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SOCIAL AND ECONOMIC ASPECTS OF BRITISH COLUMBIA AND YUKON INLAND WATERS

B.F. Friesen

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DEPARTMENT OF
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HIGHLIGHTS

1. Development of large resource-based export industries has been the prime factor in the economic growth of British Columbia and the Yukon. Forestry is the leading British Columbia industry, followed by mining, tourism, agriculture, and fishing. In the Yukon, mining is the major industry, followed by tourism, forestry, and trapping. Although British Columbia has recently been subject to unstable economic conditions because of inflation and depressed world markets, it is one of Canada's fastest growing provinces. Major Yukon development activities are expected very soon.

2. The combined mean annual flow of all streams in British Columbia and the Yukon is approximately one-third that of Canada. This vast inland water resource has a profound role in the social and economic development of British Columbia and the Yukon. Unlike trees or minerals, which are utilized primarily as process inputs to economic activities, water has a myriad of uses. Some uses (e.g. industry) consume water while others (e.g. fisheries) utilize it in its natural course. Drought, floods, hydroelectric generation and pollution are among the special resource management problems associated with this unique resource.

3. Manufacturing (especially pulp and paper), agriculture, and municipal waterworks, in that order, are the major consumptive water users in British Columbia. Mining is the major Yukon consumptive water user. Surface water meets most of these needs.

4. Water is essential to the British Columbia forest industry. It is used to transport logs and wood chips and as a process input, especially in the pulp and paper industry.

5. Most of the principal British Columbia agricultural areas are deficient in summer precipitation. Vegetable and tree fruit production is dependent on irrigation, and the beef industry is dependent on feed from irrigated summer pastures.

6. About 95 percent of British Columbia electricity requirements are met by hydroelectric generation. Electrical load is expected to double in the next nine to 12 years and hydro development has the potential to play a major role in meeting this demand.

7. One of the major functions of many British Columbia rivers, lakes and estuaries is for spawning and rearing Pacific salmon. High quality inland water is essential for this purpose.

8. British Columbia and Yukon inland waters sustain valuable sports fisheries; direct British Columbia benefits from this industry exceed $50-million annually. Subsistence fishing is particularly important to Native people.

9. Inland waters and related lands offer numerous recreational opportunities; over 50 percent of Canadian vacation trips are oriented to water-based activities.

10. Rivers and lakes provide an important means of transporting bulky raw materials; the Lower Fraser River is an important deep-sea port.

11. Because many British Columbia communities are located on flood-plains, a high cost often must be paid in the form of flood control programs or flood damages. If Lower Fraser Valley dyke capacity were exceeded, damage costs could reach $500-million.

12. Peace and Columbia River hydroelectric potential is almost fully developed. Dam sites on other rivers and alternative power sources (mainly thermal) are now being considered. Important decisions must be made, however, in order to minimize impacts on fish and other environmental factors.

13. British Columbia and Yukon water quality problems generally occur where heavy concentrations of sewage or industrial effluent are released into rivers and lakes. Toxic discharges from mining and pulp and paper industries are a major concern in several areas. Algae blooms caused by nutrients from sewage and agricultural activities have occurred in Okanagan, Kootenay and Koocanusa Lakes.

14. The Fraser Estuary (including both freshwater and its interface with salt water) is subject to the conflicting demands of transportation, industry, settlement, environment, and recreation. In recognition of this, and the multitude of jurisdictions, the senior governments have initiated a study to develop a management plan for this valuable area. Similar problems have already occurred or are anticipated in other estuaries.

15. Although British Columbia has vast inland water resources, drought could become a serious problem in dry southern interior valleys. These valleys (e.g. Okanagan) receive limited precipitation but support intensive agriculture and significant urban populations.

16. Water quantity and quality data gathering is an important federal activity; data collection is basic to all aspects of water management.

17. River basin planning under the Canada Water Act is a cornerstone of federal inland water management policy. The Okanagan Basin Study and subsequent Implementation Agreement are examples of major achievements in British Columbia under the Act.

18. The Fraser River Flood Control Program is one major area of federal involvement (federal share is $60-million) in British Columbia flood protection. Discussions are continuing between federal and British Columbia officials toward an Agreement under the federal Flood Damage Reduction Program; this program includes provisions for flood risk mapping and other innovative approaches to flood problems.

19. The Columbia, Yukon and other river basins are shared with the United States. The federal government has jurisdiction over these inland waters. Important activities include participation on International Joint Commission (IJC) boards and committees which carry out investigative and regulatory functions. Administration of the Columbia River Treaty is a major federal responsibility.

20. The federal government is involved in the restoration and protection of water quality through: development of water quality objectives, national effluent regulations, and nutrient control. Canada's responsibilities concerning transboundary pollution under the Boundary Waters Treaty of 1909 are an important rationale for this federal role.

22. Federal research efforts initially concentrated on resolving limnological problems which occur in the hydrologically variable intermontaine lakes of British Columbia and the Yukon. Future activities will be broadened to include research on the impacts of pollution on river and estuarine systems.

23. In recognition of the federal Environmental Assessment and Review Process, environmental factors are considered as an integral component of federal water management activities.

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I. INTRODUCTION

The combined mean annual flow of all streams in British Columbia and the Yukon is approximately one-third that of Canada. This vast inland water resource has had a profound impact on the social and economic growth and development of the region. Water resources contribute to the British Columbia and Yukon economy by providing municipal and industrial water supply, irrigation water, water for recreation and transportation purposes, and most of the electric power.

The purpose of this report is:

(1) to outline the importance of inland waters in the social and economic development of British Columbia and the Yukon;

(2) to identify some current and future issues in the management and development of British Columbia and Yukon inland waters; and

(3) to discuss the Federal role in managing inland water resources.

Section II provides an overview of physical and climatic characteristics of British Columbia and the Yukon. Section III outlines general social and economic trends which have an impact on inland waters. Section IV provides a brief examination of individual water using sectors of the economy (e.g. municipal, recreation) and Section V outlines some water management issues. The final section discusses the Federal role in managing British Columbia and Yukon inland water resources.

II. PHYSICAL GEOGRAPHY AND WATER RESOURCES

Physiography

British Columbia has an area of about 948,000 square kilometres, while the Yukon is a little over half that size.

British Columbia and the Yukon have a diverse physiography composed of the Cordillera and Great Plains Regions. The Cordillera includes the largest complex of mountain systems and plateaus in Canada. It consists of three broad parallel units extending from the United States border to the Beaufort Sea: the Rocky Mountain System, the Interior System of scattered plateaus and mountains, and the mountainous Western System. The relatively flat northeastern corner of British Columbia is an extension of the Great Plains.

The Rocky Mountain System is seldom more than 100 Km wide, but together with the Mackenzie, Selwyn, and Richardson Mountains to the north, it forms an almost continuous series of ranges from the 49th parallel to the Arctic. The Rockies were formed from intensely folded, faulted, and uplifted sedimentary rocks. The Rocky Mountain Trench, a deep valley paralleling the western slope of the Rocky Mountains, extends the full length of British Columbia.

In contrast to the rugged Rocky Mountain System is the older but generally higher Western System, consisting of the Coast and Outer Mountain areas. The Coast Mountains, extending from the 49th parallel to the Yukon, are formed primarily of igneous and metamorphic rocks. These mountains have an average width of 150 Km. The Outer Mountain area, west of the Coast Range, consists of two discontinuous ranges - the St. Elias and Insular Mountains. Mt. Logan (6054 m), the highest peak in the Yukon and Canada, is found in the St. Elias Mountains. The Insular Mountains form Vancouver, Queen Charlotte, and other lesser islands.

The Interior System, between the Rocky Mountain and Western Systems is composed of lesser ranges and plateaus. The Interior Plateau lies between the Columbia Mountains in southeastern British Columbia and the Coast Mountains. North of 55° latitude the Interior Plateau gives way to the Cassiar Mountains and the extensive Yukon Plateau.

Climate

Mountainous topography and a considerable range of latitude (49°N to 69°N) give British Columbia and the Yukon the greatest climatic diversity in Canada. Predominating air masses originate over the Pacific Ocean bringing moderating, moist conditions and over the Arctic bringing cold, dry conditions.

The Cascade Range and Coast Mountains generally protect coastal regions from intrusions of Arctic air. Similarly, the tempering influence of maritime air does not extend more than a few kilometres inland except where warm air masses are able to penetrate river valleys. The coastal region characteristically experiences abundant rainfall and mild temperatures. Some Vancouver Island locations experience the heaviest rainfalls in Canada. Heavy snowfalls comprise a large portion of winter precipitation on the north coast of British Columbia.

The southern interior is much drier than the coast as ascending air drops a large portion of its moisture on coastal facing mountain slopes and descends to the interior valleys as warm, dry air. Southwestern interior valleys are desert-like as a consequence of this rainshadow effect. The rainshadow is interrupted eastward of the Interior Plateau where the Selkirk, Cariboo and Monashee Mountains induce a marked increase in precipitation. The southeastern interior has a less arid and more extreme climate than the southwest. The effects of the Pacific air system are minimal and Arctic air frequently penetrates the valleys from the north and east.

The northern interior of British Columbia generally has long, cold winters and short, cool summers. In the northwest, this pattern is upset by maritime air moving up the Nass and Skeena River valleys. The climate of the northeast is similar to the continental climate of the prairies.

Yukon climate is influenced by high latitude and the St. Elias Mountains which block Pacific air. It is characterized by long, cold, relatively dry winters and by short, warm summers with slightly more precipitation.

Water Supply

Average annual streamflow in British Columbia is of the order of 1,100,000 cubic feet per second, representing nearly one-third of Canada's total flow. Regional variations in surface runoff are determined mainly by precipitation and snowpack storage. Seventy to 80 percent of the annual flow of the interior rivers of British Columbia occurs as the accumulated snowpack melts in the spring. Rivers rising in the Coast Mountains have discharge peaks associated with heavy fall and winter rains. A summary of the average flow of major streams and areas of British Columbia and the Yukon is given in Table 1.

Groundwater is also an important source of water supply in British Columbia. The most heavily used aquifers are the sands and gravels of the Lower Fraser Valley. It has been estimated that total available groundwater in the Fraser Valley is over 25-million gallons per day. Groundwater levels respond to climate; most aquifers refill by melting snow or rain percolating downward from the surface. Recharge is greatest during the spring freshet.

TABLE 1

SELECTED BRITISH COLUMBIA AND YUKON TERRITORY DRAINAGE BASINS

Drainage Basin	Area sq.mi	Average Flow cfs
Vancouver Island		
Nimpkish River	680	4,560
Smaller Pacific Coast		
Capilano River	67	710
Fraser River (Hope)	83,800	96,100
Skeena River (Usk)	16,300	32,600
Nass River (Aiyansh)	7,410	28,300
Stikine River (Butterfly Creek)	13,900	23,100
Taku River (Tulsequah)	6,000	8,710
Liard River (Lower Crossing)	40,300	40,500
Peace River (Taylor)	38,300	48,600
Columbia River (International Boundary)	59,700	101,000
Yukon River (Whitehorse)	7,500	8,430
Yukon River (Dawson)	102,000	78,400
Alsek River (Bates River)	6,250	7,940
Peel River (Canyon Creek)	9,940	6,450
Porcupine River (Old Crow)	21,400	12,600
Firth River (near Mouth)	2,240	1,450
Teslin River (Teslin)	11,700	10,800
Kootenay River (Corra Lin)	17,700	28,400
Thompson River (Spences Bridge)	21,200	27,900
Fort Nelson River (Fort Nelson)	17,200	27,900
Nechako River (Isle Pierre)	16,400	11,400
Pelly River (Pelly Crossing)	18,900	13,900
Stewart River (Mouth)	19,700	16,400

SOURCE: (8)

Movement of groundwater in the north is restricted by permafrost. In the far north, where temperatures are below freezing for over six months of the year, permafrost extends to depths of up to 450 m. Summer temperatures thaw only the upper (active) layers (from 1 to 4 metres).

Rivers

There are many rivers in British Columbia and the Yukon which rise in the glacial, snowcapped mountains and drain the interior regions (Map 1, Map 2). Some important rivers include the Fraser, Columbia, Skeena, Nass, Stikine, Peace, Liard and Yukon.

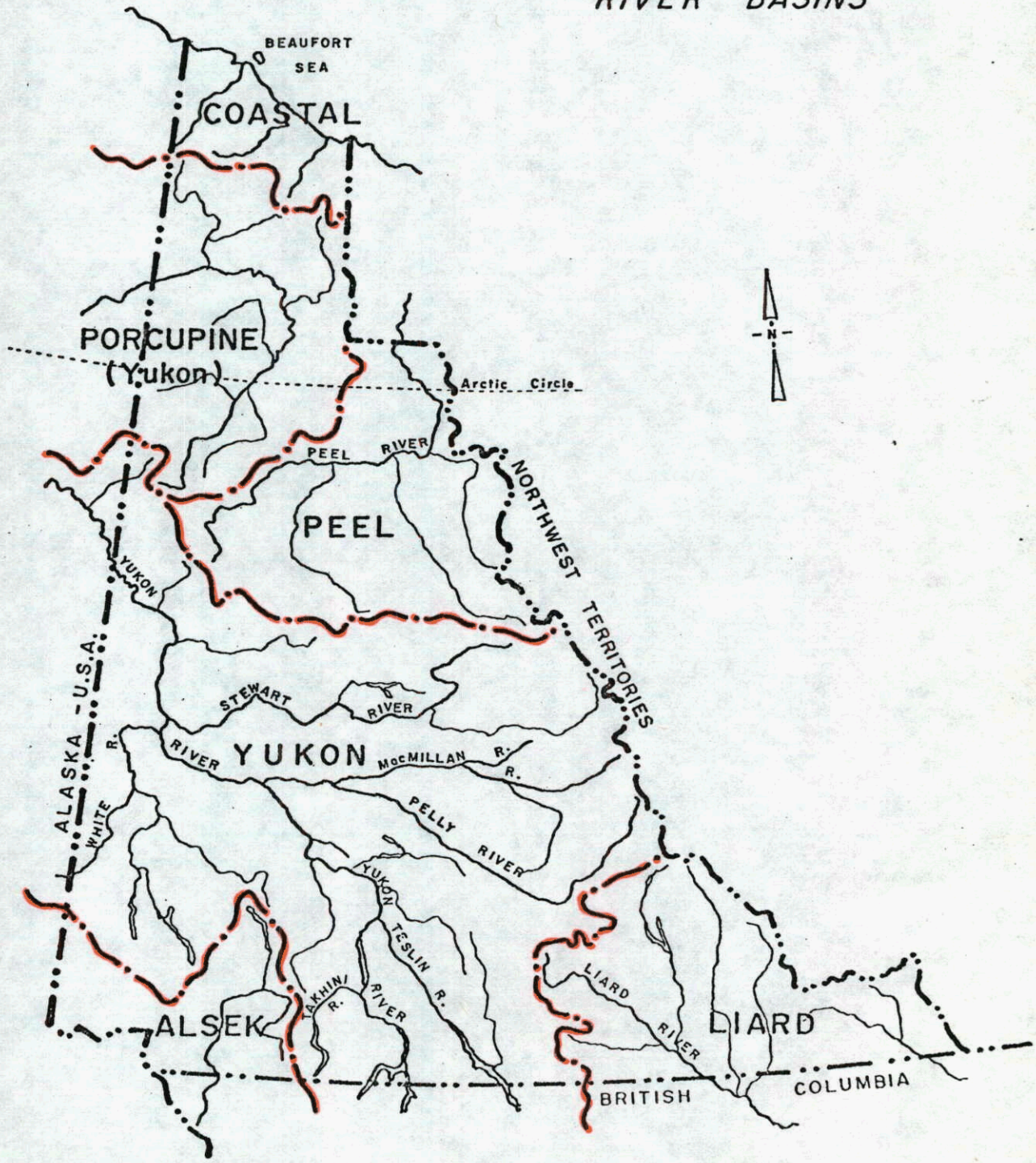
The Fraser River and its tributaries, the Nechako, Chilcotin, Bridge, Quesnel and Thompson rivers drain approximately one-quarter of the area of British Columbia, including most of the Interior Plateau. The Fraser's main stem is about 1,400 Km long. It rises in the Rocky Mountains, flows northward through the Rocky Mountain Trench, then turns southward near Prince George, crosses the Interior Plateau, and eventually enters the Strait of Georgia at Vancouver. The lower reach of the Fraser River has a fertile floodplain which extends about 130 Km inland. The river supports one of the largest salmon runs in the world. The Fraser River estuary is the largest in British Columbia and is vitally important for fish and wildlife.

The Columbia River rises in the Purcell Mountains. This river flows northward for about 300 Km, then it turns and flows south to the International Boundary where it is met by the Pend-d'Oreille River. The Kootenay rises in the Rockies but unlike the Columbia, flows directly southward across the International Boundary and then turns northward returning into Canada before joining the Columbia near the International Boundary. Another tributary, the Okanagan River, meets the Columbia in Washington State.

MAP I
BRITISH COLUMBIA
RIVER BASINS

I.W.D., W.P. 8 M. 20-04-78

MAP 2
YUKON TERRITORY
RIVER BASINS



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The Skeena, Nass and Stikine Rivers of northwestern British Columbia rise in the mountainous Western System and empty into the Pacific Ocean north of Prince Rupert. The Stikine enters the Pacific Ocean through Alaska.

The Peace and Liard Rivers, two tributaries of the Mackenzie River, originate in the Rocky Mountain Trench and drain part of the Great Plains in northern British Columbia.

The Yukon River (including Canadian and American reaches) is the fifth largest drainage basin and has the fifth largest average discharge in North America. The Yukon River rises in the St. Elias Mountains near the British Columbia-Yukon border, flows north from the Yukon Plateau, and enters Alaska en route to the Bering Sea. Important tributaries include the Stewart, Pelly, Teslin, White, and Takhine Rivers.

III. SOCIAL AND ECONOMIC OVERVIEW

This section briefly outlines general social and economic trends in British Columbia and the Yukon which have an impact on inland water resources. Some statistical indicators of economic activity in British Columbia and the Yukon are summarized in Tables 2 and 3 respectively.

Population

British Columbia, with a population of 2,466,608 in 1976, recorded a growth rate of 12.9 percent between 1971 and 1976, or about twice the national rate. The annual population growth rate, however, dropped substantially in 1975 and 1976 primarily because of a decline in net interprovincial migration (3). The population of the Yukon in 1976 was 21,835, an increase of 18.7 percent since 1971 (11).

Approximately two-thirds of the total population of British Columbia are located in the Lower Mainland and the Greater Victoria areas. Areas with the highest population growth rates between 1971 and 1976 were Central Fraser Valley (Abbotsford, Langley, etc.), Central Okanagan, and North Okanagan (3). About 60 percent of the population of the Yukon is located in Whitehorse (11).

Labour Force, Employment, Income

Estimated British Columbia labour force in 1976 was 1,135,000 persons. The ten-year average growth rate since 1966 was the highest in Canada, averaging 4.7 percent per year (3). Employment in British Columbia grew at an average annual rate of 4.4 percent from 1971 to 1976 compared to only 3.3 percent for Canada as a whole. Particularly rapid employment growth occurred in service industries (3). Unemployment, however, averaged 8.6 percent in 1976. This exceeded unemployment rates in the prairie provinces and Ontario and is the highest annual rate experienced in British Columbia in over a decade.

TABLE 2

STATISTICAL INDICATORS OF ECONOMIC ACTIVITY IN BRITISH COLUMBIA[1]

	UNIT	1961	1971	1975	1976[2]
DEMOGRAPHIC					
Population (June 1)	Persons	1,629,082	2,184,621	2,457,000[3]	2,466,608
LABOUR					
Labour force	Thousands	575[4]	900	1,103	1,135
Employment	Thousands	527[4]	835	1,009	1,038
INCOME					
Personal income	$ millions	3,091	8,185	15,411	17,664
Per capita personal income	Dollars	1,897	3,746	6,272	7,091
FORESTRY					
Timber scaled	Million cu.ft.	1,167	1,997	1,768	2,455
Lumber production	Million F.B.M.[5]	5,620	8,937	7,469	10,671
Pulp production	Thousands tons	2,254	4,860	4,350	5,894
MINING					
Value of mineral production	$ millions	179	527	1,364	1,486
Copper	Kilograms	8,965	131,038	331,694	396,837
Crude oil	Cubic metres	1,900	66,472	94,230	113,390
Natural gas	Cubic metres	8,819	31,946	214,734	269,173
AGRICULTURE					
Farm cash receipts	$ Thousands	135,077	224,688	405,554	436,751
FISHING					
Wholesale marketed value	$ Thousands	78,806	120,089	167,018	297,621
ELECTRIC POWER					
Generation	GWh[6]	13,204	29,038	34,406	38,544
Consumption	GWh[6]	13,179	29,040	32,575	36,439
MANUFACTURING					
Factory shipments	$ Millions	1,927	4,236	7,328	8,719

1 Dollar values are given in current dollars.
2 Estimated or preliminary
3 Estimated on the basis of the 1971 census and subject to revision based on the 1976 census.
4 1961 estimates are not directly comparable to later years due to survey revisions.
5 F.B.M.= feet board measure
6 GWh = gigawatt hour = 1 million kilowatt hours.

TABLE 2 (cont'd)

STATISTICAL INDICATORS OF ECONOMIC ACTIVITY IN BRITISH COLUMBIA[1]

	UNIT	1961	1971	1975	1976
CAPITAL INVESTMENT					
Capital and Repair expenditures	$ Millions	1,240.9	3,722.2	5,823.6	6,359.7
HOUSING					
Housing completions	Dwelling units	11,167	30,478	31,530	34,910
TRANSPORTATION					
Motor vehicle licences [7]	Thousands	584.0	1,084.2	1,167.4	1,220.1
Shipping					
Coastal loadings	Thousand tons	1,081	2,771	6,359	7,437
International loadings	Thousand tons	422	1,340	2,589	3,057
RETAIL TRADE					
Retail sales	$ Millions	1,604	3,632	5,939	6,675
EXTERNAL TRADE					
Exports [8]	$ Millions	1,081	2,771	6,359	7,437
Imports [8]	$ Millions	422	1,340	2,589	3,057
TOURISM					
Entries from the U.S.	Thousands persons	N/A	N/A	3,359	3,147
PRICES					
Consumer price index - Canada	1971=100	75.0	100.0	138.5	148.9
Consumer price index - Vancouver	1971=100	78.7	100.0	137.7	151.0

7 Data prior to 1974 show vehicle registrations and from 1974 to 1976 only vehicle licenses.

8 Through British Columbia customs ports.

N/A = Not available

SOURCE: (3)

TABLE 3

STATISTICAL INDICATORS OF ECONOMIC ACTIVITY IN THE YUKON

	UNIT	1961	1966	1971	1976
DEMOGRAPHIC					
Population (June 1)	Persons	14,628	14,382	18,388	21,836
LABOUR					
Labour force	Persons	-	7,500	-	10,400
INCOME					
Salaries and Wages	$-millions	-	28.7	-	92.5
MINING					
Net value of Production	$-millions	-	12.0	-	138.5
FOREST PRODUCTS					
Net Value of Production	$-millions	-	0.4	-	1.3
TRAPPING					
Net Value of Production	$-millions	-	0.1	-	0.4
FISHING					
Net Value of Production	$-millions	-	-	-	0.1
CONSTRUCTION					
Net Value of Production	$-millions	-	19.0		20.0
RETAIL TRADE					
Retail sales	$-millions	-	21.7	-	57.0
TOURISM					
Direct Expenditures	$-millions	-	7.0	-	25.0

SOURCE: (16)

Estimated 1976 personal income in British Columbia was $17.7-billion, or $7,091 per capita, second only to Ontario. Of the ten provinces, British Columbia has the highest wages and salaries per employed person (3).

The Yukon labour force totalled about 10,400 in 1976. Average earnings are very high compared to the rest of Canada (16).

The Economy

Development of large resource-based export industries has been the prime factor in the economic growth of British Columbia. Forestry is the leading industry in the Province, followed by mining, tourism, agriculture, and fishing. In the Yukon, mining is the major industry, followed by tourism, forestry and trapping.

Forestry

British Columbia's standing timber equals approximately one-quarter of the North American inventory (3). Forest-based industries comprise the most important sector of the provincial economy and employ an estimated 85,000 persons. Total harvest during 1976 was approximately 2.5-billion cubic feet. The industry produces 67 percent of the softwood lumber, 27 percent of the pulp, 17 percent of the paper, and 88 percent of the softwood plywood in Canada (3).

Forestry is expected to continue to be the dominant sector in future, but other sectors of the economy, such as mining and tourism, appear to offer greater growth potential. Sawmilling has historically been the main forest-based industry, but since 1960 the largest relative gains have been in pulp and paper. Success of the industry as a whole is dependent on international competition and markets.

Forest-based industries are not well developed in the Yukon. However, there is potential for growth in this sector as local demand for forest products increases (16).

Mineral Industry

Total value of British Columbia mineral production in 1976 exceeded $1.5-billion. The leading minerals in order of importance are copper, coal, natural gas, crude oil and molybdenum. Together they account for 80 percent of the total value of mineral production in British Columbia (3).

Total production value of Yukon mining for the 1975-76 fiscal year was $220.9-million. Employment in the industry for the same period was 1,331 (16).

Tourism

Because of British Columbia's abundant recreational and scenic opportunities, tourism is a prominent and expanding industry. The 1976 value of tourist expenditure in British Columbia was about $1.1-billion. Persons residing outside of British Columbia contribute the greatest share (60 percent) of revenues (3).

More than 300,000 tourists visited the Yukon in 1976 and spent an estimated $25-million (16).

Agriculture

British Columbia agriculture is characterized by its diversity. Cash receipts from 1976 farming activities totalled about $436.8-million. Dairy farming and livestock and related production constitute the greatest portion of these cash receipts to the economy (3). Fruit and vegetable production is also important.

Fisheries

The fishing industry in British Columbia has historically been the most valuable in Canada. The wholesale value of fisheries products in 1976 was $298-million. Exports of fishery products in the same year totalled $175.5-million. Salmon is the most valuable commercial species (3).

The inland waters of the Yukon support a varied and valuable fishery resource. Although the commercial fishing industry is small, it has potential for growth.

Manufacturing

The three predominant manufacturing industries in British Columbia are wood, pulp and paper, and food and beverage industries. Factory shipments in 1976 totalled $8.7-billion (3).

The Future

British Columbia has recently been subject to unstable economic conditions because of inflation and depressed world markets. However, in the view of the British Columbia Ministry of Economic Development, major economic indicators - capital investment, factory shipments, business incorporations, personal income, and international trade - all suggest promise of an accelerated growth. The Province is expected to experience a stronger recovery than Canada as a whole (3).

The Yukon economy was depressed in 1976 as a consequence of labour disputes at three of the Territory's five operating mines. Major development, however, is expected to improve economic conditions in the early 1980's with possible construction of a major highway, pipeline, as many as six mines, power facilities, and a rail extension (16). Furthermore, continued diversification in other industries, such as tourism, is expected to give the Yukon economy greater stability.

IV. SOCIAL AND ECONOMIC IMPORTANCE OF INLAND WATERS

Water is a multiple purpose resource which is important to most social and economic activities. Water also has a role in satisfying such social objectives as economic growth, equitable income distribution, and regional development.

The importance of inland waters in the over-all development of British Columbia and the Yukon is graphically illustrated by examining the settlement pattern and transportation routes. Map 3 clearly demonstrates that major population centres in southern British Columbia are located along the banks of rivers and lakes. This pattern extends throughout the remainder of British Columbia and the Yukon. Access to transportation, recreation, convenient water supply, relatively level land for building, and fertile land for crops are among the advantages of locating near certain watercourses. A similar pattern is also evident in the road and railway network. These transportation routes generally are located in valley bottoms parallel to rivers and lakes.

This section begins by briefly discussing some uses of water resources. It then outlines water use by various sectors of the British Columbia and Yukon economy.

Uses of Water

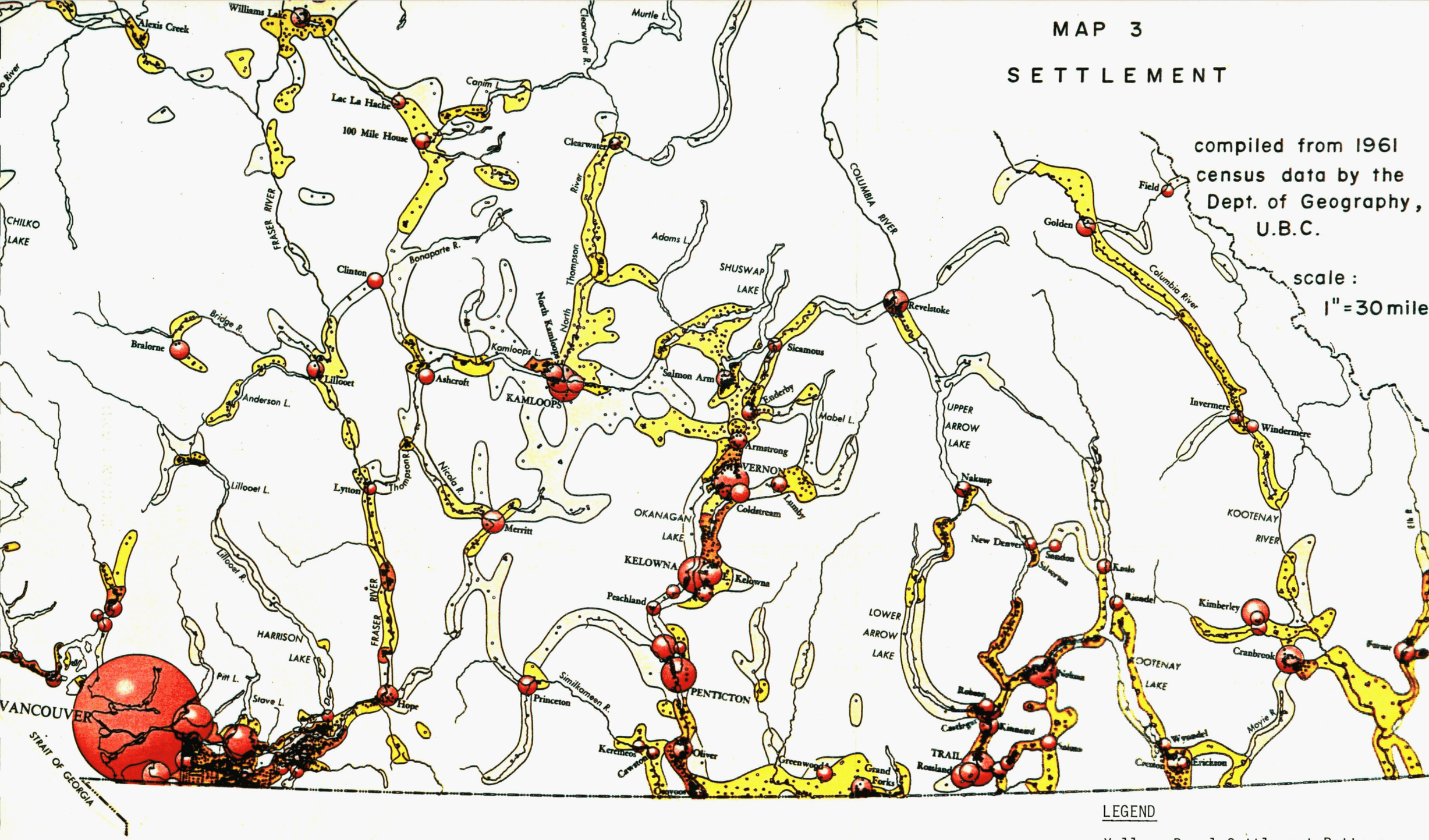
Water has certain characteristics which make it a unique resource. The amount of water available at any given location and time varies, but the supply is constantly renewed. Unlike non-renewable resources such as oil, or other renewable resources such as forests, water cannot be conserved for long periods by non-use.

MAP 3

SETTLEMENT

compiled from 1961 census data by the Dept. of Geography, U.B.C.

scale: 1" = 30 mile



LEGEND

Yellow: Rural Settlement Pattern
Red: Urban Settlement Pattern

Some uses involve withdrawing water from its natural course. Domestic water use by households, industrial water use as a process input, as a cooling agent, and as a medium for waste disposal, and irrigation water use in agriculture are a few examples of withdrawal uses. Other uses, such as fishing, hunting, outdoor recreation and transportation, depend on naturally occurring water in streams and lakes. Still further uses, such as hydroelectric power generation, rely upon the flow characteristics of rivers.

Withdrawal is commonly discussed in terms of intake, consumption, and discharge. Water intake is the amount withdrawn from a watercourse, and consumption is the water "used up" or not returned. Water discharge is that portion of the original intake returned to the source. Discharge may contain varying amounts of polluting substances.

In municipal and domestic use, most of the water intake is discharged but usually its quality has been altered through the introduction of wastes. Industrial water is generally returned with only a slight reduction in quantity. The quality of industrial discharges, however, has often been substantially reduced by pollutants. In some cases, water which has been used as a coolant is discharged causing thermal pollution which can be as deleterious as chemical or organic pollution. While municipal and industrial uses consume only 5 to 10 percent of the water withdrawn, irrigation consumes more than half of it. Some of the water withdrawn for irrigation is used in plant growth. Much of it is returned to the atmosphere by evaporation and transpiration. The remainder percolates into the ground to become groundwater which may later reach a stream. This water often is of lower quality because it is contaminated with varying amounts of salts.

Consumptive Water Use

During 1974, water withdrawals for all consumptive purposes in British Columbia and the Yukon were estimated at 1,744-million gallons per day (mgd), or roughly 10 percent of total Canadian withdrawal (Table 4). Manufacturing, agriculture and municipal water works, in that order were the major water users in British Columbia. Mining was the most important water use for the Yukon. This differs from Canada as a whole where thermoelectric generation accounts for the largest withdrawal.

TABLE 4

WATER WITHDRAWAL FOR CONSUMPTIVE USE - 1974
(millions of gallons per day)

	British Columbia	Yukon and Northwest Territories	Canada
Municipal and Rural	250	6	2,191
Manufacturing	943	-	5,677
Agriculture	290	-	1,599
Mining	69	13	636
Thermoelectric	173	-	6,538
Total	1,725	19	16,641

SOURCE: (7)

Municipal and Domestic Use

Municipal and domestic water use includes use for waterworks, domestic purposes, lawn and garden sprinkling, and commercial buildings. Surface water meets about 90 percent of these needs but some British Columbia communities, such as those in the southern part of the Lower

Fraser Valley, also use groundwater. Most of the population of British Columbia is urbanized and is served by public water supply systems. However, private waterworks and individual intakes and wells are also important. It is estimated that municipal works serve three-quarters of the population of British Columbia. The Greater Vancouver system alone serves half the population of the province (14).

Most Yukon residents use groundwater for domestic purposes (13). Mining towns, major centres, and government communities usually have water delivered by a central pipe system. Water is trucked into other areas.

Estimated municipal and rural withdrawal during 1974 in British Columbia was 250.1-million gallons per day (mgd), and in the Yukon it was 3.6 mgd (Table 5).

Municipal water use per capita in Canada varies considerably. There is generally a relationship between per capita use and water availability. British Columbia is a relatively heavier water user per capita than the drier prairie provinces (Table 5). High per capita use in the Yukon occurs in part because water must be kept flowing to prevent freezing.

TABLE 5

MUNICIPAL AND RURAL DOMESTIC WATER USE - 1974

	Municipal	Rural	Total	Per Capita Municipal	Per Capita Rural
	(millions of gallons per day)			(gallons per day)	
British Columbia	226.8	23.3	250.1	126	40
Yukon	3.3	.3	3.6	275	40
Manitoba	55.3	9.3	64.6	79	30
Ontario	731.7	50.1	781.8	110	35
Canada	2,004.1	186.1	2,190.2	116	35

SOURCE: (7)

Manufacturing Industrial Use

Water availability is an important factor in the location decisions of many firms because of its numerous applications in industrial operations. Its heat-absorptive capacity makes it the most common cooling medium and vast quantities are used for this purpose. It also serves an essential role in the production of steam for generation of electricity and for industrial processes. Water often is the medium in which industrial processing takes place, such as in the electroplating industry. Water is also incorporated in products such as soft drinks. As well, water is used for sanitation and general cleaning tasks within industrial plants.

Few data are available on water use by manufacturing industries for British Columbia and the Yukon. Judging from water use data for Canadian manufacturing industries (Table 6), British Columbia industries generally account for a larger share of Canadian industrial water withdrawals (on a per capita basis) than many other provinces. This is partially accounted for by the major importance of the pulp and paper industry. Paper and allied industries account for the largest share of manufacturing industrial water withdrawals in Canada. Water use in the mineral industry (Table 7) is significant in view of the importance of mining to British Columbia and the Yukon. The high rate of consumption in British Columbia is accounted for by the petroleum industry which uses deep well injection to force crude oil to the surface.

Agricultural Use

British Columbia's agricultural water withdrawals account for approximately 20 percent of the Canadian total (Table 8). Much of this is used for irrigation to support intensive agriculture in the southern interior valleys. The Okanagan Valley is perhaps the best example of an intensely irrigated area.

TABLE 6

MANUFACTURING WATER USE - 1974

	Total Water Intake (millions of gallons per day)	Consumption Rate (per cent)
Province		
British Columbia	943	4.1
Ontario	2,646	4.0
Manitoba	82	7.3
Total - Ten Provinces	5,677	4.2
Industry (for Canada as a whole)		
Paper and Allied Industries	2,015	3.8
Primary Metal	1,023	2.7
Chemical and Chemical Products	1,007	6.5
Food and Beverage	338	5.3
Wood	156	3.2
Non-Metallic Mineral Products	99	5.1

SOURCE: (7)

TABLE 7

WATER USE IN THE MINERAL INDUSTRY - 1974
(millions of gallons per day)

	British Columbia	Yukon and Northwest Territories	Canada
Withdrawal			
Non-Metallic	0.0	0.3	30.4
Metallic	41.1	12.9	315.8
Fuel	28.2	0.0	290.3
Total	69.3	13.2	636.3
Amount Consumed	28.5	1.3	322.7

SOURCE: (7)

TABLE 8

AGRICULTURAL WATER WITHDRAWALS BY REGION - 1974
(millions of gallons per day)

Region	Irrigated Acreage	Withdrawals		
		Irrigation	Stock-watering	Total
Atlantic	7,027	.8	11.7	12.5
Quebec	104,763	16.2	60.0	76.2
Ontario	112,777	36.4	84.1	120.5
Prairies	655,954	975.9	124.4	1,100.3
British Columbia	227,050	273.7	16.1	289.8
Canada, Total	1,107,571	1,303.0	296.3	1,599.3

SOURCE: (7)

While farming in the dry southern interior of British Columbia would be impossible without irrigation, it also should be noted that most of the principle agricultural areas of the Province are deficient in summer precipitation. Even in such areas as the Lower Fraser Valley, irrigation is increasingly used to obtain high production levels (14). Fruit and vegetable production is heavily dependent on irrigation. The interior beef industry is completely dependent on winter feed that has been harvested from irrigated land. In fact, growth of British Columbia beef industry is dependent on a continued supply of irrigated summer pasture (6). Considering the province's relatively small percentage of available land for farming, it supports a fair share of Canada's poultry and livestock (6). As a consequence 16.1-millions of gallons per day are required for stock watering (Table 8).

Non-Consumptive Water Use

Hydroelectric Power

The combination of numerous rivers and mountainous terrain has endowed British Columbia and the Yukon with an immense water power potential. British Columbia derived over 95 percent of its electricity requirements from hydroelectric generation in 1976 (Table 9). Hydro development is expected to continue through the year 2000. Thermal generation is expected to become more important by the mid 1980's (5).

TABLE 9

ELECTRICAL ENERGY GENERATION (GWh) 1976

	Hydro	Thermal/ Nuclear	Total
British Columbia	36,689	1,854	38,543
(% Total)	(95.2)	(4.8)	
Yukon	258	49	307
(% Total)	(84.0)	(16.0)	
Ontario	38,292	48,945	87,237
(% Total)	(43.9)	(56.1)	
Canada	213,049	80,318	293,367
(% Total)	(72.6)	(27.4)	

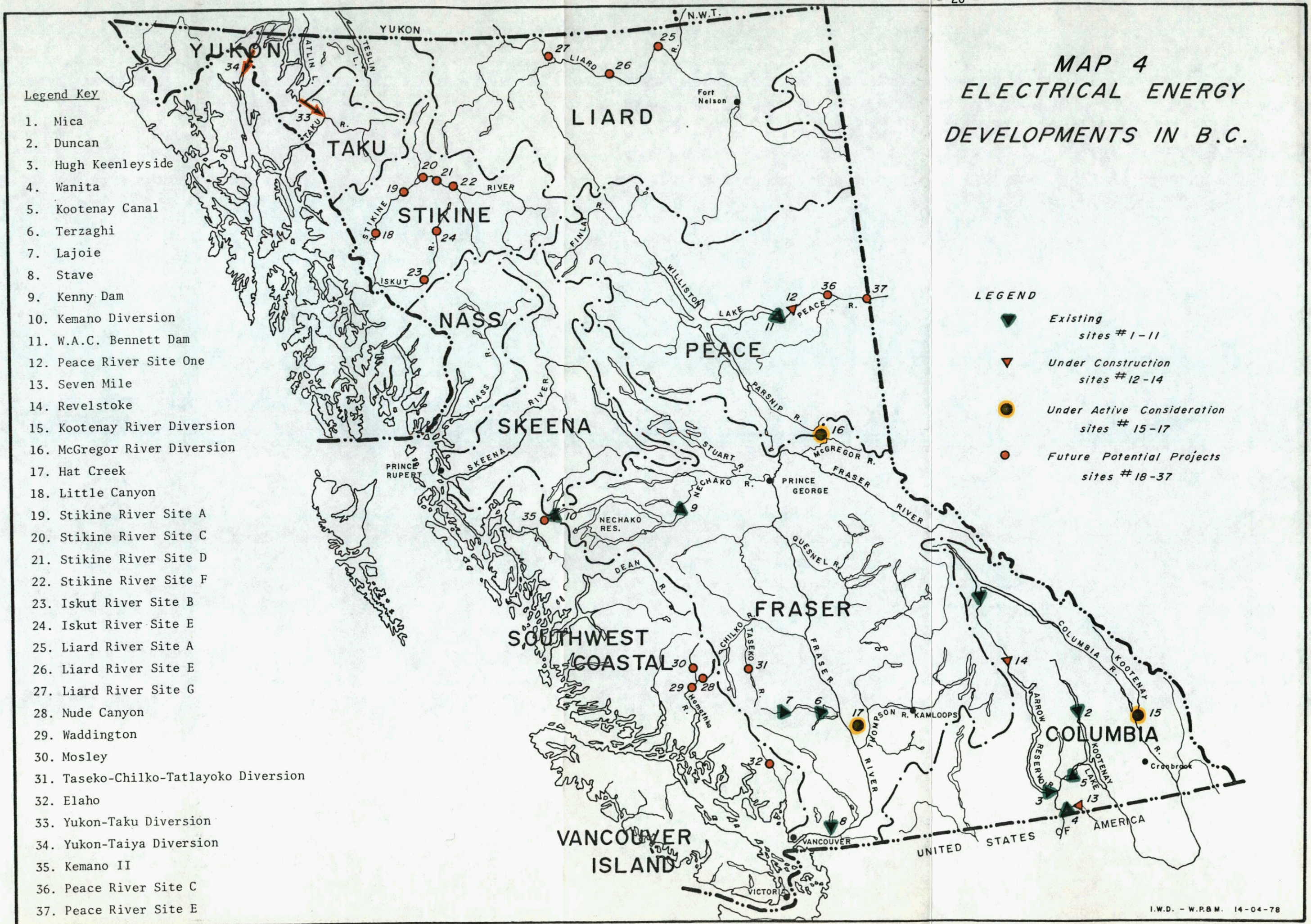
SOURCE: (5)

Although much hydroelectric development has already taken place in British Columbia (Map 4), the balance available is relatively undiminished, and hydropower will likely continue to play an important part in the future economic growth of the Province. According to a 1975 inventory of principal undeveloped hydropower sites, British Columbia has an estimated potential generating capacity of 20,960 MW of firm power. This estimate of gross available power may be revised upward as increasing

MAP 4
ELECTRICAL ENERGY DEVELOPMENTS IN B.C.

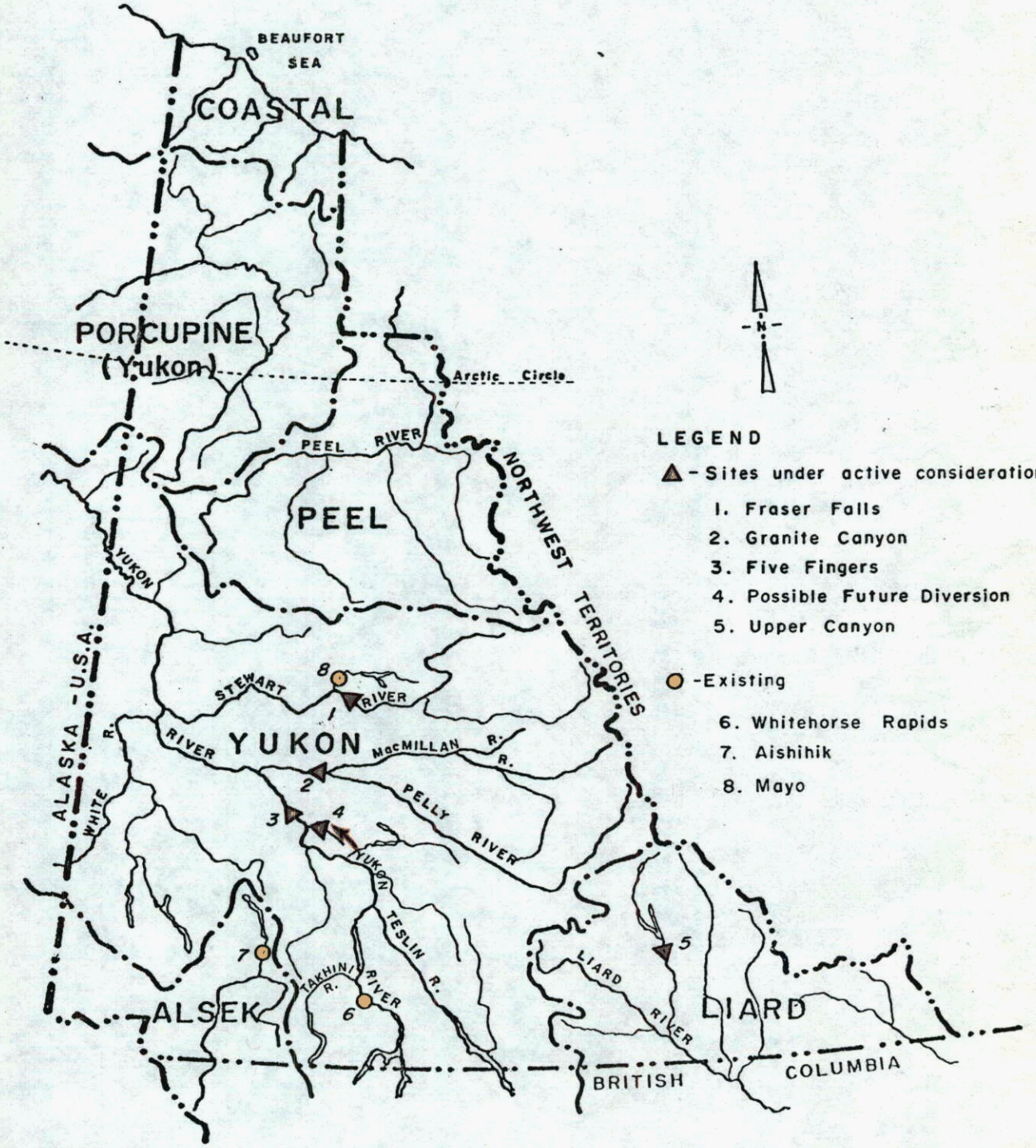
Legend Key

1. Mica
2. Duncan
3. Hugh Keenleyside
4. Wanita
5. Kootenay Canal
6. Terzaghi
7. Lajoie
8. Stave
9. Kenny Dam
10. Kemano Diversion
11. W.A.C. Bennett Dam
12. Peace River Site One
13. Seven Mile
14. Revelstoke
15. Kootenay River Diversion
16. McGregor River Diversion
17. Hat Creek
18. Little Canyon
19. Stikine River Site A
20. Stikine River Site C
21. Stikine River Site D
22. Stikine River Site F
23. Iskut River Site B
24. Iskut River Site E
25. Liard River Site A
26. Liard River Site E
27. Liard River Site G
28. Nude Canyon
29. Waddington
30. Mosley
31. Taseko-Chilko-Tatlayoko Diversion
32. Elaho
33. Yukon-Taku Diversion
34. Yukon-Taiya Diversion
35. Kemano II
36. Peace River Site C
37. Peace River Site E



I.W.D. - W.P.B.M. 14-04-78

MAP 5
ELECTRICAL ENERGY DEVELOPMENT IN THE YUKON TERRITORY



I.W.D., W.P.&M. 19-04-78

fossil fuel prices make development of smaller-scale hydroelectric plants economically attractive. However, not all of the potential sites are expected to be developed. Some of the technically promising sites are in regions with difficult access, while others could create serious environmental problems (4).

In British Columbia the electrical system now has about 9200 MW of installed capacity, about 7300 MW of which are at hydroelectric plants and the remainder in thermal plants. This corresponds to about 5000 MW of firm energy (or currently about 44000 GWh per year). Electrical load growth is estimated at about seven percent per year which means that the capability of the system must double in the next nine to 12 years by adding another 9000 MW.[1/] Plants currently under construction at Site One on the Peace River, Seven-Mile on the Pend-d'Oreille River and Revelstoke on the Columbia River will add some 2100 MW by 1983. Other sources must be chosen in the near future from available hydroelectric sites, thermal power developments or nuclear plants in order to meet this demand by the economy.

The major rivers comprising the Yukon Basin possess an enormous potential for hydroelectric power development. Map 5 shows a few potential development sites which have been selected for further study. The mining industry currently uses over half of the hydroelectric power produced in the Basin. With increasing population and resource development, residential and commercial power demand is rising. Any new major industrial development in the Basin (e.g. smelter, pulpmill, gas pipelines) will probably require a new major power installation.

Fish and Wildlife

Fish and wildlife are dependent on a high quality inland water resource. Fish and wildlife not only are sources of food and employment but also are the basis of a wide variety of recreational activities.

1/ Based on analysis by the Water Planning and Management Branch, 1978.

One of the most important functions of many British Columbia rivers, lakes, and estuaries, from a fisheries standpoint, is as a spawning and rearing site for Pacific salmon. High quality freshwater is essential for their life cycle. The salmon fishery provides substantial commercial and recreational value to the residents of British Columbia.

British Columbia inland fisheries are commercially less valuable than the salmon fishery, but they have considerable social and economic value from a sports fishery point of view. Total recreational activity (resident and non-resident) supported directly by British Columbia fish and wildlife resources was estimated at over 8-million days of recreation for 1976-77. Ninety-four percent of this represents activity by residents, over half of which represents time fishing (2). The total estimated spending by all types of recreationists is summarized in Table 10, and direct benefits to British Columbia from various uses of fish and wildlife are presented in Table 11.

Subsistence fishing is carried out on British Columbia inland waters mainly by native people. Estimated value of the subsistence harvest is $2-million (Table 11).

Yukon inland fisheries are important from a commercial, sports and sustenance standpoint. Sports fishery based employment and income is significant, particularly on the Yukon River. The commercial fishery employs part-time fishermen; Native people primarily benefit from the sustenance fishery.

Wetlands associated with inland waters are prime breeding grounds for many birds and animals, and so are of interest to hunters and photographers. The Creston Valley Wildlife Management Area, Alaksen National Wildlife Area and Marshall-Stevenson Wildlife Area are prime examples of controlled water use for wildlife in British Columbia.

TABLE 10

SUMMARY OF SPENDING BY RECREATIONISTS, 1976-77

	B.C. Resident	Non-Resident	Total
Fishermen	$103,000,000	$20,050,000	$123,050,000
Hunters	66,900,000	5,430,000	72,330,000
Non-Consumptive Recreation	17,500,000	n.a.	17,500.000
	$184,400,000	$25,480,000	$212,880,000

SOURCE: (2)

TABLE 11

SUMMARY OF DIRECT BRITISH COLUMBIA BENEFITS FROM USES OF THE FISH AND WILDLIFE RESOURCE, 1976-77

Use / Measure of Value	Provincial Direct Benefits		
	Residents	Non-Residents	Total
Sport Fishing			
Licences	$ 1,336,000	$ 710,000	$ 2,046,000
Other Expenditures	--	2,808,000	2,808,000
Value of Recreation	47,000,000	--	47,000,000
Subsistence Fishing 1/			
Value of Harvest	$ 2,000,000	--	$ 2,000,000
Sport Hunting			
Licences	$ 2,068,000	$1,103,000	$ 3,171,000
Other Expenditures	--	1,420,000	1,420,000
Value of Recreation	32,500,000	--	32,500,000
Subsistence Hunting			
Value of Harvest	$ 1,000,000	--	$ 1,000,000
Trapping			
Net Value of Furs	$ 840,000	--	$ 840,000
Non-Consumptive Recreation			
Value of Recreation	$ 18,000,000	--	$ 18,000,000
Total all activities	$104,744,000	$6,041,000	$110,785,000

1/ Mainly important to Native people.

SOURCE: (2)

Recreational Water Use

Water and related lands provide numerous recreational opportunities in British Columbia and the Yukon. Participation in outdoor recreation is growing much faster than population, primarily because of larger incomes and increased leisure time. This, coupled with the fact that 75 percent of outdoor recreation is water oriented, has brought new pressures to bear on water-based recreation areas, especially in the heavily populated southern portions of British Columbia (7).

The importance of water to outdoor recreation is demonstrated by various statistical indicators. For example, in 1973 British Columbia had 118 provincial parks, with a total area of 8,572 square miles, which had water-based or water-enhanced activities or facilities (7). It was estimated that 36 percent of the population of Canada participated in angling in 1972 (6). A 1970 analysis of vacation trips in Canada indicates that about 55 percent of these trips are oriented to water-based activities (6).

Water Transport

Historically natural waterways opened up British Columbia and the Yukon to settlement and economic development. Water transport was essential to the fur trade and early mineral exploration. Large scale development of the forest industry was dependent on floating logs downstream to centrally located mills.

With the development of railways and other modes of transport, the relative importance of inland waterways for transportation declined. Rivers and lakes, however, still provide an important means of transporting bulky raw materials. Inland waters still serve a vital function in British Columbia's forest industry for the purpose of transporting logs and wood chips for processing.

Considerable international and coastal cargo is loaded and unloaded along the Lower Fraser River. New Westminster is a major Canadian port; about 2.3 million metric tons of cargo are loaded and unloaded annually. Sand and gravel, logs, pulpwood and lumber are the principal commodities (10).

V. CURRENT WATER MANAGEMENT ISSUES

The preceding section highlighted the importance of water resources in the social and economic fabric of British Columbia and the Yukon. In this section water management issues will be discussed with emphasis on potential water use conflicts for British Columbia and the Yukon.

Floods

For the reasons noted above, many communities in British Columbia and the Yukon are located along river banks, on fertile deltas, or on coastal plains. Often a high cost must be paid, in the form of flood control works, flood damage reduction programs, or in flood damages, for locating on floodplains.

River levels in the central and southern Cordillera rise slowly as spring temperatures gradually melt the mountain snowpack. Sudden warming trends or heavy rainfalls, however, can cause damaging floods. Table 12 denotes urban centres in British Columbia with potential flood problems.

Over the past 100 years the Fraser River has risen to damaging heights more than 25 times. Serious flooding occurred in the Fraser Valley in 1894 and 1948 when high temperatures caused rapid melting of mountain snowpacks. In the 1948 flood, total damage exceeded $25-million (1948 dollars) and in excess of 16,000 people had to be evacuated from various areas of the Fraser Valley. If the present dyke capacity of Lower Fraser flood control works were exceeded, potential damages could exceed $500-million (1972 dollars). Heavy damages have also been experienced in other river valleys of British Columbia such as the Thompson, Kootenay, and Columbia River Valleys.

TABLE 12

CENTRES WITH POTENTIAL FLOOD PROBLEMS

Centre	River	Population-1976
British Columbia		
Alberni	Kitsucksus Creek	19,585
Campbell River	Campbell	12,072
Castlegar	Columbia	6,255
Chilliwack	Fraser	8,634
Courtenay	Tsolum	7,733
Duncan	Cowichan	4,106
Golden	Kicking Horse	3,282
Hope	Fraser	2,963
Kamloops	South Thompson and Thompson	58,311
Kent	Fraser	2,924
Lake Cowichan	Cowichan Lake	2,369
Matsqui	Fraser	31,178
Merritt	Nicola and Coldwater	5,680
Mission City	Fraser	14,997
Osoyoos	Similkameen and Okanagan	2,100
Penticton	Okanagan	21,344
Pitt Meadows	Fraser	4,689
Prince George	Fraser and Nechako	59,929
Quesnel	Fraser and Quesnel	7,637
Terrace	Skeena and tributaries	10,251
Trail	Columbia	9,976
Vancouver (Greater)	Fraser, Coquitlam, Nicomekl and Serpentine	1,085,242

SOURCE: (6)

Floods in northern British Columbia and the Yukon are frequently attributable to ice-jams. These occur when a sudden spring thaw causes river discharge to increase rapidly. As a consequence ice is broken into large sheets which may be blocked by gravel bars or other river obstructions. The resulting ice-jam may extend several kilometres upstream. Heavy flooding may occur as a result of the build up of water behind the ice-jam or by the flood wave which may surge downstream when the jam breaks up.

Use or potential use of floodplains for urban activities creates a need for management decisions. Dams, dykes and river channel improvements have all been used in British Columbia to reduce social and economic costs associated with flooding. Non-structural flood damage reduction measures (including land use zoning, subdivision regulations and building codes) can be used to discourage high intensity land use such as residential and industrial development, and alternatively encourage low intensity use such as agricultural and recreational activities on floodplains. It is essential, therefore, to determine the social and economic consequences of floodplain use before management decisions are made.

Dams and Diversions

As noted above, British Columbia is a fast growing area and power demand is expected to double over the next nine to 12 years. In recent years large dams have been constructed on the Columbia and Peace Rivers to keep pace with power needs. These rivers, however, will soon be fully developed. Since it takes six to 10 years to bring a power project on line, decisions to develop new projects to meet the high demand of the 1980's and 1990's will have to be made soon. Some options include:

1. Development of the existing hydro potential of the province. With the exception of the Liard and very few projects in northern British Columbia, however, most of the hydro projects are not acceptable from a fisheries point of view.

2. Coal fired thermal plants. Thermo and air pollution problems are associated with this option.

3. Nuclear power and perhaps some of the more exotic forms of power generation such as solar, tidal and geothermo power.

4. A mix of the above mentioned forms of power generation.

Since any form of power generation will affect the environment in one way or another, an important task will be to determine what type of power generation will best satisfy social, economic, and environmental objectives.

The hydroelectric power development alternative is very important judging from the many potential dam sites under investigation (Map 4). Many sites would require large dams which could have significant social and environmental impacts. Large dams often produce extensive storage reservoirs and alter the natural flow regime of rivers. As a consequence the power, flood control and other benefits of large dams must be weighed against environmental costs. Four important environmental issues associated with large dams include:

1. In the mountainous regions of British Columbia and the Yukon Territory, river valley bottoms generally are the only suitable places for permanent human settlement and agriculture. Large storage reservoirs flood valley bottoms at the expense of these alternative land uses.

2. Most of the large rivers flowing towards the Pacific Ocean and Bering Sea have valuable salmon runs (e.g. Fraser, Skeena, Yukon) which could be diminished by the construction of large dams.

3. Large dams destroy the cultural and recreational value of rivers in their natural state.

4. Problems at certain reservoir sites may result from inadequate land clearing; remaining trees may cause water quality problems or be hazardous to recreational boaters.

Diversion projects are under active consideration for the Kootenay and McGregor Rivers. The Kootenay River Diversion at Canal Flats could be carried out under the terms of the Columbia Treaty. The McGregor River Diversion could significantly increase Peace River power generation and at the same time provide flood control for Prince George and the Lower Fraser Valley. The environmental consequences of this diversion, however, may be significant as parasites found in the Fraser River drainage might affect fish in the Peace River basin.

Water Quality

The population and economic trends outlined above have significant implications for water quality. Although water quality problems are not widespread in British Columbia and the Yukon, certain areas have experienced significant deterioration of the water resource.

The net amount of municipal waste discharges depends on population size and the level of municipal treatment. A 1972 survey indicated that 63 percent of the British Columbia urban population had some form of treatment (32 percent by primary treatment systems, 30 percent by secondary systems, and one percent by tertiary systems). These percentages are significantly lower than those for Ontario and the prairies (6).

Industrial wastes generally have a more serious impact on water resources than municipal wastes. Uncontrolled discharge of industrial wastes is one of Canada's most serious water pollution problems. In

contrast to the three major municipal domestic wastes (biochemical oxygen demand, suspended solids, and phosphates), there are 65 different types of industrial wastes, some of which are exceedingly difficult to treat. Thousands of manufactured products, which use a variety of production techniques, generate this diversity of waterborne wastes.

Few data are available on daily waste loadings discharged by industry. However, British Columbia and the Yukon have major pulp and paper, mining, and other industries which are acknowledged to be serious polluters. Pulp and paper, for example, is estimated by some to be the most serious polluter in Canada (6). Other forest industry operations also cause serious water quality problems. For example, certain logging practices and methods of transporting logs can have deleterious effects on water. Mining is another major industry which may cause serious water quality problems.

The effect of increasing water pollution levels is diverse. Each type of pollutant has its own particular set of effects, ranging from diminishing the oxygen content of a water body to the build up of toxic and poisonous substances. These effects may result in damage to commercial and sport fisheries; the closure of recreational beaches because of public health hazards; damage to wildlife habitats; and a general decline in aesthetic quality of the aquatic environment. A widespread problem is bacterial contamination from untreated or partially treated domestic sewage discharged into rivers and lakes. Organic waste consumes oxygen available for freshwater life.

Dissolved oxygen levels are high in most British Columbia and Yukon rivers, except where wastes are released in heavy concentrations into constricted channels and stagnant backwaters. Toxic materials from acid mine wastes, industrial discharge and pesticide residues are found in many rivers. Heavy metals such as copper, manganese, and lead

accumulate in the animals of the river-based food chain, but it is not clear whether the amounts are large enough to have a serious long-term effect on aquatic life or even on the health of people who eat fish.

A possible water quality problem with international ramifications could arise if the Sage Creek coal development is carried out. The proposed strip mine near a tributary of the Flathead River, which flows into Montana, could adversely affect water quality. Pollutants might be carried into the American section of the river, which has been declared a "Wild and Scenic River" under United States legislation.

In British Columbia and the Yukon, groundwater is generally of higher quality than surface water. The soils and rocks through which it percolates screen out many of the harmful bacteria. However, septic tank contamination, industrial pollution, and the accumulation of nitrates from agricultural fertilizers will become serious problems if intensive development continues without sufficient controls over waste discharges. The trend towards increased use of agricultural chemicals and high density confinement of livestock could pose serious water quality problems in such areas as the Okanagan and Lower Fraser Valley.

Another type of water quality problem occurs when man's activities act to speed up natural aging processes in lakes. For example, the Okanagan Lake system is faced with an ever increasing quantity of sewage and industrial water discharges. Large quantities of nutrients from these sources, combined with soluble phosphates and nitrates from agricultural fertilizers which are carried by runoff or groundwater to the lakes, cause algae blooms. In the summer months, when flows are low, the Okanagan River and its tributaries are unable to flush the materials discharged into the lake system and nutrients accumulate rapidly. Dense mats of algae floating on the lake surfaces are unsightly and interfere with recreational activities such as swimming and boating. Similar problems, which are under investigation, have occurred at Kootenay and Koocanusa Lakes.

Estuaries

The Fraser River estuary is the largest and most important of the many estuaries on the British Columbia coast. Problems in this area are typical of those presently experienced or those which may be anticipated in other estuaries. Major issues in the Fraser estuary are related to the conflicting demands on the area. Port development and related works to accommodate shipping and transportation industries may require extensive land areas and channel modifications. Fish, wildlife, and recreation requirements suggest that this estuary be preserved in an essentially natural state. Continued urban growth on adjacent lands and associated waste discharge may adversely affect the quality of Fraser estuarine waters. In view of these issues, a federal-provincial study has been initiated to develop a management plan which recognizes the complex demands on the Fraser estuary.

Water Quantity

Although British Columbia and the Yukon have vast inland water resources, there are great regional variations in supply. The southern interior valleys are the major areas where water scarcity could become a problem. These valleys support intensive agriculture and significant urban populations but receive limited precipitation. The major concern is for a sufficient water supply to meet heavy irrigation demands. The amount of low cost water which is available for irrigation is limited. Little use has been made of many major rivers because they flow in deep valleys and because potential irrigated land areas are too high and too dispersed. It has been estimated that over 50 percent of British Columbia's water supply, which is located in the coastal islands and Coast Mountains, cannot play an important role in water supply development because of geographical and topographical factors (15).

Present irrigation development in the Province is largely based on diversions from small streams near land to be irrigated. Water is transferred by gravity systems or by pumping where the lift does not exceed 200 feet (14). Many streams have been regulated for irrigation by construction of upstream storage reservoirs to retain a portion of the freshet. During the summer months, stored water is used for irrigation and there is little or no streamflow below the dam.

The Okanagan Basin is one area where water supply is a major concern. Fear that rapid population and economic growth would outstrip water supplies led to proposals for large scale water importation in the late 1960's. A major finding of the Okanagan Basin Study, however, is that with good management enough water is available in the basin to supply all projected withdrawals and meet proposed fishery and recreation requirements.

VI. FEDERAL INVOLVEMENT IN WATER MANAGEMENT

The constitutional division of powers between the federal and provincial governments is the setting in which water management in British Columbia and the Yukon is carried out. This division is defined in the British North American Act. Under this Act, water resources belong to the provinces, but the federal government has certain specified controls. British Columbia can legislate in such matters as domestic and industrial water supply, pollution abatement, power, irrigation and reclamation, and water related recreation. Canada has legislative jurisdiction over navigation and fisheries, shares jurisdiction with British Columbia over agricultural water uses, and has certain responsibilities for interprovincial waters. The federal government has jurisdiction over water in national parks and in the Yukon and Northwest Territories, and over international waters (12). The federal government also has general power to legislate with regard to peace, order and good government, and with regard to numerous other matters which can influence water resources development both directly and indirectly.

Within this constitutional framework, articulation of water management policies is not the sole responsibility of any one level of government. As a consequence, water resource planning and development is undertaken by federal and provincial agencies. Recognizing the need for intergovernmental cooperation, the federal government enacted the Canada Water Act in 1970. This Act recognizes two basic facts: that water ignores political boundaries and that it has a diversity of uses. The Act provides for joint federal-provincial water management in drainage basins where there is a significant national interest.

In view of this administrative framework, the remainder of this section highlights some aspects of the federal role in water management and planning in British Columbia and the Yukon.

Data Gathering (Water Quantity)

Data gathering traditionally has been a major federal role in water management. Although the federal role in the water resources field has expanded over the past two decades, this is still an important function.

Federal involvement in water quantity data gathering dates back to the 1890's, with the growth of hydroelectric generation and irrigation accentuating the need for reliable data on a continuous basis. In addition, the 1909 Boundary Waters Treaty necessitated monitoring of flows at the United States border. There currently are specific data gathering requirements under various federal-provincial and international agreements.

Water quantity data collection is basic to water resource management. For example, such data may be used in the design and operation of dams and other structures. The data may be used to predict flood or drought conditions, and may help determine the impact of withdrawals on natural flows.

River Basin Planning

River basin planning under the Canada Water Act is a cornerstone of federal inland waters management policy. The planning and implementation approach to water management, as set forth in the Act, is based firmly upon the constitutional responsibilities of the federal and provincial governments, with respect to water resources, and the need for cooperative approaches to water resource management and development.

All of the studies under the planning provisions of the Canada Water Act have been jointly funded and carried out by the federal and provincial governments. The studies have resulted in projects and developments for implementation in British Columbia. In the Yukon, where the federal government has the sole responsibility for water related matters, a cooperative inter-agency approach for the regulation (i.e. licensing) of water use is facilitated through the Territorial Water Boards established under the authority of the Northern Inland Waters Act.

The Okanagan Basin Study and subsequent Implementation Agreement are examples of major achievements in British Columbia under the Canada Water Act. The objective of the Study was to produce a comprehensive framework plan for the development and management of Okanagan Basin water resources for the social well-being and economic growth of Okanagan communities, while maintaining or enhancing environmental quality. The study took place between October 1969 and March 1974 and cost a total of $2.0-million (shared equally by Canada and British Columbia). Implementation of the framework plan commenced in February 1976 and will continue to 1981. Total cost of implementation to the federal government will be $2.5-million. In addition, Central Mortgage and Housing Corporation funding of $17-million is provided to upgrade municipal waste treatment facilities in the Okanagan.

Preplanning activities have been initiated for the Yukon River Basin involving the Governments of Canada, British Columbia and the Yukon Territory. These and other concerns in the Shuswap-Thompson Basin could lead to additional cooperative agreements for comprehensive planning under the Canada Water Act.

Flood Control

The Fraser River Flood Control Program is a major area of federal involvement in flood protection in British Columbia. Lower Fraser flood problems were extensively studied by federal-provincial boards established

to consider the multiple uses of the Fraser River, culminating in the Fraser River Board's Final Report in 1963. The recommendations of this 1963 report and a subsequent 1967 report were used as a basis for the federal-provincial agreement on flood control signed in 1968, under which the federal government's share of capital works is currently $60-million. Briefly, this agreement includes the following aspects of flood protection: river dykes, sea dykes, pumping and ditching, and bank protection. The internal drainage component has subsequently been deferred.

In addition to the Fraser agreement, the federal government participates with British Columbia in implementing comprehensive plans which involve flood protection. The Okanagan Basin Implementation Agreement, for example, includes several programs for upgrading the Okanagan flood control system.

Discussions are continuing between federal and provincial officials toward an agreement under the federal Flood Damage Reduction Program. Agreements have been reached with other provinces and flood risk mapping is under way in these areas. Other innovative adjustments to flood problems provided for in the Program include flood forecasting, land use adjustments (zoning), and flood proofing. Flood Damage Reduction Program activities in the Yukon are provided for under a Memorandum of Understanding and subsequent correspondence between the Minister of Fisheries and Environment Canada and the Minister of Indian and Northern Affairs. It is proposed that a committee be established to oversee completion of mapping, and costs will be shared equally by the two departments. A formal agreement is to be developed with the Yukon Territory, similar to those negotiated with the provinces.

International Activities

Numerous rivers cross the boundary between the United States and Canada, including the Columbia, Kootenay, Flathead, Okanagan, Skagit, Stikine and Yukon. The federal government has jurisdiction over water management and development matters pertaining to all international waters. The Inland Waters Directorate is a major component of the federal administrative structure which is responsible for these waters.

The International Joint Commission (IJC) composed of Canadian and United States representatives, investigates matters affecting natural levels and flows and water quality along the international boundary. In British Columbia, the Commission has been involved with matters relating to the Columbia, Kootenay, Pend'd'Oreille, and Skagit Rivers and Osoyoos Lake. Federal agencies provide staff and funding for IJC boards and committees which carry out investigative and regulatory functions.

Administration of the Columbia Treaty is a major federal concern in British Columbia. The Columbia River basin covers almost all of the southern boundary of British Columbia, and with the Columbia River Treaty as a basis, storages are operated as a unified system for international power and flood control benefit.

Water Quality Management

The federal government is committed to the restoration and protection of water quality and the enhancement of aquatic ecosystems through: the development of water quality objectives to protect water uses; the application of national effluent regulations and guidelines to control pollution discharges at source; and the control of nutrients and chemical substances which can become dispersed in the environment.

The federal government is also committed to ensuring that water management actions and activities which affect boundary and international waters are consistent with the principles of the Boundary Waters Treaty of 1909. This Treaty guarantees rights of both Canada and the United States and imposes obligations with respect to water use and protection related to transboundary pollution and to the injury of health or property.

Various functions are associated with water quality management, including planning, regulating, financing, monitoring and surveillance, and research and development. Most water resource planning by the federal government is done under the Canada Water Act, which prescribes a comprehensive approach to water management (including water quality) in various river basins of the country. In the federal-provincial Okanagan Basin Implementation Agreement, for example, several measures are included to improve and monitor water quality.

National effluent regulations are being developed on an industry-by-industry basis under the provisions of the Fisheries Act, and in cooperation with the provinces and industries. The federal government has statutory responsibility for the development of these regulations, although, in most cases, administrative and enforcement responsibilities are carried out jointly with the provinces. Water Quality Criteria to protect specific users, applicable to all Canadian waters are being developed. From these, specific Water Quality Objectives related to use, can be assigned on a basin-by-basin basis, jointly with the provinces. Requirements more stringent than the national effluent regulations may be negotiated on a case-by-case basis when needed to meet specific water quality objectives in some basins. The Environmental Contaminants Act permits the federal government in consultation with the provinces to restrict the commercial uses and disposal of chemical

substances which pose dangers to human health and the environment. The nutrient control provisions of the Canada Water Act allow for the development of regulations to limit the phosphorous content of any cleaning agent or water conditioner.

To fulfill its financing function, the federal government has several programs aimed at assisting in meeting the cost of water pollution control equipment in order to achieve early improvements in water quality. These are authorized under various federal Acts, such as the National Housing Act, the Income Tax Act, and the Regional Development Incentives Act.

The federal government is committed to monitoring the quality of international, interprovincial, Indian Reserve, National Parks, and other waters in Canada where there is a significant national interest. Federal monitoring activities are designed to identify pollution problems; to establish baseline information to identify water quality trends on a national and regional scale; to determine whether water quality objectives are being met; to assess the effectiveness of regulatory measures in achieving the desired level of water quality, and to provide a basis for revising effluent control requirements where necessary.

Water Research

The large and hydrologically variable intermontaine lake systems of British Columbia and the Yukon give rise to specific research needs. To respond to these needs, the federal government established a multi-disciplinary, applied research organization to carry out site-specific research of particular problems, to coordinate interservice and external cooperative research, and to develop long-term basin management techniques specific to British Columbia and the Yukon.

Research to date has focused on specific problems in two large lakes - Kamloops and Kootenay. The Federal-Provincial Kamloops Lake study examined pollution effects of Kamloops City wastewater and pulp mill effluent on the lake and the river downstream. A process of "downstream displacement" of pollution effects was identified as the primary cause of nuisance algae blooms in the Thompson River below the lake and a variable wastewater nutrient release scheme was proposed. This option was subsequently adopted by the City of Kamloops in 1977 and has now been implemented at a considerable reduction in treatment costs.

The Kootenay Lake Study will assess limnological effects of flow regulation by Libby Dam and of potential diversion of the Upper Kootenay River on the limnology of the lake. Cause-effect relationships between the altered flow patterns and the physical, chemical, biological and geological dynamics of the lake have been identified. Water management guidelines are being prepared which will permit variations in flow releases for limnological benefit of the lake system.

Future research activities will be broadened to include river and estuarine pollution problems. These include research on the ecological side effects of 2,4-D use for milfoil control, review of the effects of implementing waste treatment programs, consideration of impacts of thermal electric plant discharge on aquatic systems, and analysis of effects of nutrients and toxic substances on river and estuary systems.

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