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WATER AND RELATED RESOURCES IN THE ALSEK RIVER BASIN

PREPARED BY:
TRISHA D. MACKAY

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Inland Waters
Pacific and Yukon Region
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ENVIRONMENT CANADA
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ABSTRACT

The Alsek River drains approximately 27 920 square kilometers of southwestern Yukon and northwestern British Columbia. Originating at the confluence of the Kaskawulsh and the Dezadeash rivers in the Yukon, the Alsek river flows south into the extreme northwestern tip of British Columbia. Here the river turns to the southwest, crosses over the international boundary into Alaska where, over 240 kilometers later, it empties into the Gulf of Alaska.

The Basin's topography is characterized by plateaux in the north and a world class mountain system in the south bordering the coast. The two domains are separated by a wide trench lying northwest to southeast across the Basin. Climatic conditions vary across the Basin as a mild coastal regime dominates the south and a more extreme continental regime influences the north. Such a climate combined with the Basin's high latitude make agricultural activity non-feasible.

About one third of the Alsek Basin lies within the Kluane National Park boundary and is exempt from most development. The rest of the Basin remains relatively undeveloped with the exception of the community of Haines Junction.

The study area supports a variety of bird and wildlife which are protected within the Parks boundaries. The park is also a major attraction for outdoor recreation seekers. Abundant fish and game populations outside the Park appeals to anglers and hunters from around the world. Mining, the initial catalyst to economic activity in the Basin, has been somewhat depressed in recent years; it may soon be gaining ground pending future decisions on a major mining project. Due to poor access to timber stands in the southern Basin, and relatively low quality timber supply to the north, forestry is virtually non-existent with the exception of the native fuelwood gathering and raw log production for cabin construction.

Though there is a strong native presence in the Basin, Indian Reserves are non-existant. Instead the natives occupy "land set aside for native use" until the Council for Yukon Indians (CYI), the Yukon Territorial Government and the federal Department of Indian Affairs and Northern Development(DIAND) decide upon current land claims.

Areas of federal water concern for Environment Canada may lie within the proposed Windy Craggy copper mine project. Should Geddes Resources gain final approval from the Government of British Columbia to construct a proposed roadway into the minesite, water monitoring should be such that it detects changes in water quality conditions both directly downstream from the minesite and at the international boundary on the Alsek River.

RESUME

La rivière Alsek draine une superfécie approximative de 27 920 km2 de la région sud-ouest du Yukon et du nord-ouest de la Colombie-Britannique. Elle débute au confluent des rivières Kaskawalsh et Dezadeash au Yukon et se dirige au sud en traversant l'extrême région nord-ouest de la Colombie-Britannique. De là, la rivière coule en direction sud-ouest vers l'Alaska où elle coule pendant 240 km avant de se jeter dans le golfe d'Alaska.

La topographie du bassin se distingue par des plateaux au nord et par une chaîne de montagnes longeant la côte maritime au sud. Tous deux sont séparés par une large fosse traversant le Bassin du nord-ouest au sud-ouest. L'on retrouve un climat océanique au sud du bassin à un climat continental au nord. Ce Bassin n'est pas propice pour le développement agricole à cause de ses variances dans le climat et les hautes altitudes.

Le parc national Kluane occupe à peu près le tiers du bassin Alsek où la plupart des développements ne sont pas permis. Le reste du bassin est relativement sous-développé sauf pour la présence de la communauté de Haines Junction.

Il y a une variété d'oiseaux et de faune qui habite la région et ceux en à l'intérieur du parc Kluane sont protègés. Le Parc est aussi une attraction majeure pour les touristes. La région hors du parcoù habite des populations abondantes de poissons et de gibiers attire beaucoup de pêcheurs sportifs et de chasseurs de tout les coins du monde. L'exploitation minière, qui fut la première, avait stimulée jadis l'activité économique du Bassin mais durant les années récentes elle a éprouvée une baisse d'activitée. Cependant elle pourrait y redevenir si l'on procéde avec le développement d'un projet minier d'envergure majeure. D'autre part, la sylviculture est quasi non-existante dû à l'inaccessibilité des forets au sud du bassin et à

la pauvre qualité du bois dans le nord. Elle est exploitée seulement par les autochtones qui l'utilisent pour la construction de cabines et comme bois de chauffage.

Il y a beaucoup d'autochtone qui demeurent dans le bassin mais il n'y a pas de réserves indiennes. Toutefois, les autochtones occupent "des terres qui ont été mises de côté pour leur utilisation" jusqu'à ce que le Conseil des autochtones du Yukon, le governement territorial du Yukon et le département fédéral des affaires indiennes et du nord se proclament sur les droits des terres.

Les intérêts d'Environnement Canada pour ce bassin vont sans doute être au sujet du projet proposé de la mine de cuivre Windy Craggy. Si ce projet proposé par Geddes Resources pour la construction d'un chemin accessible à la mine est approuvé par le gouvernement de la Colombie-Britannique, le monitorage d'eau devrait être telle qu'on puisse détecter des changements de qualité d'eau de la rivière Alsek directement en aval de la mine et à la frontière internationale.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

1.1 STUDY AREA

The study area for this report is the Alsek River Basin which drains a portion of southwestern Yukon and the northwestern extremity (the "Haines Triangle") of British Columbia (Figure 1). The study area includes the sub-basins of the Aishihik, Dezadeash, Kaskawulsh and Tatshenshini Rivers. From its origin at the Kaskawulsh/Dezadeash confluence in the Shakwak Trench, the Alsek River flows predominantly south for 148 kilometers before being joined by its largest tributary, the Tatshenshini River in British Columbia. At this point, the Alsek River turns southwest, crosses the international boundary and flows another 85 kilometers before draining into the Gulf of Alaska. The Alsek River travels over 243 kilometers from its source to its mouth (Canada 1977a).

The Alsek River is fed by the massive glaciers of the St. Elias Mountains, the world's second highest coastal mountain range. Much of the Basin is a remote wilderness area and undisturbed natural habitat for both coastal and arctic plant and animal species.

The Basin presently supports three small communities, the largest of which is Haines Junction with a population of less than 600. The dominant feature of the Alsek Basin is Kluane National Park which incorporates about one third of the Basin's total area.

1.2 OBJECTIVES AND OUTLINE

The objectives of this report are to summarize the physical and biological characteristics of the Alsek River Basin, describe existing and potential resource uses and suggest areas that may require the attention of Inland Waters Directorate (IWD), Environment Canada.

Chapter two of the report provides an overview of the Basin's water and related resources including physiography, climate, vegetation, wildlife and fisheries.

Chapter three discusses the economic development of the Basin with particular emphasis on the importance of the National Park Reserve within the Basin. An historical perspective and discussion of the Basin's social environment is also included.

The final chapter provides a summary and concluding remarks related to potential areas of concern or involvement for IWD.

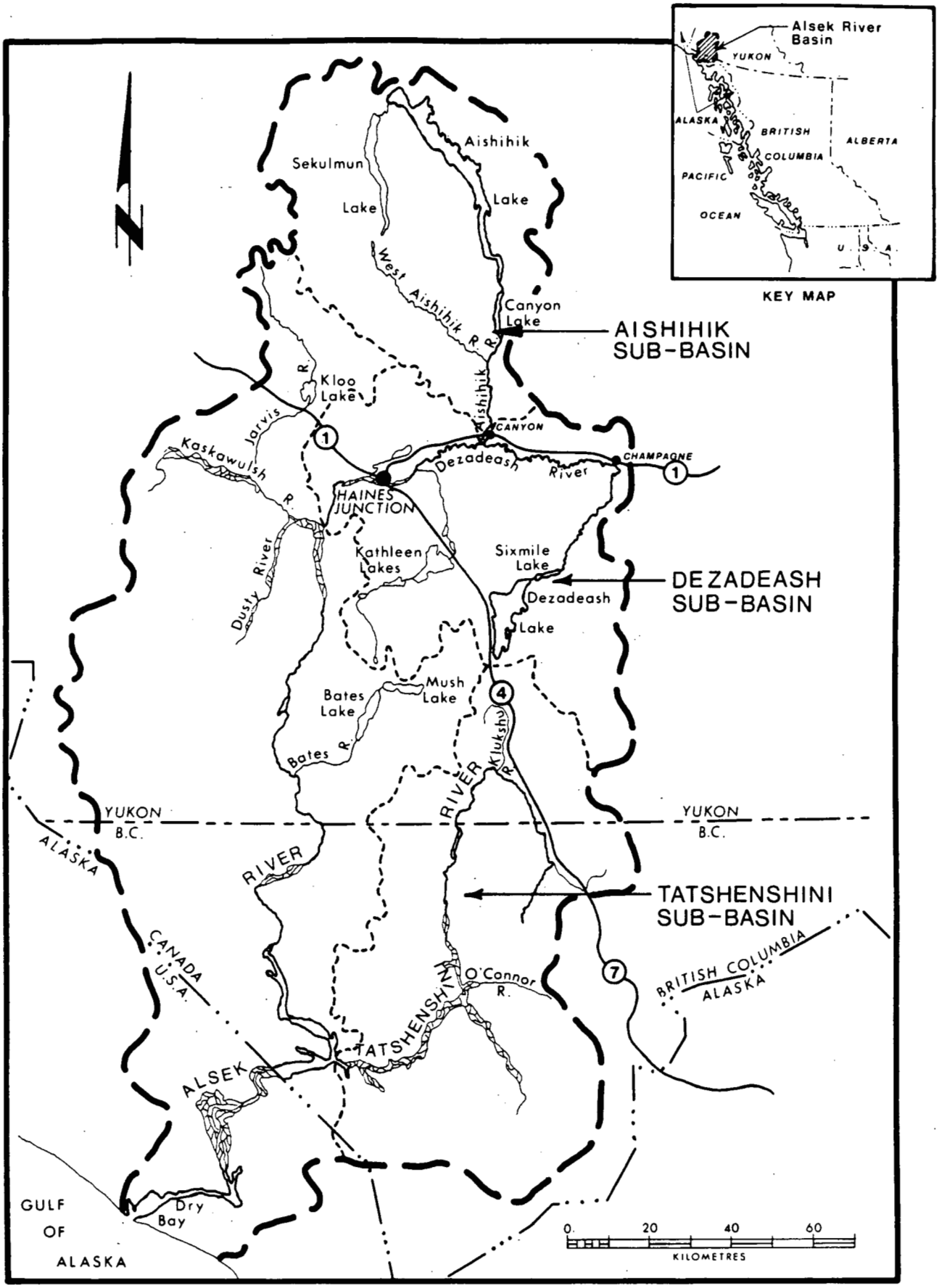

Figure 1 The Alsek River Basin.

2. WATER AND RELATED RESOURCES

2.1 PHYSIOGRAPHY

2.1.1 Landforms and Geology

The Alsek River Basin is comprised of a variety of physiographic units, the most dominant being the St. Elias Mountains. This mountain range is claimed to be the largest coastal range in the world and the most tectonically active region in Canada. Other major landforms are the Coast Mountains, Kluane Plateau, Shakwak Trench, Takhini Valley, Duke Depression and Dezadeash and Ruby Mountain ranges. Figure 2 locates these landforms within the study area.

The St. Elias mountains make-up close to half of the western-southwestern portion of the Basin and are characterized by high, rugged mountains and extensive icefields. Aside from a few major valley drainages, nearly all of this mountain range lies over 1 500 meters above sea level. Within the study area, the St. Elias Mountains are divided into a number of subunits: Kluane, Alsek, Icefield and Fairweather Ranges and the Duke Depression.

The Kluane Ranges, unique in their ruggedness, are composed primarily of metamorphic and volcanic rock with some intrusive rock in the form of granite and granodiorite. Further south, the ranges become largely volcanic with some quartz diorite intrusive bodies. The ranges form a narrow ridge bounding the St. Elias Mountains on the northeast and incorporate the Auriol Range in the Southeast corner of the Dezadeash Kaskawulsh confluence.

The Alsek Ranges, an eastern subdivision of the St. Elias Mountains, lie south of the Duke Depression, east of the Alsek River and primarily west of the Tatshenshini River though they extend beyond the Tatshenshini in its lower reaches. These ranges are comprised primarily of intrusive granodiorite, granite and quartz bedrock. Two smaller mountain groups within the Alsek Ranges are the Squaw Range lying within the bend of the upper Tatshenshini and the Noisy Range at the Northeastern corner of the Alsek/Tatshenshini confluence which are more precipitous and reach elevations over 2 700 meters above sea level. Valley glaciers are common

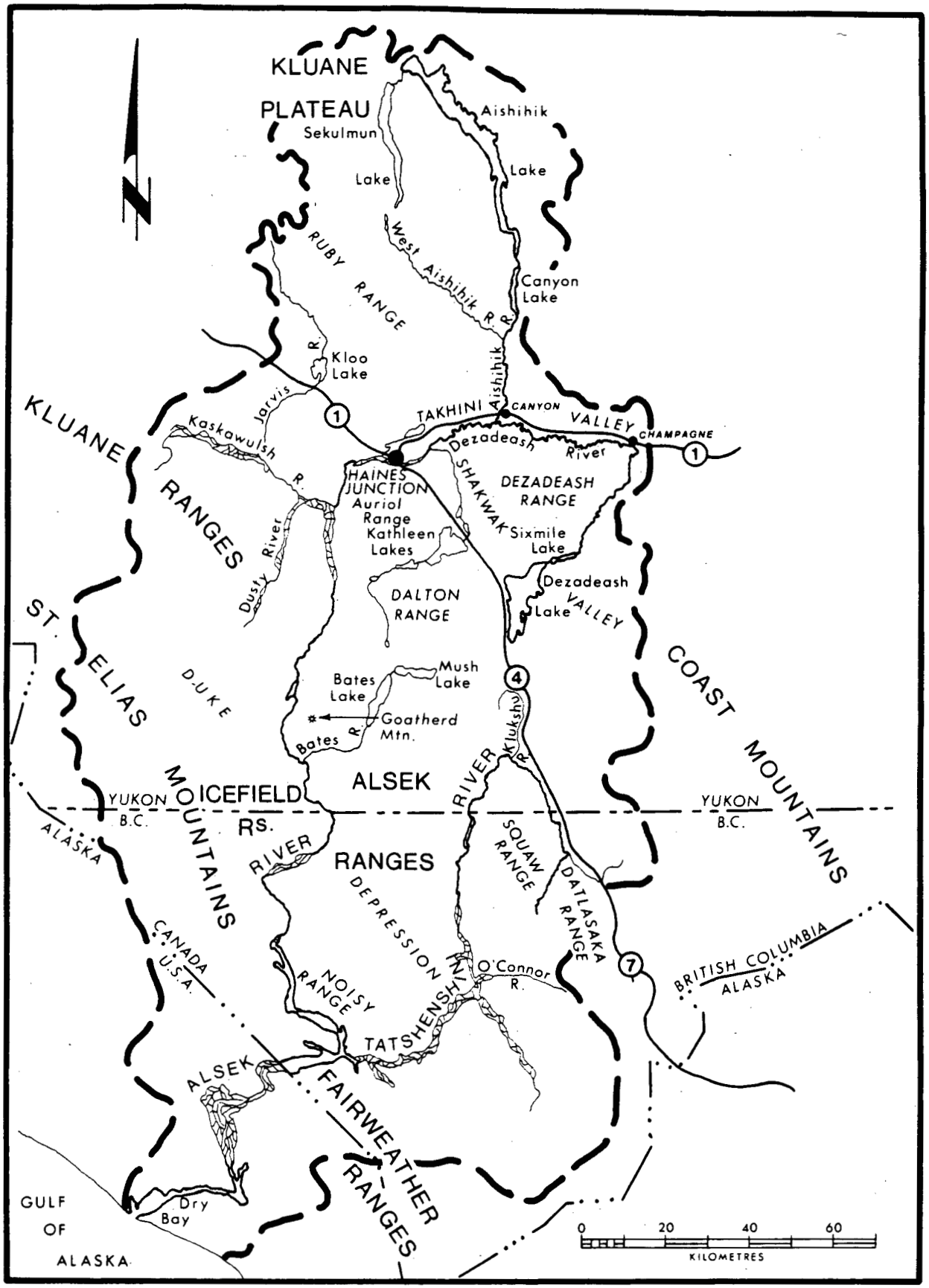

Figure 2 Physiographic Regions.

amongst the Alsek Ranges bordering the lower Tatshenshini and Alsek Rivers.

The Icefield Ranges are the largest central unit of the St. Elias Mountains found within the study area. These ranges border the Alsek River to the west and continue west beyond the Basin's boundary. They are composed primarily of metamorphic and volcanic rock with the occasional occurence of large, intrusive granite and granodiorite rock bodies. South of the Lowell Glacier, the area is predominantly snow and ice yet further north, the snow and ice become increasingly less perennial.

Lastly, the Fairweather Ranges, a southeastern unit of the St. Elias Mountains, are located in the extreme south of the Basin just below the mouth of the Tatshenshini River, along the British Columbia/Alaska border. A narrow valley occupied by the Alsek River separates the Fairweather Ranges from the Icefield Ranges. Consisting mainly of Poleozoiz Rock, such as limestone, sedimentary and volcanic rock, with frequent granite intrusions, this mountain range forms the Pacific and North American tectonic plates boundary and is therefore displaced laterally several centimeters every year (Jordan 1986).

The Duke Depression, an expression of the Denali Fault, follows the western portion of the Kaskawulsh Valley and the west side of the Alsek River Valley widening east of the Alsek. The Depression extends south to the Bates River Valley then, north to the bend in the Tatshenshini River where it crosses the Yukon/British Columbia border. The Depression is a complex of valleys and plateaux separating the Kluane and Icefield ranges and though very prominant northwest of the Basin, its existence within the Basin is less obvious and doubted by some geologists.

The Coast Mountains are separated from the St. Elias Mountains by a line formed by the Shakwak Valley, Dezadeash Lake, Klukshu River and the Tatshenshini Headwaters. The Shakwak Valley, also a physiographic expression of the Denali Fault system, runs diagonally northwest to southeast through the Basin. With a mean elevation of 760 meters above sea level, the valley eventually forms the Lynn Canal near Haines, Alaska. Many of the Basin's lakes and rivers are located in or near this broad valley. Such waterbodies include: Jarvis River and Kloo Lake, Kathleen Lakes, Dezadeash Lake, Kathleen River, Klukshu River and the lower Dezadeash

River. As well, both the Haines and Alaska highways make use of this wide, trench-shaped valley.

The Kluane Plateau covers the rest of the Basin northeast of the Shakwak Valley and includes such landforms as the Takhini Valley and the Dezadeash and Ruby Ranges.

The Takhini Valley forks northeastward from the Shakwak Valley at Haines Junction and separates the Ruby and Dezadeash Ranges. This valley contains both glacially scoured bedrock and thick, unconsolidated deposits and is occupied by several streams and rivers including the upper Dezadeash River.

The Dezadeash Range is a relatively small mountain range bounded by the Dezadeash River on two sides and by the Kathleen River on a third. The Ruby Range, occupies the land in the northwest corner of the Basin, west of Aishihik Lake. While the Dezadeash Range is composed of Mesozoic sedimentary rocks, the Ruby Range is a large batholith consisting primarily of granodiorite, quartz diorite and granite.

Both mountain ranges exhibit rolling to undulating hills over 900 meters above sea level with the highest peak reaching 2 200 meters above sea level in the Ruby Range.

The northwestern tip of the Coast Mountains emerges within the Alsek drainage south of the Duke Depression boundary in the Takhini River Watershed. Part of the Coast Plutonic Complex, these mountains consist of granitic rocks such as schist, greiss, quartzite and slate. Characterized by rugged, mountainous topography, the Coast Mountains reach a maximum height of 2 200 meters above sea level before clearing the Basin's boundaries and heading south down the British Columbian coastline.

Information for this section was taken primarily from Jordan 1986 and Canada 1977.

2.1.2 Glaciation and Surficial Deposits

The St. Elias Mountains and valleys to the northeast underwent repeated glaciation during the Pleistocene Epoch (1,500,000 to 6,000 years before present). During the latest major glaciation, about 500 years ago to the present (known as the "Kluane Glaciation"), ice flowed northwards into the Shakwak Valley from the Alsek and Tatshenshini rivers and their

tributaries. Maximum depths of this ice sheet have been estimated as being 1 680m near Dalton Post and 1 800m in the Alsek River Valley (Jordan 1986).

During deglaciation, glaciofluvial deposits, mostly gravels were formed in many valleys and large, meltwater channels were created by diverted runoff. As well, large, ice-dammed lakes often occured such as Glacial Lake Champagne which filled the upper Dezadeash and Takhinni River Valleys. Thick, glaciolacustrine deposits remain in these places today.

The most recent period of glacial advance took place about 450 years ago as the terminal moraines of several glaciers within the Basin indicate. Large surges of the Lowell Glacier caused it to run up against the west face of Goatherd Mountain creating a lake which extended more than 60 miles up the Alsek, Kaskawulsh and Dezadeash River Valleys. The largest Neoglacial lake in North America, "Lake Alsek" was dammed repeatedly behind the Lowell Glacier, most recently between about 1848 and 1891 (Figure 3). When the dam failed, outburst floods of immense size resulted (up to 4 million c.f.s.), and formed spectacular fluvial landforms in the Alsek River Valley downstream(Canada 1977a). Such landforms include scour marks hundreds of feet above the current water level, giant ripple marks and flood terraces along the lower Alsek near the Tatshenshini confluence as well as sparse, young vegetation and recently deposited gravels at the Alsek's mouth in Dry Bay, Alaska.

Today, though most glaciers in the study area are retreating, two huge valley glaciers, the Lowell and the Alsek, are actively calving into the Alsek, another, the Tweedsmuir, reaches to the the water's edge, and the Fisher, Vern Ritchie, Battle, Melbern, Reynolds and Novatak come close to the river.

2.2 CLIMATE

The climate of the Alsek River Basin is influenced by two separate climate regimes: the southwestern half is under the influence of a maritime climate while the remainder of the Basin is heavily influenced by a continental climate regime.

Though no climate stations exist within the southwestern portion of the Basin, for comparative purposes, climatic data was used from the

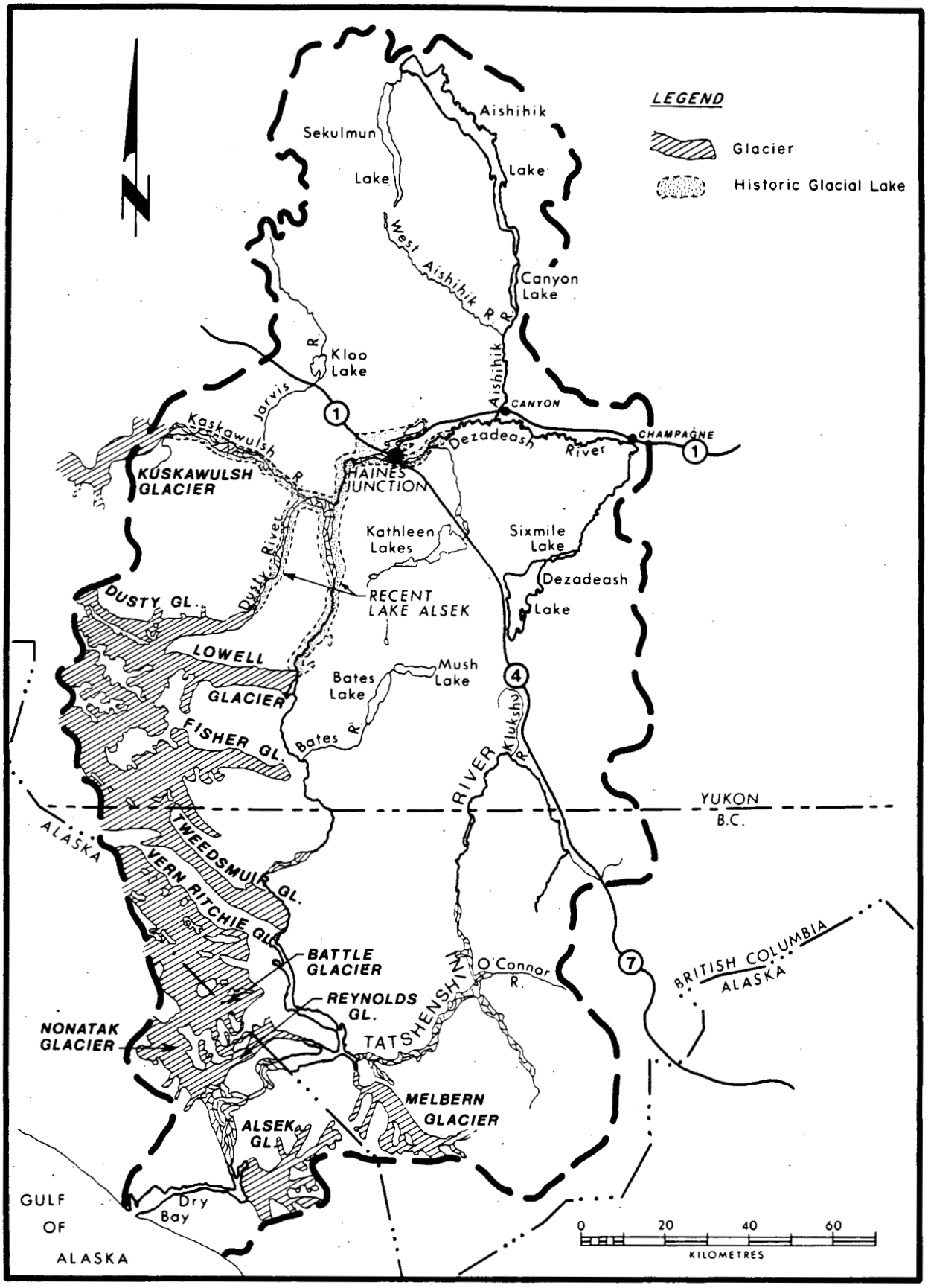

Figure 3 Glaciers and Glacial Lake Alsek.

nearest station in Yakutat, Alaska located approximately 80 km northwest of the Alsek River mouth.

Mild winters with a January mean of -3°C and cool summers with a July mean of 12°C are a reflection of oceanic influences as well as cooling by surrounding glaciers and icefields. As much as 3 364mm of orographic precipitation, much of it in the form of snow, may fall annually on the southwestern slopes of the St. Elias and Coast Mountain Ranges (Senyk 1977). Such large volumes of precipitation maintains the numerous glaciers and icefields in the area. In comparison, Haines Junction, further inland receives only 292.5mm of precipitation annually (Senyk 1977). Towards the coast fog occurs frequently and cloud cover increases with stratus clouds being most common.

The climate of the northeastern half of the Basin falls under the influence of a continental arctic air mass originating over the cold, dry environment of the Mackenzie Mountains in western Northwest Territories. Under the influence of this climatic regime, the northeastern Alsek Basin experiences very long, cold winters usually with clear skies. The January mean temperature for the Aishihik Lake area is -23.6°C (Canada 1977b). The summers are warm but short with a July mean temperature of just over 12.0°C (Canada 1977b). Continental climates such as this tend to experience extremes in temperatures. Temperatures in the Aishihik Lake area have been recorded as high as 30.6°C and as low as -56.7°C (Canada 1977b).

Haines Junction, being somewhat distant from any major water bodies, best exemplifies this large annual variation in temperature. On average, the community experiences sixteen warm spells (distinguished by the daily maximum temperature being within 5°C of the average extreme temperature) of three or more days annually. As well, an average of fifteen cold spells with a mean length of eight days occurs throughout the winter months (Canada 1977b).

Precipitation in the Northeastern half of the Basin is sparse due to both the dryness of the continental air mass and a rainshadow effect created by the high peaks of the St. Elias and Coast Mountains. On average, about 250mm of precipitation can be expected in a year with most of it occuring in July. Winter snow depths are usually small but vary greatly due to drifting. Relative humidity in the summer months is in the

low 60's and there is little evidence of cooling by glaciers. Clouds are not common and they tend to be high clouds when they do appear with the presence of convective clouds after mid-day.

In addition to maritime and continental air masses, the climate of the Alsek Basin is also influenced by its latitude and altitude. Due to the Basins' latitude (approximately 59° 11' to 61° 42') it receives as much as nineteen hours of sunlight daily at the time of the summer solstice in June. During the winter solstice the study area receives only a few hours of sunlight per day (Canada 1977b).

The altitude of the Alsek Basin, aside from creating a rainshadow over much of the northeastern portion, also produces a chinook effect during the winter. This occurs when air descending down the leeward slopes of the St. Elias/Coast Mountain peaks, becomes warmed and dries adiabatically thus producing the warm winds of a chinook.

Other topographical features also have an effect on the Basin's climate. Different surfaces such as forested valleys, alpine, and icefields produce differences in wind resistance, temperature and precipitation. Forested valleys, besides channeling winds, generally experience an average temperature in the warmest month exceeding 10°C. The alpine climate, however, is more exposed to winds and therefore has an average temperature in the warmest month being below 10°C but above 0°C, and icefield climate has all its average monthly temperatures below 0°C (Canada 1977b). Data for five representative climate stations are provided in Appendix 1; stations and climatic boundaries are located on Figure 4.

2.3 WATER

2.3.1 Hydrology

The Alsek River Basin cover about 27 920 sq. km, 17 737 sq. km of which lie in the Yukon, 7 907 sq. km in northwest British Columbia and the remaining 2 277 sq. km in the State of Alaska. The Alsek River is about 243 km in length (Canada 1977a). From its origin at the confluence of the Kaskawulsh and Dezadeash rivers, the Alsek river drops over 585 meters creating an average gradient of 2.4 meters per kilometer (Canada 1977a).

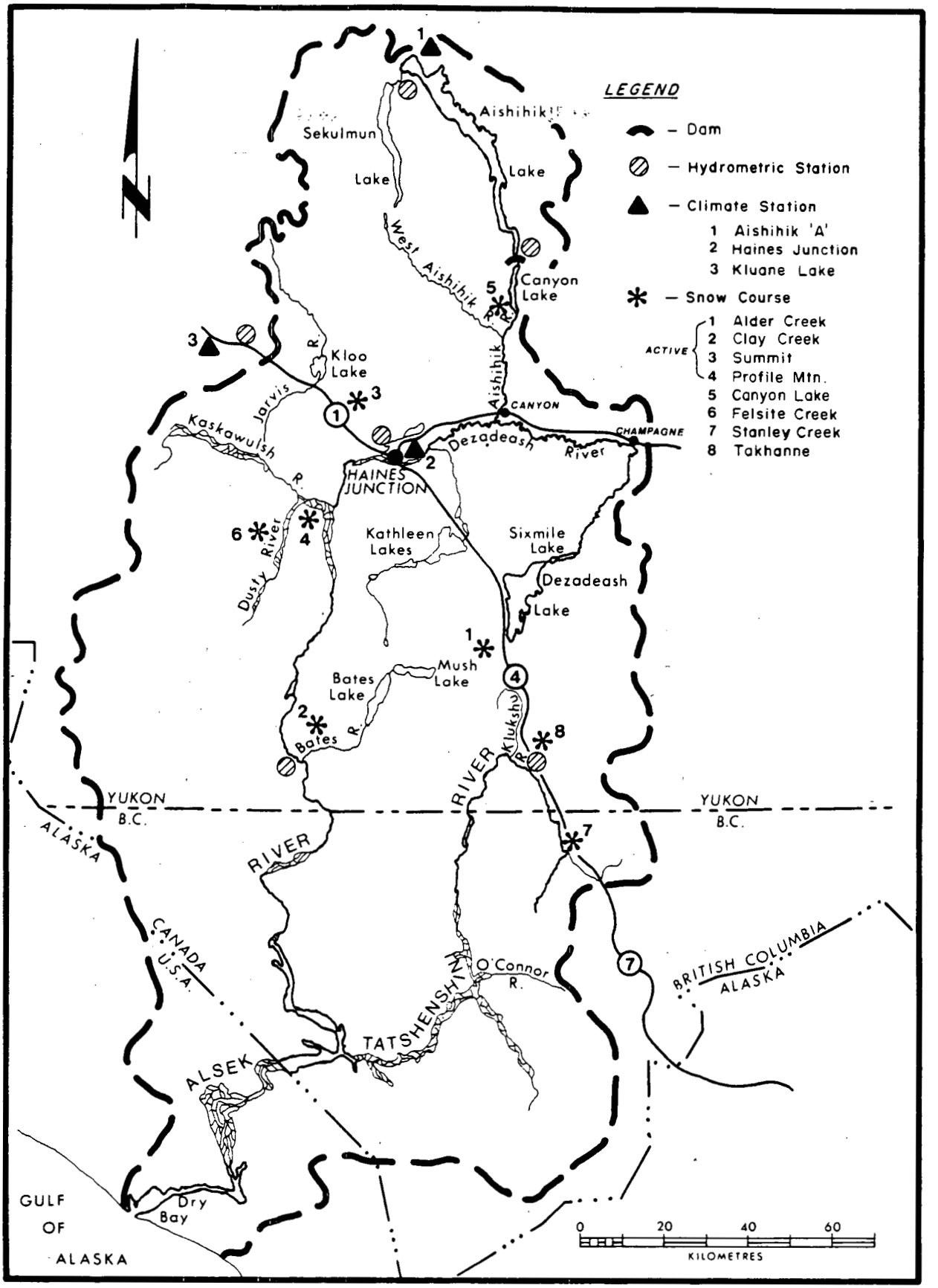

Figure 4 Climate, Hydrometric and Snow Survey Stations and Dams.

Maximum gradient, through Turnback Canyon (at the toe of the Tweedsmuir Glacier), is not known.

The Alsek Basin consists of four sub-basins: Aishihik, Dezadeash, Tatshenshini and the Kaskawulsh/Alsek. The Aishihik River Basin covers approximately 4 137 sq. km of the Southern Kluane Plateau. The mainstem Aishihik River drains the Sekulmun, Aishihik and Canyon lakes while the west Aishihik River drains the Ruby Mountain Ranges. The two rivers converge and then flow south 25 km to join the Dezadeash River.

In 1975, the Aishihik River Power Project was completed by Northern Canadian Power Commission (NCPC). The project is now run by the Yukon Electric Corporation which took over operations in 1979. The project consists of a small dam at the outflow of Aishihik Lake and a powerhouse situated on Canyon Lake (see Figure 4 for dam location). The power generated from this project supplies the small community of Haines Junction with one to two percent of the power, the Faro lead/zinc mine with up to 35 percent and the city of Whitehorse with the remaining 63 percent of the total power generated. The Aishihik River represents the only regulated water flow in the Alsek Basin.

The Dezadeash River Basin drains an area of about 4 756 sq. km, most of which lies within the Shakwak Trench. The river begins at the outlet of Sixmile Lake in the Dezadeash Mountain Range. The Dezadeash flows north a short distance then turns and flows slowly westward meandering along the wide valley floor for about 85 km before joining the Kuskawulsh River. Along the way, the river is fed from the north by the Aishihik River and further along from the south by the Kathleen River which drains the Kathleen Lakes and the adjacent Auriol Mountains.

The Kaskawulsh and Alsek sub-basin covers an area of approximately 12 737 sq. km. Beginning at the tip of the Kaskawulsh Glacier, the Kaskawulsh River flows north then turns sharply to the southeast and flows for about 45 km before joining the Dezadeash River. The Jarvis River, draining the northwestern corner of the Basin, flows south and joins the Kaskawulsh River. The Dusty River drains the Dusty Glacier and joins the Kaskawulsh from the south just prior to the Kaskawulsh/Dezadeash confluence.

From this confluence emerges the Alsek river which flows

predominantly south until converging with its major tributary, the Tatshenshini River. At this point, the Alsek turns to head southwest to cross the international border and drain into the Alaskan Gulf. Throughout its length, the Alsek River is surrounded by numerous receding glaciers some of which are actively calving right into the river. In addition, numerous sediment laden streams flow into the Alsek along its route. These include the Bates River which enters the Alsek from the northeast draining the waters of Lakes Mush and Bates in the upper Alsek ranges and of course the Tatshenshini River which acts to nearly double the Alseks volume when the two rivers converge southwest of the Noisy Range. The Alsek drains the eastern portion of the massive St. Elias Mountain complex.

The Tatshenshini River sub-basin covers an area of approximately 6 290 sq. kms. Its headwaters are located amongst the Squaw Range and the Coast Mountain complex. Many large side streams contribute to the volume of the Tatshenshini River such as the Blanchard, Takhanne, Klukshu, Sediments, O'Connor and Ninety-Eighter to name a few. The Tatshenshini River drains primarily the lower Alsek ranges and likely the western fringe of the Coastal Mountain complex.

Water Resources Branch of Inland Waters Directorate, an agency of Environment Canada, operates eight hydrometric stations in the Basin; data for these stations are shown in Table 1 and their locations are identified in Figure 4. Analysis of discharge data indicates seasonal flow patterns depicting the glacial regime of the Basin. The Kaskawulsh, Alsek and Tatshenshini rivers are all glacially fed and, therefore, generally exhibit peak flows in midsummer. Strictly snowmelt drainages such as the Aishihik and Dezadeash rivers exhibit flow peaks in the late spring and early summer months. Runoff estimates for the Tatshenshini and Alsek Rivers are provided in Table 2.

The Water Resources Division of Indian and Northern Affairs Canada conducts the Yukon Snow Survey Program which includes eight snow courses within the Alsek River Basin (Figure 4). Four of these snow courses are no longer active. Data for the winter of 1988-89 reveals high snow pack conditions with values of snow water equivalent ranging from 132 percent of normal at Alder Creek to 225 percent of normal at Canyon Lake (Canada 1989f). A Basin wide snow pack average has been estimated to be 150

Table 1. Monthly and annual mean discharges and extremes of record for selected stations (Canada 1988c).

		Dezadeash River	Aishihik River (near lake)	Aishihik River	Aishihik Lake
Station Number		08AA003	08AA010	08AA001	08AA005
Period of Record		1952-	1980-	1956-1986	1972-1988 (only stage data available)
Drainage Area (sq. km)		8 500	2 960	4 300	
Monthly Mean Discharge (m^3/s)	Jan	16.1	8.11	6.50	Water Level(m) 2.823
	Feb	14.9	8.30	5.90	2.617
	Mar	14.0	7.35	5.35	2.596
	Apr	17.0	6.81	5.37	2.494
	May	48.0	7.90	17.1	2.446
	Jun	103.0	7.00	31.8	2.678
	Jul	91.1	8.47	25.5	2.876
	Aug	65.4	7.38	21.3	2.946
	Sep	53.5	7.24	19.6	2.967
	Oct	41.2	6.19	14.0	2.976
	Nov	25.2	7.14	9.82	2.960
	Dec	19.3	8.98	8.19	2.859
Annual Mean Discharge (m^3/s)		42.2	7.55	14.3	2.775
Maximum Daily Discharge (m^3/s)		700(Est) (Jun 8 '82)	25.6 (Jul 23 '86)	143(Est) (Jun 20 '62)	4.078 (Jul 22 '75)
Minimum Daily Discharge (m^3/s)		6.74 (ice cond.) (Mar 22 '67)	1.8 (May 1 '83)	2.01 (ice cond.) (Apr 3 '83)	0.973 (May 10 '82)

Continued

Table 1. Concluded.

		Sekulmun Lake	Sekulmun River	Takhanne at Tatshenshini	Alsek above Bates
Station Number		08AA007	08AA008	08AC001	08AB001
Period of Record		1980-	1981-	1984-	1974- (sediment data also available)
Drainage Area (sq. km)			1 250	365	16 200
Monthly Mean Discharge (m^3/s)	Water Level(m)				
	Jan	2.077	0.674	11.3	34.0
	Feb	2.080	0.157	8.87	31.8
	Mar	2.094	0.088	7.81	32.9
	Apr	2.095	0.762	7.16	40.2
	May	2.217	4.31	11.8	125.0
	Jun	2.414	10.5	80.2	387.0
	Jul	2.467	12.1	162.0	677.0
	Aug	2.405	9.91	140.0	599.0
	Sep	2.358	8.48	90.5	300.0
	Oct	2.225	5.44	53.9	124.0
	Nov	2.123	2.84	29.9	57.1
	Dec	2.087	1.61	17.4	43.0
Annual Mean Discharge (m^3/s)		2.219	4.76	51.7	204.0
Maximum Daily Discharge (m^3/s)		2.830 (Jun 12 '82)	22.9 (Jun 12 '82)	279 (Jun 21 '64)	1 130 (Jul 13 '75)
Minimum Daily Discharge (m^3/s)		1.964 (ice cond.) (Feb 25 '87)	0 (Mar 9'81)	3.62 (ice cond.) (Apr 1 '56)	16.9 ice cond.) (Feb 12 '82)

percent of normal. However, actual stream flow from snow and glacier melt will depend largely on summer temperatures. Snow survey data is provided in Table 3.

Table 2. Runoff estimates (Jordan 1986).

	TATSHENSHINI RIVER (at Mouth)	ALSEK RIVER (at Alaska Border)
Mean Annual Discharge	$100m^3/s$	$500m^3/s$
Mean July Discharge	$350m^3/s$	$1,600m^3/s$
Mean Annual Maximum Discharge	$500m^3/s$	$2,200m^3/s$

Table 3. Snow survey stations (British Columbia 1981).

Snow Course	Station Number	No. Years Record	Elev (m)	April 1 Water Equivalent (mm) 1987	1986	1985	Max.	Min.	Normal
Alder Creek	08AA-SC2	8	768	147	164	197	197	100	136
Clay Creek	08AB-SC2	10	670	646	693A	802	802	304	544
Summit	08AB-SC3	8	1000	207A	298	252	298	132	210
Profile Mtn	08AB-SC4	2	900	270A	277	-	277	270A	274
Canyon Lake	08AA-SC1	11	1160	-	-	113	124	38	79
Felsite Creek	08AB-SC1	8	762	-	-	299	299	152	232
Stanley Creek	08AC-SC1	9	925	-	-	299	330	184	258
Takhanne	08AC-SC1	6	762	-	-	-	268A	145A	181

2.3.2 Water Quality

With the exception of heavy natural sediment loads in many of the main rivers and their immediate tributaries, water quality is considered good throughout the Basin. Some areas however, may receive localized water quality degradation due to mining (both placer and hard rock) and community effluent discharges (see sections 3.2.1. and 3.4).

Historically, placer mining claims existed throughout the Alsek Basin. Today however, placer mines operate only on the Yukon portion of the Tatshenshini River that lies outside the Kluane National Park Reserve. Due to the increased sediment from placer mining operations, the size of the water licence granted relates to the value of the river as a fisheries habitat. The Tatshenshini River holds a high fisheries habitat rating and is protected from any type of development both in British Columbia and in Alaska. Monitoring of sediment discharge from such operations on the Yukon portion of the river is undertaken by Indian and Northern Affairs Canada.

In addition to increased sediment from mining operations and community waste discharges, campers in the park may be causing a slight water degradation problem. Though no problems arise from park campgrounds, recreationalists in other areas of the park are seen as being the main cause for the increased distribution of pathogens from human wastes in the Basin's waters. A very slight, but definite increase in the occurence of giardia ("beaver fever") contracted from drinking waters within the Basin has been noted (Pers. comm. Gerry Whitley, Indian and Northern Affairs Canada).

2.4 VEGETATION AND SOILS

The Alsek River Basin can be divided into three major vegetation zones: Coast Mountains, St. Elias Mountains and the Kluane Plateau. Figure 5 depicts the boundaries of these major zones (Senyk 1977).

The Coast Mountain Zone involves the largest portion of the Basin. This zone is bounded on the east by the Alsek River Valley and on the north by a line connecting Haines Junction to the north tip of Six Mile Lake. A great deal of this zone lies above treeline (1 050 to 1 200 meters above sea level); thus, subalpine and alpine vegetation dominates. Terraces and

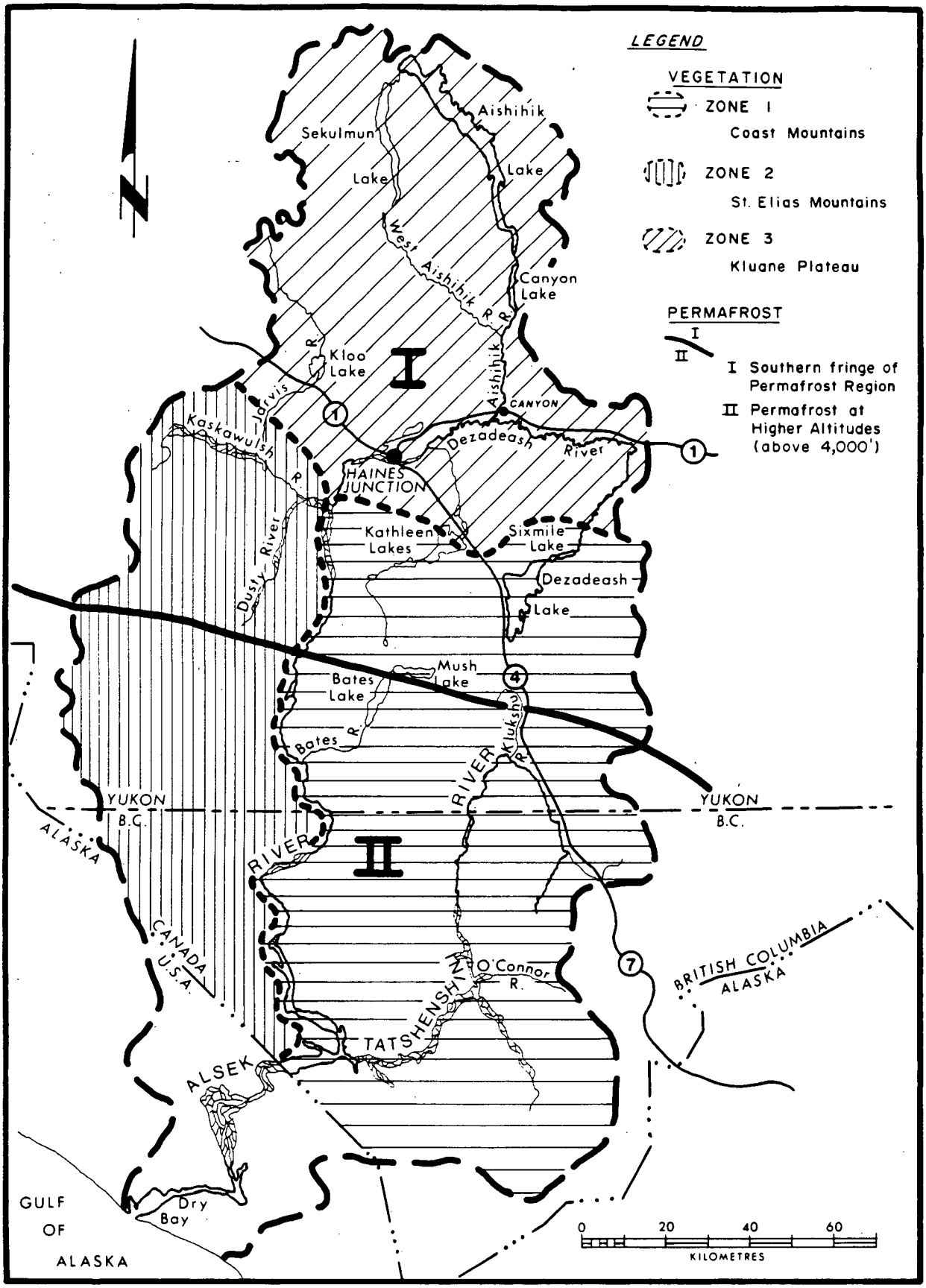

Figure 5 Vegetative and Permafrost Zones.

lower slopes usually consist of open-growing white spruce whereas richer, alluvial soils in valley bottoms with poor drainage support closed stands of white spruce usually mixed with balsam, poplar and willow. Lodgepole pine, sitka alder, bogbirch and black cottonwood may also be present at lower elevations. Aspen grows on warmer sites, but is not common except in burnt areas. The shrub growth at lower elevations consists of soapberry and willows.

Subalpine vegetation consists of shrub birch and willow. Moss, herbs, graminoids (grasses, sedges, cottongrass, bullrushes, reeds, etc.) and ericaceous shrubs (shrubby plants with thick, leathery leaves) are also common throughout the subalpine areas. Lichen, ericaceous shrubs and prostrate willows occur in the extensive alpine areas.

The St. Elias Mountain vegetation zone, covers that portion of the Basin lying west of the Alsek River. Treeline in this zone occurs at about 1050 meters above sea level. Open and stunted white spruce, aspen, balsam, poplar, paper birch and rarely lodgepole pine occur in low elevation valleys and lower slopes. In general, forests are scattered, never dense, and often dominated by deciduous trees and shrub communities. Shrubs include willow, shrub birch and often soapberry in protected valleys. In poorly drained valley bottoms, sedge tussock fields occur.

In alpine areas, grassy meadows supporting forbs are prominent whereas rocky slopes and ridges support lichens, prostrate willow and ericaceous shrubs. Most of the terrain over 3 000 meters above sea level is ice and snow covered.

The vegetation of the northern portion of the Basin is represented in the third major zone of the Kluane Plateau. Here, the tree line extends to 1 200 meters above sea level. White spruce is again common yet black spruce dominates in moister areas. Paper birch is found at lower elevations while aspen, balsam and poplar occur on warmer sites and burnt areas. Lodgepole pine, though scarce, may also be found. The shrub vegetation in the lower to mid elevations include willow, shrub birch, soapberry, alder and ericaceous shrubs. The subalpine and alpine areas are dominated by moss, shrub birch and willow communities. Sedge tussock fields dominate moist sites, while sedge and grass meadows with forbs and ericaceous shrubs prevail on gentle slopes. Rocky and steep sloping alpine

terrain is vegetated with lichen, ericaceous shrubs and forbs.

A rare plant community has been documented in the Dezadeash-Alsek river area. The carex sabulosa (Siberian dune sedge) is a unique and rare plant community which is found on the sand dunes near the Kaskawulsh/ Dezadeash confluence (Canada 1977b). It has been reported in only one other North American location, also in the southern Yukon. A detailed description of the vegetation of the Alsek River Basin is provided in Appendix 6.2.

The soils of the mainstem Alsek are largely regosolic (immature) due to periodic flooding from surging glaciers and erosion of steep slopes within the St. Elias and Coast Mountains. Alpine soils in the Basin are often alpine eutric due to their high humus content. The organic soils of the lowland areas surrounding Aishihik Lake often have perma frost features such as peat plateaus and palsas (a peat mound with a perennially frozen core). Permafrost is relatively nonexistant in the southern portion of the basin, except at high elevations, yet becomes more prevalent north of Mush Lake.

Local variations such as north facing slopes will have thicker and more widespread discontinuous permafrost than will south facing slopes. Figure 5 depicts general permafrost boundaries.

2.5 WILDLIFE

Wildlife resources are abundant in both the British Columbia and Yukon portions of the Alsek River Basin. Most significant are the populations of grizzly (brown) bear, Dall sheep and mountain goat.

The grizzly bear population within the Basin is considered to be of national significance as it represents the largest, stable population of grizzly bears in Canada (British Columbia 1989c). Within the boundaries of Kluane National Park, there is an estimated 265 grizzly bears with the highest densities being found along the Alsek and Kaskawulsh river valley (British Columbia 1989c). The British Columbia portion of the watershed contains roughly 100 grizzly bears (Canada 1989h). These bears are most often seen in alpine tundra or treeless areas in berry season, while during salmon runs they descend to creek valleys to feed on the spawning salmon.

Dall sheep is the most abundant large mammal within the Basin. The British Columbian portion of the Basin contains what is believed to be the only Dall sheep winter range in the province. North of the British Columbia/Yukon border, Dall sheep are found almost exclusively in the Kluane Ranges, their numbers ranging from 450 to 500 (British Columbia 1989c).

Another abundant large mammal is the mountain goat of which there are an estimated 600 throughout the Basin (British Columbia 1989c). These goats generally occupy vegetated mountians near the British Columbia/Yukon border Goatherd Mountain, on the east side of the Alsek River, likely has the highest density of goats within the Basin. Though there is some overlap of Dall sheep and mountain goat distribution, there seems to be little competition for food resources.

Other large mammals that inhabit the study area include timber wolves, moose, mule deer, black bear, wolverine, coyote, lynx and red fox. Mule deer and caribou may be found but are considered very rare.

Timber wolves, an important predator for moose, are scattered throughout the Basin yet are most prevalent near the Kathleen Lakes and throughout the Auriol Mountain Range.

Moose found within the study area are members of the largest subspecies in North America (Canada 1977b). Within this subspecies, several albinos have been reported. The highest moose density is found in the Alder Creek/ Mush Lake area.

Mule deer have recently established themselves in the Yukon and though quite rare, they are usually seen in the Haines Junction/Kathleen Lakes area.

The black bear is a fairly common inhabitant of the spruce forest zone. More abundant than grizzly bears, they tend to avoid the larger bear when possible, and are found throughout the Basin.

Wolverines are found in all types of vegetated terrain in moderate numbers along the Alsek River and west of the Kathleen Lakes. This ferocious scavenger, though no bigger than a bear cub, will defend its food against a grizzly if necessary.

Coyotes are common predators found throughout the Basin. Their populations tend to fluctuate with snowshoe hare and ground squirrel

densities.

The lynx population, though quite small in size, also fluctuates greatly with snowshoe hare populations. This cat family member is only found in the forested zones of the Basin.

The red fox is also few in number inhabiting both the forest and alpine areas of the Basin. Like the lynx and coyote, the red fox preys upon small mammals such as mice, squirrels and hares.

Smaller mammals such as the pine marten, short-tailed weasel, mink, otter, hoary marmot, beaver, and porcupine are also found in varying abundances throughout the Basin. As well, species of shrew, chipmunk, squirrel, mouse, lemming, pika, hare, muskrat and bat are found in greatest diversity in the marshes along the Dezadeash River and the area bordering the Haines Road near the Kathleen Lakes, as well as in areas recovering from fire.

The Shakwak Trench which runs northwest to southeast through Haines Junction lies directly along a major migratory bird flyway. It is estimated that over 100,000 waterfowl and other avifauna use this valley as a migratory staging and production area. The diversity of habitats within this major valley as well as in surrounding territories within the Basin has lead to a high species diversity of waterfowl and other birds.

The Alsek Basin is also home to a few predatory birds such as the peregrine falcon, gyr falcon, bald eagle, golden eagle and osprey.

Both the peregrine and gyr falcons are considered endangered species with estimates of 20 and 30 respectively inhabiting the Basin (British Columbia 1989c). Both falcons prefer to nest on high inaccessible cliff ledges found along the lower Alsek and Tatshenshini rivers.

The bald eagle, though more numerous than the peregrine and gyr falcons, is also considered an endangered species. Having a diet preference for fish, it frequents areas near rivers and lakes and is often seen near the bigger lakes in the southern Basin such as Kathleen, Dezadeash, Sixmile, Mush and Bates lakes. The golden eagle, being more abundant overall in Canada than the bald eagle, is quite common within the study area. Its nesting area is mainly the canyons of the Alsek Ranges. The osprey is rarely found within the Basin.

A variety of land birds as well as species of loons and gulls also

Table 4. Avian habitat and typical species in the Alsek River Drainage Basin (Canada 1976).

Habitat	Species	Examples of Habitat in Study Area
Large Lakes	Arctic Loon, Harlequin Duck, Arctic Tern, Common Loon, mergansers, scoters, grebes, gulls	Mush Lake, Bates Lake
Small Lakes, Ponds	Greater Scaup, Green-winged teal, Barrow's Goldeneye, Horned Grebe, Mallard, other diving and dabbling ducks	Small Lakes and Ponds east of Aishihik Lake
Nesting Islands	Herring gull, Sparrows, Loons, Mew Gull, Arctic Tern, Diving Ducks	Kathleen Lake, Bates Lake
Marsh, Wetland, Fen	Red-winged Blackbird, Arctic Tern, Rusty Blackbird, Northern Phalarope, Common Yellowthroat, Common Snipe, Lesser Yellowlegs	Dezadeash River, Aishihik River, Alder Creek
Stream Courses, Shoreline	Semipalmated Plover, Spotted Sandpiper, Kingfisher	Aishishik River Mush Lake
Sub-alpine Shrub	Willow Ptarmigan, Hammond's Flycatcher, Brewer's Sparrow, Dark-eyed Junco, Wilson's Warbler, Tree Sparrow, Common Redpoll	Subalpine terrain throughout the Basin
High Cliffs	Peregrine Falcon, Gyr Falcon, Golden Eagle, Bald Eagle, Osprey	Lower Alsek and Tatshenshini Mountains, Noisy Range
Diverse Upland Habitats-Fire Successional Stages	White Crowned Sparrow, Warblers, Chipping Sparrow Swainson's Thrush, Robins, Gray Jays, Juncos	Near Mush and Bates Lakes, Alsek River Valley
Alpine Tundra	Whimbrel, Ptarmigan, American Golden Plover, Horned Lark, Water Pipit	Alpine areas throughout the Kluane Plateau

inhabit the study area. Table 4 describes both the habitat, geographic location and species of bird found within the Basin.

2.6 FISHERIES

The Alsek River Basin supports a considerable fishery resource including both anadromous and freshwater fish stocks. Table 5 lists the fish species found within the study area.

2.6.1 Anadromous Fish

The Lowell glacier, which has at times completely blocked the mainstem Alsek River, creating a large ice-damned lake, has been the major barrier to anadromous fish migration to over 50 percent of the Basin. Kokanee (land-locked sockeye salmon) have been documented in the waters of Kathleen and Sockeye lakes indicating that this portion of the Basin was open to anadromous salmonids in the past (Lindsey 1981).

Today, though all five species of salmon are known to inhabit the mainstem Alsek River, they are only able to ascend the river to the Tweedsmuir Glacier, as extremely high water velocities, from 40 to 45 km/h in Turnback Canyon, block even chum salmon from the Upper Alsek river(Canada 1977a). However, salmon rarely ascend the Alsek River this far due to the heavy suspended sediment load.

Three salmon species, chinook, coho and sockeye are found in the Tatshenshini River system ascending all the way to the headwaters. These three species tend to spawn in the less turbid tributaries of the Tatshenshini River upstream from Sediments Creek, in particular Klukshu, Takhanne and Blanchard rivers. All three salmon species spawn from late summer to mid fall (early August to early October) and all rear in freshwater for at least one summer.

Steelhead (anadromous rainbow trout) are also present in the Tatshenshini system and spawn either in early spring or late summer in the less turbid waters of the upper Tatshenshini.

2.6.2 Freshwater Fish

The Alsek Basin sustains a wide variety of freshwater fishes and is one of the few Pacific draining watersheds containing northern pike,

round whitefish and arctic grayling. It is hypothesized that these species entered the system during the formation of the ice-dammed lake (Glacial Lake Champagne) that connected the Alsek and Yukon River Basins.

Freshwater bodies throughout the Basin also contain two additional species of whitefish, three species of trout as well as Dolly Varden char, burbot, longnose sucker and slimy sculpin. As well, Table 5 lists some additional freshwater fishes which may occur in the Basin. Virtually all lakes in the Basin support populations of fish with the exception of a very few high altitude lakes (pers. comm. Al von Finster, Indian and Northern Affairs Canada.

Table 5. List of Fishes known to occur in the Alsek Drainage Basin (Canada 1989b).

	Common Name	Scientific Name
Freshwater:	Lake Whitefish	Coregonus Clupeaformis
	Round Whitefish	Prosopium cylindraceum
	Pygmy Whitefish	Prosopium coulteri
	Artic Grayling	Thymallus arcticus
	Lake Trout	Salvelinus namaycush
	Rainbow Trout(Steelhead)	Salmo gairdneri
	Cutthroat Trout	Salmo clarki
	Northern Pike	Esox lucius
	Dolly Varden Char	Salvelinus malma
	Burbot	Lota lota
	Longnose sucker	Catostomus catostomus
	Slimy Sculpin	Cottus cognatus
Anadromous:	Sockeye(Kokanee)	Oncorhynchus nerka
	Chinook	Oncorhynchus shawytscha
	Coho	Oncorhynchus kisutch
	Chum	Oncorhynchus keta
	Pink	Oncorhynchus gorbuscha

The following is a list of freshwater fishes that may or may not occur in the Alsek Basin.

Arctic Lamprey	Lampreta japonica
Green Sturgeon	Acipenser medirostris
White Sturgeon	Acipenser transmontanus
Longfin Smelt	Spririnchus thaleichthys
Eulachon	Thaleichthys pacificus
Threespine Stickleback	Gasterosteus aculeatus
Prickly Sculpin	Cottus aleuticus
Coast Range Sculpin	Cottus asper

Rainbow trout is present in both the Tatshenshini and the Dezadeash river systems and is the only species known to have been stocked in the Aishihik River during construction of the Alaska Highway in the early 1940's. It is believed however, that the species was already indigenous to these areas (Canada 1989c).

3. EXISTING AND POTENTIAL RESOURCE USE

3.1 HISTORICAL PERSPECTIVE

Human occupation in the Alsek River Basin likely began during deglaciation, about 10,000 years ago; the earliest known occupied site in the Basin is the Canyon site, dated at about 7,100 years ago (Workman 1978). The prehistoric record for the Basin as reconstructed by Workman recognizes five cultural phases. Distinguished by their differences in stone tool technology, these cultural "groups" were affected most significantly by the periodic formation and drainage of proglacial and neoglacial lakes. Table 6 depicts the chronological order of events concerning both the cultural phases and glacial lake formation beginning with the Kluane Ice retreat some 12 000 years ago. Figure 3 illustrates the maximum extent of Glacial Lake Alsek.

According to R.M. Gotthardt, the first Euro-Americans to visit the Alsek Basin were E.J. Glave and Jack Dalton in 1890 and again in 1891. Following the Chilkat Trail from Lynn Canal (see Figure 6), the two were able to reach Klukshu Lake and the Tatshenshini River which they descended to the Alsek river which took them back out to the coast. The following year they travelled via the Chilkat Trail again through the Shakwak valley to the village of Aishihik on the north shore of Aishihik Lake. On their return, Dalton and Glave travelled past the Kaskawulsh Glacier, down the Kaskawulsh River to the Dezadeash River, which they ascended back to Klukshu Lake, and from there back to the coast.

Dalton returned in 1894 to improve the Chilkat trail and establish Dalton Post on the Tatshenshini River. The improved trail, now called the Dalton Trail, was used to transport livestock to Dawson in 1898 and 1899.

The discovery of gold in Roberts and Victoria Creeks in 1898 and in the Jarvis river area in 1903-1904, brought a rush of prospectors and supplies along the Dalton Trail. Low productivity from placer mining

Table 6. Geo-Archaelogical chronology of the Alsek Basin (Modified from Workman 1978).

YEARS BEFORE PRESENT	GLACIATION	GLACIAL LAKES	CLIMATE	ARCHAELOGICAL CULTURES
0	Proglaciation A.D. 1870 & 1600	Lake Alsek 150± B.P. Kluane Lake-	Warming Cooling	Aishihik/Lake Prehistoric Athapaskan
1000		recent level 340± B.P. Lake Alsek-recent level 1450 - 1650± B.P.	Cool/Moist Drier/Glacial retreat	Taye Lake/ Northern
2000	Neoglaciation 2600+ B.P.	Recent Alsek Formation		Archaic
3600			Cool/Moist	
4000				
5000				Little Arm/ Northwest
6000		Kluane Lake-40' (?)	Warmer than present	Microblade
7000				Northern Cordilleran?
8000			Warning/Glacial retreat	
9000	Ice Inside Proglacial Limits 9700± B.P.	Glacial Lk. Drainage Kluane Lake Established Pacific Drainage		?
10,000			Drying/Colder	
11,000			Warmer/ Moister	
12,000	Kluane Ice Retreat 12,500 B.P.		Cold/Dry	

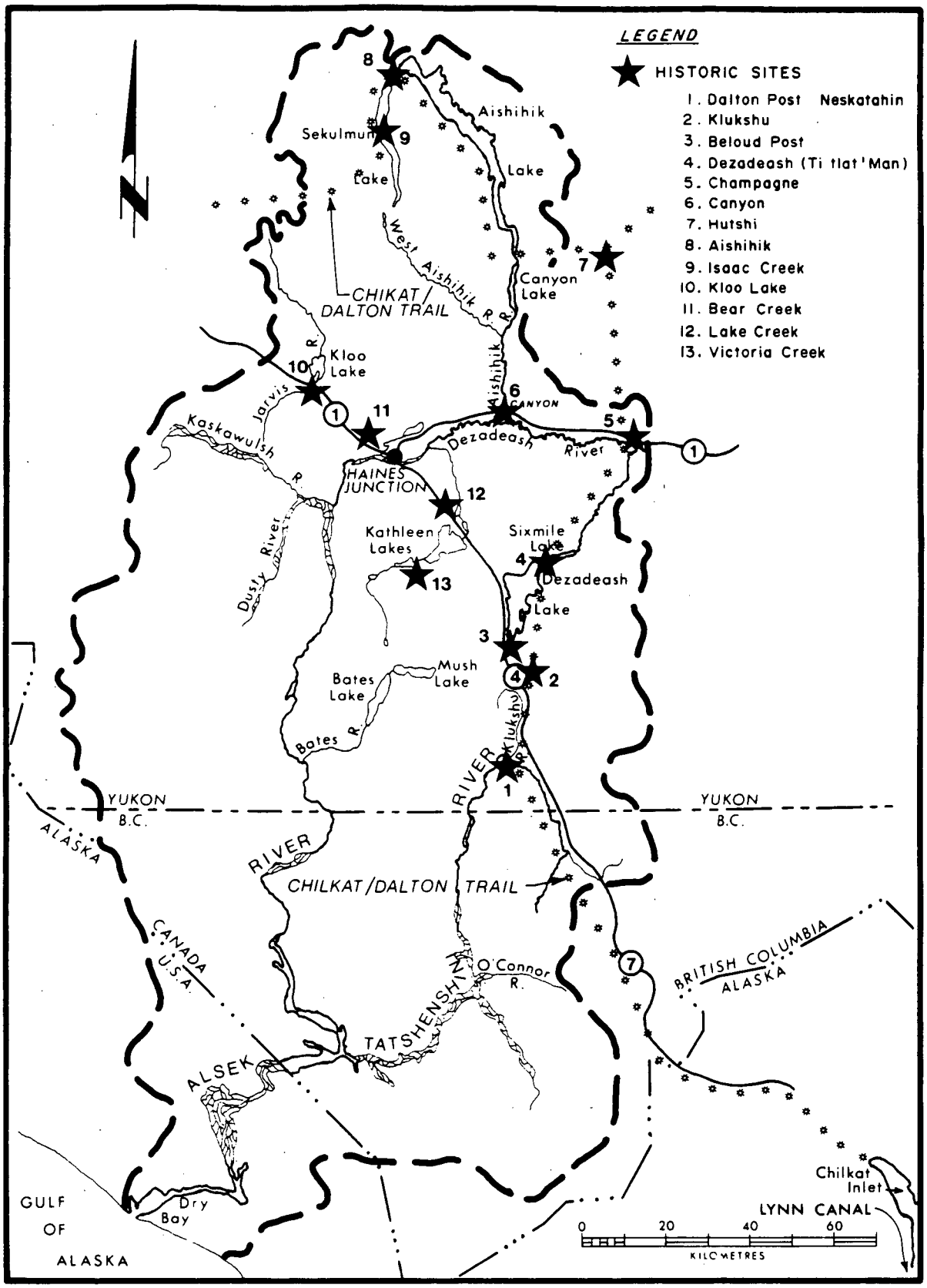

Figure 6 Historical Sites and Trails.

discouraged many miners and by 1906 the mining population in the area had dropped from approximately 1,200 to only 40 people (Gotthardt 1989).

By 1915, hunting, guiding and trapping replaced mining as the principal economic activities. The discovery of gold on Squaw Creek in 1927-1928 caused a minor resurgence of mining activity in the area, however, by 1940, mining was again depressed (Gotthardt 1989). Today, Squaw Creek remains the only active placer mining site in the Basin.

The construction of the Alaska Highway during the early 1940's had major impacts both economically and socially on the population residency in the Basin. The arrival of thousands of military and civilian personnel during the 2 to 3 years of construction introduced new strains of disease such as measles, influenza and dysentary from which the natives had no resistance. The result was hardship and death for many Southern Tutchone native groups with the Champagne-Aishihik band being particularly hard hit (Cruikshank 1985).

Excessive hunting created a severe depletion of game reserves in the Basin which caused the Yukon Government to set aside 25 900 sq. kms of land as the Kluane Game Sanctuary in December of 1942. This placed additional hardship on the Kluane Southern Tutchone natives. Of the initial 25 900 sq. km set aside as a game sanctuary in 1942, 22 015 sq. km of it officially became the Kluane National Park Reserve in 1972 (Canada 1977b).

Settlement patterns were also changing as people began to move to new communities along the new highway, including Haines Junction, to take advantage of government services, transportation and employment opportunities (Gotthardt 1989). In return, traditional native settlements such as Aishihik and Kloo Lake were gradually depopulated (Cruikshank 1985).

In 1945, the Federal Department of Agriculture set up the Pine Creek Experimental Farm to test the agricultural potential of the southern Yukon. Some success was gained in growing certian cereal crops as well as the raising of cattle and poultry. The farm operated until 1970 when the Department of Forestry took over the site.

Today, Haines Junction remains the largest populated center in the Basin followed by Canyon and Champagne, the original native communities.

The Basin's economy is now based heavily on tourism and the recreation sector. These activities continue to increase due to the presence of the Kluane National Park Reserve. Pending future decisions regarding the development of a major mineral find within the Basin, mining may again become an important activity.

3.2 SOCIAL ENVIRONMENT

3.2.1 Population and Amenities

The Alsek River Basin supports three small communities, all of which are located along the Alaska Highway. By far the largest community is Haines Junction which grew out of its location at the junction of the Alaska and Haines Highways. With a population of 596, Haines Junction is the fifth largest community in the Yukon Territory (Yukon 1989b). Canyon, a native residential community supports forty three native people and twelve native people reside in Champagne bringing the total Basin population to 651 (Yukon 1989b). A population by age breakdown for Haines Junction is given in Table 7.

Table 7. Population by age for Haines Junction (Yukon 1989b).

Age	Haines Junction	Whitehorse	Yukon Territory
0 - 4	50	1,796	2,619
5 - 9	59	1,698	2,437
10 - 14	49	1,356	1,967
15 - 24	76	3,130	4,628
25 - 34	126	4,613	6,738
35 - 44	99	3,937	5,492
45 - 54	59	1,979	2,815
55 - 64	43	1,069	1,670
65+	35	658	1,045
TOTAL	596	20,236	29,411

The largest employers within the Basin are the Yukon Territorial Government, Champagne-Aishikik Enterprises and Parks Canada. The Yukon Territorial Government is responsible for highways maintenance, natural resource management, education, health and other community services in Haines Junction. Champagne-Aishihik Enterprises is the major employer of the Basins native population and involves itself with roadwork, house construction, fuelwood collection and various other band related projects. Parks Canada employs administrative and service staff for Kluane National Park Reserve.

Telephone service is provided by North West Tel and electric power is supplied by Yukon Electric through the Aishihik power project. Haines Junction has a multi-cell sewage system and the nearby community of Canyon is soon to be hooked up to it.

In June, 1989, the Haines Junction Council, the Champagne-Aishihik Band and the Yukon Territorial Government signed a $3.2 million sewer and water pact that will provide Haines Junction with an array of improvements to its existing water distribution system. The community will receive a new well and pumphouse, a new water tower and new water mains where needed. As well, increasing population density of the Champagne-Aishihik native community just east of Haines Junction in Canyon, will be accomodated with the installation of sewer and water lines. The water and sewer improvements are expected to meet the needs of both communities for the next twenty years.

Basic amenities in Haines Junction include five motels, three lodges, three restaurants (1 in winter), four gas/service stations and a general store/post office. Other basic services include an RCMP post, health clinic, firehall, a community hall, a sports arena including a swimming pool, curling and ice rinks, a school providing education up to grade twelve and banking services twice weekly in the parks administration building.

Cable television is not availabe, therefore the residents of the Basin receive only three channels, including the CBC. Some residents bring in other channels via dish satelite receivers.

The Basin is serviced by two highways. The Alaska Highway (No. 1) runs east to Whitehorse and northwest to Destruction Bay on Kluane Lake.

The Haines Highway (No.4) begins at Haines Junction and heads southeast 254 km before reaching Haines, Alaska. Daily bus service operates from Haines Junction to either Whitehorse or Destruction Bay. Bus service from the junction to Haines, Alaska operates every other day. Haines Junction also maintains a small airstrip and though regular air service does not exist, helicopter service is available for charter.

3.2.2 Native Population

The Alsek River Basin is home to some 260 native people, all members of the Champagne-Aishihik Band. The Band's ancestors were the Southern Tutchone who lived primarily within the bounds of the Basin for over 5,000 years (Duff 1964). The coastal portion of the Basin was inhabited by the Tlingit natives who have since left the Basin or were killed off by disease in the mid-19th century (Canada 1977b).

Today, though traditionally nomads, the Champagne-Aishihik are now established in the permanent native settlements of Champagne and Canyon, with populations of 12 and 43 respectively. The majority of the native population comprises about one third of the population of Haines Junction.

Many native people still use the hunting and fishing grounds used by their ancestors. The Champagne-Aishihik Band, in conjunction with the Council for Yukon Indians (CYI) has requested that such lands plus others of importance be protected from development. Figure 7 shows such lands as they exist within the study area. Negotiations between the CYI, Yukon Territorial Government and Indian and Northern Affairs Canada regarding these claims and others have been ongoing for several years now and will resume in the fall of this year.

According to O'Leary (1984), the Southern Tutchone were forced to abandon their traditional hunting grounds in 1908 when they were no longer allowed to hunt south of 60° (the British Columbia/Yukon border). Though there is no evidence of the Champagne-Aishihik currently using this portion of the basin south of the border, they are considered to be the most probable groups to establish a legitimate land claim in the area. However, progress towards a claim here has been halted due to lack of recognition of Yukon native claims in British Columbia by the provincial government.

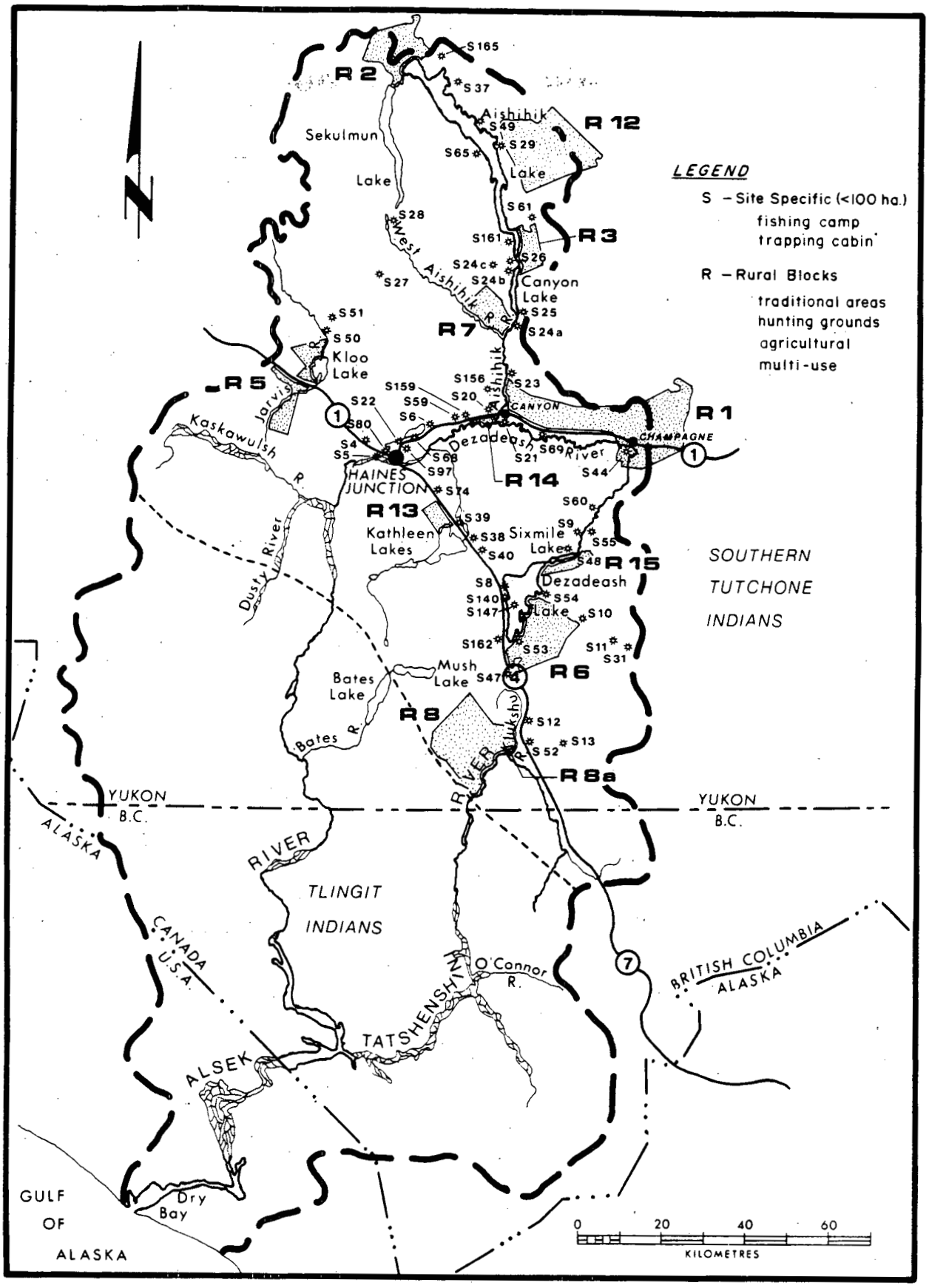

Figure 7 Lands Protected for Native Use.

As of 1982, members of the Champagne-Aishihik Band have regained the right to hunt, trap and fish within the Kluane National Park Reserve boundaries. Such will be the case until there is a legal settlement of the Champagne-Aishihik land claims at which point Kluane National Park Reserve will become Kluane National Park (Canada 1989h).

3.3 FORESTRY

The forest industry within the study area is presently undeveloped both provincially and territorially and therefore information concerning the industry is sparse.

In British Columbia, the Basin makes up most of the Alsek Public Sustained Yeild Unit (PSYU) which was last surveyed in 1975. Information obtained from this survey is available on a series of thirty six "40-chain" forest cover maps. Productive forest lands for the entire Basin are shown on Figure 8. Forested areas in this portion of the Basin are not presently being harvested and future harvesting of good quality timber stands near the Tatshenshini/Alsek river confluence may be hampered by difficult access.

The Yukon portion of the Basin outside the National Park Reserve boundaries amounts to approximately 8 900 sq. km of which about 22 percent is productive forest land (pers. comm. Gerry Perrier, Forest Resources, Indian and Northern Affairs Canada). Though more accessible than the British Columbian portion of the Basin, harvestable timber stands are fewer and lower in quality (Yukon 1988). This is due primarily to the longer, colder winters, drier conditions and shorter growing seasons in the northern Basin as opposed to the more moderate conditions for growth further south. In general, however, upland stands support small trees with potential for pulpwood and alluvial lowland sites support larger trees, some of which are harvested for saw logs. The most common harvestable species are white and black spruce. There is one sawmill in the Basin located just east of Haines Junction. The Wild Mountain Thyme sawmill operated by Boyd Campbell is a small one to two-man operation and manufactures small quantities of sawn lumber, much of which is used locally in construction.

The Champagne Indian Band has established its own logging firm

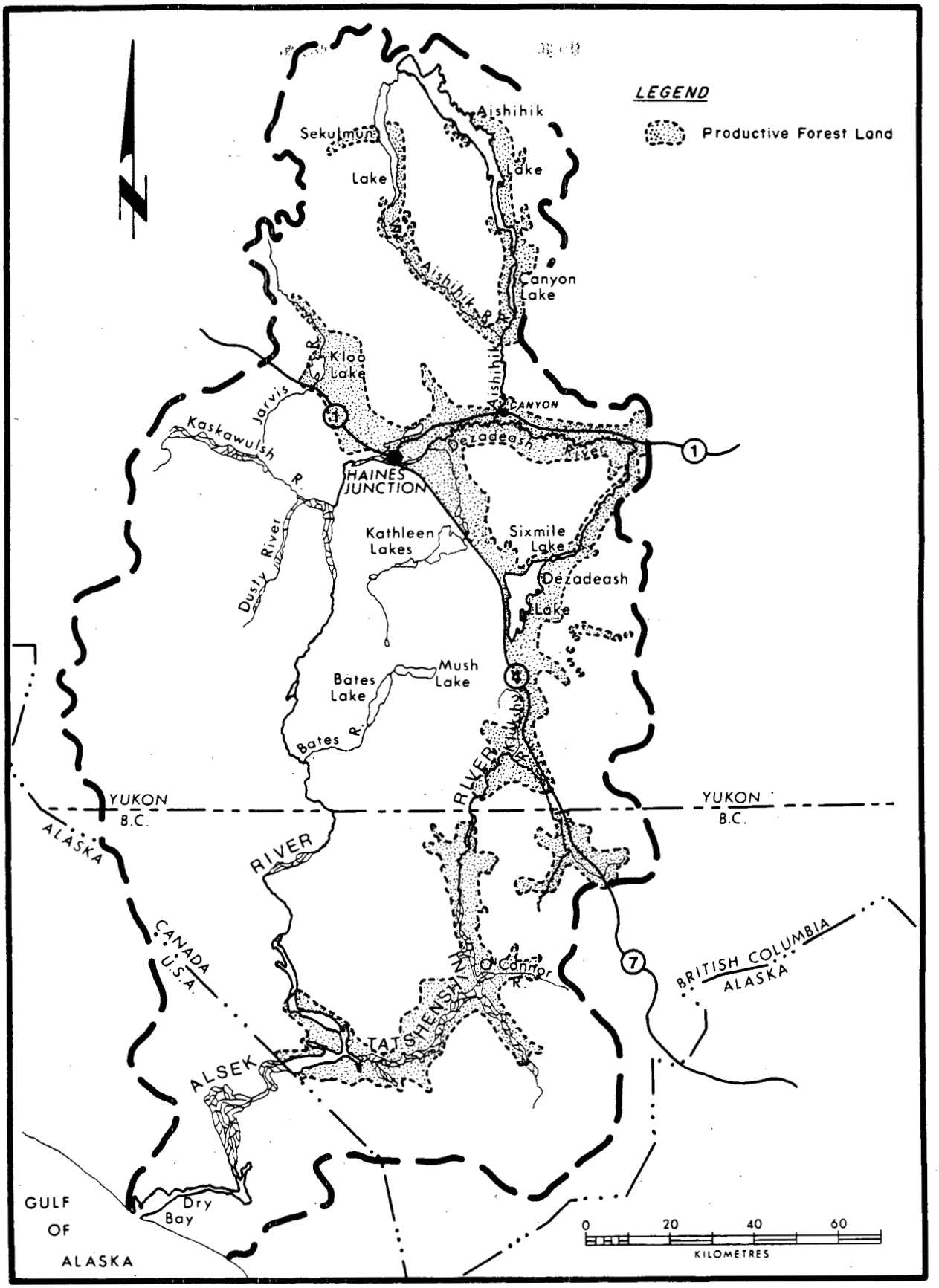

Figure 8 Forest Capability.

which is based in Whitehorse. The firm harvests timber from the Band's protected lands which is used as fuelwood and to produce sawn lumber for house construction. At present this is a small operation supplying primarily the needs of the local Champagne-Aishihik Band members within the Basin.

3.4 MINING

As with much of the Yukon Territory, placer gold mining was the single most important activity that drew outsiders to the Alsek River Basin. The Dalton Trail was the main route into the Alsek Basin during the initial gold rush years from 1898 to 1899. Prospecting and mining activities of the first Kluane gold rush in the Alsek Basin were limited principally to Roberts and Victoria Creeks (Gotthardt 1989). Gold was also found in the Shorty and Alder creeks area; however, only a small amount was found and the area was soon abandoned. A minor gold rush at Mush Creek, again in 1898, began with the discovery of gold by C. Towl and partners. Yet low productivity caused the mining to cease by 1902 (Stevenson 1979). In 1903, Skookum Jim and Tagish Charley discovered gold on Ruby Creek. News of the discovery attracted some 500 to 600 prospectors into the area between 1903 and 1904. During this rush, claims were staked in the Ruby and Kluane Ranges, at the Fourth of July Creek, Twelfth of July Creek, Dixie, McKinley, Marshall and Granite Creeks.

Tent cities were built at Ruby Creek and on Kloo Lake. The initial rush ended prematurely due to severe flooding along the creeks (which impeded placer mining) and the discovery of placer gold on Burwash Creek outside the Alsek Basin (Stevenson 1979).

By 1915, mining had come to be sporadic in the area and continued this way until the discovery of gold on Squaw Creek, near Dalton Post in 1927. This caused a minor resurgence of mining activity in the Basin which lasted until the mid-1930's. In this period, mining was carried out at Victoria, Jarvis and Shorty Creeks and in 1939-1940, gold mining was carried out on Beloud Creek (Gotthardt 1989). By the end of 1940, however, mining was again depressed and only creeks outside the Basin in Kluane Lake area continued to be worked (Stevenson 1979).

Presently, placer mining activity is sparse within the Basin and

contributes little to the community of Haines Junction. The mineral claim maps of the Alsek Basin depict numerous claims in the area, both placer and hard rock though few are actually worked. Today, placer mining activities in the Basin occur periodically and are initiated by fluctuating gold prices. The Squaw Creek area just south of the Yukon/British Columbia border is the only area that supports continuous seasonal operation. Operations in this area employ five to ten people and the major company is Arbor Resources Inc. (British Columbia 1989a).

Hardrock or lode mining, a relatively new concept in the Basin's mining activities, has been thrust into the forefront with the advanced mineral exploration project in the Windy Craggy properties owned by Geddes Resources. One of the largest single exploration projects in British Columbia, the Toronto-based company is presently employing fifty-five people in further exploration of the huge copper sulphide deposit. The company has plans to spend $11.2 million in exploration in 1989 bringing the three year total to over $32 million (British Columbia 1989b). To date, diamond drilling has defined a "Gold Zone" and improved the definitions of the ore reserves in the North and South deposits (British Columbia 1989b). Further details concerning this potential hardrock mine are found in Appendix 6.3.

The British Columbia Mine Development Steering Committee (MDSC) has received the terms of reference for the Stage I environmental impact study which is due to be released in early 1990. The Steering Committee is currently reviewing a submission from Geddes Resources Ltd. to construct a 110 km, all-season mine access road. The preferred and alternative routes to the minesite are also outlined in Appendix 6.3.

An older and much smaller minesite is located near the headwaters of the O'Connor River in the Tatshenshini watershed. In 1985, a diamond drilling program on the property, owned primarily by Queenstake Resources Limited, revealed gypsum deposits totalling 10 million tonnes. A detailed feasibility study was prepared in 1987 and a Stage I environmental impact assessment was submitted to the British Columbia MDSC. Exploration at the site was halted in 1987 as complications arose from the results of the Stage I study with the MDSC.

Other hardrock mining activities ongoing in the study area include geochemical sampling in the Jarvis River watershed. Pezgold Resources Corporation and Silverquest Resources Ltd. carried out surveys on both the east and west zones of their properties located just north of Granite Creek (British Columbia 1989a). Exploratory drilling was also carried out in 1988 by Bond Gold Canada and Newmont Exploration. Their East Arm property is located just six to eight miles east of the Windy Craggy property. Having drilled through the 30m thick ice cap, the companies plan to begin taking core samples this year. Copper is expected to be the primary resource.

Past and present mineral exploration and development sites are shown on Figure 9. Table 8 details mining activities within the Basin.

3.5 TRAPPING

Fur trapping has been an important economic activity in the Basin since the early 1800's when the Basin's Southern Tutchone natives traded mainly furs and other goods for the eulachon oil, blankets, tobacco, dye, and seafoods of the Tlingit natives to the south. The arrival of European and Russian traders in the late 1800's distrupted this native trade. By 1894, Jack Dalton had built a post along the Dalton Trail and fur trading between the Southern Tutchone natives and the Europeans was well underway.

Today, detailed trapping information is available for the Yukon portion of the Basin which contains a total of twenty-two trapping concessions (Yukon 1989a). Figure 10 indicates concession location. Due to its remoteness, the British Columbian portion of the Basin contains only one trapping concession, the boundaries of which are unavailable.

The fur bearing animals most widely tapped are; beaver, fox, lynx, marten, mink, muskrat, land otter, squirrel, weasel, wolverine, wolves and coyote. Open seasons for the trapping of certain fur bearing animals are provided in Table 9.

3.6 PARKS

Nearly half of the Yukon portion of the Alsek Basin is comprised of Kluane National Park Reserve. Spreading over 22 000 sq. km in total, the park features some of the worlds largest icefields, Canada's highest

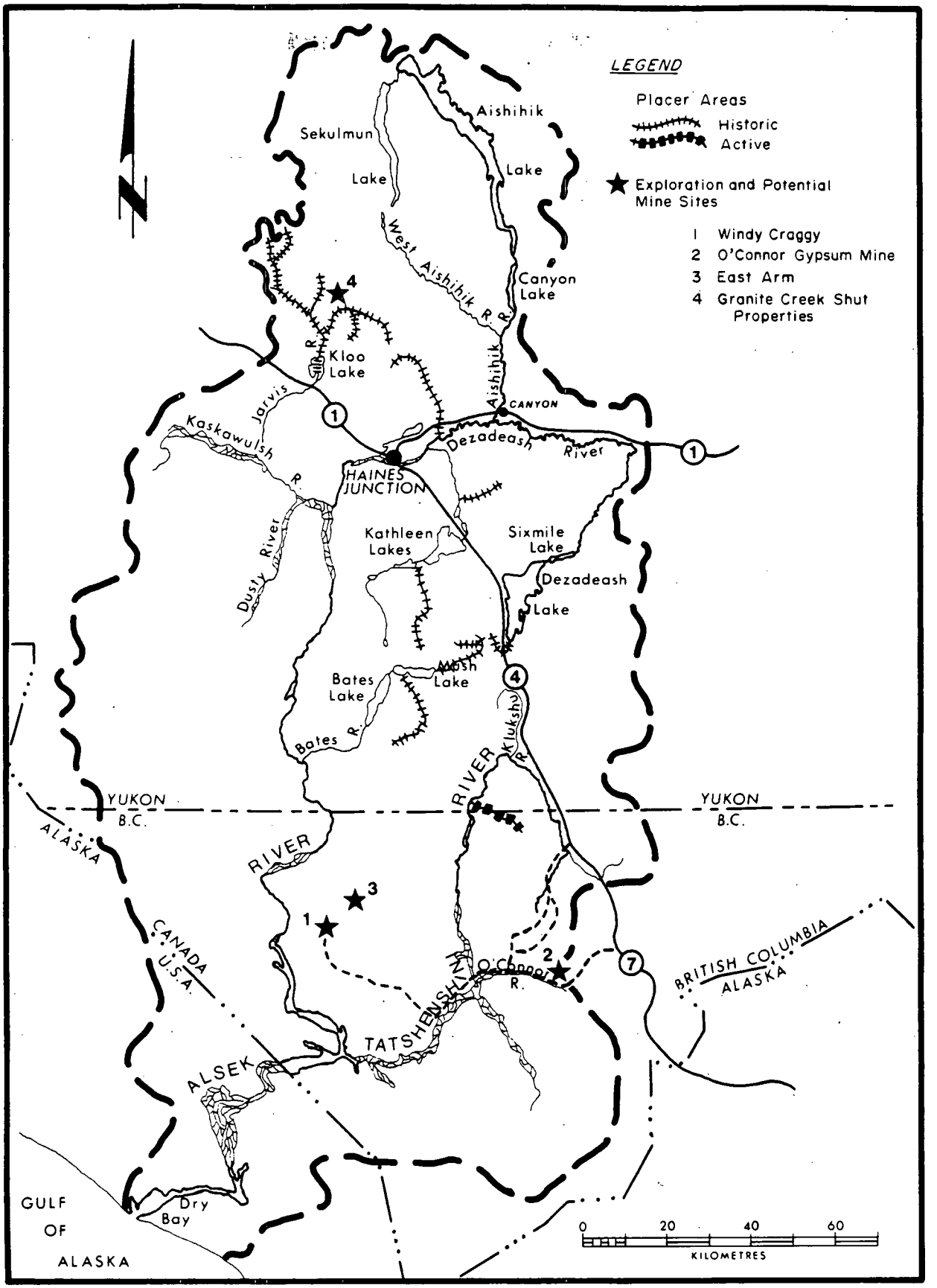

Figure 9 Mineral Exploration and Development.

Table 8. Operating mines and mineral exploration (British Columbia 1989a).

Property	Company	Activity	Commodity	Reserves
Windy Craggy AU	Geddes Resource Ltd.	Aggressive exploration Stage 1 to be completed in early 1990	Cu, Au, Co	100 mt @; 2% Cu,4g/t 1% Co (confirmed)
East Arm	Bond Gold Canada and Newmont Exploration	Exploratory drilling	Cu	unknown
Squaw Creek	Arbor Resources Inc.	Exploratory drilling and placer gold production	Placer Au	unknown
O'Connor River	Queenstake Resources	No activity as of 1987	Gypsum	10 mt (confirmed)
Shut Properties (Granite Creek YT)	Pezgold Resource Corp and Silverquest Ltd.	Geochemical sampling	unknown	unknown

Table 9. Open seasons for the trapping of furbearing animals in the Alsek Basin (Adapted from British Columbia 1989d and Yukon 1989a).

SPECIES	YUKON	BRITISH COLUMBIA
Beaver	Oct 1 to June 10	Oct 1 to May 31
Muskrat	Oct 1 to June 15	Oct 1 to May 31
Land Otter	Nov 1 to Mar 31	Oct 1 to May 31
Squirrel	Nov 1 to Mar 31	Nov 1 to Mar 31
Wolverine	Nov 1 to Mar 10	Nov 1 to Feb 28
Marten	Nov 1 to Feb 28	Nov 1 to Feb 28
Mink	Nov 1 to Feb 28	Nov 1 to Feb 28
Weasel	Nov 1 to Mar 31	Nov 1 to Feb 28
Fox(Red, Cross, Silver)	Nov 1 to Mar 10	Nov 1 to Feb 28
Coyote	Nov 1 to Mar 10	Nov 1 to Feb 28
Lynx	Nov 1 to Mar 10	Nov 1 to Feb 28
Wolf	Nov 1 to Mar 10	Nov 1 to Feb 28

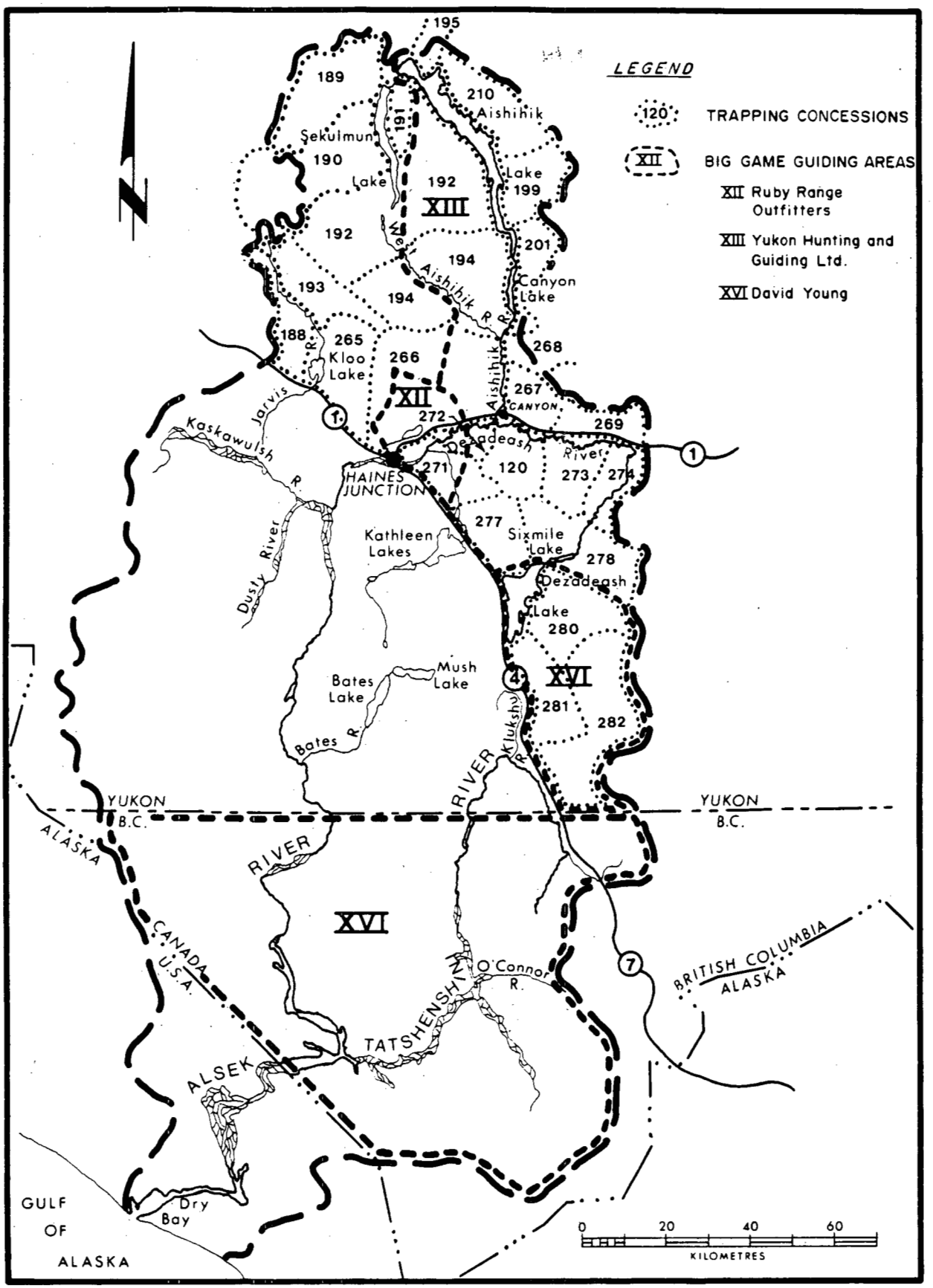

Figure 10 Trapping Concessions and Guide/Outfitter Boundaries.

mountains and longest valley glaciers plus large populations of northern mammals protected in their native habitat. First established in 1972, Kluane was designated Canada's largest mountain park in 1980 and named a World Heritage Site by UNESCO the same year (Yukon 1989c).

The Kluane National Park Reserve management plan was approved in 1980 and is presently undergoing revision. An integral part of the revised plan will be a zoning system in which land and water areas within the park will be classified according to their need for protection and their capability to withstand visitor use. The National Parks Zoning System consists of five zone classifications ranging from Zone I (Special Preservation) which permits minimal or no public use to Zone V (Park Services), which provides for centralized visitor services and park administration with less emphasis upon resource preservation objectives (Canada 1989h). Table 10 details the current zone descriptions for Kluane. The newly revised park management plan is subject to further public input before a final draft is sent to the Minister of the Environment for approval.

A major concern currently facing park planners are the issues of access and development. While tour operators call for more road access, many local residents, intent on preserving the parks wilderness characteristic, are opposed to development within the park altogether. The newest management plan attempts to appease both sides by increasing access to the interior of the park by improving the existing trail system (Figure 11) and easing rules governing air and water access. The new plan calls for about $3 million in spending above the parks normal operating budget (Canada 1989h).

Areas presently receiving the most use are the Dezadeash-Alsek River corridor, the Mush-Bates Lake corridor and the Kathleen Lakes. Attractions in these areas range from viewpoints, picnic grounds and day-use trails to motor boating, canoeing and overnight hiking.

3.7 RECREATION

Recreation within the Alsek River Basin consists of both resource consumptive activities such as fishing and hunting and non-consumptive activities such as wildlife viewing, hiking, canoeing, rafting, ski touring etc.

Table 10. Kluane National Park Reserve - zone descriptions(Canada 1989h)

ZONE	DESCRIPTION
I Special Preservation	Specific areas or features which deserve special preservation because they contain or support unique, rare or endangered features or the best examples of natural features. Access and use will be strictly controlled or may be prohibited altogether. No motorized access or man-made facilities will be permitted.
II Wilderness	Extensive areas which are good representations of each of the natural history themes of the park and which will be maintained in a wilderness state. Only certain activities requiring limited primitive visitor facilities appropriate to a wilderness experience will be allowed. Limits will be placed on numbers of users. No motorized access will be permitted. Management actions will ensure that visitors are dispersed.
III Natural Environment	Areas that are maintained as natural environments and which can sustain, with a minimum of impairment, a selected range of low-density outdoor activities with a minimum of related facilities. Non-motorized access will be preferred. Access by private vehicles will only be permitted where it has traditionally been allowed in the past.
IV Outdoor Recreation	Limited areas that can accommodate a broad range of education, outdoor recreation opportunities and related facilities in ways that respect the natural landscape and that are safe and convenient. Motorized access will be permitted and may be separated from non-motorized access.
V Park Services	Towns and visitor centres in certain existing national parks which contain a concentration of visitor services and support facilities as well as park administration functions. Motorized access will be permitted. Currently, there are no Zone V areas in Kluane.

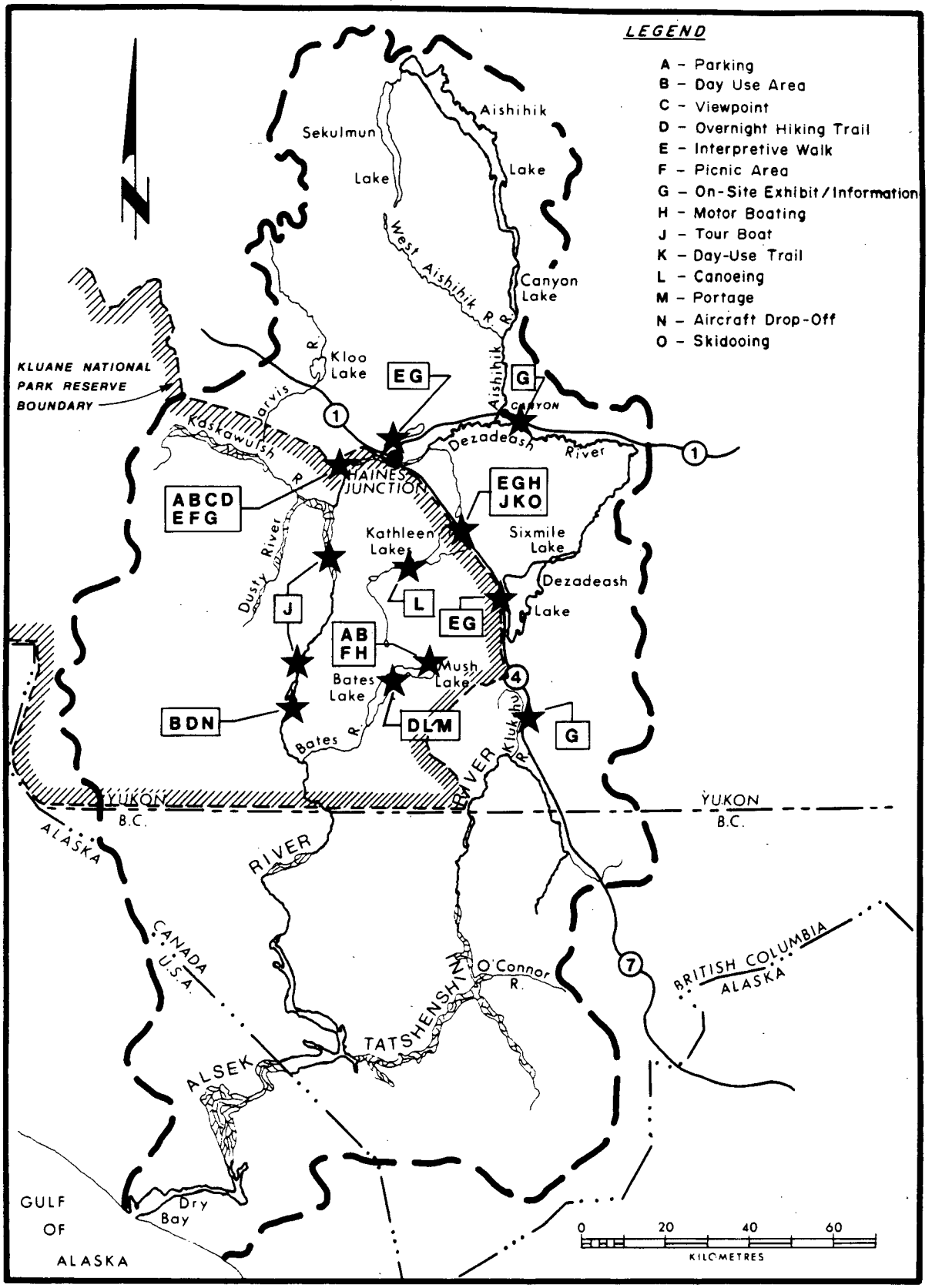

Figure II Parks and Recreation.

3.7.1 Fishing

Fishing is a major resource use activity in the Alsek River Basin with most waters open to sport fishing for both anadromous and freshwater species.

The only Pacific salmon fishery easily accessible within the Basin is located in the relatively sediment free tributaries of the upper Tatshenshini river such as the Klukshu, Blanchard, and Takhanne rivers. The three salmon species caught here are chinook, coho and sockeye, and at least one of which is available from June through to the end of October. The area represents the only river where sockeye can be sport fished in Canada (Canada 1989b).

The Klukshu river is the most important producer of salmon in the Basin and therefore receives heavy use from both the native subsistence and sport fishing groups throughout the summer salmon runs. It is estimated that between 20 and 50 anglers per day use the Klukshu river during the season with heavy weekends reportedly drawing up to 200 anglers per day(Canada 1989b).

Sport anglers are regulated to three fish per person per day. Native anglers follow the same regulations; however, they are able to obtain special gaffing and netting licences from the Department of Fisheries and Oceans (DFO) providing that all fish caught in this manner are used as personal food supply.

The salmon fishery is regulated and monitored closely by DFO. A fishing weir built in 1976 on the Klukshu river, aids the DFO staff in determining the spawning population necessary in developing fisheries management plans. Recently, salmon counts at the Klukshu weir have indicated a decline in both the early and late sockeye stocks. The cause of this decline has yet to be researched and a ban on sockeye catch has been put into effect until the cause of this decline can be determined. Table 11 lists the salmon sport harvests from the upper Tatshenshini river for the period 1976-1988.

Table 11. Canadian sport catch of Alsek-Tatshenshini salmon, 1976-1988 (Canada 1988a).

Year	Chinook	Sockeye	Coho
1976	200	600	100
1977	300	500	200
1978	300	500	200
1979	650	750	100
1980	200	600	200
1981	315	808	109
1982	224	755	109
1983	312	732	16
1984	475	289	20
1985	250	100	100
1986	165	307	9
1987	365	383	49
1988	249	322	192

A wide variety of freshwater species are fished throughout the Alsek Drainage Basin with lake trout, arctic grayling and northern pike being the most popular.

To some degree, accessibility dictates fishing pressure; waterbodies located along the Haines and Alaska Highways have become popular sport fishing areas. Other road accessible areas important to the freshwater fishery include Aishihik, Klukshu, and Pine lakes along with the Kathleen and Jarvis rivers. The Kathleen River, in particular, is heavily sport fished for rainbow trout.

The commercial sport fishery involves highway lodges and guide operators who offer fishing opportunities (both anadromous and freshwater) on road accessible lakes and streams and guiding packages into more remote lakes and streams accessible only by boat or plane. Such remote places include Lakes Sekulmun and Sixmile. Winter ice-fishing on Kloo, Pine and Rainbow Lakes is popular primarily with resident anglers.

Federal jurisdiction over the freshwater fisheries resource in the Yukon portion of the Basin was turned over to the Yukon Territorial Government in April of 1989. The Yukon Territory fishing regulations, specifically freshwater legislation, will be administered by the Yukon

Territorial Government. Parks Canada maintains its jurisdiction over biological and habitat management within the Kluane National Park Reserve and requires anglers within the park to obtain a separate fishing permit. British Columbia Fish and Wildlife Branch maintains jurisdiction over biological and habitat management of freshwater fish and anadromous trout (Steelhead) in British Columbia waters.

3.7.2 Hunting

With the exception of the presence of Kluane National Park Reserve and two game sanctuaries which are closed to hunting, the Alsek River Basin offers plenty of hunting opportunities.

Three registered hunting guide/outfitters operate within the Basin; one in the northeast portion of the Basin, a second operates in the Haines Junction area and the third makes use of the southeastern portion of the Basin in the Yukon and the entire British Columbian portion of the Basin (see Figure 10).

Most of the hunting in the area is done by non-residents, most of whom come from outside Canada, primarily American and European visitors (Peepre 1986). Non-residents, who are usually more inclined towards trophy hunting, are required to use guide/outfitter services. Grizzly bear, mountain sheep, and mountain goats are the most sought after game species yet other species such as black bear, wolves, lynx, and wolverine along with various grouse, ptarmign and waterfowl are also taken.

Wildlife management in the Basin has been restrictive with limited entry hunting for residents and a non-resident quota.

Air access into remote regions of the Basin outside the park is often used by hunters as road access is limited to the Alaska and Haines highways and associated mining exploration spur roads (Peepre 1986). Poaching is perceived to be a problem in the area, with limited manpower available for monitoring and enforcement activities (pers. comm.Jean Carey Fish & Wildlife Branch, Renewable Resources, INAC).

3.7.3 Non-consumptive Use

The Alsek River Basin supports a wide variety of non-consumptive recreational activities with minimal impacts upon the environment.

Kluane National Park Reserve along with both the Alsek and Tatshenshini rivers create a powerful year round attraction to both resident and non-resident outdoor recreationalists.

The Kluane National Park Reserve is the hub of most recreational activities within the Basin. In addition, there exists many proposals in the draft park management plan to improve existing sites and facilities and develop new ones. According to the Kluane National Park Reserve Management Plan Review, outdoor activities within the park have been concentrated in three general areas; Dezadeash-Alsek Valley, Mush-Bates Corridor and Kathleen Lakes. Each area provides an array of activities in which park visitors can participate.

The Dezadeash-Alsek Valley may be accessed by road, boat or aircraft. The road crosses 3 km of the Kluane Game Sanctuary to reach the park where a day-use recreation area development is proposed. This route is presently used by mountain-bike tours, extended day hikes and overnight use. Currently under study is the feasibility of controlled motorized boat access on the Dezadeash/Alsek rivers to provide one-day commercial boat tours to the toe of the Lowell Glacier from Haines Junction. The commercially outfitted and private rafting and kayak ventures presently using these waters may be enhanced by a proposed aircraft landing node near the toe of the Lowell Glacier which would allow for raft/kayak group pick-ups. The air access could also provide drop-offs for wilderness back country hiking and day-use.

The Mush-Bates Corridor currently provides back country aquatic recreation for low-density use. Future plans include developing an extensive back country trail network. Private vehicle access will soon be permitted using a self registration system to ensure Canadian Parks Service (CPS) control of access. Parking, a picnic area and primitive walk-in camping facilities will be located at the east end of Mush Lake. Controlled motorboat access and associated recreation will be permitted on Mush Lake. Bates Lake will be zoned for non-motorized use only and a key-lock canoe rental service is to be provided.

The Kathleen Lakes area is presently the focal point for highway accessible camping and aquatic based recreation. The recently upgraded campground and day-use area provide easily accessible day and overnight

recreation at the parks periphery. The campground is soon to be linked to an existing trail system and on site exhibits will be developed to interpret the Kathleen Lakes area. While motorboating is permitted on the larger Kathleen Lake, only non-motorized use is permitted on the smaller lake and a key-lock operated canoe/boat rental is to be provided in the near future.

Snowmobiling is presently permitted on the larger Kathleen lake only, primarily to serve ice-fishing recreation. Seen as being incompatible with the wilderness character of the park, there is a need to relocate recreational snowmobiling in other areas of the Basin outside the park.

Both the Tatshenshini and Alsek rivers are recognized internationally as world class rafting/kayaking rivers. In order to maintain the wilderness experience, the number of commercially outfitted trips down the Tatshenshini/Alsek River route has been limited to 34 annually, split equally amongst Canadian and American companies (per comm. John Mikes President of Adventure Tourism, B.C.). To date, 13 companies, seven American and six Canadian, make use of this arrangement (Table 12). American companies have used their entire quota of 17 trips per season since 1981, while Canadian companies have run only 5 to 7 trips per year (Peepre 1986). At least one Canadian company rents equipment to private parties. Though there is no reliable data on private parties using the rivers, it is known that though they are increasing in number they pose no potential risk to the wilderness rafting experience.

Commercial rafting/kayaking on the Alsek River is limited by the presence of Turnback Canyon and the difficulty in transporting large parties over or around 15 km of the Tweedsmuir Glacier in order to avoid the canyon. Several companies are investigating the possibility of helicopter ferries around the canyon (Peepre 1986).

Some winter recreational activities aside from camping, hiking and snowmobiling within the Alsek Basin include mountaineering and heli-skiing which take place in the park's Kluane and Icefield Ranges.

Table 12. Volume of business by companies offering Tatshenshini/Alsek River raft trips (Yukon 1989c)

COMPANY	Number of Trips	Number of People per trip	Number of Days per trip	Total User Days	Cost per Person per trip ($ Can.)	Number of people trips (1x2)	Total Revenues ($ Can.)
	1	2	3	4	5	6	7
Alaska Discovery	3	14	1	42	2,000	42	84,000
Arctic Edge	1	11	14	154	1,300	11	14,300
Canadian River Expeditions	2	3	1	6	22,000	6	132,000
Chilkat Guides	2	1	1	2	1,500	2	3,000
Colorado River & Trail Guides	1	15	13	195	1,900	15	28,500
James Henry River Journeys	1	19	11	29	2,600	19	49,400
Sobek Canada	1	8	1	8	2,000	8	16,000
Sobek Explorations	7	8	1	56	2,000	56	112,000
Tatshenshini Expediting	2	13	1	263	?	26	?
Whitewater Adventures	1	12	12	144	2,100	12	25,200
Tatshenshini Day Trips	1	175	1	175	90	175	15,750
Wilderness River Outfitters	1	6	1	6	2,100	6	12,600
Alaska Cross Country Guiding & Rafting	?	?	?	?	?	?	?
Totals	23	285	58	1080	-	378	492,750

3.8 TOURISM

Tourism is the Basin's primary industry and revenues obtained both directly and indirectly from this sector continue to increase. Visitors to the Basin are attracted by the unspoiled wilderness of Klunae National Park Reserve and the surrounding lands.

As the Basin's major employer, the tourism industry employs over half of the community of Haines Junction both directly and indirectly (pers. comm. Brent Little, Parks Canada). Both the Yukon Department of Tourism and Canada Parks Service have carried out visitor surveys of Kluane National Park Reserve in the past. Results of these surveys indicate that the size of the North American market for Kluane is approximately 11 million people; 10 million from the United States and 1 million from Canada. During a single visitor season, approximately 180 000 visitors drive through Haines Junction and past the Park Reserve along the Alaska Highway. About 70 000-80 000 of these travellers stop at the interpretation centers in Haines Junction. About 1 000 people register for backcountry use permits that involve overnight use in the park. In general, visitors to the Basin are predominantly from the United States, come by private vehicle, travel in small groups and are over 55 years of age (Canada 1989h).

Tourist travel to the Basin has grown an average of 4 percent per year over the past 12 years (Canada 1989h). Presently, the Yukon Territorial Government is developing a Kluane Region Tourism Plan. Within the plan, Kluane National Park Reserve is seen as the "high end" of the wilderness recreation market with the surrounding region providing support services and other more facility-oriented attractions from which tours into the park may be staged, e.g. lodges, recreational vehicles(RV) camps, etc.

The Basin offers a variety of accommodations for visitors both in Haines Junction and along the highway routes. The Territorial Government maintains 4 campgrounds accommodating both tents and RV's, and 1 day-use area. Canada Parks Service maintains the Kathleen Lakes Campground within the Park Reserve. Haines Junction provides a total of 60 units of accomodations in 5 motels and 3 lodges and another 33 units are provided in various locations within the Basin.

Haines Junction contains the headquarters for Kluane National Park Reserve. The Haines Junction Visitor Reception Centre, located in the headquarter's building, provides information on what to see and do in the Basin including details on hiking trails and canoe routes as well as an international award-winning audio-visual describing the park. Other local attractions can be previewed on a laser disc player also located in the centre. The centre is open year round.

4. SUMMARY & CONCLUSION

4.1 SUMMARY

The Alsek River originates at the confluence of the Kaskawulsh and Dezadeash rivers in the southwestern corner of the Yukon. The river flows south for 148 km into the northwest corner of British Columbia where it turns southwest, crosses the International boundary and flows another 85 km before draining into the Gulf of Alaska.

The Alsek River Basin is comprised primarily of the St. Elias Mountains with the Coast Mountain complex occupying the western side and the Kluane Plateau covering the Basin's northern portion. The Shakwak valley runs northwest to southeast through the Basin and divides the mountain systems of the south from the plateau lands of the north.

The Basin's climate is influenced by two external climatic regimes; the moist, mild maritime climate of the southwest and the dry, extreme continental climate of the northeast. Precipitation increases dramatically as one nears the coast where it reaches an annual maximum of 364 mm. Temperatures range from a summer average of 12°C in the northeast while the southwestern portion of the Basin experiences a more moderate average temperature range. Alpine temperatures are cooler throughout the Basin. Winters are mild with a January mean temperature of -3°C.

The Alsek River Basin drains approximately 27 920 sq.km. and has a mean annual discharge of approximately 500 m^3/s at its mouth. The Alsek's largest tributary, the Tatshenshini River, is estimated to contribute 100 m^3/s of this flow. The greatest percentage of streamflow arises from melting snow and glacial ice. All rivers in the Basin exhibit natural flow with the single exception of the Aishihik River which was dammed in 1975.

A small powerhouse at the damsite generates power that is supplied to the lead-zinc mine in Faro, just north of the Basin, the city of Whitehorse, and Haines Junction, the Basin's main community.

Both the Aishihik and the Dezadeash rivers maintain excellent water quality; other rivers within the Basin contain glacial flour and moderate to heavy sediment loads. Local water degradation from Haines Junction is not significant.

There are three major vegetation zones represented in the Basin: the moist Coast Mountain Zone covering the eastern, central and southern portions of the Basin; the cooler St. Elias Mountain Zone to the west and northwest; and, the drier Kluane Plateau Zone to the north. White and black spruce are the dominant tree types and are usually mixed with a variety of deciduous trees and occasionally lodgepole pine. The shrub vegetation is comprised primarily of soapberry, willows and shrub birch whereas the extensive alpine portions of the Basin are vegetated with lichen, ericaceous shrubs and forbs.

The biogeoclimatic differences within the Basin provide for a diversity of wildlife from the moose to the lemmings and mice. Of greatest significance is the grizzly (brown) bear population, as it is one of the largest in Canada. Dall sheep and mountain goats are also important mammals as are black bears, timber wolves and lynx.

The Alsek Basin is also important to a number of predatory birds and to many waterfowl species who use the Shakwak Trench as a migratory flyway and production area.

The Basin supports a considerable fishery resource including both anadromous and freshwater fish stocks. Chinook, coho and sockeye are found in the Tatshenshini river while a wide variety of freshwater fishes are found in most other rivers, streams and lakes within the Basin.

Human inhabitation of the Basin began some 5,000 years ago with the arrival of the Southern Tutchone. The first non-native settlers arrived in the 1890's in search of gold. Some fifty years later, after the search for gold had subsided, the construction of the Alaska Highway brought thousands of military and civilian personnel to the Basin. The effect of such a population influx was highly detrimental to the native people as many succumbed to newly introduced diseases and starved due to a

depletion in game reserves. Today, while the non-native population centered in Haines Junction, numbers approximately 391, the descendants of the Southern Tutchone natives, members of the present day, Champagne-Aishihik Band, number 260. Most of the Basin's native people are settled in Haines Junction with the remaining few residing in the traditional communities of Canyon and Champagne.

In response to severe game depletions in the Basin in 1942, the Federal government set aside some 25 900 sq. kms of land in the southwestern corner of the Yukon as the Kluane Game Sanctuary. Fifty years later, most of this land became the Kluane National Park Reseve, a feature which has dominated the Basin ever since. In areas outside park boundaries, resource use and development has not been extensive. In the mining sector, the Squaw Creek area in the Tatshenshini watershed supports a small scale, seasonal placer operation and further south, between the Tatshenshini and Alsek rivers, plans are under way to develop a massive ore deposit on the Windy Craggy properties. Property owners, Geddes Resources Ltd., have spent over $32 million to date to further define the reserves and are expected to submit a Stage I environmental impact study to the British Columbia Mine Development Steering Committee (MDSC) in early 1990. The MDSC is currently reviewing a submission from Geddes Resources Ltd. to construct a 110 km, all-season mine access road from the potential minesite east to Highway 7.

The forest resources in the Basin have remained commercially unexploited due to non-viable timber stands and to poor access to viable stands. The Champagne-Aishihik Indian Band has established its own logging firm which harvests timber from the Band's protected lands, most of which is used as fuelwood and to produce sawn lumber for native construction projects. At present, this is a small scale operation employing and supplying the needs of the Basin's band members. In addition, a one-man sawmill just east of Haines Junction, produces small quantities of sawn lumber which is used locally in construction.

Due to its rich diversity in fish and wildlife, fishing and hunting within the Alsek Basin have become important economic sectors for the Basin's population. The Basin's largest employer and foremost industry is tourism. Kluane National Park Reserve features some of the worlds

largest icefields, Canada's highest mountains and longest glaciers plus large populations of northern mammals protected in their native habitat. Such features attract thousands of visitors to the Basin each year. The park also attracts many outdoor recreationalists whose interests lie in hiking, climbing, canoeing, rafting, kayaking, ski touring etc. Long term management plans for the park are still being revised and are open to public input. Park headquarters, the administrative center and the park Visitor Reception Area are located in Haines Junction and are open year round.

4.2 CONCLUSION

The Alsek River Basin is an area of potential economic opportunity. Though future expansion of the forest industry seems unlikely, the mining sector may experience considerable growth providing the Windy Craggy properties in the southern Basin are developed as planned. There is considerable concern that increased road access into the Basin, as proposed by the Windy Craggy mine development would result in reduced viable habitat for some species, as well as a direct impact from increased hunting of certain game species due to increased access to the previously remote area. Of primary concern for the Inland Waters Directorate is the potential degradation of water quality of the Tatshenshini and Alsek rivers downstream from the proposed development site. There is an expressed need for a continuous monitoring of water quality on the Tatshenshini River immediately upstream and downstream from Tats Creek (Windy Craggy mine site drainage) and also on the Alsek River at the Canada/U.S. border. To date, there are no water quality or hydrometric stations on either rivers downstream from the development site.

Inland Waters Directorate may also have an interest in determining if water quality degradation is a reason behind the significantly depleted sockeye stocks in the Tatshenshini River system. There is also considerable potential for further hydro electric power development on the Alsek River. The demand for such power, does not exist at this time and such projects are therefore unlikely in the foreseeable future.

The Basin plays a critical role as a major northern migratory flyway for some 100 000 waterfowl and other avifauna who use the Shakwak

Valley as a staging and production area. Though much of this valley is protected within the bounds of Kluane National Park Reserve, its most eastern portion lies outside the park boundary and is therefore subject to impact from potential development. The expertise of the Inland Waters Directorate and other services within Conservation and Protection may be requested if development is to occur in such areas.

In summary, then, there appears to be limited areas of concern or increased involvement for Inland Waters Directorate in the Alsek River Basin. Most important of these is the potential for water quality deterioration from the proposed Windy Craggy development. The establishment of hydrometric and water quality stations to monitor the Basin's waters for any water quality changes seem warranted at this time. A Federal/Provincial/Territoral Agreement Respecting Water Resource Management and Information Exchange in the Yukon and Alsek River Basins is expected to be signed in 1990. Issues associated with water management in the Alsek River Basin are expected to be addressed under this Agreement.

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Appendix 6.1. Climate Data

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
AISHIHIK A													
61°39'N 137°29'W 966m													
Daily Maximum Temperature	-18.1	-10.2	-4.5	2.9	10.5	16.2	18.2	16.5	10.7	2.3	-8.4	16.3	1.7
Daily Minimum Temperature	-29.6	-24.1	-20.9	-10.3	-2.4	3.2	5.6	3.7	-1.1	-9.1	-19.3	-27.1	-11.0
Daily Temperature	**-23.6**	**-16.9**	**-12.2**	**-3.7**	**4.2**	**9.8**	**12.1**	**10.3**	**5.1**	**-2.6**	**-13.6**	**-21.9**	**-4.4**
Standard Deviation, Daily Temperature	5.6	3.4	3.3	2.0	1.7	1.5	1.1	1.1	1.1	1.3	2.5	5.1	5.3
Extreme Maximum Temperature	8.3	7.2	11.1	18.3	28.3	30.6	30.6	28.9	22.8	17.2	9.4	6.7	30.6
Years of Record	23	23	23	23	23	23	24	24	24	23	23		
Extreme Minimum Temperature	-52.8	-58.7	-46.1	-37.8	-16.7	-5.0	-2.8	-8.9	-20.0	-27.8	-47.2	-50.6	-56.7
Years of Record	23	23	23	23	23	23	24	24	24	23	23		
Rainfall	0.0	0.0	0.0	0.6	13.8	40.0	48.5	39.6	18.2	1.3	0.0	0.0	162.0
Snowfall	13.5	10.0	11.4	8.9	8.4	1.1	0.0	0.8	6.2	15.4	15.4	13.4	104.5
Total precipitation	**11.7**	**9.1**	**10.1**	**8.3**	**22.4**	**41.1**	**48.5**	**40.5**	**24.5**	**16.0**	**12.4**	**11.7**	**256.3**
Standard Deviation, Total Precipitation	9.2	4.5	5.8	6.9	11.3	13.4	23.1	23.0	8.5	7.6	6.8	5.1	30.2
Greatest Rainfall in 24 hours	T	T	0.5	6.6	25.9	25.7	44.7	38.4	19.1	6.6	T	0.5	44.7
Years of Record	23	23	23	23	23	24	24	24	24	23	23	23	
Greatest Snowfall in 24 hours	11.4	7.1	16.5	14.0	12.7	7.4	0.0	T	15.2	15.2	7.1	9.1	16.5
Years of Record	23	23	23	23	23	24	24	24	23	22	23	23	
Greatest Precipitation in 24 hours	11.4	7.1	16.5	15.2	25.9	25.7	44.7	38.4	19.1	17.8	7.1	9.1	44.7
Years of Record	23	23	23	23	23	24	24	24	24	22	23	23	
Days with Rain	0	0	0	0	5	11	12	11	7	1	0	0	47
Days with Snow	10	8	8	5	3	0	0	0	3	9	10	10	66
Days with Precipitation	9	8	8	5	8	11	12	11	9	9	9	10	109

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
KLUANE LAKE													
61° 1'N 138° 24'W 786m													
Daily Maximum Temperature	-15.3	-9.2	-4.4	3.7	11.1	16.7	18.6	17.1	11.6	2.9	-5.3	-13.7	2.8
Daily Minimum Temperature	-27.3	-23.0	-18.9	-7.4	-1.1	3.6	6.0	4.6	0.5	-6.7	-15.1	-24.2	-9.1
Daily Temperature	**-20.5**	**-15.4**	**-10.9**	**-1.8**	**5.4**	**10.3**	**12.6**	**11.2**	**6.3**	**-1.6**	**-9.7**	**-18.5**	**-2.7**
Standard Deviation, Daily Temperature	5.8	7.5	2.9	1.7	0.9	0.9	0.7	1.5	0.9	1.9	5.4	5.9	0.8
Extreme Maximum Temperature	7.2	8.3	8.5	19.5	20.0	26.1	27.2	27.8	22.2	14.0	11.1	3.9	27.8
Years of Record	8	7	7	6	9	11	10	10	9	7	8	9	
Extreme Minimum Temperature	-48.9	-46.0	-41.1	-23.9	-6.7	-3.3	-0.0	-4.4	-11.1	-21.1	-31.7	-46.1	-48.9
Years of Record	8	7	7	6	8	11	10	10	9	8	9	9	
Rainfall	3.0	0.2	0.0	1.0	24.7	32.3	47.0	33.8	15.7	6.0	3.4	1.8	168.9
Snowfall	6.2	6.2	5.5	7.4	3.1	0.0	0.0	0.2	1.5	11.4	15.2	10.2	66.9
Total precipitation	**7.2**	**5.9**	**5.2**	**7.9**	**22.1**	**32.3**	**47.0**	**34.1**	**17.2**	**16.3**	**17.7**	**11.0**	**223.9**
Standard Deviation, Total Precipitation	5.0	7.0	5.2	6.1	11.6	21.7	24.6	34.0	15.4	14.2	14.3	7.9	22.1
Greatest Rainfall in 24 hours	12.7	T	0.0	0.0	16.6	22.1	30.7	29.8	15.7	14.7	6.4	0.0	30.7
Years of Record	8	7	7	7	6	8	8	7	8	6	8	8	
Greatest Snowfall in 24 hours	6.4	11.4	11.4	8.9	10.0	0.0	0.0	0.8	7.9	11.0	37.0	8.9	37.0
Years of Record	8	7	7	7	7	8	8	8	8	6	7	8	
Greatest Precipitation in 24 hours	12.7	11.4	11.4	8.9	16.6	22.1	30.7	29.8	15.7	23.6	37.0	8.9	37.0
Years of Record	8	7	7	7	6	8	8	7	8	6	7	8	
Days with Rain	0	0	0	0	5	7	11	8	6	2	0	0	39
Days with Snow	5	5	4	3	1	0	0	0	0	4	8	7	37
Days with Precipitation	5	5	4	3	4	7	11	8	6	7	8	7	75

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
HAINES JUNCTION													
60° 46'N 137° 35'W 599 m													
Daily Maximum Temperature	-17.0	-8.0	-1.9	5.9	12.6	18.1	19.9	18.5	13.1	4.5	-6.5	-14.7	3.7
Daily Minimum Temperature	-28.6	-23.1	-18.1	- 7.1	-1.9	2.5	5.0	3.0	-0.9	-7.1	-17.8	-26.2	-10.0
Daily Temperature	**-22.9**	**-15.6**	**-10.0**	**-0.6**	**5.4**	**10.3**	**12.5**	**10.8**	**6.2**	**-1.3**	**-12.2**	**-20.5**	**-3.2**
Standard Deviation, Daily Temperature	5.5	4.7	3.1	1.8	1.0	1.5	1.0	1.3	1.2	2.4	4.9	5.1	1.1
Extreme Maximum Temperature	12.2	15.0	15.6	20.6	27.8	32.8	31.1	31.0	25.6	18.9	13.9	10.6	32.8
Years of Record	36	36	36	36	36	35	36	36	36	36	37	37	
Extreme Minimum Temperature	-53.9	-53.9	-43.9	-30.6	-12.2	-6.7	-3.3	-11.1	-17.2	-30.6	-47.2	-53.9	-53.9
Years of Record	36	36	36	36	36	36	36	36	36	36	36	36	37
Rainfall	0.6	0.6	0.3	1.2	11.6	29.1	36.3	28.8	28.9	13.4	4.0	2.8	157.6
Snowfall	22.5	16.4	10.1	6.9	3.4	0.0	0.0	0.1	0.5	19.7	31.1	30.0	140.7
Total precipitation	**21.9**	**15.9**	**9.5**	**7.6**	**14.9**	**29.1**	**36.3**	**28.9**	**29.4**	**33.1**	**34.1**	**31.8**	**292.5**
Standard Deviation, Total Precipitation	13.4	9.8	7.1	6.5	10.9	16.6	22.5	17.0	17.0	7.6	6.8	5.1	72.5
Greatest Rainfall in 24 hours	12.7	10.2	3.8	12.7	20.6	33.0	28.4	25.0	32.5	55.1	51.6	58.4	58.4
Years of Record	36	35	35	36	35	35	36	36	35	35	37	36	
Greatest Snowfall in 24 hours	33.3	29.2	14.2	12.7	10.0	3.6	0.0	3.0	7.6	67.3	35.0	23.9	67.3
Years of Record	36	34	35	36	35	35	36	36	35	35	34	36	
Greatest Precipitation in 24 hours	33.3	19.3	14.2	12.7	25.7	33.0	28.4	25.0	32.5	67.3	54.6	58.4	67.3
Years of Record	36	34	35	36	36	35	36	36	35	35	34	36	
Days with Rain	*	*	*	1	4	7	9	8	8	4	1	*	42
Days with Snow	8	7	5	3	1	0	0	*	*	6	9	11	50
Days with Precipitation	9	7	5	4	5	7	9	8	8	9	10	11	92

Appendix 6.2. Biogeoclimatic Zone Vegetation

FOREST COMMUNITY

SCIENTIFIC NAME	COMMON NAME
Picea glauca/Sherpherdia canadensis (closed phase)	White spruce/buffaloberry closed coniferous forest
Picea glauca/Sheperdia canadensis (open phase)	White spruce/buffaloberry open coniferous forest
Picea glauca/Salix glauca	White spruce/greyleaf willow coniferous forest
Picea glauca/Salix glauca/ Arctostaphylos	White spruce/greyleaf willow/ bearberry coniferous forest
Picea glauca/Betula glandulosa/ Empetrum nigrum	White spruce/shrub birch/ crowberry coniferous forest
Picea glauca/Arctostaphylos alpina var. rubra/Thuidium abietinum	White spruce/red bearberry/ Thuidium moss coniferous forest
Picea glauca/Thuidium abietinum	White spruce/Thuidium moss coniferous forest
Picea glauca/Cladina arbuscula	White spruce/reindeer moss coniferous forest
Picea glauca/Aulocomnium palustre	White spruce/Aulocomnium moss forest
Picea glauca/Hylocomium splendens	White spruce/Hylocomium moss forest
Picea glauca/Salix planifolia - Betula glandulosa/Carex aquatilis	White spruce/diamond willow-shrub birch/water sedge fen
Picea glauca/Betula glandulosa/ Carex aquatilis	White spruce/shrub birch/water sedge fen
Picea glauca - Populus tremuloides	White spruce - trembling aspen/
Populus balsamifera (dry phase)	Balsam poplar dry deciduous forest
Populus balsamifera (mesic phase)	Balsam poplar mesic deciduous forest
Populus balsamifera/Shepherdia canadensis	Balsam poplar/buffaloberry desiduous forest
Populus balsamifera/Elaeagnus commutata	Balsam poplar/silverberry

Populus tremuloides/Arctostaphylos uva-ursi	Trembling aspen/bearberry deciduous forest
Salix scouleriana	Scouler's willow deciduous forest

SHRUB AND HERB COMMUNITY

SCIENTIFIC NAME	COMMON NAME
Salix glauca	Greyleaf willow shrub
Salix glauca/Calamagrostis purpurascens	Greyleaf willow/purple reedgrass shrub
Salix glauca/Arctosstaphylos uva-ursi	Greyleaf willow/bearberry shrub
Salix setchelliana	Setchell's willow shrub
Salix setchelliana - Oxytropis campestris	Setchell's willow - field crazyweed shrub
Salix alaxensis	Alaska willow shrub
Salix bebbiana/Salix glauca/ Festuca altaica	Long-beaked willow/greyleaf willow/ fescue low forest
Salix planifolia - Salix barclayi/ Carex aquatilis	Diamondleaf willow - Barclay's willow/water sedge fen
Elaeagnus commutata	Silverberry shrub
Elaeagnus commutata/Ditrichum flexicaule	Silverberry/Ditrichum moss shrub
Shepherdia canadensis/Festuca altaica	Buffaloberry/fescue shrub - meadow
Betula glandulosa/Aulocomnium palustre	Shrub birch/Aulocomnium moss shrub
Betula glandulosa/Festuca altaica	Shrub birch/fescue shrub - meadow
Betula glandulosa/Carex aquatilis	Shrub birch/water sedge fen
Juniperus horizontalis	Creeping juniper shrub
Juniperus communis/Arctostaphylos uva-ursi	Common mountain juniper/bearberry shrub
Artemisia frigida - Agropyron yukonense	Prairie sage - Yukon wheatgrass shrub - grassland

Artemisia frigida	Prairie sage shrub
Artemisia firgida - Poa glauca	Prairie sage - glaucous bluegrass shrub - grassland
Artemisia frigida/Ditrichum flexicaule	Prairie sage/Ditrichum moss shrub
Artemisia frigida/Calamagrostis purpurascens	Prairie sage/purple reedgrass meadow
Artemisia alaskana	Alaska sagewort shrub
Calamagrostis purpurascens	Purple reedgrass meadow
Dryas frummondii	Yellow dryas meadow
Hedysarum boreale - Agropyron yukonense	Northern hedysarum - Yukon wheatgrass dry meadow
Agropyron yukonense	Yukon wheatgrass dry meadow
Dryas integrifolia scirpoides	Entire-leaved dryas - sedgelike horsetail meadow
Dryas integrifolia	Entire-leaved dryas meadow
Carex sabulosa	Siberian sedge dunes
Picea glauca/Salix brachycarpa - Shepherdia canadensis/Juncus arcticus	White spruce/barren-ground willow - buffaloberry/bltic rush shrub
Salix brachycarpa/Juncus arcticus	Barren-ground willow/baltic rush
Carex aquatilis	Water sedge floodplain
Salix brachycarpa/Carex aquatilis	Barren-ground willow/water sedge floodplain
Juncus articus	Baltic rush floodplain
Hordeum jubatum	Squirrel-tail floodplain
Aster yukonensis	Yukon aster floodplain
Puccinellia nutkaensis	Pacific alkaligrass floodplain
Taraxacum ceratophorum	Horned dandelion floodplain

SUBALPINE COMMUNITY

SCIENTIFIC NAME	COMMON NAME
Salix glauca	Greyleaf willow shrub
Dryas integrifolia	Entire-leaved dryas meadow
Oxytropis viscida	Viscid oxytrope meadow
Flaeagnus commutata	Silverberry shrub
Carex filifolia	Thread-leaf sage meadow
Salix barrattiana - Salix myrtillifolia	Barratt willow - bilberry willow shrub
Alnus crispa ssp. lacinata	Alder shrub
Salix barclayi	Barclay's willow shrub
Calanagrostis canadensis - Equistem arvense	Bluejoint - common horsetail mesic meadow
Veratrum eschscholtzii - Saussurea americana	False hellebore - america sawwort mesic medow

ALPINE COMMUNITY

SCIENTIFIC NAME	COMMON NAME
Kobresia myosuroides	Bellard's kobresia meadow
Dryas octopetala	White dryas meadow
Carex podocarpa	Black nodding sedge meadow
Carex microchaeta	Small nodding sedge
Carex membranacea - Salix reticulata	Black sedge - netleaf willow meadow
Salix polaris	Polar willow meadow
Salix reticulata	Netleaf willow meadow
Salix barrattiana	Barratt willow shrub
Salix barclayi	Barclay's willow shrub

Salix reticulata - Festuca altaica	Netleaf willow - fescue meadow
Cassiope tetragona	Lapland cassiope meadow
Cassiope stelleriana	Alaska moss heath meadow
Artemisia - Oxytropis viscida	Sage - viscid oxytrope meadow
Festuca altaica	Fescue meadow
Poa rupicola	Timberline bluegrass meadow
Eriophorum angustifolium	Tall cottongrass meadow
Luetkea pectinata	Partridgefoot meadow
Luetkea pectinata - Salix polaris	Partridgefoot - polar willow meadow
Luzula piperi	Piper's woodrush scree
Phyllodoce empetriformis	Red-mountain heather meadow

Appendix 6.3 Windy Craggy Minesite Data

PROJECT DETAILS

Project Location: NW British Columbia at 59°N, 138°W
Estimated Capital Cost: $400 million (1989 dollars)
Minerals: Copper, gold, silver (Cobalt and Zinc possible)
Mine System: Open Pit to be followed by Underground
Estimated Production: 15,000 to 20,000 tonnes per day.
Process Plant/Mill: Flotation
Proposed Mine Life: + 30 years

MINERAL RESERVES/RESOURCES

Reserves: Drill Indicated + 70 Million tonnes
Possible 150 Million tonnes
Average Grade of Ore: 2.4% Cu, 0.22 g/t Au, 2.6 g/t Ag, 0.08% Co
Cut-off Grade: 1.0% Cu
Potential For Additional Reserves: Excellent

ACCESS/TRANSPORTATION

Currently under review is road access to haul concentrate from the mill, and air access to transport personnel.

Road Preference: From Mile 90 of the Haines Riad via Scottie Pass to the Tatshenshini River and then up Tats Creek and Glacier to the mine - 110 km.
Alternative Routes: Parton Pass or O'Connor River.
Rail: N/A
Air Access: For crew rotation, by chartered large aircraft from Whitehorse/Smithers
Shipping: Haines, Alaska

POWER SUPPLY

Requirements: Approximately 15 MWatt
Supply Alternatives: Large diesel generators, hydro dam on Tats Creek.

WORKFORCE INFORMATION
(Annual average at full production)

Housing Options: Camp
Construction Workforce (man-years): 2000
Workforce Rotation: 2 weeks on/2 weeks off
Indirect/Induced Employment: 1500 man-years

DEVELOPMENT SCHEDULE

Stage I Submission Filed: early 1990
Site Construction Startup: 2nd Quarter 1990
Production Startup: 4th Quarter 1992