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TULAMEEN ENVIRONMENTAL PROGRESS REPORT - 1978

Similkameen Mining District, B. C.

N.T.S. 92 H - 7, 10

Latitude: 49° 30' N   Longitude: 120° 45' W

by

P. M. DEAN

CYPRUS ANVIL MINING CORPORATION

November 22, 1978

Field Work Done During the Periods:
April 24 - 26, 1978   May 15 - 19, 1978
July 10 - August 6, 1978

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TULAMEEN ENVIRONMENTAL PROGRESS REPORT - 1978

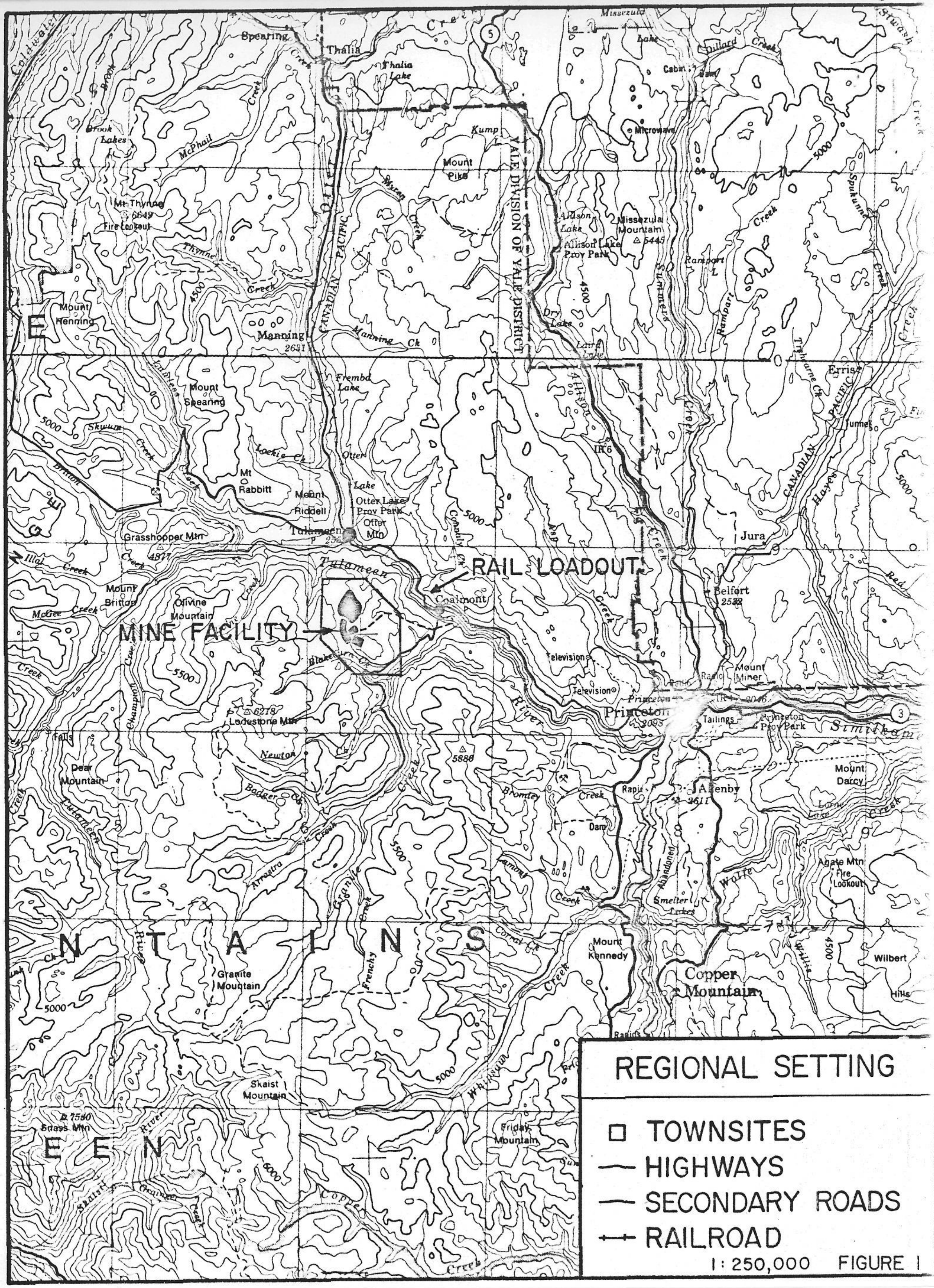
1.0 INTRODUCTION

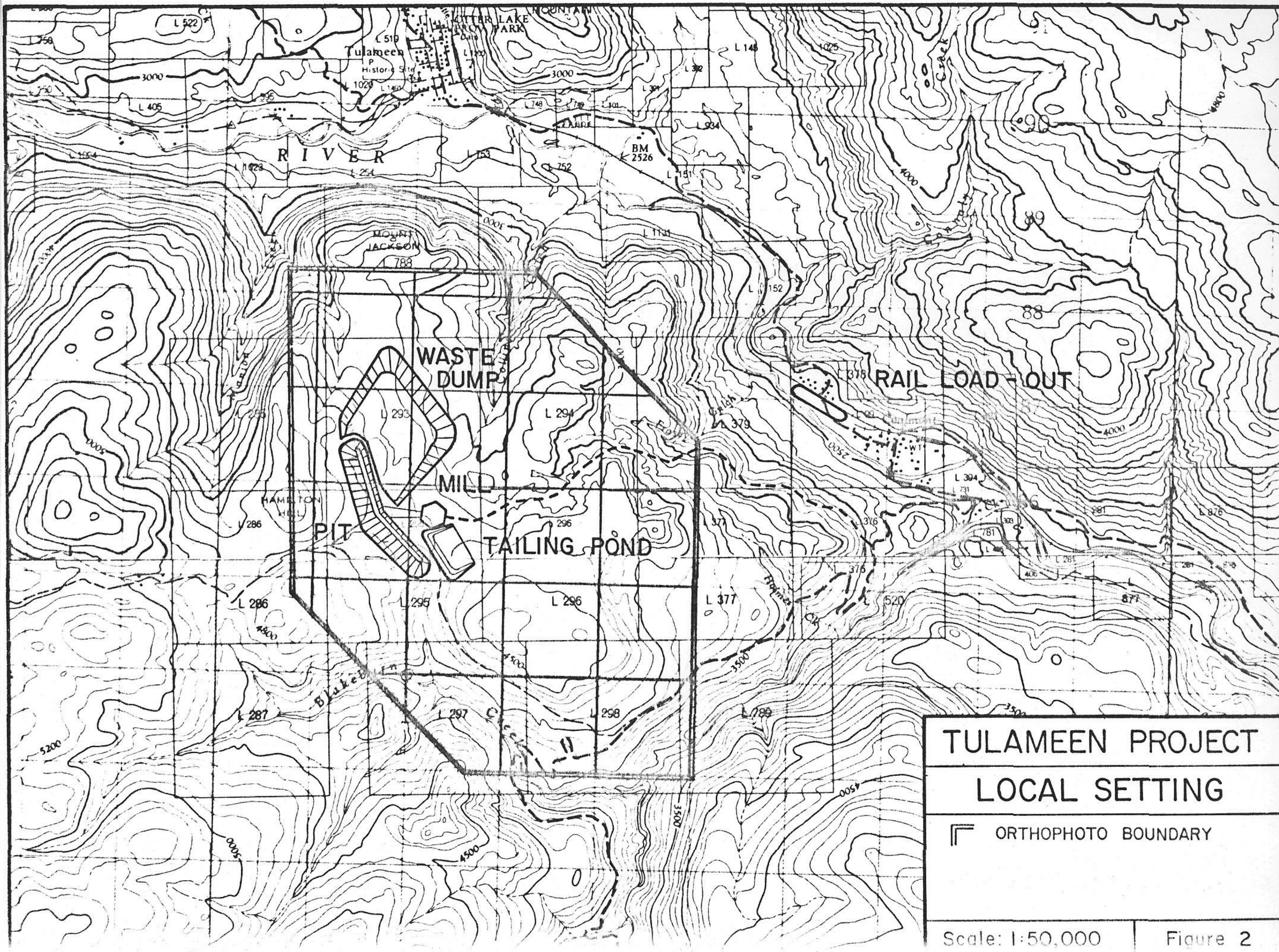
A preliminary feasibility study carried out on the Tulameen coal prospect during the Spring of 1978 indicated that the property was close to being economically viable. Accordingly, it was decided that some environmental investigations should be initiated which would be required when the time came to prepare a Stage I Environmental Impact Assessment. It was also decided that much of the environmental work could be done "in-house", thereby avoiding at least in part the excessive fees charged by consulting companies, and at the same time building up some "in-house" environmental expertise. The technical skills and general familiarity with environmental problems which will be gained on this project may serve the company well in future projects, when environmental issues will effect mining companies much more dramatically than they do today.

During this first season, environmental investigations on the Tulameen Project have consisted largely of compiling the existing biophysical data available from various government sources. Some field time was spent on water quantity and quality investigations, and on initial descriptions of the plant communities present on the property. A substantial amount of office time has been spent in the acquisition of general environmental material and in learning specific technical field procedures in hydrology, forestry, agriculture, plant ecology, etc. This learning experience is continuing, and given enough time, we should be able to carry out all but the most highly technical investigations required for the Stage I assessment without recourse to consulting companies.

It should be emphasized that the work I am doing, as outlined in this progress report, only concerns itself with the biophysical aspects of the environmental assessment. The Stage I report must also include an assessment of the socio-economic impacts of the development, and it remains to be decided whether this also will be done "in-house" or contracted to a consulting company. The work requires a person with an economics background and an interest in community social and economic planning. The socio-economic impact assessment will not require the lead time that some aspects of the biophysical assessment requires, and can be carried out over a relatively brief period of time.

The collection of some of the data required for the Stage I biophysical assessment requires substantial outlays of money for automatic monitering equipment, and these costs are best delayed until the viability of the project is assured. When potential markets have been found for the coal, final feasibility studies are completed, and a schedule for construction has been finalized, then meteorological equipment, automatic stream stage recorders, etc. can be purchased and installed. Investigations of revegetation and reclamation procedures, plus whatever other environmental work the government may require, can also be carried out at this later time. In the meantime, it is worthwhile to continue the water quantity and quality studies, some biological investigations, and other aspects of the work which are inexpensive and in progress now.


RAIL LOADOUT
MINE FACILITY
Tulameen
Coalmont
Princeton
Allenby
Copper Mountain
Thalia
Spearing
Manning
Jura
Belfort
Erris
Mount Henning
Mount Spearing
Mt Rabbitt
Mount Riddell
Otter Lake Prov Park
Otter Mtn
Grasshopper Mtn
Mount Britton
Olivine Mountain
Lodestone Mtn
Deer Mountain
Granite Mountain
Skaist Mountain
Friday Mountain
Mount Kennedy
Mount Miner
Mount Darcy
Agate Mtn Fire Lookout
Wilbert Hills
Mt Thynne 6649 Fire Lookout
Mount Pike
Missezula Mountain
Allison Lake Prov Park
Princeton Prov Park
YALE DIVISION OF YALE DISTRICT
CANADIAN PACIFIC
Tulameen River
Similkameen
N T A I N S
E E N
REGIONAL SETTING
TOWNSITES
HIGHWAYS
SECONDARY ROADS
RAILROAD
1: 250,000
FIGURE 1



TULAMEEN PROJECT

LOCAL SETTING

Scale: 1:50,000 Figure 2

2.0 DISCUSSION OF SPECIFIC ASPECTS OF BIOPHYSICAL INVESTIGATIONS

2.1 CLIMATE

The nearest government meteorological stations to the property are at Princeton, Merritt, and Osprey Lake. None of these stations are likely to be paricularly representative of weather conditions at the minesite, but they are useful for indicating long range climatic cycles, and the data from these stations will aid in interpretting site-specific data when we begin to collect it. Weather data for the past 20 to 30 years is available for these locations.

Snow depth data has been collected at a station on Hamilton Hill since 1960. This data consists of snow depth and water equivalent values measured 6 times during the winter and is used by the government to predict run-off. This data is particularly useful to us as it relates to the water flow in Blakeburn Creek, the proposed water supply for the development. When we have collected stream flow data through this winter we can compare the flow data with snow pack data for the year and thereby predict possible minimum flow volumes which may be expected in drought years.

At least one full year before the Stage I assessment is prepared we will have to purchase and install a meteorological station at some suitable permanent location at the minesite. Schultz International Ltd. have estimated the cost of this equipment at $5,000.00. It may be possible to obtain the co-operation of Environment Canada in supplying or setting up this equipment, since it would add a useful new location to their weather station grid. This possibility will be investigated after our Prospectus is submitted to the government and it becomes clear that the project is going to proceed.

2.2 WATER RESOURCE

2.2.1 Water Required by Development

The water balance of the proposed mine and mill as outlined in the Techman Feasibility Report is summarized in Figure 3. It can be seen that the mill will require 5043 Imperial gallons of water per minute during normal operation. Of this total amount, 4980 gpm will be returned to the tailings pond and 63 gpm will be permanently lost from the system as moisture in the coal product and in the reject. An additional 20 gpm or so will be required for domestic use in toilets, showers, etc., providing a total "make-up" water requirement of 83 gpm, assuming total recovery from the tailings pond.

Clearly there will not be total recovery from the tailings pond, since there will be losses through seepage and evaporation, offset perhaps by some influx of surface run-off and groundwater. Techman have allowed 117 gpm for these losses, giving a total average water requirement of 200 gpm. This water requirement may prove to be conservative during the summer months, when evaporation alone may exceed 117 gpm. Rates of evaporation are virtually impossible to predict because of the numerous variables involved, but if we take some average annual evaporation figures from Grey (1973) for various parts of Alberta, and recalculate them for the size of tailings pond suggested in the Techman report, we end up with average evaporation rates ranging from 97 gpm to 183 gpm during the summer months. These figures based on Alberta conditions may not be completely applicable to the Tulameen area, but nevertheless it seems inevitable that evaporation will account for a substantial water loss. If we assume some water loss through seepage as well, then it appears that the peak water requirement might greatly exceed 200 gpm. This peak water requirement will of course occur at midsummer, when the water flow in Blakeburn Creek is at its lowest level.

TULAMEEN COAL DEVELOPMENT

WATER BALANCE

(IMP. GALLONS PER MINUTE)

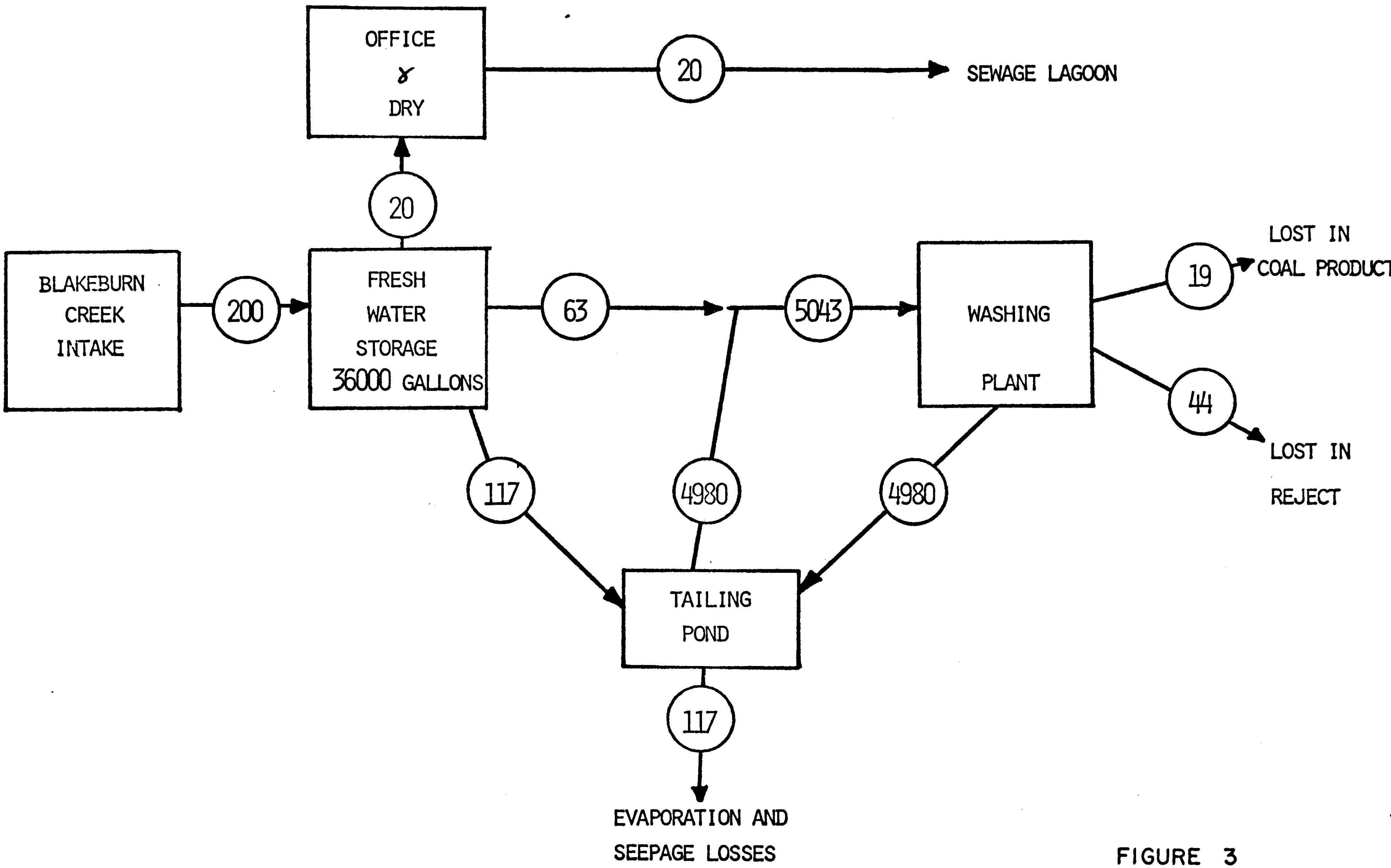


FIGURE 3

The evaporation from the tailings pond can be minimized by reducing the surface area as much as is practical and by leaving or planting a windbreak of trees as close to the perimeter of the pond as possible. Seepage losses can only be eliminated by using pond liners, which may not be economically feasible.

To summarize, the make-up water estimate of 200 gpm suggested by Techman is probably valid as a year round average, but may prove to be rather modest during the summer months.

2.2.2 Water Sources

The best water source for the operation is Blakeburn Creek at a point just below the influx of the last main tributary from the west (site A on Figure 4). This location allows a reasonable pumping distance of 1600 meters and a head of 180 meters, but the water flow at this site during minimum months may not be sufficient to supply the water quantities required. Blakeburn Creek is inaccessible to fish because of canyons and waterfalls close to Granite Creek, and there are no existing water licences on the Creek, so there should be no conflict of water use at this site. A possible disadvantage of this location is that it is downslope from the drainage from both the open pit and the tailings pond, and is therefore vulnerable to pollution from our own operation. An alternate choice is Granite Creek at the junction of Blakeburn Creek, a distance of 3 kilometers from the minesite and 430 meters below it in elevation. A steep canyon on the lower part of Blakeburn Creek makes access to this site very difficult. The only viable third choice would be the Tulameen River, requiring a pumping distance of about 9 kilometers and a head of almost 600 meters.

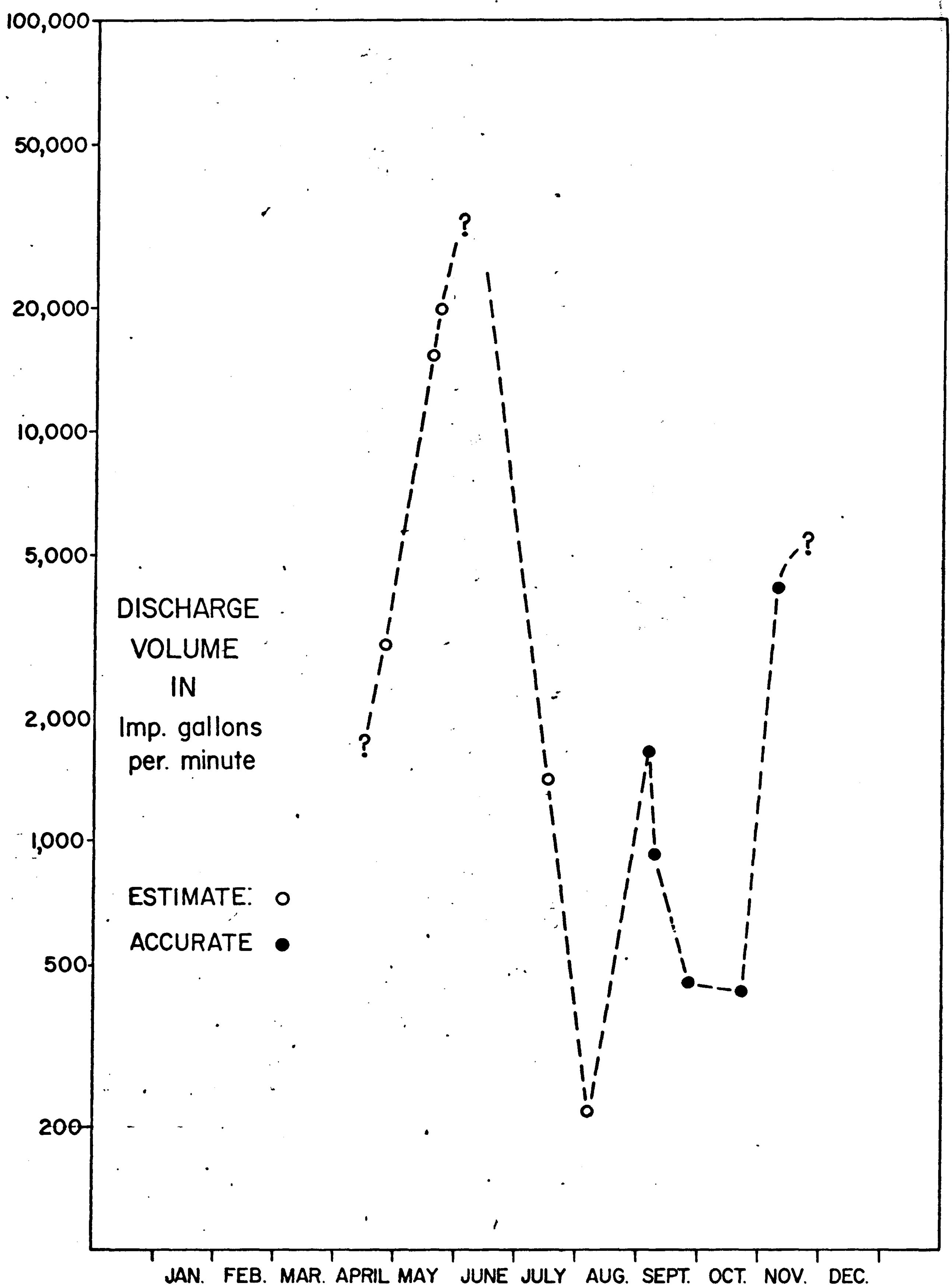
2.2.3 Stream Discharge Records

The Water Survey of Canada has maintained stream gauging stations on Otter Creek at Tulameen and on the Tulameen River at Princeton for many years. In addition, the B. C. Water Resources Branch has measured the flow rate of Granite Creek at the mouth during the summer months since 1973. The data for Granite Creek is of most benefit to us, since its headwaters includes the Blakeburn Creek tributary and the flow variations in the two creeks should be similar. It is interesting to note that the minimum flow measured in Granite Creek in the three years for which records are available is 2.7 ft^3/sec. (1009 gpm). If this figure is reduced proportionally to account for the smaller Blakeburn drainage area, it suggests that the flow in Blakeburn Creek could drop as low as 126 gpm. As our data base for Blakeburn Creek grows, we should be able to extrapolate to other years using this Granite Creek data.

We have measured the discharge in Blakeburn Creek at periodic intervals since April of this year (Table I). Measurements taken before September are not accurate, since the water velocity had to be estimated. After that date a current meter was used, and the stream bed was modified by the construction of a small cement weir so that the cross sectional area of the water channel could be measured accurately during low flow regimes.

The minimum flow so far measured is 431 gpm on October 19th, but during early August, before the acquisition of the current meter, the flow dropped to about half this amount. It remains to be seen what happens to the pattern of flow during the winter months.

One possible way of overcoming the problem of insufficient water flow in the creek during certain months would be to dam the creek to produce a reservoir. Because of the relatively steep topography around the intake site, a dam of modest height would not impound



<u>Table I</u>: Instantaneous Discharge Measurements
<u>BLACKBURN CREEK — 1978</u>

a great deal of water. A dam 5 meters high, for example, would produce a reservoir about 80 meters long by 20 meters wide which would contain only 570,000 gallons of water, a two day supply. A dam of this height would be 12 meters long at the top and 5 meters long at the creek level. Because of the terrain at the site, the maximum height dam that is possible, without incurring excessive costs, is 7 meters, and a dam of this height would produce a reservoir impounding about 1,100,000 gallons.

2.2.4 Water Quality

Baseline, pre-development water quality information is required in the Stage I Environmental Report for all streams which may be effected by the proposed development. We have begun to collect water quality data at the following locations (Figure 4):

Site A: Blakeburn Creek at the proposed intake site. This location is down-drainage from both the open pit and the tailings pond, and will be the stream most effected by the operation.

Site B: Granite Creek 1 kilometer above the influx of Blakeburn Creek.

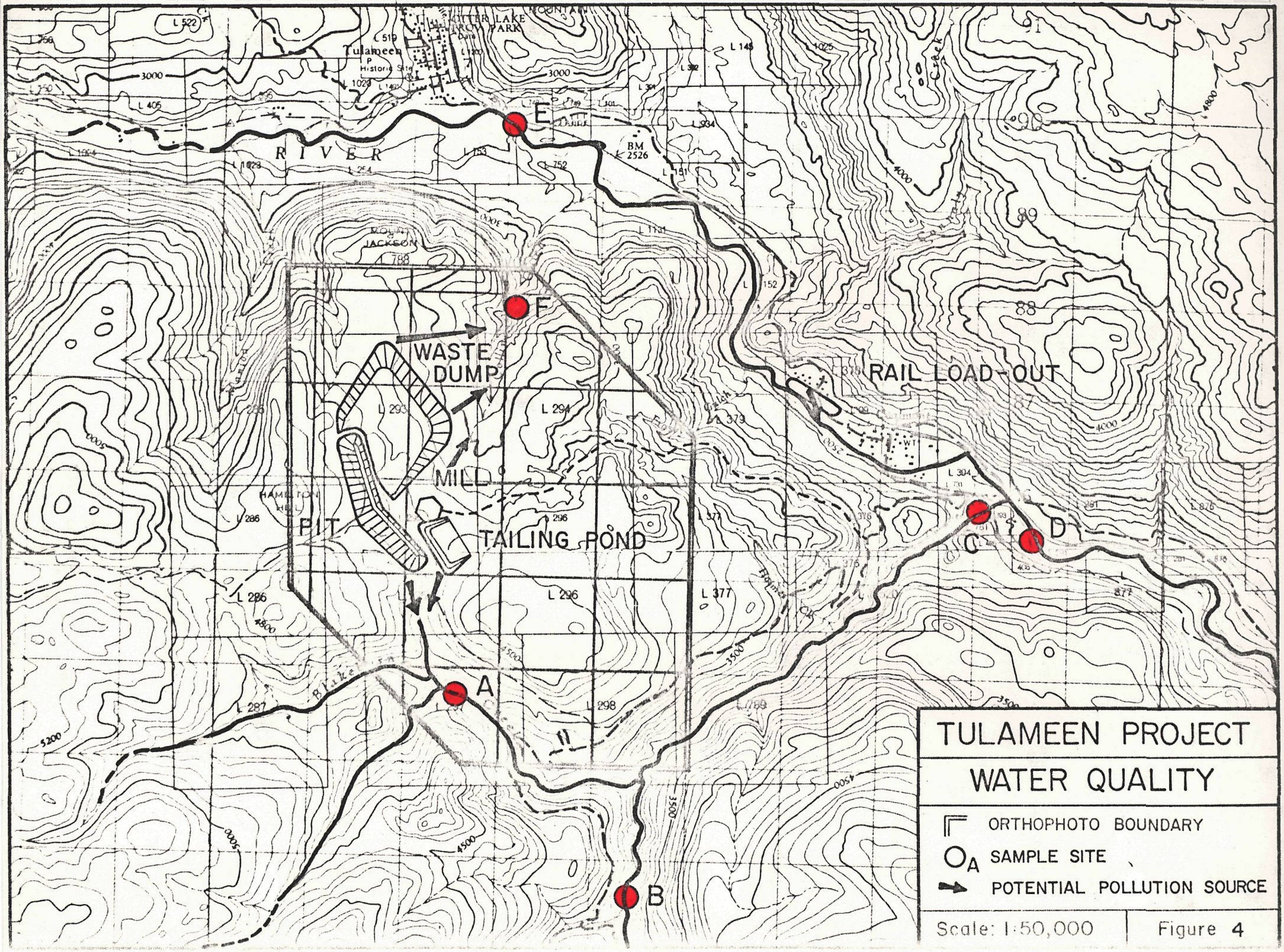
Site C: Granite Creek at the mouth.

Site D: Tulameen River 1 kilometer below the influx of Granite Creek.

Site E: Tulameen River 1 kilometer above the influx of Collins Gulch.

Site F: Collins Gulch about 1 kilometer below the proposed waste dump location.

These locations have been chosen to provide water quality data upstream and downstream from the sources of potential pollution on all effected streams. The samples have been analyzed for most of the parameters suggested in "Guidelines for Coal Development",



TULAMEEN PROJECT
WATER QUALITY

Figure 4

TABLE II WATER QUALITY DATA

SAMPLE SITE AND DATE

Water Quality Parameter	Site A 17 May 1978	Site A 14 July 1978	Site B 15 July 1978	Site C 15 July 1978	Site D 15 July 1978	Site E 15 July 1978	Site F 15 July 1978
pH	7.30	7.93	8.10	8.10	7.88	7.93	7.93
Sus Solids (mg/l)	5.6	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Diss Solids (mg/l)	93	77	62	85	62	31	98
Tot Hardness (mg/$CaCO_3$)	40.3	63.2	68.5	73.4	59.1	45.1	61.3
Turbidity (NTU)	2.5	0.37	0.78	0.53	0.33	0.30	1.05
Conductivity (umhos/cm)	70	118	125	133	107	78	148
NO_2 + NO_3 (mg/lN)	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	0.02
Tot PO_4 (mg/lP)	0.05	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02
SO_4 (ppm)	2	2.5	11.0	4.5	8.2	2.8	8.5
Cl (ppm)	0.60	1.0	0.28	0.50	0.72	0.45	0.60
Tot Fe (ppb)	340	19	37	< 1	< 1	13	27
Tot Mn (ppb)	< 10	5	10	10	10	5	10
Tot Pb (ppb)	< 1	5	2	2	2	1	2
Tot Zn (ppb)	< 1	3	1	2	2	1	< 1
Tot As (ppb)	4.4	2	< 1	< 1	1	< 1	< 1
Tot Cu (ppb)	3	4	< 2	< 2	< 2	< 2	2
Tot Hg (ppb)	0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05

Analysis carried out by: Chemex Labs Ltd.,
212 Brooksbank Ave.,
North Vancouver, B. C.
V7J 2C1

and also for certain metals which might be expected to occur naturally in streams in the Tulameen area (Table II). The results up to now indicate that the streams are completely unpolluted, as would be expected in this sparsely populated and non-industrial area. Until the project is closer to the construction phase, samples will be taken twice each year, once at low water in the late summer and once during the spring run-off. The analytical work is being done by Chemex Labs Ltd., 212 Brooksbank Avenue, North Vancouver, B. C.

2.3 VEGETATION

2.3.1 Introduction

The Tulameen coal property lies on the eastern flanks of the Cascades in an area which is subject to both coastal and interior climatic influences. The transitional nature of the area is reflected in the vegetation, which includes a wide variety of species typical of both wet coastal and dry interior environments. Using the classification system of Krajina (1973), the majority of the development area lies within the "subalpine engelmann spruce-subalpine fir" forest region, with the "interior douglas fir" and "ponderosa pine-bunch grass" communities appearing at lower elevations. Under the system proposed by Rowe (1972), the higher parts of the property lie within the "subalpine forest region", while areas at a lower elevation lie within the "montane forest region".

The elevation differences characteristic of these two forest types are somewhat blurred on the Tulameen property by site differences, with the montane forest favouring more exposed and drier locations, regardless of elevation.

The plant communities which characterize these forest types in virgin areas have been moderately to severely altered in the project area by a long history of human activities, including mining, ranching, and logging. The extensive effect that these activities have had is illustrated by the fact that typical climax forest types occupy less than 20% of the 450 hectare area which will be directly effected by the development. Much of the area appears to be kept in a permanent subclimax stage by the frequent fires and by intensive grazing, which presumably destroys the tree seedlings.

2.3.2 Vegetation Analysis Methods:

The existing plant communities on the property were studied by locating 30 sample plots, 10 meters by 20 meters in size, scattered over the area where the most intensive development will take place. Each plot was subjectively located to include a typical sample of the vegetation at that locality, and every plant community which occurs on the property is represented by two or more plots. The problem of subjectively vs. randomly selected sample plots is discussed in some detail in a paper by Beil (1974), and most of his arguments in favour of the subjective approach apply equally well to our situation. The abundant roads, mine workings, and other man-made clearings in the development area also favour a subjective over a random approach.

In each sample plot, plant species are listed by strata, and cover abundance is estimated for shrub and herb species making up 10% or more of a particular strata. All trees over 10 cm dbh are enumerated by species and diameter. Increment cores and height measurements have been done on one or more mature trees on most plots, and age, volume and average wood production per year for the past 20 year period has been calculated for these trees. In addition, elevation, slope angle and direction, bedrock type, and where possible, soil conditions have been described for each site. The data for each plot is recorded on sheets with a standard format.

A list of all plant species identified to date on the property is included as Appendix Ia.

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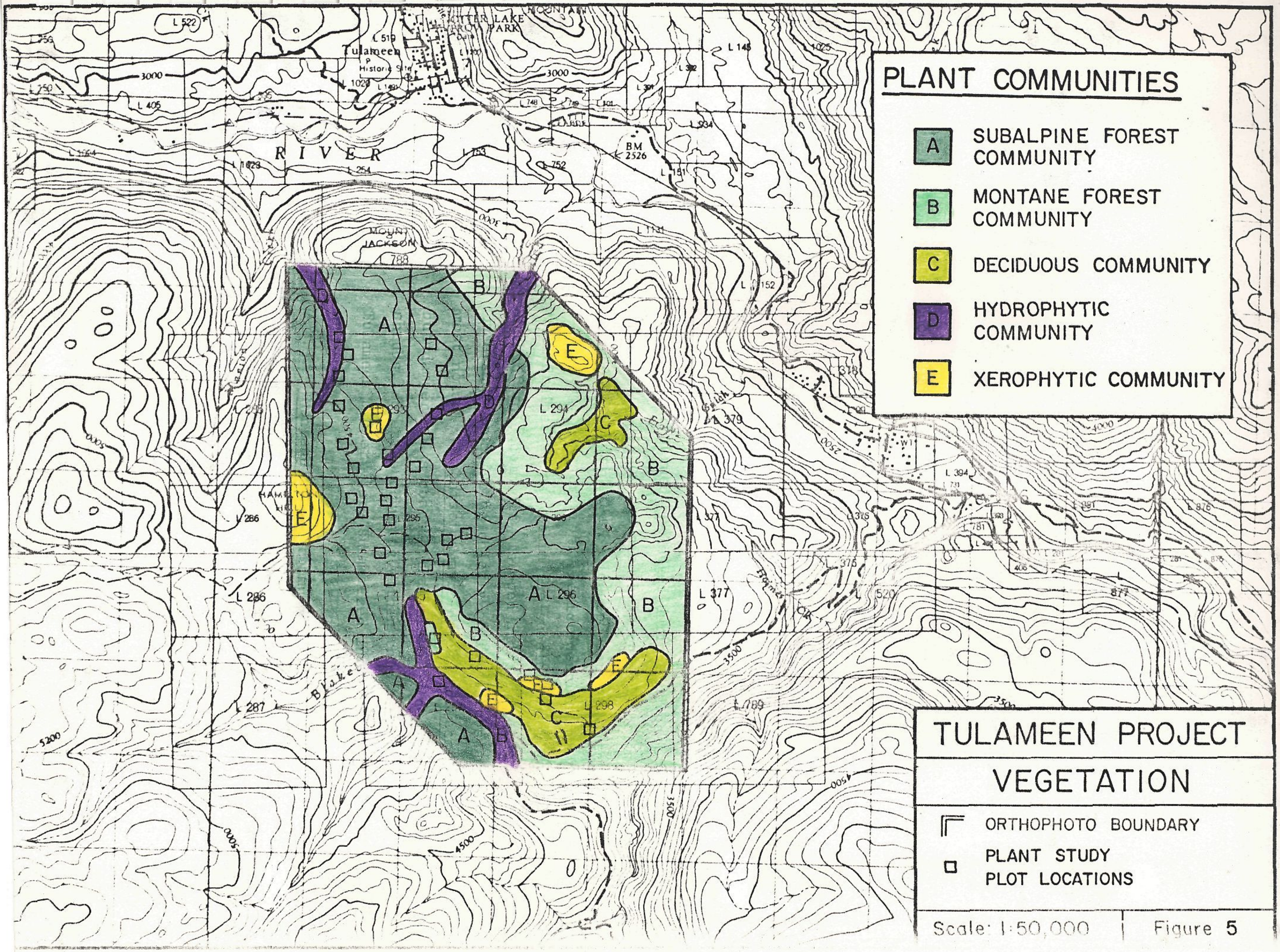


PLANT COMMUNITIES
A SUBALPINE FOREST COMMUNITY
B MONTANE FOREST COMMUNITY
C DECIDUOUS COMMUNITY
D HYDROPHYTIC COMMUNITY
E XEROPHYTIC COMMUNITY
TULAMEEN PROJECT
VEGETATION
ORTHOPHOTO BOUNDARY
PLANT STUDY PLOT LOCATIONS
Scale: 1:50,000
Figure 5
Tulameen
RIVER
MOUNT JACKSON

2.3.3 Discussion of Plant Communities

Five plant communities are recognized on the property, each characterized by a distinctive association of species (Figure 5). Of these five communities, two represent widespread forest types which are recognized over large parts of southern B. C., two are local specialized communities on very wet and very dry sites, and one is a somewhat artificial vegetation association which has grown up on disturbed areas around the old mine workings and townsite. The proposed development lies almost entirely within areas occupied by subalpine forest, and the other plant associations would be little effected.

2.3.3.1 Subalpine forest community:

Climax forest communities of this type are characterized by alpine fir and engelmann spruce, and these trees are dominant in small sections of the forest existing on the Tulameen coal property. Most of the area however has been either burned or logged during the past one hundred years, and is now occupied by pioneer subclimax tree communities dominated by lodgepole pine, with alpine fir and spruce regeneration. Relict douglas fir occur on some well drained sites within the subalpine forest community. Much of this community is open and park-like, with the understory consisting chiefly of low shrubs and herbs, most notably *Pachistima myrsinites* and *Vaccinium scoparium*, but damper areas contain thickets of alder and other tall shrubs. Species occuring within this community on the Tulameen property are summarized in Appendix Ib.

2.3.3.2 Montane forest community

This forest type is characterized by open, park-like stands of interior douglas fir and ponderosa pine, with bunch grass and low shrubby vegetation between. Lodgepole pine is a pioneer subclimax tree species in this community as well as in the subalpine forests, and as a result, it is often difficult to clearly distinguish the two forest types on the Tulameen coal property. The montane forest type occupies better drained, more exposed sites, generally below 1200 meter elevation. Species occuring in this community, on the Tulameen property are summarized in Appendix Ic.

2.3.3.3 Deciduous woodland community

This plant association appears to be a relatively permanent subclimax type occupying terrain where montane forest would normally occur. Bebb's willow, douglas maple, and aspen dominate the tree stratum, with mountain alder and water birch occuring in wetter areas. A great variety of shrubs and herbaceous species occur in the understory and in open meadow areas between the tree thickets. This community occupies the abandoned townsite of Blakeburn and other heavily disturbed areas. There appears to be no regeneration of coniferous trees within this deciduous community, except perhaps at the edges where it contacts areas of montane forest. Because of its southern exposure and wide variety of deciduous vegetation, this plant association is an important winter range area for deer and other game species, and is heavily utilized by domestic cattle during the summer months. It also harbours a greater variety of birdlife and small mammals than the other forest types that occur on the Tulameen property. Plant species which have been identified up to now in this plant community are summarized in Appendix Id.

2.3.3.4 Hydrophytic communities: stream margins, seepage meadows, etc.

Locations on the property with high humidity and year round water availability are occupied by a distinctive group of plants which are more typical of the coastal forest than the dry interior. Tree species include douglas fir, engelmann spruce and occasionally red cedar. Mountain alder is always present as a tall shrub or small tree, and red-osier dogwood is also invariably abundant. Other shrub species which occur only or mainly in these wet habitats are devil's club, thimbleberry, water birch, black twinberry, squashberry, and swamp currant. Many herbaceous plants are restricted to these sites as well, and these are listed in detail in Appendix Ie.

2.3.3.5 Xerophytic communities: exposed rocky bluffs, talus slopes, etc.

The driest and most exposed sites on the property are occupied by a relatively restricted group of xeric adapted plants. This habitat type grades into the montane forest community and shares many plant species with it. Typical of this community, and restricted to it, is the western juniper, *Juniperus scopulorum*. Douglas fir, ponderosa pine and aspen also occur on these dry sites but are more abundant and better developed elsewhere. Common juniper, kinnikinnick, and squaw currant are the most abundant shrubs, and all reach their best development in this plant association. Other plants typical of this habitat, and for the most part restricted to it, are columbia lewisia, the fern *Woodsia oregana*, lance-leaved stonecrop, and arrowleaf balsamroot. Other species occuring in this community are summarized in Appendix If.

2.3.4 Summary

The vegetation studies carried out during 1978 represent only a start and more work is needed before we have a thorough knowledge of the structure and relationships of the plant communities that will be effected by the development. Nevertheless, the following conclusions can be safely made at this time:

1. All plant communities and individual species which have been identified on the property up to now are common and widespread in southwestern B. C.

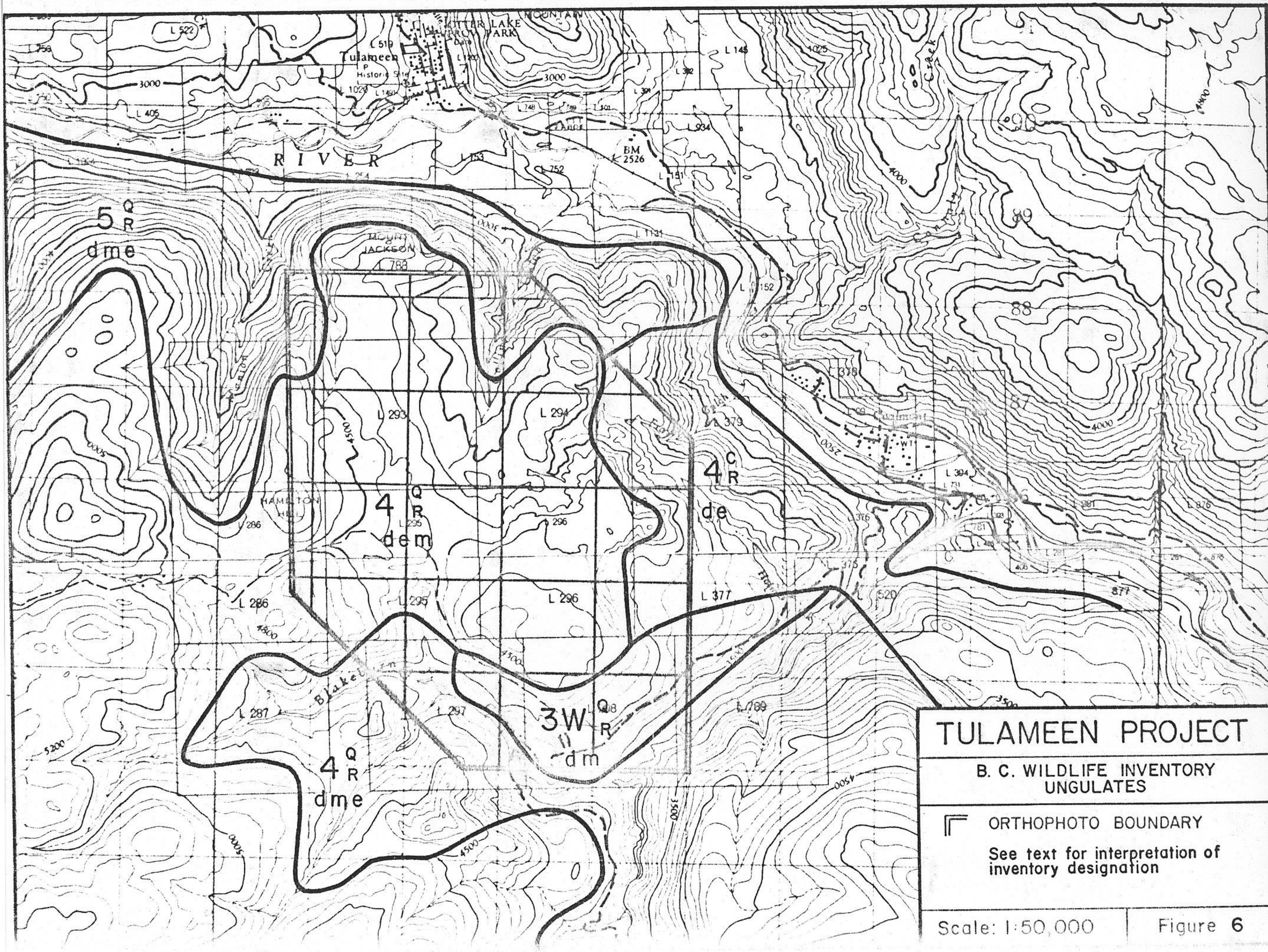
2. Most of the area that will be effected by the new development has already been moderately to severly effected by previous human activities over the past 100 years.

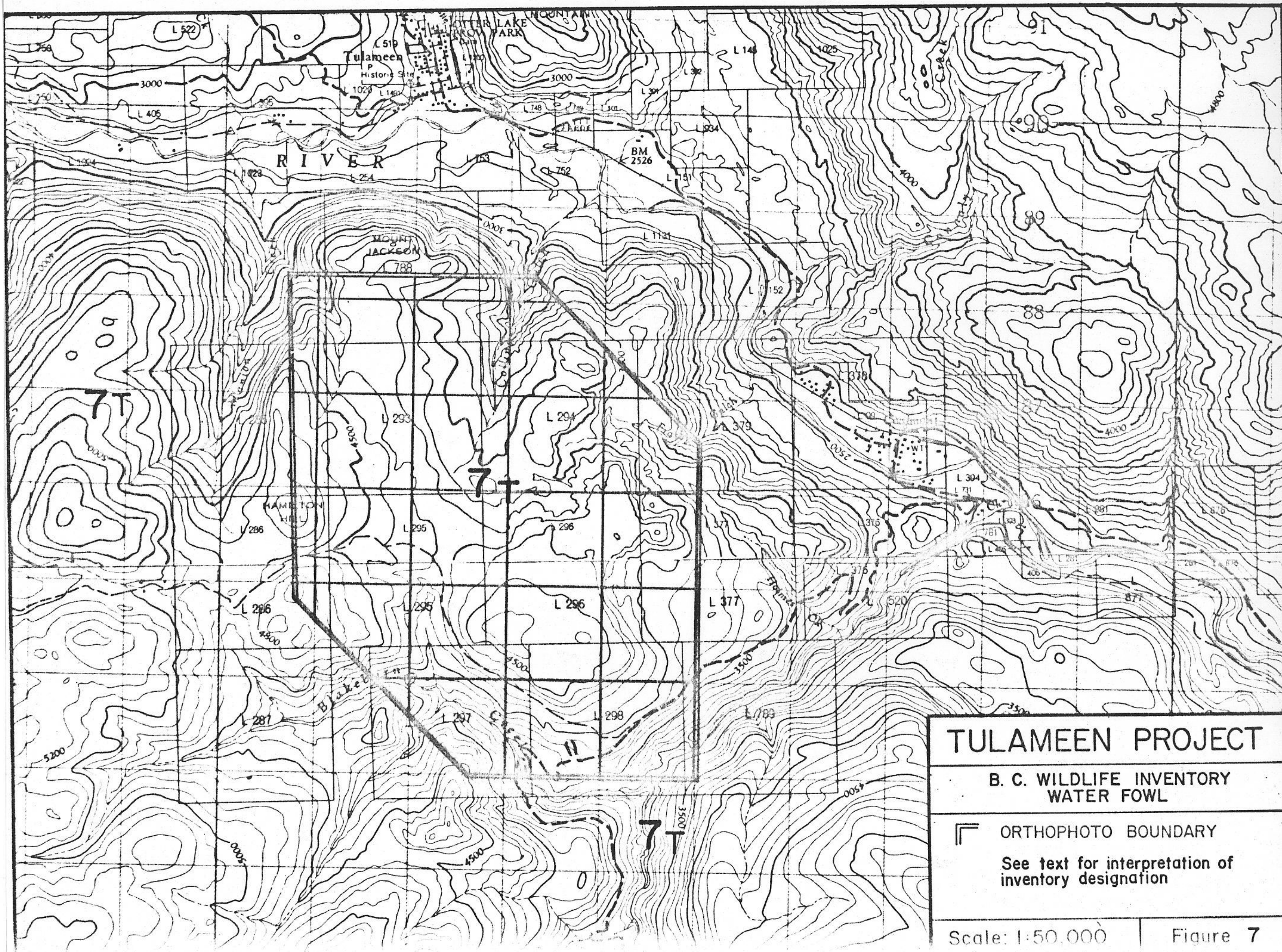
3. Most of the plant communities on the property are at a subclimax successional stage dominated by pioneer species. These same pioneer species, especially lodgepole pine, can be used in our revegetation plans so that we can regenerate in a relatively short period of time a forest similar in character to the one we remove. In other words, we are not destroying climax plant communities which have taken hundreds of years to develop.

4. The plant community of greatest value as range for both wild ungulates and domestic beef cattle is the "deciduous woodland community" which will be little effected by the development. Oddly enough, this plant community dominates in the areas which have been most drastically effected by man in the past, and represents the greatest divergence from a natural plant association.

2.4 WILDLIFE

No investigations of wildlife were carried out during 1978, and the only site-specific data collected this season is a few random observations which were made in the course of other work. Some wildlife information is available from B. C. Wildlife Inventory maps, which attempt to rate geographic areas according to their carrying capacity for ungulates and for waterfowl. These maps do not represent actual existing population levels, but rather define potential population carrying capacities, assuming good non-intensive wildlife management practises.


TULAMEEN PROJECT
B. C. WILDLIFE INVENTORY
UNGULATES
ORTHOPHOTO BOUNDARY
See text for interpretation of inventory designation
Scale: 1:50,000
Figure 6
Tulameen
RIVER
JACKSON
HAMILTON HILL
5 Q R dme
4 Q R dem
4 C R de
3W Q R dm
4 Q R dme
L 293
L 294
L 295
L 296
L 297
L 286
L 287
L 377
L 379
L 378
L 152
L 788
BM 2526
88
89
87
4000
4500
3000
5200


TULAMEEN PROJECT
B. C. WILDLIFE INVENTORY
WATER FOWL
ORTHOPHOTO BOUNDARY
See text for interpretation of inventory designation
Scale: 1:50,000
Figure 7
Tulameen
OTTER LAKE PROV PARK
Historic Site
RIVER
MOUNT JACKSON
HAMILTON HILL
BM 2526
7T
7T
7T

On the B. C. Wildlife Inventory ungulate map, Figure 6, the area of the main mine development is classed as 4^{Q}_{R}, which indicates moderate to severe limitations for the production of ungulates, due to snow depth and rock outcrops. This area will sustain a population equivalent to 20 to 40 ungulate units per square mile. (Note that a mule deer = 1.2 ungulate units, an elk, 4.0 ungulate units, and a moose, 6.0 ungulate units). Mule deer, elk and moose would be expected to occur in the area, in that order of abundance. The Blakeburn townsite area, which would be little effected by the mine development as now envisioned, has a higher rating of $3W^{Q}_{R}$. This rating indicates a potential carrying capacity of 40 to 60 ungulate units per square mile, with the same limitations as the last. In addition, this area is an important winter range for deer and moose because of the southern exposure and abundant deciduous vegetation.

Mule deer were commonly observed on the property during April and May in groups of 1 to 12 individuals. Most of the sightings were made in the area classed as $3W^{Q}_{R}$. During July, deer appeared to be generally absent, only one or two individuals being seen during the month of field work. It seems likely that they mainly utilize the area during the winter months, moving to higher ground as the snow melts in the spring. Droppings of either moose or elk were observed at one location on the property, and tracks of black bears were present in snow during the Spring, but neither species was seen "in the flesh". These casual observations made during this first season would seem to suggest that the ungulate populations presently utilizing the area of the Tulameen coal leases are much lower than the potential carrying capacities suggested by the Canada Land Inventory.

The mammals in the following list have been observed on the property during the field work in 1978:

mule deer	(*Odocoileus hemionus hemionus* Rafinesque)
black bear	(*Ursus americanus* Pallas)

yellow-bellied marmot	(Marmota flaviventris avara Bangs)
cascade mantled groundsquirrel	(Spermophilus saturatus Rhoads)
columbian groundsquirrel	(Spermophilus columbianus columbianus Ord.)
northwestern chipmunk	(Eutamias amoenis affinis Allen)
red squirrel	(Tamiasciuris hudsonicus streatori Allen)
mountain cottontail	(Sylvagus nuttalli nuttalli Bachman)

The B. C. Wildlife Inventory map for waterfowl capability (Figure 7) rates the area as "7t", which indicates severe limitations due to adverse topography. There are no ponds or lakes in the area of the development and therefore no waterfowl currently utilize it. The tentative reclamation plans call for flooding of the open pit at the termination of mining operations, and if this takes place the value of the habitat for waterfowl will be marginally enhanced.

Bird species identified on the property during 1978 include the following:

robin	(Turdus migratorius)
varied thrush	(Ixoreus naevius)
myrtle warbler	(Dendroica coronata)
white-crowned sparrow	(Zonotrichia leucophrys)
oregon junco	(Junco oreganus)
black-capped chickadee	(Parus atricapillus)
blue grouse	(Dendragopus obscurus)
yellow-bellied sapsucker	(Sphyr·picus varius)
red-shafted flicker	(Colaptes cafer)
dipper	(Cinclus mexicanus)

raven	(*Corvas corax*)
western tanger	(*Piranga ludoviciana*)
sparrow hawk	(*Falco sparverius*)

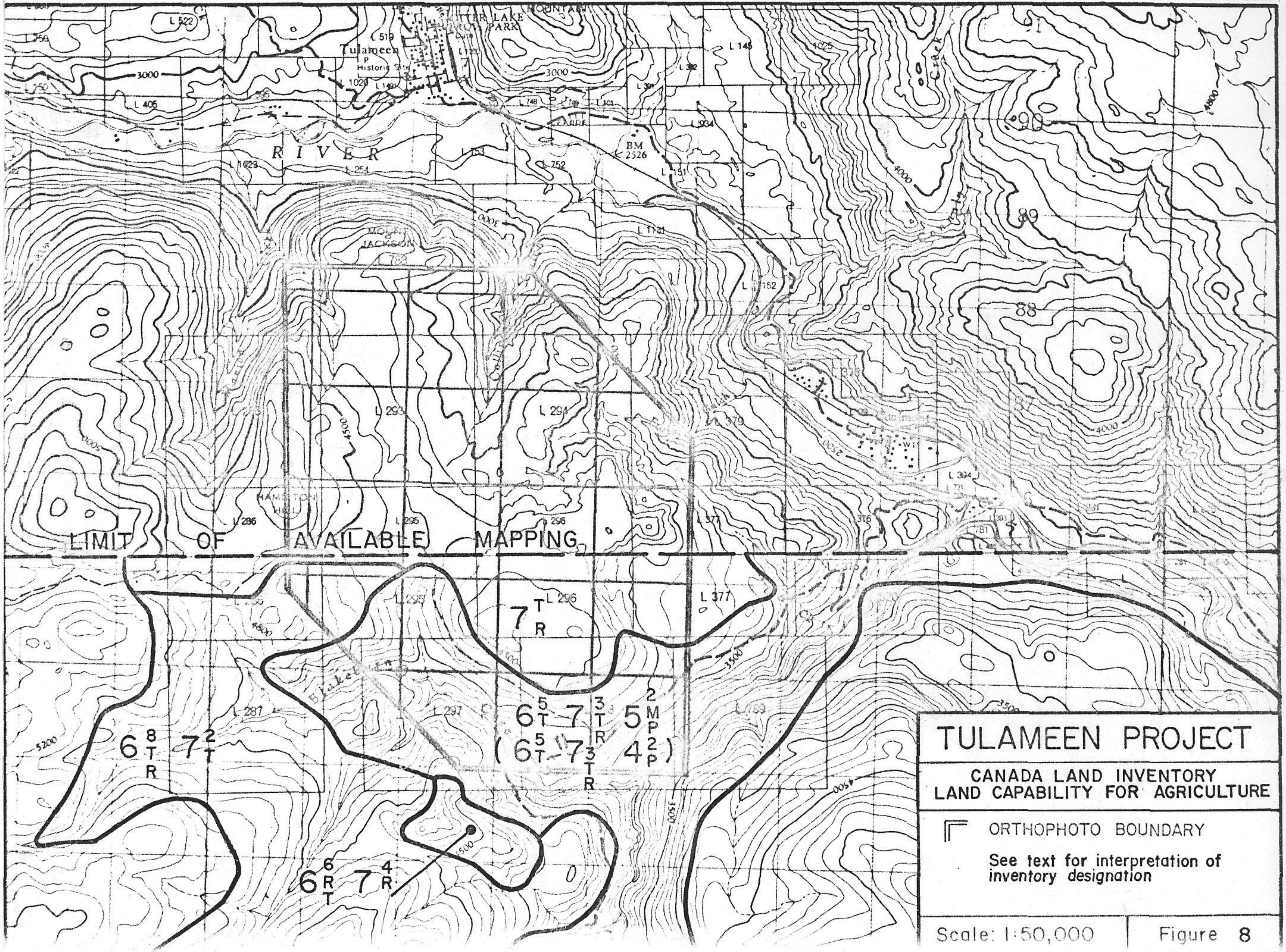
Undoubtably numerous other species of birds utilize the area, but only the above species have been positively identified up to now.

No rare or endangered species of wildlife have been observed on the property, nor are any likely to occur. The value of the area as habitat for wildlife species of recreational significance is moderately to severely limited due to deep snow, rock outcrops, and lack of ponds and lakes. It therefore seems unlikely at this early stage that any serious conflicts will develop between the proposed coal mining operation and the utilization of the area as range for wildlife.

2.5 AGRICULTURE

The area of the proposed mine facility is utilized for grazing at various times of the year by local ranchers in the Coalmont area. The cattle mainly use the open meadowlands around Blakeburn Creek and townsite, but occasionally they stray into the more heavily forested areas east of Hamilton Hill. If our development goes ahead, about 400 hectares of this more marginal grazing land would be removed from ranching use.

The Canada Land Inventory classes the area east of Hamilton Hill as 7^{T}_{R}, which indicates no capability for agriculture or permanent pasture due to topographic constraints and bedrock outcrops (Figure 8). The classification for the Blakeburn Creek valley area indicates that 70% contains some natural pasture, but only a small part of this can be improved by range management practises. The main constraints again are the ruggedness of the topography, the presence of bedrock outcrops, the stoniness of the soil, and the lack of soil moisture.


TULAMEEN PROJECT
CANADA LAND INVENTORY
LAND CAPABILITY FOR AGRICULTURE
ORTHOPHOTO BOUNDARY
See text for interpretation of inventory designation
Scale: 1:50,000
Figure 8
LIMIT OF AVAILABLE MAPPING
RIVER
Tulameen
MOUNT JACKSON
HAMILTON HILL
BM 2526
3000
4000
4500
5000
3500
5200
4800

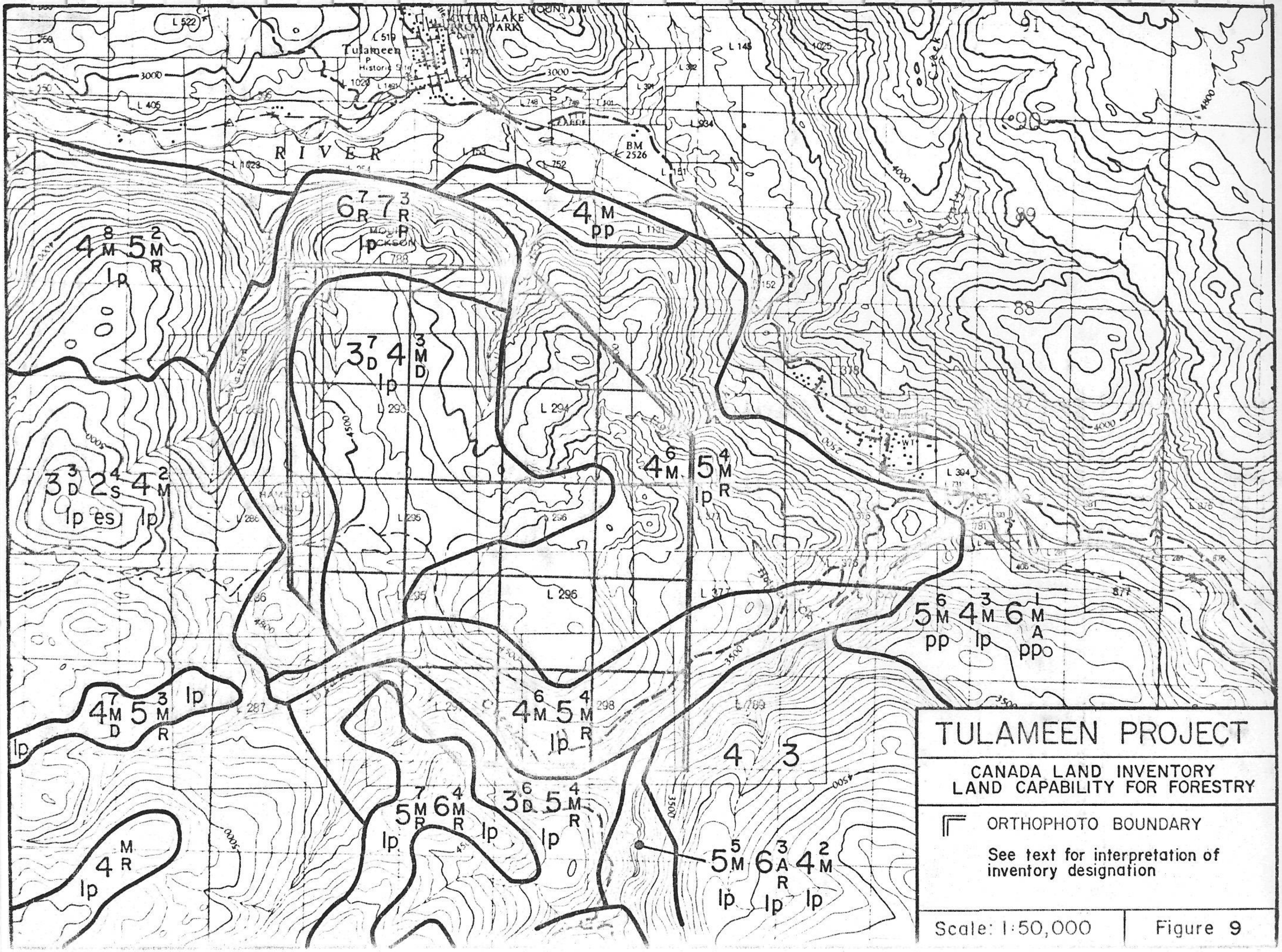
The area in Coalmont which we would use for our rail loading facility appears to lie within an agricultural land reserve. Approximately 4 hectares of valley bottom land would be required for the rail siding and other structures. This new construction would lie to a large extent on land previously used as the terminus of the abandoned aerial tramway, an area which presently is not arable because of numerous derelict building foundations, roadways, and so on. It is doubtful if this land could be economically rehabilitated into productive farmland, and therefore our loading facility does not represent an alienation of arable land from agricultural use, in spite of the land reserve classification.

2.6 FOREST RESOURCES

The B. C. Forest Service produces maps of forest cover at scales of 1" = 1,320' for forest lands in some parts of the province. These maps summarize data on tree species, stocking, age, and height, and in addition estimate site quality for the production of commercial timber. These maps provide a detailed and useful forest inventory which would be difficult to improve on without carrying out work of an excessively detailed nature. The data from these B. C. Forest Service maps has been replotted at our orthophoto scale of 1:5,000 (Map 1).

These forest cover maps have been evaluated for the 450 hectare area which will be effected by the proposed development, and the results for various parameters are discussed briefly here. The site quality is classed as "good" for about 50% of the development area, with 37% classed as "moderate". The balance is considered to be poor or non-productive. About 53% of the area contains no trees of marketable size. In the species classification, 44% of the forest area is dominated by lodgepole pine, and an additional 29% is characterized by mixed forest with lodgepole pine, douglas fir, and spruce. Non-commercial brush makes up 9% of the area and forest dominated by douglas fir and spruce, which are the main commercial species, make up 18%. The forest has not been logged in any systematic way, although

.... 28


Tulameen
Historic Site
RIVER
Creek
BM 2526
L 519
L 522
L 405
L 1023
L 153
L 752
L 145
L 934
L 151
L 1131
L 152
L 293
L 294
L 295
L 296
L 286
L 287
L 298
L 377
L 378
L 394
L 876
L 877
3000
4000
4500
3500
91
90
89
88
6^7_R $7^3_{R P}$ lp
4^M_{pp}
4^8_M $5^2_{M R}$ lp
3^7_D $4^3_{M D}$ lp
3^3_D 2^4_s 4^2_M lp es lp
4^6_M $5^4_{M R}$ lp
5^6_M 4^3_M $6^1_{M A}$ pp lp ppo
$4^7_{M D}$ $5^3_{M R}$ lp
4^6_M $5^4_{M R}$ lp
4 3
$5^7_{M R}$ $6^4_{M R}$ lp lp
3^6_D $5^4_{M R}$ lp
4^M_R lp
5^5_M $6^3_{A R}$ 4^2_M lp lp lp
TULAMEEN PROJECT
CANADA LAND INVENTORY
LAND CAPABILITY FOR FORESTRY
ORTHOPHOTO BOUNDARY
See text for interpretation of inventory designation
Scale: 1:50,000
Figure 9

a certain amount of timber has been cut in various parts of the area for use in the former coal mines. The mature trees range in age from 80 to 100 years, suggesting that a forest fire probably swept through the area about 100 years ago. Over all, the area would appear to be only of modest value for the production of commercial timber.

The Canada Land Inventory classes the area as 70% land having moderate limitations to the growth of commercial forest, and 30% land having moderately severe limitations, with the physical restraints being shallowness of soils and lack of soil moisture (Figure 9). The average sustained yield capability is estimated to be 5.2 cubic meters per hectare per year (75 cubic feet per acre per year).

Timber cleared from exploration sites and access roads during 1977 and 1978 was cut and piled at various locations on the property at the request of the B. C. Forest Service, who have attempted to sell it on our behalf. They have been unsuccessful in finding a buyer, mainly due to the poor quality of the logs, and they have now informed us that the timber will be burned. This timber represents a reasonable cross-section of the trees available on our minesite area, and its unsaleability is an indication of the value of the timber resource.

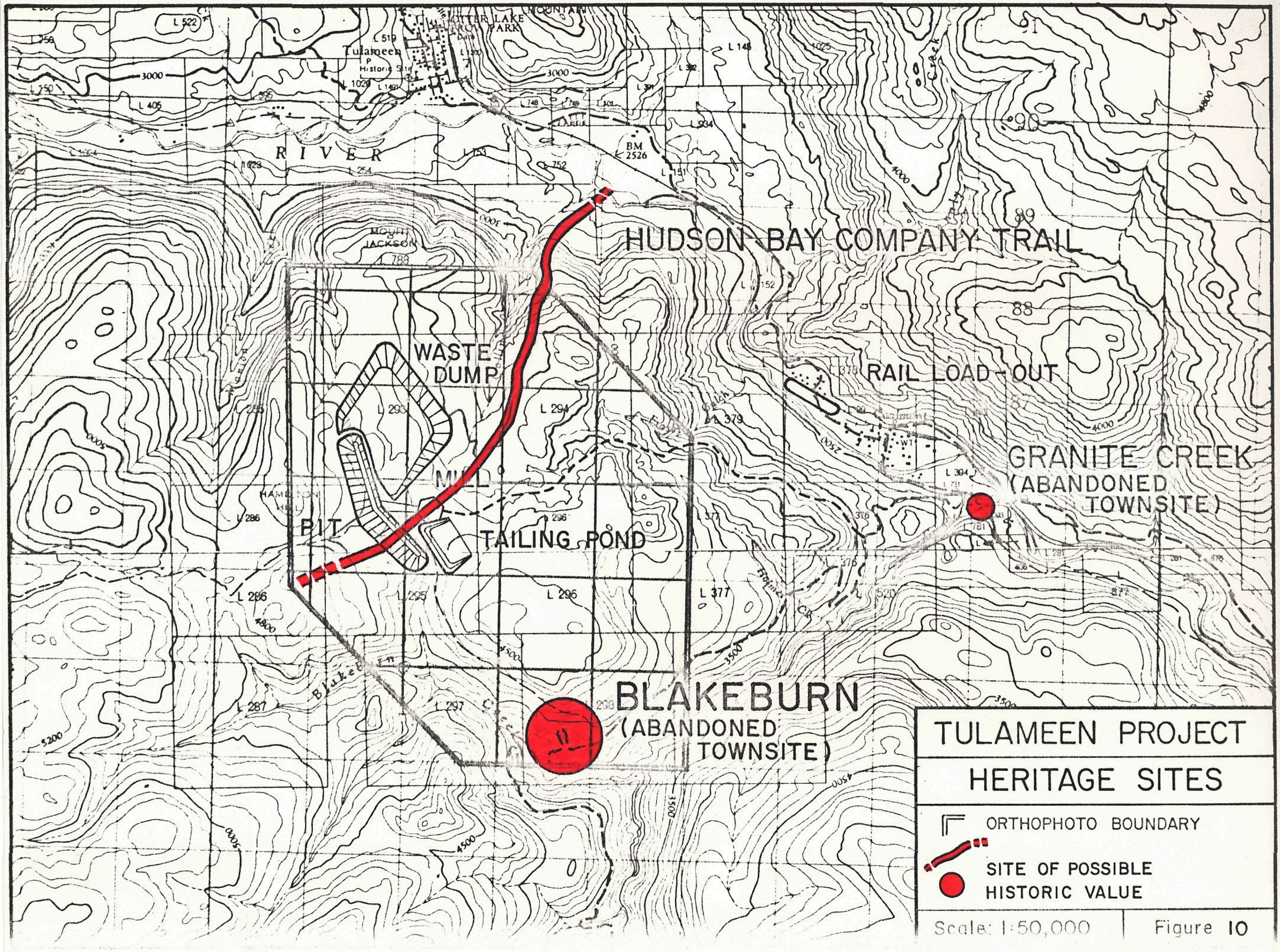
Increment cores, size and species abundances, and other data collected from our vegetation plots are generally consistant with the data on the B. C. Department of Forestry Forest Cover Maps.

2.7 HERITAGE RESOURCES

Three sites of possible historic value are present in the general vicinity of Coalmont and the Tulameen coal property: "the ghost towns" of Granite Creek and Blakeburn, and the Hudson Bay trail.

Granite Creek was founded in 1885 when placer gold was discovered in the vicinity, and for a brief period of time became the third largest

.... 30



TULAMEEN PROJECT

HERITAGE SITES

Scale: 1:50,000

Figure 10

city in B. C. It has been abandoned since 1912 but a few log buildings still remain and the site is maintained by the B. C. Forest Service. The site will not be effected in any significant way by our coal development.

Blakeburn was occupied by employees of Coalmont Collieries during a period from about 1918 to 1940, when the mine ceased operations. Most of the houses and other structures were dismantled during the Second World War by people scavenging lumber, and little now remains of the town other than foundations and outhouses. The site would appear to have little historical value. Our mine plan as now envisioned would not effect the Blakeburn townsite, but future expansion to recover reserves left in the old workings would encroach on the edges of the former townsite.

The Hudson Bay trail was one of the main access routes to the interior during the middle to late 1800's, and the trace of the trail is still visible on the ground at some places. The trail has been flagged by the B. C. Historical Society and is used by hikers during the summer months. The trail crosses through the middle of our proposed mine and mill site, and a portion of it amounting to about one mile will be destroyed when mining commences.

3.0 OUTLINE OF REMAINING WORK

The following paragraphs discuss briefly the main areas of investigation which must be carried out before a Stage I report can be completed.

3.1 WEATHER STATION

This equipment must be set up and operating for a minimum period of one year to produce meaningful data. Three years is much better. We will need technical assistance to choose a site for this equipment and to install it. The equipment requires monthly servicing year round while operating.

3.2 STREAM STAGE RECORDER

The instantaneous discharge measurements of stream flow which I have been making are of limited usefulness. Since the water flow in Blakeburn Creek appears to reach critically low levels during the summer months, we should install an automatic stream stage recorder at the measuring site. This equipment would give us a continuous record of stream flows which can be usefully correlated with weater data, snow depths, and other information. This equipment would require monthly servicing while in operation.

3.3 GROUNDWATER

A groundwater expert should evaluate the presence and movements of groundwater in the area of the minesite. This work should be of sufficient technical quality to be of use in designing the tailings pond and other mine structures.

3.4 SOIL STUDIES

The distribution of soil types and the depths of top soil should be mapped throughout the area of the minesite. This data is necessary

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to determine what areas have a sufficient depth of soil to be worth stockpiling for reclamation purposes.

3.5 WILDLIFE

Appropriate government agencies should be consulted to determine the level of investigation of wildlife which is expected. Detailed and meaningful studies of a biological nature, studies of ungulate populations for example, are extremely time consuming to carry out, and hopefully we won't be expected to get involved in studies of that type.

3.6 AQUATIC RESOURCES

The streams which may be effected by the development must be surveyed as habitat for fish and other aquatic organisms. I may or may not be able to do this depending on the level of detail expected by the government.

3.7 AESTHETIC CONSIDERATIONS

The location of the mine buildings, the waste dumps, and other developments should be evaluated to determine the impact of the mine on the visual environment.

3.8 RECLAMATION

Chemical and physical properties of the waste dump material and of the overburden will have to be analysed to determine their suitability for plant growth. Proposals for enhancing these materials so they will support plant species should be made, and tentative plans for seeding mixtures and rates of application, terracing and recontouring, and other reclamation procedures should be developed. These studies will mainly be theoretical for the Stage I report, but recommendations for specific "on site" test plots should be prepared.

3.9 SOCIO-ECONOMIC IMPACT EVALUATION

This part of the report can be done "in-house" or by consultants. The estimate of cost assuming we contract it to a consulting company is basically a guess and may prove to be either excessive or conservative.

4.0 BUDGET ESTIMATE TO COMPLETION OF STAGE I (based on 1978 costs)

SALARIES AND WAGES:			
Dean	18 months x $2300/mon.	$ 41,400.00	
Drafting	2 months x $1600/mon.	3,200.00	
Special skill people (probably U.B.C. students in particular fields such as soils, groundwater, etc).	4 months x $2000/mon	8,000.00	
		$ 52,600.00	
	Non wage labour costs (15%)	7,890.00	
			$ 60,490.00
CONSULTING FEES:			
(a) Socio-economic impact assessment	Estimate	$ 15,000.00	
(b) Miscellaneous	Estimate	15,000.00	
			30,000.00
ASSAYS AND ANALYSIS:			
Water quality Analysis		$ 2,500.00	
Analysis of soils and dump material		1,000.00	
			3,500.00
EQUIPMENT AND SUPPLIES:			
(a) Miscellaneous field equipment and supplies		$ 5,000.00	
(b) Special equipment (weather station, stream stage recorder for Blakeburn Creek, etc.		10,000.00	
			15,000.00
CARRIED FORWARD			$ 108,990.00

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BALANCE BROUGHT FORWARD			$ 108,990.00
FIELD COSTS:			
(a) Food and accommodation - estimate average of 2 people for 6 months total field work.			
	2 people x 180 days x $30/day	$ 10,800.00	
(b) Truck costs			
	6 months x $1500/mon.	9,000.00	
			19,800.00
ESTIMATED TOTAL COSTS			$ 128,790.00

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5.0 SUMMARY STATEMENT

The environmental work carried out up to now suggests that the Tulameen coal project is unlikely to have any serious negative impacts on the natural environment. Conflicts of land use are minimal and the costs associated with these conflicts will be minor compared to the economic benefits the development will have on the area. There is every indication that the mine areas can be reclaimed to a satisfactorily level of usefulness and that no permanent or long term damage will be inflicted on the local ecology.

On the other hand, the mine is located in an area that is close to population centers, and is fairly intensively used for recreational purposes. As a result, the development will be subjected to intensive public scrutiny, and much care will have to be exercised in dealing with environmental problems. Aesthetic considerations should play a part in designing the positioning of the mine structures, and landscaping and reclamation of all cleared areas should be carried out concurrently with mining wherever possible. If the topography and existing forest cover in the area of the deposits is used to advantage it should be possible to develop and operate the mine and mill with no degradation of the scenic environment.

As has been indicated in Part 3.0 of this report, much work remains to be done before a Stage I impact assessment report can be prepared. The minimum time frame for completing this work is 1½ to 2 years, and during that period very little of my time would be available for other work. The costs I have indicated in the estimated budget represent the best reasonable guess I can make at this time. The budget is based on 1978 costs, and the budget required will have to be escalated to account for inflation, assuming the work does not begin immediately.

Respectfully submitted,

P. M. Dean

November 22, 1978.

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INVENTORY OF PLANTS IDENTIFIED TO OCTOBER, 1978

ON TULAMEEN PROPERTY

ACERACEAE:

Acer glabrum Torr. var. douglasii (Hook) Dippel (douglas maple)

ARALIACEAE:

Oploponax horridum (Smith) Miq. (devil's club)

BERBERIDACEAE:

Berberis aquifolium Pursh (tall oregongrape)

BETULACEAE:

Alnus tenuifolia Nuttall (mountain alder)

Betula occidentalis Hooker (water birch)

BORAGINACEAE:

Cynoglossum officionale L. (common hound's tooth)

Hackelia deflexa (Wahlenb.) Opiz. (nodding stickweed)

CAPRIFOLIACEAE:

Linnaea borealis L. (twin flower)

Lonicera utahensis Wats. (Utah honeysuckle)

Lonicera involucrata (Rich.) Banks (black twinberry)

Sambucus cerulea Raf. (blue elderberry)

Symphoricarpos oreophilus (mountain snowberry)

Viburnum edule (Michx.) Raf. (squashberry)

CARYOPHYLLACEAE:

Arenaria macrophylla Hook (big leaf sandwort)

Cerastium arvense L. (field chickweed)

CELASTRACEAE:

Pachistima myrsinites (Pursh.) Raff. (myrtle boxwood)

COMPOSITAE:

Achillea millefolium L. (yarrow)

Anaphalis margaritacea (L.) B. & H. (pearly-everlasting)

Arnica cordifolia Hook (heart-leaf arnica)

Arnica fulgens Pursh. (orange arnica)

Balsamorhiza sagittata (Pursh) Nutt (arrowleaf balsamroot)

Erigeron philidelphicus L. (fleabane)

Hieracium albiflorum Hook (white-flowered hawkweed)

Matricaria matricarioides (Less.) Porter (pineapple weed)

Taraxacum officionale Weber (common dandelion)

Tragopogon dubius Scop. (yellow solsify)

CORNACEAE:

Cornus canadensis L. (bunch berry)

Cornus stolonifera Michx. var. occidentalis (T. & G.) Hitchc. (red-osier dogwood)

CRASSULACEAE:

Sedum lanceolatum Torr. (lance-leaved stonecrop)

CUPRESSACEAE:

Juniperus commonis L. var. montana Ait. (common juniper)

Juniperus scopulorum Sarg. (western juniper)

Thuja plicata Donn. (red cedar)

ELAEGNACEAE:

Shepherdia canadensis (L.) Nutt (soopolallie)

EQUISETACEAE:

Equisetum sp. (horsetail)

ERICACEAE:

Arctostaphylos uva-ursi (L.) Spreng. (kinnikinnick)

Chimaphila umbellata (Prince's-pine)

Pterospora andromeda Nutt. (pinedrops)

Pyrola uniflora L. (wood nymph)

Pyrola asarifolia Michx. (leafless pyrola)

Pyrola secunda L. (one-sided wintergreen)

Vaccinium scoparium Lieberg (grouseberry)

GROSSULARIACEAE:

Ribes cereum Dougl. (squaw currant)

Ribes inerme Rydb. (whitestem gooseberry)

Ribes lacustre (Pers.) Poir. (swamp currant)

Ribes viscosissimum Pursh (sticky currant)

HYDROPHYLLACEAE:

Hydrophyllum capitatum Dougl. (ballhead waterleaf)

Phacelia hastata Dougl. (silver-leaved phacelia)

LABIATAE:

Prunella vulgaris L. (self-heal)

LILIACEAE:

Clintonia uniflora (Schult) Kunth (clintonia)

Erythronium grandiflorum Pursh var. grandiflorum (avalanche lily)

Lilium columbianum Hanson (tiger lily)

Smilacina racemosa (L.) Desf. (false Solomon's seal)

Streptopus amplexifolius (L.) DC. (twisted-stalk)

Veratrum viride Ait. (false hellebore)

LORANTHACEAE:

Arceuthobium campylopodum Engelm. (dwarf mistletoe)

ONAGRACEAE:

Epilobium angustifolium L. (fireweed)

ORCHIDACEAE:

Goodyera oblongifolia Raf. (rattlesnake plantain)

PINACEAE:

Abies lasiocarpa (Hook.) Nutt. (alpine fir)

Picea engelmanni Parry (engelmann spruce)

Pinus ponderosa Dougl. (ponderosa pine)

Pinus contorta Dougl. (lodgepole pine)

Pseudotsuga menziessii (Mirbel) Franco var. glauca (Beissn.) Franco (interior douglas fir)

POLYGONACEAE:

Eriogonum heracleoides Nutt. (parsnip-flowered eriogonum)

POLYPODIACEAE:

Dryopteris austriaca (Jacq.) Woynar. (wood fern)

Woodsia oregana D. C. Eat. (woodsia)

PORTULACACEAE:

Claytonia lanceolata Pursh. var. *lanceolata*	(spring beauty)
Lewisia columbiana (Howell) Robins.	(columbia lewisia)

RANUNCULACEAE:

Actea rubra (Ait.) Willd.	(baneberry)
Aquilegia formosa Fisch.	(red columbine)
Ranunculus glaberrimus Hook.	(sagebrush buttercup)
Ranunculus occidentalis Nutt.	(western buttercup)

RHAMNACEAE:

Ceanothus velutinus Dougl.	(sticky-laurel)

ROSACEAE:

Amelanchier alnifolia Nutt.	(serviceberry)
Fragaria vesca L.	(woods strawberry)
Fragaria virginiana Duchesne	(blueleaf strawberry)
Geum macrophyllum Willd.	(large leaved avens)
Potentilla arguta Pursch.	(glandular cinquefoil)
Potentilla glandulosa Lindl.	(sticky cinquefoil)
Potentilla gracilis Dougl.	(cinquefoil)
Prunus virginiana L.	(common chokecherry)
Sorbus sp.	(mountain ash)
Spirea betulifolia Pall.	(birch-leaved spirea)
Rosa nutkana Presl	(rose)
Rubus idaeus L.	(red raspberry)
Rubus leucodermis Dougl.	(black raspberry)
Rubus parviflorus Nutt.	(thimbleberry)

SALICACEAE:

Populus tremuloides Michx.	(trembling aspen)
Salix bebbiana Sargent	(Bebb's willow)

SAXAFRAGACEAE:

Saxifraga bronchialis L.	(spotted saxifrage)
Saxifraga punctata L.	(dotted saxifrage)
Tiarella trifoliata L.	(coolwort)

SCROPHULARIACEAE:

Castilleja miniata Dougl.	(scarlet paintbrush)
Collinsia sparsiflora Fisch. & Mey	(blue-eyed Mary)
Linaria vulgaris Hill	(butter and eggs)
Mimulus guttatus DC.	(yellow monkey-flower)
Pedicularis bracteosa Benth.	(bracted lousewort)
Verbascum thapsus L.	(great mullein)
Veronica americana Schwein.	(brooklime)

UMBELLIFERAE:

Angelica arguta Nutt.	(sharptooth angelica)
Heracleum lanatum Michx.	(cow-parsnip)
Lomatium sp.	(lomatium)
Sanicula graveolens Poepp.	(Sierra sanicle)

URTICACEAE:

Urtica dioica L.	(stinging nettle)

VIOLACEAE:

Viola glabella Nutt.	(stream violet)

SUBALPINE FOREST COMMUNITY

TREE STRATUM:		
	climax forest:	Abies lasiocarpa and Picea engelmanni
	subclimax:	Pinus contorta
		Pseudotsuga menziessii
TALL SHRUB STRATUM:	often absent or sparse	
	abundant:	Alnus tenuifolia
		Lonicera utahensis
	common:	Salix bebbiana
		Sorbus sp.
		Amelanchier alnufolia
		Spirea betulifolia
	less common:	Ribes viscossissimum
		Ribes lacustre
		Viburnum edule
		Cornus stolonifera
		Rubus parviflorus
		Shepherdia canadensis
		Vaccinium membraraceum
		Juniperus communis
		Sambucus cerulea *
LOW SHRUB STRATUM:		
	abundant:	Pachistima myrsinites
		Vaccinium scoparium
	common:	Linnaea borealis
	less common:	Berberis aquifolium
		Rosa nutkana
		Symphoricarpos oreophilus

HERBACEOUS PLANTS:

abundant:	Pyrola secunda
	Arnica cordifolia
	Goodyera oblongifolia
	Lupinus arcticus
common:	Clintonia uniflora
	Ozmorhiza chilensis
	Actea rubra
	Aquilegia formosa
	Lilium columbianum
	Pedicularis bracteosa
	Pedicularis racemosa
	Pyrola asarifolia
less common:	Pterospora andromeda
	Chimaphila umbellata
	Hieracium albiflorum
	Smilacina racemosa
	Cornus canadensis
	Tiarella trifoliata
	Fragaria vesca
	Fragaria virginiana
	Dryopteris austriaca *

* Species which are present in this community but which did not occur in the study plots.

MONTANE FOREST COMMUNITY

TREE STRATUM:

climax forest:
- Pseudotsuga menziessii
- Pinus ponderosa

subclimax:
- Pinus contorta
- Populus tremuloides

TALL SHRUB STRATUM:

abundant:
- Juniperus commonis
- Amelanchier alnifolia
- Ceanothus velutinus

less common:
- Shepherdia canadensis
- Rubus idaeus
- Ribes cereum

LOW SHRUB STRATUM:

abundant:
- Arctostaphylos uva-ursi
- Pachistima myrsinites

common:
- Spirea betulifolia
- Lonicera utahensis
- Berberis aquifolium

HERBACEOUS PLANTS

abundant:
- "grass"

less common:
- Achillea millefolium
- Hieracium gracile
- Hieracium albiflorum
- Taraxacum officionale
- Cirsium sp.
- Ranunculus occidentalis
- Fragaria vesca
- Fragaria virginiana
- Tragopogon dubius
- Lupinus arcticus
- Arnica cordifolia
- Balsamorhiza sagittata *
- Erigeron philidelphicus *
- Castilleja miniata *

DECIDUOUS WOODLAND COMMUNITY

TREE STRATUM:

Salix bebbiana
Acer glabrum douglassii
Populus tremuloides
Alnus tenuifolia
Betula occidentalis

TALL SHRUB STRATUM:

Cornus stolonifera
Amelanchier alnifolia
Lonicera involucrata
Sambucus cerulea
Prunus virginiana

LOW SHRUB STRATUM:

Symphoricarpos oreophilus
Ribes lacustre
Ribes inerme
Ribes viscosissimum
Rubus leucodermis
Rosa nutkana
Shepherdia canadensis
Ceanothus velutinus

HERBACEOUS PLANTS:

"grass"
Fragaria vesca
Fragaria virginiana
Achillea millefolium
Taraxacum officionale
Aquilegia formosa
Urtica dioica
Arenaria macrophylla
Hackelia deflexa *
Cynoglossum officionale *
Potentilla glandulosa *
Potentilla gracilus *
Viola glabella
Anaphalis margaritacea *
Arnica fulgens *
Erigeron philidelphicus *
Matricaria matricarioides *
Hydrophyllum capitatum *
Prunella vulgaris *
Eriogonum heracleoides *
Linaria vulgaris *
Collinsia sparsiflora *
Verbascum thapsus *
Sanicula graveolens *
Tragopogon dubius
Phacelia hastata *
Epilobium angustifolium *
Claytonia lanceolata *
Ranunculus occidentalis
Ranunculus glaberrimus *
Lomatium sp. *

* Species which are present in this community
but which did not occur in the study plots.

HYDROPHYTIC COMMUNITIES

TREE STRATUM:

- Picea engelmanni
- Pseudotsuga menziessii
- Thuja plicata

TALL SHRUB STRATUM:

- Alnus tenuifolia
- Betula occidentalis *
- Cornus stolonifera
- Lonicera involucrata *

LOW SHRUB STRATUM:

- Oploponax horridum *
- Viburnum edule
- Ribes lacustre
- Rubus parviflorus

HERBACEOUS PLANTS:

- Cerastium arvense *
- Equisetum sp. *
- Prunella vulgaris *
- Streptopus amplexifolius *
- Fragaria vesca
- Geum macrophyllum *
- Potentilla arguta *
- Saxifraga bronchialis *
- Saxifraga punctata *
- Tiarella trifoliata
- Smilacina racemosa
- Mimulus guttatus *
- Veronica americana *
- Angelica arguta *
- Heracleum lanatum *
- Viola glabella
- Veratrum viride *
- Dryopteris austriaca *

* Species which are present in this community but which did not occur in the study plots.

XEROPHYTIC COMMUNITIES: EXPOSED ROCKY BLUFFS, TALUS SLOPES, ETC.

TREE STRATUM:

Pinus ponderosa
Pseudotsuga menziessii
Juniperus scopulorum
Populus tremuloides

TALL SHRUB STRATUM:

Juniperus commonis
Amelanchier alnifolia
Shepherdia canadensis
Ceanothus velutinus
Rosa nutkana
Ribes cereum
Rubus idaeus
Prunus virginiana *

LOW SHRUB STRATUM:

Arctostaphylos uva-ursi
Pachistima myrsinites
Berberis aquilinium

HERBACEOUS PLANTS:

"grass"
Woodsia oregana
Sedum lanceolatum *
Lewisia columbiana *

* Species which are present in this community but which did not occur in the study plots.