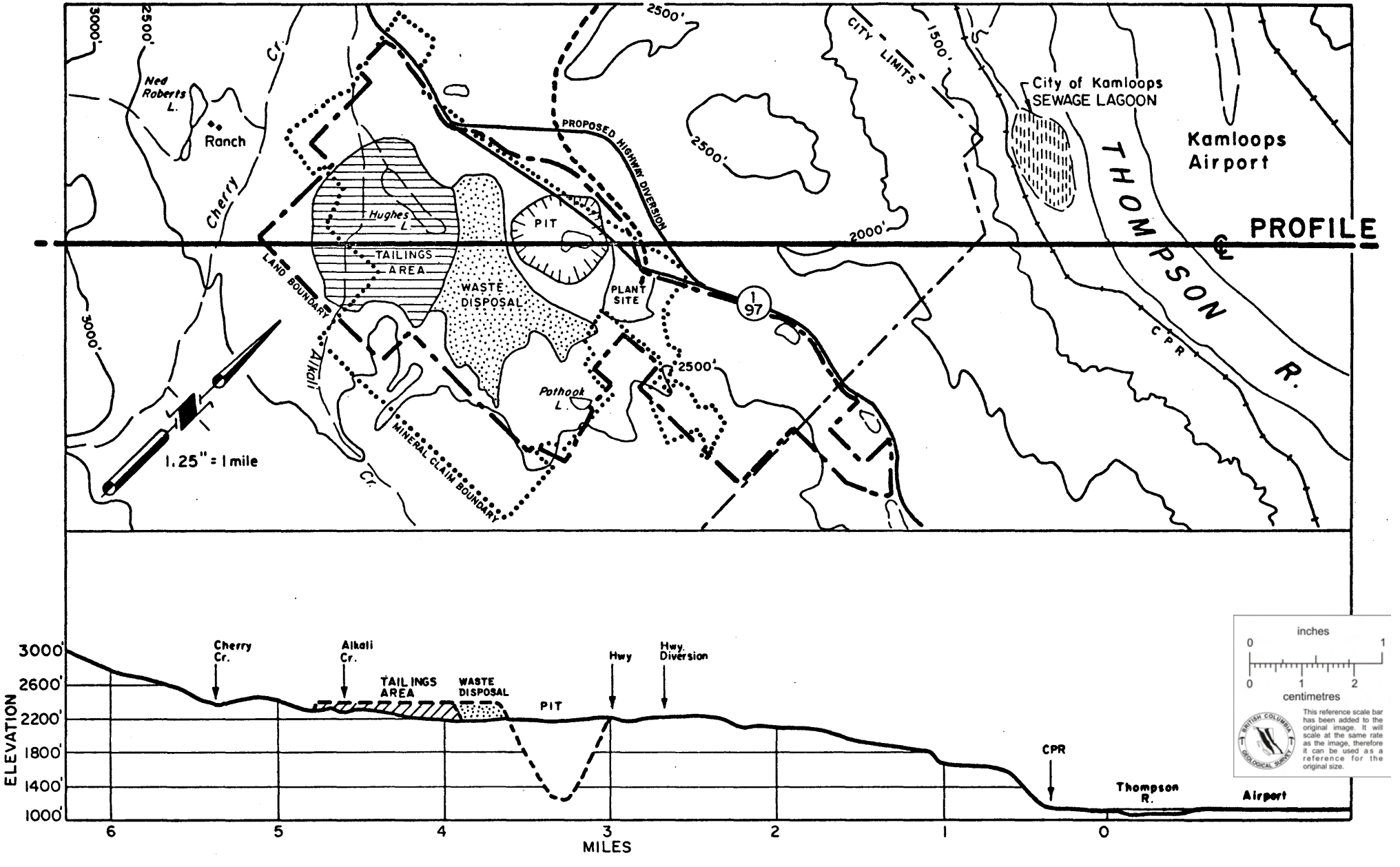
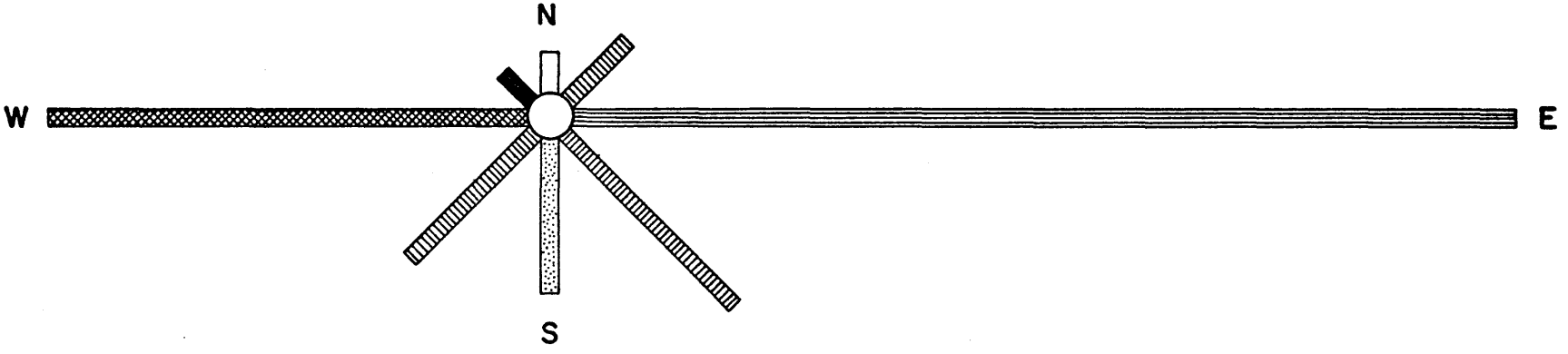


Figure 5

KAMLOOPS WIND ROSE



0 4 8 12

Scale of frequency by percent

NOTE: The summation of all the directions equals 99 percent. The frequency of calm weather is one percent

Average wind speed (mph) from wind direction

- 4.0 - 4.9
- 5.0 - 5.9
- 6.0 - 6.9
- 7.0 - 7.9
- 8.0 - 8.9
- 9.0 - 9.9

inches

0 1

0 1 2

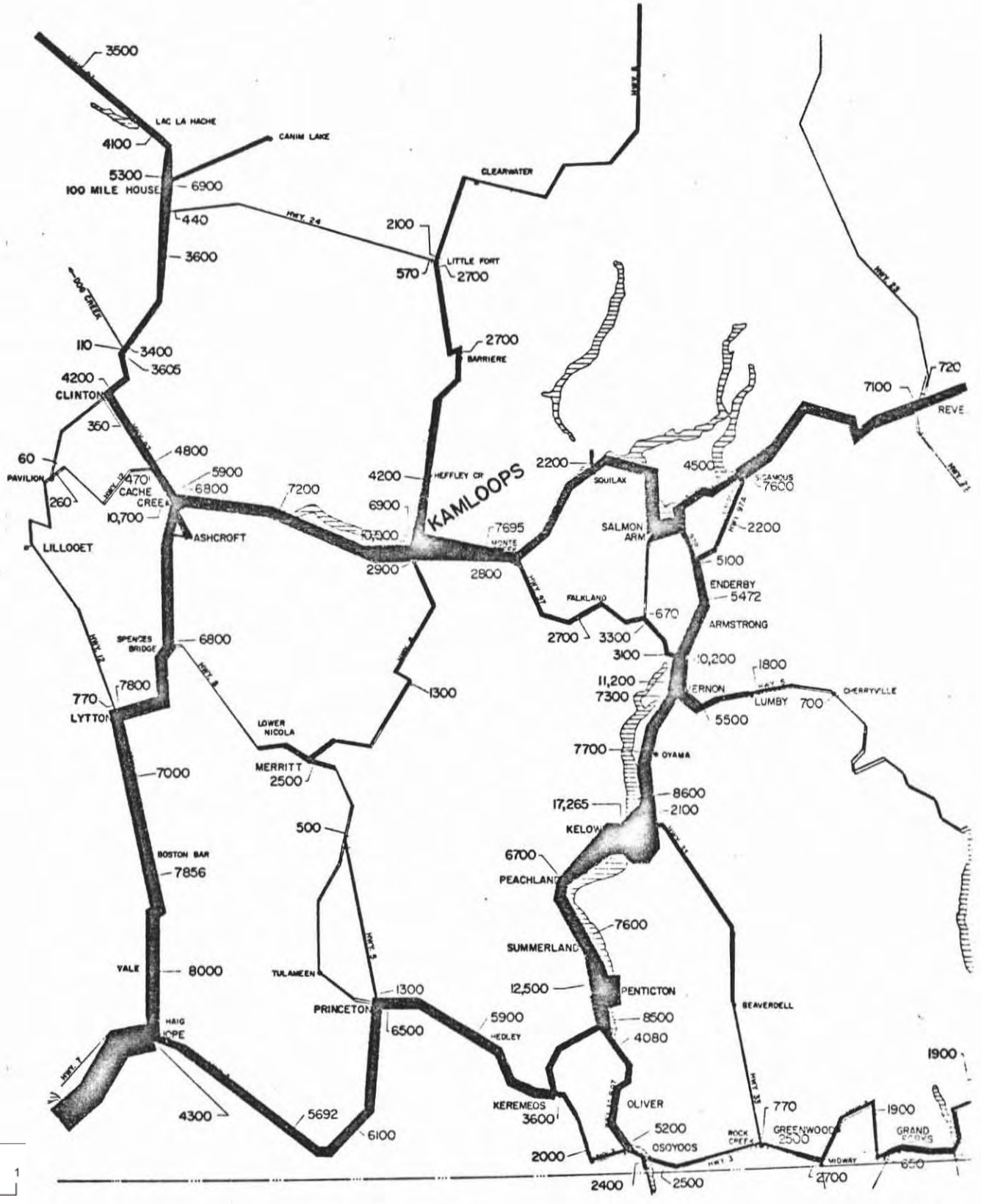
centimetres

This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.

Figure 6

AVERAGE DAILY TRAFFIC FLOW, JULY-AUGUST 1972

(Number of Vehicles)



SOURCE : B. C. Dept of Highways, Victoria

inches
0 1
0 1 2
centimetres

This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.

BRITISH COLUMBIA GEOLOGICAL SURVEY

APPENDIX I

PROVINCE OF BRITISH COLUMBIA

PLEASE QUOTE
FILE 1-4.11

THE ARCHAEOLOGICAL SITES ADVISORY BOARD
OF
BRITISH COLUMBIA
BOX 200, PARLIAMENT BUILDINGS
VICTORIA, BRITISH COLUMBIA
CANADA

December 13, 1973

British Columbia Research,
3650 Wesbrook Crescent,
Vancouver, British Columbia.

Attention: Mrs. Viona Coates

Dear Mrs. Coates:

Thank you for your letter of December 4, 1973, regarding possible conflicts between Archaeological sites and the proposed development of lands owned by Afton Mines in the Kamloops area.

Our records do not indicate any known site locations in the development area. However, the area in question has never undergone a systematic field inspection. Such an inspection could be carried out by my office in the Spring. I would therefore appreciate any detailed information you may have regarding the proposed development. If possible, I would also appreciate receiving a map or plan showing the specific area which is included in the feasibility study.

Thank you for your concern for the protection of Archaeological sites.

Yours very truly,

Bjorn O. Simonsen,
Provincial Archaeologist

BOS/jb

APPENDIX 1a

PLEASE QUOTE

FILE

THE ARCHAEOLOGICAL SITES ADVISORY BOARD
OF
BRITISH COLUMBIA
BOX 200. PARLIAMENT BUILDINGS
VICTORIA, BRITISH COLUMBIA
CANADA

July 3, 1974

Mrs. Viona Coates
B.C. Research
3650 Wesbrook Crescent
Vancouver, B.C.

Dear Mrs. Coates:

You will recall sending me a letter dated December 4, 1973 in which you requested information about the possibility of archaeological sites being located in the area of Afton Mines near Kamloops, B.C.

In my letter to you of December 13th, 1973 I promised to have a field inspection carried out in the spring of this year. This work has now been completed and I wish to report that no archaeological sites were reported by our field crew.

Yours very truly,

Bjorn O. Simonsen
Provincial Archaeologist

BOS:jb