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# THE STIKINE RIVER BASIN:

# AN OPPORTUNITY FOR FUTURE WATER RESOURCE MANAGEMENT

D. SHERWOOD
SEPTEMBER 1982



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WATER PLANNING AND MANAGEMENT BRANCH

INLAND WATERS DIRECTORATE

# THE STIKINE RIVER BASIN:

# AN OPPORTUNITY FOR FUTURE WATER RESOURCE MANAGEMENT

BY

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PLANNING DIVISION

VANCOUVER, B.C.

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# ABSTRACT

This report has been prepared by the Planning Division, Water Planning and Management Branch in order to update and collate available information relating to water resource management in the Stikine River Basin. The objective of the report is to study development opportunities in the Stikine River Basin, consider the potential for water and related resource use conflicts, and identify areas of possible Inland Waters Directorate involvement.

The report describes the physical, biological, and human characteristics of the Basin and then outlines existing and foreseeable developments. Those developments discussed include hydroelectric projects, mining, fishing, forestry, parks, tourism and recreation, transportation, trapping, and agriculture.

An analysis of the effects of these developments on the Basin's natural resources and socioeconomic conditions is provided, and the compatability of the alternative resource use options is evaluated. The report outlines current management practices, including the present extent of Inland Waters Directorate participation in the Basin. Recommendations are made pertaining to future water resource planning and management activities in the Basin.

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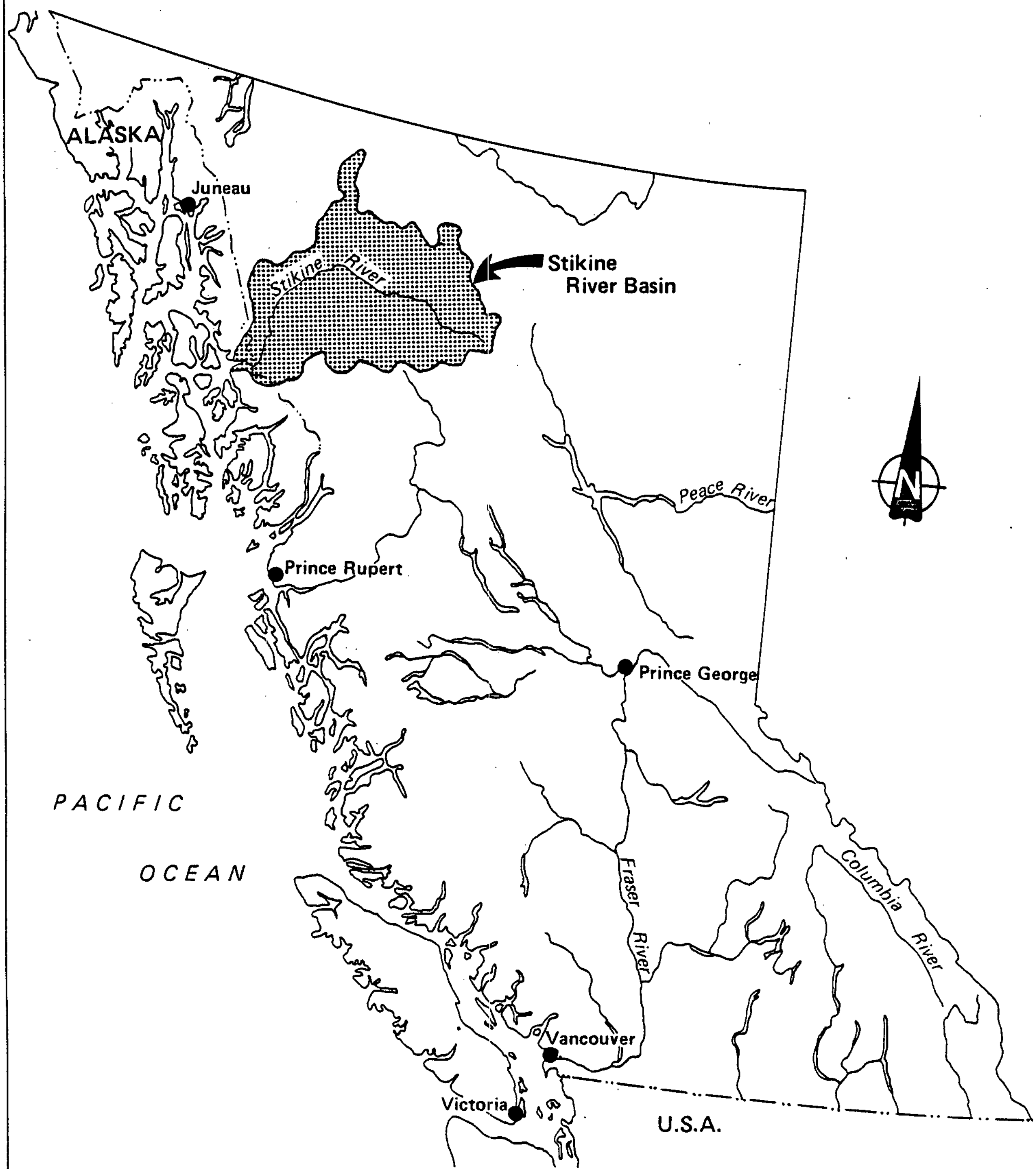


# I. INTRODUCTION

## Background and Outline

This report has been prepared by the Planning Division, Water Planning and Management Branch and is intended to be used as a guide to the source and nature of emerging water resource problems in the Stikine River Basin. The objective of this report is to study development opportunities in the Basin, to consider the potential for water and related resource use concerns, and to identify areas for Inland Waters Directorate participation.

Chapter II provides a brief description of the natural and human resources of the Stikine River Basin. Current research related to these resources is summarized where applicable. The complex physiography, climate, and hydrology of the area are discussed. The Basin's biological resources -- fisheries, wildlife, and vegetation -- and human resources -- population base, communities, and amenities -- are also reviewed.

Chapter III analyses existing and foreseeable developments in the Basin. Hydroelectric projects are discussed under the headings: project description, engineering and environmental studies, regulatory requirements, and federal government and public involvement. Other resource developments are described in less detail and include mining, fisheries, forestry, parks, tourism and recreation, trapping and agriculture, and transportation.

The final chapter summarizes the key potential developments in the Stikine Basin and their effects on the Basin's economic, social, and ecological systems. Areas of potential resource use conflict are identified and the possible extent of Inland Waters Directorate involvement in the Basin is considered.

## Study Area

The Stikine River Basin covers approximately 50 000 square kilometres of northwestern British Columbia. Rising in the Skeena Mountains, the Stikine flows north and then west across the Stikine Plateau. The plateau is bounded to the east and north by the Omineca and Cassiar Mountains. At the western extremity of the plateau, the Stikine has eroded the Grand Canyon of the Stikine -- an 80 kilometre, narrow gorge with walls rising vertically several hundred metres. Leaving the plateau, the Stikine widens and runs south through the rugged Boundary Ranges of the Coast Mountains. The river is joined by its major tributary, the Iskut, before winding west and crossing the international border into Alaska. The Stikine traverses approximately 500 kilometres in Canada and a further 35 kilometres through the Alaskan Panhandle to the sea.

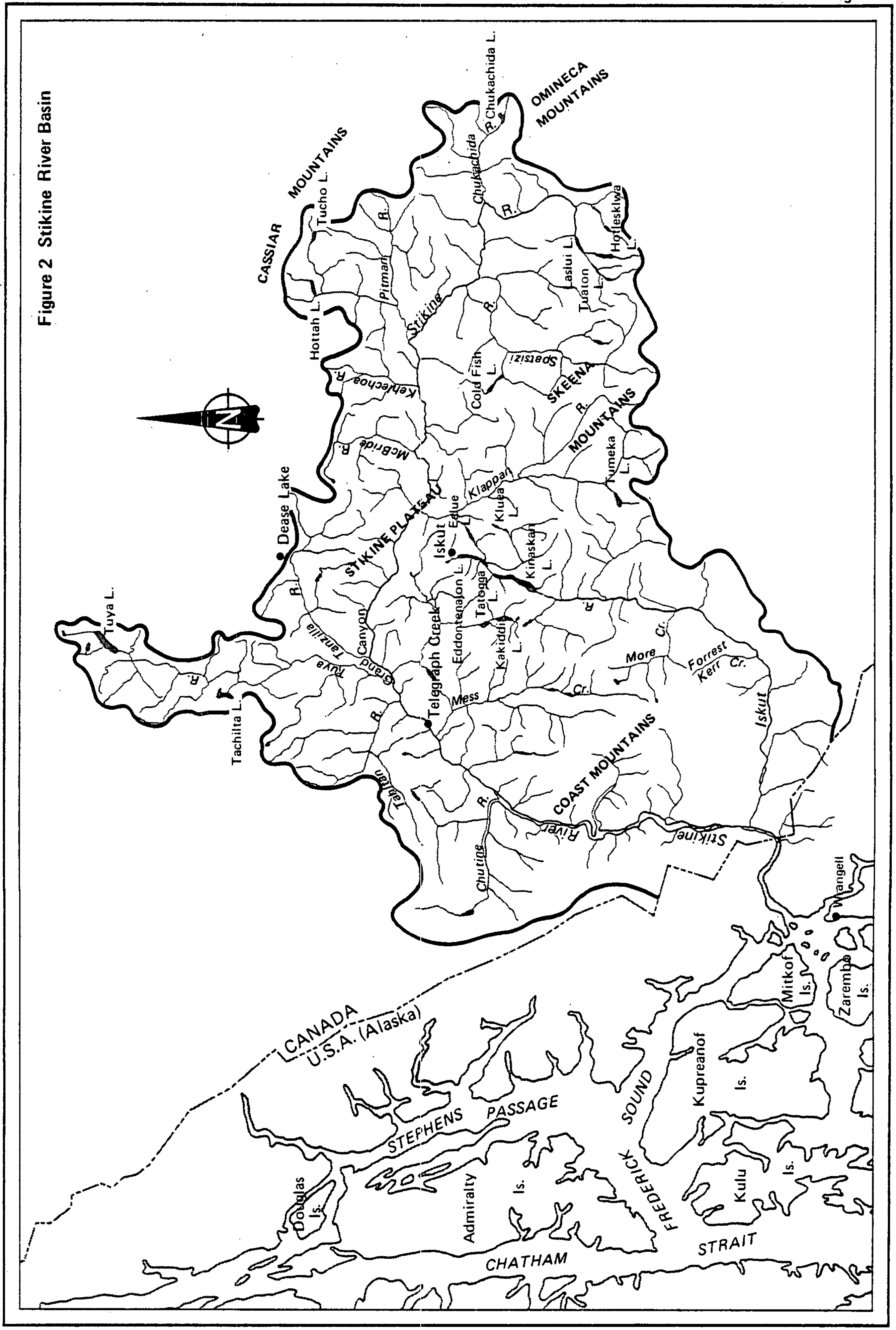



Figure 2 Stikine River Basin

# II. PHYSICAL, BIOLOGICAL, AND HUMAN RESOURCES

## A. Physical Resources

### 1. Physiography

The Stikine River Basin lies within the Western and Interior Systems of the Cordilleran Region. In the Basin, the Western System is represented by the Coast Mountain Area comprising the Boundary Ranges. The Interior System is represented by the Central Plateau and Mountain Area comprising four further subdivisions: the Stikine Plateau and the Skeena, Omineca, and Cassiar Mountains. These physiographic regions are listed in table 1 and located on figure 3.

Table 1. Physiographic Subdivisions of the Stikine River Basin

| Major Subdivision of Canada | System | Area | Secondary Area | Units |
|---|---|---|---|---|
| Canadian Cordillera | Western | Coast Mountain | Coast Mountains | Boundary Ranges |
| | Interior | Central Plateau and Mountain | Stikine Plateau | Tahltan Highland<br>Nahlin Plateau |
| | | | | Kawdy Plateau |
| | | | | Tanzilla Plateau |
| | | | | Klastline Plateau |
| | | | | Spatsizi Plateau |
| | | | Cassiar Mountains | Stikine Ranges |
| | | | Omineca Mountains | Swannell Ranges |
| | | | Skeena Mountains | Eaglenest Ranges |
| | | | | Klappan Ranges |

(Holland, 1976)

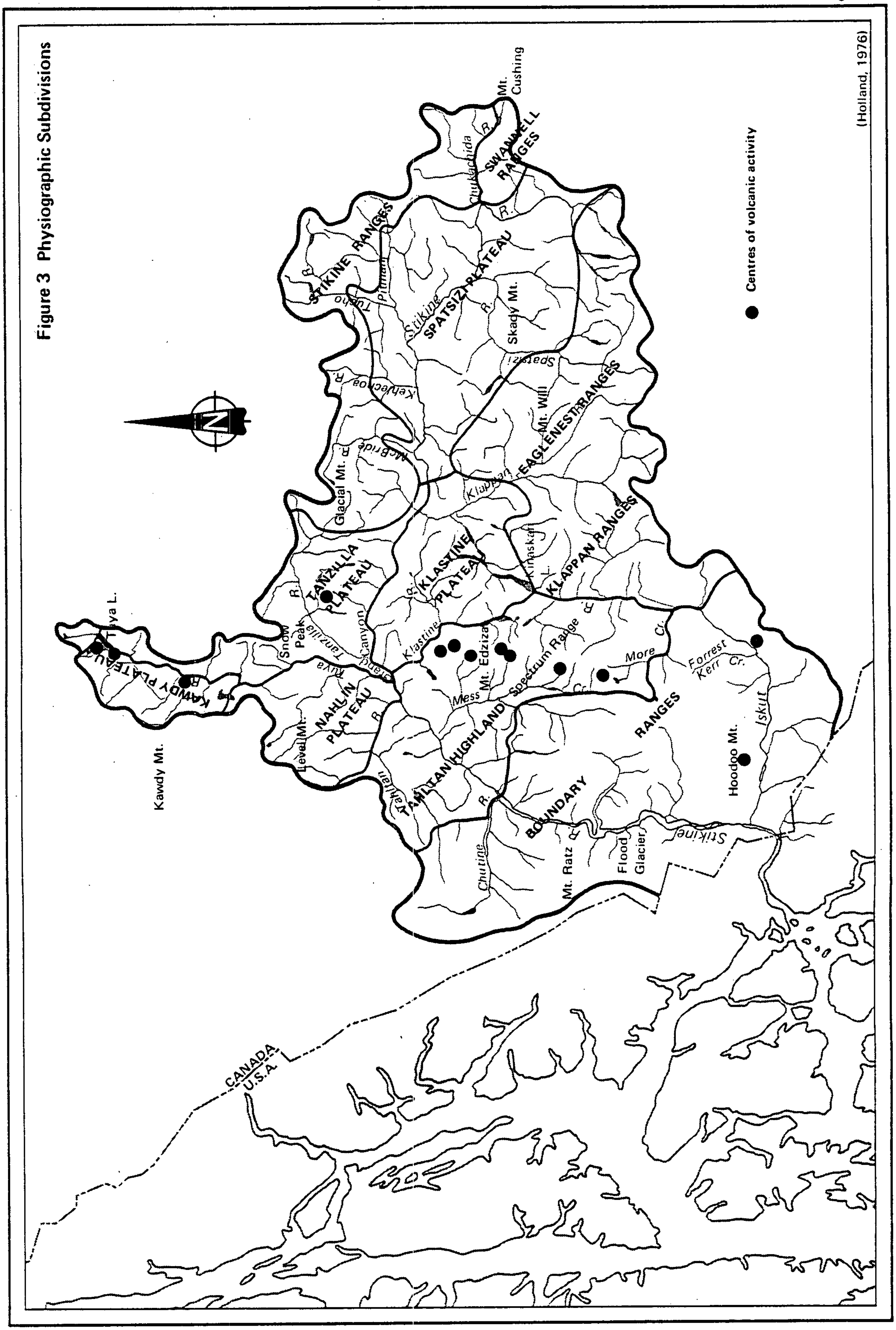


Figure 3 Physiographic Subdivisions

## Coast Mountains

The Boundary Ranges of the Coast Mountains trend northwest along the British Columbia-Alaska border. The Ranges are dominantly granitic flanked on the east by volcanic and sedimentary rocks. The mountains display extreme topographic relief and extensive glaciation. From sea level to the summit of Mount Ratz is 3136 metres. Numerous other peaks are over 2100 metres in elevation. Glacial features such as cirques, hanging valleys, U-shaped valleys, arrêtes, and oversteepened slopes are common, indicating all but the highest peaks have been covered by ice. Some terraces and benches at elevations over 140 metres are of marine origin suggesting submergence below present sea level by heavy glacial ice. Cirque glaciers and icefields occupy the highest peaks, while valley glaciers often extend below treeline. For example, Flood Glacier terminates in the lower Stikine Valley at 153 metres while timberline occurs above 1200 metres. The Stikine and Iskut are the principal rivers draining the Boundary Ranges. Originating before the last ice age, the river valleys are now deeply incised and oversteepened by glaciation.

Hoodoo Mountain, on the north side of the lower Iskut River, is one of northern British Columbia's most spectacular and unique mountains. Unlike the surrounding jagged peaks, Hoodoo Mountain is of volcanic origin and retains that characteristic shape. Almost perfectly circular, it rises with gentle slopes to an ice-filled crater at 1985 metres. Irregularities such as vertical cliffs, waterfalls, and hoodoos (needle-like pyramids up to 150 metres in height) give the mountain an unusual appearance. Although volcanic activity was initiated prior to glaciation, recent flows were within the last few hundred years indicating a dormant rather than extinct volcano.

## Stikine Plateau

The Stikine Plateau is an undulating, upland surface that lies between the Coast, Cassiar, and Skeena Mountains and merges to the north with the

Yukon Plateau. Underlain mostly by folded and faulted sedimentary and volcanic rocks, the plateau occupies approximately half of the Stikine River Basin. The Stikine Plateau is composed of six distinct units: the Tahltan Highland and the Nahlin, Kawdy, Tanzilla, Klastline, and Spatsizi Plateaux.

The Tahltan Highland extends along the western side of the Stikine Plateau and forms a transition between the plateau and the Boundary Ranges. The highland is drained by the Tahltan, Stikine, and Iskut Rivers. The Tahltan Highland is between 8 kilometres and 48 kilometres wide and 1525 metres and 1930 metres in elevation. There are several sharp peaks and a series of volcanic cones including Mount Edziza (2789 m) which rise above the dissected upland. Spectrum Range, named for the brillantly coloured lavas which underlie it, extends south of Mount Edziza and is included in the Tahltan Highland. Lava flows, volcanic debris, and glacial features cover large parts of this area.

The Nahlin Plateau is drained by the Tuya and Tahltan Rivers which flow into the Stikine River, and the Nahlin and Sheslay Rivers which flow into the Taku River. The plateau is dominated by Level Mountain, a shield volcano that is 32 kilometres in diameter and rises to 2164 metres at Meszah Peak. Streams and glaciation have dissected the gently dipping slopes of the plateau.

The Kawdy Plateau is situated on the west side of the Tuya River and has an average elevation of 1500 metres. Conspicuous features of the relatively undissected Kawdy Plateau, west and southwest of Tuya Lake, are the flat-topped, steep-sided volcanoes called tuyas. The highest is Kawdy Mountain (1942 m), rising almost 600 metres above the local plateau level.

The Tanzilla Plateau is bounded by the Tuya and Stikine Rivers and the Cassiar Mountains. Snow Peak, at 1935 metres, is the highest mountain on the plateau which generally lies between 1500 metres and 1800 metres.

The Tanzilla Plateau is characterized by broad valleys and rounded ridges and peaks.

The Klastline Plateau, south of the Stikine River and east of the Tahltan Highland, lies at 1500 metres with peaks rising to 2290 metres. The rolling plateau is extensively dissected and glacial features are common.

The Spatsizi Plateau is bounded by the Skeena, Omineca, and Cassiar Mountains. The gently rolling upland is dissected by wide, drift-filled valleys. The highest peak is Skady Mountain at 2130 metres. The Spatsizi Plateau is underlain by sandstone, shale, conglomerate, and minor coal deposits. The plateau is drained by the Tucho, Pitman, and Spatsizi Rivers all of which join the Stikine River within this unit.

## Cassiar Mountains

The Stikine Ranges of the Cassiar Mountains lie within the northeastern part of the Basin. The ranges consist of a belt of mature, dissected mountains with a granitic core overlain by sedimentary and volcanic rocks. Many of the valleys are wide and drift-filled. The highest peak of the ranges is Glacial Mountain at 2305 metres elevation. There are several large cinder cones north of Glacial Mountain which have long, black talus slopes. The ranges are drained by tributaries of the Stikine: the Tanzilla, Tucho, Kehlechoa, and McBride Rivers.

## Omineca Mountains

The Swannell Ranges of the Omineca Mountains are drained by the Chukachida River in the Basin. The Ranges extend southeast from the Cassiar Mountains and are bounded on the west by Spatsizi Plateau and on the south by Thutade Lake. Arbitrarily separated from the Stikine Ranges by the Chukachida River and Mount Cushing (2644 m), there is complete topographic and geologic continuity between the two regions. Although rugged, the relief is less than the Boundary Ranges since valley bottoms are between elevations of 900 metres and 1200 metres. Glaciation was extensive in the Swannell Ranges and is evidenced by the scoured U-shaped and hanging valleys, drift-filled valleys, and serrated peaks. Peaks below 1800 metres are rounded from glacial action.

Skeena Mountains

The Skeena Mountains are bounded on the north by the Stikine Plateau; on the west by the Boundary Ranges, Tahltan Highland, and Nass Basin; on the south by the Interior Plateau; and, on the east by the Omineca Mountains. They comprise a distinctive unit formed of folded sedimentary rocks, principally argillite, shale, and greywacke. The mountains consist of a number of closely-spaced ranges. Rugged peaks rise between 1800 metres and 2400 metres and are separated by a series of prominent northwest trending valleys that are generally wide and drift-filled. Parts of the Eaglenest and Klappan Ranges are located in the Basin. Mount Will in the Eaglenest Range rises to more than 2440 metres. Most of the peaks and ridges are serrated by glaciation and remnant glaciers occur in the Eaglenest Range. The Klappan Range is more gently sloping and parts are underlain by lava flows from Mt. Edziza.

Little information is published concerning the surficial geology of the Stikine River Basin. Data is available on the bedrock and structural geology and is published by the Geological Survey of Canada and the British Columbia Ministry of Energy, Mines, and Petroleum Resources. However, such detail is beyond the scope of this report.

## 2. Climate

Prior to 1979, fifteen meteorological stations collected temperature and precipitation data in the Stikine Basin. Most stations operated on a short-term, voluntary basis and frequently opened and closed the same year. Table 2 gives a list of active and inactive stations and their period of record. Station locations are shown on figure 4. Only two stations -- Telegraph Creek and Dease Lake -- offer long term data for reliable forecasting; this information is compiled in appendix 1. Appendix 2 provides a summary of 1977 climatic data from eight Atmospheric Environment Service stations operating that year.

Faced with a scarcity of climatic information for hydroelectric planning in the Basin, B.C. Hydro and Power Authority and the provincial Air Studies Branch installed a network of 18 automatic climatological stations in June 1979. Table 3 lists those stations and parameters measured; locations are indicated on figure 4. Charts are collected once a month by B.C. Hydro personnel and forwarded to either the Air Studies Branch or the federal Atmospheric Environment Service (AES) for processing. Published data is not yet available from these stations. Following five years of reliable data collection mathematical models incorporating key climatic, streamflow, and snow course data will be calibrated.

A subjective discussion of the Basin's climate is possible from the available data, supplemented by a few general principles. The northern latitude suggests a rigorous climate of long, cold winters and brief, pleasant summers. The north-south orientation of the Coast Mountains and the proximity of the Pacific Ocean also are controlling factors in determining the Basin's climate.

The Coast Mountains are an effective barrier to moist air moving eastward from the north Pacific Ocean. Forced to uplift and rise over the mountains, the Pacific air expands and cools releasing abundant precipitation on the windward slopes. Annual precipitation, occurring

Table 2. Available Temperature and Precipitation Data

| Station Name | Station Number | Location Lat (°'N) | Location Long (°'W) | Elevation (m) | Period of Record |
|---|---|---|---|---|---|
| 1. Baker Mine * | - | 5712 | 12657 | 1646 | Nov 80 → |
| 2. Bob Quinn Lake | 1200R0A | ≈5627 | 13017 | 457 | Sept-Oct 74, Dec 77 → |
| 3. Cold Fish Lake | 1201770 | 5740 | 12850 | 898 | 55-62 summers only |
| 4. Dease Lake *,**,*** | 1192340 | 5825 | 13000 | 816 | Sept 44-Oct 45, Oct 46 → |
| 5. Eddontenajon | 1202638 | 5750 | 12958 | 885 | Sept-Oct 72 |
| 6. Galore Creek | 1203046 | 5707 | 13127 | 790 | Jan 66-Nov 68, June-Oct 73 |
| 7. Hatin Lake * | 12033M0 | 5839 | 13143 | 945 | Sept 76-July 77 |
| 8. Hyland Post | 1203640 | 5739 | 12810 | 1068 | Jan-May 64, Oct 71-Mar 72 |
| 9. Iskut | 1203670 | 5750 | 12958 | 885 | Aug-Dec 73 |
| 10. Iskut Ranch | 1203672 | 5750 | 13000 | 899 | June 76 → |
| 11. Kinaskan Lake | 1204215 | 5732 | 13012 | 815 | 66-70, 71-77 - summers only |
| 12. McBride River | 1204958 | 5758 | 12916 | 915 | June-Sept 69, June 70-Nov 73, May-Oct 74 |
| 13. Schaft Creek | 1207125 | 5721 | 13100 | 915 | 69-74 |
| 14. Telegraph Creek** | 1208040 | 5754 | 13110 | 183 | Jul 42-Apr 58, Aug 60-Feb 62, Oct 73 → |
| 15. Todagin Ranch** | 1208202 | 5736 | 13004 | 899 | 73 → |

* outside the Basin
** also records rain intensity
*** also records sunshine hours and wind

(Schaeffer, 1981; AES, 1971; B.C. Dept. of Agr., 1971)

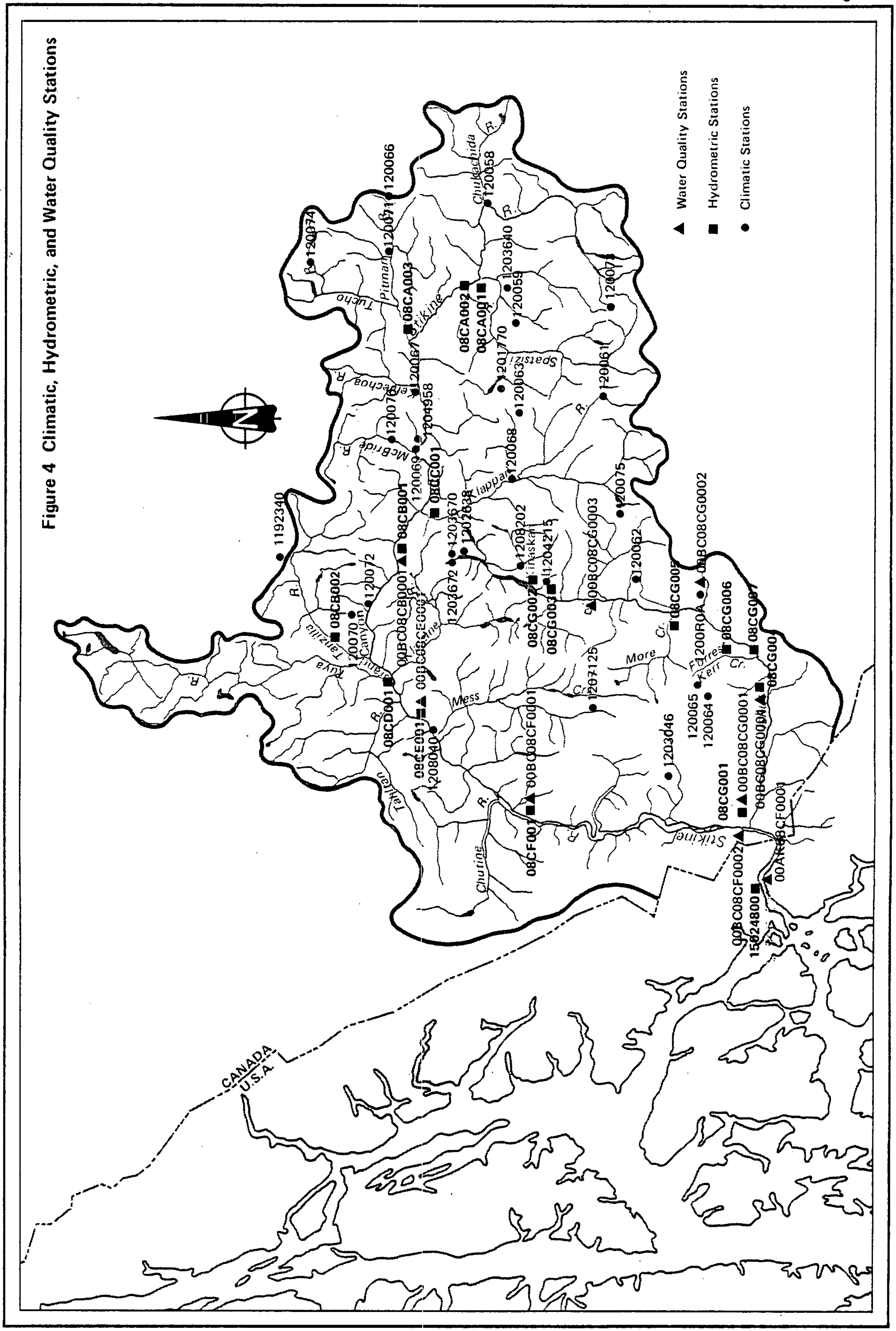



Figure 4 Climatic, Hydrometric, and Water Quality Stations

Table 3. B.C. Hydro-British Columbia Cooperative Meteorological Network

| Station Name | Stn # | Elements* Measured | Latitude | Longitude | Elevation m |
|---|---|---|---|---|---|
| Chukachida | 120058 | T/P/RRG | 5740 | 12736 | 1067 |
| Dawson | 120059 | T/P | 5738 | 12812 | |
| Didene | 120061 | T/P/RRG/W | 5717 | 12852 | 1286 |
| Durham | 120062 | T/P/RRG | 5710 | 13009 | 1061 |
| Eaglenest Ck | 120063 | T/P/RRG/SS | 5737 | 12900 | 1536 |
| For. Kerr Glacier | 120064 | T/P/FP | 5655 | 13057 | 1183 |
| For. Kerr Lower | 120065 | T/P/RRG/SS | 5657 | 13048 | 561 |
| Frog River | 120066 | T/P/RRG/SS | 5759 | 12729 | 1481 |
| Kehlechoa | 120067 | W | 5756 | 12850 | 800 |
| Klappan | 120068 | T/P/RRG | 5736 | 12926 | 884 |
| McBride River | 120069 | T/P/FP | 5758 | 12916 | 792 |
| Pallen | 120070 | T/P/RRG/W | 5812 | 13023 | 1402 |
| Pitman | 120071 | T/P/FP | 5802 | 12752 | 884 |
| Stikine Canyon | 120072 | T/P | 5808 | 13019 | 823 |
| Upper Stikine | 120073 | T/P/FP/SS | 5715 | 12819 | |
| Tucho | 120074 | T/P/RRG | 5819 | 12755 | 1225 |
| Tumeka Lake | 120075 | T/P/FP/SS | 5714 | 12942 | 1225 |
| McBride 5000 | 120076 | T/P/RRG | 5803 | 12909 | 1463 |

* P............Accumulated Precipitation (snowdepth in winter)
RRG..........Daily Precipitation (recording rain gauge)
T............Daily Temperatures (using a thermograph)
SS...........Snowdepth and Snow density (Snow Survey)
W............Wind speed and Direction (Recording anemometer)

(Marsh, 1980)

predominately in autumn and winter, ranges from 190-380 cm and falls for nine months of the year as snow. Snow depths can reach more than two to three metres on the river flats. Temperatures in the coastal area range between lows of -5°C and -8°C and highs of -1°C and 4°C during the winter months. Average summer minimum temperatures are between 7°C and 10°C, while summer highs range from 16° to 21°C. Mild winters, cool summers, low sunshine hours, and a relatively long frost-free season are characteristic of this area which extends upriver to Telegraph Creek on the Stikine and More Creek on the Iskut.

Approaching the Stikine Plateau, precipitation decreases and sunshine hours increase markedly. Snow rarely accumulates over 46 cm and average annual precipitation is 25 cm. Telegraph Creek averages 32 cm of precipitation annually. Precipitation is distributed evenly throughout the year, although a spring minimum and summer maximum is evident. Orographic uplift causes slightly greater precipitation on the windward slopes of the Skeena and Omineca Mountains. In winter, frequent influxes of Arctic air produce a continental climate characterized by clear, calm, and cold conditions. The January mean for Dease Lake is -19.4°C°; Telegraph Creek is slightly warmer at -15.5°C. During cold spells, temperatures are lowest in valley bottoms as dense, cold air pools there. On an annual basis though, protected valleys are warmer and drier than highland areas. The July mean for Dease Lake is 12.8°C; Telegraph Creek is again warmer at 15.5°C. Three to four months of the year temperatures are greater than 10°C, providing long, frost-free days for rapid plant growth. The first frost generally occurs in early September and temperatures drop to below freezing for six months of the year.

Wind direction is generally up valley in summer and down in winter. Cold air draining from glaciers cools the hotter, drier plateau in the summer and augments cold air flowing towards the ocean during winter.

Storm activity occurs throughout the year but most frequently in fall and winter. These storms are caused by a sequence of frontal waves that move around the semi-permanent 'Aleutian Low' and onto the northwestern British Columbia coast. The strong southwest to northeast flow of moist air may persist for four days. In that time windward coastal slopes receive most of the precipitation -- from five to ten times as much as the interior. However, heavy snowstorms in the interior do occur from occasional mixing of Pacific and Arctic air masses.

Spring and summer storms are not associated with westerly winds and orographic precipitation production but with cold low pressure centers forming in northeastern British Columbia and northwestern Alberta. The moist centers circle north of the Rockies, traverse northern B.C., and extend to high levels in the Basin. Spring and summer storms are not as frequent nor as long in duration as fall and winter storms but could occur at the same time as maximum snowmelt.

# 3. Water Resources

## Hydrology

The Water Resources Branch of the Inland Waters Directorate operates 14 hydrometric stations in the Basin (figure 4). Parameters measured include continuous streamflow, water level, and water temperature. Seven of the stations also collect suspended sediment data. Active and inactive hydrometric stations and their periods of record are listed in table 4. Currently, the Stikine River below Butterfly Creek is not monitored by the Water Resources Branch; however, negotiations are underway to convert the U.S. Geological Survey station near the border to an international gauging station (Dobson, 1982). Monthly and annual mean discharges for eleven of the stations are given in table 5, and appendix 3 lists the annual extremes of discharge and annual total discharge for two stations on the Stikine mainstem and two on the Iskut River. These figures indicate that seasonal fluctuations of discharge are more pronounced in the Stikine than in the Iskut River.

In the 1981 report Stikine-Iskut Feasibility Study - Hydrology, River Regime and Morphology, B.C. Hydro calculated annual average unit runoff for selected sub-basins (table 6). These runoff figures confirm climatic patterns evident in the Basin: very dry in the north and east to extremely wet conditions in the south and west (see page 10).

The flow regime of the Stikine Basin is dominated by three runoff-generating events: snowmelt on the Stikine Plateau, glacier melt in the Coast Mountains, and fall rain on the Coast Mountains. Snowmelt on the Stikine Plateau and to a lesser degree on the Omineca and Cassiar Mountains dominates the Telegraph Creek flow records. The "Stikine River at Telegraph Creek" station indicates that the river normally begins to rise in late April and reaches its maximum daily discharge in May, June, or rarely, July. During late summer, fall, and early winter, flows gradually and irregularly decline. Minor peaks occur due to rain or delayed snowmelt.

Table 4. Hydrometric Stations

| Active | | Period of Record |
|---|---|---|
| 08CB001 | Stikine River above Grand Canyon** | 1964→ |
| 08CC001 | Klappan River near Telegraph Creek** | 1964→ |
| 08CD001 | Tuya River near Telegraph Creek | 1964→ |
| 08CE001 | Stikine River at Telegraph Creek | 1964→ |
| 08CF001 | Stikine River above Butterfly Creek** | 1971→ |
| 08CG001 | Iskut River below Johnson River** | 1964→ |
| 08CG003 | Iskut River at outlet of Kinaskan Lake | 1964→ |
| 08CG004 | Iskut River above Snippaker Creek** | 1967→ |
| 08CG004 | More Creek near Mouth** | 1972→ |
| 08CG006 | Forrest Kerr Creek above 460m Contour** | 1972→ |
| 08CG007 | Iskut River above Forrest Kerr Creek* | 1981→ |
| 08CA001 | Spatsizi River near Mouth | 1980→ |
| 08CA002 | Stikine River below Spatsizi River | 1980→ |
| 08CA003 | Pitman River near the Mouth | 1980→ |
| 15024800 | Stikine River near Wrangell, Alaska (U.S.-proposed international) | 1976→ |
| **Inactive** | | |
| 08CB002 | Tanzilla River near Telegraph Creek | 1959-66 |
| 08CG002 | Kinaskan Lake near Telegraph Creek* | 1965-77 |

* Water level only
** Also records sediment (1979→)

(Dobson, 1982)

Table 5. Monthly and Annual Mean Discharges (cms)

| Station Name (Drainage Area) | Jan. | Feb. | Mar. | Apr. | May. | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Forrest Kerr Creek above 460 m Contour (311 sq. km.) | 1.22 | 0.955 | 0.772 | 2.18 | 11.8 | 43.4 | 82.0 | 87.5 | 41.2 | 27.7 | 6.24 | 1.87 | 24.5 |
| Iskut River above Snippaker Creek (7230 sq. km.) | 33.1 | 29.0 | 29.7 | 47.8 | 245 | 674 | 726 | 607 | 361 | 266 | 127 | 53.3 | 265 |
| Iskut River at outlet of Kinaskan Lake (1250 sq. km.) | 3.95 | 3.60 | 3.34 | 3.94 | 9.73 | 39.1 | 46.5 | 31.5 | 21.0 | 16.1 | 9.07 | 5.12 | 15.9 |
| Iskut River below Johnson River (9350 sq. km.) | 63.5 | 58.7 | 63.7 | 118 | 404 | 974 | 1180 | 973 | 619 | 503 | 223 | 104 | 432 |
| Klappan River near Telegraph Creek (3550 sq. km.) | 10.9 | 9.49 | 8.72 | 12.0 | 59.5 | 218 | 217 | 135 | 82.6 | 56.0 | 24.1 | 13.4 | 70.3 |
| More Creek near the Mouth (844 sq. km.) | 5.81 | 5.25 | 4.88 | 8.41 | 37.6 | 99.7 | 143 | 136 | 63.8 | 54.9 | 18.0 | 7.97 | 48.8 |
| Stikine River above Butterfly Creek (36 000 sq. km.) | 94.8 | 86.9 | 82.4 | 121 | 744 | 1850 | 1690 | 1130 | 710 | 573 | 229 | 127 | 625 |
| Stikine River above Grand Canyon (18 800 sq. km.) | 45.1 | 36.4 | 34.1 | 48.2 | 343 | 1070 | 761 | 433 | 305 | 242 | 109 | 61.7 | 287 |
| Stikine River at Telegraph Creek (29 300 sq. km.) | 65.9 | 58.0 | 53.9 | 83.4 | 592 | 1440 | 985 | 540 | 389 | 313 | 148 | 86.5 | 389 |
| Tanzilla River near Telegraph Creek (1600 sq. km.) | 3.33 | 2.41 | 2.62 | 4.45 | 27.0 | 64.3 | 40.1 | 20.1 | 17.1 | 17.5 | 8.33 | 4.38 | 13.7 |
| Tuya River near Telegraph Creek (3600 sq. km.) | 6.87 | 6.09 | 5.59 | 9.17 | 101 | 166 | 50.1 | 26.0 | 32.9 | 30.3 | 13.0 | 8.85 | 37.1 |

(IWD, Water Resources Branch, 1980)

Table 6. Average Annual Unit Runoff for Selected Stikine Sub-basins

| | |
|---|---|
| <u>Stikine River</u> | |
| Drainage Area above "Stikine River above Grand Canyon" gauge excluding the Klappan Basin | 452 mm |
| Drainage area above "Klappan River near Telegraph Creek" gauge | 636 mm |
| Drainage Area between Grand Canyon gauge and Telegraph Creek gauge | 304 mm |
| Drainage Area between Telegraph Creek and Butterfly Creek gauge | 1220 mm |
| Drainage Area between Butterfly Creek gauge and USGS Wrangell gauge | 2260 mm |
| <u>Iskut River</u> | |
| Drainage area above "Iskut River at outlet of Kinaskan Lake" | 410 mm |
| Drainage area between Kinaskan Lake gauge and Snippaker Creek gauge excluding More and Forrest Kerr basins | 1280 mm |
| Drainage area between Snippaker Creek gauge and Johnson River gauge | 2480 mm |
| Drainage area above "More Creek near the Mouth" | 1870 mm |
| Drainage area above "Forrest Kerr Creek above 460 m Contour" | 2230 mm |

(B.C. Hydro, 1981)

The "Iskut River below Johnson River" station characterizes the runoff patterns found in the Coast Mountains. The tributaries drain large glaciers and ice fields which tend to delay peak flows. "This may be because in spring and early summer solar radiation is relatively high in magnitude, but the albedo (reflectivity) of the glacier surface is also high and wind velocities and air temperatures are lower. In mid-summer, radiation is slightly diminished but the average albedo has decreased, making radiation a highly effective melting agent." (Beak Cons. Ltd., 1979). Annual peak runoff from snow or ice melt at the "Iskut River below Johnson River" gauge has been measured as late as August 20.

The third runoff-generating process, fall rain storms, is most evident on the western slopes of the Coast Mountains. The "Iskut River below Johnson River" station provides a twenty year record of runoff, including five examples of fall rain floods. In 1961, 1969, 1974, 1978, and 1979 maximum daily discharge for the year occurred in October or November. The warm maritime air masses, which brought the fall rains into the Basin, probably induced early snow (and possibly ice) melt which augmented the already high runoff rates.

Peaks in discharge may also be caused from the sudden outburst of ice jams or glacier-dammed lakes. The October 1974 daily discharge records for the "Iskut River above Snippaker Creek" station indicate an increase from 776 cms to 2000 cms in two days. On October 9 maximum instantaneous discharge rose to 2520 cms -- the highest discharge in over ten years of data (see appendix 3). Nearby climatic stations did not record precipitation in that period, so it is likely the peak discharge was caused by the breaking up of an ice-dam.

Water temperature records indicate that the Stikine River upstream of the Iskut confluence is generally ice-covered from late October or early November until late April or May. At the Grand Canyon gauge freezing occurs up to a week earlier than the Telegraph Creek gauge reflecting the higher elevation and greater distance from maritime air influence.

Break-up at the Grand Canyon gauge occurs from one to three weeks later than at Telegraph Creek. The Iskut River is usually ice-covered from late November or early December to late March or early April, while higher tributaries freeze earlier and thaw later.

Glaciology

Runoff from glaciers represents a significant portion of total runoff on the Iskut and lower Stikine Rivers. The extent of glaciation in the Basin can be seen on figure 5. The Snow and Ice Division of the National Hydrology Research Institute has been carrying out a glaciology program in the Basin since 1978.

The overall objectives of the program are --

"a) to obtain information on glacier activity to assess the influence of glaciers on downstream discharge and on B.C. Hydro's water management in the area;

b) to estimate glacier contribution to the flow regime of More and Forrest Kerr Creeks which are strongly influenced by glacier response;

c) to investigate locations susceptible to glacier outburst floods; and,

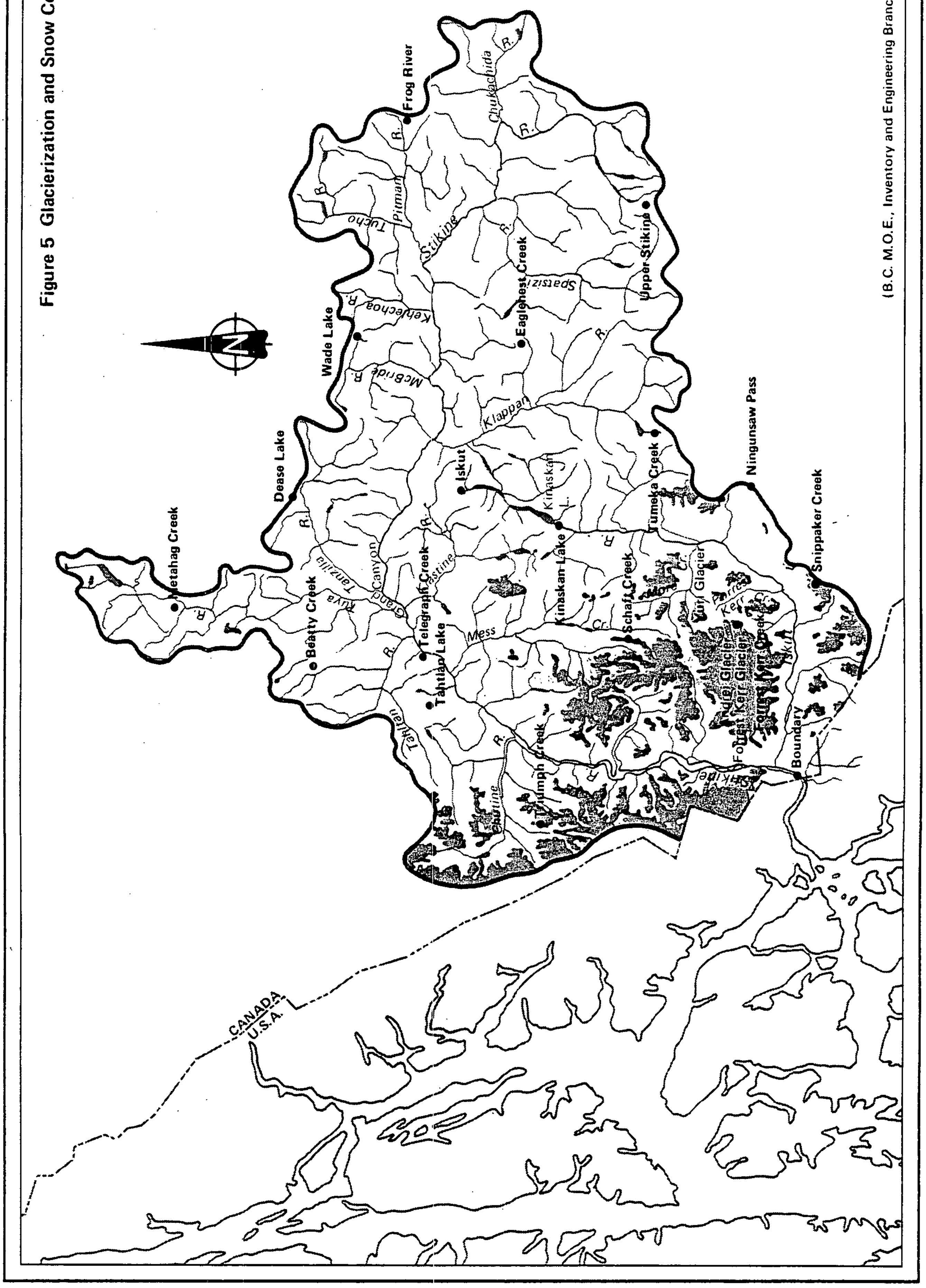
d) to establish the long term trend of glacier variation in Northwest British Columbia." (NHRI, 1981).

Studies are as follows:

a) A program to interpret perennial snow and ice cover. The inventory to date has taken place in the Iskut River Basin: 1400 glaciers have been identified in four sub-basins, 560 in six sub-basins, and there are four remaining sub-basins. This portion of the study should be completed in 1982. Further inventory will be carried out in the Stikine Basin.

b) Two reports relating to glacier-dammed lakes have been published. One provides a regional reconnaissance of

## Figure 5 Glacierization and Snow Courses




(B.C. M.O.E., Inventory and Engineering Branch, 1981) glacier-dammed lakes in the Stikine and Iskut River system, and gives estimates of possible discharges from a number of critically located lakes. The other report is a case study of Flood Lake and discusses observations made prior to and after a sudden discharge that occurred in mid-August 1979.

c) The Snow and Ice Division has been cooperating with B.C. Hydro in a glaciology study program on several glaciers in the Iskut Basin: Andrei, Yuri, and Forrest Kerr glaciers. In 1978 a field program was established including the installation of a snow accumulation and ablation stake network and a meteorological station, as well as a regional reconnaissance program. Specific objectives of the study are:

   (1) to establish long-term estimates for glacier mass balance;
   (2) to establish estimates of probable maximum rates of glacier runoff for use in designing the spillway design discharge; and,
   (3) to establish estimates of glacier contribution to suspended sediment and bed load.

Appendix 4 provides a bibliography of NHRI reports on the Stikine River Basin snow and ice studies.

Snow Courses

Table 7 shows a list of snow courses which have historically operated in the Stikine Basin with mean annual April 1 water equivalent values up to 1980. Three stations are located within the Basin, while one, Dease Lake, is just outside.

In June 1979 a network of 14 snow courses was installed in the Basin by the provincial Ministry of Environment. Snow courses are now located in each sub-basin with an average of one snow course per 2590 sq. km. Eight stations that are located upstream from the proposed dam sites are scheduled to be sampled each winter on or about the first of February, March, April, May, and June; six that are located downstream from the

Table 7. Snow Courses

| Snow Course | Elevation (m) | Record Began | Mean Water Equivalent on April 1 1980 | Mean to 1980 |
|---|---|---|---|---|
| Dease Lake | 820 | 1964 | 134 | 138 |
| Telegraph Creek | 580 | 1974 | 179 | 163 |
| Iskut | 1000 | 1974 | 122 | 174 |
| Ningunsaw Pass | 690 | 1974 | 308 | 426 |
| Metahag Creek | 1220 | 1980 | 286 | - |
| Beatty Creek | 1130 | 1980 | 294 | - |
| Tahltan Lake | 1220 | 1980 | 404 | - |
| Triumph Creek | 1220 | 1980 | 1018 | - |
| Schaft Creek | 1140 | 1980 | 505 | - |
| Forrest Kerr Creek | 560 | 1980 | 531 | - |
| Snippaker Creek | 620 | 1980 | 601 | - |
| Tumeka Creek | 1220 | 1980 | 517 | - |
| Kinaskan Lake | 1020 | 1980 | 381 | - |
| Eaglenest Creek | 1540 | 1980 | 279 | - |
| Upper Stikine | 1450 | 1980 | 362 | - |
| Frog River | 1480 | 1980 | 298 | - |
| Wade Lake | 1370 | 1980 | 317 | - |
| Boundary | 469 | 1980 | - | - |

(MOE, Inventory and Engineering Branch, 1981) proposed dam sites are scheduled to be sampled on April 1 only. These stations are also shown on table 7 and located on figure 5.

Water Quality

The Water Quality Branch of the Inland Waters Directorate is carrying out an intensive study on the Stikine River. The overall objective of this program is to describe current water quality conditions and to identify concerns related to the potential impact of proposed dam construction on water quality. Preliminary surveys were carried out in 1979-80, with a systematic sampling program to be conducted from 1981-83. Water quality sampling locations are shown on figure 4 and listed on table 8. Particular emphasis is being placed on measuring concentrations of suspended sediments, nutrients, selected major ions, and metals; estimating numbers and biomass of phytoplankton and bacteria; and, clay-typing by x-ray fluorescence. Cross-sectional and seasonal variability for selected water quality parameters are being observed in a downstream reach. Bed sediments in the main channel and back channel sites are being characterized, and differences in water quality among several locations relevant to the location of dam sites will be compared.

A routine inventory program is also being carried out at water quality stations indicated on table 8. Parameters measured are listed on table 9. These stations will be sampled weekly by B.C. Hydro personnel from June to October 1982. The sampling frequency after October has not yet been determined.

Table 8. Water Quality Stations

| | | |
|---|---|---|
| 00BC08CG0001 | Iskut River Below Johnson River | RM |
| 00BC08CF0001 | Stikine River at Butterfly Creek | RM |
| 00BC08CF0002 | Stikine River at Great Glacier | RM |
| 00AK08CF0001 | Stikine River near Wrangell, Alaska | RM |
| 00BC08CG0004 | Iskut River at Snippaker Creek | |
| 00BC08CE0001 | Stikine River at Telegraph Creek | |
| 00BC08CG0003 | Iskut River above Burrage Creek | |
| 00BC08CG0002 | Ningunsaw River at Echo Lake | |
| 00BC08CB0001 | Stikine River Highway Bridge | |

Note: all stations are intermittently sampled; however, 'RM' denotes stations that were established as routine monitoring sites in June 82.

(Churchland and Thorp, 1982)

Table 9. Water Quality Parameters

| Code | Description | Naquadat Number |
|---|---|---|
| T-AF | Temperature Air Field (Celcius) | 97060S |
| T-WF | Temperature Water Field (Celcius) | 02061S |
| T-WL | Temperature Water Lab (Celcius) | 02061L |
| PH-L | Ph Lab | 10301L |
| SC-L | Specific conductance Lab. (us/cm) | 02041L |
| TURB | Turbidity | 02073L |
| COLR | Colour | 02011L |
| ALKP | Alkalinity Phenophth. (mg/l) CaCO3 | 10151L |
| ALKT | Alkalinity Total (mg/l) CaCO3 | 10101L |
| HARD | Hardness Total (mg/l) CaCO3 | 10603L |
| CA-D | Calcium Dissolved (Mg/) | 20101L |
| MG-D | Magnesium Dissolved (mg/l) | 12108L |
| K -D | Potassium Dissolved (mg/l) | 19103L |
| NA-D | Sodium Dissolved (mg/l) | 11103L |
| CL-D | Chloride Dissolved (mg/l) | 17206L |
| F -D | Fluroide Dissolved (mg/l) | 09106L |
| SIO2 | Silica Reactive (mg/l) | 14105L |
| SO4 | Sulphate Dissolved (mg/l) | 16306L |
| N-TD | Nitrogen Total Dissolved (mg/l) | 07651L |
| NN-D | Nitrate Nitrite Dissolved (mg/l) | 07110L |
| N-PO | Nitrogen Particulte (mg/l) | 07902L |
| P-TD | Phosphorus Total Dissolved (mg/l) | 15103L |
| RNFL | Residue Nonfilterable (mg/l) | 10401L |
| R-FL | Residue Filterable (mg/l) | 10451L |
| RFNF | Residue Fixed Nonfilterable (mg/l) | 10501L |
| R-FF | Residue Fixed Filterable (mg/l) | 10551L |
| AS-X | Arsenic Extractable (mg/l) | 33304L |
| SE-X | Selenium Extractable (mg/l) | 34302L |
| CD-X | Cadmium Extractable (mg/l) | 4830_P |
| CU-X | Copper Extractable (mg/l) | 2930_P |
| ZN-X | Zinc Extractable (mg/l) | 3030_P |
| FE-X | Iron Extractable (mg/l) | 2630_P |
| PB-X | Lead Extractable (mg/l) | 8230_P |
| MN-X | Manganese Extractable (mg/l) | 2530_P |
| HG-X | Mercury Extractable (□g/l) | 80311P |
| PHEN | Phenolic Material (mg/l) | 06606P |
| TIC | Total Inorganic Carbon (mg/l) | 06051L |
| TOC | Total Organic Carbon (mg/l) | 06001L |

(Thorp, 1982)

## B. Biological Resources

### 1. Fisheries

All species of Pacific salmon are indigeneous to the Stikine system. However, due to natural falls, rock slides, and other migration barriers only the lower reaches are accessible to salmon. A major block is the Grand Canyon which is situated a few miles upstream of Telegraph Creek and denies access to greater than fifty percent of the Basin. Enhancement possibilities are discussed on page 74.

Sockeye and coho salmon are the biggest producers in the Stikine system. Tahltan Lake sockeye counts alone are over 18,000, while the lower Iskut produces over 17,000 coho annually. Pink salmon stocks have declined greatly from over 200,000 before 1950 to a few thousand in recent years. Causes are not documented but overfishing has been suggested as a major factor (Peterson, 1982). Chum and chinook have also declined in abundance; annual escapements are presently a few thousand for each species.

Sockeye and chinook salmon spawn from early June through August along the Stikine, Tahltan, and Iskut Rivers. In late summer and fall coho spawn in the lower mainstem Stikine and along the Iskut, while chum and pink generally remain along the lower mainstem and tributaries of the Stikine in American territory (Hatler, 1980).

The Stikine system appears to differ from southern systems by having juveniles rear longer in river habitats. Thus, overwintering populations of chinook and particularly sockeye, not common in the Fraser River for example, are found in the Stikine (B.C. Hydro, 1982).

Aerial spawning surveys of the Stikine and Iskut tributaries are carried out by the federal Department of Fisheries and Oceans and the Alaska Department of Fish and Game on a regular basis. A summary of recent surveys is contained in appendix 5. These surveys highlight the major spawning areas for chinook, sockeye, and coho. Due to the inefficiency of aerial survey methods, the counts do not reflect the absolute abundance of spawning populations in the respective areas. A counting fence has been operated at Tahltan Lake since 1959. Table 10 indicates the total escapements and timing of the Tahltan Lake sockeye runs.

B.C. Hydro is conducting fisheries studies on the Stikine and Iskut Rivers to evaluate the impacts of the proposed hydroelectric dams. Studies to date include spawning sites, habitat, and species distribution below the dam sites. To supplement this work, the Alaska Department of Fish and Game is beginning a salmon count on the lower Stikine below the international border using side-scan solar and other sampling techniques.

Freshwater species found in most of the Basin's rivers and lakes include: coastal cutthroat trout, lake trout, rainbow trout, Dolly Varden, grayling, mountain whitefish, and longnose suckers (Parks Canada, 1976). The provincial Aquatic Studies Branch is currently conducting biophysical surveys of lakes and streams in the Basin. The objective of these studies is to plan for future management issues associated with an increasing sports fishery. The surveys, to be mapped at a scale of 1:50,000, are concentrating initially on the production capability of waters near existing and potential corridors or settlements, i.e., the lower Stikine and Iskut Rivers, Telegraph Creek area, Highway 37 corridor, Bob Quinn Lake, and the Klastline Plateau area.

## 2. Wildlife

The Stikine Basin has been acknowledged as one of the finest wildlife areas in the province, yet until recently the data base has been very limited. Prior to 1974 infrequent aerial surveys and ground observations were conducted in the Basin to determine the winter distribution and relative abundance of ungulates. From 1974 to 1979 extensive inventory work was undertaken in the Spatsizi Wilderness Park. Population size

Table 10. Tahltan Lake Sockeye Timing

| Year | Weir Installed (date/month) | Sockeye Arrival | 50% | 90% | Total Escapement |
|---|---|---|---|---|---|
| 1959 | 1/7 | 3/8 | 13/8 | 17/8 | 4,311 |
| 1960 | 15/7 | 2/8 | 24/8 | 27/8 | 6,387 |
| 1961 | 21/7 | 10/8 | 12/8 | 17/8 | 16,619 |
| 1962 | 2/8* | 3/8 | 6/8 | 9/8 | 14,508 |
| 1963 | 4/8 | 5/8 | ** | ** | 1,780 |
| 1964 | 23/7 | 26/7 | 16/8 | 25/8 | 18,353 |
| 1965*** | 20/7 | 19/8 | 3/9 | 8/9 | 1,471 |
| 1966 | 13/7 | 4/8 | 14/8 | 22/8 | 21,580 |
| 1967 | 12/7 | 15/7 | 22/7 | 29/7 | 38,801 |
| 1968 | 11/7 | 21/7 | 25/7 | 8/8 | 19,726 |
| 1969 | 8/7 | 12/7 | 19/7 | 1/8 | 11,706 |
| 1970 | 6/7 | 26/7 | 2/8 | 12/8 | 8,419 |
| 1971 | 13/7 | 20/7 | 29/7 | 13/8 | 18,523 |
| 1972 | 13/7 | 13/7 | 19/7 | 31/7 | 52,354 |
| 1973 | 11/7 | 25/7 | 31/7 | 7/8 | 2,877 |
| 1974 | 4/7 | 29/7 | 4/8 | 18/8 | 8,106 |
| 1975 | 11/7 | 26/7 | 9/8 | 18/8 | 8,159 |
| 1976 | Unknown | 29/7 | 1/8 | 6/8 | 24,111 |
| 1977 | 7/7 | 12/7 | 17/7 | 11/8 | 42,960 |
| 1978 | 11/7 | 11/7 | 21/7 | 30/7 | 22,788 |
| 1979 | 10/7 | 24/7 | 2/8 | 12/8 | 10,211 |
| 1980 | 4/7 | 16/7 | 24/7 | 12/8 | 11,018 |
| 1981 | | | | | 50,790 |

*Question as to date installed

**Daily counts available

***Slide year

(Milligan, 1982)

and winter distribution were noted for the Spatsizi caribou, mountain sheep, and moose. Fly-overs in a fixed-wing aircraft of the Stikine River and Highway 37 were also completed during this period (Hatler, 1980).

Recent development proposals by B.C. Hydro have prompted the initiation of several intensive wildlife studies in the Basin. First, the provincial Terrestrial Studies Branch is assessing and mapping (1:250,000) the wildlife capability of the entire Basin. Preliminary vegetation, soil, and terrain maps are available for the Cry Lake, Dease Lake, and Level Mountain map sheets. Second, B.C. Hydro is carrying out wildlife studies downstream of the proposed dam sites and in the proposed impoundment areas. These studies are discussed in section III.A of this report. Finally, the Association of United Tahltans has received partial funding for a Basin-wide wildlife inventory and capability assessment.

Published information to date provides only a broad perspective on the Basin's wildlife. Mountain sheep and mountain goats are found in good numbers on the Spatsizi, Stikine, Klastline, and Edziza Plateaux. Osborn caribou herds are found in three locations in the Basin: the Spatsizi Plateau, north of the Stikine River upstream of the Highway 37 bridge, and the Edziza Plateau. The Grand Canyon provides habitat to over 300 mountain goats (B.C. Hydro, 1979). Coast and blacktail deer and brown bears are also found in parts of the Basin. Moose and wolves are found throughout the Basin, as are mule deer though in smaller numbers.

A unique area of the Stikine Basin, the Spatsizi Plateau provides the most outstanding wildlife habitat in British Columbia -- in terms of diversity and numbers of large animals (Parks Canada, 1976). The Plateau encompasses the entire winter and summer range for species including: Stone sheep, Osborn caribou, mountain goat, black and grizzly bear, moose, wolves, mule deer, coyote, wolverines, and a variety of small game. Gladys Lake Ecological Reserve, located within the Park, was established to curb over-hunting and preserve the range of the Stone sheep, a subspecies of Thinhorn sheep found only in northwestern British Columbia. While the Spatsizi area claims the largest caribou concentration in the province, numbers are declining as the region is opened up to development.

Migratory birds such as geese and ducks nest along the rivers, while grouse and ptarmigan inhabit the interior plateaux. An endangered subspecies of the peregrine falcon is suspected to nest in the Grand Canyon and the golden eagle is found in Spatsizi.

### 3. Vegetation

The Stikine River Basin can be divided into six major biogeoclimatic zones. These are: coastal, coastal transition, interior transition, sub-boreal transition, dry boreal, and boreal. The zones are shown on figure 6 and discussed below.

The coastal zone is comprised mainly of mature coastal western hemlock and sitka spruce at low elevations. Balsam, cottonwood, aspen, birch, willow, and thick underbrush are found along the river valleys. Mountain hemlock and alpine fir occur from 460 m to 1070 m, while alpine tundra is dominant above treeline.

The biogeoclimatic transition zones reflect the climatic changes from the coast to interior areas. Decreasing precipitation and severe winter temperatures result in less dense and smaller vegetation. Sparsely timbered areas are extensive with lodgepole pine, aspen, balsam, alpine fir, and black and white spruce as dominant species.

The coastal transition zone has coastal western hemlock and sitka spruce below 460 m and Engelmann spruce and subalpine fir to treeline. A 2047 hectare ecological reserve was established at Bob Quinn Lake to preserve this zone at its northern extremity. The interior transition zone is characterized by a cedar and hemlock association to 760 m and the

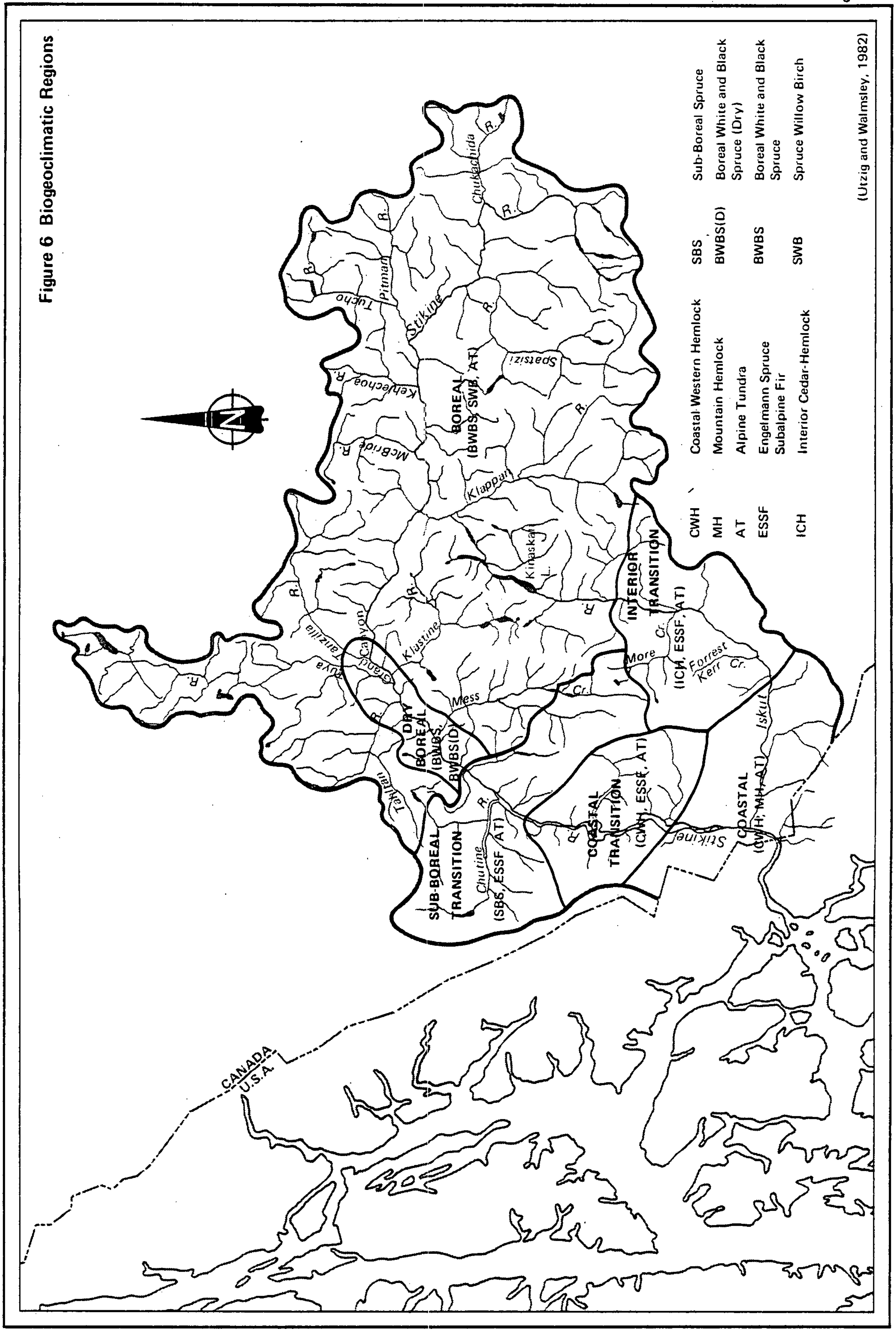



Figure 6 Biogeoclimatic Regions

Engelmann spruce-subalpine fir association to treeline at 1220 m. The sub-boreal transition zone is comprised of sub-boreal spruce at elevations lower than 910 m and Engelmann spruce-subalpine fir from 910 m to 1280 m.

The dry boreal zone occupies a small interior area of the Basin and consists mostly of boreal white and black spruce. The boreal zone dominates the Basin and is comprised of white and black spruce to 1040 m and spruce, willow, and birch from 1040 m to 1530 m. Alpine tundra occurs at elevations greater than 1580 m and consequently covers a large area of the boreal zone. At these higher elevations conifers give way to an association dominated by woody shrubs such as willows, heather, and birch with mosses, sedges, and lichens at ground level. Forest cover in the boreal forest zone has been modified by fires. Extensive areas are dominated by deciduous birch, aspen, and popular trees; by shrubs such as willow and alder; or by ground cover of firewood, grasses, and forbes.

Table 11 provides a summary of the biogeoclimatic zones, climax species, and elevation ranges. Successional and edaphic[1] species are also indicated. The existing data base for vegetation zones in the Basin is being supplemented by the Terrestrial Studies Branch of the provincial Ministry of Environment. The Branch is currently preparing vegetation, soil, and terrain maps for the Stikine watershed. The Association of United Tahltans has also undertaken a biogeoclimatic survey of the Basin.

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[1]A plant community whose vegetation is influenced by soil characteristics such as salinity or drainage.

Table 11. Biogeoclimatic Zones

| Climatic Region[1] | Biogeoclimatic Zone | Climax Trees[2] | Seral & Edaphic Climax Trees[3] | Approx Elev. Ranges |
|---|---|---|---|---|
| COASTAL | Coastal Western Hemlock | Hw, (Ss) | Ac, (Yc, Dr, Hm, Bl, Pl, Ep) | < 460m |
| | Mountain Hemlock | Hm, Bl | (Sx, Hw) | 460-1070m |
| | Alpine Tundra | - | (Bl, Hm) | > 1070m |
| COASTAL TRANSITION | Coastal Western Hemlock | Hw, (Ss) | Ac, Bl, Pl, Ep (sx) | < 460m |
| | Engelmann Spruce-Subalpine Fir | Bl | (Hw, Sx, Pl, Hm) | 460-1070m |
| | Alpine Tundra | - | (Bl, Hm) | >1070m |
| INTERIOR TRANSITION | Interior Cedar-Hemlock | Hw | Ac, At, Pl, Ep, Sw, Sx, Bl | < 760m |
| | Engelmann Spruce-Subalpine Fir | Bl | Sw (Hw, Sx) | 760-1220m |
| | Alpine Tundra | - | (Bl) | > 1220m |

Table 11. Biogeoclimatic Zones (cont'd)

| | | | | |
|---|---|---|---|---|
| | Sub-Boreal Spruce | Sx | Ac, At, Bl, Pl Ep, Sw (Sb) | < 910m |
| SUB-BOREAL TRANSITION | Engelmann Spruce-Subalpine Fir | Bl | Sx (Pl, At) | 910-1280m |
| | Alpine Tundra | - | (Bl) | > 1280m |
| DRY BOREAL | Boreal White and Black Spruce (Dry) | Sw | At, Ac, Pl, Ep, (Sb) | < 610m |
| | Boreal White and Black Spruce | Sw, (Sb) | At, Ac, Pl, Bl, (Ep) | < 1040m |
| BOREAL | Spruce Willow Birch | Bl | Sw, Pl, (Sb, At, Ac) | 1040-1580m |
| | Alpine Tundra | - | (Bl) | > 1580m |

1 See map of Biogeoclimatic Regions

2 Tree species symbols:

Ac - poplar
At - trembling aspen
Bl - alpine fir
Yc - yellow cedar
Dr - red alder
Ep - common paper birch
Hm - mountain hemlock
Hw - western hemlock
Pl - lodgepole pine
Ss - sitka spruce
Sb - black spruce
Sw - white spruce
Sx - hydrid spruce

3 The ratings given here are intended only as broad generalizations. Ratings given in brackets represent a minor occurrence; those without brackets being that of major occurrence.

(Utzig and Walmsley, 1982)

## C. Human Resources

### 1. Historical Perspective

The Tahltan Indians, who are believed to have migrated from the west during prehistoric times, were the first human occupants of the Stikine Basin. They settled on the banks of the Stikine River and relied on hunting and salmon fishing for their livelihood. The Tahltans traded with their neighbours the coastal Tlingit and interior Kasca tribes, intermingling goods and cultures.

The first white contact was made during the early 1800's as promises of a lucrative fur trade attracted Russian, American, and Canadian trading companies to the lower Stikine. Until 1934, when the Hudson's Bay Company established the first interior trading post at Dease Lake, the Tlingits acted as bartering middlemen not allowing the Tahltans access to the coast to trade directly with the Europeans.

Later in the 1800's several minor gold rushes lured thousands of prospectors to the Basin, but these booms were short-lived. From 1901 to 1936 the Yukon Telegraph joined Dawson with Vancouver; the line crossed the Stikine River at Telegraph Creek following the route of an earlier ill-fated telegraph proposal.

By 1928 a trail from Telegraph Creek to Dease Lake had been improved for truck traffic, and Telegraph Creek as head of navigation on the Stikine became the distribution centre for northwestern British Columbia. However, in 1941 and 1942 the Stikine saw its last boom as a supply route for construction of the Alaska Highway and military airfields up the Pacific Coast. Steamboats continued to operate on the river until 1971 but were discontinued as alternate routes to the Basin and the north were developed and interest in Telegraph Creek waned.

## 2. Communities and Population

Today Telegraph Creek is a quiet community of 200-300 with few facilities. The townsite rests on sloping terraces above the Stikine River and is actually two distinct communities: the newer, upper town and the older, lower town. The upper town is mostly Indian and has a new school, nursing station, post office, cooperative store, small museum, cabins, and the Tahltan Band administration building. The lower town has an Anglican church, RCMP post, and during some summers, a café, store, and lodge.

The town is serviced by a B.C. Hydro diesel generator, Northwestel, weekly mail service by truck from Terrace, and several charter and scheduled air companies. While there is no service station in Telegraph Creek, gas is usually available. Downstream from Telegraph Creek at Glenora, a few homesteaders are developing small farms.

Iskut and Eddontenajon are the only other communities in the Basin. Iskut has an Indian population of about 300 and is located on Highway 37, 32 kilometres south of the Stikine River. The town has a post office, grocery store, gas station, nursing station, air strip, cabins, and campsite. Eddontenajon is located two kilometres south of Iskut and has a service station, general store, motel, cabins, restaurant, boat rentals, and float plane base.

There are two Indian bands in the Stikine Basin: Telegraph Creek and Iskut. The Telegraph Creek Band is the original Tahltan Band; the Iskut Band is the nomadic Bear Lake Tribe of the Sekani division. While the two bands have different ethnic backgrounds, they have been grouped together as Tahltan by the Reserve Commission (1916). Indian reservations in the Basin are listed on table 12 and located on figure 7; table 13 indicates recent status Indian populations. The Association of United Tahltans represents status and non-status Indians from both bands and was formed to secure the Tahltans' aboriginal rights in their

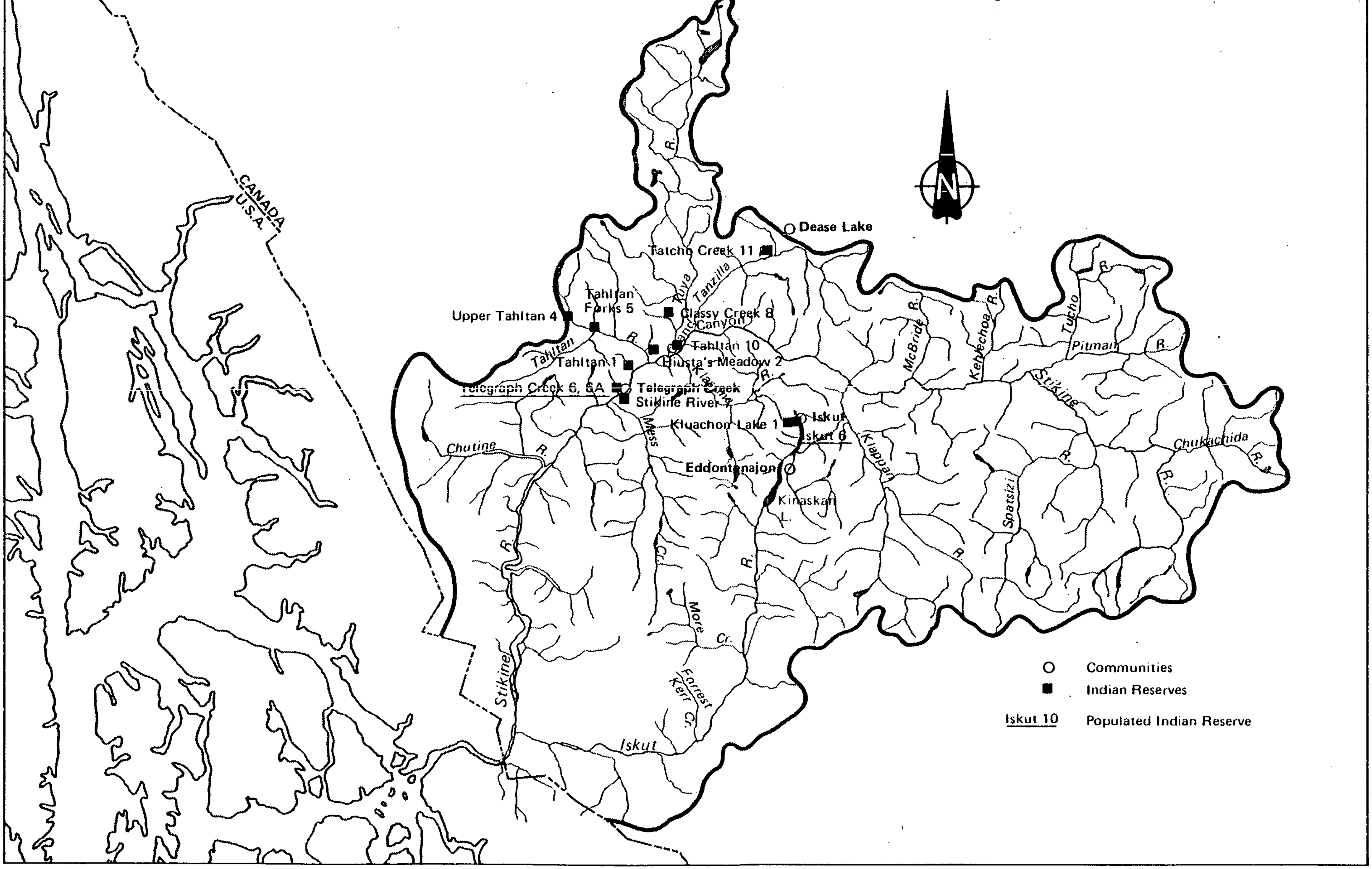
Table 12. Tahltan Indian Reserves in the Study Area

| Reserve | Band | Size |
|---|---|---|
| Classey Creek 8 | Telegraph Creek Band | approx 259 hectares |
| Hiusta's Meadow 2 | Telegraph Creek Band | approx 16 hectares |
| Iskut 6 | Iskut Band | approx 19 hectares |
| Kluachon Lake 1 | Telegraph Creek Band | approx 16 hectares |
| Stikine River 7 | Telegraph Creek Band | approx 46 hectares |
| Tahltan 1 | Telegraph Creek Band | approx 152 hectares |
| Tahltan 10 | Telegraph Creek Band | approx 260 hectares |
| Tahltan Forks 5 | Telegraph Creek Band | approx 19 hectares |
| Tatcho Creek 11 | Telegraph Creek Band | approx 222 hectares |
| Telegraph Creek 6 | Telegraph Creek Band | approx 24 hectares |
| Telegraph Creek 6A | Telegraph Creek Band | adjoins #6, 32 hectares |
| Upper Tahltan 4 | Telegraph Creek Band | approx 65 hectares |

Total hectares: 3432.9
Total hectares in region: 2792.9

(DIAND, 1982)

Figure 7 Indian Reserves and Communities



traditional territory.

Table 13. Status Indian Population -- 1982[1]

| | Total | On-Reserve | Off-Reserve[2] |
|---|---|---|---|
| Iskut Band | 342 | 218 | 124 |
| Telegraph Creek Band | 518 | 187 | 331 |
| Tahltan Band | 860 | | |

1 Non-status Indian and non-native population data were unavailable.

2 Off-reserve Indians may be located outside of the Basin.

(DIAND 1982; Mousseau, 1982)

## III. EXISTING AND POTENTIAL DEVELOPMENTS

### A. Hydroelectric Projects

The hydroelectric potential of the Stikine and Iskut Rivers has been realized for over 20 years. In the early sixties the discovery of two large copper deposits prompted the search for power sources in the region.

The earliest field studies and site investigations were conducted by Brinco Ltd., a Montreal-based British company which developed the Churchill Falls hydroelectric project in Labrador. By 1964 provincial orders-in-council held lands near the proposed dam sites in reserve, restricting mining activities, and by 1972 still further provincial orders-in-council reserved 320 kilometres in the Stikine and Iskut valleys for flooding. In 1976 B.C. Hydro stepped up investigations of the Stikine and Iskut in order to meet predicted electrical demands for the 1990's. Two years later the crown corporation announced plans for a five-dam, 2765 megawatt power development costing $7.6 billion (Faustmann, 1982). The Stikine-Iskut project would be the biggest, most expensive power development in Britsh Columbia to date.

#### 1. Project Description

The proposed Stikine-Iskut hydroelectric project consists of four major sites: Site Z and Tanzilla on the Stikine River and More Creek and Iskut Canyon on the Iskut River. An additional dam on Forrest Kerr Creek, a tributary of the Iskut, would divert flows to the More Creek reservoir.

Data on the projects are given in table 14, project locations are shown on figure 8, and river profiles with project locations are represented on figure 9. As indicated, total installed capacity would be 2765 megawatts or approximately 40 percent of B.C.'s existing generating ability.

Table 14. Hydroelectric Project Data

| Damsites | No. Gen. | Gen. Cap. (mw) | Total Installed Capacity (mw) | Average Energy (Gwh) | Dam Height (m) | Maximum Gross Head (m) | Reservoir Surface Area (ha) | Length (km) |
|---|---|---|---|---|---|---|---|---|
| Stikine | | | | | | | | |
| Site Z | 3 | 305 | 915 | | 270 | 262 | 12 700 | 103 |
| Tanzilla | 3 | 305 | 915 | | 193 | 252 | 900 | 40 |
| Combined Stikine Projects | 6 | | 1 830 | 10 450 | | | 13 600 | |
| Iskut | | | | | | | | |
| Iskut Canyon | 3 | 260 | 780 | | 150 | 202 | 3 800 | 25 |
| More Creek | 1 | 155 | 155 | | 135 | 147 | 4 100 | 30 |
| Forrest Kerr Creek (Diversion) | | | | | 30 | | | |
| Combined Iskut Projects | 4 | | 935 | 4 143 | | | 7 900 | |
| TOTAL | 10 | | 2 765 | 14 593 | | | 21 500 | |

(B.C. Hydro, 1980; Vancouver Province, May 28, 1981)

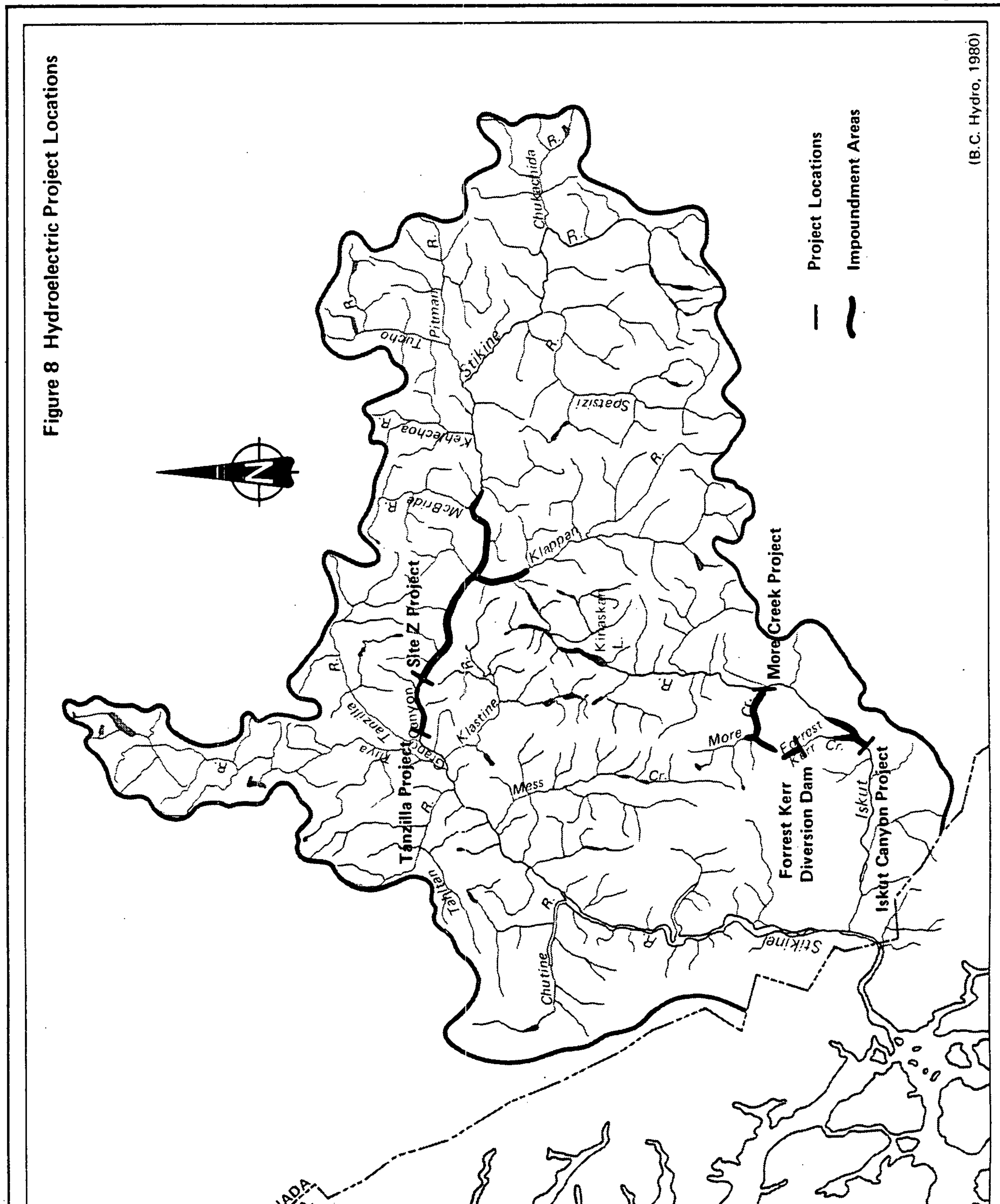



Figure 8 Hydroelectric Project Locations

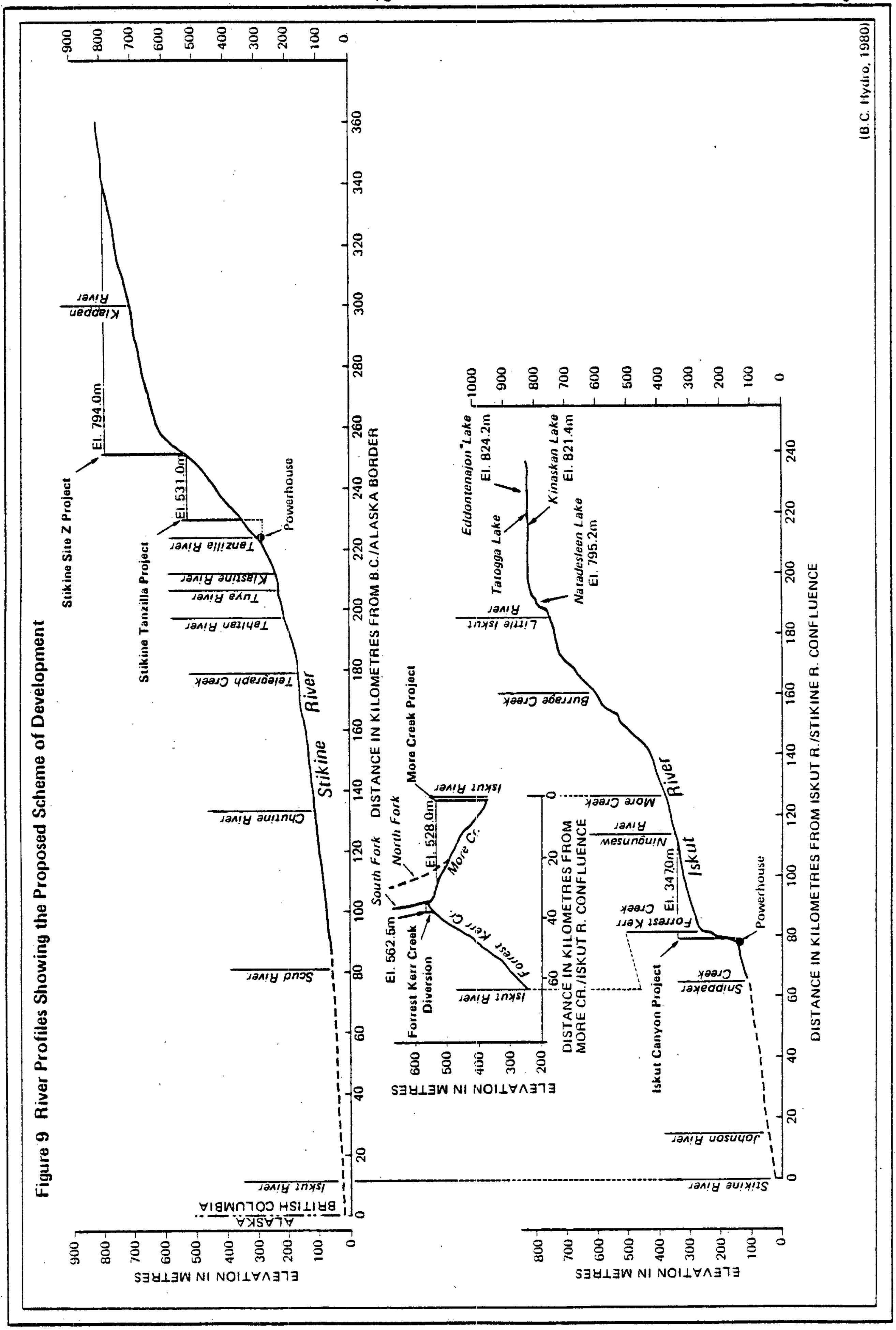



Figure 9 River Profiles Showing the Proposed Scheme of Development

Site Z is located 64 kilometres upstream of Telegraph Creek in the Grand Canyon. The Site Z dam would consist of three main sections: a 270 metre high, concrete arch dam across the Grand Canyon, the highest arch dam in North America; an intermediate section of concrete gravity construction; and a major earthfill, rockfill, or concrete arch dam in the adjacent box canyon. Outlet valves and an auxilary spillway would provide for water releases. An underground powerhouse, releasing on average 94 percent of total flows, would consistently yield maximum energy production. The high degree of flow utilization would be made possible by the Stikine Z reservoir which with an operational drawdown depth of 45 metres would provide live storage of 3800 million cubic metres. The reservoir would have a total length of 103 kilometres, an average width of 1.25 kilometres, and a maximum surface area of 12 700 hectares. The reservoir would flood the unused British Columbia Railway bridge and five kilometres of Highway 37, including the Highway 37 bridge south of Dease Lake.

The Tanzilla or Site C Project is located 40 kilometres upstream of Telegraph Creek at the confluence of the Stikine and Tanzilla rivers. The project would consist of a 190 metre high, concrete arch dam and downstream powerhouse, connected by a five kilometre long power tunnel. The Tanzilla reservoir would be operated on a run-of-the-river basis with no seasonal drawdowns. The reservoir would have a surface area of 900 hectares and an average width of 0.4 kilometres and would flood the lower portion of the Grand Canyon to the Site Z dam.

The Iskut Canyon project is the largest development on the Iskut River, with an installed capacity of 780 megawatts compared to 155 megawatts at More Creek. A composite dam comprising a central arch section and a concrete gravity system with earthfill wing dams on each flank would span the Iskut Canyon. The powerhouse, located 1.5 kilometres downstream of the dam, would provide a high degree of flow utilization. Regulation would be obtained by a 30 metre reservoir drawdown depth giving 800 million cubic metres of live storage and by controlling flows of More

Creek . The Iskut Canyon reservoir would have a total length of 25 kilometres and a maximum surface area of 3800 hectares.

The More Creek project would be located 46 kilometres upstream of Iskut Canyon. Flow regulation and power production from the combined projects would be increased by diverting upper Forrest Kerr Creek into the More Creek reservoir. An earthfill dam 37 metres high and 200 metres long would be required to divert flows across the low divide. With this diversion, average flows at More Creek would be increased 42 percent. The More Creek reservoir would have a drawdown depth of 40 metres, 1300 million cubic metres of live storage, a total length of 30 kilometres, and a maximum surface area of 4100 hectares.

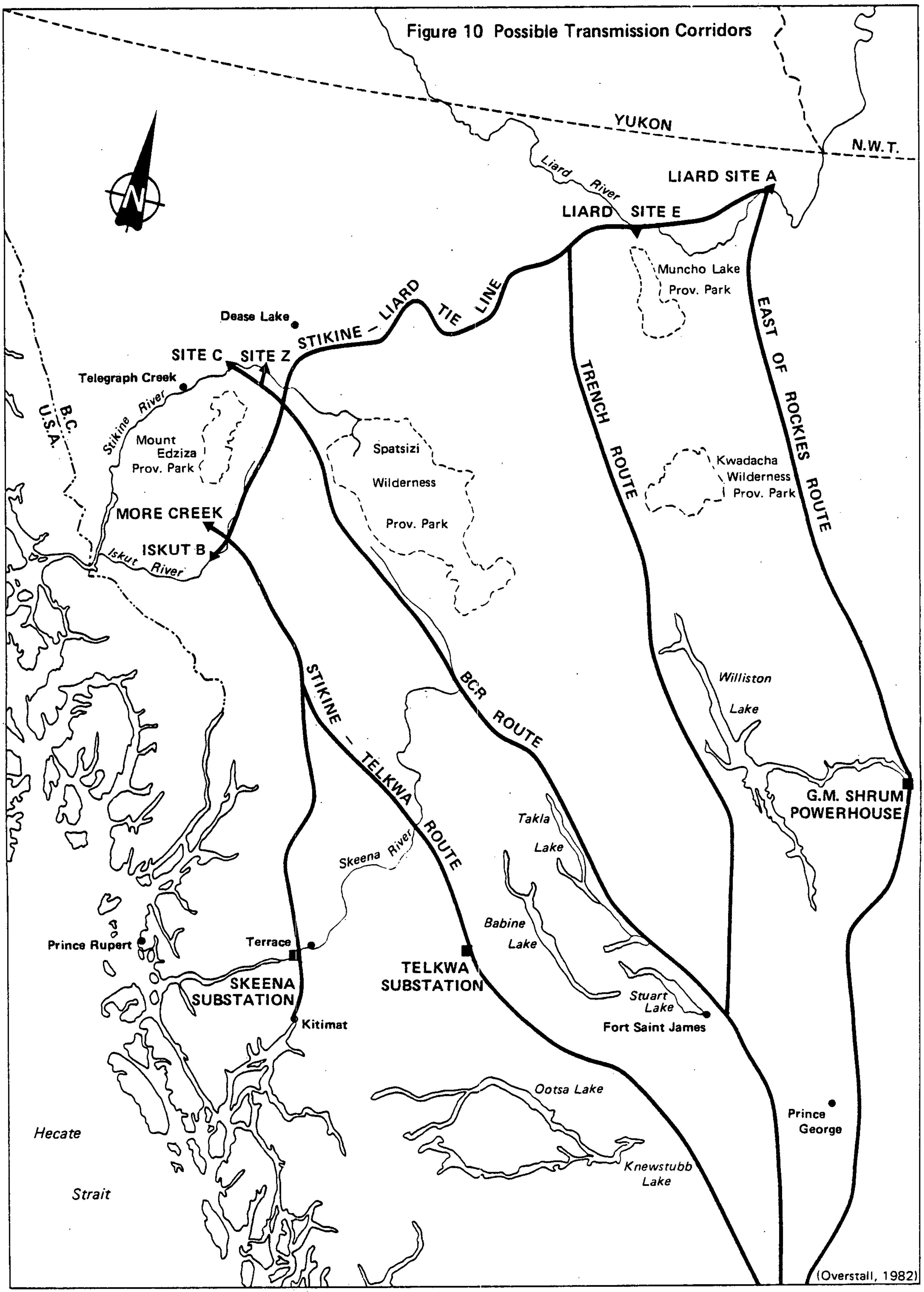
B.C. Hydro is also investigating potential transmission routes between the Stikine-Iskut generating stations and the provincial electrical grid. The route favoured would bring a 500 kilovolt transmission system along Highway 37 through the Kispiox and Bulkley valleys to the Telkwa substation. An alternate route for a single, high voltage line down the Stewart-Cassiar Highway to the Skeena substation at Terrace is also being considered. The latter connection would safeguard the Northwest's electrical supply and could allow Stikine power to generate Alcan's proposed new aluminum smelter if the Kemano II power project is shelved.

Other alternatives being studied combine transmission line corridors for the Stikine-Iskut with the Liard River dams. While separate routes are most efficient from an engineering standpoint, sharing the corridor is preferred economically. The routes being considered include the BCR-Dease Lake extension right-of-way, the Rocky Mountain Trench, and a route east of the Rockies (figure 10).

## 2. Engineering and Environmental Studies

B.C. Hydro completed engineering feasibility studies of the proposed Stikine-Iskut hydroelectric project in 1980. The technical and economic

Figure 10 Possible Transmission Corridors



feasibility of all four sites under consideration was established. Preliminary design studies are now underway. Investigations completed to May 1982 are given in table 15. The exploration program along with required access and campsite requirements for the remainder of the preliminary design stage is outlined in appendix 6. The summer program for 1982 includes extensive diamond drilling, seismic and survey lines, and rock-testing involving 2 camps, 110 men, and 10 helicopter pads.

Completion of the Phase 1 preliminary design for the Stikine Site Z is tentatively scheduled for late 1982. However, winter access road permits to the site have been denied by the provincial Ministry of Lands, Parks, and Housing pending public hearings; consequently, the exploration program is already behind schedule.

Pursuant to B.C. Utilities Commission requirements, B.C. Hydro is also conducting environmental studies of the Stikine Basin. Most field work for preliminary environmental impact studies has been completed and several reports are available to the public. Other reports are 'in draft' and should be available for review in summer 1982. Further detailed studies may be carried out where B.C. Hydro deems it warranted. A list of environmental studies undertaken, the author, and status to June 1982 are shown on table 16. Summaries from the following preliminary studies are included in appendix 7:

a) Economic Geology
b) Mountain Goat Ecology
c) Caribou and Snow Depth Survey
d) Hydrology, River Regime and Morphology
e) Impact of Hydroelectric Development on Biological Resources of the Stikine Estuary
f) Fisheries (1979)

B.C. Hydro originally intended to complete engineering and environmental studies and apply for an Energy Project Certificate in early 1983. The crown corporation anticipated the licensing procedure would take three

Table 15. Engineering Investigations to May 1982

Stikine Site Z

- 39 diamond drill holes totalling 6500 m
- 3 audits totalling 1075 m
- seismic refraction and gravity surveys
- auger holes and test pits for materials exploration

Tanzilla

- 9 diamond drill holes totalling 2550 m
- seismic refraction, gravity and airborne magnetic surveys
- auger holes and test pits for materials exploration

Iskut Canyon

- 30 diamond drill holes totalling 3570 m
- permeability tests
- seismic refraction, seismic reflection, gravity and magnetic surveys
- hand dug test pits for materials exploration

More Creek

- 6 diamond drill holes totalling 975 m
- auger holes and test pits for materials exploration

(B.C. Hydro, 1982)

Table 16. Stikine-Iskut Hydroelectric Project Environmental Studies

| Study/Report | Author | Status |
|---|---|---|
| 1980 Economic Geology | P.T. McCullough | Published |
| 1980 Hydrology, River Regime & Morphology | L.B. Davies, B.C. Hydro | Published |
| Test Reach Morphology | L.B. Davies, B.C. Hydro | In Progress |
| Sediment Regime | L.B. Davies, B.C. Hydro | In Draft* |
| Temperature Modelling/ Reservoir & Downstream | Consultant | Proposal stage |
| Climate/Meteorology | J.H. Emslie, B.C. Hydro | In Draft |
| Wildlife Studies | D.A. Blood | In Progress |
| Goat Report | B.Foster, Mar Terr | Published |
| Caribou Survey & Snow Depth | M. Wyborn | Published |
| Caribou Migration | D. Hatler | In Draft, Data Available in Progress Reports |
| Furbearer Survey 1980 | D. Penner, McCourt Management | In Draft |
| Furbearer Survey 1981 | D. Penner, McCourt Management | In Draft |
| Habitat for Wildlife | W. Gorman, B.C. Hydro | In Draft |
| Vegetation | D. Polster, Techman | In Draft |
| Vegetation/Habitat Mapping | W. Biggs, Talisman | In Draft |
| Land Systems/Terrain | | Initiate Study Spring 1982 |
| Agriculture | P. Christie, Talisman | In Draft |
| Forestry | K. Smith, Forestal | In Draft (Released) |
| Forestry Addendum | Forestal | In Draft |
| Stikine Estuary 1979 | K. Hyatt/A.J. Jordan, Beak | Published |
| Stikine Estuary 1980/81 | A.J. Jordan, Beak | In Draft |
| Fisheries 1979 | P. McCart, AEL | In Draft (Released) |
| Fisheries 1980/81 | P. McCart, AEL | In Draft |
| Regional Economy & Human Communities | S. Constable (Bentley LeBaron), Canadian Resourcecon | In Progress |
| Townsite Report | C. Qualife et al, B.C. Hydro | In Draft |
| Recreation, Tourism & | D. Williams, DPA | In Draft |
| Aesthetics Cultural Heritage & Historic Sites 1979 | I. Wilson, Aresco | In Draft (Released) |
| Cultural Heritage & Historic Sites 1980/81 | I. Wilson, Aresco | In Draft |
| Land Use Planning | | Initiate Study Spring 1982 |

* "In Draft" indicates a preliminary report has been prepared and is currently under review.

(Singleton, 1982)

years. A further six years for construction would bring the in-service date to 1992. Recent budget cuts and forecast revisions have set this schedule back one year. Other delays have been caused by land use permit requirements and even further delays may be encountered with the B.C. Utilities Commission licensing procedure.

### 3. Regulatory Requirements

The regulatory statutes which are, or could be, applicable to the authorization of the Stikine-Iskut project include:

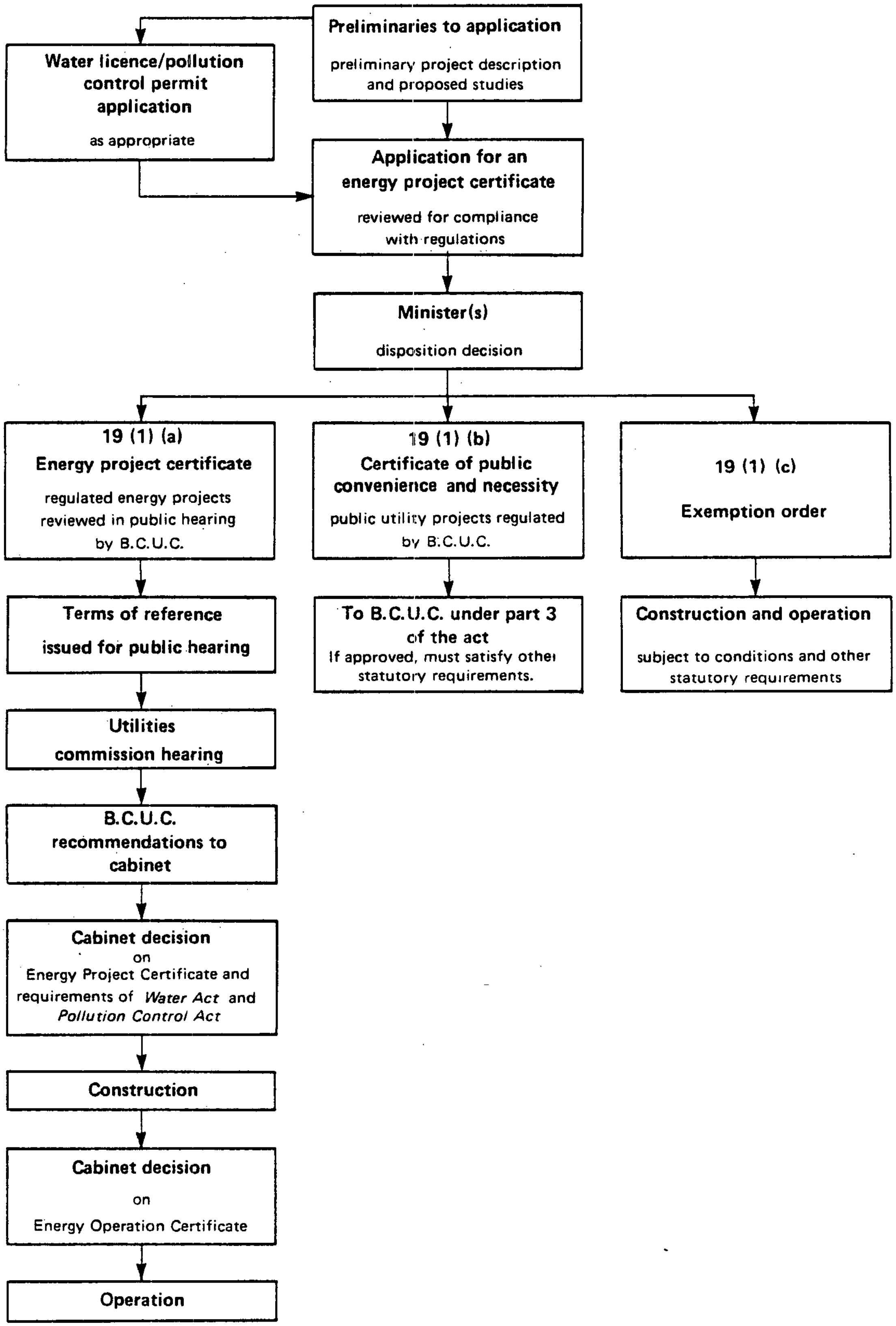
a) Utilities Commission Act (B.C. -- BCUC)
b) Water Act (B.C. -- MOE)
c) Environment and Land Use Act (B.C. -- MOE)
d) Heritage Conservation Act (B.C. -- MOE)
e) Fisheries Act (Canada -- DFO)
f) Migratory Birds Convention Act (Canada -- DOE)
g) Navigable Waters Protection Act (Canada -- MOT)
h) International River Improvements Act (Canada -- DOE)
i) Boundary Waters Treaty Act (Canada -- External Affairs)

Administered by the British Columbia Utilities Commission, the Utilities Commission Act of 1980 is designed to streamline the regulatory processes surrounding approval of major energy projects. The Act integrates energy and environmental assessment and provides for decisions to be reached on water licences and pollution control permits as part of a combined review procedure. The Act also provides for public participation in decisions on energy projects and policies.

There are four phases in the review process (see figure 11):

a) Pre-application
b) Application
c) Disposition
d) Certification

## Figure 11 Energy Project Review Process




(B.C. Energy, Mines and Petroleum Resources, 1981)

B.C. Hydro is currently at the pre-application stage which includes the preparation of benefit-cost analysis, project justification, site alternatives, engineering and environmental studies, compensation and mitigation proposals, and monitoring programs. Once application is made, the Commision reviews the documents and may hold public hearings. The recommended disposition is submitted to provincial Cabinet which then orders an Energy Project Certificate be granted, with or without conditions, or denied. Cabinet may also order that a Water Licence and a Pollution Control Permit be issued.

Once the Energy Project Certificate is granted, construction may start. Before operation commences and if the terms and conditions of the Energy Project Certificate have been complied with, Cabinet will issue an Energy Operation Certificate.

The Environment and Land Use Act requires permits for use of crown lands. The Heritage Conservation Act protects sites of historical significance. Constraints to hydroelectric development are not expected from either of these Acts.

Federal responsibilities with respect to the effects of hydroelectric development in the Stikine are met by the Fisheries Act, which protects anadromous fish; the Migratory Birds Convention Act; and, the Navigable Waters Protection Act, which guarantees perpetual rights to navigation. In addition, the 1955 International River Improvements Act (IRIA) provides for federal regulation of the construction, operation, and maintenance of improvements on international rivers. Any proposed development in Canada which significantly alters the flows or the use, existing or potential, of the river outside Canada may require a licence from DOE under this Act. Terms and conditions of the IRIA are similar to BCUC requirements, except the proponent should have an Energy Project Certificate before applying for an IRIA licence.

Two international treaties could be applied to the Stikine River: the 1871 Treaty of Washington (or Amity) specifically mentions the Stikine and guarantees free navigation to both United States and Canada; and, the 1909 Boundary Waters Treaty, and sanctioning legislation the Boundary Waters Treaty Act, provide for the right to legal redress by the downstream user if any interference with the river in Canada results in injury in the United States. The Treaty guarantees existing navigation, maintenance of water levels and flows except by prior agreement, and provides recourse for deleterious water pollution. Under this treaty, an International Joint Commission composed of three members from each country is empowered to act where there is a dispute over actions by one country which could affect interests of the other. The Stikine-Iskut project is not expected to affect navigation adversely. However, international discussions may be required regarding changes in water flows and levels and accompanying downstream effects.

## 4. Federal Government and Public Involvement

### Federal Government Involvement

The federal government has exclusive legislative powers over navigation, anadromous fisheries, and migratory birds, as well as legislative jurisdiction over developments affecting boundary and transboundary waters. The statutes which enforce these mandates have been outlined in the previous section. To ensure that federal responsibilities with respect to the effects of the proposed Stikine-Iskut hydroelectric project are met, several federal departments have commenced research programs in their areas of interest.

Since officials from the Department of the Environment (DOE) will likely review B.C. Hydro's application under the International River Improvements Act and the Boundary Waters Treaty Act, several water-related studies are underway.

Inland Waters Directorate (IWD) is collecting water quality and quantity information to determine the potential transboundary effects of hydroeletric development. The Directorate is also carrying out a sediment sampling program to analyze the role existing sediment loads have on the biological productivity of the estuary. Snow and ice studies, conducted by the National Hydrology Research Institute of IWD, include a glacier inventory of the Stikine River Basin and an analysis of peak discharges from glacier-dammed lakes in the Basin.

A federal interdepartmental task force, chaired by the Department of Fisheries and Oceans (DFO) with DOE representatives from Atmospheric Environment Service, Canadian Wildlife Service, and Inland Waters Directorate, has been established. The task force will safeguard federal environmental interests by providing advice to B.C. Hydro, reviewing study progress, and evaluating completed impact assessment reports. DFO is also operating counting fences at Tahltan Lake and conducting aerial spawning surveys. These programs, while part of DFO's normal functions, have received a higher priority since B.C. Hydro's proposal to dam the rivers (Milligan, 1982).

A "Cooperative Information Exchange Agreement between the Province of British Columbia and the State of Alaska" was signed by the premier of British Columbia and the governor of Alaska on May 3, 1982. The Agreement provides for the dissemination of data in each country and ensures full exchange of all information regarding the potential impacts of the Stikine-Iskut hydroelectric project. Participating governments and agencies are identified as follows:

a) Government of British Columbia
b) State of Alaska
c) B.C. Hydro
d) Department of Fisheries & Oceans (Canada)
e) Department of the Environment (Canada)
f) U.S. Department of Agriculture
g) U.S. Department of Interior

h) U.S. Department of Commerce

i) U.S. Environmental Protection Agency

The Agreement will be administered by the "Stikine-Iskut Rivers Information Exchange Committee" consisting of three representatives each from British Columbia and Alaska. The Committee will ensure the fulfillment of the purpose of the Agreement by exchanging information on at least a quarterly basis, preparing annual reports, and verifying cooperation and information receipt from participating agencies. The Agreement is not legally binding on the Governments of Canada or the Unites States and is subject to normal provisions of confidentiality.

Public Involvement

The catalyst for public interest in the Stikine-Iskut project was a Sierra Club workshop held in Vancouver in January 1980. The three-day workshop laid the groundwork for public opposition to the dams. Various environmental groups and concerned citizens united to form the "Friends of the Stikine". This society is "dedicated to the preservation of the Stikine in its natural state, and to enhancing public awareness of the advantages of doing so" (FOS, 1981). Friends of the Stikine has published newsletters, written magazine and newspaper articles, presented film and slide shows, and corresponded with government agencies.

Since 1980 over thirty organizations have expressed concern over the future of the Basin; some of these include:

a) Anglican Church of Canada

b) Association of United Tahltans

c) Canadian Native Federation

d) Iskut Band Council

e) Petersburg (Alaska) Chamber of Commerce

f) Regional District of Kitimat-Stikine (Board)

g) Residents for a Free-flowing Stikine

h) Sierra Club of Western Canada

i) Skeena Protection Council

j) Southeast Alaska Conservation Council
k) Steelhead Society of British Columbia
l) Stikine Action Committee (residents of Petersburg and Wrangell, Alaska)
m) Telkwa Foundation
n) United States Sierra Club
o) Wrangell Chamber of Commerce

Local residents are also concerned. Running on an anti-dam ticket, Joe Murphy was elected to the Board of the Kitimat-Stikine Regional District in an overwhelming victory (FOS, 1982).

The Association of United Tahltans have initiated their own environmental studies. They have completed "The Stikine River Basin Analysis" which outlines a 3.5 year, $7 million study to inventory and analyse the resources of the Basin. The Tahltans claim sovereign rights to the Basin and will oppose the hydroelectric project until Indian land claims are settled.

The United States has established a task force of federal and state environmental agencies to study issues relating to the Stikine-Iskut hydroelectric proposal (Wilson, 1982). The task force, headed by the U.S. Forest Service, has allotted over $500,000 in the 1983 tentative budget for field studies on the lower Stikine. The Governments of Alaska and the United States are also parties to and participating agencies of the Cooperative Information Exchange Agreement outlined earlier.

Public opposition was instrumental in the rejection of a B.C. Hydro application to construct a winter access road to Site Z. The provincial Lands Branch denied the request on the basis of:

a) Public opposition
b) Availability of alternative access
c) Damage to sensitive alpine tundra
d) Inability to restrict access by other uses

The Lands Branch stated that B.C. Hydro could reapply for the access permit after public hearings were held in the local communities. B.C. Hydro held the hearings in February 1982 and reapplied for approval in March. The permit had not been granted by June 1982.

Public concerns related to the Stikine-Iskut dams are outlined in appendix 8. A summary of potential environmental impacts as stated by B.C. Hydro in the 1980 Progress Report on Feasibility Studies is also included in appendix 8. It is evident from this data that public concerns with respect to the hydroelectric project have a wider scope than the provincial Energy Project Review Process is legislated to address.

## B. Mining

Predicting the mineral potential of an area is difficult. New explorations, new discoveries, and changes in prices dramatically influence the economic feasibility of developing a mineral deposit. Generally then, areas in the Basin of relatively low mineral potential include Spatsizi Plateau, Klappan River sub-basin, and Level Mountain Range. Upstream of Glenora much of the remaining area is of moderate potential, while the Coast Mountains, downstream of Glenora, are of considerably higher potential (Barry and Freyman, 1970). Copper and iron deposits are among the largest in northwestern British Columbia. Molybdenum, nickel, asbestos, gold, and silver are also found in the Basin.

The Stikine River Basin has had considerable mineral-related activity since the discovery of placer gold on its river bars in 1861. Since the introduction of helicopters in the early 1950's, exploration has intensified with the main emphasis on large tonnage, relatively low-grade copper and molybdenum deposits. While there are presently no producing mines in the Basin, many prospects have been discovered. Two are promising: Stikine Copper and Schaft Creek, the latter containing significant amounts of molybdenum in addition to copper. Low, unstable copper prices and high development costs are hindering the development of either prospect. Mining properties are shown on figure 12.

### Stikine Copper

Stikine Copper is a large, high-grade copper deposit located 16 kilometres east of the Stikine River in the Coast Mountains. The property is managed by Hudson Bay Mining and Smelting Co. Ltd., a South African firm, but the majority shareholder is Kennco Co., an American firm, with Cominco of Canada holding a minority interest.

Copper was first discovered in 1955 and exploration started in 1960. Published reserves estimate 59 million tons of 1.2 percent copper in the

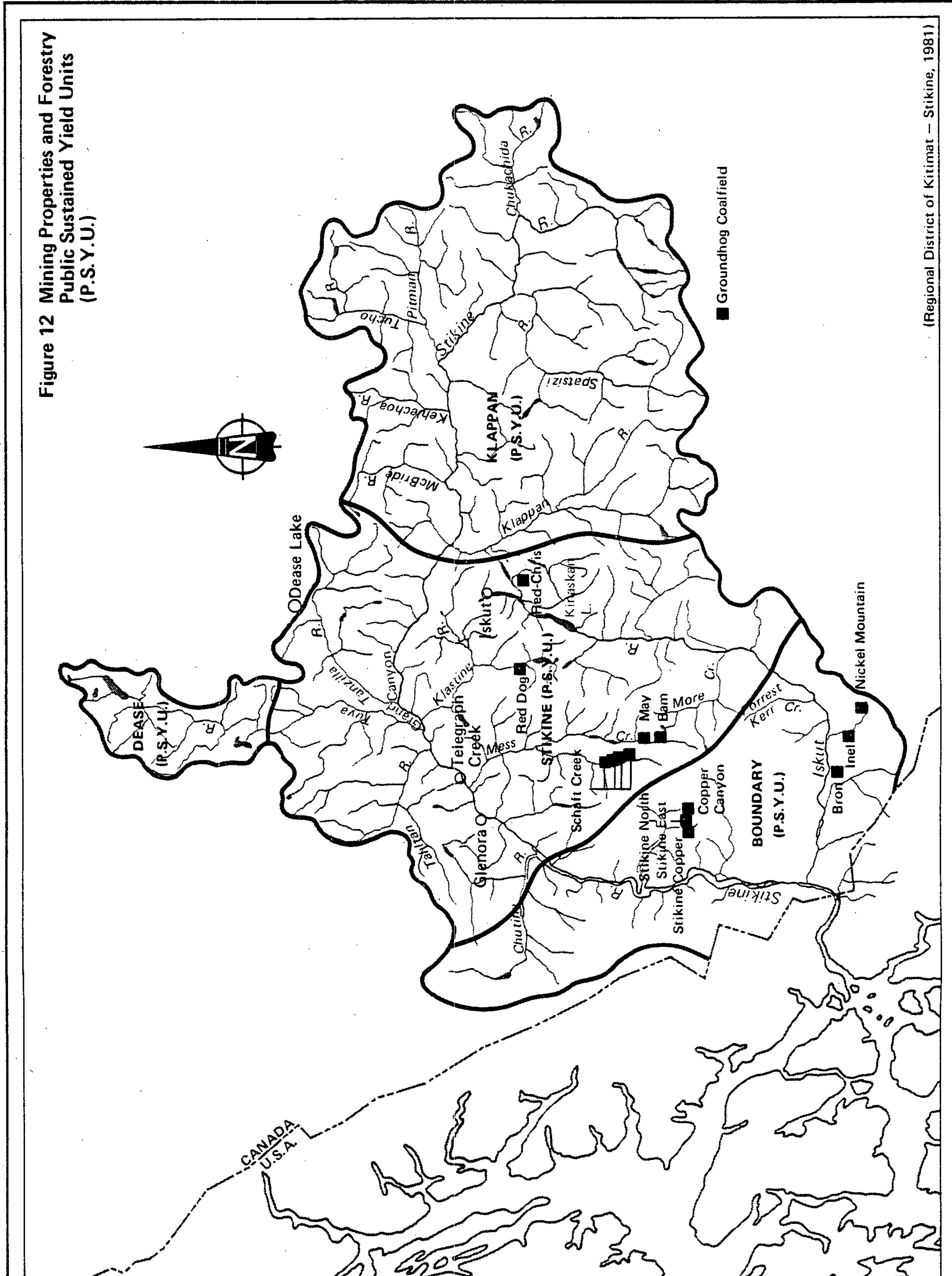


Figure 12 Mining Properties and Forestry Public Sustained Yield Units (P.S.Y.U.)
Groundhog Coalfield
(Regional District of Kitimat – Stikine, 1981)
KLAPPAN (P.S.Y.U.)
STIKINE (P.S.Y.U.)
DEASE (P.S.Y.U.)
BOUNDARY (P.S.Y.U.)
Dease Lake
Iskut
Telegraph Creek
Glenora
Red-Chris
Red Dog
May
Bam
Schaft Creek
Copper Canyon
Stikine North
Stikine East
Stikine Copper
Bron
Inel
Nickel Mountain
Klappan
Spatsizi
Stikine
Tuchodi
Pitman
Chukachida
Kehlechoa
McBride
Kinaskan
Klastline
Tanzilla
Tuya
Grand Canyon
Tahltan
Chutine
Mess
More
Forrest Kerr Cr.
Iskut
CANADA
U.S.A.

southern zone and 79 million tons of 1.0 percent copper in the northern zone.[1] In addition, precious metal content is estimated at 0.015 ounces of gold and 0.3 ounces of silver per ton (Green, 1980). Stikine Copper is one of the largest known potential copper ore deposits in Western Canada. It has the grade and proven tonnage to supply a large mine for 15 years.

Access is a major constraint to development of this property. At present the site is accessible only by air or on foot. Future access alternatives include:

a) a road down Galore Creek and Scud River to the Stikine River
b) a 13 kilometre tunnel west to the Stikine
c) a 32 kilometre tunnel east to Mess Creek

All alternatives are costly. In 1977, the Mess Creek tunnel was the preferred option. Mess Creek Valley offers a favourable townsite location, infrastructure sharing with other mining interests, and greater use of existing transportation facilites. However, recent studies have indicated serious problems with tunnel construction and maintenance. Kennco Co. is now favouring the first alternative with a connecting road either to Alaska along the southern shore of the Stikine or up the Iskut River to the Stewart-Cassiar Highway (Stevenson, 1982).

Energy supply also poses a development constraint. The mine is expected to process 30 000 tonnes per day and have a power requirement of approximately 48 megawatts (Patterson, 1981). Connection to the B.C. Hydro electrical or natural gas grid at Terrace would have prohibitively high capital costs; a thermal plant burning coal or oil would have high operating costs. A hydroelectric facility at More Creek is a feasible

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[1] In both cases the cut-off grade was set at 0.6 percent copper. At a cut-off grade of 0.4 percent, minable reserves are estimated at 180 million tons (Ministry of Economic Development, 1977).

alternative, but would generate excessive power. B.C. Hydro is hoping to develop this site as part of the Stikine-Iskut Project but current plans are to export power generated at More Creek to southern B.C.. However, Kennco is confident that a direct link-up to an Iskut or Stikine generating station is possible (Stevenson, 1982).

Difficult access, energy supply, unstable metal prices, and marketing problems are hindering the development of this high-grade copper deposit.

## Schaft Creek

The Schaft Creek deposit, managed by Teck Corporation, is located 64 kilometres south of Telegraph Creek and 32 kilometres northeast of Stikine Copper. Total reserve figures differ according to the source. Teck Corporation's latest figures indicate approximately one billion minable tons of ore grading 0.3 percent copper and 0.034 percent molybdenite, with 0.004 ounces per ton of gold and 0.035 ounces per ton of silver (Bilheimer, 1982).

As with Stikine Copper the major constraints to development are energy supply and access. Schaft Creek is expected to process 50 000 tonnes per day and would require approximately 80 megawatts of power (Patterson, 1981). Several power options have been outlined in the Stikine Copper discussion. The More Creek hydro project alone would not be large enough to supply both mines. Teck Corporation is urging B.C. Hydro to provide power from the Stikine-Iskut Project to the region (Hunter, 1982). Additionally, Teck is considering hooking up to the natural gas grid at Terrace (Bilheimer, 1982).

The likeliest access would be a road through Mess Creek and More Creek to the Stewart-Cassiar Highway. Other alternatives are either too long or require road construction through Mount Edziza Park -- a route opposed by environmentalists (Marty Loken ed., 1979).

Due to easier access, development of the low-grade Schaft Creek deposit is feasible at lower copper prices than development of the high-grade Stikine Copper property. Schaft Creek could be brought into profitable production for $600 million and a copper price per pound of $1.25 to $1.75 (Bilheimer, 1982). Copper prices have ranged between $.60 and $.70 per pound to date in 1982.

There would be advantages to Stikine Copper and Schaft Creek sharing costs and benefits of infrastructure. Townsite and transportation sharing now seem unlikely since Stikine Copper has apparently abandoned the Mess Creek tunnel alternative. However, power sharing is still a possibility. Discussions between the two mining interests are ongoing and it is possible that the two developments could proceed simultaneously.

### Red-Chris Group

Red-Chris is a joint venture in which Texasgulf Canada Ltd. holds majority interest and Silver Standard Mines Ltd. and Norcen Energy Resources Ltd. are minority shareholders. Two deposits nearby, Groat Creek and Rose, are 100 percent Texasgulf owned. The copper-gold porphyry properties are located approximately 24 kilometres east of the Stewart-Cassiar Highway at Eddontenajon Lake. Exploration work was undertaken in 1981 to re-evaluate published reserves of 38 million tons grading 0.59 percent copper (Patterson, 1981).

Access is not a problem for these properties as the deposits are just off a connector road between the Stewart-Cassiar Highway and the B.C.R. right-of-way. Energy supply remains a major constraint. Demand is estimated at 4.5-15 megawatts.

The Red-Chris Group is an interesting prospect because of its potential for relatively high-grade ore; however, more exploration is necessary to determine project feasibility.

## Other Prospects

Once access is completed to the Stikine Copper area, other properties in the area could assume greater importance. The Copper Canyon property, owned by Racicot Syndicate (Silver Standard, Teck, and Brameda) is eight kilometres east of the Stewart-Cassiar Highway. Reserves are estimated at 100 million tons of ore grading one percent copper (Min. of Ec. Dev., 1977). Stikine North and Stikine East, two copper deposits owned by Silver Standard, American Smelting and Refinery Co., and Scurry Rainbow Oil Ltd. are also nearby. Reserves are unknown.

If Schaft Creek goes into production, two other deposits may become viable: May, owned by Utah Mines Ltd., approximately eight kilometres southeast of Schaft Creek property; and, Bam, held by Phelps Dodge Corp. of Canada Ltd., located ten kilometres southeast of Schaft Creek.

Prospects in the Iskut River area include: Nickel Mountain, a nickel and copper deposit located 72 kilometres southwest of Stewart-Cassiar Highway at Bob Quinn Lake and owned by Silver Standard Mines; and, Bron and Inel prospects located south of the Iskut River and owned by Texasgulf. Finally, Consolidated Silver Ridge Mines Ltd. is carrying out exploration activity at the Red Dog gold prospect east of Mt. Edziza Park. Reserves have been estimated at 1.55 million tons at 0.041 ounces of gold per ton (Min. of Ec. Dev., 1977).

## Coal

One notable coal deposit has been identified near the Stikine Basin. The Groundhog coalfield, approximately 260 square kilometres in area, is located in the Skeena Mountains straddling the headwaters of the Stikine, Spatsizi, and Skeena rivers. The deposit is largely thermal-grade anthracite, low volatile, high ash, and non-coking. Reserves have not been properly established, but the 1946 Report of the Royal Commission on Coal estimates 900 million tons of possible coal (Min. of Ec. Dev., 1977).

Over the years, many mineral right licences have been taken and lapsed. Current holders are: Groundhog Coal Ltd., a consortium holding three coal licences covering 777 hectares; Gulf Canada Resources Inc.; Imperial Metals and Power Ltd.; and Lloyd G. Scott. Gulf Canada and Imperial Metals carried out exploration in 1981. Gulf Canada is currently undertaking a preliminary feasibility study for a coal mining facility near the Klappan River.

In 1970, Placer Development concluded that Groundhog may never be a major coalfield, but could provide fuel for a large power plant in the region (Min. of Ec. Dev., 1977). Due to present market conditions, operating costs of thermal plants are considered too high to be an economic power alternative for the Basin's potential copper producing areas.

## C. Fisheries[1]

Canadian commercial harvest of Stikine River salmon began in 1975. A limited market existed in Telegraph Creek and all fishing effort was concentrated around this remote community. While a large number of local residents held commercial fishing licences, catches were mostly used for domestic purposes.

In 1979 fishing effort shifted to the lower Stikine when B.C. Packers introduced a brine barge refrigeration unit near the Stikine and Iskut confluence. From the barge, fish were flown to processing facilities in Prince Rupert. The organised marketing system resulted in an increased catch for all species over previous years with an estimated landed value of $166,914.

In 1980 two distinct fisheries were established on the upper and lower sections of the river. The upper fishery, located on the Stikine from the confluence of the Porcupine River to the confluence of the Tahltan River, concentrated on sockeye and chinook salmon bound for the Tahltan River system. This fishery was established to satisfy local markets in Cassiar and Dease Lake, B.C.. Five licenced individuals participated in the fishery which operated on a one day a week basis from June to October. The lower fishery was located on the Stikine between the international boundary and the Porcupine River, and on the lower ten kilometres of the Iskut River. This fishery targeted mainly on sockeye and coho salmon, some pink and chum salmon and steelhead trout were also taken. Twenty-six licenced individuals participated in the fishery which operated two to three days a week from June to October. B.C. Packers again provided handling facilities during the 1980 season. The estimated landed value of the catch was $250,000.

In 1981 the upper and lower fisheries continued. The upper fishery was

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[1]The material for this section was obtained from DFO Whitehorse except where otherwise noted.

again limited to five licenced individuals and fishing was permitted one day a week from June to September. The lower fishery operated with similar boundaries as in 1980. Weekly open periods varied from one to five days depending on run strength. Twenty-three of twenty-seven licenced permit holders participated in the lower fishery in 1981.

Two new marketing systems were in service on the lower Stikine in 1981. A cooperative of ten Stikine fishermen, Great Glacier Salmon, constructed a fish processing plant on the Stikine approximately 1.6 km below the Stikine-Iskut confluence. The processing facilities included a cleaning and grading room, glazing room, and storage locker room. Fish were barged to Wrangell, Alaska in reefer units which were then transferred to Prince Rupert by ferry. Great Glacier Salmon also purchased salmon from fishermen who elected not to join the cooperative.

The competing market system involved a freezer packer which was located 0.8 km above the Stikine-Iskut confluence. Two fishermen converted a fireboat to a freezer packer. Fish were gutted and frozen on board the vessel, and when a sufficient load was accumulated it was taken to facilities in Prince Rupert or Vancouver. In addition to the two principal owners, three other fishermen delivered to the freezer packer on a permanent basis.

Both processing facilities appear to have lowered the high operating costs that made B.C. Packers brine barge-air transport system uneconomical. B.C. Packers did not operate on the Stikine in 1981.

Table 17 summarizes the total commercial and food harvests from 1971-1981. The 1981 sockeye, pink, and chum catch was the highest recorded in the three year period. DFO is attempting to limit the harvest of coho and chinook salmon for conservation measures. In 1981 the coho season was closed early and the chinook season was opened late with a mesh-size restriction in effect until July 27.

Table 17. Canadian Salmon Harvest, Stikine River, 1971-1981
(Number of Fish)

| | Chinook | | | Sockeye | | | Coho | | | Pink | | | Chum | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Commercial | Food | Total | Commercial | Food | Total | Commercial | Food | Total | Commercial | Food | Total | Commercial | Food | Total |
| 1971 | * | | | * | | | * | | | * | | | * | | |
| 1972 | * | | | * | 230 | 230 | * | | | * | | | * | | |
| 1973 | * | 200 | 200 | * | 3670 | 3670 | * | | | * | | | * | | |
| 1974 | * | | | * | 3500 | 3500 | * | | | * | | | * | | |
| 1975 | 178 | 1024 | 1202 | 270 | 1982 | 2252 | 45 | 5 | 50 | | | | | | |
| 1976 | 236 | 924 | 1160 | 733 | 2911 | 2644 | 13 | | | | | | | | |
| 1977 | 62 | 100 | 162 | 1975 | 4355 | 6310 | 32 | | | | | | | | |
| 1978 | 100 | 400 | 500 | 1500 | 3500 | 5000 | | | | | | | | | |
| 1979 | 775 | 850 | 1625 | 10534 | 3000 | 13534 | 10720 | | | 1994 | | | 424 | | |
| 1980 | 1644 | 587 | 2231 | 18819 | 2100 | 20919 | 6669 | 100 | 6769 | 756 | | | 771 | | |
| 1981 | 736 | 586 | 1322 | 22287 | 4697 | 26984 | 2558 | 200 | 2758 | 3687 | 200 | 3887 | 1031 | | |

*No commercial fishing previous to 1975

(DFO, 1982)

In general, the quality of Stikine salmon is quite high. Sockeye, chinook, coho, and steelhead are generally of higher quality than are pink and chum salmon. The poor quality of the pink and chum is due to the presence of local spawning areas which occur between the international border and the Iskut River. Although other species are usually in excellent shape, many have water stains that result from their freshwater residency. These water stains reduce many fish from export quality to number one domestic quality.

## Fishing Methods

Fishing methods involve the use of gillnets. In the upper fishery the length of the gillnet is restricted to 12 metres. A log-boom is positioned perpendicular to the river and the net is strung out to the log-boom with a rope-pulley system. In the lower fishery, each permit holder is allowed one 137 metre long gillnet. These nets are usually set in back eddies or off points. There is increased interest in the use of other fishing methods such as fish-wheels and drift gillnets and these may be used in future seasons.

Fishing gear is often destroyed and fishing periods disrupted by flood conditions. Severe fluctuations in water levels result from glacier melt during periods of prolonged sunshine, release of glacier impounded water, and heavy rainfall in coastal mountains which results in increased flow from tributaries such as the Scud, Porcupine, and Iskut Rivers. A fish-wheel tagging study, conducted by DFO on the lower river in 1981, demonstrated that salmon migration is usually delayed during peak flood periods. As a result of this study, DFO intends to keep fishing period restrictions flexible to conform with favourable water conditions and maximum run strength.

## Native Food Fishery

The Tahltan Indians have historically fished the Stikine and Tahltan Rivers. Their present fishing area extends from Telegraph Creek to a point approximately 16 km downstream. The highest concentration of nets is found at the Stikine-Tahltan confluence where the log-boom structures previously described are used.

Food fishing is permitted seven days a week. The numbers of licences issued in recent years are as follows: 1979, 60 licences; 1980, 36 licences; and, 1981, 47 licences. The native fishery concentrates on sockeye and chinook salmon, chum and coho are also taken. Table 17 indicates catch size for the native fishery from 1971-1981.

## Alaskan Commercial Fisheries

Alaskan commercial fishing of Stikine salmon has occurred since 1895. Alaskan catches are mainly made in two statistical catch areas: Area 108 is located adjacent to the mouth of the Stikine and Area 106 is located further out in the coastal archipelago. Tables 18 and 19 summarize the catches in these areas from 1951-1981. The Alaskan annual catches averages over 500 000 kilograms and is valued over one million dollars. Stikine River coho and chinook salmon are heavily fished in the Alaskan troll fishery. While the information base on this fishery is poor, harvest rates in the 70-90 percent range are thought to be responsible for the current low stock levels. DFO is currently involved in international negotiations which could divide the "total allowable catch" of Stikine salmon between Canada and the United States.

A shellfish fishery for crabs (Dungeness, King, and Tanner) and shrimps (three species) occurs in areas near the river mouth with annual catches in recent years averaging over 23 000 kilograms of crabs and over 46 000 kilograms of shrimps. Prawns are fished in adjacent bays and at least three species of clams are present. In addition, groundfish, mainly

Table 18. Alaskan Salmon Harvest, Area 108, 1951-1981
(Number of Fish)

| YEAR | SOCKEYE | CHUM | PINK | COHO | CHINOOK |
|---|---|---|---|---|---|
| 1951 | 21527 | 11382 | 60944 | 78696 | 5162 |
| 1952 | 22831 | 17902 | 5579 | 47054 | 59358 |
| 1953 | 29214 | 34602 | 7687 | 53187 | 11331 |
| 1954 | 26896 | 38898 | 19376 | 70374 | 17323 |
| 1955 | 11287 | 11617 | 17287 | 52398 | 12518 |
| 1956 | 12176 | 29086 | 4733 | 38013 | 9591 |
| 1957 | 21083 | 23931 | 4042 | 39967 | 8409 |
| 1958 | 22320 | 23443 | 15617 | 45248 | 10901 |
| 1959 | 19910 | 6553 | 34962 | 47974 | 12599 |
| 1960 | 13635 | 8189 | 5584 | 27479 | 7824 |
| 1961 | 21557 | 12535 | 52295 | 36858 | 7243 |
| 1962 | 27514 | 20290 | 36325 | 38386 | 7491 |
| 1963 | 9995 | 11155 | 10340 | 11446 | 2106 |
| 1964 | 20299 | 10771 | 114555 | 29388 | 2911 |
| 1965 | 21419 | 2480 | 4729 | 8301 | 3106 |
| 1966 | 36710 | 17730 | 61908 | 16493 | 4516 |
| 1967 | 29226 | 5955 | 4713 | 6747 | 6361 |
| 1968 | 14594 | 14537 | 91028 | 36407 | 4604 |
| 1969 | 19211 | 2318 | 11910 | 5791 | 5015 |
| 1970 | 15120 | 12305 | 20523 | 18403 | 3207 |
| 1971 | 18143 | 4665 | 21806 | 14876 | 3717 |
| 1972 | 51734 | 17363 | 17153 | 38520 | 9332 |
| 1973 | 21373 | 6674 | 6581 | 5831 | 9253 |
| 1974 | 2428 | 2107 | 4188 | 16021 | 8197 |
| 1975 | 0 | 1 | 0 | 0 | 1534 |
| 1976 | 18 | 124 | 722 | 6056 | 1123 |
| 1977 | 48374 | 4236 | 16253 | 14405 | 1443 |
| 1978 | 56 | 1001 | 1157 | 32650 | 531 |
| 1979 | 2158 | 1064 | 13440 | 234 | 91 |
| 1980 | 14053 | 6910 | 7224 | 2946 | 631 |
| 1981 | 8672 | 3563 | 1440 | 1406 | 1904 |

(DFO, 1982)

Table 19. Alaskan Salmon Harvest, Area 106, 1951-1981
(Number of Fish)

| YEAR | SOCKEYE | CHUM | PINK | COHO | CHINOOK |
|---|---|---|---|---|---|
| 1951 | 16360 | 160039 | 1978897 | 97914 | 16186 |
| 1952 | 7929 | 46429 | 133876 | 31420 | 6992 |
| 1953 | 16209 | 73027 | 63818 | 27210 | 9753 |
| 1954 | 24868 | 71184 | 118841 | 81261 | 5112 |
| 1955 | 10280 | 13311 | 338665 | 19767 | 8333 |
| 1956 | 11580 | 22647 | 120648 | 18786 | 6420 |
| 1957 | 14784 | 48375 | 77004 | 13641 | 5947 |
| 1958 | 17390 | 17324 | 99000 | 20876 | 11125 |
| 1959 | 19258 | 4806 | 183681 | 11659 | 8011 |
| 1960 | 9584 | 5003 | 15977 | 7113 | 7135 |
| 1961 | 10330 | 21698 | 105440 | 12390 | 3350 |
| 1962 | 21546 | 25912 | 254221 | 36129 | 4654 |
| 1963 | 87788 | 115526 | 880809 | 72685 | 12935 |
| 1964 | 82571 | 74265 | 1043555 | 104669 | 15782 |
| 1965 | 96222 | 33346 | 1203992 | 115937 | 10477 |
| 1966 | 97327 | 53587 | 1066965 | 108480 | 16122 |
| 1967 | 87480 | 28909 | 102013 | 22085 | 11999 |
| 1968 | 66590 | 94607 | 561899 | 105052 | 13765 |
| 1969 | 71521 | 12337 | 256368 | 15969 | 7108 |
| 1970 | 44325 | 43045 | 188504 | 48136 | 9797 |
| 1971 | 54907 | 73190 | 1211174 | 100240 | 5649 |
| 1972 | 103932 | 93575 | 233139 | 134030 | 10841 |
| 1973 | 76043 | 114307 | 662634 | 55820 | 11143 |
| 1974 | 58690 | 62426 | 146707 | 70885 | 10891 |
| 1975 | 36134 | 40189 | 674841 | 47571 | 9666 |
| 1976 | 16850 | 13828 | 388814 | 45558 | 9601 |
| 1977 | 74987 | 28243 | 1174406 | 24437 | 5003 |
| 1978 | 41994 | 19161 | 362688 | 85905 | 5472 |
| 1979 | 74367 | 41944 | 1637950 | 53040 | 8745 |
| 1980 | 107423 | 26299 | 48964 | 26612 | 4802 |
| 1981 | 167354 | 30520 | 359154 | 18623 | 1912 |

(DFO, 1982)

starry flounder and sole, are commercially trawled near the estuary (Sierra Club, 1980).

### Enhancement

Natural barriers prohibit salmon access to approximatey 50 percent of the Stikine drainage area. Major blockages occur at the Grand Canyons of the Stikine and Iskut and at the mouth of the Tuya River. Enhancement is not felt to be feasible for the Grand Canyon barriers, although the 10 meter falls on the Tuya could be overcome by tunnelling or by fishway construction. These facilities would then provide salmon access to 150 km of mainstem river, 72 sq. km of lacustrine habitat, and numerous tributary streams. It is estimated that this system could support spawning populations of at least 200,000 sockeye, 49,000 chinook, and 67,000 coho and possibly a total stock approaching 1 million fish. Therefore, the Tuya River has the potential of more than doubling Stikine salmon production.

## D. Forestry

In 1978 the new Forest Act amalgamated groups of existing Public Sustained Yield Units (PSYU) into Timber Supply Areas (TSA). The Cassiar TSA, managed by the B.C. Forest Service district office in Dease Lake, includes all of the PSYU's in the Stikine Basin. Two PSYU's, Stikine and Klappan, are totally contained within the Basin, while two others, Boundary and Dease Lake, are partially in the Basin (see figure 12). Potential annual allowable cuts for the PSYU's have been calculated as follows: Klappan, 13.4 million cubic feet; Stikine, 23.4 million cubic feet; Boundary, 14.8 million cubic feet; and, Dease Lake, 30.2 million cubic feet (Hynd, 1981). Further forest inventory statistics are available from the B.C. Forest Service; however, there have been no major updates since 1978.

Most merchantable timber is located in the Coast Mountains along the Stikine and Iskut Rivers. This belt of good timber varies from three to eight kilometers wide with sitka spruce reaching diameters of two metres and western hemlock, one metre. The interior forest is less dense and smaller. Principal tree types include spruce, balsam, and lodgepole pine.

Several "Small Business Timber Sale Licences" issued under the B.C. Forest Service Small Business Enterprise Program and many "Free Use Permits" are held in the Stikine River Basin. Currently, the Tahltan Indians operate a small gypo sawmill near Telegraph Creek. However, the number of sawmills is highly variable, as is their frequency of operation. All logging and milling in the Basin is small-scale and supplies the domestic market only; potential for a large-scale operation is unlikely (Hynd, 1982). Transportation and access difficulties, distance to markets, and lack of demand will continue to discourage commercial development of the Stikine forests.

## E. Parks

### Existing

There are two Class A provincial parks and one recreation area located within the Basin (see figure 13)[1]. Mount Edziza Provincial Park, 130 000 hectares, and the adjacent Mount Edziza Recreation Area, 99 600 hectares, are located west of Iskut and southeast of Telegraph Creek in Spectrum Range. Mt. Edziza is an active volcano; vents surrounding the summit have erupted within the past 1200 years. Numerous craters and lava beds give the park a unique moonscape appearance.

Spatsizi Plateau Wilderness Conservancy, 680 000 hectares near the headwaters of the Spatsizi River, is the largest Class A park in the province. The Spatsizi Plateau hosts B.C.'s largest herd of Osborn caribou (about 3000 animals). This herd migrates through Lawyers Pass, near the southeast corner of the park, each year.

Gladys Lake Ecological Reserve, 80 000 hectares, is located within Spatsizi Wilderness Park and was established to protect and conserve populations of Stone sheep and mountain goat. This reserve is the only no-hunting area in the basin. Bob Quinn Lake Ecological Reserve, 2022 hectares in the Iskut drainage, was established to preserve the northern limit of the Coastal Western Hemlock Biogeoclimatic Zone and associated Engelmann Spruce and subalpine fir zones.

There is a provincial park campground at Kinaskan Lake offering 40 campsites, a boat launch, and fishing. The park is soon to be designated Class A and will encompass 1800 hectares (Heathman, 1982).

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1 Exploitation of natural resources is not permitted in Class A parks, while development is conditionally permitted in recreation areas.

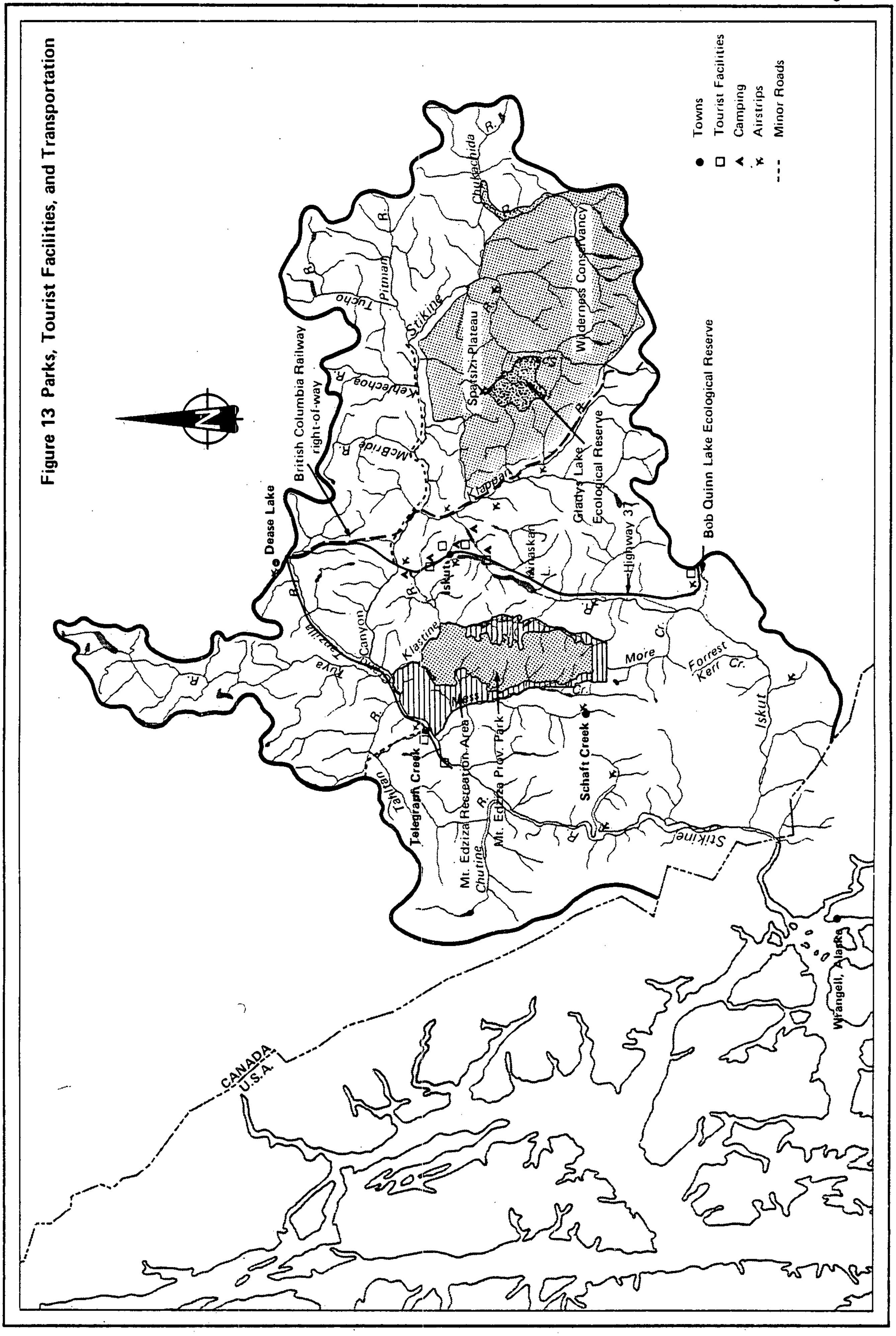


Figure 13 Parks, Tourist Facilities, and Transportation

The entire Stikine River watershed on the U.S. side of the border, about 180 000 hectares, was designated a wilderness area under the Alaska National Interest Lands Act (P.L. 96-487) on December 2, 1980. The Stikine-LeConte Wilderness Area is located within Tongass National Forest and includes the spectacular LeConte glacier and LeConte Bay. Section 1113 of the Act mandates the President to consult with Canada and report to Congress within five years concerning the need, if any, for Canadian access up the Stikine and the effect of the wilderness area designation upon these access requirements. The report is to include the social, environmental, and economic impacts which may result from various forms of access along the Stikine and Iskut Rivers. Usually, development is precluded within U.S. wilderness areas; however, Congress is empowered to grant special provisions.

## Future Considerations

Parks Canada recently released a summary of The Final Report of the Task Force on Heritage Rivers for consideration by the responsible ministers in each province or territory. This report represents the recommendations of a federal-provincial-territorial task force on the establishment and management of a Canadian Heritage Rivers System. The objective of the System is to give national recognition to outstanding examples of Canadian heritage rivers and to ensure their protection. Rivers, or parts of rivers, and the immediate environments will be selected for human, natural, or recreational values. As presently proposed, designations will be made by an intergovernmental Canadian Heritage River Board, but nominations and subsequent management will remain a provincial or territorial responsibility. The Stikine is a prime candidate for inclusion in the Canadian Heritage River Systems. The provincial Ministry of Lands, Parks, and Housing has mentioned the Stikine in a list of possible rivers for inclusion in such a heritage system. In 1973 Parks Canada staff canoed the Stikine River during a national wild river survey and commented that "wild rivers are a priceless part of our natural heritage" (Parks Canada, 1980).

Parks Canada is currently involved in discussion with the provinces and territories to develop a Canadian Landmarks System. In 1976 Parks Canada's Regional Analysis of Natural Region 7 classified the Grand Canyon of the Stikine as an area of national landmark interest and a truly spectacular feature of the Canadian northwest (appendix 9). Again, the ultimate responsibility for inclusion in such a system would rest with the province.

Other Parks Canada's interests in the Stikine Basin include the recognition of Mt. Edziza and Spatsizi Plateau as natural areas of Canadian significance (NACS). The northern boundaries for both of these areas would be the Stikine River (Davidson, 1981).

Apart from joint federal-provincial plans for the Basin, the provincial Ministry of Lands, Parks, and Housing and the B.C. Forest Service are discussing the possibility of establishing either a provincial park or forest downstream of Spatsizi Wilderness Park to the Highway 37 bridge. An integrated resource management plan is being considered since this area has both timber and recreational values.

There is also international interest in the natural values of the Stikine River. In the spring of 1981 the Canada - Unites States Environmental Council (CUSEC) met in Washington, D.C. and passed a resolution calling for the preservation of the Stikine as a wild river and its designation as a World Heritage Site. The Sierra Club Alaska Task Force has passed a similar resolution (FOS, 1981). The World Heritage Site System is a United Nations Educational, Scientific, and Cultural Organization (UNESCO) program to protect outstanding natural and historic areas of international significance.

## F. Tourism and Recreation

The Stikine River Basin offers visitors and residents a diverse array of recreational opportunities. In this wilderness region potential activities include: sightseeing and touring -- by air, motor vehicle, horse, or foot; boating -- by raft, canoe, kayak, or jet boat; and, fishing and hunting.

Tourists are attracted to the Basin for the spectacular scenery, fishing, and as an alternate route from the Alaska Highway to destinations in Yukon and Alaska. For locations west of the Rockies, the Stewart-Cassiar Highway represents a 200 kilometre shortcut to the North. Travellers embarking on this highway are cautioned that a minimum of automobile service facilities and lodging is available on the majority of the route (Ministry of Tourism, 1981). Camping areas and rest stops along Highway 37 are maintained by the provincial Ministries of Highways, Forestry, and Lands, Parks, and Housing. The limited accommodation and service facilities are indicated on table 20 and located on figure 13.

The provincial and federal governments have shown some interest in the future development of Highway 37 and, through the Tourism and Industrial Development Subsidiary Agreement, have undertaken a study of feasible future development in the area (Min. of Lands, Parks, and Housing, 1980). Meanwhile the Ministry of Lands, Parks, and Housing, in conjunction with the Regional District of Kitimat-Stikine, has prepared a land use plan for the Highway 37 with the following objectives --

a) to improve the level of service, particularly commercial facilities, available to local residents and travelling public;
b) to recognize and preserve the wilderness character of the highway corrider including the water quality of nearby lakes and rivers;
c) to ensure development takes place in an orderly and controlled fashion; and,
d) to monitor and accommodate future demand.

Table 20. Traveller Accommodation and Service Facilities

| * | | |
|---|---|---|
| Km 314 | Bob Quinn Lake | Highway maintenance camp, airstrip. |
| Km 412 | Tatogga Lake Resort Iskut, B.C. | Cabins, camping, coffee shop, gas and repairs, aviation fuel, fishing, highway maintenance camp. |
| Km 428 | Tenajon Motel Eddontenajon, B.C. | Modern lodge-sleeping units, 3 cabins,restaurant, gas, plane and helicopter base. |
| Km 431 | Iskut | Gas, store, P.O., airplane base, cabins, camping, boat rentals. |
| Km 435 | 40 Mile Flats | Cabins, coffee shop, gas and minor repairs, camping. |
| Km 508+113 | Fletcher Day Telegraph Creek, B.C. | 4 cabins with cooking facilities. |
| Km 508+113 | Telegraph Creek | Coffee shop (seasonal), gas, store, RCMP, P.O., airstrip. |
| Km 508+113 | Glenora Guest Ranch Glenora, B.C. | Cabins, trail rides, river boat trips,access by boat or plane only. |

*Km 0 Kitwanga
(Regional District of Kitimat-Stikine, 1981)

The five-year plan restricts development to two areas in the Basin: Lake Country and Bob Quinn Lake. Despite long distances between nodes, grouping of facilities is encouraged to avoid monopoly situations and to provide mutual support. A 200 metre reserve along either side of the highway ensures controlled development.

The Lake Country encompasses a 50 kilometre stretch along Kinaskan Lake and has facilities and services at Tatogga, Eddontenajon, and Iskut (see table 20). Plans for improvements of the existing facilities include the redevelopment and expansion of Tatogga Lake Resort and the expansion of the existing motel at Eddontenajon. Lake Country is expected to be the major tourist attraction along Highway 37. It is a prime recreational area in close proximity to Mt. Edziza Provincial Park and Recreation Area, Spatsizi Wilderness Park, and Kinaskan Lake Park.

Bob Quinn Lake has been identified as a secondary node to be developed as the need arises. If the Iskut hydroelectric project goes ahead Bob Quinn Lake will be the location where the new route to the dams will join Highway 37, with the possibility of a later connection to the Alaskan panhandle.

## Sportfishing

Sportfishing is popular in the Basin and is highly rated at the Stikine-Tahltan confluence where chinook salmon and steelhead trout are caught. No data is available on steelhead harvests, although the numbers of chinook harvested are as follows: 1979, 75-100; 1980, 100-150; and, 1981, 200. Sportfishing in the Stikine mainstem is limited due to the glacial origin of the water. However, in the mainstem's clearwater creeks and sloughs cutthroat trout and dolly varden char are abundant.

Numerous excellent fishing opportunities exist along the Highway 37 corridor. Fishing accounts for the largest amount of recreational time spent by tourists in the Basin. Fly-in sportfishing regularly occurs at

Tahltan and other lakes in the Basin, although there is no detailed information on catch or effort. An active sports fishery is centered around Wrangell, Alaska where 1500 chinooks were taken in the 1981 derby.

## Hunting

A major attraction to the Basin is big-game hunting. One of the finest hunting areas in B.C., the Stikine Basin offers moose, mountain goat, mountain sheep, black and grizzly bears, deer, and caribou, as well as grouse, ptarmigan, and waterfowl. An established guiding and outfitting industry caters to big game and trophy hunters. There are six registered guide-outfitters in the Basin, each with their own territory, and several hunting and fishing lodges. In previous years one had to be wealthy to afford wilderness hunting in the Stikine; today the upgraded Highway 37 has made the area accessible to anyone with a vehicle. However, non-resident hunters must still be accompanied by a local guide. In recent years both the quota system enforced in Spatsizi Wilderness Park and the right to hunt in a Class A park has received criticism from environmental groups.

## Boating

In 1980 Parks Canada published Wild Rivers: The Northwest Mountains, a report praising the virtues of canoeing wild rivers. Included was a narrative of a canoe trip down the Stikine describing the 93 kilometre Grand Canyon as unique and unnavigable. A year later, a team of experienced American kayakers succeeded in running the Grand Canyon with the assistance of a helicopter which lifted them over several impassible sections. The adventure was filmed on ABC-TV and will presumably be shown on that network in due course.

For the less adventuresome, several companies offer guided canoe and raft expeditions down the Stikine River -- none of which attempt the Grand Canyon. Table 21 lists tour operators who offer raft trips on the

Stikine, as well as backpacking, horseback riding, scenic flights, and jet boat rides. The number of operators has tripled in recent years, perhaps owing to the efforts of various groups promoting a free-flowing Stikine and to recent media coverage of the Grand Canyon and Spatsizi.

Table 21. Commercial Tour Operators

| | | |
|---|---|---|
| 1. | Canadian River Expeditions<br>Vancouver, B.C. | Rafting trips |
| 2. | Iskut Trail & River Adventures<br>Iskut, B.C. | Rafting and trail rides |
| 3. | Spatsizi Wilderness Vacations<br>Smithers, B.C. | Pack trips, angling, wildlife photography, float trips |
| 4. | Stikine River Song Rafting and Back Country Adventures<br>Telegraph Creek, B.C. | Rafting trips-includes transportation to/from Terrace, rafts for rent |
| 5. | Ecosummer Canada Expeditions<br>Vancouver, B.C. | Backpacking, photographic and nature excursions to Spatsizi and Mt. Edziza Parks |
| 6. | Black Tusk Touring and Guide tour Service Ltd.<br>North Vancouver, B.C. | Backpacking and photographic to Mt. Edziza |
| 7. | Willie Williams<br>Dease Lake, B.C. | Hoseback rides along north side of Grand Canyon |
| 8. | Telegraph Creek Expediting Ltd.<br>Tatogga, B.C. | Air charters over Grand Canyon in Beaver or Cessna 180 |
| 9. | Trans-Provincial Airlines<br>Eddontenajon, B.C. | Charter sight-seeing flights |
| 10. | B.C.-Yukon Charter<br>Dease Lake, B.C. | Charter sight-seeing flights |
| 11. | Ron Bruns<br>Telegraph Creek, B.C. | Float plane for hire |
| 12. | Tatogga Triangle Services Ltd.<br>Iskut, B.C. | Jet boat trips upstream to lower end of Grand Canyon |
| 13. | Trina-Anne Excursions<br>Telegraph Creek, B.C. | Boat trips to Wrangell |

## G. Transportation

Historically, the Stikine River provided important access to unclaimed riches in the North. In 1942 the new Alaska Highway offered a less arduous route north and the Stikine was virtually forgotten. Steamboats still ploughed the waters from Wrangell, Alaska to Telegraph Creek carrying a few prospectors, surveyors, and outfitters but even this service was discontinued in 1971. A 100 kilometre gravel track linked Telegraph Creek with an even remoter Hudson Bay Post at Dease Lake. In 1960 Dease Lake was connected to the Alaska Highway via Cassiar and in 1972 the road south to Stewart along the Iskut and Bell-Irving Rivers was completed. Forestry roads connected Stewart with Highway 16 to Prince Rupert or Terrace. Recent improvements to the road, particularly the completion of a bridge across the Skeena River at Kitwanga, 90 kilometres west of Terrace, have made what is now Highway 37 a major access to the North. A sharp increase in gas sales occurred after the opening of the Skeena bridge. Sales increased 43 percent per annum in 1976 and 1977, declining to 10 percent increase per annum in 1978 and 1979 (Min. of Lands, Parks, and Housing, 1980).

Highway 37, commonly referred to as the Stewart-Cassiar Highway, stretches 760 kilometres from Kitwanga to the Alaska Highway near Watson Lake (figure 13). It is mostly a gravel road, in poor condition at both starting points but in good condition through the Stikine Basin. Paving is underway; the southern section from Kitwanga to Meziadin Junction is due for completion in 1983. One hundred kilometres of road near Dease Lake and Cassiar is already paved; however, no schedule has been established for completion of the northern section (Regional District of Kitimat-Stikine, 1981).

At present the highway is used by several trucking companies operating between Highway 16 and Cassiar and Dease Lake. Approximately 30 percent of the traffic in summer months is recreational, despite inadequate accommodations and service facilities (Min. of Lands, Parks, and

Housing, 1980).

Projects such as the construction of the proposed Foothills gas and oil pipelines along the Alaska Highway corridor could have a major impact on the area. The Stewart-Cassiar Highway could be used extensively as a supply route and upgrading would be necessary.

Other roads penetrate the Stikine River Basin, mostly to access mineral deposits. The Omineca mining road is being extended from Fort St. James to Black Lake Mine, east of Spatsizi Wilderness Park. Future plans indicate this road may continue north through Lawyers Pass and parallel the eastern park boundary to tie in with either an existing cat trail along the north bank of the Stikine River east of Highway 37 or with the Kutcho Creek mining access road which runs east from Dease Lake into the mountains north of Spatsizi (Marty Loken, ed., 1979). The resulting road network would encircle Spatsizi Wilderness Park providing unlimited access to wildlife populations.

Speculations on future roads in the Basin include a link between Telegraph Creek and Atlin, and a road down the Iskut River Valley connecting Highway 37 with the coast.

Trans Provincial Air flies from Terrace to Schaft Creek, Bob Quinn, Eddontenajon, Telegraph Creek, and Dease Lake as required, five days a week, Monday to Friday. The airlines operates wheeled and float planes, scheduled and charter services. There are two unlicenced float plane bases in the Basin at Kinaskan Lake and Telegraph Creek. Table 22 and figure 13 indicate airstrips and their locations.

The most northerly portion of the British Columbia Railway Dease Lake extension is located in the study area. The right-of-way follows the Little Klappan River to the Stikine River, along the Stikine to Highway 37, then north to Dease Lake. The BCR extension was initiated in the late 60's on the basis of a forecast of transportation volumes and

Table 22. Airstrips

1. Bob Quinn

The Bob Quinn airstrip is an emergency airstrip located on Highway 37 and directly east of Bob Quinn Lake. This portion of the highway is gravelled and has been widened to a width of approximately 23 metres for a distance of 1219 metres. The north end of the airstrip has a large clear area which is suitable for aircraft parking.

2. Burrage

The Burrage airstrip is an emergency airstrip which is located on Highway 37 approximately 3 kilometres north of the Burrage Creek bridge. The airstrip has a gravelled runway which has been constructed almost perpendicular to the highway and crossing the highway near the mid-point. The runway is approximately 762 metres long.

3. Iskut

The Iskut airstrip is located approximately 1 kilometre north of the community and has a single gravel runway which is 1097 metres in length. Although the runway is in good condition, wind conditions and hills off the end of the runway can make landings and take-offs quite hazardous.

4. Morcheau Lake

The Morcheau Lake airstrip has a 457 metre gravel runway and is located directly east of Highway 37 and approximately 20 kilometres north of Iskut.

5. Other

A number of other airstrips are located within the Basin. Briefly, these include:

- Snippaker Creek - 549 metre gravel runway
- Galore - 457 metre runway, for emergency use only
- Scud River - 1219 metre gravel runway
- Schaft Creek - 1219 metre gravel runway
- Eagles Nest - 1128 metre gravel runway
- Little Klappan - 1097 metre gravel runway
- Klappan - 975 metre gravel runway
- Cold Fish - 610 metre runway, for emergency use only
- Telegraph Creek - 1524 metre gravel runway

(Regional District of Kitimat - Stikine, 1981) economic development in the Northwest. The line was to form a long-planned rail link between southern B.C. and Yukon, perhaps eventually reaching Alaska. In subsequent years the forecast proved too optimistic. In 1977 a Royal Commission was established to investigate the construction of the Dease Lake extension. As a result of the Commission's findings, the provincial government decided to halt the project. The issue of the Dease Lake extension surfaces occasionally, but it does not seem likely that the project will be reconsidered in the near future.

Other rail ideas for the Basin include a BCR branch line departing the Klappan River to follow the Klastline River to Telegraph Creek. A CNR line from Terrace to Meziadin Junction and on to the Groundhog Coalfield has been shelved pending settlement of native land claims.

## H. Trapping and Agriculture

Since the establishment of the fur trade in the early 1800's, trapping has provided lucrative, seasonal employment for residents of the Basin. Today there are 23 registered trapping areas in the Stikine Basin; over 18 of these are active. Furbearers taken include lynx, wolverine, muskrat, marten, fox, squirrel, weasel, and beaver. While there are no quotas on furbearers in the province, non-native trappers are required to apply for a licence annually and report the furbearers taken in the previous year and the market sold to. Native trappers are only required to register their trap-lines. Since the majority of trappers in the Basin are native, it is difficult to estimate the value and amount of harvest. In winters when access is not a difficulty and weather not a hindrance, the value of the furs taken is speculated to be approximately one million dollars (Pucett, 1981).

There is presently little agricultural development in the Basin and future possibilities appear limited. Unsuitable soil types, severe climatic conditions, high latitude, and a variable topography restrict agricultural potential. However, local anomalies do exist. Influenced by mild maritime air moving up the Stikine River from the Alaskan panhandle, Telegraph Creek and Glenora have been compared to the productive Bulkley Valley and both have frost-free seasons greater than 100 days. This section of valley bottom from the Stikine-Chutine confluence to near the Stikine-Tahltan confluence is proposed Agricultural Land Reserve. Currently, the Ministry of Lands, Parks, and Housing has seventeen agricultural and grazing leases in this area, as well as several near Iskut. In recent years, Glenora has been repopulated by homesteaders, each subsisting largely on their own produce. The agricultural leases near Iskut are successfully growing forage crops and some root vegetables. Yields are not as high as other areas in the province, but the costs are generally lower than imported feed. High land clearing, labour, and transportation costs limit the feasibility of competitive commercial-scale agriculture. Potential for agriculture in the Basin appears to be limited to cold-tolerant crops and forage for local consumption.

## IV. SUMMARY AND CONCLUSIONS

### Summary

The Stikine River Basin covers 50 000 square kilometres of northwestern British Columbia. The river rises in the Skeena Mountains and flows across the vast Stikine Plateau, its tributaries draining ranges of the Omineca and Cassiar Mountains. Before leaving the plateau, the Stikine cuts through the 80 kilometre Grand Canyon, a narrow, steep-walled gorge where the river drops an amazing 12 metres per kilometre. The Stikine widens and flows south through the jagged Coast Mountains with glaciers often dropping below treeline to meet the river. The Iskut River, its major tributary, joins the now meandering Stikine for the final reach west to the international border. Thirty-five kilometres further the Stikine empties into Frederick Sound, Alaska.

The Stikine's northern latitude, its proximity to the ocean, and the north-south lineation of the Coast Mountains dictate the major climatic patterns of the Basin. The Coast Mountains receive abundant precipitation, falling nine months of the year as snow. Storm activity in the fall and winter is frequent. Mild winters, cool summers, low sunshine hours, and a relatively long frost-free season are characteristic of the coastal area. The interior region is protected from maritime influences by the Coast and Skeena Mountains. Precipitation is much lower and distributed evenly throughout the year, but temperatures are more extreme. Winter temperatures are affected by prevailing cold, continental air masses from the Yukon Plateau or northeastern British Columbia.

The flow regime of the Stikine River is dominated by three events: interior snowmelt in May and June; coastal glacier melt in July and August; and, coastal autumn rains. Other peaks in discharge may be caused by sudden outbursts from ice-jams or glacier-dammed lakes. The Stikine and Iskut Rivers are usually ice-covered from October to April or May.

All species of Pacific salmon are indigenous to the Stikine, but sockeye and coho are the major producers. Over 50 percent of the Basin is inaccessible to spawning salmon due to natural falls, rock slides, or major blocks such as the Grand Canyon. Freshwater fish such as trout, Dolly Varden, and grayling are found in most of the Basin's rivers and lakes.

The Stikine Basin has the largest wildlife populations in British Columbia. The expansive Spatsizi Plateau is world famous for its diversity and numbers of ungulates and provides both winter and summer habitat for many species of wildlife. Osborn caribou populations are the largest in the province and herds are found in three locations in the Basin. A rare subspecies of Thinhorn sheep found only in northwestern British Columbia is protected by the Gladys Lake Ecological Reserve. The Grand Canyon is home to over 300 mountain goats. Moose, wolves, deer, mountain sheep, bears, and many small furbearers are found in good numbers throughout the Basin.

Much of the Stikine Plateau lies above 1500 metres and is dominated by alpine tundra or boreal forest. The coastal area is characterized by coastal western hemlock and sitka spruce at lower elevations and mountain hemlock and alpine fir to treeline. Throughout the Basin fires have created large tracts of grasslands or stands of successional tree species including lodgepole pine, balsam, poplar, aspen, and alpine fir. An ecological reserve at Bob Quinn Lake protects the Engelmann spruce-subalpine fir association at its northern limit.

The first human occupants in this immense wilderness area were the Tahltan Indians, who still claim sovereign rights to the Basin. The 19th century saw the first white contact with traders and prospectors lured to the Basin for furs, gold, and a route north. These periods of activity were short-lived and today the Basin is still vastly wilderness in character. At present the only significant signs of human occupancy are three small communities with few facilities, scattered cabins and airstrips, and a gravel highway dissecting the Basin. Some hunting, trapping, fishing, and agriculture provide sustenance to the Basin's small, mostly native population.

But times are changing in the Stikine. The area is buzzing with activity as hydroelectric and mining interests accelerate. B.C. Hydro is preparing preliminary designs and environmental studies for four hydroelectric projects on the Stikine and Iskut Rivers. Two sites on the Stikine, Site Z and Tanzilla, would supply 1830 megawatts and create a reservoir surface area of 13 600 hectares, flooding the Highway 37 bridge and the unused BCR bridge. Two sites on the Iskut River, More Creek and Iskut Canyon, with an additional diversion dam at Forrest Kerr Creek, would provide 935 megawatts and create a reservoir surface area of 7900 hectares. This venture would be B.C.'s largest energy project to date, creating 40 percent of the province's existing generating ability.

The Coast Mountains in the Basin have considerable reserves of economic minerals, especially copper, iron, and molybdenum. Two mining properties appear promising: Stikine Copper and Schaft Creek. Low, unstable copper prices and high development costs, particularly energy supply and access, are hindering the initiation of either project.

Stikine salmon have been commercially fished by Alaskans since 1895 and Canadians, to a lesser extent, since 1975. International negotiations which could divide the total allowable catch of Stikine salmon between Canada and the United States are underway.

The completion of Highway 37 in the late 1970's has increased tourism in the Basin. Accommodation and service facilities are being upgraded, commercial tour operators are multiplying, and public awareness of the Basin's outstanding scenery is growing.

Parks Canada has also shown an interest in the natural values of the Basin. Various surveys have resulted in recognition of the Stikine as a candidate for the proposed Canadian Heritage Rivers System, for the Grand Canyon as a nominee to the proposed Canadian Landmarks System, and for inclusion of Mount Edziza and Spatsizi Plateau in the Natural Areas of Canadian Signficance Program. International interests have recommended preservation of the Stikine under UNESCO's World Heritage Site System.

## Potential Resource and Resource Use Conflicts

The Stikine River Basin has the potential for traditional confrontations between development on the one hand and preservation on the other. Future water and related resource management decisions affecting the Basin will not be clearcut. Tradeoffs and compromises will have to be negotiated in a system where complex interrelationships and interdependencies are not well understood, where secondary and cumulative effects of development actions are not easily predicted.

An effort has been made to identify resources and socioeconomic factors that may be affected either beneficially or adversely by future developments in the Basin. This is indicated on table 23. The interactive matrix is a simple means of illustrating first-order environmental effects of alternative actions.[1] As can be expected, activities with the least impact on resources (using mitigative measures where possible) are: parks, recreation and tourism, fisheries, hunting, trapping, and agriculture. Industries such as mining, forestry, transportation, and hydroelectric power generation have impacts of varying degrees. Wildlife is the most adversely affected resource followed by habitat, fisheries, and aesthetic values. Water quality and quantity are also adversely affected by several of the developments; however, significant mitigative measures are generally possible for

[1]The matrices provide a guide for intuitive reasoning and a checklist for overlooked interrelationships. They are not predictive; secondary and cumulative effects, uniqueness, magnitude, and importance are not identified. The ratings are linear and subjective.

Table 23. Impacts of Resource Developments in the Basin

| | Hydroelectric Projects | Mining | Forestry | Trans-portation | Commercial Fisheries | Recreation and Tourism | Parks | Hunting and Trapping | Subsistence Fisheries | Agriculture |
|---|---|---|---|---|---|---|---|---|---|---|
| Water Quality | - a | -1* | -1* | 0* | 0 | 0* | 0 | 0 | 0 | 0* |
| Hydrology | - a | 0 | 0* | 0* | 0 | 0* | 0 | 0 | 0 | 0 |
| Fisheries | - a | 0* | -1* | -1* | -2→0* | 0* | 0 | 0 | 0 | 0 |
| Wildlife | -2 | -2 | -2→+2 b | -2 | 0 | -1 | 0 | 0* | 0 | 0 |
| Vegetation (habitat) | -2 | -1 | -2 | -1* | 0 | 0* | 0 | 0 | 0 | 0 |
| Existing Land Use | -2 | 0 | 0 | 0* | 0 | 0 | 0 | 0 | 0 | 0 |
| Economy | +1 | +1 | +1 | +2 | +1→+2* | +1 | 0 | +1→+2* | +1 | +1 |
| Existing Recreation | -1* | 0 | -1 | +2 | 0 | +2 | +2 | 0 | 0 | 0 |
| Aesthetics | -2 | -2 | -2 | -1 | 0 | 0 | +2 | 0 | 0 | 0 |
| Lifestyle | -2 | - a | 0* | -1 | +1→+2* | 0 | +1 | +2 | +2 | +1 |

Note:

- 2 high adverse impact
- -1 low adverse impact
- 0 no impact
- +1 positive impact
- +2 very positive impact
- * includes mitigation, compensation, or enhancement

- a degree of impact difficult to quantify
- b forestry activities have varying effects on different wildlife species

activities relating to mining, recreation and tourism, forestry, and transportation.

The effects of hydroelectric development on the water resource have not been quantified. That there will be impacts is inevitable, but the magnitude and importance are as yet unknown. However, a general discussion is possible. The proposed projects would flood the Grand Canyon of the Stikine changing the river from fast-flowing and turbulent to a slow-moving stream or lake environment. The reservoir and resulting flow regulation would likely affect downstream temperature, ice regimes, and turbidity. The dams would increase winter flows and reduce summer flows. The shape and complexity of the downstream channel would be altered while braided channels would be eliminated. The lower Stikine would likely remain freer of ice. Reservoir interception of sediments would decrease sediment loads downstream and probably affect delta growth. The annual temperature cycle would be altered and a delay in spring warming and fall cooling could be expected.

Table 24 plots development against development. Incompatible resource uses are indicated with a minus sign, while mutually beneficial activities have a plus sign. No impact is denoted with a zero; an asterisk implies mitigative measures are possible. Hydroelectric projects may have an adverse impact on both commercial and subsistence fisheries, parks, traditional hunting and trapping areas, and existing recreational use. Mining may have the same effects - except on fisheries. Many parks initiatives would preclude hydroelectric projects, mining, forestry, and even transportation. Transportation developments would likely increase recreation and tourism and provide easier access to sensitive wildlife populations. Existing resource uses in the Basin such as commercial and subsistence fishing, hunting, trapping, and agriculture would not adversely impact on other development initiatives.

Table 24. Resource Development Interactions

| | Hydroelectric Projects | Mining | Forestry | Trans-portation | Commercial Fisheries | Recreation and Tourism | Parks | Hunting and Trapping | Subsistence Fisheries | Agriculture |
|---|---|---|---|---|---|---|---|---|---|---|
| Hydroelectric Projects | 0 | 0 | 0 | 0 | 0* | 0 | - | 0 | 0* | 0 |
| Mining | + | + | 0 | + | 0 | 0 | - | 0 | 0 | 0 |
| Forestry | + | + | 0* | + | 0 | 0 | - | 0 | 0 | 0 |
| Transportation | + | + | + | 0 | 0 | + | - | 0 | 0 | 0 |
| Commercial Fisheries | - | 0 | 0* | 0 | 0* | 0 | 0 | 0 | 0 | 0 |
| Recreation and Tourism | -, + a | - | - | + | 0 | + | + | 0 | 0 | 0 |
| Parks | - | - | - | 0 | 0 | + | 0 | 0 | 0 | 0 |
| Hunting and Trapping | - | - | + | - | 0 | - | 0 | 0* | 0 | 0 |
| Subsistence Fisheries | - | 0 | 0* | 0 | 0* | 0 | 0 | 0 | 0 | 0 |
| Agriculture | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Note:

- \+ positive impact
- 0 no impact
- \- negative effect
- * with mitigation, compensation, or enhancement

a a change in present recreation use will occur

## Water Resource Management in the Basin

The potential for major resource use conflicts is emerging in the Stikine Basin. Choosing one course of action over another will be unavoidable. Future managers will have to determine the best resource allocation -- for the Basin, for the province, and for Canada. However, as not all developments in the Basin are proceeding simultaneously, there is a risk that management decisions may be made on a first-come, first-serve basis without consideration of future developments which may be precluded.

Currently, the most imminent development in the Basin is B.C. Hydro's Stikine-Iskut hydroelectric project. Approval for the project rests ultimately with the provincial Cabinet which administers the Utilities Commission Act. This Act is designed to streamline regulatory processes related to major energy projects and to integrate all aspects of legislative requirements in one review process.

The pre-application phase of the Energy Project Application Process includes a prospectus and a preliminary planning report. The planning report is intended to briefly assess alternative locations, identify site preferences, outline terms of reference for environmental, social, and project justification studies, and describe a public consultation program. The application phase concentrates on the preferred alternative and immediate study area. This phase includes details on project description, technical and financial feasibility, environmental and social impact assessment, ancillary applications, public consultation, and other information as required. Following review by the Energy Project Coordinating Committee and Working Committees, including public hearings and interventions, the application is either granted or denied. As the BCUC procedure is very new, it has not yet been determined what federal involvement there might be in the process: one possibility is an interdepartmental task force which submits comments directly to the Utilities Commission or intervenes in the public hearings.

The Stikine River has the added complication of being an international river and as such may require further federal involvement with respect to hydroelectric development. The International River Improvements Act stipulates that any activity which affects the use, existing or potential, of a river outside Canada, or increases, decreases, or otherwise alters the natural flow of an international river may require a licence from Environment Canada. Regulations pertaining to compliance with this Act are similar to requirements under the provincial Utilities Commission Act.

The International Boundary Waters Treaty Act (1914) legally confirms in Canada the Boundary Waters Treaty (1909), and might apply to B.C. Hydro's proposal. The Act is administered by the Department of External Affairs, but any rules and regulations stipulated by the International Joint Commission may be enforced by the Inland Waters Directorate. The Boundary Waters Treaty Act provides legal redress to the United States if a Canadian activity results in injury on the U.S. side of the border. The Treaty itself is somewhat lengthier and contains articles relating to the rights of navigation, the maintenance of transboundary water levels and flows except by prior agreement, and transboundary pollution on either side which leads to the injury of health or property of the other.[1]

Another pending major development in the Basin is mining. Proposals for mining projects would proceed through a parallel review process under the provincial Mining Regulations Act; transportation developments would follow ELUC's "Guidelines for Linear Developments".

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[1]As part of its mandate in relation to various acts and treaties, the Inland Waters Directorate has several studies ongoing to ensure that federal responsibilities with respect to national and international water resource interests are addressed. These studies include an intensive water quality program, suspended sediment data collection and analysis, various snow and ice studies, and routine water quantity and quality monitoring. The Directorate also participates on an interdepartmental task force which reviews B.C. Hydro's completed environmental impact assessment reports and in the recently established Cooperative Information Exchange Agreement between British Columbia and Alaska.

There are important limitations to these review processes. For example, each development is treated individually and each proponent prepares an environmental and social impact assessment for a limited study area. Proponents are not required to evaluate their projects in a regional context or to assess the cumulative impacts of all resource developments in the Basin. Moreover, the environmental impact assessment process is reactive rather than proactive; it is a mechanism which requires integration into a broader planning strategy. Unfortunately for the Stikine Basin, this planning strategy does not exist and decisions are being made despite the lack of adequate long-range goals.

A provincial government planning process would not be enough in the Stikine. Federal interests are high: navigation rights, transboundary waters, anadromous fisheries, native peoples, regional economic expansion, national parks, migratory birds, etc. Clearly the full range of water and water-related management policies is not the sole responsibility of one level of government. The need for a federal-provincial cooperative approach to water management is evident.

The Canada Water Act (1970) provides an adequate vehicle for addressing the concerns of both governments in water resource management. This Act facilitates interjurisdictional liaison and provides a forum for the development of management plans which benefit the region, Canada, and society as a whole. It provides an administrative framework for joint federal-provincial cooperative programs for dealing with water resource problems and for planning the future management and utilization of these waters in the most beneficial way.

Canada Water Act river basin planning studies formulate and select water management strategies for a basin's development. Preparation of these plans include forecasting water demands on the basis of projected regional developments and public preferences, evaluating water management alternatives, determining their technical and economic feasibility, assessing social and environmental effects, and, finally, selecting the best management plan (IWD, 1978). While there has been criticism of previous CWA river basin studies, the underlying precepts of the Act are still valid.[1] A joint approach to river basin planning is essential.

Because of major federal responsibilities in the Basin, applications under the International River Improvements Act and the Boundary Waters Treaty and reviews by interdepartmental task forces will not sufficiently address the full gambit of federal concerns for long term management of water and related resources in the Basin. Whether or not the Canada Water Act will provide the forum for long-term management and intergovernmental cooperation, a strategy for planning in this remote area must be adopted. Resource developments should not proceed ad hoc in the Stikine. Without the foresight that planning offers, impending resource use conflicts could reach irreversible positions and the future of the Stikine Basin, rightly or wrongly, may be determined by the actions of a select few proponents.

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[1]A discussion of the methods of river basin planning is beyond the objectives of this report.

Appendix 1. Climatic Data For Telegraph Creek and Dease Lake

Appendix 1. Climatic Data for Telegraph Creek and Dease Lake

| Telegraph Creek | Jan. | Feb. | Mar. | Apr. | May. | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean daily temp. (°F) (a) | 4.8 | 14.8 | 26.6 | 39.6 | 50.0 | 57.1 | 59.9 | 58.8 | 50.9 | 39.1 | 21.6 | 10.2 | 36.0 |
| (Yrs. of record) | (17) | (17) | (17) | (16) | (17) | (17) | (17) | (17) | (17) | (17) | (18) | (18) | |
| Mean daily max. temp. (b) | 11.2 | 22.7 | 38.5 | 51.0 | 63.7 | 71.0 | 72.7 | 71.5 | 62.8 | 47.7 | 27.8 | 16.6 | 46.4 |
| Mean daily min. temp. (b) | -2.8 | 3.3 | 15.3 | 27.2 | 36.0 | 44.3 | 48.1 | 45.5 | 39.9 | 30.7 | 16.7 | 3.9 | 25.7 |
| Extreme max. recorded (b) | 46 | 49 | 59 | 71 | 86 | 95 | 92 | 90 | 84 | 71 | 52 | 47 | 95 |
| (Yrs. of record) | (16) | (20) | (16) | (15) | (14) | (16) | (15) | (16) | (17) | (17) | (13) | (15) | |
| Extreme min. recorded (c) | -43 | -38 | -21 | -1 | 23 | 30 | 36 | 32 | 19 | 2 | -23 | -40 | -43 |
| (Yrs. of record) | (12) | (15) | (15) | (14) | (11) | (12) | (11) | (11) | (12) | (13) | (10) | (12) | |
| Mean total precipitation (a) (inches) | 1.46 | 0.91 | 0.66 | 0.40 | 0.34 | 0.72 | 0.93 | 1.03 | 1.43 | 1.99 | 1.41 | 1.27 | 12.55 |
| (Yrs. of record) | (18) | (18) | (17) | (17) | (18) | (18) | (18) | (18) | (18) | (17) | (19) | (17) | |
| Greatest Precip. in 24 hrs (inches) | 1.22 | 0.83 | 1.00 | 0.77 | 0.60 | 1.04 | 0.98 | 0.84 | 1.56 | 1.36 | 1.0 | 0.6 | 1.56 |
| No. of days with frost (d) | 31 | 28 | 30 | 24 | 9 | - | - | - | 3 | 17 | 29 | 31 | 202 |

Notes:
(a) Mean calculated with up to and including 1975 data
(b) From 'Climatic Normals 1941 - 1970', based on 15 to 19 years of data between 1941 and 1970
(c) From 'Climatic Normals 1941 - 1970', based on 10 to 14 years of data between 1941 and 1970
(d) From 'Temperature and Precipitation 1941 - 1970 for British Columbia', based on 10 to 14 years of data between 1941 and 1970

Appendix 1. Climatic Data for Telegraph Creek and Dease Lake (cont)

| Dease Lake | Jan. | Feb. | Mar. | Apr. | May. | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean Rainfall | 0.03 | 0.01 | 0.02 | 0.05 | 0.66 | 1.48 | 2.08 | 2.13 | 1.69 | 0.62 | 0.12 | 0.02 | 8.91 |
| Mean Snowfall | 11.6 | 11.5 | 9.0 | 4.6 | 1.8 | 0.3 | 0.5 | T | 0.3 | 7.4 | 13.5 | 13.0 | 73.5 |
| Mean Total Precipitation | 1.11 | 1.02 | 0.83 | 0.46 | 0.84 | 1.51 | 2.12 | 2.13 | 1.72 | 1.34 | 1.26 | 1.19 | 15.53 |
| Greatest Rainfall in 24 hrs. | 0.46 | 0.10 | 0.44 | 0.29 | 0.79 | 1.10 | 1.57 | 1.80 | 0.91 | 0.84 | 0.34 | 0.22 | 1.80 |
| Greatest Snowfall in 24 hrs. | 9.2 | 10.1 | 10.3 | 6.1 | 6.0 | 2.5 | 11.3 | 0.7 | 1.4 | 11.1 | 10.2 | 8.6 | 11.3 |
| Greatest Precip. in 24 hrs. | 0.77 | 0.94 | 0.96 | 0.47 | 0.79 | 1.10 | 2.33 | 1.80 | 0.91 | 1.11 | 0.90 | 0.89 | 2.33 |
| Mean Daily Temperature (°F) | -2.8 | 8.2 | 19.1 | 31.8 | 43.5 | 51.4 | 54.7 | 52.6 | 45.3 | 34.3 | 17.1 | 3.9 | 29.9 |
| Mean Daily Maximum (°F) | 5.6 | 18.4 | 31.2 | 42.7 | 56.2 | 64.4 | 66.9 | 64.8 | 56.0 | 42.6 | 24.6 | 11.6 | 40.4 |
| Mean Daily Minimum (°F) | -11.3 | -2.1 | 7.0 | 20.8 | 30.7 | 38.3 | 42.4 | 40.5 | 34.5 | 26.0 | 9.5 | -4.0 | 19.4 |
| Extreme Maximum (°F)<br>(Yrs. of record) | 48<br>(25) | 53<br>(25) | 55<br>(25) | 66<br>(25) | 89<br>(25) | 93<br>(25) | 89<br>(25) | 88<br>(25) | 84<br>(25) | 62-26<br>(26) | 58<br>(26) | 45<br>(26) | 93<br>(26) |
| Extreme Minimum (°F)<br>(Yrs. of Record) | -60<br>(25) | -55<br>(25) | -45<br>(25) | -25<br>(25) | 12<br>(25) | 22<br>(25) | 28<br>(25) | 21<br>(25) | 5<br>(25) | -10<br>(26) | -38<br>(26) | -51<br>(26) | -60<br>(26) |
| Sunshine Hours | | | | | | | | | | | | | |
| 1975 | 43 | M | 170 | 182 | 260 | 211 | 214 | 171 | 160 | 70 | 56 | 18 | M |
| 74 | M | M | M | 137 | 221 | 176 | 182 | 221 | 128 | 90 | 37 | 17 | M |
| 73 | 65 | 87 | 92 | 177 | 194 | 219 | 202 | 157 | 156 | 83 | 93 | 37 | 1562 |
| 72 | M | M | M | M | M | M | M | M | M | M | 117 | 31 | M |

Appendix 2. 1977 Climatic Data For Eight Stations
(MOE, Air Studies, Branch, 1980)

# Appendix 2. 1977 Climatic Data for Eight Stations
## Monthly Temperature Summary
## (Degrees Celsius)

### 104G/NE KINASKAN LAKE 1204215

| Y Mo | Mean Maximum | Mean Minimum | Monthly Mean | Extreme Max. | Extreme Min. | Missing Max. | Missing Min. | Days Minimum Below 0 | −5 | −10 | −20 | −30 | Degree Days Above 5 | Degree Days Below 18 | Effective Above 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 01 | −4 | −10 | −7 | 1.1 | −22.2 | 0 | 0 | 31 | 28 | 16 | 1 | 0 | 0 | 778 | 0 |
| 77 02 | 2 | −6 | −2 | 5.6 | −18.9 | 0 | 0 | 27 | 15 | 5 | 0 | 0 | 0 | 567 | 0 |
| 77 03 | 0 | −11 | −6 | 4.4 | −23.9 | 0 | 0 | 31 | 25 | 16 | 6 | 0 | 0 | 729 | 0 |
| 77 04 | 7 | −3 | 2 | 16.7* | −12.2* | 2 | 2 | 23* | 11 | 1 | 0 | 0 | 8* | 435* | 1* |
| 77 05 | 12* | −1* | 5 | 19.0* | −5.6* | 0 | 0 | 18* | 3 | 0 | 0 | 0 | 32 | 388 | 3 |
| 77 06 | 16 | 3 | 9 | 23.3 | −2.8 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 132 | 258 | 26 |
| 77 07 | 19 | 6 | 12 | 26.7 | .6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 221 | 183 | 70 |
| 77 08 | 21 | 6 | 13 | 30.0 | −2.8 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 258 | 145 | 99 |
| 77 09 | 12 | 1 | 7 | 15.6 | −3.9 | 0 | 0 | 12 | 0 | 0 | 0 | 0 | 55 | 340 | 8 |
| 77 10 | M | M | M | 7.2* | −7.2* | 16 | 16 | M | M | M | M | M | M | M | M |
| 77 11 | M | M | M | M | M | 30 | 30 | M | M | M | M | M | M | M | M |
| 77 12 | M | M | M | M | M | 31 | 31 | M | M | M | M | M | M | M | M |
| **Annual** | **M** | **M** | **M** | **30.0*** | **−23.9*** | **79** | **79** | **M** | **M** | **M** | **M** | **M** | **M** | **M** | **M** |

Longest 1977 period with minimum above 0 61 DAYS JUL 01 — AUG 30
−2 87 DAYS JUN 05 — AUG 30
−4 139 DAYS MAY 18 — OCT 03

Period between first and last occurrences of five consecutive days all with mean temperatures above 5°C in 1977: 130 DAYS* MAY 15 — SEP 22

Degree days above 5°C for same period: 685

### 104B/NE BOB QUINN LAKE 1200R0J

| Y Mo | Mean Maximum | Mean Minimum | Monthly Mean | Extreme Max. | Extreme Min. | Missing Max. | Missing Min. | Days Minimum Below 0 | −5 | −10 | −20 | −30 | Degree Days Above 5 | Degree Days Below 18 | Effective Above 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 01 | M | M | M | M | M | 31 | 31 | M | M | M | M | M | M | M | M |
| 77 02 | M | M | M | M | M | 28 | 28 | M | M | M | M | M | M | M | M |
| 77 03 | M | M | M | M | M | 31 | 31 | M | M | M | M | M | M | M | M |
| 77 04 | M | M | M | M | M | 30 | 30 | M | M | M | M | M | M | M | M |
| 77 05 | M | M | M | M | M | 31 | 31 | M | M | M | M | M | M | M | M |
| 77 06 | M | M | M | M | M | 30 | 30 | M | M | M | M | M | M | M | M |
| 77 07 | M | M | M | M | M | 31 | 31 | M | M | M | M | M | M | M | M |
| 77 08 | M | M | M | M | M | 31 | 31 | M | M | M | M | M | M | M | M |
| 77 09 | M | M | M | M | M | 30 | 30 | M | M | M | M | M | M | M | M |
| 77 10 | M | M | M | M | M | 31 | 31 | M | M | M | M | M | M | M | M |
| 77 11 | M | M | M | M | M | 30 | 30 | M | M | M | M | M | M | M | M |
| 77 12 | −12 | −19 | −16 | 3.0 | −36.0 | 0 | 0 | 31 | 30 | 27 | 14 | 4 | 0 | 1047 | 0 |
| **Annual** | **M** | **M** | **M** | **3.0*** | **−36.0*** | **334** | **334** | **M** | **M** | **M** | **M** | **M** | **M** | **M** | **M** |

Longest 1977 period with minimum above 0 M DAYS
−2 M DAYS
−4 M DAYS

Period between first and last occurrences of five consecutive days all with mean temperatures above 5°C in M DAYS

Degree days above 5°C for same period: M

### 104G/NE ISKUT RANCH 1203672

| Y Mo | Mean Maximum | Mean Minimum | Monthly Mean | Extreme Max. | Extreme Min. | Missing Max. | Missing Min. | Days Minimum Below 0 | −5 | −10 | −20 | −30 | Degree Days Above 5 | Degree Days Below 18 | Effective Above 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 01 | −3 | −12 | −7 | 4.4* | −26.1* | 2 | 2 | 29* | 23 | 18 | 3 | 0 | 0* | 704* | 0* |
| 77 02 | 3 | −4* | 0* | 6.7* | −15.0* | 3 | 5 | 20* | 7 | 3 | 0 | 0 | 0* | 405* | 0* |
| 77 03 | 2 | −9 | −4 | 4.4* | −20.0* | 2 | 2 | 29* | 22 | 10 | 0 | 0 | 0* | 632* | 0* |
| 77 04 | 8 | −2 | 3 | 18.3 | −10.0* | 0 | 3 | 20* | 7 | 1 | 0 | 0 | 18* | 415* | 2* |
| 77 05 | 13 | −1 | 6 | 18.3 | −6.7 | 0 | 0 | 17 | 4 | 0 | 0 | 0 | 43 | 375 | 4 |
| 77 06 | M | M | M | 23.9* | −.6* | 9 | 10 | M | M | M | M | M | M | M | M |
| 77 07 | M | M | M | 26.7* | 1.1* | 9 | 10 | M | M | M | M | M | M | M | M |
| 77 08 | 22 | 5 | 13 | 31.1 | −5.0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 260 | 144 | 99 |
| 77 09 | 14 | 0 | 7 | 17.8 | −6.1 | 0 | 0 | 19 | 3 | 0 | 0 | 0 | 57 | 338 | 9 |
| 77 10 | 6 | −3 | 2 | 10.0 | −11.1 | 0 | 0 | 22 | 8 | 1 | 0 | 0 | 1 | 503 | 0 |
| 77 11 | −3 | −15 | −9 | 5.6 | −36.7 | 0 | 0 | 30 | 24 | 18 | 9 | 4 | 0 | 807 | 0 |
| 77 12 | −12 | −23 | −18 | 4.4 | −42.8 | 0 | 0 | 31 | 31 | 28 | 18 | 6 | 0 | 1105 | 0 |
| **Annual** | **7*** | **−5*** | **1*** | **31.1*** | **−42.8*** | **25** | **32** | **219*** | **130** | **79** | **30** | **10** | **643*** | **5698*** | **190*** |

Longest 1977 period with minimum above 0 M DAYS
−2 M DAYS
−4 M DAYS

Period between first and last occurrences of five consecutive days all with mean temperatures above 5°C in 1977: 141 DAYS* MAY 03 — SEP 21

Degree days above 5°C for same period: 617*

Appendix 2. (cont)
Monthly Temperature Summary (cont)
(Degrees Celsius)

**104H/NW MCBRIDE RIVER 1204958**

| Y/Mo | Mean Maximum | Mean Minimum | Monthly Mean | Extreme Max. | Extreme Min. | Missing Max. | Missing Min. | Days Minimum Below 0 | -5 | -10 | -20 | -30 | Degree Days Above 5 | Degree Days Below 18 | Effective Above 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 01 | -7 | -16 | -12 | 1.7 | -30.0 | 0 | 0 | 31 | 30 | 27 | 6 | 0 | 0 | 923 | 0 |
| 77 02 | 2 | -11 | -5 | 8.9 | -22.2 | 0 | 0 | 28 | 26 | 12 | 3 | 0 | 0 | 633 | 0 |
| 77 03 | 2 | -13 | -6 | 6.7 | -25.0 | 0 | 0 | 31 | 28 | 19 | 7 | 0 | 0 | 730 | 0 |
| 77 04 | 9 | -4 | 3 | 20.0 | -13.3 | 0 | 0 | 26 | 14 | 1 | 0 | 0 | 18 | 465 | 1 |
| 77 05 | 13 | 0 | 7 | 18.9 | -5.0 | 0 | 0 | 16 | 2 | 0 | 0 | 0 | 53 | 355 | 6 |
| 77 06 | 17 | 4 | 10 | 24.4 | -2.2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 156 | 234 | 36 |
| 77 07 | 20 | 7 | 14 | 27.8 | 3.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 264 | 140 | 97 |
| 77 08 | 22 | 6 | 14 | 32.2 | -1.7 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 291 | 119 | 124 |
| 77 09 | 15 | -1 | 7 | 18.9 | -5.0 | 0 | 0 | 18 | 1 | 0 | 0 | 0 | 66 | 325 | 6 |
| 77 10 | 6 | -3 | 1 | 12.8 | -9.4 | 0 | 0 | 24 | 11 | 0 | 0 | 0 | 3 | 515 | 0 |
| 77 11 | -7 | -18 | -12 | 7.2 | -38.3 | 0 | 0 | 30 | 30 | 23 | 10 | 6 | 0 | 914 | 0 |
| 77 12 | M | M | M | 1.1* | -48.9* | 13 | 13 | M | M | M | M | M | M | M | M |
| **Annual** | **7** | **-6** | **1** | **32.2*** | **-48.9*** | **13** | **13** | **224*** | **160** | **100** | **40** | **16** | **851*** | **6146*** | **270*** |

Longest 1977 period with minimum above 0 68 DAYS JUN 24 — AUG 30
-2 88 DAYS JUN 05 — AUG 31
-4 126 DAYS MAY 27 — SEP 29

Period between first and last occurrences of five consecutive days all with mean temperatures above 5°C in 1977: 160 DAYS APR 23 — SEP 30

Degree days above 5°C for same period: 844

**104G/NE TODAGIN RANCH 1208202**

| Y Mo | Mean Maximum | Mean Minimum | Monthly Mean | Extreme Max. | Extreme Min. | Missing Max. | Missing Min. | Days Minimum Below 0 | -5 | -10 | -20 | -30 | Degree Days Above 5 | Degree Days Below 18 | Effective Above 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 01 | -4 | -13 | -9 | 2.2 | -30.6 | 0 | 0 | 31 | 29 | 21 | 5 | 1 | 0 | 831 | 0 |
| 77 02 | 3 | -8 | -3 | 7.8 | -18.9 | 0 | 0 | 28 | 20 | 8 | 0 | 0 | 0 | 584 | 0 |
| 77 03 | 1 | -12 | -5 | 5.6 | -23.9 | 0 | 0 | 31 | 29 | 15 | 6 | 0 | 0 | 718 | 0 |
| 77 04 | 8 | -4 | 2 | 18.3 | -14.4 | 0 | 0 | 27 | 12 | 1 | 0 | 0 | 10 | 483 | 1 |
| 77 05 | 13 | -2 | 5 | 18.9 | -7.2 | 0 | 0 | 19 | 5 | 0 | 0 | 0 | 31 | 391 | 3 |
| 77 06 | 16 | 1 | 9 | 23.3 | -3.9 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 117 | 273 | 20 |
| 77 07 | 19 | 4 | 12 | 27.8 | -.6 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 211 | 192 | 63 |
| 77 08 | 22 | 5 | 13 | 31.7 | -5.0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 254 | 149 | 92 |
| 77 09 | 13 | 0 | 7 | 17.8 | -6.7 | 0 | 0 | 15 | 4 | 0 | 0 | 0 | 54 | 343 | 9 |
| 77 10 | 5 | -4 | 1 | 8.9 | -12.2 | 0 | 0 | 24 | 10 | 2 | 0 | 0 | 1 | 535 | 0 |
| 77 11 | -5 | -16 | -10 | 2.8 | -38.3 | 0 | 0 | 30 | 26 | 19 | 10 | 4 | 0 | 854 | 0 |
| 77 12 | -16 | -26 | -21 | -.6 | -45.6 | 0 | 0 | 31 | 31 | 30 | 22 | 8 | 0 | 1205 | 0 |
| **Annual** | **6** | **-6** | **0** | **31.7** | **-45.6** | **0** | **0** | **245** | **167** | **96** | **43** | **13** | **678** | **6558** | **188** |

Longest 1977 period with minimum above 0 29 DAYS AUG 02 — AUG 30
-2 87 DAYS JUN 05 — AUG 30
-4 96 DAYS MAY 27 — AUG 30

Period between first and last occurrences of five consecutive days all with mean temperatures above 5°C in 1977: 152 DAYS APR 23 — SEP 22

Degree days above 5°C for same period: 674

**104G/NW TELEGRAPH CREEK 1208040**

| Y Mo | Mean Maximum | Mean Minimum | Monthly Mean | Extreme Max. | Extreme Min. | Missing Max. | Missing Min. | Days Minimum Below 0 | -5 | -10 | -20 | -30 | Degree Days Above 5 | Degree Days Below 18 | Effective Above 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 01 | -4 | -10 | -7 | 4.4 | -20.0 | 0 | 0 | 31 | 26 | 14 | 0 | 0 | 0 | 783 | 0 |
| 77 02 | 3 | -4 | -1 | 7.2 | -10.6 | 0 | 0 | 27 | 10 | 1 | 0 | 0 | 0 | 519 | 0 |
| 77 03 | 5 | -5 | 0 | 10.6 | -12.2 | 0 | 0 | 31 | 15 | 2 | 0 | 0 | 0 | 556 | 0 |
| 77 04 | 12 | 0 | 6 | 23.3 | -5.0 | 0 | 0 | 16 | 1 | 0 | 0 | 0 | 55 | 365 | 9 |
| 77 05 | 18 | 2 | 10 | 23.9 | -1.7 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 150 | 253 | 28 |
| 77 06 | 20 | 7 | 13 | 27.2 | 2.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 254 | 136 | 94 |
| 77 07 | 24 | 9 | 16 | 31.1 | 3.9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 355 | 60 | 177 |
| 77 08 | 26 | 10 | 18 | 34.4 | 1.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 410 | 48 | 245 |
| 77 09 | 18 | 3 | 11 | 21.7 | -1.7 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 167 | 223 | 41 |
| 77 10 | 8 | -1 | 4 | 14.4 | -5.0 | 0 | 0 | 16 | 1 | 0 | 0 | 0 | 14 | 442 | 1 |
| 77 11 | -6 | -12 | -9 | 5.0 | -29.4 | 0 | 0 | 30 | 25 | 13 | 8 | 0 | 0 | 816 | 0 |
| 77 12 | -16 | -23 | -19 | -3.9 | -37.2 | 0 | 0 | 31 | 31 | 28 | 19 | 5 | 0 | 1163 | 0 |
| **Annual** | **9** | **-2** | **3** | **34.4** | **-37.2** | **0** | **0** | **195** | **109** | **58** | **27** | **5** | **1405** | **5364** | **595** |

Longest 1977 period with minimum above 0 97 DAYS MAY 27 — AUG 31
-2 162 DAYS APR 22 — SEP 30
-4 167 DAYS APR 20 — OCT 03

Period between first and last occurrences of five consecutive days all with mean temperatures above 5°C in 1977: 180 DAYS APR 03 — SEP 30

Degree days above 5°C for same period: 1391

Appendix 2. (cont)
Monthly Temperature Summary (cont)
(Degrees Celsius)

### 104J/NW HATIN LAKE 12033M0

| Y/Mo | Mean Maximum | Mean Minimum | Monthly Mean | Extreme Max. | Extreme Min. | Missing Max. | Missing Min. | Days Minimum Below 0 | -5 | -10 | -20 | -30 | Degree Days Above 5 | Degree Days Below 18 | Effective Above 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 01 | -3 | -14 | -8 | 6.1 | -31.1 | 0 | 0 | 30 | 26 | 22 | 6 | 1 | 0 | 815 | 0 |
| 77 02 | 2 | -10 | -4 | 7.2 | -23.3 | 0 | 0 | 28 | 22 | 16 | 2 | 0 | 0 | 622 | 0 |
| 77 03 | 0 | -14 | -7 | 3.3 | -26.1 | 0 | 0 | 31 | 30 | 22 | 6 | 0 | 0 | 777 | 0 |
| 77 04 | 7 | -5 | 1 | 16.7 | -12.2 | 0 | 0 | 27 | 18 | 4 | 0 | 0 | 8 | 515 | 0 |
| 77 05 | M | M | M | M | M | 31 | 31 | M | M | M | M | M | M | M | M |
| 77 06 | 16 | 1 | 9 | 22.8 | -3.9 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 112 | 279 | 20 |
| 77 07 | 18 | 3 | 11 | 26.1 | -3.9 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 172 | 231 | 41 |
| 77 08 | M | M | M | M | M | 31 | 31 | M | M | M | M | M | M | M | M |
| 77 09 | M | M | M | M | M | 30 | 30 | M | M | M | M | M | M | M | M |
| 77 10 | M | M | M | M | M | 31 | 31 | M | M | M | M | M | M | M | M |
| 77 11 | M | M | M | M | M | 30 | 30 | M | M | M | M | M | M | M | M |
| 77 12 | M | M | M | M | M | 31 | 31 | M | M | M | M | M | M | M | M |
| **Annual** | **M** | **M** | **M** | **26.1*** | **-31.1*** | **184** | **184** | **M** | **M** | **M** | **M** | **M** | **M** | **M** | **M** |

Longest 1977 period with minimum above 0 M DAYS
-2 M DAYS
-4 61 DAYS JUN 01 — JUL 31*

Period between first and last occurrences of five consecutive days all with mean temperatures above 5°C in M DAYS

Degree days above 5°C for same period: M

### 104J/SE DEASE LAKE 1192340

| Y/Mo | Mean Maximum | Mean Minimum | Monthly Mean | Extreme Max. | Extreme Min. | Missing Max. | Missing Min. | Days Minimum Below 0 | -5 | -10 | -20 | -30 | Degree Days Above 5 | Degree Days Below 18 | Effective Above 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 01 | -6 | -14 | -10 | 1.7 | -30.0 | 0 | 0 | 31 | 28 | 23 | 5 | 0 | 0 | 870 | 0 |
| 77 02 | 2 | -8 | -3 | 8.0 | -17.5 | 0 | 0 | 28 | 20 | 10 | 0 | 0 | 0 | 596 | 0 |
| 77 03 | 0 | -11 | -5 | 5.3 | -20.7 | 0 | 0 | 31 | 27 | 16 | 2 | 0 | 0 | 727 | 0 |
| 77 04 | 8 | -4 | 2 | 18.4 | -11.7 | 0 | 0 | 24 | 9 | 1 | 0 | 0 | 17 | 474 | 1 |
| 77 05 | 13 | 0 | 6 | 19.2 | -5.6 | 0 | 0 | 16 | 1 | 0 | 0 | 0 | 51 | 363 | 6 |
| 77 06 | 16 | 4 | 10 | 25.3 | -1.9 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 153 | 237 | 37 |
| 77 07 | 19 | 6 | 12 | 25.3 | 1.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 231 | 173 | 76 |
| 77 08 | 21 | 6 | 14 | 30.2 | -2.7 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 272 | 135 | 111 |
| 77 09 | 13 | 1 | 7 | 16.9 | -4.2 | 0 | 0 | 15 | 0 | 0 | 0 | 0 | 64 | 334 | 8 |
| 77 10 | 7 | -3 | 2 | 12.2 | -10.6 | 0 | 0 | 25 | 8 | 2 | 0 | 0 | 3 | 509 | 0 |
| 77 11 | -7 | -16 | -12 | 3.8 | -35.2 | 0 | 0 | 30 | 27 | 23 | 10 | 2 | 0 | 888 | 0 |
| 77 12 | -19 | -27 | -23 | -4.3 | -45.1 | 0 | 0 | 31 | 31 | 29 | 24 | 9 | 0 | 1271 | 0 |
| **Annual** | **6** | **-6** | **0** | **30.2** | **-45.1** | **0** | **0** | **233** | **151** | **104** | **41** | **11** | **791** | **6577** | **239** |

Longest 1977 period with minimum above 0 87 DAYS JUN 05 — AUG 30
-2 96 DAYS MAY 27 — AUG 30
-4 125 DAYS MAY 21 — SEP 22

Period between first and last occurrences of five consecutive days all with mean temperatures above 5°C in 1977: 152 DAYS APR 22 — SEP 21

Degree days above 5°C for same period: 780

# Appendix 2. (cont)
## Precipitation Summary

### 104B/NE BOB QUINN LAKE 1200R0J

| | Monthly Total Precipitation (mm) | | | | Accumulated Precipitation (mm) | | | | Snow Pack | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Y/Mo | Manual Observation | Recording Gauge | Days With Precipitation | Days Missed | Storage Gauge 1 | Storage Gauge 2 | Interval | Monthly Snowfall (cm) | Depth (cm) | Cover (%) | Date |
| 77 01 | M | | M | 31 | | | | M | M | | JAN31 |
| 77 02 | M | | M | 28 | | | | M | M | | FEB28 |
| 77 03 | M | | M | 31 | | | | M | M | | MAR31 |
| 77 04 | M | | M | 30 | | | | M | M | | APR30 |
| 77 05 | M | | M | 31 | | | | M | M | | MAY31 |
| 77 06 | M | | M | 30 | | | | M | M | | JUN30 |
| 77 07 | M | | M | 31 | | | | M | M | | JUL31 |
| 77 08 | M | | M | 31 | | | | M | M | | AUG31 |
| 77 09 | M | | M | 30 | | | | M | M | | SEP30 |
| 77 10 | M | | M | 31 | | | | M | M | | OCT31 |
| 77 11 | M | | M | 30 | | | | M | M | | NOV30 |
| 77 12 | 40.8 | | 9 | 0 | | | | 38.7 | 35 | | DEC31 |
| **Annual** | **M** | | **M** | **334** | | | | **M** | | | |

### 104G/NE ISKUT RANCH 1203672

| | Monthly Total Precipitation (mm) | | | | Accumulated Precipitation (mm) | | | | Snow Pack | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Y/Mo | Manual Observation | Recording Gauge | Days With Precipitation | Days Missed | Storage Gauge 1 | Storage Gauge 2 | Interval | Monthly Snowfall (cm) | Depth (cm) | Cover (%) | Date |
| 77 01 | 18.7 | | 5 | 0 | | | | 18.7 | M | | JAN31 |
| 77 02 | 2.0 | | 1 | 0 | | | | 2.0 | M | | FEB28 |
| 77 03 | 16.6 | | 6 | 0 | | | | 16.6 | M | | MAR31 |
| 77 04 | 9.7 | | 3 | 0 | | | | 9.7 | M | | APR30 |
| 77 05 | 22.6 | | 9 | 0 | | | | T | 0 | | MAY31 |
| 77 06 | M | | M | 11 | | | | M | 0 | | JUN30 |
| 77 07 | M | | M | 9 | | | | .0 | 0 | | JUL31 |
| 77 08 | 31.3 | | 9 | 0 | | | | .0 | 0 | | AUG31 |
| 77 09 | 15.1 | | 7 | 0 | | | | T | 0 | | SEP30 |
| 77 10 | 23.7 | | 5 | 0 | | | | .5 | M | | OCT31 |
| 77 11 | 5.0 | | 3 | 0 | | | | 5.0 | M | | NOV30 |
| 77 12 | 8.2* | | 2* | 0 | | | | 8.2* | M | | DEC31 |
| Annual | **M** | | **M** | **20** | | | | **M** | | | |

### 104G/NE KINASKAN LAKE 1204215

| | Monthly Total Precipitation (mm) | | | | Accumulated Precipitation (mm) | | | | Snow Pack | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Y/Mo | Manual Observation | Recording Gauge | Days With Precipitation | Days Missed | Storage Gauge 1 | Storage Gauge 2 | Interval | Monthly Snowfall (cm) | Depth (cm) | Cover (%) | Date |
| 77 01 | 12.0 | | 11 | 0 | | | | 12.0 | M | | JAN31 |
| 77 02 | 34.5 | | 9 | 0 | | | | 34.5 | M | | FEB28 |
| 77 03 | 19.1 | | 6 | 0 | | | | 19.1 | M | | MAR31 |
| 77 04 | M | | 2* | 2 | | | | 21.4 | M | | APR30 |
| 77 05 | M | | 10* | 3 | | | | M | 0 | | MAY31 |
| 77 06 | 26.1 | | 12 | 0 | | | | .0 | 0 | | JUN30 |
| 77 07 | 45.2 | | 17 | 0 | | | | .0 | 0 | | JUL31 |
| 77 08 | 29.2 | | 11 | 0 | | | | .0 | 0 | | AUG31 |
| 77 09 | 9.2* | | 7* | 0 | | | | .0 | 0 | | SEP30 |
| 77 10 | M | | M | 16 | | | | M | M | | OCT31 |
| 77 11 | M | | M | 30 | | | | M | M | | NOV30 |
| 77 12 | M | | M | 31 | | | | M | M | | DEC31 |
| Annual | **M** | | **M** | **82** | | | | **M** | | | |

### 104G/NE TODAGIN RANCH 1208202

| | Monthly Total Precipitation (mm) | | | | Accumulated Precipitation (mm) | | | | Snow Pack | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Y/Mo | Manual Observation | Recording Gauge | Days With Precipitation | Days Missed | Storage Gauge 1 | Storage Gauge 2 | Interval | Monthly Snowfall (cm) | Depth (cm) | Cover (%) | Date |
| 77 01 | 27.3 | | 11 | 0 | | | | 27.3 | 48 | | JAN31 |
| 77 02 | 19.5 | | 7 | 0 | | | | 19.0 | M | | FEB28 |
| 77 03 | 15.9 | | 5 | 0 | | | | 15.9 | 45 | | MAR31 |
| 77 04 | 21.1 | | 4 | 0 | | | | 15.5 | 0 | | APR30 |
| 77 05 | 17.6 | | 13 | 0 | | | | .3 | 0 | | MAY31 |
| 77 06 | 36.6 | | 16 | 0 | | | | .0 | 0 | | JUN30 |
| 77 07 | 56.1 | | 16 | 0 | | | | .0 | 0 | | JUL31 |
| 77 08 | 32.1 | | 10 | 0 | | | | .0 | 0 | | AUG31 |
| 77 09 | 13.0 | | 9 | 0 | | | | .0 | 0 | | SEP30 |
| 77 10 | 41.6 | | 14 | 0 | | | | 9.2 | T | | OCT31 |
| 77 11 | 25.0 | | 15 | 0 | | | | 23.5 | 25 | | NOV30 |
| 77 12 | 18.4 | | 9 | 0 | | | | 18.4 | 43 | | DEC31 |
| Annual | 324.2 | | **129** | **0** | | | | **129.1** | | | |

# Appendix 2. (cont)
# Precipitation Summary (cont)

## 104G/NW TELEGRAPH CREEK 1208040

| Y Mo | Monthly Total Precipitation (mm): Manual Observation | Recording Gauge | Days With Precipitation | Days Missed | Accumulated Precipitation (mm): Storage Gauge 1 | Storage Gauge 2 | Interval | Monthly Snowfall (cm) | Snow Pack: Depth (cm) | Cover (%) | Date |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 01 | 34.3 | | 9 | 0 | | | | 34.3 | 45 | | JAN31 |
| 77 02 | 19.2 | | 8 | 0 | | | | 2.1 | 35 | | FEB28 |
| 77 03 | 7.6 | | 4 | 0 | | | | 7.6 | 27 | | MAR31 |
| 77 04 | 10.8 | | 4 | 0 | | | | 5.1 | 0 | | APR30 |
| 77 05 | 16.9 | | 9 | 0 | | | | .0 | 0 | | MAY31 |
| 77 06 | 15.6 | | 8 | 0 | | | | .0 | 0 | | JUN30 |
| 77 07 | 22.6 | | 9 | 0 | | | | .0 | 0 | | JUL31 |
| 77 08 | 37.1 | | 11 | 0 | | | | .0 | 0 | | AUG31 |
| 77 09 | 7.2 | | 6 | 0 | | | | .0 | 0 | | SEP30 |
| 77 10 | 43.3 | | 12 | 0 | | | | .0 | 0 | | OCT31 |
| 77 11 | 35.8 | | 10 | 0 | | | | 35.8 | 25 | | NOV30 |
| 77 12 | 19.1 | | 6 | 0 | | | | 19.1 | 30 | | DEC31 |
| **Annual** | **269.5** | | **96** | **0** | | | | **104.0** | | | |

## 104H/NW MCBRIDE RIVER 1204958

| Y Mo | Monthly Total Precipitation (mm): Manual Observation | Recording Gauge | Days With Precipitation | Days Missed | Accumulated Precipitation (mm): Storage Gauge 1 | Storage Gauge 2 | Interval | Monthly Snowfall (cm) | Snow Pack: Depth (cm) | Cover (%) | Date |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 01 | 55.3 | | 15 | 0 | | | | 55.3 | 58 | | JAN31 |
| 77 02 | 8.0 | | 7 | 0 | | | | 8.0 | 48 | | FEB28 |
| 77 03 | 18.3 | | 14 | 0 | | | | 18.3 | 53 | | MAR31 |
| 77 04 | 16.5 | | 7 | 0 | | | | 8.1 | 0 | | APR30 |
| 77 05 | 42.1 | | 17 | 0 | | | | 1.3 | 0 | | MAY31 |
| 77 06 | 51.6 | | 22 | 0 | | | | T | 0 | | JUN30 |
| 77 07 | 73.7 | | 20 | 0 | | | | .0 | 0 | | JUL31 |
| 77 08 | 46.9 | | 11 | 0 | | | | .0 | 0 | | AUG31 |
| 77 09 | 14.2 | | 4 | 0 | | | | .0 | 0 | | SEP30 |
| 77 10 | 34.7 | | 10 | 0 | | | | 21.8 | T | | OCT31 |
| 77 11 | 33.7 | | 17 | 0 | | | | 32.9 | 20 | | NOV30 |
| 77 12 | 27.5 | | 7 | 0 | | | | 27.5 | 40 | | DEC31 |
| **Annual** | **422.5** | | **151** | **0** | | | | **173.2** | | | |

## 104J/NW HATIN LAKE 12033M0

| Y Mo | Monthly Total Precipitation (mm): Manual Observation | Recording Gauge | Days With Precipitation | Days Missed | Accumulated Precipitation (mm): Storage Gauge 1 | Storage Gauge 2 | Interval | Monthly Snowfall (cm) | Snow Pack: Depth (cm) | Cover (%) | Date |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 01 | 14.2 | | 4 | 0 | | | | 14.2 | 35 | | JAN31 |
| 77 02 | 4.3 | | 3 | 0 | | | | 4.3 | 22 | | FEB28 |
| 77 03 | 13.7 | | 12 | 0 | | | | 13.7 | 27 | | MAR31 |
| 77 04 | 9.4 | | 4 | 0 | | | | 6.1 | 0 | | APR30 |
| 77 05 | M | | M | 31 | | | | M | M | | MAY31 |
| 77 06 | 42.2 | | 10 | 0 | | | | .0 | 0 | | JUN30 |
| 77 07 | 38.3 | | 9 | 0 | | | | .0 | 0 | | JUL31 |
| 77 08 | M | | M | 31 | | | | M | M | | AUG31 |
| 77 09 | M | | M | 30 | | | | M | M | | SEP30 |
| 77 10 | M | | M | 31 | | | | M | M | | OCT31 |
| 77 11 | M | | M | 30 | | | | M | M | | NOV30 |
| 77 12 | M | | M | 31 | | | | M | M | | DEC31 |
| **Annual** | **M** | | **M** | **184** | | | | **M** | | | |

## 104J/SE DEASE LAKE 1192340

| Y Mo | Monthly Total Precipitation (mm): Manual Observation | Recording Gauge | Days With Precipitation | Days Missed | Accumulated Precipitation (mm): Storage Gauge 1 | Storage Gauge 2 | Interval | Monthly Snowfall (cm) | Snow Pack: Depth (cm) | Cover (%) | Date |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 01 | 38.0 | | 17 | 0 | | | | 56.0 | 65 | | JAN31 |
| 77 02 | 7.2 | | 7 | 0 | | | | 8.8 | 52 | | FEB28 |
| 77 03 | 28.6 | | 17 | 0 | | | | 36.8 | 65 | | MAR31 |
| 77 04 | 16.3 | | 8 | 0 | | | | 13.6 | 0 | | APR30 |
| 77 05 | 24.7 | | 11 | 0 | | | | .4 | 0 | | MAY31 |
| 77 06 | 61.7 | | 23 | 0 | | | | T | 0 | | JUN30 |
| 77 07 | 84.7 | | 23 | 0 | | | | .0 | 0 | | JUL31 |
| 77 08 | 49.7 | | 12 | 0 | | | | .0 | 0 | | AUG31 |
| 77 09 | 30.1 | | 14 | 0 | | | | 1.4 | 0 | | SEP30 |
| 77 10 | 18.7 | | 12 | 0 | | | | 5.2 | 3 | | OCT31 |
| 77 11 | 20.3 | | 14 | 0 | | | | 30.2 | 23 | | NOV30 |
| 77 12 | 23.0 | | 15 | 0 | | | | 42.8 | 42 | | DEC31 |
| **Annual** | **403.0** | | **173** | **0** | | | | **195.2** | | | |

# Appendix 2. (cont)
## Monthly Wind Summary

**104J/SE DEASE LAKE 1192340**

| Y Mo | Prevailing Direction | Mean Speed (km/h) | Maximum Hourly Wind Speed (km/h) | Maximum Hourly Wind Direction | Maximum Hourly Wind Date | Calm | 1-5 | 6-10 | 11-20 | 21-30 | 31-40 | 4[illegible] | [illegible] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 01 | NE | 4.5 | 19 | NE | 17 | 9 | 59 | 27 | 4 | | | | |
| 77 02 | NE | 7.6 | 29 | S | 18 | 1 | 35 | 42 | 19 | 3 | | | |
| 77 03 | SW | 8.0 | 34 | S | 04 | 3 | 34 | 38 | 21 | 4 | - | | |
| 77 04 | SW | 9.0 | 29 | SW | 12 | 3 | 31 | 33 | 27 | 6 | | | |
| 77 05 | SW | 7.6 | 27 | S | 02 | 2 | 37 | 36 | 23 | 1 | | | |
| 77 06 | SW | 7.1 | 24 | NW | 22 | 2 | 41 | 34 | 23 | - | | | |
| 77 07 | SW | 5.9 | 19* | NE | 13 | 3 | 51 | 33 | 12 | | | | |
| 77 08 | M | M | M | | | M | | | | | | | |
| 77 09 | M | M | M | | | M | | | | | | | |
| 77 10 | M | M | M | | | M | | | | | | | |
| 77 11 | M | M | M | | | M | | | | | | | |
| 77 12 | M | M | M | | | M | | | | | | | |
| **Annual** | **M** | **M** | **M** | | | **M** | | | | | | | |

Speed Classes (km/h) - Frequency (%)

**Mean Wind Speed (km/h) and Percentage Frequency**

| Y Mo | N | NE | E | SE | S | SW | W | NW | V | Data Pairs (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| 77 01 | 4.9 | 5.9 | 2.4 | 4.5 | 4.3 | 4.7 | 3.2 | 8.5 | .0 | 100.0 |
| | **16** | **25** | **2** | **6** | **25** | **15** | **1** | **1** | **0** | |
| 77 02 | 6.2 | 7.9 | 3.4 | 6.3 | 9.6 | 8.0 | 3.3 | 6.4 | .0 | 100.0 |
| | **14** | **34** | **2** | **5** | **19** | **20** | **3** | **1** | **0** | |
| 77 03 | 6.6 | 7.5 | 3.0 | 6.8 | 7.6 | 9.0 | 6.4 | 13.4 | .0 | 100.0 |
| | **10** | **16** | **1** | **14** | **21** | **21** | **2** | **11** | **0** | |
| 77 04 | 4.7 | 6.5 | 3.1 | 7.8 | 10.3 | 11.3 | 4.6 | 10.3 | .0 | 100.0 |
| | **5** | **13** | **2** | **12** | **28** | **31** | **2** | **4** | **0** | |
| 77 05 | 5.8 | 6.8 | 3.8 | 6.6 | 6.8 | 10.4 | 5.8 | 9.5 | .0 | 100.0 |
| | **12** | **12** | **3** | **15** | **18** | **28** | **3** | **7** | **0** | |
| 77 06 | 4.9 | 5.9 | 2.5 | 5.0 | 6.2 | 9.7 | 5.5 | 8.7 | .0 | 100.0 |
| | **7** | **6** | **2** | **12** | **28** | **36** | **4** | **5** | **0** | |
| 77 07 | 4.8 | 5.8 | 3.0 | 4.2 | 4.8 | 8.4 | 6.2 | 9.0 | .0 | 91.5 |
| | **10** | **8** | **3** | **11** | **26** | **28** | **3** | **7** | **0** | |
| 77 08 | M | M | M | M | M | M | M | M | M | .0 |
| 77 09 | M | M | M | M | M | M | M | M | M | .0 |
| 77 10 | M | M | M | M | M | M | M | M | M | .0 |
| 77 11 | M | M | M | M | M | M | M | M | M | .0 |
| 77 12 | M | M | M | M | M | M | M | M | M | .0 |
| **Annual** | **5.5*** | **6.9*** | **3.1*** | **6.0*** | **7.0*** | **9.2*** | **5.1*** | **10.5*** | **.0*** | **57.4** |
| | **11** | **16** | **2** | **11** | **24** | **26** | **3** | **5** | **0** | |

Appendix 2. (cont)
Monthly Bright Sunshine Summary
(Hours)

**104J/SE DEASE LAKE 1192340**

| Y Mo | Total | Percent Possible | Days no Sunshine | Hours Missed |
|---|---|---|---|---|
| 77 01 | 38.5 | 18 | 12 | 0 |
| 77 02 | 77.5 | 31 | 7 | 0 |
| 77 03 | 136.1 | 38 | 3 | 0 |
| 77 04 | 189.8 | 45 | 2 | 0 |
| 77 05 | 201.9 | 40 | 1 | 0 |
| 77 06 | 209.3 | 39 | 2 | 0 |
| 77 07 | 219.9 | 41 | 2 | 0 |
| 77 08 | 246.4 | 52 | 3 | 0 |
| 77 09 | 125.5 | 33 | 1 | 0 |
| 77 10 | 97.7 | 31 | 7 | 0 |
| 77 11 | 76.6 | 33 | 8 | 0 |
| 77 12 | 56.3 | 29 | 9 | 0 |
| **Annual** | **1675.5** | **36** | **57** | 0 |

Appendix 3. Annual Extremes of Discharge and Annual Total Discharge for Selected Stations (IWD, Water Resources Branch, 1980)

Appendix 3. Annual Extremes of Discharge and Annual Total Discharge for Selected Stations

STIKINE RIVER AT TELEGRAPH CREEK - STATION NO. 08CE001

| Year | Maximum Instantaneous Discharge ($m^3/s$) | Maximum Daily Discharge ($m^3/s$) | Minimum Daily Discharge ($m^3/s$) | Total Discharge ($dam^3$) |
|---|---|---|---|---|
| 1954 | --- | --- | --- | --- |
| 1955 | --- | 3 400 ON JUN 26 * | --- | --- |
| 1956 | --- | 1 420 ON JUN 20 | --- | --- |
| 1957 | --- | 2 940 ON MAY 23 | --- | --- |
| 1958 | --- | 2 230 ON MAY 28 | 40.2B ON MAR 24 | --- |
| 1959 | --- | 3 400 ON JUN 23 | --- | --- |
| 1960 | --- | 2 560 ON JUN 27 | 47.3B ON FEB 26 | --- |
| 1961 | --- | 3 140 ON JUN 8 | 60.0B ON FEB 1 | --- |
| 1962 | --- | 9 920 ON JUN 23 | 55.2B ON FEB 12 | --- |
| 1963 | --- | 2 560E ON JUL 11 | --- | --- |
| 1964 | --- | 3 370 ON JUN 11 | --- | --- |
| 1965 | --- | 2 270 ON JUN 3 | 51.0B ON APR 6 | 10 800 000 |
| 1966 | --- | 2 270 ON JUN 18 | 43.9B ON FEB 27 | 11 700 000 |
| 1967 | --- | 2 420 ON JUN 7 | 55.2B ON MAR 22 | 12 900 000 |
| 1968 | --- | 1 740 ON MAY 23 | 50.4B ON DEC 31 | 11 500 000 |
| 1969 | --- | 2 100 ON MAY 26 | 31.1B ON MAR 21 * | 12 100 000 |
| 1970 | --- | 2 610 ON JUN 4 | 56.9B ON APR 5 | 12 500 000 |
| 1971 | --- | 2 120A ON JUN 10 | 47.0B ON APR 6 | 11 400 000 |
| 1972 | 3 370 AT 20:17 PST ON MAY 31 * | 3 280 ON MAY 31 | 48.1B ON APR 12 | 13 400 000 |
| 1973 | 2 040 AT 21:02 PST ON JUN 14 | 1 910 ON JUN 15 | 53.8B ON MAR 31 | 13 300 000 |
| 1974 | 1 870 AT 20:19 PST ON JUL 17 | 1 760 ON JUL 17 | 45.3B ON APR 5 | 14 500 000 |
| 1975 | 1 820 AT 20:35 PST ON JUN 30 | 1 800 ON JUN 30 | 56.6B ON MAR 25 | 11 600 000 |
| 1976 | 2 420 AT 00:07 PST ON JUL 2 | 2 320 ON JUL 1 | 52.1B ON APR 9 | 14 300 000 |
| 1977 | 1 980 AT 18:40 PST ON JUN 16 | 1 960 ON JUN 15 | 52.4B ON MAR 27 | 12 900 000 |
| 1978 | 1 400 AT 18:30 PST ON JUN 6 | 1 370 ON JUN 6 | 47.3B ON APR 11 | 8 550 000 |
| 1979 | 2 240 AT 14:57 PST ON JUN 3 | 2 210 ON JUN 3 | 45.0B ON FEB 12 | 12 700 000 |
| | | | | 12 300 000 Mean |

Appendix 3. (cont)

STIKINE RIVER ABOVE BUTTERFLY CREEK - STATION NO. 08CF001

| Year | Maximum Instantaneous Discharge ($m^3/s$) | Maximum Daily Discharge ($m^3/s$) | Minimum Daily Discharge ($m^3/s$) | Total Discharge ($dam^3$) |
|---|---|---|---|---|
| 1971 | --- | --- | --- | --- |
| 1972 | 4 160 AT 12:27 PST ON JUN 15 * | 4 110 ON JUN 15 * | 71.4B ON APR 16 | 21 500 000 |
| 1973 | 2 690 AT 02:07 PST ON JUN 15 | 2 620 ON JUN 15 | 82.1B ON JAN 20 | 19 800 000 |
| 1974 | 2 350 AT 02:32 PST ON JUL 18 | 2 290 ON JUL 18 | 73.6B ON MAR 25 | 21 700 000 |
| 1975 | 3 090 AT 04:11 PST ON JUL 5 | 3 030 ON JUL 4 | 83.0B ON MAR 21 | 18 300 000 |
| 1976 | 3 430 AT 00:27 PST ON JUL 2 | 3 370 ON JUL 1 | 73.6B ON APR 6 | 21 800 000 |
| 1977 | 2 890 AT 04:06 PST ON JUN 16 | 2 860 ON JUN 16 | 79.3B ON DEC 31 | 19 700 000 |
| 1978 | 2 000 AT 03:50 PST ON JUN 7 | 1 950 ON JUN 7 | 63.1B ON APR 12 * | 14 500 000 |
| 1979 | 3 000 AT 00:28 PST ON JUN 3 | 2 950 ON JUN 3 | 73.6B ON FEB 6 | 20 400 000 |
| | | | | 19 700 000 Mean |

ISKUT RIVER ABOVE SNIPPAKER CREEK - STATION NO. 08CG004

| Year | Maximum Instantaneous Discharge ($m^3/s$) | Maximum Daily Discharge ($m^3/s$) | Minimum Daily Discharge ($m^3/s$) | Total Discharge ($dam^3$) |
|---|---|---|---|---|
| 1967 | 1 570 AT 20:00 PST ON JUN 23 | 1 480 ON JUN 23 | 23.3 ON MAR 23 | --- |
| 1968 | 1 180 AT 15:20 PST ON JUL 6 | 1 120 ON JUL 5 | 24.4B ON FEB 4 | 8 050 000 |
| 1969 | 1 600 AT 06:00 PST ON JUN 16 | 1 510 ON JUN 16 | 19.9B ON MAR 13 | 9 070 000 |
| 1970 | 1 370 AT 09:30 PST ON JUN 4 | 1 260 ON JUN 4 | 26.9B ON DEC 31 | 8 680 000 |
| 1971 | 1 410 AT 23:48 PST ON JUN 23 | 1 280 ON JUN 23 | 19.1B ON FEB 10 | 8 570 000 |
| 1972 | 1 290 AT 20:06 PST ON OCT 6 | 1 190 ON JUL 8 | 16.8B ON MAR 5 * | 9 070 000 |
| 1973 | 1 050 AT 13:45 PST ON JUL 20 | 1 000 ON JUL 20 | 19.5B ON MAR 19 | 7 840 000 |
| 1974 | 2 520 AT 00:08 PST ON OCT 9 * | 2 000 ON OCT 9 * | 18.0B ON FEB 26 | 8 530 000 |
| 1975 | 1 510E AT 06:03 PST ON JUL 9 | 1 460E ON JUL 10 | 22.8B ON DEC 17 | 7 400 000 |
| 1976 | 1 310E AT 03:15 PST ON JUL 1 | 1 170E ON AUG 11 | 22.9B ON JAN 14 | 8 740 000 |
| 1977 | 954 AT 09:13 PST ON JUL 13 | 1 915 ON JUL 13 | 25.2B ON JAN 11 | 8 060 000 |
| 1978 | 1 860 AT 04:03 PST ON OCT 19 | 1 500 ON OCT 19 | 23.8B ON MAR 21 | 8 090 000 |
| | | | | 8 370 000 Mean |

Appendix 3. (cont)

ISKUT RIVER BELOW JOHNSON RIVER - STATION NO. 08CG001

| Year | Maximum Instantaneous Discharge ($m^3/s$) | Maximum Daily Discharge ($m^3/s$) | Minimum Daily Discharge ($m^3/s$) | Total Discharge ($dam^3$) |
|---|---|---|---|---|
| 1959 | 1 860 AT 13:30 PST ON JUL 20 | 1 830 ON JUL 20 | --- | --- |
| 1960 | 2 760 AT 10:00 PST ON JUL 18 | 2 590 ON JUL 18 | --- | --- |
| 1961 | 7 930A ON OCT 15 * | 6 880A ON OCT 15 * | 48.1B ON JAN 25 | --- |
| 1962 | 1 690 AT 13:00 PST ON JUL 24 | 1 640 ON JUL 24 | 45.9B ON JAN 19 | --- |
| 1963 | 1 940 AT 15:00 PST ON JUL 10 | 1 830 ON JUL 10 | --- | --- |
| 1964 | --- | 2 000 ON JUN 11 | 59.5B ON DEC 31 | --- |
| 1965 | 1 880E AT 17:00 PST ON OCT 19 | 1 760 ON JUL 12 | 53.2B ON JAN 12 | 12 200 000 |
| 1966 | 2 650 AT 16:30 PST ON SEP 5 | 2 390 ON SEP 5 | 42.5B ON FEB 26 | 13 300 000 |
| 1967 | 2 360 AT 02:30 PST ON AUG 11 | 2 220 ON AUG 10 | 27.8 ON MAR 15 * | 16 100 000 |
| 1968 | --- | 1 730E ON JUL 10 | 43.3B ON FEB 4 | 13 200 000 |
| 1969 | 3 370 AT 17:00 PST ON NOV 2 | 2 940 ON NOV 2 | 35.4B ON FEB 20 | 14 700 000 |
| 1970 | 2 200 AT 08:32 PST ON JUN 4 | 2 040 ON JUN 4 | 57.2B ON DEC 31 | 13 500 000 |
| 1971 | --- | 1 890 ON JUN 23 | 39.6B ON JAN 31 | 13 900 000 |
| 1972 | 1 830 AT 12:00 PST ON JUL 8 | 1 800 ON JUL 8 | 33.1B ON MAR 8 | 14 500 000 |
| 1973 | 1 580 AT 11:15 PST ON AUG 4 | 1 520 ON AUG 4 | 42.5B ON DEC 31 | 12 300 000 |
| 1974 | 5 150E AT 08:44 PST ON OCT 9 | 4 560E ON OCT 9 | 35.4B ON FEB 18 | 14 200 000 |
| 1975 | 2 470E AT 07:56 PST ON JUL 11 | 2 380E ON JUL 10 | 35.7B ON DEC 17 | 11 900 000 |
| 1976 | 2 320E AT 00:49 PST ON NOV 4 | 2 000 ON AUG 11 | 47.6B ON JAN 12 | 14 100 000 |
| 1977 | 1 530 AT 04:35 PST ON AUG 21 | 1 480 ON AUG 20 | 56.1B ON DEC 31 | 13 100 000 |
| 1978 | 3 820 AT 11:50 PST ON OCT 19 | 3 370 ON OCT 19 | 46.2 ON MAR 20 | 12 800 000 |
| 1979 | 2 590 AT 09:45 PST ON OCT 10 | 2 320 ON OCT 10 | 42.5B ON FEB 25 | 14 300 000 |
| | | | | 13 600 000 Mean |

Note: A - Manual Gauge B - Ice Conditions * - Extreme Recorded for the Period of Record
E - Estimated

Appendix 4. A Bibliography of NHRI Snow and Ice Studies in the Stikine River Basin

## Appendix 4. A Bibliography of NHRI Snow and Ice Studies in the Stikine River Basin

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Mokievsky-Zubok, O. 1980. Report on Glaciological Studies in Iskut River Basin, 1980. Annual report, NHRI, Environment Canada.

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Perchanok, Max S. 1980. Reconnaissance of Glacier-dammed Lakes in the Stikine and Iskut River Basins, B.C. NHRI, Environment Canada.

Waldron, D.A. 1981. Model Simulation of the Sudden Discharge of Glacier-dammed Flood Lake, Aug. 1979. Dep. of Geophysics and Astronomy, University of British Columbia.

Appendix 5. Salmon Escapement in the Canadian Section of the Stikine River 1971-1980 (DFO, 1982)

Appendix 5. Salmon Escapement in the Canadian Section of the Stikine River 1971-1980

| YEAR | LOCATION | CHINOOK | SOCKEYE | COHO |
|---|---|---|---|---|
| 1971 | Craig River | 1 | | 3,000 |
| | Tuya River | 50-100 | | |
| | Tahltan Lake and River | | 18,523 | |
| | Iskut River | | | 300-800 |
| 1972 | Tahltan Lake and River | | 52,354 | |
| | Tuya River | 40 | | |
| 1973 | Tahltan Lake and River | | 2,877 | |
| 1974 | Tahltan Lake and River | | 8,106 | |
| 1975 | Christina River | 275 | | |
| | Chutine River | 1000-2000 | 500-1000 | 2000-5000 |
| | Craig River | | 1,000 | 934 |
| | | | | 400 |
| | Missusjay Creek | | | 50 |
| | Shakes Creek | 75 | | |
| | Tahltan Lake and River | 5,000 | 8,159 | |
| | | 2,908 | | |
| | Tskihini Creek | 50 | | |
| | Yehiniko Creek | 50 | | |
| | Little Tahltan River | 700 | | |
| 1976 | Iskut River | | 220 | 30 |
| | Tahltan Lake and River | 120 | 24,111 | |
| | | 600 | | |
| | Little Tahltan River | 400 | | |
| | Craig River | | | 150 |
| 1977 | Iskut River | 290 | | 2,775 |
| | Tahltan Lake and River | 25 | 42,960 | |
| | Little Tahltan River | 800 | 5,000 | |
| | | 650 | | |
| | Craig River | | | 1,960 |
| 1978 | Tahltan Lake and River | 756 | 22,488 | |
| | | 1,000 | | |
| | Little Tahltan River | 632 | | |
| | | 650 | | |
| | Tuya River | 50 | | |

Appendix 5. (cont)

| YEAR | LOCATION | CHINOOK | SOCKEYE | COHO |
|---|---|---|---|---|
| 1979 | Little Tahltan River | 1,166 | 2,500 | |
| | | 100 | | |
| | Tahltan Lake and River | 2,118 | 10,211 | |
| | | 425 | | |
| | Tuya River | 15 | | |
| 1980 | Chutine River | 6 | 600 | |
| | Shakes Creek | 30 | 50 | |
| | Little Tahltan River | 2,137 | | |
| | Beatty Creek | 500 | | |
| | Tahltan Lake and River | 3,000 | 11,016 | |
| | Craig River | | 12 | |
| | Verret River | | 500 | |
| | Iskut River | | 6,000 | |
| | Stikine mainstream | | 3,000 | |
| 1981 | Beattie Creek | 550 | | |
| | Chutine River | | | 150 |
| | Little Talhtan River | 1800 | | |
| | Iskut River | | | 1500 |

Appendix 6. Pre-Construction Site Investigations for the Stikine-Iskut River Projects (B.C. Hydro, 1981)

Appendix 6. Pre-Construction Site Investigations for the Stikine-Iskut River Projects

| | DEC. 81/MAR. 82 | 1982/83 | 1983/84 | 1984/85 |
|---|---|---|---|---|
| **STIKINE SITE Z PROJECT** | | | | |
| A. Exploration Programs | | | | |
| 1. Exploratory Adits: for rock mechanics programs and geological logging. | - | 6 adits: 4 box canyon arch abutments, 1 lower left main arch abutment, 1 powerhouse area. Total length 1200-1500m. | 1 adit upper left abutment main arch dam 100-300m. | Possible additional adit and rock mechanics testing. |
| 2. Diamond Drilling Bedrock. | Underground 1500-2000m. | Underground 600-1000m, surface site area and reservoir slopes 1000-2000m. | Underground 1000-2000m, surface site area and reservoir slopes 500-1000m. | Possible additional drilling as may be required to fill in missing information 0-1000m. |
| 3. Overburden Drilling Foundations. | Commence box canyon Becker drilling. | Complete box canyon Becker drilling 1000-1500m. | Possible box canyon Becker drilling 1000-1500m. | Possible additional drilling as may be required 0-1000m. |
| 4. Construction Materials Exploration. | 15-25 test pits, 3000-4000m Becker drilling. | 20-50 test pits, 1000-3000m Becker drilling. Also Becker drilling immediately north and east of Site Z included with box canyon program. | Probable similar program as in 1982/83. 20-50 test pits, 1000-3000m Becker drilling. | Possible additional test pits and drilling as may be required 0-20 test pits, 0-1000m drilling. |
| B. Exploration Access | Cat trail access to Site Z north side. Winter access road from and west of Morchuea Lake. | Continued use of cat trail. Possible alternative airstrip north and east of Site Z if cat trail not approved. Winter access road west of Morchuea Lake. | Possible re-use of cat trail or airstrip for further overburden drilling, if required. Winter access road west of Morchuea Lake. | Possible re-use of cat trail, if required, or possible alternative use of airstrip. Possible re-use of winter accesss road west of Morchuea L. |
| C. Exploration Camp | Continued used of existing low-level camp. | Continued use of high-level camp site. | Continued use of high-level camp site. | Continued use of high-level camp site. |
| **TANZILLA PROJECTS** | | | | |
| A. Exploration Programs | | | | |
| 1. Exploratory Adits: for rock mechanics programs and geological logging. | - | 1 left dam abutment, 1 powerhouse area. Total length 400-500m. | - | 1 right bank abutment 200-300m. |
| 2. Diamond Drilling Bedrock. | - | Underground 500-1500m, surface sites and reservoir slopes 2000-4000m. | Underground 500-1500m, surface sites and reservoir slopes 2000-3000m. | Underground 500-1500m. Surface sites and reservoir slopes 1000-2000m. |
| 3. Geophysical Exploration. | - | Seismic & resistivity lines 2000-3000m. | Possible seismic line 2000-3000m. | Probably no further seismic survey required. |

Appendix 6. Pre-Construction Site Investigations for the Stikine-Iskut River Projects (cont)

| | DEC. 81/MAR. 82 | 1982/83 | 1983/84 | 1984/85 |
|---|---|---|---|---|
| 4. Construction Materials Exploration. | - | 10-20 test pits, 200-400m Becker drilling. | 20-40 test pits, 400-800m Becker drilling. | Possible additional pits and drilling as required. 0-20 test pits, 0-1000m drilling. |
| B. Exploration Access | - | Winter road: Extension to Tanzilla area from Site Z area west of Morchuea Lake. | Re-use of winter road extending from Morchuea Lake. | Re-use of winter road extending from Morchea Lake. |
| C. Exploration Camp | - | New campsite. Probably located in vicinity of existing coreshack. | Continued use of 1982/83 campsite. | Continued use of 1982/83 campsite. |
| ISKUT CANYON | | | | |
| A. Exploration Programs | | | | |
| 1. Exploratory Adits for Rock Mechanics Programs and Geological Logging. | - | None planned. | 3 adits, 500m in main canyon for dam foundation and power house | 1 adit, 200m. |
| 2. Diamond Drilling Bedrock. | | 1000-1500m surface drilling in main canyon for dam foundations, power tunnels and powerhouse, and in saddle dam area to assess grouting program. | 2000-3000m surface drilling in canyon for dam foundations and power tunnels. 1000-1500m underground drilling for powerhouse. | 1000m surface drilling in main canyon for dam, powerhouse and diversion tunnel exploration. |
| 3. Grout Test Program including Percussion Drilling. | - | 2000-2500m of percussion drilling to be grouted and water tested in saddle dam area. | 500-1000m of percussion drilling to be grouted and water tested in saddle dam area. | Possible addition 500m of percussion drilling to be grouted and water tested in saddle dam area. |
| 4. Large Diameter Churn Holes. | - | None planned. | 250m in saddle dam (lava flows) area. | Probably no further large diameter holes required. |
| 5. Geophysical Exploration. | - | 5000 lin. m geophysical surveys (seismic, gravity, resistivity, etc.) | 1000-2000 lin. m geophysical surveys. | 1000-2000 lin. m geophysical surveys. |
| 6. Construction Materials Exploration. | - | 20-50 test pits for granular materials, 15-20 pits with Menzie Mucker for impervious mainly in Forrest Kerr Creek area. | As for 1982-83. | 1000-2000m Becker drilling in lower Forrest Kerr Creek area. |

Appendix 6. Pre-Construction Site Investigations for the Stikine-Iskut River Projects (cont)

| | | 1982-83 | 1983-84 | 1984-85 |
|---|---|---|---|---|
| B. Exploration Access<br>1. Airstrips. | - | Construct exploration airstrip on lava flats downstream of proposed saddle dam. | Continued use of exploration airstrip on lava flats. | Continued use of exploration airstrip on lava flats. |
| 2. Access Roads. | - | Construct local access road from exploration airstrip to gravel borrow area and the grout test area. | Extend local access roads to powerhouse area and main canyon dam axis. | Continued use of local access roads used in previous years. Extend local access road system across Iskut river and up to 8 km along east bank of Forrest Kerr Creek. |
| C. Exploration Camps | - | Continued use of the Bob Quinn Lake campsite.<br><br>Preparation of an Iskut Canyon campsite area in gravel borrow area on southern edge of lava flats. | Establish Iskut Canyon Campsite. | Continued use of Iskut Canyon campsite. |
| MORE CREEK PROJECT | | | | |
| A. Exploration Programs<br>1. Exploration Adits for Rock Mechanics Programs and Geological Logging. | - | None planned. | 1 adit, 200-300m in north canyon wall for dam foundations and powerhouse (helicopter access). | Probably no further adits required. |
| 2. Diamond Drilling (All access for diamond drilling is planned to be by helicopter.) | - | None planned. | 500-1000m surface drilling and 500-1000m underground drilling in canyon for dam foundations, power tunnel and powerhouse. | 500-1000m surface drilling in canyon for dam foundations, power tunnel and powerhouse. |
| 3. Construction Materials Exploration. | - | 15-30 test pits, 10-20 pits with Menzie Mucker, and 50 power auger holes primarily in More Creek upstream of Canyon (helicopter access). 10 to 20 pits with Menzie Mucker for impervious downstream of Canyon (helicopter access). | 10-20 test pits and 30 power auger holes in More Creek. 500-1000m Becker drilling downstream of Canyon (winter access for Becker drill). | 10-20 test pits and possibly 500-1000m Becker drilling in More Creek upstream of Canyon (airstrip access). |
| 4. Geophysical Exploration. | - | 1000-2000 lin. m geophysical surveys (seismic and/or gravity). | 1000-2000 lin. m geophysical surveys (seismic and/or gravity). | |

Appendix 6. Pre-Construction Site Investigations for the Stikine-Iskut River Projects (cont)

| | | 1982-83 | 1983-84 | 1984-85 |
|---|---|---|---|---|
| B. Exploration Access | | | | |
| 1. Access Roads. | - | None planned. | Winter access road from Bob Quinn Lake for materials exploration downstream of More Creek Canyon (Becker drilling). | Possible summer access from temporary airstrip to gravel areas upstream of More Creek Canyon. |
| 2. Airstrip. | - | None planned. | None planned. | Possible temporary air-strip in More Creek up-stream of canyon to provide access for materials investigations. |
| C. Exploration Camps | - | None planned specifically for More Creek | Use of the Bob Quinn Lake camp site. | Continued use of the Bob Quinn Lake campsite. |

NOTE

1. Note that the exploration programs beyond the 1982/83 exploration year cannot be closely defined since they are necessarily dependent on the findings from the previous year's exploration. The program shown for 1984/85 is particularly speculative.

Appendix 7. Summaries from Preliminary Environmental Studies

Appendix 7. Summaries from Preliminary Environmental Studies
1. Economic Geology Report Summary

"The purpose of this investigation is to provide baseline data for the Resource Economics section of the environmental feasibility studies and to describe and evaluate mineral, rock, coal, oil and natural gas deposits that would be affected by the proposed hydroelectric development. The impacts of the development on these resources are also described."

"This report examines the effects of the Stikine-Iskut Rivers Hydroelectric Project on the resources of petroleum and natural gas, coal, industrial minerals, aggregate, base metals, precious metals and lapidary rocks and minerals. It was found that possibly two base metal (copper) showings and one precious metal (gold) showing would be adversely affected by the proposed development. Of these showings only one copper showing is described and it has pyrite and chalcopyrite in fractures in silicified andesite. There is no indication of significant mineral deposits in the reservoir areas despite considerable exploration. Potential host rocks for coal lie along the southern margin of the Tanzilla and Stikine Z reservoirs, but no coal has been found within the reservoir boundaries.

The Stikine-Iskut Rivers Hydroelectric Project could have a favourable, though marginal, impact on transporation through the development of roads, and possibly by providing common facilities for mining exploration and development personnel. New roads in the Iskut River area would open some new country to prospectors with ground transportation and provide part of potential haul roads to bring mill or smelter products from areas with extensive mineral reserves, such as Galore Creek or Schaft Creek. More importantly the development could provide hydroelectric power for mine and related facilities."

(B.C. Hydro, Generation Planning Dept., 1980)

Appendix 7. (cont)
2. Mountain Goat Ecology Report Summary

1." INTRODUCTION

The major study objective was to determine abundance and seasonal distribution of mountain goats in the Grand Canyon of the Stikine River, and to relate these findings to proposed hydroelectric projects. Field studies were carried out from February 1979 to February 1980.

2. METHODS

A complete aerial survey by helicopter was flown during each of eight field trips, and comparative ground counts were made on two sample areas. Goats were classified to sex and age. Twenty six animals were color marked to study movements and home range. Habitats were classified into 15 types, and habitat use was assessed from 2,372 ground observations of goats in those habitats. Food habits were evaluated by means of rumen samples and field observations of foraging goats and cropped vegetation. Chemical composition of twelve soil samples from or adjacent to mineral licks was analysed spectrographically. U.B.C. and B.C. Hydro computers aided in data processing and analysis.

3. REGIONAL SETTING

The study area is bounded on the north by the Tanzilla Plateau and south by the Klastline Plateau, both of which are part of the larger Stikine Plateau. Annual precipitation varies regionally from 30 to 40 cm, and mean monthly temperatures range from -17°C in January to 15°C in July. Regional soils are primarily Dystric Brunisols, and vegetation is mostly characteristic of the Boreal White and Black Spruce (BWBS) Zone. Mountain goats are widely distributed in the region but most herds occupy discrete ranges separated by wide valleys or broad plateaus.

4. GRAND CANYON STUDY AREA

4.1 Mountain Goat Habitat

The study area was along 65 km of the canyon between Highway 37 and the Klastline River. The canyon is most rugged and deeply incised along its northernmost arc between the Tanzilla River and Blamey Creek, where its walls are about 300 m high. Microclimatic variations related to aspect and cold air drainage are pronounced. Soils are little developed wthin the canyon proper, and typical BWBS vegetation is greatly modified by aspect, bedrock exposure and fire. Much forestland in and along the canyon is in early seral stages due to fire. Six major habitat types were described (Closed Forest; Open Woodland; Burned Forest; Scrub; Grassland; Sparsely Vegetated Land) and subdivided into a total of 15 types.

Appendix 7. (cont)

4.2 Mountain Goat Population

The herd was estimated to contain 316 goats in September 1979. Spring and fall aerial surveys provided best results. A cummulative total of 1392 goat observations from eight aerial surveys allowed mapping of distribution and intensity of habitat use. High, moderate and low use habitats were mapped at 1:50,000 scale. Goats are most abundant between Tanzilla River and Blamey Creek, and equal numbers occur north and south of the Stikine. Very few goats are believed to cross the river.

During the rut, tending males heavily utilized the Site Z damsite area and ranges across from Bob's Knoll. Birth sites were scattered throughout the canyon. Twins comprised 18% of the 1979 kid crop. Herd composition expressed as a ratio of 100 females was 30 adult males, 47 kids, 29 sub-adults, 24 yearlings and 21 unclassified. Causes of mortality are largely unknown, but survivorship curves showed kid and yearling cohort mortality to exceed 50 and 30% respectively. High fecundity and birth rates, low levels of predation, and other indicators suggest the herd has a high capability for expansion, and may in fact be increasing in size and distribution range.

4.3 Relationships Between Goats and Their Environment

Over the course of a year, sparsely vegetated (rocky) habitats received more goat use than any other type. This was followed by open woodland, burns, closed forest, scrub and grassland. Use of closed forest is underestimated because goats are difficult to see when in that type. Tree stands were important for cover (particularly conifer stands in winter), burns for foraging (particularly spring and fall), and rocky, sparsely vegetated areas for escape terrain.

Goats grazed on a variety of herbaceous plants during the snow-free period and browsed woody plants in winter, particularly lodgepole pine saplings. They regularly drank at streams during hot weather.

Two known mineral licks were examined. Goat sign was abundant at the lick near the Tanzilla Dam site. Chemical analysis of soil samles from that lick and adjacent areas indicated little significant difference between lick and non-lick samples, although lick samples had higher levels of selenium and sodium.

Daily movements by goats averaged 400 m, and the longest observed was 1700 m. Average vertical extent of annual home ranges was only 275 m; average linear extent (along the canyon) was 4.5 km. Mean home range size was about 280 ha.

Appendix 7. (cont)

## 5. POTENTIAL IMPACT OF HYDROELECTRIC DEVELOPMENT

### 5.1 Proposed Hydroelectric Development

Two dams, Tanzilla and Site Z and their reservoirs, powerhouses and access roads would result in direct and possible indirect impacts on the goat herd.

### 5.2 Methods

Response of goats to stressful exploration activities, including close-flying helicopters, fixed-wing aircraft, people on foot, and loud blasts, was observed and recorded. The level of response was analysed in relation to factors such as season of year, distance and relative position of the disturbance, availability of cover, and social groupings of disturbed animals.

Potential population losses were based upon average annual goat use of each reservoir area and on the percentage of total goat observations occurring above and below projected floodlines. Occurrence of critical habitat elements above and below the floodlines (winter habitat; kidding and rutting areas; mineral licks) was also considered.

### 5.3 Potential Impacts

Goats displayed a strong stress-response to close-flying helicopters, and this was accentuated if the goats were not in escape terrain and if the disturbance came from above or level with the subject animals. This and other kinds of harassment can be particularly detrimental during very cold weather, in late winter when goats are in poorest physical condition, and during late pregnancy and kidding periods. Exploration activities at Site Z damsite in summer 1979 caused 10 to 25 goats to temporarily relocate from that site to adjacent less favorable habitat . Up to 56 goats which occupy ranges immediately below the Site Z and Tanzilla Damsites and in the Tanzilla Powerhouse vicinity, are expected to be disturbed by construction activities. They will probably move to adjacent ranges during the construction period, which may cause increased mortality.

Permanent habitat loss will result primarily from reservoir flooding. About 66% of Stikine Canyon goat use occurs in the Tanzilla Reservoir area, but only 7% of that use is below the maximum reservoir level. Flooding there would reduce the carrying capacity of the Stikine Canyon by about 15 goats. About 15% of goat use occurs in the Site Z Reservoir area, but most (83%) of that use is below reservoir level. Filling this reservoir is estimated to reduce carrying capacity by 40 goats. Therefore, permanent losses due to flooding are expected to total at least 55 goats. This is 17.4% of the Stikine Canyon

Appendix 7. (cont)

population, and 21.5% of the combined Tanzilla Reservoir - Site Z Reservoir population. Remnant post-development habitats in the Site Z will probably not support goats all year-round.

Additional losses will probably occur as a result of habitat permanently taken up by facilities, habitat eroding into the reservoirs, and over-use of adjacent ranges to which goats are displaced. Access roads, boat and float-plane use of reservoirs, and travel on reservoir ice in winter could allow the herd to be excessively hunted or disturbed, but would also facilitate non-consumptive recreational use.

6. MITIGATION AND COMPENSATION

6.1 Mitigation of Potential Impacts
Loss of habitat under reservoir waters could only be mitigated by reduction of reservoir levels. Impacts of temporary and permanent facilities on goat habitat can be slightly mitigated by careful planning through all phases of development. Excessive exploitation can be at least partially avoided by careful planning of access methods and routes and by government regulations and enforcement. Aircraft disturbance should be largely minimized via route and height guidelines. Restrictions may have to be placed on boat and float-plane use of reservoirs.

6.2 Compensation
Potential compensation measures include enhancement of remaining habitat, establishment of new goat herds in vacant habitat, and development of facilities to allow public viewing of Stikine Canyon goats. Feasibility of these measures is briefly discussed, but all require further study."

(Mar-Terr Enviro Research Ltd., 1981)

Appendix 7. (cont)

3. Caribou and Snow Depth Survey Report Summary

"Caribou Survey

1. Surveys were flown for a total of 51 hours from February 20 to March 28, 1980. Groups of caribou were found in the folowing locations: Blamey Creek, Cake Hill, Flat and Ferry creeks, Kechlechoa River (and Mt. Sister Mary), Tsenaglode Mountain region and Turnagain Lake.

2. Approximately 297 caribou were observed. Caribou movement from one location to another between surveys and visual problems associated with aerial surveys, could mean that this count is low.

3. Migrations to alpine areas occurred in four of the six caribou groups, apparently in response to snow melt.

4. Migration of caribou from the Kechlechoa River area to Tsenaglode Mountain and to the Mt. Sister Mary area is described. Many trails crossed the Stikine River, between McBride River and Cullivan Creek.

Snow Depth Survey

1. Twelve snow depth stations were checked. Snow depth data from dease Lake meteorological station were also studied.

2. Slope, forest cover, aspect, elevation, wind direction and velocity, and lake surfaces are factors that affected snow depth. Lake surfaces had the most significant effect on snow depth.

3. The threshold snow depth for caribou (60 cm) was exceeded in 6 of 11 years at Dease Lake. Peak depth occurred in February or March."

(Wyburn, 1981)

Appendix 7. (cont)

4. Hydrology, River Regime and Morphology Report Summary

"The Hydrology, River Regime and Morphology Studies of the Stikine-Iskut Development described in this report were carried out for two major reasons. Firstly, to provide information for use in the project feasibility study and secondly, to provide information for the environmental impact analysis.

Field and office studies were carried out to provide preliminary estimates for each proposed project of long-term flow patterns, flood frequencies, probable maximum floods and useful reservoir life.

Field and office studies were also carried out to provide preliminary estimates of the regulated flow regime, channel morphology changes and water temperature changes that would result from the construction of the project.

The significant findings of these studies are listed below:

1. The following tabulation highlights the important hydrologic features for economic and design considerations.

| Site | Average Annual Flow ($m^3/s$) | 15-year Return Period Flood ($m^3/s$) | PMF Peak Inflow ($m^3/s$) | Spillway Design Discharge ($m^3/s$) | Useful Reservoir Life ($m^3/s$) |
|---|---|---|---|---|---|
| Site Z | 286.5 | 2440 | 9175 | 7645 | 2200 |
| Tanzilla | 291.8 | 2480 | 7645 | 7645 | - |
| Iskut Canyon | 251.4 | 1630 | 6286 | 5680 | 180 |
| More Creek | 69.4 | 500 | 2676 | 1580 | 1600 |

2. The river reaches downstream of the project sites will likely be affected by changes in flow regime, channel morphology and water temperature.

   The flow changes on both rivers are likely to result in a reduction of approximately 50 percent in summer flows and an increase ranging from 300 to 500 percent in winter flows at the major project sites. Near the mouth of the Stikine at the USGS gauge the approximate effect on flows is likely to be a 25 percent reduction in summer flows and a 100 percent increase in winter flows. This would translate into a .8 m decrease in summer water level and a .8 m increase in winter water levels. The downstream braided sections of the Iskut would probably become less braided as side channels silt up and the main channel widens and deepens. A similar process would occur on the Stikine but to a much lesser extent. The downstream

Appendix 7. (cont)

water temperatures resulting from the proposed regulation would probably be cooler in summer and warmer in winter.

This report was prepared largely during 1980 on the basis of the data available at that time (basically up to the end of 1979, except for snow course data, the latest of which was dated April 1980). An extensive field data collection program has been established which will provide additional data for environmental, design and operational studies as required during the preliminary design stage of the development. It is intended that addendum reports be prepared in the future at such intervals as the additional data warrant."

(B.C. Hydro, Generation Projects Division, 1981)

Appendix 7. (cont)
5. Impact of Hydroelectric Development On
Biological Resources of the Stikine Estuary Report Summary

"This preliminary analysis of potential impacts on the Stikine River estuary from the proposed Stikine-Iskut Hydroelectric project is based upon a series of conceptual and mathematical models which summarize the key processes in the estuary. The models were based on information obtained from a variety of sources including the U.S. Geological Service, Alaska Fish and Wildlife, B.C. Hydro Hydrology, and National Oceanographic and Atmospheric Administration as well as on data collected during limited field studies in September and October 1979. Use was also made of extensive studies of other estuaries, in particular those on the Squamish, Nanaimo and Fraser Rivers. These information sources combined to allow a thorough and systematic assessment of the influence of water flow regulation on physical, chemical and biological processes within various regions of the Stikine Estuary.

Six submodels were employed: (1) river hydraulics and sedimentology, (2) plume dynamics and tidal mixing, (3) marsh succession, (4) marsh and foreshore productivity, (5) offshore-surface productivity and (6) offshore-bottom productivity. The analysis of these models shows that the proposed Stikine-Iskut River impoundments will alter the river's sediment regime, clarity, flow, temperature and stage and possibly delta and river channel morphology and the frequency and duration of side channel flooding. These physical changes could in turn affect a variety of biological processes, including plankton bloom dynamics, nearshore benthic production and marsh succession, leading to alterations in waterfowl habitat, growth and survival of juvenile salmonids and starry flounders, upriver invertebrate production, visual predator success and ungulate winter range. Less likely are potential effects on recruitment of nearshore demersal and benthic species, and reduced salmon and eulachon spawning success due to modifications in flow, temperature and substrate. Finally, fish rearing capacity may be reduced due to shifts in the species composition of nearshore surface invertebrate populations. Not all impacts identified were negative. Increases in offshore demersal and benthic production are possible.

The accuracies of the impact predictions made are dependent on how adequately the models describe the physical and biological processes within the estuary, and their interrelationships. Because predictions of the potential impact of upstream impoundment and flow regulation on the estuarine ecosystem are predicated by a detailed knowledge of the physical system, it is recommended that further detailed impact assessments should be developed initially in terms of the physical variables related to the regulated and unregulated flow, river regime and morphology."

(Beak Consultants Ltd., 1981)

Appendix 7. (cont)
6. Stikine-Iskut Fisheries Studies Summary

"This report STIKINE-ISKUT FISHERIES STUDIES, has been prepared to assist B.C. Hydro in assessing the impact of hydroelectric development in the Stikine-Iskut Basin. It includes a brief review of available information describing the downstream effects of dams on fish populations, a presentation of data describing fish populations in the study area, a description of the likely effects of the proposed developments on aquatic environments, and a preliminary assessment of the potential impacts of such developments on fish populations in the study area.

With respect to the effects of environmental alteration of fish resources in the study area, the major conclusions of the study are that:

1. Chinook salmon, especially juveniles, appear to be the species most likely to be adversely affected by stream regulation. Rearing juveniles occupy habitats, including the margins of major channels, side channels, slack-water areas, and logjams, which are very likely to be reduced in area during the summer rearing period. In addition, juveniles may be adversely affected by stranding associated with rapid fluctuations in discharge, by reduced temperatures during the summer growth period, and by reduced food availability. Chinook salmon spawn in the mainstems of the Stikine and, probably, the Iskut River and they and their spawn might also be adversely affected by interruptions of upstream migrations, disruptions of spawning behaviour, stranding, and the elimination of prespawning holding areas, by the exposure of deposited eggs and by changes in the characteristics of spawning substrates.

2. Sockeye salmon spawning and rearing along the margins of the mainstem of the two streams might also be adversely affected in many of the same ways listed for chinook salmon above. The effects are, however, likely to be less severe for this species because both spawning and, to a lesser extent, rearing habitat tend to be associated with stable groundwater discharges which are largely independent of fluctuations in stream discharge.

3. Two species, the coho salmon and steelhead trout, are primarily associated with tributary streams and, except for the possibility of difficulties in migration, should be largely unaffected by developments along the mainstems.

4. Two species, the pink and chum salmon, are found in only small numbers in the Canadian portion of the Stikine-Iskut Basin and total populations of these species should be little affected by changes in aquatic environments in Canada.

Appendix 7. (cont)

5. A number of measures to mitigate potentially adverse effects of hydro development on fish populations are suggested. These include:

   a) The manipulating of water releases to accommodate the needs of fishes during critical periods;

   b) The maintenance of access of tributary streams and major groundwater sources now used as spawning and rearing areas;

   c) The use of enhancement techniques such as hatcheries and rearing facilities as well as spawning channels and the provision of access to suitable streams now inaccessible to fish;

   d) Fisheries management to reduce pressure on stocks which have been temporarily stressed.

   At this stage in our analysis, it would appear that potential losses of salmon and steelhead trout can be largely mitigated provided that appropriate measures are instituted."

(McCart, 1979)

Appendix 8. Potential Environmental Impacts of the Proposed Hydroelectric Projects

# Appendix 8. Potential Environmental Impacts of the Proposed Hydroelectric Projects

## 1. A Summary of Public Concerns

a) Objection to rapid and unplanned development in the North
b) The need for additional power has not been established
c) Destruction of the character of the Grand Canyon
d) Destruction of wilderness recreational values
e) Destruction of wildlife habitat and unique plant communities in the impoundment areas. Wildlife adversely affected includes mountain goats, moose, and caribou
f) Flooding of two bridges: Highway 37 and BCR
g) Greater access for hunting, recreation, and mineral development
h) Water pollution from exploratory drilling programs and sewage disposal
i) Alteration of streamflow by amount and season and changes in water temperature, sediment loads, and other water quality characteristics resulting in ecological disturbance to the Basin. Loss of riparian, waterfowl, and wildlife habitat in the estuary and on the delta may result in decreased fisheries, shellfish, waterfowl, and wildlife production
j) Negative social and economic impacts may be felt by regional communities
k) Irreversible commitment of the area to energy development before Indian land claims are settled

## 2. Excerpts from "Progress Report on Feasibility Studies", B.C. Hydro, 1980

### Physical Environment

"The reservoirs and the resulting flow regulation are expected to have some effect on the temperature and ice regimes and turbidity in the downstream reaches of the Stikine River. The reservoirs would intercept sediments which originate upstream decreasing sediment loads downstream and altering the annual temperature cycle to some extent by delaying spring warming and fall cooling. Temperature effects would be limited because of the extent of glacier-derived runoff in the downstream reaches.

The Iskut and More creek reservoirs similarly would intercept sediments and alter the annual temperature cycle of the river. Temperature effects on the Iskut projects would probably be less than on the Stikine because the reservoirs would be smaller and would retain water for shorter times.

Flow regulation resulting from the proposed development would increase

Appendix 8. (cont)

the low winter flows and reduce the high summer flows. Effects of flow regulation would be most noticeable in the immediate vicinity of the dams, and would decrease markedly in downstream progression because ofthe large tributary runoff from increasingly wetter downstream areas which are influenced by moist Pacific climatic conditions.

Just below the damsites, reservoir filling would reduce May to July flows to approximately 45 percent, on average, of normal unregulated flows and November to April flows would increase to approximately 400 percent, on average, of normal unregulated flows. Flows during August to October would be changed very little on average, by the proposed flow regulation.

For the Stikine River estuary, with refilling of the reservoirs during May to July post-development flows would be approximately 81 percent, on average, of the natural unregulated flows. Winter post-development flows would be about 184 percent, on average, of the normal unregulated flows. Average flows would be virtually unchanged by upstream regulation during the months of August to October, and in particular, the peak autumn floods characteristic of the lower Stikine and Iskut rivers would be modified very little by upstream hydroelectric development.

Physical effects would be observable near the estuary where the river water level is directly related to river flow. Further downstream in the estuary, river levels are controlled by tidal flows so no impoundment effects are expected. Sediment interception by the reservoirs would reduce downstream river sediment loads which may affect the rate at which the Stikine delta grows. Sediment data is presently too limited to permit calculation of the annual sediment load or to predict whether sediment loads would decline significantly... Impoundment would not interfere with the intrusion of salt water in the Stikine estuary as the salt wedge is controlled primarily by tidal phenomena.

The shape and complexity of the river channel is expected to be altered in places by flow regulation, particularly in alluvial channel reaches immediately downstream of the proposed dam sites. This is expected to eliminate the complex multiple channel reaches on the Iskut River below the Iskut Canyon project and may similarly affect the middle to upper reaches below the Tanzilla project. Vegetation overgrowth on bars and along side channels would also occur and would tend to stabilize these features.

Increased winter flows and higher winter temperatures caused by the reservoirs are expected to influence the downstram ice regime. More of the lower Stikine likely would remain free of ice...

The presence of reservoirs is expected to alter micro-climates and increase the incidence of fogging. The overall effects on climate are expected to be small when compared to natural climatic variations.

Appendix 8. (cont)

The Stikine reservoirs would partially inundate some of the Grand Canyon of the Stikine, an area noted for its scenic value, fast-flowing water and unique geology. Partial flooding of the Grand Canyon would reduce the quality of these features. Improved access into the project area, however, expecially down into the canyon along the Tanzilla project reservoir, would provide new opportunities for the public to view the Grand Canyon. The development would not be compatible with efforts by agencies such as Parks Canada to create a wilderness national park in the canyon area, but would not preclude the creation of other kinds of parks. The 45 m drawdown in the Site Z reservoir could aggravate the impact on scenic values in the area. In particular, sloughing and bank erosion in portions of the Site Z reservoir could temporarily detract from its overall appearance until slope stabilization and revegetation took place.

The project would not directly affect the Spatsizi Plateau Wilderness park, which is more than 60 km southeast of Site Z and is 15 to 20 km south of the Site Z reservoir. Indirect effects on wildlife are possible. Several Caribou herds utilize the Spatsizi and migration to adjacent range lands could be affected by the Site Z reservoir... The Iskut Canyon also has steep, overhanging canyon walls and a turbulent flowing river... The Iskut basin is subject to severe climatic conditions and extremely difficult access. Although the region is heavily mineralized, no identified commercial mineral resources would be flooded by either the Stikine or Iskut reservoirs.

Biological Environment

One adverse effect of the development would be to eliminate much of the habitat used by moose and caribou for winter range and for browse. The effect of this loss of habitat would be to reduce the number of animals in the immediate vicinity of the reservoirs. Some mountain goat habitat would be lost through flooding although there presently appears to be unused habitat both upstream and downstream of the Stikine project that could support the displaced animals.

On the Iskut River, habitat of some species also would be flooded. Particularly affected would be the black bears which use the area. Some mountain goats also would be affected, although the number of mountain goats is substantially less than in the Stikine Canyon. A major concern is the potential for improved access to areas that are not readily accessible at present. Access would put increased hunting pressure on wildlife populations presently protected by their remoteness. The need to control access would require innovative solutions if wildlife are to be protected.

Forestry resources would be affected in the Stikine and Klappan Public Sustained Yield Units. However, the effect would be small with less than

Appendix 8. (cont)

three percent of the allowable annual cut removed from the two PSYU because of flooding. The annual timber volume lost through flooding is estimated at 19 400 cu. m.

Effects on aquatic resources would be principally in terms of downstream effects on fish and aquatic habitat. None of the reservoirs would block salmon migrations. In general, annual operation of the project would reduce peak floods and tend to even out flows. In contrast to this regime, short-term daily flow fluctuations could increase load variations in the aquatic environment which might cause some mortality in fish rearing downstream from the dam. These effects could be avoided by suitable operating criteria. Altered temperature could affect egg incubation and fish migration. Some fish habitat would be eliminated becuase of the anticipated changes in some river reaches fom multiple to single channels. Increased winter flows might also have effects on habitat but these are not known at this time. Preliminary assessment indicates that mitigation at reasonable cost could largely protect fish runs from the effects of flow regulation. Although some fish habitat would be lost upstream of the dams, it is possible that a viable sport fishery could develop in the reservoirs.

In the estuary the effects of flow variations from upstream regulation are not expected to affect the upstream migration of salmon. Other species of fish, such as eulachon and starry flounder, occur in the estuary and are of commercial or sport importance.

Information on annual sediment load is inadequate at this time to forecast what effects changes in sediment load would have on the sediment dynamics in the estuary. Lower average river levels in June and July, due to flow regulation, may alter the frequency of summer flooding of the meadows below the Stikine/Iskut River confluence. Autumn floods would be virtually unchanged by the upstream hydroelectric development. Because flooding is a principal factor in maintaining these meadows in their present ecological state, any significant reduction in flooding of the wet meadows is likely to cause change in the riparian habitat. As a result, meadows could become bogs and forests with consequent effects on wildlife populations. Waterfowl populations also could be affected, as they utilize the area during migration.

Social and Economic Development

Dease Lake, Iskut, Telegraph Creek and Bob Quinn Lake are the closest communities to the project areas. The influx of a large construction work force and the regional increases in population required to support this work force would have social impacts on these small communities. Careful planning would be required to minimize these impacts. Because Telegraph Creek is remote from project access and construction activities it would be least directly affected.

Appendix 8. (cont)

A grazing lease and several traplines would be partially flooded as well as some of the lands within six guiding territories. The principal effects on the social and economic environment would be on the lifestyles of the residents. These would be caused mainly by construction activities, and the large work force.

Regional economic development could be stimulated by the Stikine-Iskut power development... The mining industry could be influenced positively by the availability of a better transportation network and power from the project if within economic transmission distance. This may tend to accelerate northern development and promote industrialization of the area. Such activity would conflict with the present wilderness lifestyle of the local residents. Recreation activity in the area, although presently at a low rate of use and restricted to guiding, hunting, hiking, river rafting and canoeing, would likely be expanded by the opportunities afforded through imporved transportation."

Appendix 9. Areas of National Park and Landmark Interest (excerpts from Regional Analysis of National Region 7, Parks Canada, 1976.)

# Appendix 9. Areas of National Park and Landmark Interest

## SPATSIZI PLATEAU AREA

NATIONAL PARK INTEREST

LOCATION: NTS 94E; 94C; 104H; 104I

SETTING: The interior of British Columbia roughly 340 air miles northwest of Prince George.

PHYSIOGRAPHIC UNITS PRESENT:
Stikine Plateau (Spatsizi Plateau)
Skeena Mountains
Omineca Mountains
Cassiar Mountains

SIGNIFICANT FEATURES:

- the Spatsizi Plateau is one of six component plateaux of the Stikine Plateau, consisting of several tablelands, or individual plateau units in a youthful stage of dissection, separated from each other by a network of large, deep U-shaped valleys.

- the Plateau rises to and is nearly surrounded by the rugged ranges of the Cassiar, Omineca and Skeena Mountains.

- highly interpretable representation of the transition from mountain to plateau units is present.

- glaciation in the Plateau only slightly modified the pre-Pleistocene topography while the surrounding mountains display many of the classic features of mountain glaciation.

- the area contains the headwaters of the Stikine River system.

- Boreal forest and alpine tundra are presented, with the rather sparse forested areas limited primarily to the wide drift-filled valleys.

- the Spatsizi Plateau area is considered to be one of the most important wildlife areas in Canada, providing excellent habitat for large populations of ungulates and carnivores. The area encompasses the complete ecosystem for a variety of wildlife, including the entire (summer and winter) range for such species as stone sheep, osborn caribou, mountain goat, moose, grizzly bear, wolf and numerous species of fur bearing animals and small mammals.

- the Plateau comprises one of the largest areas of low resource

Appendix 9. (cont)

- conflict in the Province, with minimal private land ownership, and only minor mineral and forestry potential.

- land access to the area via the recently upgraded Stewart-Cassiar Highway, and the soon to be completed British Columbia Railroad, is excellent.

- the area provides excellent wilderness recreational potential including canoeing, camping, nature interpretation, backpacking and so on.

- two Class A provincial parks are located in the immediate area. The recently announced (Nov. 1975) Spatsizi Plateau Wilderness Park covers a large portion of the area of interest - with a core Ecological Reserve (82,000 acres) surrounded by a park area of 1,668,000 acres. Tatlatui Provincial Park (261,500 acres) borders the area of interest to the south.

Appendix 9. (cont)

EDZIZI/COAST MOUNTAINS AREA

NATIONAL PARK INTEREST

LOCATION: NTS 104B; 104F; 104G; 104J

SETTING: Northwestern British Columbia adjacent to the Alaska Panhandle approximately 175 miles north of Prince Rupert.

PHYSIOGRAPHIC UNITS PRESENT:
Stikine Plateau (Klastline Plateau; Tahltan Highland)
Coast Mountains (Boundary Ranges)

SIGNIFICANT FEATURES:

- area vividly portrays the transition between a variety of landscapes, and encompasses portions of Regions 6 and 7.
- rolling upland plateau surfaces are mainly unwooded, lie above 5000 feet, and have been deeply incised by rivers.
- a sloping and heavily dissected belt of transitional highlands lies between plateau and mountain systems.
- the extremely rugged and serrated peaks of the Coast Mountains comprise the western portion of the area.
- highly interpretable representation of volcanic activity is present. Lava flows, cinder cones, and breccia pipes are found in the vicinity of Mt. Edziza, (elevation 9,143 feet), a huge dome-like composite volcano; nearby, brilliantly coloured altered lavas underlie the Spectrum Range. In the Boundary Ranges is found the spectacular Hoodoo mountan, an extinct or possibly dormant volcano.
- evidence of intense Pleistocene glaciation is evident throughout the area. Upland plateau surfaces have been subdued by erosion and the deposition of drift, and drumlins are present; all classical features of mountain glaciation are present in the Coast Mountains.
- extensive icefields are present in the Coast Mountains along with glaciers, some of which extend to rivers edge along the Stikine River.
- rivers of the coastal drainage system dominate the area, principally the lower Stikine River and its tributaries, including the Iskut. The rivers generally have a steep gradient and heavy

Appendix 9. (cont)

silt content due to glacial meltwater.

- fluvial processes are dramatically portrayed by the Grand Canyon of the Stikine River, in which the river has eroded a spectacular canyon approximately 40 miles long with nearly vertical walls several hundred feet deep, in lavas that originated from Mt. Edziza. A similar canyon of somewhat smaller dimensions has been created by Mess Creek, which joins the Stikine just below Telegraph Creek.

- representation of four major land ecosystems is present. A central core of alpine tundra and icefields is surrounded by the coast forest which extends up the Stikine and Iskut Rivers. The subalpine forest predominates on the upper Iskut, with the boreal forest found inland along the Stikine valley.

- wildlife of the area is felt to be representative, with seals being a notable addition, migrating up the Stikine River to capture salmon during spawning run.

- Mt. Edziza Provincial Park encompasses a portion of the area, centering on a Class A Provincial Park (326,000 acres) surrounded by a Recreation Area (249,000 acres), both established in 1972.

- land access to the eastern portion of the area is excellent, via the recently upgraded Stewart-Cassiar Highway, and the soon to be completed British Columbia Railroad.

- excellent wilderness recreation opportunity, including canoeing, camping, nature interpretation, hiking, etc.

- some mineral deposits are known to exist and exploration continues. A possible railroad link into the Edziza area has been discussed. Forestry potential is generally low, except for some merchantable stands along the lower river valleys. The development of hydro power on the Stikine and Iskut Rivers is considered to be feasible, but no plans to utilize it have been announced.

- historical values associated with the Klondike Gold Rush of 1898 are present: the Stikine River provided access to one overland route to the Yukon; the Telegraph Trail also passes through the area.

- the Stikine River has been recommended as a National Wild River.

Appendix 9. (cont)

GRAND CANYON OF THE STIKINE

NATIONAL LANDMARK INTEREST

LOCATION: NTS 104 G,J, 130 degrees 10'W - 121 degres 05'W
57 degrees 54'N - 58 degres 08'N

PHYSIOGRAPHIC REGION:
Stikine Plateau

THEME REPRESENTATION:
Volcanic and Fluvial Landforms

SOURCE: Roed, M.A. Ltd. Theme Study of Geologic and Related Features and Phenomena in Part of Western Canada. Parks Canada Document No. I0309R3. April 1973.

DESCRIPTION AND GEOLOGICAL SIGNIFICANCE:

- the Grand Canyon of the Stikine is approximately 50 miles in length extending from just east of Blamey Creek to the town of Telegraph Creek. The unglaciated surface of the Canyon's volcanic flows suggests that the present Stikine Canyon was excavated by the turbulent waters of the Stikine River in Recent time.

- a tremendous variety of volcanic structures, textures and rock types are found along the Stikine Canyon walls. Along the canyon from Blamey Creek to Klastline River, Upper Cretaceous and Paleocene conglomerate, sandstone, shale and minor coal occur with pre-Upper Cretaceous volcanic rocks, minor conglomerate, greywacke, chert and argillite. The river intersects Permian limestone just east of the Tanzilla River confluence. From Klastline River to Eight Mile Creek pre-Upper Jurassic volcanic rocks, minor conglomerate, greywacke, and argillite occur with basalt, rhyolite ash, tuff and agglomerate of Pleistocene age. The Stikine Canyon intersects intrusive rocks just southwest of Tahltan and at Latham Creek. In several places along the canyon lava beds directly overly fluvial gravel beds.

- located near the junction of the Tahltan and Stikine Rivers, a striking cross-section of a large Quaternary basalt flow displays radial columnar jointing and a small central lava tube. Upper Triassic pillow lava outcrops on the floor of the valley. This locality is referred to as Tahltan Butte which is in itself an interesting erosional remnant of the above rocks.

Appendix 9. (cont)

SITE ANALYSIS:

- Tenure: Mainly B.C. Crown, some private, some Indian Reserve
- Resources: Scientific, interpretive, scenic, fishing
- Settings: The steep-walled canyon is along the boundaries of the Tanzilla Plateau, Klastline Plateau, Nahlin Plateau and the Tahltan Highland within the Stikine Plateau. A road connecting Telegraph Creek with Tahltan occurs on the north side of the canyon for about 15 miles.
- Implications: Just to the north of Mount Edziza Provincial Park
- Conflicts: Town, road and ranch development along the western 15 miles of the canyon on the north side. Indian Reserve at Tahltan. Possible site for mineral and hydro-electric development.

PHENOMENA EVALUATION:

- High: A truly spectacular feature of the Canadian northwest.

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ADDITIONAL INFORMATION:

- The Stikine River was investigated by the Wild River Survey in the Summer of 1973 and was considered to be the most spectacular of the wild rivers surveyed in northern B.C.
- The Grand Canyon of the Stikine is a steep-walled canyon many hundreds of feet deep, eroded by the river after it was diverted from its old channel by Pleistocene and Recent lava flows originating at Mount Edziza.

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