AN ASSESSMENT OF INFORMATION CONCERNING RECREATIONAL AND RENEWABLE RESOURCE WATER USE IN WESTERN CANADA

BY

JOSEPH LENNON

A practicum submitted to
the University of Manitoba in partial fulfillment of the
requirements of the degree of

MASTER OF NATURAL RESOURCES MANAGEMENT

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ABSTRACT

In 1979 the Canada West Foundation initiated a two year study designed to establish the importance of water resources to western and northern Canada. This practicum, dealing with recreational and renewable resource use (for wildlife (mainly waterfowl), forests, fisheries and all aquatic life) of water, is a part of that study.

The major objective of the practicum was to evaluate existing information concerning recreational and renewable resource use of water resources in the study region. The review was conducted within a framework of water use which included: quantity requirements and effects, quality requirements and effects, future use and constraints on use. Each of the three regional drainage areas -- Hudson Bay, the Arctic Ocean and the Missouri River -- was analyzed; and where possible, or feasible, a river basin approach was used.

Generally it was concluded that a great deal of information does exist on the topic of recreational and renewable resource water use; however, the information is quite scattered. The river basin approach to water resources management with its extensive planning studies has aided in consolidating much of this information in parts of the basin.

The major constraints to water use, for recreation and renewable resources, were found to be:

a) in the prairie region, an unreliable water supply resulting from both inadequate rainfall and from artificial regulation for other water uses;

b) in other regions of the study area, artificial regulation of river flows.

Within each of the drainage areas a number of conclusions were arrived at. In both the agricultural and Canadian Shield regions of Hudson Bay's

drainage, artificial regulation of flow was seen as the major constraint to optimal water use. In the Arctic drainage area, artificial regulation was found to be a constraint to water use in the southern portion; while in the northern region a major concern of water resources managers was found to be the lack of data concerning water use. In the Missouri drainage area there is a considerable need for data pertaining to water quantity and quality before effective allocative measures can be implemented.

The research raises a number of issues concerning recreational and renewable resources water use in western Canada.

A major issue concerning governments in the agricultural areas of western Canada is apportionment agreements: Should water supplies be augumented for recreational or renewable resource purposes? Because many reservoirs serve purposes other than recreation, their value as recreational resources may disappear during periods of low flow. Waterfowl habitats, in the study region are endangered by water levels that are either too low or too high; and by farming practices which seem to encourage the draining of wetlands. Fish spawning areas are also endangered by inadequate flows. A major issue thus arises as to whether governments can define these needed flows, and if so, can they be guaranteed by legislation?

Water of sufficient quality is a necessity for recreational and renewable resource water use. The major water quality concerns with respect to recreational water use are: What level of water quality can we afford; what level should we strive for and what uses are reasonably compatible? The major activities which adversely affect water quality, thus placing constraints on renewable resources activity, appear to be: Clear cutting, which causes heavy sedimentation, chemicals from agricultural run-off and perhaps in the not too distant future--acid rain.

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CHAPTER 1

1.1 INTRODUCTION

With increasing agricultural, industrial and population growth in the prairie provinces a recurrence of the 1976-77 or 1980 droughts could have significant impacts on agriculture, hydro-electric energy production, recreation and renewable resource users of water. In order to implement effective water management schemes, water demand and water supply information must be available. The Canada West Foundation, recognizing the importance of water resources to western Canada's future, initiated a two year study to produce an overview of information concerning water use in western and northern Canada. The primary objective of their report is to facilitate and initiate public debate on water resources in western Canada. Among the sub-objectives of the study is an intention to provide a comprehensive overview of factual information regarding: the supply, quantity, quality and current use of water resources.

This study, at the Natural Resources Institute, will consider the demands placed on the overall water regime, by recreational and renewable resource users. The topic will be dealt with, where possible and feasible, on a river basin basis.

1.2 RECREATIONAL AND RENEWABLE RESOURCE WATER USE

This report concerns recreational and renewable resource use of water resources. This section introduces these two terms, which are the focus of the report. Quantity and quality aspects of water use are also explained, as they form the framework of the analysis.

1.2.1 Recreation

In this study water-based recreation includes those forms of recreation which depend on the use of water. According to the Saskatchewan Nelson Basin Board (SNBB) Study (1972), water oriented outdoor recreation is an all inclusive term which includes water sports, and any other outdoor recreational activity in which water enhances or influences the recreational experience. The SNBB includes power boating, fishing, hunting, water skiing, canoeing and camping as water-based recreational activities.

The SNBB made it clear that the values of recreation in relation to water resources are of two distinct kinds. There is that aspect of recreation which makes use of the water body directly and includes boating, swimming and associated uses. In addition, there is another aspect of recreation that depends only on the quality of personal experience and is associated with aesthetics. Included in this aspect of recreation would be such activities as hiking, picnicing, bird watching, hunting etc.

In this report, recreational water use refers primarily to those human activities that depend on water directly for their enjoyment. Such activities include those referred to in the SNBB definition. Activities which take advantage of aesthetic qualities of water resources will only be included where their use is directly influenced by water quality or quantity. Hunting will be dealt with in the renewable resources aspects of this report.

1.2.2 Renewable Resources

In this report, renewable resources which make use of water are: fish (subsistence and commercial), wildlife (primarily waterfowl), forests, furbearing animals and all related aquatic life.

Renewable resource utilization is a subject of concern to native groups, as in some locations part of their livelihood is derived from traditional practices of fishing, trapping and hunting.

1.2.3 Water Use

Water use consists of withdrawal uses, "in situ" uses, and in-stream, or flow, uses. Withdrawal uses are those which remove water from its sources, distribute it to various water using activities and return all or part of it to the source. Recreational and renewable resources water uses are termed as "in situ" or on site water uses (Environment Canada 1975, p. 10). Other methods of classifying water uses are:

a) according to the purpose of which it is used or;

b) consumptive versus non-consumptive.

This study, considers the two most important characteristics of surface water -- quantity and quality. The quantity and quality aspects of recreational and renewable resource use of water are the limiting factors to such use. Recreation is a prime responsibility of the provinces and thus considerable information related to its use of water resources has come from provincial reports. Of course, the federal government does influence recreational water use through its proprietary rights to national parks. Renewable resources use of water is a joint concern of both the federal government and the provinces. One method that effectively deals with both quantity and quality aspects of water use, at both the provincial and federal levels, has been the comprehensive river basin plans initiated by the Canada Water Act of 1970. The Prairie Provinces Water Board (PPWB) is also concerned with quantity and quality aspects of water use. The Board -- consisting of two representatives for

Canada and one for each of the provinces -- administers the apportionment agreement, which is based on the equitable sharing of water between the three prairie provinces. Environment Canada, at the request of the board, collects water quantity and quality data at interprovincial boundaries. The quantity and quality aspects of both types of water users have also been considered at the provincial level.

The major purpose of this study was to consider quantity and quality aspects of recreational and renewable resources use of water in western Canada. The assessment of information was conducted within a framework of characteristics of water use suggested by the Canada West Foundation. These characteristics include:

- quantity requirements
- quantity effects
- quality requirements
- quality effects
- future requirements) quantity and quality
- future effects) quantity and quality
- constraints (present and foreseeable).

In this report, quantity or quality requirements refer to the requirements of recreational or renewable resource water users. Quantity or quality effects refer to the effects of recreational and renewable resource water users on the water regime. The methods in which such criteria have been applied are discussed, in greater detail, in section 1.8.1.

1.3 DESCRIPTION OF STUDY AREA

The area of study for this report is western Canada, east of the Great Divide. The report addresses all waters draining to the Arctic Ocean, to Hudson Bay, and to the Missouri River system. A number of large rivers originate within the three drainage areas, the Churchill, the Mackenzie and the Saskatchewan being three examples.

The major drainage systems of western Canada are summarized in Table 1.1; Figure 1.1 indicates the locations of the major drainage systems. According to the National Atlas of Canada (1973): "A drainage area is a surface area that is occupied by a drainage system or contributes surface water to that system".

Thus, in Figure 1.1, basins are outlined by identifying divides between streams on maps of various scales. The map also indicates the area occupied by each drainage system in Canada and the United States. Because of the immensity of the study area, a more detailed description will be confined to background information given in the chapters (or parts of chapters) dealing with individual drainage areas. Any conclusions in the report will also be limited to each of the drainage areas since water resource issues cannot be generalized over the entire study region. For instance, recreational water use, and water demands, are of a vastly different nature in southern Alberta from those in the Churchill River Basin.

1.4 RIVER BASIN PLANNING

It has been recognized, by water resource managers and planners, that the river basin, rather than political jurisdictions, is the natural unit to use when water allocation concerns are to be identified. River basin plans provide the framework for this report on water use in western Canada.

In Canada's history, as in most parts of the world, the creeks, rivers, lakes and oceans have provided the natural paths and locations for settlement. When water was needed for any purpose, be it domestic, agricultural or industrial, the source was simply tapped and water was withdrawn as needed. Water was seen as a free good (i.e. its economic

TABLE 1.1

DRAINAGE SYSTEMS OF WESTERN AND NORTHERN CANADA

	Drainage km^2	Area mi^2	Mean m^3/sec	Discharge cfs
ARCTIC OCEAN[a]				
Mackenzie	1,787,000	690,000	9,910	350,000
Back	107,000	41,400	612	21,600
Other Rivers	1,663,000	642,000	5,890	208,000
HUDSON BAY[b]				
Thelon	142,000	55,000	804	28,400
Kazan	71,500	27,600	566	20,000
Churchill	298,000	115,000	1,270	44,800
Nelson	1,132,000	437,000[d]	2,830	100,000
Hayes	108,000	41,700	694	24,500
GULF OF MEXICO[c]				
Milk River	61,227	23,640[e]		
Other Basins	5,076	1,960		

a and b: Environment Canada. 1979. Hydrological Atlas of Canada. Ottawa: Ministry of Supply and Services.

c : Canada Department of Energy, Mines and Resources, 1974. National Atlas, Ottawa: Ministry of Supply and Services.

d : includes 57,000 mi^2 in the U.S.A.

e : includes 15,300 mi^2 in the U.S.A.

Figure 1.1 Canada West Foundation Study Area

value was zero) as opposed to an economic good, which is priced because of its scarcity. In the early decades of western Canadian settlement, water supply was seen as a local problem. When the western provinces were given ownership rights to "All Lands, Mines and Minerals" within their borders, via the Natural Resources Transfer Agreement of 1930, no thought was given to the fact that conflicts would arise in the use of interregional rivers and streams and thus no attempt was made to create the machinery necessary to resolve such conflicts (Schramm, 1970, p. 3).

Within Canada, water appears to be quite abundant. However, with the increase in demand, people have begun to realize that our supplies are not inexhaustible. The supply of water was, in the past, seen to be fixed. On the prairie provinces, the major river system -- the Saskatchewan -- flows west to east across the three provinces. In some areas, rivers flow across international boundaries.

Through river basin planning, all users of the basin can be given equal consideration in the planning process. Water's major purposes must be reviewed before the development of a plan occurs. The Ontario Conservation Authorities and Alberta Environment, Planning Branch, are two examples in Canada, of agencies which utilize multi-purpose planning on a basin-wide perspective. Within southern Ontario the river basin is very effective as a planning unit for basin development plans. The Conservation Authorities are effective units for planning management strategies, as not only do they incorporate direct water uses into the planning process, but related resource activities (forestry, land use, wildlife and recreation) are under their scrutiny.

Within Alberta it is up to one department -- Alberta Environment -- to balance the demands on water supply. "The philosophy of water management is based on better use of available water supplies, where necessary,

[and] reduction of consumption" (Alberta Environment, 1980, Communications Branch). In order to achieve such objectives it is government policy to manage water resources on a river basin basis rather than stream by stream. In all planning and development, multi-purpose use is to be emphasized as is stated in Alberta Environment policy: the water resources of Alberta "are to be managed in support of the overall economic objectives of the province." River basin planning is one of the responsibilities of the Planning Division of Environmental Support Services (which is an arm of the Department of the Environment).

River basin planning has also been adopted to water management in Saskatchewan and Manitoba. Because of the vastness of northern Canada and the difficulties involved in compiling inventories, it is only now being used extensively in the Northwest Territories (mostly in the Mackenzie basin).

Any water use within a river basin also affects other water users. "Regulating reservoir levels and diversion upstream can affect levels and flows downstream. All these may limit [, or enhance,] the degree of opportunities for downstream users of the basin's water resources" (Fisheries and Environment Canada, 1976, p. 5). Because of the inter-dependencies of water users, the river basin is a much more effective unit than are political or economic boundaries, in dealing with water management issues.

The Canada Water Act of 1970 encourages the basin planning approach to water resources management. "It recognizes that every lake and every river in the populated areas of Canada is used for several purposes which can be reconciled only by an overall, superior authority"..."and that our lake and river systems respect no provincial boundaries" (Cram, 1971, p. 175). Under the Canada Water Act, the federal government can establish joint federal-provincial committees in order to evaluate projects that are of significant national interest.

The Canada Water Act also authorizes the federal government to enter into agreements with one or more provinces to set up committees dealing with the control of water quality. In the prairie provinces the Canada Water Act is very significant as most major rivers flow from west to east across one or more provinces and thus planning would best be carried out from a river basin perspective. The PPWB appears to have more impact than the Canada Water Act, as it has already established water quantity, and quality, stations at interprovincial boundaries.

1.5 STUDY NEED

Although it is generally thought that Canada has an abundant supply of fresh water it is not always present where and when it is needed. Western Canada -- particularly the western region -- has become more reliant upon dependable water supplies than was ever the case in the 1930's. During the 1976-1977 drought streamflows were significantly low(Figures 1.2 and 1.3). The impacts of this drought were widespread. Northwestern Ontario and Manitoba suffered severe cutbacks in hydroelectric generation during the winter of 1976-77 and the spring and summer of 1977; and Saskatchewan's hydroelectric generation was reduced due to the low storage level in Lake Diefenbaker. With heavy spring rains, northwestern Ontario retained its reservoir levels. It was also suggested that a second winter of below normal precipitation would curtail hydroelectric generation in Alberta and Saskatchewan. It was even suggested that with average precipitation and run-off over the winter of 1977-78, upstream demands for water in the Saskatchewan-Nelson system would limit Manitoba Hydro's ability to restore full hydroelectric potential during 1978 (Fisheries and Environment

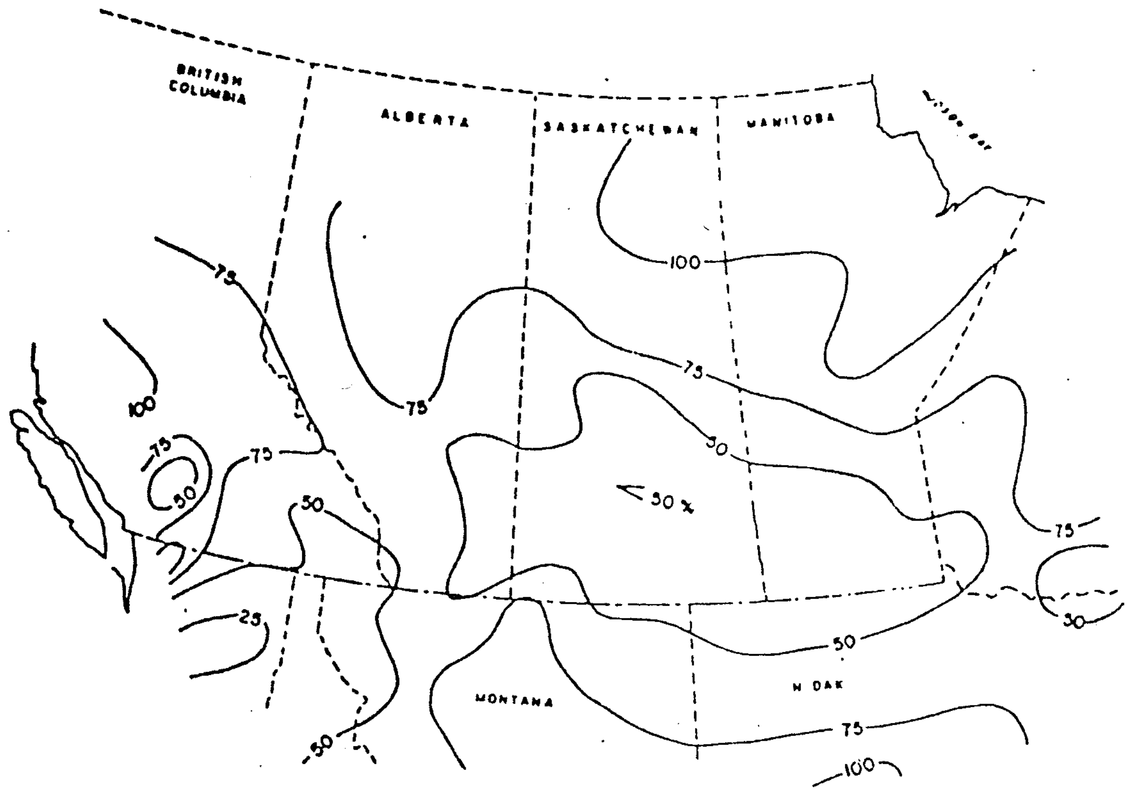

FIGURE 1.2 PRECIPITATION AS A PERCENTAGE OF NORMAL - WESTERN INTERIOR - SEPTEMBER 1, 1976 TO MARCH 31, 1977

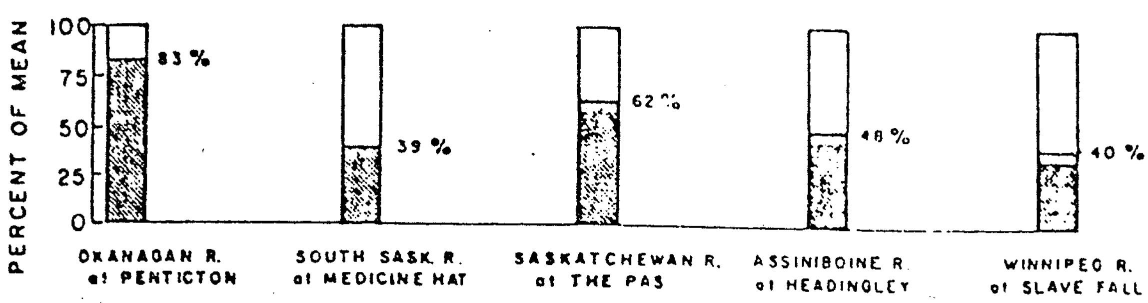

FIGURE 1.3 STREAMFLOW AS A PERCENTAGE OF MEAN AT SELECTED STATIONS WESTERN INTERIOR - SEPTEMBER 1, 1976 to SEPTEMBER 1, 1977

Source : Fisheries and Environment Canada (1977)

Canada, 1977, pg. iv).

With increasing economic activity in the southern region of the prairie provinces a recurrence of the 1976 drought could have significant impacts on agriculture, energy production, recreation and other renewable resource users of water. The 1976-77, as well as the 1980 droughts, have illustrated the importance of dependable water supplies. The federal government has suggested various short-term and long-term initiatives to deal with the problems of balancing water supply and demand. However, in order to undertake any such initiatives both water demand and supply information must be available. There is some information available on consumptive and withdrawal use of water in the study region (see table 1.2). In this table withdrawal uses represent the amount of water used; and consumption, the amount which is lost from further use. Water consumption, however, tends to be heaviest in the summer months when supplies may be low, thereby having an effect somewhat greater than suggested by table 1.2. Consumptive use is also understated as the table fails to allow for minimum flows required for pollution abatement and navigation. There does exist information on a local basis, of the water needs of recreation and renewable resources but extensive basin-wide data do not exist.

Because of federal and provincial concern for measuring water supply and demand; and because of the lack of water demand information, of a basin-wide nature, there is a need to identify issues and sources of information before meaningful water management practices can be carried out in Western Canada. This area of concern has been addressed by the Canada West Foundation in its two year study. The primary objective of the Foundation's study is to initiate knowledgeable public debate on water resources in western Canada.

TABLE 1.2[a]

SUPPLY AND TOTAL USE OF WATER, BY DRAINAGE BASIN, IN WESTERN AND NORTHERN CANADA
(millions of litres per day)

Basin	Supply	(Reliable Flow)	Total Daily Withdrawal			Total Daily Consumption		
	Annual	Monthly	1980	1985	2000	1980	1985	2000
Mackenzie	468,238.00	56,261.00	81.83	95.47	163.65	31.83	35.37	63.65
Peace-Athabasca	218,208.00	57,975.14	1,536.55	1,863.86	3,309.48	784.36	948.64	1,674.31
Arctic Coastal	171,838.80	61,889.24						
Milk	381.86	0.00	731.90	881.92	1,582.01	104.00	114.08	159.67
Churchill	88,192.40	73,631.56	172.75	195.48	318.21	22.73	27.28	36.37
Nelson	39,413.82	18,834.08	836.47	981.93	1,600.19	104.57	122.74	181.84
North Saskatchewan	15,092.72	1,809.31	10,578.53	13,060.66	24,721.15	850.42	944.56	1,729.04
South Saskatchewan	12,501.50	2,982.18	7,119.04	8,028.24	11,660.48	3,287.18	3,674.84	5,280.80
Red-Assini-boine	2,863.98	340.95	3,868.66	4,686.21	8,469.21	343.77	389.87	568.92
Winnipeg	41,732.28	34,981.47	677.36	809.19	1,377.44	37.12	41.84	69.96

Source: Environment Canada, 1980b Water and the Canadian Economy (Draft Paper), Inland Waters Directorate, Ottawa.

a: All flow data (reliable supplies) reflects the effects of natural and artificial storage, which have a greater influence on monthly supplies than annual supplies. Reliable flow data is that flow which would be available 90% of the time, or 9 out of 10 years. Reliable monthly flow is the lowest monthly flow experienced in 10 years.

1.6 OBJECTIVES

Many studies have been conducted in western and northern Canada dealing with recreational and renewable resource uses of water, but few have been comprehensive. It is the intent of this study to identify such water uses, on a basin by basin basis, and arrive at general conclusions concerning water demand and/or requirements for further research. Recreational and renewable resources uses of water, in western Canada, were analyzed with the aid of the results of major river basin studies, localized studies, prairie-wide and Canada-wide studies. The following objectives were selected:

1. To evaluate existing information concerning recreational and renewable resource utilization of water resources in western and northern Canada.
2. To synthesize such information in order to arrive at basin-wide perspectives of water resource needs.
3. To consider quantity and quality aspects of recreational and renewable resources uses in the synthesis.
4. To identify common, and major, problems in achieving optimal use of water for recreation and renewable resources.

1.7 LIMITATIONS

This report is limited to the water quantity and quality requirements, and effects, of recreation and renewable resources, on the water regime. It is concerned with Arctic drainage, Missouri drainage and Hudson Bay drainage. Pacific drainage may be considered, by the Canada West Foundation, in a subsequent report.

It was not the intent of this study to predict water demand, yet it does summarize literature which is concerned with making predictions. The purpose of the report was: to analyze the existing information and arrive at conclusions concerning common issues gleaned from the information.

Renewable resources, which are considered to be dependent on water resources of adequate quantity and quality are: wildlife (mainly waterfowl), fisheries (commercial and subsistence), forests and all other aquatic life. Sports fishing will be treated as a recreational water user. Only primary aspects (cutting, planting and growing) of forestry will be considered in this report.

The amount of material pertaining to each basin, or drainage area, does not necessarily reflect the importance of that basin or drainage area. The length of each section is often a reflection of previous research conducted, or information available.

1.8 ASPECTS OF WATER USE

1.8.1 Quantity and Quality Considerations

The following characteristics of water use are those upon which the analysis, contained in the remainder of the report, is based.

a) Quantity Requirements: A sufficient level of water must be retained in a system for given activities. For instance, enough water must be present in a stream in order to protect fish habitat and to provide waterfowl habitat on shorelines. Quantity, in terms of water flow, should provide proper dissolved oxygen levels in streams.

b) Quantity Effects: This refers to the impacts of using a water course expressly for recreation or renewable resources. If an impoundment is created in order to increase fish yield, the effect of such an undertaking on other water users must be determined.

c) Quality Requirements: This refers to a level of water quality that is required in order to protect water users. This may involve the identification of users in a river basin and it may involve the selection of minimum flows that are required in order to preserve or provide a given level of quality.

d) Quality Effects: This refers to that effects that a recreational or renewable resource use may have on the water system. For example, the use of a water body by cottagers may add to the nutrient load on a water system, thereby leading to eutrophic (highly productive in terms of organic matter but low in oxygen) conditions.

e) Future Requirements: This characteristic refers to the future quantity and quality requirements of the two water users being considered. Thus any reports that have predicted, or speculated on such requirements, will be incorporated into the report.

f) Future Effects: These refer to the quantity and quality effects that future changes in the use of water, by recreation or renewable resources, may have on the overall water regime.

g) Constraints: This refers to, present or foreseeable (quantity or quality), constraints that prevent optimal use of water systems by recreational or renewable resource users.

1.8.2 Overview of Water Requirements[a]

Before beginning an extensive study of the river basins of western Canada it is necessary that general water quantity and quality requirements for recreational and renewable resources practices be outlined.

a) Recreational Water Use: Water and its related lands play a significant role, as the resource base, in providing for many outdoor recreational opportunities. The value of a water based recreation site is determined by such characteristics as its surface area, depth, shape, salinity, odour and temperature. All areas of river basins are potential recreational sites. Upland areas where springs are located are prime

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[a]The information for this section is based on Environment Canada (1975).

recreational sites. Fast flowing rivers are popular for white-water canoeing and mouths of some rivers form prime recreational sites. The formation of reservoirs for flood control, power generation and/or irrigation has augmented the water-based recreation sites in western Canada. Many reservoirs have been built in the past 10 years, near urbanized areas, with recreation as their primary purpose.

It is difficult to make general statements about water quantity requirements yet it would be safe to say that, in the prairies, recreation requires near constant reservoir levels during July and August, which may conflict with other users. In terms of water quality, recreation, especially body contact recreation (swimming and water skiing), requires high water quality. Appendix B5 lists water quality guidelines for recreational waters, as interpreted by Environment Canada.

b) Renewable Resources: General statements will be made in this section concerning the water quantity and quality requirements for fish, wildlife (furbearers, ungulates and waterfowl) and forestry operations.

Generally, fish require water of high quality and a minimum flow in order to remain viable. The minimum flow requirement is established to ensure adequate depth and thus adequate dissolved oxygen, in the water courses; and to prevent spawning grounds from becoming exposed. General water quality requirements have been established for all aquatic life, as of course fish live in an interdependent ecosystem. Appendix B3 indicates water quality guidelines that Environment Canada has suggested will protect freshwater aquatic life.

c) Wildlife and Water: Many species live in or near the water and so require it in abundance. Four major types of wildlife which need water are waterfowl, aquatic and sub-aquatic freshwater mammals, terrestrial furbearers and small and big game. Muskrat prefer a high degree of water-vegetation interspersion and inhabit areas similar to some duck species. They survive best in slightly basic waters (pH 7 to 8) and are adversely affected by waters shallower than two-feet (shown in the Peace-Athabasca Delta) (Environment Canada, 1975, pg. 134). Mink, racoon and muskrat both reach their highest densities in freshwater marsh areas, which provide the majority of the racoon's food. Mink are not primarily aquatic species but fish forms an important part of their diet.

d) Terrestrial Animals: Water and wetland areas provide food for both predator and prey in the environment of terrestrial furbearers and small game. Big game such as deer and moose require open water areas for drinking, in both summer and winter. The juxtaposition of water and nearby plant growth is a primary factor in establishing a plentiful big game area. Terrestrial big game also require water quality of an acceptable level. Appendix B6 lists the national objectives for these water users.

Because quality is a limiting factor in the use of water by recreational or renewable resource users a short description of water quality objectives, in Canada, follows.

1.8.3 Water Quality Objectives

Water quality is a limiting factor to the use of water resources by renewable resources and recreational interests.

"Most water uses, be they recreational, agricultural, industrial or domestic have very specific requirements for the quality of the water resource. In many instances the water quality dictates the limitations on the use of a water resource. Therefore, the quality of a water resource can have profound implications on the social and economic development of an area" (Environment Canada, 1979a foreward).

The federal government, through the Inland Waters Directorate of Environment Canada, exercises its jurisdictional and legislative responsibility with respect to water quality. For example, Environment Canada, at the request of the PPWB, has monitoring stations at provincial boundaries and at international boundaries where the federal government has jurisdiction. Also, because of its legislative control over fisheries, the federal government conducts water quality research in order to determine acceptable levels of chemicals in waters. The federal government regulates the levels of certain chemicals through pollution source controls (Fisheries and Environment Canada, 1978, p. 42). The provinces conduct research into various aspects of water pollution, monitor water quality and have public advisory boards to advise on environmental issues.

Water quality objectives, which have been set by Environment Canada and by the environment ministries of each of the prairie provinces, are recommendations towards maintaining acceptable levels of various water quality parameters. The levels are based on scientific investigation of the effects of various chemicals on humans, fish or aquatic life. Water quality levels, for human consumption, are understandably quite stringent and thus the Canadian Department of National Health and Welfare has set maximum acceptable levels for certain chemicals in the water systems. Water quality objectives then are not law; but specify levels of the parameters, above which, uses of the water system would be curtailed.

In addition to water quality objectives, a set of water quality guidelines is being developed, by Environment Canada, (1979a), to reflect the basic aims of water quality management in Canada. These guidelines are stated in qualitative terms and are subject to federal and provincial review. Provincial water quality objectives apply within a province but such objectives must also be cognizant of the minimum acceptable levels of certain chemicals which will protect fish (fisheries are under federal jurisdiction).

Water quality objectives are determined using a number of criteria which can be applied for any jurisdiction (whether it be national or provincial). The four most important criteria applicable to water quality management in any river basin are:

1) What are the existing uses of the basin?

2) What foreseeable uses would we like to protect?

3) What are the existing conditions of the water in the basin?

4) What socio-economic requirements are we going to satisfy?

(K. Reid, 1980, personal communication)

The criteria established by each province's environment department should be quite similar as they consulted similar literature. There may, however, be differences between provinces, which can lead to some confusion over who is responsible for detrimental effects resulting from water pollution. In some cases (such as with Saskatchewan Environment and the Prairie Provinces Water Board) water quality objectives are almost identical. Water quality objectives have been determined by the PPWB and exist at interprovincial borders in the prairies; however, such objectives are the result of an agreement and they are not law.

It is the difference in water quality objectives, among provinces, that may create some confusion in managing resources in western Canada on a regional scale.

The ideal situation seems to be a determination of water quality needs, on a local scale and the application of the criteria upon these needs.

For instance, water quality objectives set by the PPWB may apply in southern Saskatchewan; however, the natural and social system in the northern parts of the prairie vary considerably, yet the water quality objectives are still the same. In this case, it is also not feasible to suggest national water quality objectives as the natural and socio-economic conditions in the country vary to such a great extent. The Manitoba government is presently incorporating a system of water quality objectives, on a local basis. According to this system water users, present and future, are identified. The choice of the objectives incorporates environmental, social, and economic considerations, as well as past, prevailing and potential water quality.

The water use categories in this procedure are the following: domestic consumption, fisheries and recreation, industrial consumption, agricultural and wildlife, navigation and waste disposal, and other uses (Manitoba Department of Mines, Resources and Environment Management, 1978).

Water quality objectives are merely tools to be used in conjunction with water quality regulations, in order to arrive at sound water quality management. This procedure has been applied to one basin in Manitoba (the Souris). At present the Red River is undergoing the classification process. It is the intention of the Manitoba government to complete the procedure for all 19 major river basins in the province.

In each study area, the levels determined for the most sensitive use of the basin becomes the stream standard. It was also suggested that protection of waters which now have high natural quality, yet little or no demand, must be considered, as their value may be immeasurable in the future (Manitoba Mines, Resources and Environmental Management, 1978). The process, though requiring lengthy data collecting and public hearing procedures, promises to be the most favourable for water quality management purposes. One danger of applying this approach to water quality management is that pollution "havens" may be created. Nevertheless, the approach has promise.

1.9 METHODS

Basically, this study is a comprehensive literature review of recreational and renewable resource use of water in western and northern Canada -- excluding drainage to the Pacific Ocean.

The research involved three phases. In phase one an overview of the subject area was gleaned from various card catalogues, and from computer searches of literature at various libraries. Interviews, and correspondence, were also initiated with resource managers, university researchers and private consultants. In the second phase the information was categorized and reviewed; while in the third phase of the research process relevant information and literature were extracted, data were interpreted and the report was written. The information reviewed was analyzed for its contribution to one or more of the characteristics of water use, outlined earlier in this chapter.

A more detailed description of the methods is found in Chapter 3.

Structure of Chapter 4 (Conclusions and Discussions)

The study was divided into three major sections according to drainage areas -- Arctic Ocean drainage, Hudson Bay drainage and Missouri River or Gulf of Mexico drainage. Because of the vast amount of literature dealing with water resources in the Hudson Bay drainage area, two sections of chapter four were devoted to the topic. Two sections of the chapter were also devoted to Arctic drainage, although the literature was not as extensive as that for Hudson Bay drainage. Missouri River drainage is quite minimal from Canada, and so one section of chapter four was devoted to it.

The major drainage areas chosen -- Arctic, Hudson Bay and Missouri -- were those suggested by the Canada West Foundation. Where feasible, in each drainage area, a basin by basin analysis was used to survey the literature related to recreational and renewable resource utilization of water resources. Where the nature of the literature did not allow for basin by basin analysis drainage areas were analyzed from different perspectives -- comprehensive reports were used or areas were divided into regions according to the nature of the reports.

In the Saskatchewan-Nelson basin; because of the extensive use of river basin planning, a basin by basin analysis was used. Each river basin (i.e. Souris, Qu'Appelle,...) was analyzed separately, and information concerning the seven characteristics of water use (defined earlier in this paper) was extracted..

In the section dealing with "Other Hudson Bay" drainage, one major basin -- the Churchill River -- was studied in detail, while comprehensive and overview reports were used to analyze the remainder of the drainage area.

Arctic drainage, as far as the literature is concerned, is composed mostly of the Mackenzie River basin. Chapter 4.3 and 4.4 therefore dealt with the Mackenzie River and "Other Arctic drainage". Comprehensive, or general overview reports were used for the latter region, as no detailed river basin studies have been completed.

CHAPTER 2

JURISDICTION AND MANAGEMENT OF WATER RESOURCES[a]

2.1 JURISDICTION

Jurisdiction of water resources in western Canada -- is a very complex subject. The Natural Resources Transfer Agreement (1930) gave prairie provinces proprietary rights over their natural resources. The word "land" is interpreted to include water, and thus arises the proprietary right. The provinces receive legislative authority over water resources through section 92(16) of the BNA Act in its reference to 'matters of local and private nature' and section 92(10) through reference to local works and undertakings. The federal government's legislative control over water resources rests mostly upon various powers given to it in section 91 of the BNA Act (see Appendix C). In addition, the federal government is given legislative power over water resources by the preamble of section 91 dealing with the 'peace, order and good government' of Canada and by section 92(10)(c), which refers to "works wholly situate within a province but declared before or after their execution to be for the general advantage of Canada" (McDougall 1971, p. 68).

According to the BNA Act, the provinces have basic authority to manage water resources, authorize developments, license uses, regulate flows and levy fees. The BNA Act thus gave the provinces the authority to legislate on such matters as domestic and industrial water supply, power development, irrigation, reclamation, recreation and pollution abatement,

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[a]Material for this section is drawn largely from two sources:

1. Fisheries and Environment Canada, (1978).
2. Mitchell (1975).

as well as matters of a local nature (Fisheries and Environment Canada, 1977). Section 91 of the BNA Act entrusts the federal government with legislative authority over a number of areas including: navigation and shipping, sea coast and inland fisheries, criminal law, treaty power, and federal spending, to mention a few.

In the North (Northwest Territories and Yukon), sole jurisdiction over water resources rests with the federal government, mainly through the Department of Indian and Northern Affairs and Environment Canada.

Canada's investigatory and administrative relations with the United States, on most matters concerning the two country's boundary and transboundary lakes and rivers, are the responsibility of the International Joint Commission (IJC). The IJC was established under the Boundary Waters Treaty of 1909 and consists of six members, three appointed by Canada and three appointed by the United States. The Commission's approval is required for any use, obstruction or diversion of boundary waters, in one country, affecting the natural level of flow of boundary waters in the other country; and for any works, in waters flowing from boundary waters, or downstream of the boundary in rivers flowing across the boundary, which raises the natural level of water on the other side of the boundary (Environment Canada, 1975, p. 88). The Commission monitors agreements signed by the two countries, in compliance of the Boundary Water's treaty; supervises the implementation of new agreements and investigates common problems referred to it by both governments. In the Canada West Foundation study area, the principal IJC boards are: the International Lake of the Woods Control Board, which regulates the rate of total discharge from the lake when it reaches certain maximum and minimum levels; the International Souris River Control Board; and the St. Mary-Milk Rivers Accredited Officers, which is responsible for overseeing the division between Canada and the U.S.A. of the flow of the St. Mary and Milk Rivers and their tributaries (Fisheries and Environment Canada, 1977, p. 64).

At the provincial level, in western Canada, the Prairie Provinces Water Board, is responsible for administering the Master Agreement on Apportionment (1969). This agreement apportions water in streams flowing eastward across the prairie provinces. The Master Agreement on Apportionment also incorporates other matters related to interjurisdictional water management and provides a vehicle for this purpose.

2.2 FEDERAL AND PROVINCIAL ADMINISTRATION

Within Canada's constitutional framework the federal and provincial governments together are responsible for managing and regulating the use of the nation's water resources. Each jurisdiction does, however, enact legislation where it has the authority to do so.

The Federal government has therefore enacted legislation -- notably the Canada Fisheries Act -- in order to protect the fishery. Wildlife being the property of the provinces are administered by provincial legislation. Migratory birds, are protected by the Migratory Birds Convention Act and thus most of the administration related to their management is federal.

In the Territories, the Federal Department of Indian and Northern Affairs is responsible for water management. This department administers the Northern Inland Waters Act, which creates Water Boards for each of the territories, which in turn have the power to provide for the management, conservation and utilization of water resources within their respective authority.

2.2.1 Provincial Administration

In each western province, responsibility for coordination, management and regulation of water resources has normally been assigned to one or two agencies. Responsibilities have generally been divided between management for water quantity through the agencies' power to approve and licence water projects, and to allocate water; and management for water quality through the provinces power to require and authorize systems for waste management. In the three prairie provinces, as with the federal government, management of water quality tends to be grouped with general environmental quality management. Most of the provinces assign tourism planning and development (including aspects of water recreation); administration of public lands and associated waters; and fish and wildlife management, to separate ministries.

Manitoba groups renewable resources (including wildlife, fisheries, forestry and water resources) in one department -- the Department of Natural Resources. Park Planning is also now the responsibility of this ministry. The Clean Environment Commission, established under the Clean Environment Act of 1972, may determine limits on environmental pollution in cases referred to it by the Department of Consumer and Corporate Affairs and the Environment.

In Saskatchewan, the Department of Environment is charged with water management, as well as environmental protection. It also is concerned with streamflow forecasting, regional and basin planning, drainage and flooding problems. Among the responsibilities of the Department of Tourism and Renewable Resources are: the conservation, development, management and utilization of the renewable resources of the province and the development of provincial parks. This department administers the

Provincial Land Act, section 16 of which states that the Crown has "the reserved right to, and to the use of all the water in a river, lake, stream, etc.". The Department of Tourism and Renewable Resources may also make regulations pertaining to water pollution.

Alberta Environment has similar powers to its Saskatchewan counterpart. The Water Rights Branch, must approve all applications to divert and use water for any purpose (as is done in Manitoba and Saskatchewan). The Renewable Resources section of the Department of Energy and Natural Resources is charged with the efficient development and planned reforestation of Alberta's forests, the management of other public lands and the management of fish and wildlife resources.

Common approaches to water quality control by the western provinces consist of conducting regular and special purpose inventories, and assigning aspects of water management to separate agencies from those charged with general water administration. Such is not the case, however, in Manitoba.

Faced with water shortages, in the past, the western provinces developed systems for licensing and allocating priorities among water users. For example, in Manitoba, domestic purposes have precedence, then municipal, industrial, irrigation and other purposes (Geddes, and D. Kraft, 1979, p. 10).

Mainly because of provincial jurisdiction and as a result of the natural flow patterns of rivers and streams, interprovincial co-operation in water management, with the federal government, has taken place (as manifested by the PPWB and federal-provincial river basin planning).

2.2.2 Federal Administration

Environment Canada has a broad mandate to coordinate federal water policies and to work with the provinces to develop national and regional policies, plans and programs for water management.

The Inland Waters Directorate (IWD) of Environment Canada, in conjunction with provincial agencies; conducts national quantity and quality monitoring, and survey programs, to provide baseline data for all purposes. Under the Canada Water Act, the IWD is also involved with comprehensive water resources planning and implementation.

The Canadian Wildlife Service helps to provide for the preservation of waterfowl habitat (the habitat is owned by the provinces). The birds themselves are owned by the crown, when they are alive. When dead, and if shot legally, they belong to whoever has shot them. The Canadian Forestry service promotes the reduction of air and water pollution caused by wood-using industries through a government-industry research program.

The Environmental Protection Service of Environment Canada, among its various roles, is responsible for national environmental protection, both by direct regulation and by co-operating with provinces and industries; and for developing effluent quality requirements.

Other federal departments, and agencies, concerned with water management are Prairie Farm Rehabilitation Administration (PFRA), Department of Indian and Northern Affairs, Transport Canada, Department of Energy, Mines and Resources, Department of Agriculture and the International Joint Commission (IJC).

The federal government operates data networks to monitor water quality and sediments, on a national basis, in co-operation with provincial agencies (Fisheries and Environment Canada, 1978, p. 42).

After 1970, new strategies for environmental protection were pursued by the federal government. Environment Canada has developed ambient water quality objectives which suggest that the quality of Canada's waters should be such as to meet the requirements for all legitimate uses of water; and unpolluted waters should not be allowed to deteriorate. Saskatchewan, Manitoba and Alberta have each developed similar quality objectives within their boundaries; and, through the PPWB, attempts are being made to develop common interprovincial objectives.

Other policy instruments used by the federal government in addressing water quality issues are effluent standards, product standards and marine regional pollution controls. As well, an environmental impact assessment review process has been established by the Federal government for projects in which the Government of Canada has financial interest.

The Canada Water Act provides for comprehensive river basin management plans which incorporate the effects of water quality and quantity. In a basin management plan the basins of the country are ranked in order of national priority, in terms of their water quality problems. Alternative future uses are predicted and the water quality necessary to support such uses is defined.

Issues

Given the present framework of jurisdiction and management of water resources in western and northern Canada, a number of issues, related to recreation and renewable resources, can be identified. These issues concern either water quality or water quantity.

Water of good quality and sufficient quantity is necessary for optimal use for recreation and renewable resources. One stumbling block in achieving optimal water quality is the different water quality objectives of each jurisdiction. Setting water quality objectives in one jurisdiction can be frustrating when an upstream jurisdiction has different objectives. National water quality objectives and guidelines have been determined only for water courses flowing across international boundaries, but the provinces should set similar guidelines within their own borders. Water quality objectives have been determined at interprovincial boundaries by the PPWB. Issues may arise if provincial water quality objectives are different from those of the PPWB.

Another water quality issue with respect to renewable resource and recreational use of water is that of identifying uses before water quality objectives have been determined. The basic concern then, is what uses will be protected under the guidelines. It becomes a question of economics -- for example, the cost of cleaning the Red River to a safe swimming level may never be considered because of its exhorbitant cost.

Water quality objectives which have been initiated by the provinces and by the federal government are, at present, suggestions for achieving optimal levels of various water quality parameters. It is up to parliament or to provincial legislatures to enact laws which will implement water quality standards.

The flow in a water course is a prime determinant of its water quality, as the greater the flow the lower will be the concentration of pollutants, and the higher will be the level of dissolved oxygen. With greater demands being placed on western Canadian water resources, it may become more and more difficult to coordinate water quantity and water quality needs for water's many users. With more uses that need to be considered, more factors must enter into basin management plans.

CHAPTER 3

METHODS

Essentially, the report relied on secondary data, thus the methods used to collect and anlayze the data included: a bibliographic search of relevant libraries; a literature search, by computer; and correspondence with resource managers, university professors and other groups.

In the initial phases of the literature search general source material on water resources in western and northern Canada was searched. This allowed for a selective exclusion of information in the later stages of report writing. Various government, public and university libraries were used in the process. Major basin studies were relied on quite heavily in this literature survey.

3.1 COMPUTER SEARCH

With a general foundation in the subject at hand it was now possible and appropriate to consider more specific matters related to renewable resource and recreational use of water resources. Computer searches using Environment Canada's WATDOC data base, various data bases at the Canadian Plains Research Centre and various data bases at the Engineering Library, at the University of Manitoba were utilized.

WATDOC, the Water Resources Document Reference Centre is Canada's major computer-based water-resource information centre. The data bases developed by WATDOC are designated CANADA WATER, NEWS, NOUVELLES, AND D-REF CAN-WATER, covers both published and unpublished water related scientific and technical literature; NEWS AND NOUVELLES cover water related news stories in English and French, respectively; and D-REF covers environmentally related data collections. The CANADA WATER Data base provides full bibliographic citations, keywords, and abstracts to documents, published and unpublished books, journal articles, and conference proceedings dating from 1970, on Canada's water resources and related topics (Fisheries and Environment Canada 1978, p. 90). The print-out from this data base was provided by the Canada West Foundation.

The Canada Plains Research Centre completed a computer search of available water resources information compiled by the private sector, since WATDOC and the bibliographic searches had located most of the government sources of information. The computer search at the Engineering Library, at the University of Manitoba,used a data base of Environment Canada, Inland Water Directorate. The data base, called Canadian Environment (CENV), is available through the QL systems.

The bibliographic computer searches of relevant literature could, one could assume, exhaust much of the available literature. However, a method had to be established for uncovering newly published or unpublished reports. It is for this reason that consultations were initiated with various resource managers, university professors and other interested groups. By talking first hand with those directly involved in water resources management it was possible to short-cut some of the research methods.

From the initial stages of the research, written correspondence and correspondence by telephone was conducted with resource managers.

Interviews were conducted in Regina, with various water resource managers, once a firm grasp had been made of the relevant literature. By this point, in the research process, some of the comments of resource managers helped to amalgamate much of the information and fill in some of the gaps in the research.

3.2 SELECTION AND EXCLUSION OF DATA

Because this report deals with a very broad topic, a selective process was required in order to choose relevant data. Basin study reports, because of their comprehensive approach to water resources planning, were seen as valuable sources of information. Opinions expressed by government officials, pertaining to water quantity and quality were accepted more readily when they were reinforced by written documents.

Data from the present Prairie Provinces Water Board's Water Demand Study was not incorporated into this study, as it was not available in time for report writing. The objectives and terms of reference of the PPWB study have, however, been discussed in chapter four of this study.

3.3 PRIMARY AND SECONDARY SOURCES

Most of the data accumulated in this report was secondary. This took the form of data from government reports, government files and research reports from various universities.

The only form of primary data included in the report was that gleaned from conversations with resource managers and university professors. This information was considered to be primary as, upon the completion of a number of interviews, trends could be discerned concerning recreational and renewable resource uses of water resources. The information was also considered to be pertinent as it gave the author the opportunity to deal with issues and concerns that related to future or perceived water resource management problems.

CHAPTER 4

RESULTS AND DISCUSSION

The Hudson Bay drainage area is the most significant (in terms of population) of the three drainage areas which form the basis of the Canada West Foundation Study. Within the Hudson Bay drainage area, the Saskatchewan Nelson basin contains most of the habitable and arable land. Because of the importance of the basin to the Canadian economy; and because of the numerous water management studies that have been completed in the Saskatchewan-Nelson basin, it will be studied first in this water use study.

This chapter will rely heavily upon comprehensive river basin plans and consultants' reports. For each basin, major river basin reports are first discussed and these are then supplemented with other reports dealing with that particular basin. Following the natural flow system of the Saskatchewan River, the analyses will begin with Alberta (Oldman River basin) and proceed eastward to the Nelson River.

4.1 HUDSON BAY DRAINAGE I : SASKATCHEWAN-NELSON BASIN

4.1.1 Overview of Saskatchewan-Nelson System

The Saskatchewan-Nelson River system drains the majority of land in the Canadian prairie. An extensive study which has dealt with this system was completed by the Saskatchewan-Nelson Basin Board (SNBB) (1972). The objective was to "study the water resources of the Saskatchewan-Nelson basin, including the potential additional supply by diversion or storage."

The Saskatchewan Nelson basin is a large flat plain rising to the west; to the north is the Alberta plateau and the Canadian shield; to the east is Hudson Bay and to the south is the low hill county of northern Montana and North Dakota. Most of the drainage basin is found in the interior plains physiographic region. The interior area covers 241,000 mi^2 (624,190 km^2) and is divided into 3 areas -- the Manitoba Plain, the Saskatchewan Plain and the Alberta Plain (See Figure 4.1.1).

Prior to the Saskatchewan-Nelson Basin Study, little comprehensive information was available concerning winter and summer use of the basin's river systems for water-based recreation. Some of the factors that were found to detract from the system's natural potential for recreational use are "steep valley and shoreline terrain, dense vegetation growth in valley bottoms, fluctuating water levels, a rapid rate of flow and poor quality because of heavy sedimentation" (Saskatchewan-Nelson Basin Board, Appendix 7, pg. 315). The characteristics of the river basins in the Saskatchewan-Nelson basin determine, to a great extent, their recreational opportunities. Most of the region's river basins are a collection of recently formed channels in the glacially deposited clays. The Winnipeg and Nelson rivers, however, are found in the Canadian Shield region and are entirely different.

Within the Saskatchewan-Nelson basin there are three major river systems:

1) the Saskatchewan river system
2) the Red river system (including the Assiniboine)
3) the Winnipeg river system
4) the Nelson River from Lake Winnipeg to Hudson Bay.

The Saskatchewan river rises in a number cf rivers on the east-facing flank of the Rocky Mountains. The system, as is indicated in figure 4.1.1, takes in a vast area of the Canadian prairie. Its major tributaries are:

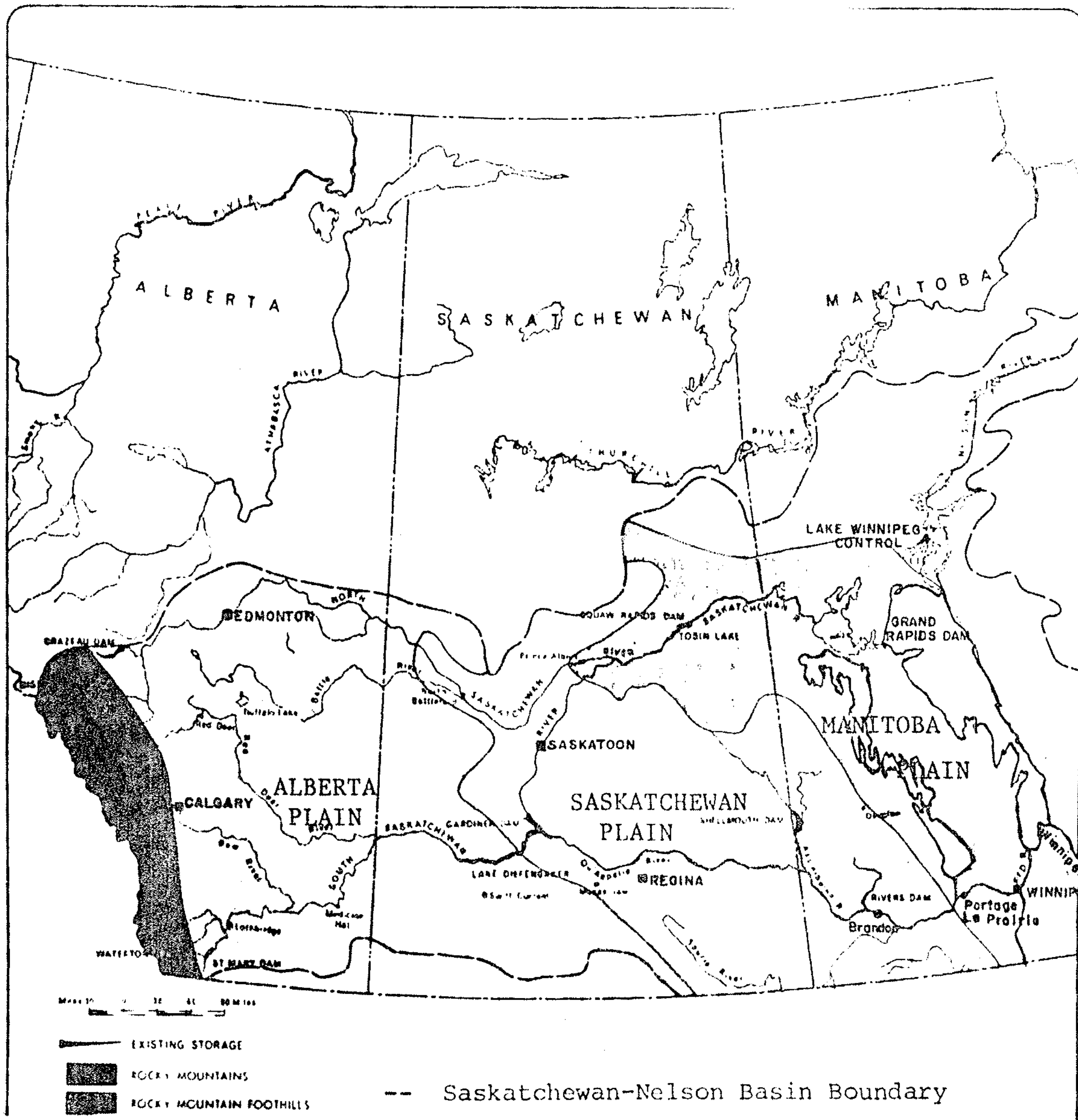


Figure 4.1.1 Physiographic Regions of Saskatchewan-Nelson Basin

Source : Saskatchewan-Nelson Basin Board (1972) Background Information the North Saskatchewan, the Battle, the Bow, the Red Deer, the Oldman and the South Saskatchewan Rivers. Little flow is accumulated across the prairies and as the river enters Manitoba -- and the Canadian Shield -- a more reliable flow is produced as evaporation rates are diminished. The Red River, which is fed by the Qu'Appelle, Assiniboine and Souris Rivers empties into Lake Winnipeg. The Winnipeg River, which arises in Ontario 50 miles west of Thunder Bay, also drains into Lake Winnipeg.

The Nelson being the only outlet from Lake Winnipeg, thus drains the Saskatchewan, Winnipeg and Red River systems.

The SNBB reviewed the supply, variability, and the extent that present uses affected the volume of water in each of the river basins. Table 4.1.1 indicates average natural flow for each of the rivers as well as the largest and smallest monthly flows that occurred during the period 1912-1967. Natural flow means the natural runoff from all portions of the basin lying upstream from the point of interest, including contributions from any areas lying in the United States (SNBB, 1972, Main Report, pg. 54).

A more recent report presenting flow data for western Canadian rivers was completed by the Inland Waters Directorate of Environment Canada (1980b). The purpose of the report was to identify purposes for which water is used in Canada. Instream users such as fish and waterfowl, recreation, hydro power generation, and pollution abatement were recognized as being as important as withdrawal uses, but not as easily quantified.

The summary report of the SNBB, as well as containing information found in Table 4.1.1, identified reservoirs in each river basin and their potential effect on the natural flow of the system (Table 4.1.2).

4.1.2 General Concerns of the Basin, Expressed by the SNBB

The Saskatchewan-Nelson Study Board made general comments concerning the use of water for recreation, and by renewable resources. The report

TABLE 4.1.1

FLOW DATA FOR MAJOR RIVERS IN SASKATCHEWAN NELSON BASIN

River	Average Natural* Flow (1912-1967) (cfs)	Minimum Flow (cfs)	Maximum Flow (cfs)
	Note: $\frac{\text{cfs}}{35.31}$ = metres^3/sec		
Oldman	4,020	220	35,000
Bow	3,320	480	17,100
Red Deer	1,780	100	16,700
Battle (Alta./Sask.)	260	1	7,490
Saskatchewan (At The Pas)	24,700	1,120	103,300
North Saskatchewan (At Prince Albert)	8,660	420	60,200
Souris	270	0	4,100
South Saskatchewan at Saskatoon (At Wawanesa)	10,900	440	74,000
Qu'Appelle (At Welby)	210	1	4,990
Assiniboine (At Portage)	1,660	5	17,200
Red (At Emerson)	2,920	12	73,800
Winnipeg (At Slave Falls Power Plant)	27,700	10,400	81,200
Nelson	70,300 (At Lake Winnipeg Outlet)		

*Natural Flow is hypothetical term meaning flow if there has been no man-made changes to the natural process

SOURCE: Saskatchewan - Nelson Basin Board (1972). Background Information.

TABLE 4.1.2

MAJOR RESERVOIRS IN THE SASKATCHEWAN-NELSON BASIN

Basin	Reservoirs	Volume Impounded (ac ft) Note: ac ft. x 1.233 = dam^3	Purpose
Oldman	Waterton	104,000	Irrigation, Recreation
	St. Mary's	320,800	Wildlife
Bow	11 Reservoirs		Power, Wildlife
N. Saskatchewan	Brazeau		Power
	Bighorn		
S. Saskatchewan	Lake Diefenbaker	3,240,000	Irrigation, Power
Saskatchewan	Tobin Lake	490,000	Power
	Cedar Lake	7,000,000	
Qu'Appelle	Buffalo Pound		
	Lost Mountain		
Assiniboine	Shellmouth Dam		Flood Control
	Rivers Dam		Flood Control
Red	Lake Traverse		Flood Control
	Red Lakes		Flood Control
	Lake Astobula		
Winnipeg	Lake of the Woods		Hydro, Power, Recreation
	Lac Seul		Power
Nelson	Kelsey, Kettle Rapids (Lake Winnipeg)		Power

SOURCE: Saskatchewan-Nelson Basin Board (1972). Background Information.

suggested that because of the growing demand for water-based recreational opportunities on the prairies, and because of the lack of available natural sites, more and more development was bound to occur around reservoirs built primarily to serve irrigation, power or municipal needs. Recreation requires near constant reservoir levels during July and August and high water quality. Waterfowl require a stable or slowly dropping water level from early spring through late summer, which avoids flooding of nests and favours vegetation growth. Most other uses (hydro power and irrigation), it was suggested, would best be served by impounding water and using the surplus at a later date. The report concluded that, in the future, reservoirs would have to be operated in a manner to serve many purposes.

Most of the major rivers of the Saskatchewan-Nelson basin originate in the foothills of the Rocky Mountains. As an introduction to a discussion of water use in the entire Saskatchewan Nelson Basin, the next two sections of this chapter address the importance of water management in the foothills of the Rocky Mountains.

4.1.3 Quantity and Quality Concerns in the Foothills Area of Alberta

As most of Alberta's rivers arise from the eastern slopes of the Rocky Mountains proper watershed management in the foothills can have pronounced effects on water use in the rivers below. A report by Alberta Environment Conservation Authority (1974a) reviewed resource development in the eastern slopes. The importance of the eastern slopes was noted in the report: "the eastern slopes serve as great collectors of water during the winter months which become the source of all rivers moving to the east and north in the Prairie Provinces." (Alberta Environment Conservation Authority, 1974a).

In one of its recommendations the ECA said "that in the resolution of land use conflicts, preference should be given to the preservation of the integrity of the watershed basins in respect of the quantity, the quality and the desired run-off rates of the water resource." (Alberta Environment Conservation Authority, 1974a p. 47).

Waterton Lakes National Park, Banff National Park and Jasper National Park are all found within the Eastern Slopes. Because of the extensive recreational uses of these parks,recommendations were made by Alberta Environment (1974a) concerning the interdependency between the Eastern Slopes and the National Parks. Extensive water use within Banff National Park, for instance, could have significant impacts on both the quantity and quality aspects of the Bow River. It was thus recommended that a liaison be established, at the planning level, between the federal and provincial parks system.

4.1.4 Effects of Forestry on Water Use

Forestry practices in Alberta, particularly in the eastern slopes, can greatly affect watershed management. Sediments, from erosion of harvesting sites, can alter water courses and cover and fill important spawning areas for cold water fish (Environment Council of Alberta 1979a p. 18).

Total flow from logged areas can be 20 to 80 percent greater than those of uncut basins. This increased water can be a direct benefit, but often its quality is low (because of sediment load) or the timing of the increased flow is not optimal. (Environment Council of Alberta, 1979a p. 19). Optimum water yields may also be promoted under a vegetation management scheme which is also favourable to ungulates and satisfies sightseers and hunters.

Poor timber harvesting practices, and road building, can have a number of negative impacts on water quality and quantity. They may result in: excessive sedimentation which kills fish eggs and even adult fish, destruction of food supplies; increased water temperatures which may be harmful or lethal to cold water fishes; blockages of streams so that fish can no longer get to spawning sites and erosion of streambeds which removes cover (Environment Council of Alberta 1979a p. 21).

The extra water produced by cutting, says the ECA, may be valuable to some downstream users but this value cannot be stored and used when needed.

4.1.5 River Basin Analyses

This chapter will rely heavily upon comprehensive river basin plans and consultants' reports. For each basin, major river basin reports are first discussed and these are then supplemented with other reports dealing with that particular basin. Following the natural flow system of the Saskatchewan River, the analyses will begin with the Alberta river basins and proceed eastward to the Nelson River.

4.1.5.1 Oldman River Basin

Physical Characteristics

The Environment Council of Alberta defines the Oldman river basin as those areas of southern Alberta which are drained by the South Saskatchewan river (excluding the Bow and Red Deer basins). Landforms vary from rugged mountains in the west through the foothills and the western plains on to the eastern plains. As landforms vary, so do perceptions of the environment.

> "Environmental considerations, within the basin range from a concern for the uniqueness of ecosystems of the western end; through concern for the perservation of a largely man-created environment in the central portion of the basin; to

primarily an interest in what can be done to enhance the environment for human habitation in the eastern end of the system." (Environment Council of Alberta, 1979c p. 28).

Available Literature

The primary reports dealing with recreation and renewable resource uses of water are the Oldman River Basin report, by the Alberta Department of Environment (1976a) (various chapters), and the report by the Management Committee which conducted hearings in response to the Oldman River Basin Report (Alberta Environment Council 1979c).

Resources

The Oldman River basin has a drainage area of 23,000 km^2 in Alberta. Its natural flow is highest in May, June and July and lowest in January. The mean annual natural flow of the South Saskatchewan River at the point of apportionment is 7.6 million acre feet (9.38 million dam^3) - 2.9 million acre feet from the Oldman River (3.58 million dam^3), 3.1 million acre feet (3.82 million dam^3) from the Bow River and 1.5 million acre feet (1.97 million dam^3) from the Red Deer River. There do exist minimum flow criteria for the river but, as of yet, such figures do not place a major emphasis on fish habitat or recreational uses (Environment Council of Alberta, 1970 c p. 46).

The diversity of habitats as well as recreational opportunities decreases as one moves from west to east in the basin. The building of reservoirs, however, has enhanced possibilities for outdoor water-based recreation in the eastern portion of the basin. Above the Lethbridge Northern Irrigation District diversion, in the western end of the basin, is the only wild river remaining in central and southern Alberta. The Oldman and Crowsnest rivers also provide good canoeing in the area. Trout and mountain whitefish abound in the area making angling very popular.

Any free-flowing or impounded water is a very precious resource in the eastern portion of the basin.

Quantity and Quality Concerns

According to Acres Consulting Services Ltd. (1978) the flow needed in the Oldman River, at Lethbridge, to meet all needs for fishing and water quality should be 360 cfs. (10.20 m^3/sec). In order to protect all fish and wildlife, this flow represents 10 per cent of the recorded mean natural flow. In the Environment Council report (1979c), Fish and Wildlife Branch, Alberta Department of Recreation, Parks and Wildlife, suggests that 20 percent of the mean annual flow during October to March and 40 percent during April to September would be more realistic. This should satisfy future specified requirements for good fishing habitat, canoeing and dilution of phosphates.

Major constraints to increased water-based recreation development -- according to hearings by the Environment Council -- appear to be the amount of water and the sites available. A need exists, in the future, for small permanent bodies of water which can be maintained as recreation sites. The many dams and diversions on the St. Mary, Belly and Waterton rivers have caused recreational opportunities and fish population to be drastically reduced, due to low flows, in conjunction with high summer temperatures.

4.1.5.2 Red Deer River Basin

Description and Reports Available

The Red Deer River joins the South Saskatchewan River at the Alberta-Saskatchewan border. Major reports dealing with the river basin were completed by Alberta Environment (1976b) and the public hearings conducted, in response to plans to regulate the river's flow.

Quantity and Quality Concerns

Quantity requirements within the river itself seem to be at dispute. The Whitewater Canoe Club reported to the hearings that a flow of 1500 cfs (42.48 m^3/sec) was necessary during May-September. The Department of the Environment recommended a flow of 540 cfs (15.29 m^3/sec) to maintain good water quality and 300 cfs (8.5 m^3/sec) to maintain fish populations. Effects of maintaining water at an adequate flow rate for fish populations would, in fact, be detrimental to whitewater canoeing people, who require higher flow rates.

In 1975 major constraints to optimal use of the stream by wildlife, sport fishing and recreation, were visualized with Alberta government's plans to build a dam on the Red Deer, to regulate flow. Building of the dam could cause flooding of moose and deer habitat and, through reduced flow, could lead to demise of fishing (a $2.5 million industry in the Basin) (Alberta Environment Conservation Authority 1977, pg. 161). The dam may also be detrimental to fish and wildlife because of the production of cool temperatures and undercurrents.

4.1.5.3 Bow River Basin

Description and Reports Available

The river is, understandably, of great concern to southern Albertans as it is the nearest source of water-based recreation for the citizens of Calgary. In 1974, the Alberta Department of the Environment conducted the "Bow River Impact Study". Its primary objective was: "to assess the environmental and sociological impact of flood management recommendations for the flood plain of the Bow river within the city of Calgary." The report examined the natural resources capability of the Bow river and flood plain area, using existing data from various sources. Inventories were completed of recreational potential and biological resources.

Resources

One study by the Alberta Environment Conservation Authority (1974a) has considered quantity aspects of the Bow River while another, being conducted presently by Alberta Environment will consider both water quantity and quality aspects.

At present, Calgary power provides the primary water based recreational sites in the Bow River valley. Because of the importance of the Bow river as a source of water for hydro-electric power, domestic and industrial use and irrigation; suggestions have been made as to the importance of watershed conservation practices in its headwaters, in the foothills. Conservation practices can have profound effects (negative or positive) on water supplied for recreational or renewable resource users in downstream areas.

In the upper reaches of the Bow, Elbow and Sheep Rivers the Alberta government, with financing from the Alberta Savings trust fund, is developing a 5200 km^2 year-round multi-use recreational area. The area, known as "Kananaskis Country" is rich in fishing opportunities -- rainbow trout, rocky mountain whitefish, cuthroat trout and eastern brook trout are common species. Opportunities exist for all types of outdoor recreational activities including camping, snowmobiling, skiing and fishing. Projects are now underway to increase recreational fishing and to enhance other wildlife opportunities. (Alberta Government, 1981)

Quantity, Quality Concerns

Concerns have also been expressed for the water quality requirements for recreational use of the Bow River as "fish are dying and people can't swim in the Bow" (Alberta Hansard, Oct. 11, 1979, p. 738). Water quality objectives, for various uses, are now being drawn up as part of the South Saskatchewan River Basin Study.

A major constraint to the use of the Bow River -- both upstream and downstream of Calgary -- is large scale fluctuations in water levels. There are, at present, eleven dams on the Bow River, upstream of Calgary, which are used for hydroelectric purposes. Hydroelectric power operations increase winter flows and decrease summer flows. Large scale fluctuations in river flows (or inadequate flows) can be detrimental to fish habitat. Downstream from Calgary, irrigation reservoirs also serve recreational purposes. Thus in periods of low flow, and increased irrigation; low flows upstream may conflict with irrigation, and hence recreation, downstream. There is also a general problem of access along the Bow River as much of the land is in private hands.

4.1.5.4 South Saskatchewan River Basin

South Saskatchewan Basin Study

This ambitious study, now being conducted by Alberta Environment, calls for an assessment of all water supplies and current demands in the basin; a forecast of probable future demand patterns; and formulation of a framework for coherent management and allocation of available water.

Users, from Calgary Power to sport fishermen, will be asked how much water they require, when they need it and what quality is necessary (Alberta Environment 1980, Communications Branch, July, pg. 27-29). The basin, encompassing an area of 143,000 km^2 and covering half the population of Alberta is drained by the Red Deer, Oldman, Bow and South Saskatchewan Rivers. The study, which involves an overview of water supply and use in the entire basin, should be completed by April 1981.

Lower Saskatchewan Basin Task Force

An overview study has been completed, by the Lower Saskatchewan Basin Task Force (LSBTF), dealing with water-related concerns in the Saskatchewan River, in the province of Saskatchewan. The study area, consists of that part of Saskatchewan that is drained by the Saskatchewan River System, excluding that portion of the basin upstream of Gardiner Dam.

In 1975, of total flow at the Alberta/Saskatchewan boundary of 7 million acre ft./year, (8.63 million dam^3) approximately 75,000 ac. ft./year (92,480 dam^3) was withdrawn in Saskatchewan, and not returned. There are certain areas where the potential for large increases in withdrawals has been identified. The first of these is the potential increase in irrigated land in the South Saskatchewan River Project, from the present 22,000 acres (8,903 ha) to 200,000 acres, (80,940 ha) which could increase withdrawals by approximately 400,000 acre-feet (493,200 dam^3) per year. Another potential diversion, from Lake Diefenbaker to the Poplar River Thermal Power Station, in the Missouri drainage area, has received some consideration by the Saskatchewan Power Corporation. Water quality of the South Saskatchewan, at the boundary, is considered adequate for downstream users (LSBFT, p. F-11).

Downstream of Gardiner Dam

Within the South Saskatchewan River basin, downstream of the Gardiner dam, quantity requirements should be met for all water users. Currently the minimum streamflow, recommended by the South Saskatchewan River Development Commission, is 1500 cfs (42.48 m^3/sec). However, the LSBTF has suggested that this figure be reviewed and updated (LSBTF, p. 51). Water recreation in the South Saskatchwean basin is made possible by water bodies or artificial impoundments (Diefenbaker Lake and Blackstrap Reservoir). The Saskatoon South East Water Supply Project (SSEWS) delivers water, by canal, to domestic, municipal, industrial, irrigation, wildlife and recreational users located southeast of Saskatoon. A number of water developments in the region were built expressly for recreation (Pike Lake) and thus control structures are needed to stabilize lake levels. The demand for recreational impoundments is expected to increase in the future and so a number of new ones will be needed.

Future Requirements

Although the LSBTF did not complete a water demand study of its study area it did suggest, in its recommendations, that the PPWB water demand study, as well as other ongoing Saskatchewan programs, were sufficient to address any water-related concerns. It also suggested that careful consideration be given to downstream impacts on the South Saskatchewan and Saskatchewan rivers before any serious thoughts are given to augmenting flows from Lake Diefenbaker to the Qu'Appelle River (LSBTF, 1979, pg. iii).

4.1.5.5 North Saskatchewan River Basin

The North Saskatchewan River basin includes parts of central Alberta and central Saskatchewan. It is very important to Alberta as it flows through the City of Edmonton and thus it is a potential prime site for water-based recreation. In Saskatchewan it provides an area of moderate capability for recreation (fishing, camping, swimming and cottage development).

Quantity and Quality Concerns

In Alberta, a flow of 2,000 cfs (56.64 m^3/sec) must be maintained to serve water users downstream of Edmonton (LSBTF, pg. 33). The PPWB is currently active in determining desirable water quality objectives for interprovincial streams under its jurisdiction.

The only specific water quantity requirements, mentioned in an Alberta Environment (1975) report, were for skilled canoeists who require swift currents.

The report utilized water quality criteria for various uses, zoned according to established recreational activities, which could be carried out within zones. Criteria (based on current uses) were based on the following uses of the system: drinking water supply, body contact recreation, biological life support and passage of fish species. Table 4.1.3 indicates the proposed recreational uses and the rationale for the decisions.

The major constraint to use of the river in the Edmonton area is the prohibitive cost of raising the river quality up to primary contact standard.

Vermillion River Basin

Alberta Environment (1974b) completed a river basin study of a small tributary of the North Saskatchewan, the Vermillion river. A fish and wildlife study was completed and the findings are described below. Opportunities exist for hunting, fishing, wildlife habitat, and canoeing in the basin. As well, the area is important as a breeding and staging ground for waterfowl. Because of this potential, water should be maintained at a stable level and water quality should conform to water quality objectives of the Alberta Department of the Environment.

The biological study of the river basin study disclosed that the river was of very poor quality for recreation because of a combination of a large fluctuation in water levels, low summer and winter flows, high turbidity and a high summer water temperature. The report suggested that in order to determine the potential for recreation and renewable resource use, information on expected water levels and impoundments to maintain the

Table 4.1.3

PROPOSED RECREATIONAL USES AND WATER QUALITY CRITERIA FOR EACH ZONE OF THE NORTH SASKATCHEWAN RIVER AT EDMONTON

	ZONE A	ZONE B	ZONE C	ZONE D
ZONE BOUNDARIES	Upstream of storm sewer at 56 Avenue Avenue (Fort Edmonton Park)	First storm sewer to James MacDonald Bridge	James Macdonald Bridge to Sewage Treatment Plant	Downstream of Sewage Treatment Plant to point of recovery
PROPOSED RECREATIONAL USES	1. Direct Body Contact Recreation (swimming). 2. Maintenance of the indigenous aquatic biological populations	1. Secondary Contact Recreation (boating, etc.) 2. Passage of fish	1. Secondary Contact Recreation (boating, etc.) 2. Passage of fish	1. No water-based recreation, only visual aesthetics 2. Passage of fish
RELEVANT WATER QUALITY CRITERIA	1. Direct Body Contact Recreation (Table 4.3) 2. Indigenous biological life survival and propagation (Table 4.2)	1. Raw Water Supply (Table 4.1) 2. Cooling Water (Table 4.5) 3. Secondary Contact Recreation (boating, etc. Table 4.4) 4. Passage of Fish	1. Secondary Contact Recreation (boating, etc. Table 4.4) 2. Passage of fish	1. Cooling Water (Table 4.5) 2. Petroleum Industry (Table 4.6) 3. Chemical and Allied Products Industry (Table 4.7) 4. Passage of fish

Source : Alberta Environment (1975)

water level, should be investigated. Reservoirs with severe fluctuations in level, suggested the report, should be avoided. Alberta Environment is conducting, or has conducted, river basin plans dealing with other watersheds in the North Saskatchewan basin. In the Sturgeon River Basin a water balance study was completed. Alberta Environment completed a study in 1979 dealing with the Battle River basin. The study concentrated on generating baseline water resources data in the areas of hydrology, river hydraulics, water use and demand, groundwater fish and wildlife. As well, a framework water resources management plan is to be prepared for the entire basin (Alberta Environment, 1978a, pg. 46).

No large scale developments are foreseen in the North Saskatchewan River, in Alberta, which will place constraints on the use of the river in downstream Saskatchewan. Population increases in the Alberta section could place constraints on water use but this has not been documented (Lower Saskatchewan Basin Task Force, 1979, p. F-1).

4.1.5.6 Saskatchewan River Basin

Description

Parts of the Saskatchewan River basin have been the subject of much controversy over land uses, as Ducks Unlimited is completing a waterfowl habitat enhancement program covering some 320,000 acres (129,500 ha) in the Cumberland Delta, while farmers in the area would like to see the area reclaimed for agricultural purposes.

Resources

With a very diversified fish fauna, in the basin, commercial fishing is quite important. Walleye, sauger, goldeye and lake sturgeon are the main species caught. In 1973-74, of the 1.2 million pounds (.54 million kg) of fish caught in the LSBTF study area, most was from the Saskatchewan River (LSBTF, 1979, p. F 21). A report by the federal government (Canada Department of Agriculture, PFRA, 1967) suggested that the area is ideal for recreation (especially canoeing).

The PFRA report also indicated that the delta area is capable of producing large numbers of waterfowl and muskrat on a sustained basis if habitats are maintained with sound management practice. A present and future requirement for water in the area is the native population, which is primarily associated with hunting, fishing, lumbering and guiding.

Also, the area was identified as suitable for fish farming operations because of the numerous small lakes. However, a major expenditure would be required for maintenance of suitable oxygen levels during winter (with the use of artifical aeration).

Another report which has studied the water resources of the Saskatchewan River was prepared by the Saskatchewan Power Corporation (1975). Walleye, sauger, northern pike, goldeye, yellow perch and white and longnose sucker were identified as dominant fish species. In the future, the area (especially the reservoir site) could have potential for recreational activities, if properly cleared. The Poplar-Nipawin Board also made several recommendations concerning preservation of fishing resources and archaelogical sites of the basin.

Quantity and Quality Concerns

The Ducks Unlimited habitat enhancement program in the Cumberland Delta will depend on augmented flow from the main stem of the Saskatchewan River (LSBTF, 1979, p. F21). In addition to wildlife habitat the Saskatchewan River Delta provides possibilities for the traditional pursuits of hunting, trapping and fishing. The retention of these traditional pursuits, with the use of control structures, has been criticized by some as it prevents marginally arable land from being used.

Waterfowl impoundments can have perceived negative impacts on other land and water users. For example, Saskeram Marsh at the junction of the Saskatchewan and Carrot Rivers covers an area of 12,000 acres (4,856 ha). Farmers in the region suggest that before the Marsh was taken over by Ducks Unlimited, it produced one million bales of hay annually (Winnipeg Free Press, March 9, 1981, pg. 9).

Saskatchewan Power Corporation's proposed hydroelectric dam at Nipawin may constrain renewable resource activities (especially fish habitat) if the reservoir is fluctuated greatly. The Saskatchewan Government (1980) has therefore recommended that the level of the reservoir not go below a maximum drawdown of 3 feet (.92 m) below full supply level. Flood suppression by upstream reservoirs may have a negative impact on the ecology of the Saskatchewan River delta. Another constraint to optimal use of the river basin by trappers, fishermen and hunters, is the rapid, abnormal fluctuations in levels, for hydro-electric power, which make travel through the area difficult and offset the dens of furbearing animals thus causing hardship to trappers (LSBTF, pg. 28).

The Red River System drains a number of rivers in western Canada--the Souris, the Assiniboine, the Roseau, the Pembina and the Qu'Appelle. Each of these river basins will be analyzed for their recreational and renewable resource characteristics in the next few sections of this report.

4.1.5.7 Red River Basin

The Red River basin provides a valuable resource base for sports fishing as well as limited furbearer harvest and white-tailed deer hunting. Sports fishing is concentrated near towns and villages, with the Lockport Dam, at Lockport, Manitoba, being the heaviest area in the province for recreational fishing (International Joint Commission, 1976c, pg. 144).

The waters of the Red River, from the La Salle River to Lockport, contain several significant species of sports fish. As well,its wooded fringes provide habitat for animals such as racoons, beavers, squirrels and various bird species. Netley Marsh, at the mouth of the Red River is a significant waterfowl breeding and staging area. Recreational resources in the Red River basin include opportunities to educate, through the use of nature and history interpretive centres (Manitoba Department of Mines, Resources and Environment, 1980a, pg. 14).

Water Quality standards have been suggested, for the Red River, north of the city of Winnipeg, to Lake Winnipeg. As a result, the Clean Environment Commission, of Manitoba, is conducting public hearings in order to determine water quality objectives. Streams in the Souris River basin have already been classified on the basis of surface water quality objectives and the possible consequences of waste discharge. The stream classifications are objectives, based on optimum social and economic benefits to residents, keeping economic realities in mind. They are not, however, necessarily attainable (Manitoba Government, 1980). It appears, from previous studies, that the Red River, in and below the city of Winnipeg, will continue to be suitable for secondary contact recreation. Under normal flow conditions the Assiniboine and Red Rivers, within the City of Winnipeg, provide for a wide range of aquatic life (Manitoba Department of Mines, Natural Resources and Environment, 1980a, pg. 296).

Once water quality objectives have been established for the Red River, it will not be difficult to monitor the parameters, as stations are already in place. Environment Canada operates a water quality monitoring station at Emerson, Manitoba (1 km north of the International Boundary). The water quality is also measured before the river discharges into Lake

Winnipeg. Of course the Assiniboine River strongly influences the quality of the Red River at Selkirk. Even though the seasonal pattern of total dissolved solids, in the Red River are influenced by the Assiniboine, the seasonal dissolved oxygen is not different from that at Emerson. (International Joint Commission, 1976b, pg. 99).

4.1.5.8 Pembina River Basin

A Manitoba Water Resources Commission (1973) report summarized and evaluated existing projects for water resource development in the Pembina River Basin. Also, general observations and conclusions concerning various aspects of water resources use (including renewable resources and recreation) were made. The upper reaches of the Pembina River Valley are frequented by waterfowl, during their migration flights. A small population of harvestable fish is also supported in the upper reaches of the basin. The lower Pembina River supports a small sports fishery. These fish migrate up from the Red River, in the spring when small dams at Walhalla are submerged. They cannot, however, get over the dams during periods of low flow (winter and summer). The report also suggests that; because some of the larger lakes in the basin are less than six feet in depth, they are unable to support a permanent game population (Manitoba Water Resources Commission, 1973, pg. 10).

4.1.5.9 Roseau River

In southeastern Manitoba water management issues have been addressed by the International Joint Commission (1975) . Those appendixes concerned with related-resources and water quality, were reviewed, for the purposes of this report.

Quantity and Quality Concerns

According to the Canada Land Inventory Capability Studies, types of recreational activity that could be supported by the Roseau River basin include canoeing, swimming and backpacking. Commercial fishing does not exist in the area, but angling is very popular. Flows need to be maintained to at least 5 cfs (.14 m^3/sec) to prevent fish kills at 4.0 mg/l of dissolved oxygen. The quality, at present, is acceptable for most purposes, but high phosphorous and nitrogen concentrations are causing eutrophication.

The only major future requirement for water is the construction of waterfowl and wildlife impoundments near Green Ridge and Gardenton, involving a total of 1400 acres (567 ha).

Constraints to use, by recreation and renewable resources, exist in the Roseau basin. For instance, low flows in late summer severely restrict canoeing. Limitations to angling include: shortage of dissolved oxygen, fluctuations in the water level and inorganic turbidity.

Waterfowl production is limited because of: available nutrient level, shallow water, lack of permanent surface water and poor shoreline development.

4.1.5.10 Qu'Appelle River Basin

Waters of the Qu'Appelle Basin are used by cities, towns and industries, as well as by agriculture, recreation, fish and wildlife habitats. The Qu'Appelle Basin is located in southern Saskatchewan and encompasses an area of 20,000 square miles (51,800 km^2).

The Qu'Appelle River flows through seven major lakes: Buffalo Pound Lake, Fishing Lakes (Pasqua, Echo, Mission, Kotespwa, Crooked Lake and Round Lake). Water from the Qu'Appelle River is also diverted into an eighth lake -- Last Mountain Lake -- during periods of high discharges.

The eight major lakes of the basin serve as focal points for water-oriented pursuits, for the city of Regina, such as swimming, boating, fishing and water skiing.

Quantity and Quality Concerns

Quantity requirements of water for recreation and renewable resources are measured in terms of a specified level of water required rather than a particular volume. For instance, water for swimming must provide adequate areas for both wet and dry beach. For cottaging, a level of water must be provided for minimum shoreline erosion as well as piers and boat-houses. During the recreation season, stable lake levels are desired. Stable levels must also be maintained in order to protect archaeological and palaeontological sites in the basin. Also, latent flooding is necessary to maintain biological life which provides habitat for waterfowl and other wildlife, and provides adequate spawning grounds for the maintenance of fish populations (Qu'Appelle River Basin Board, 1972).

Quality requirements of the Qu'Appelle system should meet the water quality objectives set out by the Saskatchewan Department of the Environment. Recreational (particularly cottage) use of the area is so intense that it could compound eutrophication and lead to the demise of wildlife and recreation in the basin. The maximum monthly flow, by 1985, from the Qu'Appelle River to the Assiniboine, required to meet combined municipal industrial ,irrigation and wildlife will be 225 cfs (6.37 m^3/sec). (Qu'Appelle River Basin Board, 1972, pg. 33).

At present, the major constraint to optimal use of the Qu'Appelle basin is the lack of an adequate water supply. In order to accommodate all users of water in the basin, flow is augmented from Lake Diefenbaker. During drought periods, flow would be even less reliable. Another constraint to optimal use of the Qu'Appelle river is the high rate of eutrophication brought on by the addition of increased amounts of nutrients.

Indian lands occupy 10% of the land in the valley (Qu'Appelle River Basin Board, 1972) and yet some suggest that Indians have not had an input into the basin planning procedures. At present the Piapot Band is conducting a basin study of the Qu'Appelle. Until the Band clearly establishes their water needs, use will be severely constrained.

4.1.5.11 Assiniboine River Basin

Description and Water Use

Generally, the use of the Assiniboine river for fishing and wildlife activities is not well developed east of its confluence with the Souris River (International Joint Commission, 1976c, pg. 144). Camping, picnicing and swimming appear to be the three most significant recreational activities throughout the entire basin and water sports activities are growing at a rate comparable to the growth in population. Canoeing may have peaked as an increasing participation activity (MacPherson, 1976, p. 141).

Quantity and Quality Concerns

The major constraint to recreation use in the basin is water supply -- the flow of the Assiniboine River is augmented from Qu'Appelle River flow which is in turn augmented by the level of water in Lake Diefenbaker. Table 4.1.4 indicates the recreational capability of the Assiniboine River basin.

The major constraint to optimal use of the river for any water-related activities, downstream of the Souris River, is the potential impacts of the Garrison Diversion Unit. The introduction of foreign biota into the Red River System, from the Missouri drainage system was the subject of

TABLE 4.1.4 Garrison Diversion Area:
Recreation Capability: Summary of Acreages from Canada Land Inventory.

Note: to obtain hectares multiply acres times .4047

SECTIONS OF STUDY AREA

Generalized Recreation Classes	Souris River	Assiniboine River	Red River	Lake Manitoba	Lake Winnipeg	TOTAL
High Capability Classes 1, 2 & 3	0	18,000	9,000	38,000	42,000	107,000
Moderate Capability Classes 4 & 5	28,000	462,000	114,000	119,000	53,000	776,000
Low Capability Classes 6 & 7	259,000	468,000	212,000	902,000	302,000	2,143,000
TOTALS	287,000	948,000	336,000	1,059,000	396,000	3,026,000

Total area in Manitoba defined by 1:250,000 map sheets 62F,G,H,I,&J (see Figure D.VII.1) is approximately 18.5 million acres.

For summarizing the areas of the recreation classes, the Census Enumeration Areas that best defined the one-half mile boundary about the rivers and lakes were used for calculations. The high acreages in the Low Capability classes are attributed to the extended part of the enumeration areas beyond the one-half mile strip. These are therefore of little value.

Source: IJC (1976c) pg. 133.

the International Garrison Study Board Report which is discussed in section 4.1.5.14.

4.1.5.12 Souris River Basin

Description and Available Information

The major report dealing with water use in this basin is the report by the Souris River Basin Study Board (1978), initiated under the auspices of the Canada Water Act, involving the governments of Canada, Saskatchewan and Manitoba. In this study, an assessment of water-related resources of the Souris river basin and demands being placed on the river, were investigated.

Quantity and Quality Concerns

Most of the water in the basin (78%) comes from annual snowmelt. The mean annual flow is 343,000 ac. ft. per year (423,090 dam^3) or 270 cfs (7.65 m^3/sec). The natural lakes in the area -- Kenose Lake and White Bear Lake in Saskatchewan and Oak Lake in Manitoba -- are important recreational areas. Important waterfowl nesting and staging areas are also found within these and other lakes of the basin. Fish species found in the basin include yellow perch, northern pike and walleye. Perch and pike spawn in the flooded marshes at the headwaters of the Souris. Within the basin, in Saskatchewan, are one provincial park, one Indian reserve, and eight regional parks. There are numerous historic sites, but these do not place a great demand on water resources. Table 4.1.4 indicates that there is no land of high recreational capability in the Souris River basin.

The Manitoba portion of the river contains two provincial parks and eight community-sponsored recreations sites. The river is also used for canoeing and some angling.

Water is required in the Souris River basin for municipal use, irrigation, recreation, wildlife and thermal-electric power generation. In Saskatchewan, 15 Ducks Unlimited projects require 1400 acre feet (1726 dam^3) of water, while in Manitoba three projects require a total of 12,200 acre feet (15,049 dam^3) as breeding and staging habitat (Souris River Basin Board, 1978). In order to maintain a live stream at the Manitoba-North Dakota border, a flow of 20 cfs (.57 m^3/sec) must be maintained. A Clean Environment Commission report notes that lack of established minimum flow criteria during the winter months has been linked to declines in water quality resulting in depletion of fish stocks by winter fish kills (Manitoba Government, 1980, Information Services Branch).

A major water quality problem in the Souris River Basin is the high level of nitrogen and phosphorous. Much of this problem in Manitoba, has been attributed to the waterfowl refuge system in North Dakota.

Parts of the Souris River Valley are quite unique for their ecological, aesthetic, recreational and archaeological values, and water control could enhance these activities. In the long term future, a small reservoir near Redvers, requiring 100 acre feet (123.4 dam^3) of water, may be constructed.

Some waterfowl projects requiring pondage in the near future include: Kisbey Flats project (2700 acre feet) (3330 dam^3). The Plum Lake project in Manitoba will control water levels but will not significantly affect overall flows on the Souris. The project is on a small tributary of the Souris River (Souris River Basin Study Board, 1978, p. 88).

A major constraint to optimal use of water in the basin seems to be the very low flows in the summer. In this respect, then, optimal flows cannot be provided, and the only way to ensure recreational or renewable resource use of a basin's water resources is to augment flows specifically for those purposes. This, of course, would put these users of water in conflict with other users.

4.1.5.13 Garrison Diversion Study Area

The Garrison Diversion Unit is a water diversion scheme, now under construction in central and eastern North Dakota. It is designed to irrigate 250,000 acres (101,180 ha) of agricultural land. Water required to feed the project will be drawn from the Missouri River with the resulting waste waters being flushed into Manitoba Lakes through the Red and Souris Rivers. The major concern of Manitobans is that, according to the scientists, fish species introduced from the Missouri drainage system into the Hudson Bay drainage system will destroy up to 50% of the sports and commercial fish populations in Manitoba's lakes and rivers. The project has been halted temporarily, as a result of a decision by the United States Supreme Court.

Description and Resources

Because of the concerns shown by both Canada and the United States over the transboundary implications of the Garrison Diversion Unit (GDU), the International Garrison Study Board was set up by the International Joint Commission. Among the subject matters which the Study Board examined were:

1) Present use and anticipated uses of waters in Canada that would be impacted by the GDU.
2) Effects of present water quality on the study area, in Canada.
3) Impacts, on water quality and quantity, resulting from completion of the Garrison Diversion Unit (GDU).
4) Impact on the Manitoba fishing industry.

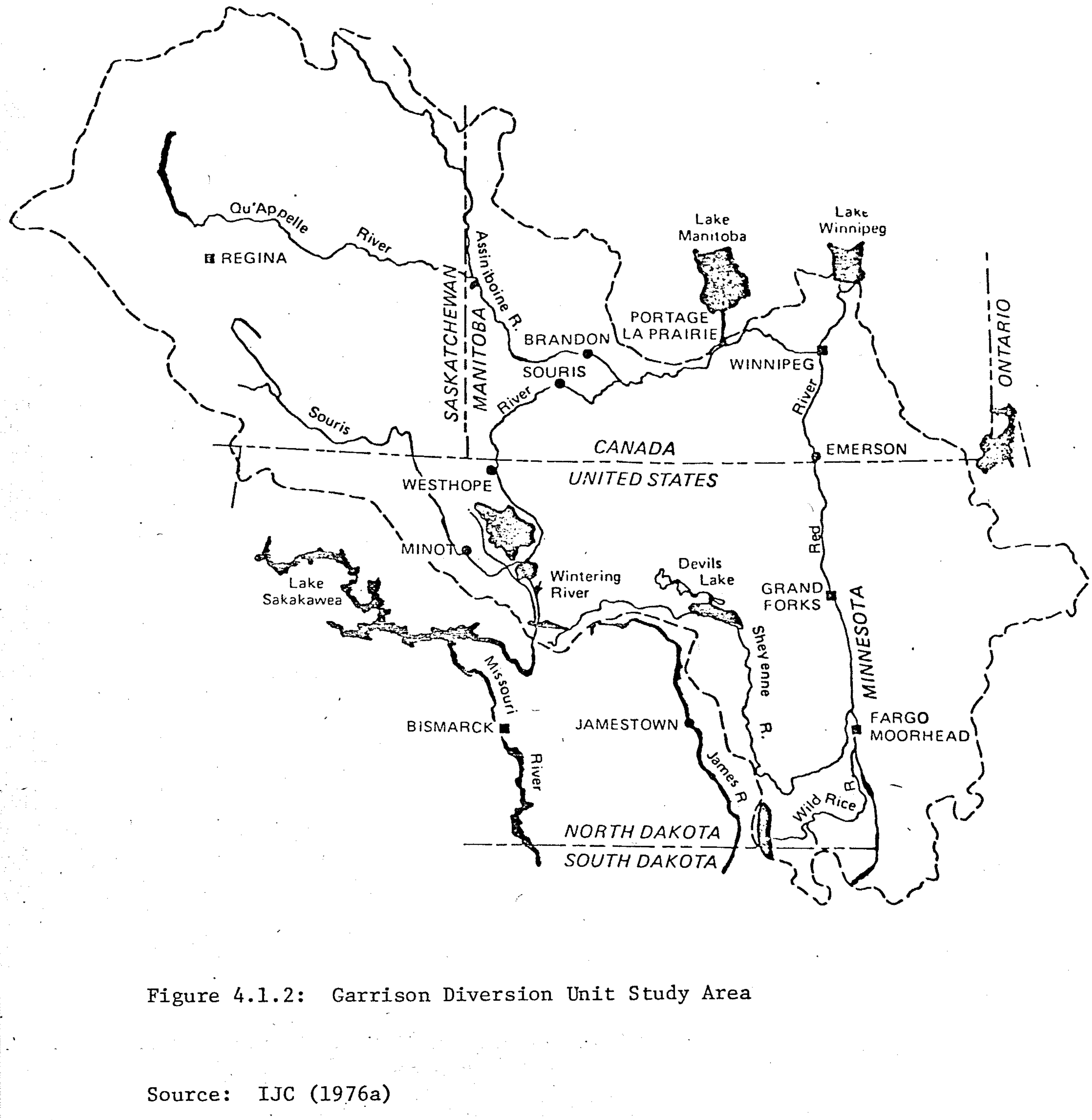


Figure 4.1.2: Garrison Diversion Unit Study Area

Source: IJC (1976a)

Present uses of water were determined from surveys, available data, and interviews; whereas anticipated uses were determined by consultation with knowledgeable people, and accepted forecasting procedures. The uses considered in the report included municipal and rural, industrial, agricultural, commercial trapping, outfitting, other commercial and subsistence uses and recreational uses. The water-based recreational activities were classified under three different categories: water dependent, water-oriented, and upland.

Quantity and Quality Concerns

Recreational use of the area was valued according to the area of land available (Table 4.1.4). A dollar figure was used to quantify value of renewable resources in the study area (Tables 4.1.5 and 4.1.6).

Table 4.1.7 describes some of the most widely accepted standards for evaluating the recreational value of water bodies. These criteria are generally consistent with the interim Water Quality Objectives for Manitoba. (International Joint Commission 1976c, pg. 139).

TABLE 4.1.7

WATER QUALITY CRITERIA FOR CONTACT RECREATION

Conditions	Criteria Measures
Clarity	- in designated swimming or diving areas Secchi disk should be visible on bottom - 1.2 m in other areas
Tactility	- conditions should not cause a pH change beyond the range 6.5-8.3 - water temp. should not exceed 30°C.
Taste and Odour	- free from substances which produce objectionable taste and odours
Health (Microbiological)	- free from pathogenic organisms so as not to pose hazards to health.

The study calculated demand in both recreation man-days and dollars for recreational fish and wildlife uses in Manitoba. These demands, as well as demands for commercial fish and wildlife uses, were projected for

TABLE 4.1.5 Garrison Diversion Area
Baseline Summary, Commercial Fish and Wildlife Uses in Manitoba.

(000's)

Environmental Aspect	1975 Expressed Demand	1985 Projected Demand	2000 Projected Demand
B1) Registered Trapping	$ 26.8	$ 26.4	$ 23.8
B2) Crafts	$ 13.0	0	0
B3) Commercial Fishing[1]	$ 2,977.2	$ 2,977.2	≥ $ 2,977.2
B4) Guiding	$ 198.0	$ 390.1	$ 1,076.6
B5) Outfitting	$ 1,344.0	$ 2,653.0	$ 7,311.0
B6) Frog, snake, salamander harvest	$ 39.4	≥ $ 39.6	≥ $ 39.4
TOTAL	$ 4,598.4	≥ $ 6,086.3	≥ $11,428.0

Source: (35, 36, 37)

≥ : Greater than or equal to
1 : Includes only walleye, sauger and whitefish food fish in Lakes Winnipeg and Manitoba, average 1971-76.

Source: IJC (1976c) pg. 148.

TABLE 4.1.6 Garrison Diversion Area:
Baseline Summary, Subsistence Fish and Wildlife Uses in Manitoba.

(000's)

Environmental Aspect	1975 Expressed Demand	1985 Projected Demand	2000 Projected Demand
C1) Subsistence Trapping	$ 62.3	$ 61.0	$ 54.9
C2) Subsistence Hunting	116.0 animals	116.2 animals	110.6 animals
C3) Subsistence Fishing	250.0 pounds	320.0 pounds	444.0 pounds

Source: (36)

Source: IJC (1976c) pg. 151

the years 1985 and 2000.

Swimming will continue to dominate water-dependent activities in the study area. It is expected to increase by 10 percent from 1975 to 1985 and by 12 percent to the year 2000. It is not likely that swimming in the Red and Assiniboine Rivers, within the city of Winnipeg, will increase at such a rate.

Factors of water quantity and quality seem to place the greatest constraints on present recreational use of the rivers in the study area. For instance, wide variations in Souris river flow reduce its potential use of many activities (canoeing, fishing). Spring floods also restrict many activities. Often, water quality of rivers in southern Manitoba does not meet criteria set forth by the Manitoba government, perhaps suggesting that the criteria are too restrictive. Large quantities of suspended solids and the occurrence of algal blooms are but two constraints that are placed on use of rivers in the study area.

Only sport fishing seems to be limited by current water quantity. Fish and wildlife tolerance levels for water quality conditions were compared to present levels in the Manitoba portion of the study, and it was found that no fish and/or wildlife populations were limited by water quality conditions of the regions. (International Joint Commission, 1976c, pg. 157).

Although archaeological resources are not overt consumers of water, their loss through erosion or flooding must be considered in calculating demand for water resources.

4.1.5.14 Lakes Winnipeg and Lake Manitoba

Lakes Winnipeg and Manitoba contribute significantly to recreational and renewable resource water use in western Canada. Lake Manitoba (especially the Delta Marsh area) is a prime area for waterfowl hunting as there are 100 small lakes in the vicinity. Lake Manitoba is also the scene of commercial fishing (it provides a livelihood for local fishermen, including treaty Indians). As well, a significant furbearer harvest is present. Lake Winnipeg has the largest commercial fishing industry in the province with 1,400 - 2,000 fishermen involved. Waterfowl, upland game and moose are found in the drainage basin and an important furbearer harvest takes place along shores, marshes and tributaries of the lake (International Joint Commission 1976c, pg. 144). Grand Beach, because of its vast sand beaches, is a popular recreational location in the summer months.

Manitoba Hydro's power development scheme on the Nelson River consists of Lake Winnipeg regulation and Churchill River diversion from Southern Indian Lake to the Nelson River. Lake Winnipeg is regulated between the levels of 711 and 715 feet (217 m to 218 m), and Southern Indian Lake is not to exceed 847 feet (258 m).

Quantity and Quality Concerns

It was predicted (Canada/Manitoba, 1975, p. 321) that beach widths would be reduced by 15 percent, 5-25 years after Lake Winnipeg regulation. The study also indicated, that when in 1974 the width of Grand Beach was reduced by some 20 percent there was not a coincident reduction in recreational demand.

Muskrat and waterfowl depend upon good growth of aquatic vegetation around the lake, however the level must not be too high or the habitat will be flooded.

The regulation of Lake Winnipeg, for use in Nelson River hydro development could constrain use of the lake for recreational purposes if beach width is consistently reduced by a substantial amount. Extensive storage of water in Lake Winnipeg also has the potential for disrupting waterfowl and aquatic furbearers.

4.1.6 Comprehensive Reports

In addition to studies which have proposed river basin plans or inventoried resources, for individual river basins, various reports have studied broader water resources management issues in the Saskatchewan-Nelson basin. The following section will discuss these reports.

4.1.6.1 Plains Aquatic Research Conference

One report, published by the Canadian Plains Research Centre (CPRC) (1980) is based on the proceedings of the Plains Aquatic Research Conference.

Reservoirs in the prairie were determined to have a significant impact on the water regime. Because of low precipitation and high evaporation, there exist lakes on the prairie (Little Manitou Lake and Old Wives Lake) which receive runoff from substantial drainage basins yet never rise enough to spill. Evaporation from their surfaces is great enough to equal inflow. Since, in most cases, surface area increases with storage volume, there is always a point at which supply begins to diminish with reservoir size, due to evaporation (Canadian Plains Research Centre, 1980, pg. 74). Reservoirs which are maintained for recreational purposes, must be carefully monitored to ensure that the supply for downstream users is not being diminished by the impoundment.

Water quality can be affected by recreation, thermal cooling and extensive use by waterfowl or livestock. Also, water quality requirements depend, to a great extent, on users. For example, recreational users are often sensitive to emergent vegetation and bacteriological quality (Canadian Plains Research Centre, 1980, p. 26). Generally, reservoirs were found to cause a high incidence of fish diseases. Resultant water level fluctuations destroy spawning grounds. The report mentions that a water resources inventory must be very general in nature, until constraints are placed on the resource. At this point, the inventory must be more specific (Canadian Plains Research Centre, 1980, pg. 55).

4.1.6.2 Ducks Unlimited Reports

Another important source of information concerning renewable resource use of water in the Saskatchewan-Nelson basin is Ducks Unlimited (DU Canada Ltd.) which, under a present program, is attempting to quantify a number of factors concerning wetlands in Canada.

Under a joint Ducks Unlimited (Canada) -- Purdue University program, data will be gathered by Landsat and analyzed. The goal of the study is to "identify wetland areas and catalogue their average shoreline miles, ratios of open water to emergent vegetation and other factors that determine a productive marsh". According to Sandy Macaulay, of Ducks Unlimited, "concentrations of wetlands, which appear, from the Landsat, to be viable [waterfowl habitats] will then be studied by ground crews" (Ducks Unlimited, 1980).

To date DU has constructed 1,718 waterfowl projects in Canada and 2,847,490 acres (1,153,234 ha) have been made available by Canadian landowners for waterfowl habitat development. This includes 11,264 (18,135 km) shoreline miles of habitat. Cumulative projects in the Prairie provinces have included 584 in Alberta, 454 in Saskatchewan and 264 in Manitoba. Most of this area is found within the Saskatchewan-Nelson basin.

Ducks Unlimited, in its 1979 Annual Report, describes its waterfowl projects in the prairie provinces.

Within Manitoba 13 new projects were started in 1979-80 involving 2,417 (978 ha) acres and 54.2 (104.97 km) shoreline miles. A huge project was begun at Summerberry marshes, near The Pas and 14 projects were under construction. In the Assiniboine river basin near Griswold, a project involves 2,700 acres (1083 ha). The project is being constructed with the co-operation of the Regional Municipality of Whitehead, which benefits from reduction in flood threats. Ducks Unlimited is also involved in projects with the Manitoba government to develop multi-use type wetland areas (specifically Delta Marsh).

In Saskatchewan, the largest DU projects is the Cumberland Marsh complex involving 320,000 acres (129,500 ha) in the Saskatchewan river delta. There are also 32 onging projects in Saskatchewan, involving 50,143 acres (24,358 ha) and 2,715 shoreline miles (435.3 km) of habitat. The Yorkton Creek Marsh project involves the Saskatchewan government and Ducks Unlimited, and when completed, will eliminate agricultural flooding, improve 12,000 acres (4,860 ha) and provide 175 shoreline miles (281.75 km) of waterfowl habitat.

By spring, Ducks Unlimited will be involved in a total of 43 new projects in Alberta involving 5,418 acres, (2194 ha) and adding 95.1 shoreline miles (153.1 km) of new nesting habitat. In addition, 11 projects were completed in 1979 involving 12,449 acres (5,038 ha). In the Ben's Lake project, on the floodplain of the Vermillion river, all waters except the flood flows of the Vermillion river will be diverted through the marsh, thus improving habitat conditions.

4.1.6.3 Federal Study of 1976-77 Drought

Fisheries and Environment Canada (1977), produced a report which deals with drought and water supply in western Canada. The report was based mainly on the 1976-77 drought conditions. Measures for increasing available supply of water in the region were discussed; and jurisdictional aspects of water resource management and related federal legislation and projects were reviewed.

The report has commented on renewable resource uses of water. Growing concerns for environmental values, since 1960, have led to an increased need to maintain streamflow levels to satisfy requirements for fish and wildlife, and for the maintenance of water quality.

Without actually inventoring water demanded by renewable resource users, Fisheries and Environment (1977) placed a dollar value on such users. In itself, this serves as an approach to evaluating non-consumptive water uses. For instance, licences for sport fishing in the prairie provinces totalled 575,000 in 1976. Using a questionnaire, it was concluded that $12,400,000 was spent on sport fishing in 1976 in Manitoba.

Waterfowl in western Canada are also economically very important and obviously water-dependent. Hanus (1975) indicated that the value of migratory birds to Saskatchewan residents amounted to $220 million in 1974. Up to 75 percent of North America's ducks are produced in prairie wetlands. Alberta, Saskatchewan and Manitoba support a total of 22,000,000 ducks and, without water, the consequences are obvious.

Drought is an obvious constraint to optimal use of streams by renewable resource users. For instance, a decrease in water level can result in loss of spawning grounds. Also, it can lead to a decrease in water quality as waters become warmer and less oxygen is available.

There are a number of major international streams in western Canada with transboundary connections between groundwater aquifers and surface drainage systems. Therefore, measures to ameliorate water shortages in the United States could have implications for Canada, over the long term. For example, in some instances (particularly the spring of 1977) the United States had difficulty meeting its commitment to maintain a flow of 20 cfs in the Souris river basin. The United States has claimed that drought was the reason for the deficiency, while others claim that better management, by the U.S. Wildlife Service of onstream ponds, may have lessened the impact of low flows in the Souris on Manitoba (Fisheries and Environment Canada 1977, pg. 35-36). A constant problem with hydro-electric reservoirs is the perception that people have of them as sources of stable water-based recreation. We become complacent and disappointed when the water level must be changed, in accordance with hydro power objectives.

4.1.6.4 Saskatchewan Environment Reports

Saskatchewan Department of the Environment (1976) produced an interesting document dealing with water resources in the province. In the recreation section several problem situations were noted:

1) Cottage development and boating have destroyed or disrupted prime wildlife habitat.

2) The quality of water in recreational areas has been lowered because of ineffective waste dispoal.

3) In addition, because of fluctuating water levels (man-made) cottages have been flooded out.

Water quantity requirements in the Saskatchewan-Nelson basin have been considered in a printout produced by the Water Rights Branch of Saskatchewan Environment. Information was sorted by sub-basin, and included projects in Saskatchewan having recreational, fisheries and wildlife uses. The printout includes information such as: proponent's name, reservoir capacity, basin number, purpose for which the project is being used, and a number of other characteristics. From the printout, purposes of the reservoirs can be categorized and total area of all reservoirs in each sub-basin can be calculated (See Table 4.1.8).

4.1.6.5 PPWB Water Demand Study

In the recreational part of the PPWB Water Demand Study, an inventory of all recreation sites was established. By then matching this inventory with visitor participation rates sites an estimate of water demand will be the result. Another sector of the study, dealing with fish and wildlife demand for water resources, will similarly identify habitats. The water demand study should be completed by March or April of 1982. (Murray Jones and Jill Vaisey, Prairie Provinces Water Board, Regina, 1980, personal communication).

4.1.6.6 Alberta Government Fisheries Report

A report by the Alberta government (1980), although not dealing exclusively with the Saskatchewan-Nelson basin, does relate to recreational and renewable resource water use. This report, concerned with the recreational and commercial fishing industry in Alberta, made some recommendations which indicate the importance of quantity and quality aspects of water use. It suggested that water quality criteria be established to protect fish resources; that minimum stream flow requirements be established to maintain healthy fish populations and that instantaneous minimum flows be legislated, for Alberta's rivers and streams. The recommendations address to the concerns of water use;

TABLE 4.1.8

SURFACE WATER PROJECTS IN SASKATCHEWAN

Purpose or Project	Multipurpose with Recreation <u>or</u> (with Wildlife)		Wildlife		Fisheries		Tourism and Recreation		Tourism Recreation and Others	
	Reservoir Area (ha.)	Reservoir Capacity (dams^3)	Reservoir Area	Reservoir Capacity	Reservoir Area	Reservoir Capacity	Reservior Area	Reservoir Capacity	Reservoir area	Reservoir Capacity
HUDSON BAY DRAINAGE										
Basin										
1. Old Wives Lake			714.6	645.6			2.2	23.4	212.8	8231.7
2. South Saskatchewan	5849.1	354603.7	768.1	6251.8			20.0	363.1		
3. North Saskatchewan					1708.2	7907.9	99.2	3601.8	75.7	1615.9
4. Qu'Appelle			3836.6	26362.7	19.3	783.3	93.6	19129.8	226.6	25533.1
5. Cypress Hills (North Slope			845.6	9262.0			0.0	0.8		
6. Souris	819.8	76337.2	912.3	6100.8						
7. Assiniboine	287.3 (89.0)	14308.4 (309.5)	911.2	7925.9	3.1	44.3				
8. Lake Winnipegosis			3179.1	21246.8			2289.1	19994.8		
OTHER HUDSON BAY DRAINAGE										
9. Churchill			4986.3	43732.1			40334.9			
MISSOURI DRAINAGE										
			1062.5	10545.0			26.3	488.4		172,687.5

Source : Saskatchewan Environment (1980) however, until extensive inventories and river basin plans are completed for each basin in the province it is doubtful if minimum instantaneous flows will be legislated.

4.1.7 General Concerns of Water Resource Managers

Discussion with various water resource managers have identified areas of concern with respect to recreational and renewable resource uses of water in the basin. For instance, fluctuating levels of reservoirs are seen as the greatest problem (Nes Mudry, Manitoba Department of Mines, Resources and Environment, personal communication, 1980) as people have expectations of stable water levels.

Water stored in reservoirs tends to evaporate very readily thus putting constraints on downstream users. The suggestion was also made that recreational reservoirs must be built close enough to populated areas, in order to justify costs. People would be willing to go to a reservoir containing water of a low quality rather than drive a further distance to an unpolluted reservoir (N. Mudry, Manitoba Department of Mines, Resources and Environment, Water Resources Branch, personal communication, July 1980).

In some areas of western Canada, extensive use of watercourses, by waterfowl, has been linked to water quality problems. Regina and Moose Jaw are spending substantial amounts of money to clean Qu'Appelle River water for drinking purposes yet, at the same time, Ducks Unlimited is planning a major water management area downstream. This adds to the nutrient load and thus affects recreational use and aquatic life. Nutrient problems are exemplified by concentrating birds in small areas (Mr. R. Hale, Environment Canada, Inland Waters Directorate, personal communication, Regina, August 1980).

Farm Drainage and Wetlands

A major concern to water resources managers is the controversy over the use of parts of their land for waterfowl versus its use for agricultural purposes. It seems quite reasonable, that because marginal farm lands are taxable, a farmer would choose to cultivate them. He looks to a way of increasing his acreage and thus the draining of wetlands seems to be an obvious solution. The major purpose for draining wetlands in the prairies was seen to be to consolidate, rather than decrease, wetland acreage. The secondary purpose was seen to be the perceived increase in cultivable acreage. The most obvious impact of such practices is, of course, that nesting habitats are destroyed and breeding birds are crowded into smaller and smaller areas (Zittlau, 1979, pg. 23).

The benefits to be gained from wetland drainage may however be short-lived. Wetlands, prairie sloughs and potholes are important regulators of spring run-off and storm flows. Their drainage results in the loss of temporary headwater storage and in increase in the magnitude of peak flows (Zittlau, 1979, pg. 26). Thus benefits derived from implementing drainage systems in one part of a drainage system may result in higher costs being incurred in another part of the system.

In order to prevent the unnecessary destruction of waterfowl habitat the answers may be found within the individual farm itself. Farming practices which encourage water retention (when it is needed) should be encouraged. Such practices include zero tillage and the retention of waterfowl habitats which serve as headwater storage areas (Sawatzky, 1981).

A system whereby, "wasteland", such as non-cultivable wetlands and shelter belts are taxed at a lower rate than cultivable land (Sawatzky, 1981, pg. 11) may also stem the onslaught of the drainage of wetlands.

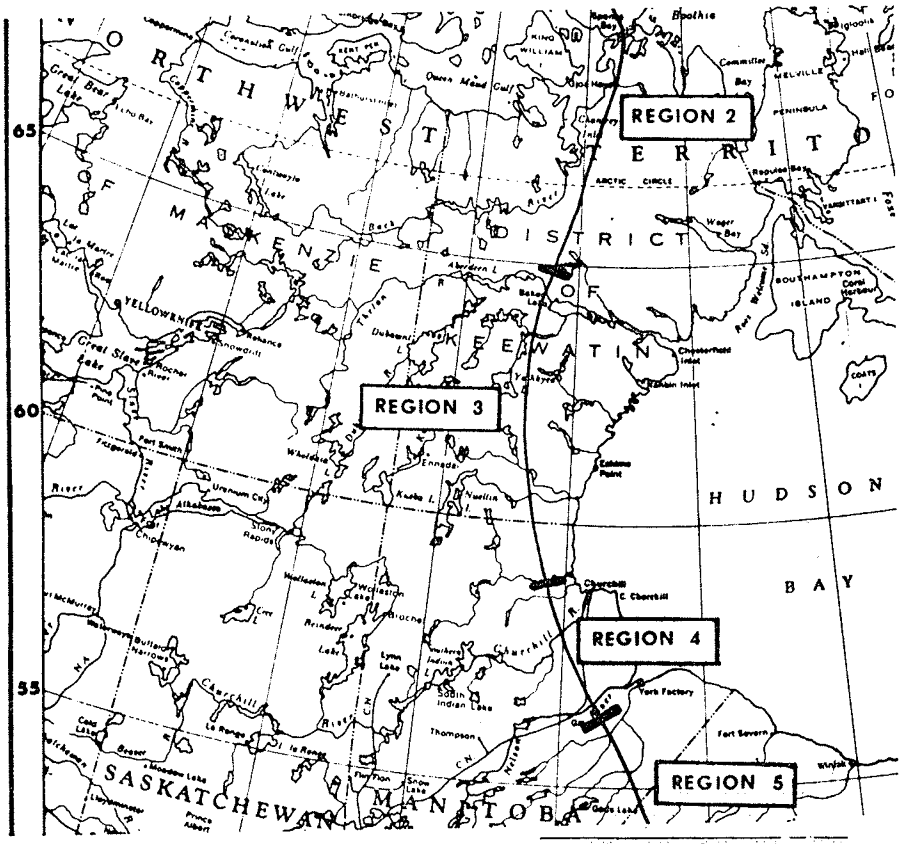
4.2 HUDSON BAY DRAINAGE II:

OTHER HUDSON BAY DRAINAGE

4.2.1 Introduction

One can appreciate that the Saskatchewan-Nelson basin is, economically speaking, the most important of those basins draining to Hudson Bay. The importance of other drainage to Hudson Bay (see Table 1.1), in western Canada is quite substantial. Of the total area of drainage into Hudson Bay, from western Canada (1,715,500 km^2), 503,000 km^2 (29.3%) is from major drainage basins not in the Saskatchewan-Nelson system. Major rivers flowing into Hudson Bay, from western Canada, discharge 6,164 m^3/sec. The Saskatchewan-Nelson system contributes 2,830 m^3/sec; the other major rivers contribute 3,334 m^3/sec. This, of course, represents natural flow; and thus accounting for a maximum diversion of 850 m^3/s of the Churchill River into the Nelson River, other Hudson Bay drainage still accounts for a considerable portion of the entire discharge.

As with the Mackenzie River, most information concerning water quality and quantity in the other Hudson Bay drainage area is collected on an *ad hoc* basis. Except for the Churchill basin, little data exists concerning the topic. Studies conducted in the past few years have consisted of "engineering reconnaisance studies [which] have been carried out in many rivers in the NWT in anticipation of major development projects such as the Mackenzie Valley and the Polar Gas pipeline route, potential mines, etc." (Jasper, Hydrologist, Department of Indian and Northern Affairs, personal communication, Yellowknife, 1980). The purpose of these studies has been mainly to assess hydroelectric power potential in northern rivers, and to assess the effects of pipeline construction on fisheries and wildlife.



Scale : 1cm=160km

Figure 4.2.1 Hudson Bay Drainage

Source: Polar Gas (1978)

4.2.2 Resources and Literature Available

Extensive studies have researched the water resources of the Churchill River basin, yet little work has been done on the more remote rivers of the northern Hudson Bay region and the region south and east of the Churchill River. The majority of information concerning Other Hudson Bay drainage has been collected as a result of the application of Polar Gas to the National Energy Board, requesting permission to build a natural gas pipeline from Melville Island, in the Arctic Ocean, down the west side of Hudson Bay to Longlac, Ontario. Literature surveys, as well as field studies, were completed in this report.

One river basin, the Hayes, was studied by the Manitoba Department of Mines, Resources and Environmental Management. The objective of the study was to assess the current resource utilization of the area. Non-consumptive, as well as consumptive, use of the river was considered in this report. The Hayes River study was a first step by the Manitoba government into setting water quality guidelines, in that region of the province. For resource information, "Mid-North Manitoba" (Manitoba Mines, Resources and Environmental Management, 1977) provides an excellent bibliography.

In addition to the above-mentioned reports, a number of studies have considered the recreational and renewable resource uses of the Hudson Bay drainage system. For instance, the Inland Water Directorate of Environment Canada (1979b) conducted a study to determine the impacts of the Churchill River Diversion upon the water quality of the Burntwood and lower Churchill Rivers. A report by the Manitoba Mines, Resources and Environmental Management completed an impact assessment concerned with the fish and wildlife resources of the lower Nelson River.

Generally, along the west coast of Hudson Bay intensive use of renewable resources (hunting, fishing) occurs near communities. Recreational use of water resources, although very limited, is much more intensive than it is further inland where it is restricted to a few canoeing parties and a number of fly-in fishing lodges.

Two basic soil types are found in the study area. In the Manitoba section, rock, peat swamp and sub-arctic soils are characterized by a combination of spruce-bog and barrens. In the Northwest Territories (NWT), tundra is the dominant soil and vegetation type.

The uses of the land and water resources of the Hudson Bay drainage area can be characterized by three biomes occuring in the area. Arctic tundra conditions prevail on the mainland, south to the Manitoba border (south of Churchill along Hudson Bay). This area is characterized by larger rivers and lakes, with fish being more abundant than in the Arctic Islands. In the tundra-forest transition zone the extensive organic terrain supports moose, aquatic furbearers and various species of waterfowl. In the southern (boreal) zone, fish species are quite abundant and grow faster than those in northern watercourses (Polar Gas 1978, p. 3).

4.2.3 Polar Gas Study

For the purposes of this chapter, three regions of the Polar Gas Study (see Figure 4.2.1) will be considered. Region 3 is called Hudson Bay North and extends as far south as the Caribou River drainage area. Regions 4 and 5 extend south to the Severn River drainage area.

The major inhabitants of the area are Inuit, and other native groups, who make intensive use of renewable resources (hunting, fishing and trapping) near their communities (Jasper, personal communication, 1980). Recreational use is rather limited because of the remoteness of the region. Limited amounts of sport and commercial fishing do occur in the lake and rivers adjacent to Hudson Bay.

Resources and Quantity and Quality Concerns

Because the subsistence economy in the Hudson Bay drainage area is based to a large extent on fishing, the remainder of this section will deal with the requirements and the effects of aquatic resources upon the water regime. Thus the quantity of water required for renewable resources would be that which is necessary to maintain the habitat of the several fish species in the area. Since Canadian Drinking Water Quality standards must be maintained in Northwest Territories rivers, such standards could be interpreted as the water quality requirements. In the Polar Gas Study, renewable resource users of water resources do not seem to have any quantity or quality effects upon the water regime nor do they place constraints on other water users.

Within region 3 of the Polar Gas Study, 37 small streams, as well as 16 large water courses were recognized as good or excellent for fish. (Hatfield et al 1978, pg. 53). In this region the Baker Lake complex harbours at least nine major fish species. The connected rivers and lakes of the complex also provide the essential habitat for fish spawners. The grayling is the chief species of the region. It typically spawns in streams which are clear and unpolluted and contain a gravel substrate. All stages (adults, juveniles, and fingerlings) overwinter in deep river pools and lakes (Hatfield et al 1978, pg. 82).

Within region 4 there exist 11 major fish species. The Churchill basin contains the majority of the region's good and excellent streams, even with the reduction in flow as a result of the Churchill River diversion.

Brook trout are found in a number of drainages in Manitoba, being most common in the lower Nelson drainage area. Their northern limit is the Seal River; and thus they are also found in the Hayes River (God's River) and lower Churchill River drainage areas. Legislation has been set up by the Manitoba government to protect some of these last remaining natural brook trout populations in North America. Some recreational use of the rivers in this region is carried out by the residents of Gillam and Long Spruce and there is a sports fishery on God's River (in Hayes River drainage area) (Hatfield et al 1978, pg. 93).

As in the other regions, the authors mention that precautions (where possible) should be taken to protect fishing areas. The brook trout, for instance, have very specific requirements for clear and cold water; and because they have such a limited distribution, it is quite important that each spawning and rearing area be protected.

Within region 5 (the boreal forest), mainstems and lakes are increasingly important as fish habitat; whereas most small streams are bog drainages and hence often become beaver dammed.

From both an aquatic and a recreational standpoint, God's River is one of the most important watercourses of the region. "Each year it is travelled by canoeists in search of its rapids, scenic beauty and good fishing." (Hatfield et al 1978, pg. 97). Because of its low turbidity and excellent water quality, God's River is both a spawning area for brook trout and an overwintering area for various species including walleye, longnose sucker, whitefish, yellow perch, and sturgeon. (Hatfield et al 1978, pg. 79). The quality requirements of God's River are thus those necessary to maintain a viable fish population. Stream standards have not yet been determined by the Manitoba government, for the God's River basin.

The Churchill River basin, because of its vast drainage area will be considered separately in this discussion of Hudson Bay drainage.

4.2.4 Churchill River Basin

Three extensive studies, as well as a board of inquiry have investigated the water resources of the Churchill River basin. Manitoba Hydro was granted a licence to direct a great portion of the flow of the Churchill River into the Nelson River. In order to determine the impacts of such a scheme the Lake Winnipeg, Churchill, Nelson Rivers Study Board was set up by the Canadian and Manitoba governments, under the auspices of the Canada Water Act. In the Saskatchewan portion of the Churchill River environmental impact studies were initiated because of Saskatchewan Power's wish to consider using the Churchill River for additional generation of hydroelectric power. A three-party study (Canada, Saskatchewan, Manitoba) was initiated under the Canada Water Act. This study considered the impacts of various impoundments (and thus various flows) upon the water resources of the downstream users. As the majority of the water resource users in the Churchill basin are native, the Saskatchewan Federation of Indians produced an impact study in order to view the hydro project from their perspective. (Saskatchewan Federation of Indians, 1976).

It is interesting to note that different groups have different perceptions of the renewable resources of a particular region. For instance, in the Churchill River Study Board Report (1976), the important resources of the area were deemed to be recreational (canoeing, sports fishing and primitive camping). The Saskatchewan Federation of Indians (1976, pg. 423) sums up its interpretation of the resources of the region with the following quote:

> The only resources of great potential for economic development known to remain in the Churchill River basin are the water and the trees, but resources not

> ceded in treaty. The state of the water must not be altered since directly or indirectly, it is the basis of the Cree lifestyles and to sacrifice the water is to sacrifice their lifestyle.

4.2.4.1 Churchill River Study and Board of Inquiry

In order to maintain the area as a recreational resource (fishing and canoeing) it was suggested, in the Manitoba portion of the project, that the flow of the Churchill not drop below 17,000 cfs (482 m^3/sec) and that fluctuations of water levels in summer not exceed four feet (1.22 m)

Historical data on physical water quality is scarce but the Churchill River Study Board (1976) did determine the existing water quality conditions at a number of locations on the Churchill and Reindeer Rivers and Reindeer Lake. Water quality requirements _per se_ were not determined but the relationship of water quality to the provincial standards was determined.

The major constraint to the use of the Churchill River as a recreational resource seems to be its remoteness from the populated regions of Canada. The Churchill Board of Inquiry (1978), however, did mention that the recreational use of parts of the Churchill River by native groups themselves was underestimated.

The Churchill River Board of Inquiry was set up by the Saskatchewan government to gain public response to its proposed hydroelectric dam. It was charged with recommending whether or not the dam should have proceeded. This remoteness is expressed by the Churchill River Study quite aptly: "although it is suitable for extensive use such as whitewater canoeing, camping and fishing it is a wilderness area and is not suitable for intensive use" (Churchill River Study Board, Summary Report 1976, pg. 32).

4.2.4.2 Saskatchewan Federation of Indian Report

The Cree of the Churchill Basin did not quantify or qualify their need for water resources but suggested that their occupation of the basin for many centuries and their dependence on the natural resources (domestic and commercial utilization of wildlife, the fishery, water and the forest) attests to the importance of such water resources. Thus the objective of the study was not to quantify resource use but to demonstrate the continuity of use during the lifetime of the contemporary Churchill Basin Cree. The area to be flooded (Saskatchewan Federation of Indians, pg. 321) by the proposed hydroelectric dam, as well as the extent of resource utilization, is indicated in Figure 4.2.2.

This study suggested that, on an annual basis, domestic food production constitutes 45 percent of the value of production, earned income 27 percent and transfer payments 18 percent. Thus domestic food production still remains the most valuable sector in the native economy. (Saskatchewan Federation of Indians 1976, pg. 319)

The report concluded that; since the proposed dam offers no significant benefit to northern natives in terms of employment opportunities, skill development or investment opportunities, it should not be built. It was also suggested, that in order to maintain the importance of domestic production within the basin, the present state of water quantity and quality should be maintained as these factors do not, at present, place any constraints on the renewable resource use of the basin.

The Churchill Board of Inquiry decided, as a result of careful analysis of the findings of the Churchill River Study, presentations at public hearings and discussions with knowledgeable people, that the hydroelectric project was not necessary.

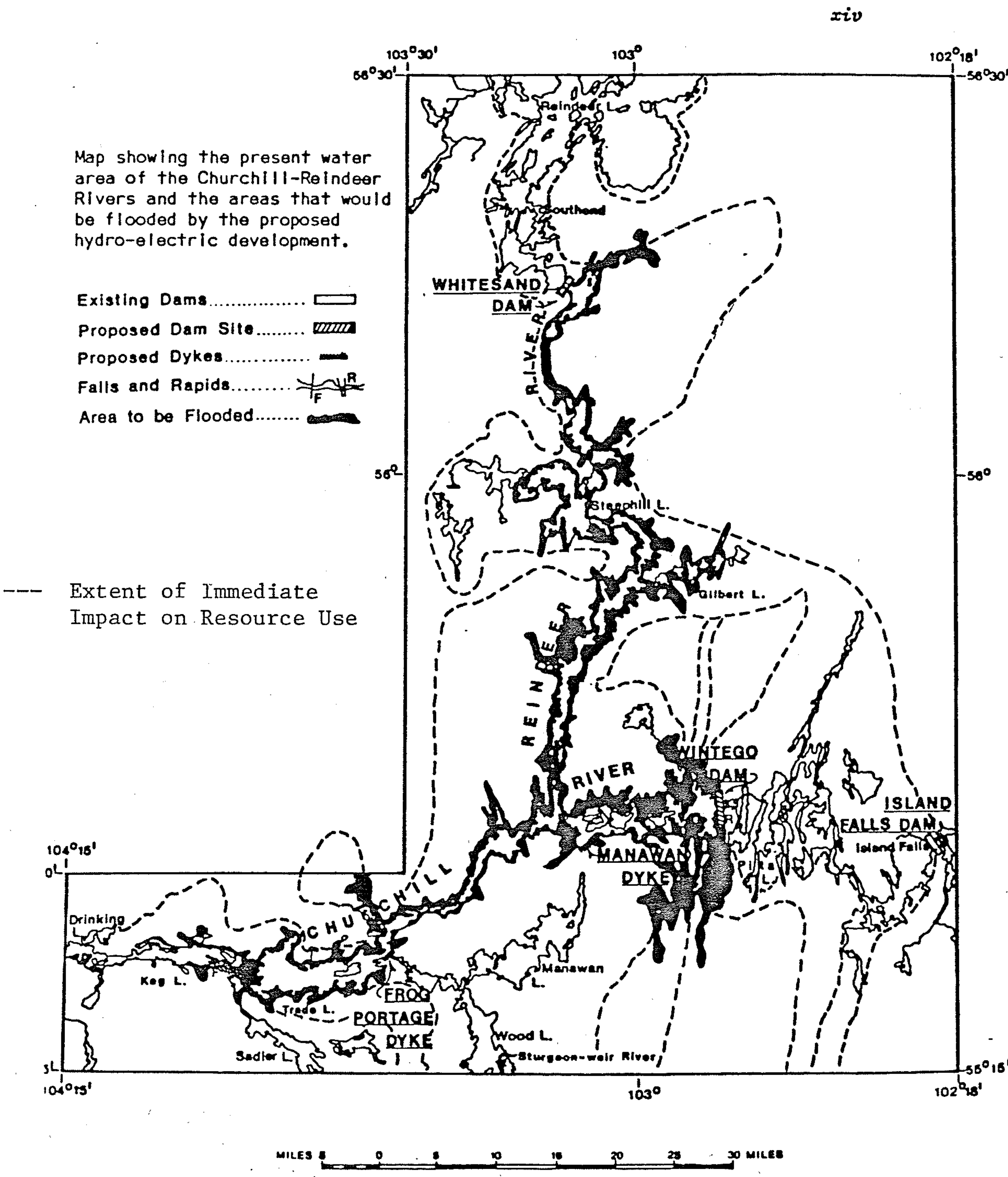


Figure 4.2.2 Impact of Churchill River Hydroelectric Development on Resource Use

Source : Saskatchewan Federation of Indians (1976) pgs. iv and 346

4.2.4.3 Acid Rain as a Constraint to Water Use in Northern Saskatchewan

A foreseeable constraint to the recreational and renewable resource use of Saskatchewan's water resources is the problem of acid rain. Air pollutants, primarily sulphur and nitrogen oxides, mix with water vapour in the atmosphere and then fall to the earth as acidic precipitation -- acid rain. Acid rain can cause deterioration of aquatic ecosystems; and by increasing soil acidity, cause reductions in crop and forest productions.

Much attention has been directed towards the acid rain problems of eastern Canada; however, Saskatchewan may have similar problems. A study by Dr. U.T. Hammer, at the University of Saskatchewan has shown that acid precipitation as low as pH 4.6 is presently occurring in Saskatchewan. Emissions from heavy oil and tar sands projects, in north-eastern Alberta will compound the problem. It is the Precambrian Shield lakes of northern Saskatchewan (in the Churchill River and Arctic drainage systems) which will be most affected, because of their low buffering capacity. The report states that "the technology of the removal of acidic gases must be improved drastically to prevent the loss of fish populations from northern lakes. If this is not done, recreation, through fishing, will be dramatically reduced in the next few decades. Commercial and domestic fisheries, the mainstay of many northern natives will likewise be greatly affected.

Ontario has completed economic studies determining the impact of acid rain, but Saskatchewan has not yet done so. To appreciate the problem, estimates have been made concerning the value of renewable resouces to the province:

- there are 150, outfitters associated with 285 lodges in northern Saskatchewan

- capital costs; by the outfitters, amounts to $24 million
- 600 people, earning $2.2 million are employed
- 62,000 anglers spent $8-$10 million in northern Saskatchewan in 1975
- the commercial fishing industry in northern Saskatchewan in 1980 employed 1,600 - 1,800 people who earned $3.5 million

Tourism and recreation were not even considered in this report yet clearly the potential for acid rain must be considered in water resources management (especially in northern Saskatchewan). (Saskatchewan Environmental Advisory Council, 1980, pg. 4-8).

4.3 ARCTIC DRAINAGE I: MACKENZIE RIVER DRAINAGE

4.3.1 Introduction

The Mackenzie River basin is the dominant basin in the Arctic Drainage area. By area, it is the largest river basin in Canada and one of the ten largest rivers in the world. In the North, it is very important as a transportation route and as source of food and livelihood for Canada's native people. To Canada, it represents one of the last great rivers that has not yet been polluted. The Mackenzie drainage basin encompasses nearly one-fifth of the area of the country--taking in northwest Saskatchewan, the northern half of Alberta, most of northern British Columbia, the eastern Yukon and the western part of the Northwest Territories. Major rivers draining into the Mackenzie include the Athabasca, the Peace, the Slave and the Liard.

The Mackenzie Valley in the Northwest Territories has provided a home and subsistence for the local native people. It has also provided the main transportation route upon which the northern fur trade was built and is today, a vital link between the people and the communities of the region. Because it is a natural travel corridor, it now sees competing uses by wildlife, traditional activities of native people and the advance of industrial development (Berger, 1977, Vol. I, p. 77).

Most of the Mackenzie basin's 250,000 people live in the Peace-Athabasca region of British Columbia, Alberta and Saskatchewan. North of 60° north latitude, the population density in the basin is one person per 50 square miles (130 km^2) compared to Canada's average of five persons per square mile (13 per km^2).

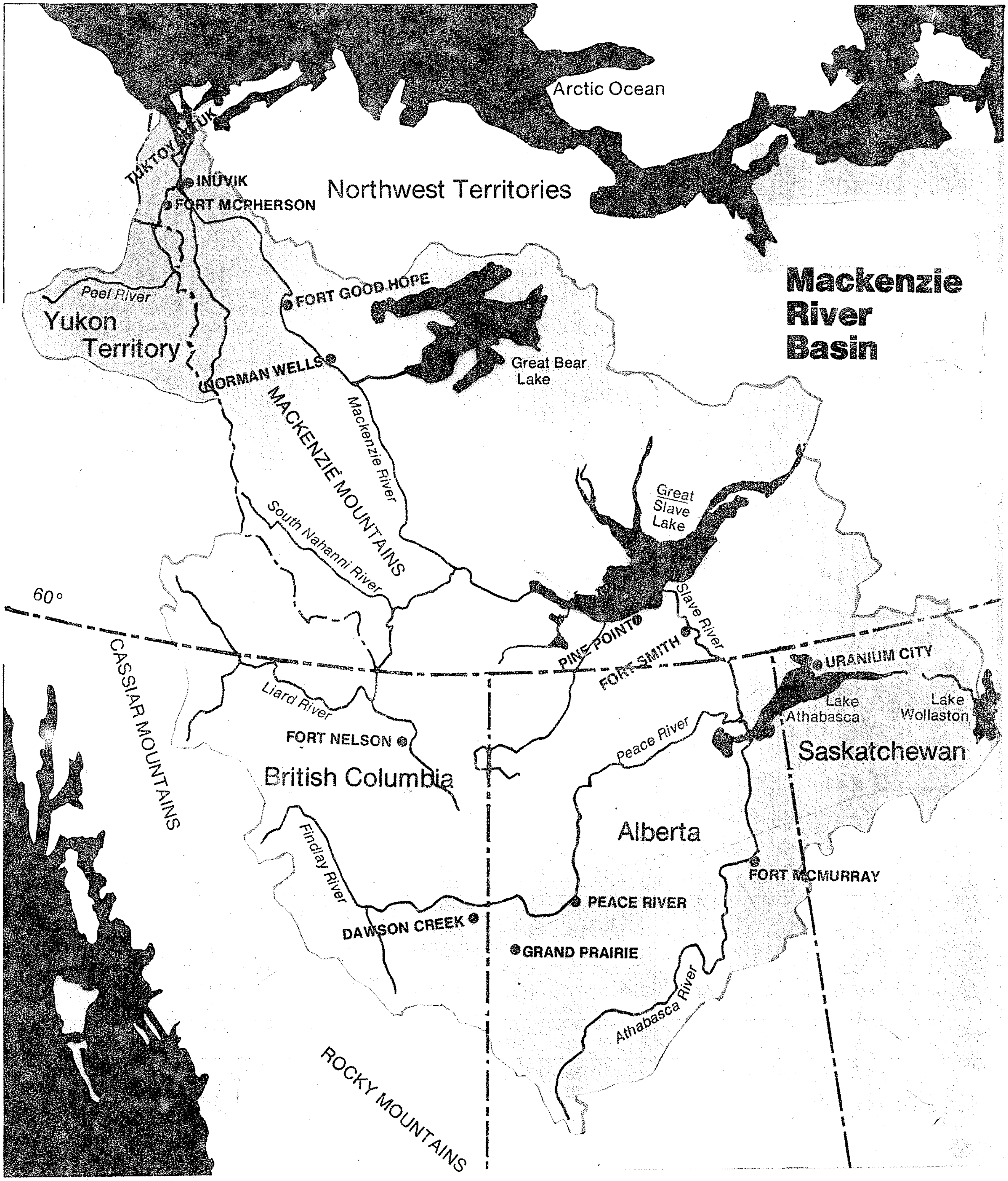


Figure 4.3.1 Mackenzie Drainage Basin

Source: Environment Canada (1975) p. 40.

An indication of the importance of the river to the north is indicated by the fact that from Fort Smith, on the Alberta boundary to Inuvik in the Mackenzie Delta, 18 small communities are dependent on the river for their supply line in summer, their community water supply, their source of fish for food and recreation and their source of furbearing animals for trapping. Because of the vast area of the Mackenzie basin; and because of the recent proposals for development in the north (particularly the Mackenzie Valley Pipeline), the majority of information dealing with northern water resources has dealt with the Mackenzie Basin. Because of the immensity of the basin and the sparseness of the population, detailed data on water use has not been collected on a comprehensive scale--dealing only with those areas that have been of economic importance.

4.3.2 Research Conducted

Most research dealing with the entire Mackenzie basin has been undertaken by the federal government through the Department of Indian and Northern Affairs and Environment Canada. Since 1972, because of the perceived importance of water resources of the basin and because of foreseeable impacts upon the water resources of the basin, a number of inter-governmental studies (Canada, Alberta, Saskatchewan, N.W.T. and British Columbia) have been initiated. Justice Berger's report (1977) concerning the impact of the proposed Mackenzie Valley gas pipeline and K.M. Lysyk's report concerning the Alaska Highway gas pipeline, have added to our knowledge of Canada's Arctic water resources.

The Water Survey of Canada conducts water quantity and quality monitoring programs. The data can then be used in comprehensive river basin planning. No comprehensive river basin study has yet been completed on the Mackenzie. Specific information dealing with renewable resources of the Mackenzie Valley was best dealt with in Justice Berger's two-volume report on the Mackenzie Valley pipeline hearings. The updated Mackenzie Basin Reference Binder is the best source of information dealing with aspects of the entire basin.

In 1978, the Government of Canada, British Columbia, Alberta and Saskatchewan agreed to a program of studies dealing with the Mackenzie River basin to "increase their understanding of the basin's water and related resources, thus facilitating future cooperation in planning and management for the best use of these resources." (Mackenzie River Basin Committee, 1979, p.80). The program is to span three years, and with a budget of $1,600,000, it will touch a number of aspects of water use within the basin. Because of land claim issues in the North, native groups are also preparing data dealing with water use and resource inventories. Understandably, the information is not yet available to the public, pending land claim settlements between native groups and the federal government. The most detailed report dealing with water management in the north is that of William MacLeod (1978) entitled "Water Management in the Canadian North".

In addition to the overview studies that have dealt with the Mackenzie drainage basin, a number of studies have been concerned with individual sites on the Peace, Liard and Slave rivers. These reports have been produced by provincial governments in order to determine the impacts of hydroelectric dams on the respective rivers.

4.3.3 Resources

Because of the vast area of the Mackenzie River basin, it is rather difficult to generalize on the renewable resources of the entire region; however, it can be said that native people are the predominant users of the resources. Native land use, as it is highly traditional, focuses on renewable resources--moose, caribou, furbearers, fish and birds.

The Mackenzie Valley is one of North America's great migratory bird flyways. Large numbers of ducks and some Canada geese, loons and shorebirds' nest in the Mackenzie Valley. Some raptors, including the peregrine falcon and the gyrfalcon nest in the Mackenzie Valley, Mackenzie Delta and the Northern Yukon. Mammals found in the basin include woodland caribou and moose. Furbearers include beaver, lynx, marten and muskrat. The Mackenzie River contains some 34 species of fish. Some are spring spawners, others are fall spawners and the burbot spawns in winter. Each of the species, including grayling, yellow walleye, northern pike, longnose sucker, whitefish, cisco, inconnu, trout and others have different sensitivities to disturbances. Limited knowledge now exists of the population distribution and dynamics of fish in the Mackenzie drainage system. The domestic fishery has traditionally been very important throughout the basin, as a source of protein.

Commercial, domestic and sports fishing are all undertaken in the Mackenzie River. Sports fishing is confined to rivers and lakes near highways or fly-in camps. There are numerous, sparsely spaced recreational fishing lodges in the basin. Domestic fishing is carried out mainly by gill netting.

The chief areas of commercial fishing in the basin are the larger lakes--Great Slave Lake in the Northwest Territories, Lake Athabasca in Alberta and Saskatchewan, and Lesser Slave Lake and Lac La Biche in Alberta. The extent of this industry can be seen in Table 4.3.1.

Use of water resources for recreation in the Mackenzie basin was not considered to any great extent in the Berger report but Berger did mention that recreation and tourism are on the increase in the valley. For instance, the Mackenzie itself is one of the few Canadian rivers without dams and it may thus be considered as an Historic Waterway. A number of tributaries could qualify as wild rivers and many are of historical and archaelogical interest. The present and potential regulation of the Mackenzie's major tributaries, for hydroelectric purposes, may however, detract from the river's possibilities for historical significance.

TABLE 4.3.1

MACKENZIE BASIN COMMERCIAL FISH PRODUCTION

	1977-78		1978-79	
Lake	Lbs.*	Dollars	Lbs.	Dollars
Lake Athabasca	759,445	213,095	333,033	128,687
Lesser Slave	606,872	115,894	768,759	211,982
Lac la Biche	134,556	40,007	165,494	61,289
Great Slave	3,592,505	1,029,706	3,424,000	1,314,129
Total	5,093,388	1,397,702	4,691,286	1,716,215

Source: Compiled from Production Statistics of Canada Department of Fisheries and Oceans, Industrial Performance Branch, Winnipeg, Manitoba.

* 1 lb. = .454 kg.

4.3.4 Water Quantity Concerns of Mackenzie River

Because a great deal of fishing takes place in the Mackenzie Basin, the quantity and quality requirements of fish are of great concern. In the North, spawning and rearing areas, overwintering sites and migration routes are all critical fish habitats. In order to survive severe arctic winters, fish must stay in waters that are sufficiently deep that they will not freeze to the bottom. Thus Berger (1977, Volume II, p.112) recommends that the flow in such areas be monitored.

General comments can also be made concerning the quantity requirements of other renewable resource water users. Thus, it was suggested that "although aquatic vegetation, furbearers, waterfowl and fish can tolerate a certain range of natural or seasonal fluctuations in water levels, untimely changes may cause effects from significant to severe." (Berger, 1977, p. 89, Vol. II). Muskrat and beaver are restricted to standing water or running water where the depth can be manipulated. Disturbance of open water areas can threaten the habitat of otter and mink.

4.3.5 Water Quality Concerns of Mackenzie River

Nutrient supply, water clarity and water temperature are the three most important factors to consider in biological aquatic productivity. For organisms in clear streams and lakes of the Mackenzie Valley, the biologically critical level for suspended sediments appears to be 10-16 milligrams of suspended sediment/litre of water. Organisms of the Mackenzie Delta area can tolerate large amounts of silt during the spring flood stage. The effects of silt in the environment during winter are unknown. In northern waters, even without man's influence, the concentration of dissolved oxygen may fall to 1 mg/l under the winter ice which is well below the needed 4 mg/l in temperate waters. (Environment Canada 1979c, pp.5-26) Many species are limited to large rivers, lakes or areas of open water when winter temperatures become severe. If such areas are sufficient in volume, discharged ground water becomes rapidly oxygenated. It can be seen, then, that such areas are critical overwintering. habitats for many species of fish.

Just as with any fish species, the spawning grounds of northern fish must have tolerable chemistry, dissolved oxygen silt loads and be free of toxicants. Northern fish have a limited tolerance to changes in water chemistry--that is to changes in temperature, in the level of suspended solids, dissolved oxygen and in pH and salt content (Berger, 1977, p.12).

4.3.6 Peace Athabasca Delta

History of Water Level Controversy

The Peace Athabasca Delta is one of the world's largest fresh water deltas, a rich one-half million acre boreal landscape that was once part of Lake Athabasca. Historically, the production of its wetlands have been almost entirely dependant upon the varying water levels of the lake. In the past, when lake water levels were low, they were returned to normal by spring flooding of the Peace River and Lake Athabasca itself. The Bennett Dam on the Peace River has been directly responsible for the reduction in water levels in Lake Athabasca. During the filling of Williston Lake (created by the Bennett Dam) it was determined that flows in the Peace River, adjacent to the Peace-Athabasca Delta were reduced by as much as 20,000 cfs, (566 m^3/sec) consequently the level of the river at that point was 10 to 12 feet (3 to 3.66 m) lower then it would have been without regulation. Thus, as a result of the building of Bennett Dam, Lake Athabasca was reduced by 2.5 feet (.76 m). The lakes connected to the delta and dependent on its flood-waters for their water supply, lost water rapidly. Between 1968 and 1970, 125,000 acres (50,287 ha) of new mud flats were exposed. From 1968-1971, 36 percent of the perched basin shoreline disappeared (Fisheries and Environment Canada, 1976, p. 51). The Peace-Athabasca Study Group; having proposed alternative plans for improving the water levels of Lake Athabasca, in order to restore the delta to its previous state of productivity, decided that the minimum action that should be taken was to restore the natural regime of Lake Athabasca and to supplement this with local works, in certain areas, to improve fishing and trapping for the people of Fort Chipewyan.

In response to the recommendations of the Peace-Athabasca Delta Study Group and to the results of public hearings, Canada, Alberta and Saskatchewan entered into an implementation agreement. Supervision of the construction was assigned to the engineering group of PFRA at a cost of $2 million (Fisheries and Environment Canada, 1976, p. 52).

The information contained in this section will be drawn mostly from these hearings. The needs of the resources, and of the people in the delta are important to the needs of the entire Peace-Athabasca basin. The renewable resources and the recreational possibilities of the area, before the building of the Bennett Dam, will be considered as an accurate picture of today's resources.

Normal summer fluctuation of three to four feet in the water level was considered to be normal. In the hearings, it was also suggested that water levels would be determined by bioenergetic studies which would determine the quantity and variety of food sources required.

Whitefish, tulibee and lake trout rely on the Delta for sufficient water levels for spawning and therefore low water levels could have serious consequences. Muskrats in the area also require suitable water levels to maintain their habitat (Alberta Department of the Environment, n.d., p. 15). Resource use in the basin can best be understood by the relationship between human ecology and biological resources. Sal Marten, a Cree trapper best summed up the water quantity needs of the area when he said:

> About trapping, the water is the boss. No water and you can't get anything to make money with or any kind of living. When there is water, there are waterfowl, moose, lots of muskrats and lots of beaver. The right level of water--not too much and not--not enough but the right level of water.

The major constraint to the optimal use of water by renewable resources and by recreational pursuits (especially Wood Buffalo National Park) is thus the proper level of water, because--without adequate flooding of Lake Athabasca, the Delta would not exist.

4.3.7 Peace River

British Columbia has developed ten generating units at its Gordon M. Shrum Generating Station on the Peace River. In addition, it is seeking permission to construct two additional hydroelectric sites on the Peace River-- Site C, about 5 km. from St. John, and Site E, near the Alberta border. (British Columbia Hydro and Power Authority, 1980).

Resources

Trapping, fishing and subsistence fishing used to be the predominant means of livelihood. Muskrat had traditionally been the major cash crop but low water levels, due to Bennet Dam, reduced this considerably (Canada, Alberta, Saskatchewan 1972, p. 43). Fishing was reported to be very important in Lake Athabasca, Claire, Richardson and Manawi. As far as recreation and tourism are concerned, there was not much potential for water-based recreation on Lake Athabasca as it is too cold and the waves are far too big for swimming or water skiing. Other important resource aspects of the delta area are: the delta is a staging area for 1,000,000 waterfowl, 1,500 residents of the region are dependent on renewable resources for their livelihood and native people depend on the waterways for transportation (Alberta Department of the Environment, n.d., p. 2.).

Quantity and Quality Concerns

The Peace-Athabasca Delta Group Study was concerned with the restoration of water levels in the Delta and so most of the information gleaned from this study and related studies deals with quantity requirements. The Delta Group thus suggested that:

> the desired water levels vary from season to season and year to year throughout Lake Athabasca and the Delta, and the desired levels appear to be relatively high and stable at approximately 684 to 685 feet. (208.6 to 208.9 m).

They also suggested that such levels be maintained throughout the water months, or shallow lakes would freeze to the bottom resulting in the death of fish and thus a decline in the muskrat population. Spring flooding is also considered to be an important source of water for the Delta Lakes.

Alberta has completed a feasibility study for a hydroelectric facility at Dunvegan, 80 miles downstream from the British Columbia border. Each of these potential projects have been accompanied by feasibility studies, and incorporated within the feasibility studies have been "water use" and "environmental effects" components.

In the British Columbia section of the Peace River, it was determined (Canadian Biological Resource Consultants Limited, 1980), by a questionnaire, that residents of the region used the Peace River more than any other rivers in the area for fishing, boating, sightseeing and hiking.

Quantity and Quality Concerns

Recreational use of the river, it was suggested, had caused little deterioration of the resource and thus there appeared to be little need to utilize management or development policies to protect the recreational resource. An annual increase in recreational use by non-residents, of 1.1 percent was anticipated for the near future.

A feasibility study, by Alberta Hydro Committee (1977), concerning the Dunvegan hydroelectric power site considered among other subjects, its environmental impacts as well as the benefits of the reservoir for flood control and recreation.

One component of the study determined that at present, in the direct vicinity of the dam, the rivers and streams are considered to be undesirable for angling. The Peace River is not popular with sports fishermen because of its large size, turbid water and relatively low numbers of sports fish species (Alberta Environment, 1976d, p.73).

The water quality of the Peace River in the vicinity of the Dunvegan Dam is relatively good, although levels of calcium, mercury and phosphorus exceed Alberta Environment surface water quality Criteria (Alberta Hydro Committee, 1977, p. 40).

Major fish species downstream from the dam are considered to be less resilient to change than those close to the dam, yet further studies need to be completed on downstream species.

Many of the constraints to the use of the Peace River (near the Dunvegan dam site) for recreational and renewable resource activities appear to be natural (Alberta Hydro Committee, 1977, p.40). The low level of phosphorous which inhibits productivity, and the low numbers of sports fish limit the recreational possibilities of the Peace River at the dam site. The building of the dam itself does not appear to constrain water use, and the reservoir could even enhance water-based recreation (Alberta Hydro Committee, 1977, p.50).

4.3.8 Slave River

A feasibility study of a hydroelectric dam site at Mountain Rapids on the Slave River just south of Fort Smith, on the Alberta-NWT border is now in progress. The final report should be made available in mid-1982.

The study, conducted by R.L. Walker and Partners, will be concerned only with the reservoir itself: it is not a comprehensive river basin plan. In the study, a number of alternative sites or projects will be considered. Changes that would result, (both upstream and downstream) on water quantity and quality, as a result of the dam will also be looked at (Swales, R.L. Walker and Partners, personal communication, Edmonton, May 4.81).

The alternatives to be considered are:

- using Lake Athabasca as a storage area
- a "run of river" scheme that would use 5-10 days of Slave River storage and thus minimize impoundment effects

Dr. Swales (1981) has mentioned that water use in the river, except for a bit of local transportation, is rather limited. The reservoir alternative, however, would flood part of Wood Buffalo National Park and would offset two large wetland areas--the Peace-Athabasca Delta and the Slave Delta. The project also presents a special environment problem as a colony of white pelicans nest on an island in the middle of the river (Alberta Environment 1980, p.25-26, June/July, 1980).

The Slave River study will consider a broad understanding of the issues, posed by the alternative sites, and thus sufficient data will not be collected to complete a detailed resource inventory. Quantity and quality aspects of both recreational and renewable resource water uses will not therefore be the prime concern of the study. If a future, more detailed study is completed, special attention will have to be addressed to the water quantity and quality requirements of the commercial fishing industry and the native uses of renewable resources, in Lake Athabasca.

4.3.9 Athabasca River Basin

The Athabasca River, like the Liard and Peace Rivers, is a typical mountain stream which experiences its lowest flow during the winter months and its maximum during May and June. Rapids and falls occur in the upper reaches but further downstream, it assumes a much lower gradient as it enters Lake Athabasca.

Because of intensive development of the Oil Sands in northeastern Alberta, extensive environmental studies have been conducted in the study area. The Alberta Oil Sands Environmental Research program (AOSERP) was established in 1975 between the governments of Canada and Alberta. The ten year study is designed to direct and coordinate research projects concerned with the environmental effects of the Athabasca Oil Sands. The study area includes much of the Athabasca River basin and so it is an excellent source of information for this study.

One component of the project dealt with a socio-economic evaluation of the renewable resources of the study area (Phillips, 1980).

Resources

The report by Phillips (1980) indicates that renewable resources make an important contribution to the lifestyle of those in the basin as well as those from outside the basin.

In 1975-76, in the AOSERP study region, 50,170 Albertans were involved in 83,393 recreation days in the non-consumptive use of fish and wildlife. Residents of the area (13,648) were involved in 54,592 recreation days of non-consumptive activities. In the study area, Albertans caught 164,422 fish, 216 big game, 5,730 upland birds and 1,760 waterfowl. Renewable resources accounted for $608,720 annually in 1975-76 (Phillips, 1980).

In that part of the Athabasca River basin in the eastern slopes of the Rocky Mountains forest production dominates land use. The majority of the region is included in the Timber Management Agreement held by the North Western Pulp and Power LImited. Most of the region has either good or moderately good existing forest cover in terms of merchantable timber. The numerous rivers, streams and small lakes are major components to the fishery resources of the region. Lake whitefish form the basis of a commercial fishing industry in Fickle Lake, while a variety of species, including rainbow trout, brook trout, arctic grayling, mountain whitefish, char and Dolly Varden enhance sport fishing. (Alberta Environment Conservation Authority 1974: Information Bulletin #9 Athabasca-Yellowhead Area).

Quantity and Quality Concerns

Water quantity and quality requirements have not yet been determined for renewable resouces uses in the Athabasca basin but two studies of the AOSERP have studied the fisheries resources of the Athabasca basin. One study by Bond (1980), considered the fishery resources downstream of Fort McMurray, Alberta. Generally, it was found that the fish populations of the lower Athabasca River are migratory in nature with only a few major species (northern pike, lake chub, trout-perch) appearing to be year-round residents. Table (4.3.2) summarizes the habitat characteristics of some of the major fish species of the lower Athabasca River. Considering the economic value of the resource and the fact that fish from Lake Athabasca spawn in the study area it is important that water quantity and quality requirements be identified and maintained.

A study was also conducted in the Athabasca River upstream of Fort McMurray (Jones et.al., 1978). Its major emphasis was to delineate actual and potential, spawning areas for Lake Whitefish. It was found that this section of the river provides habitat for a number of species including lake whitefish, goldeye, walleye, northern pike,

Table 4.3.2 Summary of Important Results Relative to the Major Fish Species of the Athabasca River

Species	Migrations	Spawning	Overwintering	Principal Foods	Predators	Competitors	Sensitive Locations and Times	Use by Man Within AOSERP Area
Goldeye	Feeding migration into Athabasca R. occurs in early spring (April) under ice. All immature fish (ages 4 to 6). Leave feeding grounds in Sept. or Oct. for overwintering areas.	N/A As adults these fish will probably spawn in Peace-Athabasca delta.	Suspected in Lake Athabasca or the Peace River.	Benthic and surface insects.	Pike, Walleye, Burbot	Few, because of varied diet.	Entire Athabasca R. up to (and probably beyond) Fort McMurray serves as summer feeding area from April to October.	Commercial Domestic Sport
Lake Whitefish	Spawning migration Sept. to Oct. Post-spawning downstream movement begins immediately after spawning. Downstream fry migration probably April to June.	Mid-Oct. in Athabasca R. upstream of Fort McMurray (Cascade and Mountain Rapids).	Most likely in Lake Athabasca. Some overwintering suspected in Mildred Lake study area.	Benthic invertebrates.	Pike, Walleye, Burbot	Bottom feeders, White Suckers, Longnose Suckers	Tributary mouths serve as resting areas during spawning migration. Egg incubation Nov. to March.	Domestic
Longnose Sucker	Spawning migration begins under ice in late April to early May. Post-spawning, downstream movement begins in mid-May. Fry emerge late May to early June. Fry migration June to August. Some non-spawners remain in tributaries until freeze-up.	Over gravel in tributaries during first half of May. Muskeg R., Steepbank R., MacKay R. are known spawning streams. Also spawn in Athabasca R. upstream of Fort McMurray.	Probably Lake Athabasca. Some young-of-year overwinter in spawning streams.	Benthic invertebrates but feed little during spawning migration.	Pike, Walleye, Burbot, Grayling, Flathead Chub	Bottom feeders, Lake Whitefish, White Suckers	Athabasca R. during migration of adults and dry (April to August). Spawning and nursery areas in tributaries (May to July). Mouth areas of tributaries are important nursery areas.	Domestic (Dog Food)
Walleye	Spawning migration begins under ice in late April. Post-spawning downstream movement in May and June. Fry hatch in May to June and migrate downstream during June and July.	Sites unknown but probably in Athabasca R. upstream of Fort McMurray in late April and early May.	Suspected in Lake Athabasca.	Mainly fish of several species. Some aquatic insects.	Pike, Burbot, Walleye	Pike, Burbot	Athabasca R. during migration of adults and fry. Tributary mouths serve as resting areas for adults and as nursery areas.	Commercial Domestic Sport
Northern Pike	Spawning movements in April and early May. Upstream migrations noted in some tributaries in May consist of ripe, spent and immature fish. Frequent lower reaches and mouth areas of tributaries during summer.	Probably late April and early May in marshy areas adjacent Athabasca R. and in some tributaries.	Probably Athabasca R. in Mildred Lake area. Those in Delta may overwinter in Athabasca R. upstream of Delta or in Lake Athabasca.	Mainly fish of several species. Some immature insects.	Pike, Burbot, Walleye	Walleye, Burbot	Marshy areas in late April and early May. Lower reaches of tributaries important feeding areas in summer.	Sport Domestic
White Sucker	Spawning migration begins under ice in late April to early May. Downstream movement of spawners begins in mid-May. Fry emerge late May and early June. Fry migration June to August. Some non-spawners remain in tributaries until freeze-up.	Over gravel in tributaries during first half of May. Muskeg R., Steepbank R., MacKay R. are known spawning streams.	Probably Lake Athabasca. Some young-of-year overwinter in spawning streams.	Benthic invertebrates but feed little during spawning period.	Pike, Burbot, Grayling, Flathead Chub	Bottom feeders, Lake Whitefish, Longnose Suckers	Athabasca R. during migration of adults and fry. Spawning and nursery areas in tributaries (May to July). Mouth areas of tributaries are important nursery areas.	Domestic (Dog Food)
Flathead Chub	May be resident in Athabasca R. Mature fish more common in Mildred than in Delta study area. Decrease in abundance after June suggests movement but extent unknown. Seldom enter tributaries. Young-of-year appear in July. Nursery areas suspected in Delta or Lake Athabasca.	Areas unknown but assumed in Athabasca R. within or upstream of Mildred Lake area during June and July.	Unknown. Suspected within Athabasca R. and Lake Athabasca.	Varied. Mainly mature and immature insects, both aquatic and terrestrial.	Pike, Walleye, Goldeye, Burbot	Few, because of varied diet.	Spawning and egg incubation probably in Athabasca R. from mid-June to mid-August.	None but sometimes taken by anglers.
Arctic Grayling	Migrate into tributary streams of Mildred Lake area in late April and early May. Seldom found in Athabasca R. during summer. Never taken in Delta. Migrate out of tributaries just prior to freeze-up in October. Tributaries provide summer feeding for adults and nursery areas for fry.	Late April and early May. Muskeg R. and Steepbank R. are known spawning streams.	Young-of-year may overwinter in spawning streams. Age 1+ and older fish overwinter in Athabasca R. probably in upper Mildred area or above Fort McMurray.	Mature and immature stages of aquatic and terrestrial insects.	Walleye, Pike, but probably little predation while in tributaries.	Few, because of varied diet.	Spawning, feeding, and nursery areas in tributaries. Overwintering areas for young in tributaries. Susceptible to overharvest by anglers.	Sport
Burbot	A spawning migration into Mildred Lake area is suspected during the winter. Burbot leave Mildred area by mid-June. Young-of-year appear early June.	Spawning for this species usually occurs from Jan. to March under ice.	Probably Lake Athabasca.	Fish of many species	Walleye, Pike	Walleye, Pike, Goldeye	Spawning and egg incubation in or upstream of Mildred Lake area Jan. to June.	Domestic Sport

Source : Bond (1980) pg. 23-24

white and longnose sucker, arctic grayling and mountain whitefish. Between Fort McMurray and Cascade Rapids it was suggested that "tens of thousands" of lake whitefish spawn in the area. The report also suggested that the lake whitefish, goldeye and walleye, spawning in the study area are part of the Lake Athabasca and Peace-Athabasca Delta populations.

Within the Athabasca River basin, as is the case throughout the eastern slopes, the implications of clear-cutting has aroused public concern. Public hearings by the Alberta Conservation Authority (1974) initiated discussion as clear-cutting techniques present the potential for serious deterioration of water quality through erosion. It was suggested that, even with good forest management practices, water regime changes can be caused by logging and associated road construction. As was mentioned, in section 4.1.14, clear cutting leads to increased erosion which can lead to the destruction of fish habitat.

Improper land use practices in the eastern slopes of the Rocky Mountains and plans that the Alberta government has for hydroelelectric development, on its northern rivers are the major potential constraints to the use of the Athabasca River, by renewable resources, and for recreation. As long as instantaneous minimum flows are first established for non-consumptive water users; and as long as these flows are then implemented before hydroelectric development occurs, constraints to use may not surface.

In 1977, Alberta Environment completed a data overview of the Athabasca basin, and at present, a river basin study is being initiated. It is hoped that the concerns of all water users will be identified in the study.

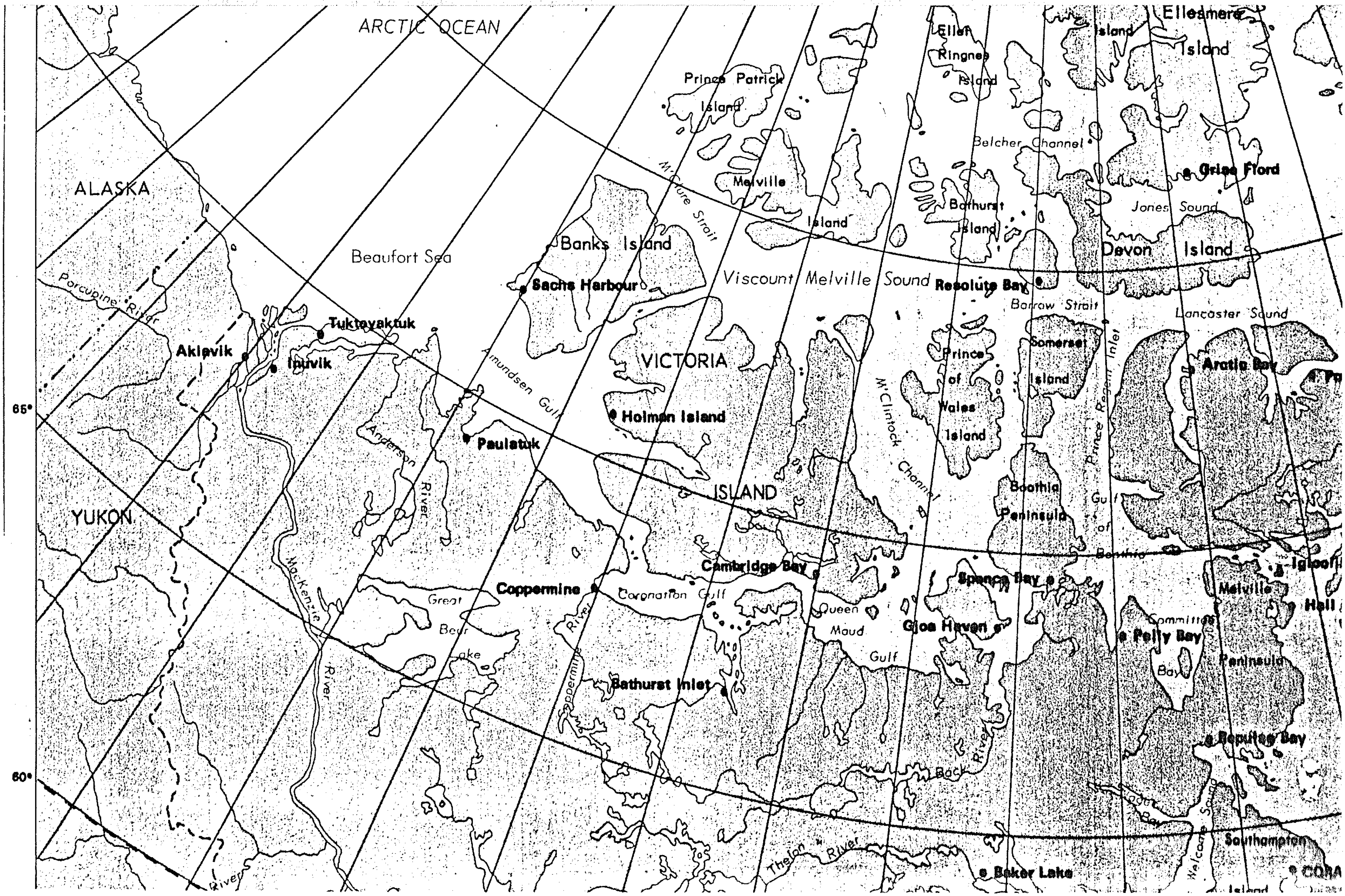
4.4 ARCTIC DRAINAGE II: OTHER ARCTIC DRAINAGE

4.4.1 Introduction

The Mackenzie River drains almost half (1,787,000 km^2) of Arctic drainage, in the Canada West Foundation study area. Other major river basins (the Back, the Anderson and the Coppermine) account for 221,704 km^2 while the Arctic Seaboard and Arctic Archipelago accounts for 1,570,576 km^2. In this section of the report, all drainage to the Arctic Ocean (except that from the Mackenzie River) will be reviewed. Such drainage will be referred to as "Arctic drainage".

The Yukon and the Northwest Territories are richly endowed with fresh water. Factors such as low annual precipitation, a short frost free period and permafrost soils tend to make the volume of available fresh water somewhat reduced. Traditionally the Indian and Inuit of the North have relied heavily upon the resources of inland and coastal waters to obtain food and cash crops. The traditional lifestyle persists though it is declining in importance. Northern waters are being used increasingly from the standpoint of transportation, hydro-electric power, industrial and municipal requirements and recreation (Naysmith, 1973).

Except for the Back River, none of the rivers in the Arctic drainage area extend further than a few hundred kilometres from the Arctic coast. Because of the absence of any communities, in the drainage area, other than along the coast (Tuktoyaktuk, Coppermine, Shepherd Bay, Spence Bay, etc.) the use of water for any purposes is rather limited. The same principle applies in the Arctic Islands.



Scale 1:10,000,000

Figure 4.4.1 Other Arctic Drainage

Source : Milton Freeman Research Limited (1976)

The Arctic coastal areas are inhabited almost exclusively by the Inuit, who rely heavily on renewable resources for their livelihood. There may be intensive hunting/fishing use of the rivers near communities while recreational use is rather light with no more than ten to thirty parties on any river at a given time. (Jasper, Hydrologist, Department of Indian and Northern Affairs, personal communication, 1980). Inuit use of water resources will be the main concern of this section of the report.

Arctic drainage will not be approached on a basin by basin perspective as research has not been conducted in this manner. There does exist a Northwest Territories Water Board which has the power to create management areas consisting of river basins but none have been set up, nor are any immediately planned, because of the immensity of the project.

> There has been no formal planning of water use (and there are no comprehensive river basin plans) as no inventory has been taken of water resources in the north. (MacLeod, 1977, p. 17)

4.4.2 Literature Available

Two extensive reports have been inventoried and assessed the significance of Inuit land use in the Arctic drainage area. A report completed by Milton Freeman Research Limited (1976) undertook to "produce a verifiable and comprehensive record of Inuit land use in the Northwest Territories." The report by Freeman Research Ltd. sought to present "in explicit and unambiguous fashion, information in support of the fact that Inuit have used and occupied the vast northern land since time immemorial and that they still use and occupy it to this day." A joint position paper;

produced by the government of Canada and the Committee for People's entitlement (COPE), respecting the land claims of the Inuit in the western Arctic, will also be reviewed. A study completed for the National Energy Board, by Polar Gas (1977) is also concerned with the Inuit land use.

In the Arctic, as in other regions of western Canada, in order to quantify and qualify water use, it is first necessary to inventory water-related resources. Both the Polar Gas report and the Freeman report, commissioned by the Inuit have sought to complete inventories. Inventories of water uses will thus be discussed, where possible, from a river basin basis.

4.4.3 Resources

In Milton Freeman Research Ltd. (1976), Inuit land was divided into five basic areas: Western Arctic, West Central Arctic, Keewatin and Somerset Island and Hudson and James Bay. The Polar Gas Study, by Hatfield et.al. (1977) studied areas in the eastern section of the study area (Boothia Peninsula, Gjoa Haven and Spence Bay regions).

Near Aklavik and Inuvik there has been a reduction in trapping by the Mackenzie Delta people but the dependence on fish and game is still quite high. Renewable resource activities in the area include fur trapping, muskrat trapping (north of a line from Aklavik to Inuvik not a single creek has not been exploited by Inuit trappers), whale hunting, fishing and wildfowling (Milton Freeman Research Ltd., 1976, p. 24).

Near Tuktoyaktuk, fox, muskrat, beaver and marten are trapped. Other resource activities include: bear, seal and whale hunting and fishing (Milton Freeman Research Limited, 1976, p. 25). The Wolverine River and various other lakes are considered by the local people, to be quite important because of the anticipated constraints that seismic activity may place on water use.

In another area of the western Arctic, near Paulatuk the major resource activities including trapping, hunting polar bears, and fishing. Char are found at the mouth of the Hornady River. Most of the major rivers in this area abound in fish, with hunting being confined to a few areas. The Coppermine, Rae, Richardson and Hornady Rivers are fished, mainly for char. The Coppermine is also classified as a wild river according to Parks Canada's classification scheme (see Appendix A). One naturalist described the attributes of the Coppermine aptly:

> In some places its generally gradual descent becomes suddenly abrupt: babbling and boiling, it is the whitewater to which canoeists from all over the world are drawn. But the whitewater is just one of the many attractions of the Coppermine watershed. The caribou at Point Lake are another."
>
> (Raffan, J., 1979, p.15)

In the Boothia peninsula area, the major fish resources and their requirements are:

Arctic Char - deep lakes for spawning and overwintering

Lake Trout - larger deep lakes for spawning and overwintering.

Humphack
Whitefish - large deep lakes
Round Whitefish

Grayling
Cisco - clear lakes and streams
Lake Trout

There appear to be no constraints to further fishing potential as none of the fish in the area is considered endangered and there appear to be no indications of adverse effects from environmental disturbance (Hatfield, et al. 1977, p.40).

In the Spence Bay area of the Boothia Peninsula, the major resource activities include: seal hunting, caribou hunting (as far south as Hayes River), polar bear hunting, fox trapping and fishing. The fishing activity is confined to the rivers and lakes along the east coast of the Boothia Peninsula and/or Prince of Wales Island (Milton Freeman Research Ltd., 1976).

In the Gjoa Haven and Spence Bay areas resource harvesting is the primary activity. There, the major activities are caribou hunting on the mainland and hunting and fishing in other areas. Overwintering habitat is scarce as none of the area appears to have winter flows.

Along the entire length of the Back River, in the major rivers and lakes close to the Arctic mainland coast, and in the Hayes River region, char, lake trout and whitefish are exploited. Sports fishing also takes place at the mouth of the Back River and in adjacent rivers and lakes. The Back River is also used as a wilderness canoe route; although it has no official status as a wild river. Wolves and wolverines are also trapped near the Back River (Polar Gas, 1977, map #12).

In the Pelly Bay region, few of the rivers that were fished (prior to 1967) for char and trout are currently exploited. Trapping and hunting of polar bears and seals still occurs, yet the activity is diminishing in frequency (Milton Freeman Research Ltd., 1976, p. 21). In the Repulse Bay area, hunters continue to exploit the renewable resources of the region as seals, whales, narwhals, polar bears, caribou, wolves and wolverines are exploited. North of the settlement, char and trout are fished for. (Milton Freeman Research Ltd., 1976, p. 64).

It appears that renewable resources are very important to the livelihood of the Inuit of northern Canada. In a joint position paper by the federal government and the Committee for Original People's Entitlement (COPE) (1978, p.21) the western Arctic region was defined as containing 115,000 square miles (298,000 km^2) of land.

> It is a region of arctic tundra with a small percentage of fringe boreal forest. Wildlife meats, furs, timber and tourism are the 'products' or resources. The resources of the sea are not dealt with.

In one table of the report, based mainly on Berger (1977) the land values of renewable resources were calculated (See Table 4.4.1)

TABLE 4.4.1

PRODUCTIVITY IN DOLLAR VALUES PER SQUARE MILE

	Wildlife Meat	Furs	Agricul-tural	Timber	Other	Total
Potential	35.20	5.27			.30	40.77
Actual Harvest	21.93	4.22			.30	26.45

4.4.4 Quantity and Quality Aspects

Environment Canada collects data on water quantity in the Northwest Territories, yet studies have not been undertaken for the purpose of determining quantity needs for renewable resource and recreational users. Normally, the studies have concentrated on assessing hydroelectric potential. It appears that the protection of spawning grounds for any fish that do overwinter in Arctic rivers, is essential.

Because renewable resources are so important to the livelihood of the Inuit of northern Canada, it is essential that water quality be maintained at an acceptable standard to ensure protection of aquatic life.

The Northern Inland Waters Act provides a framework for the planning of water resources in the north. Under the Act, water boards were established in both the Yukon and the Northwest Territories. The objectives section of the Act directs the water boards to provide for the conservation, development and utilization of water resources (of the North) in a manner that will provide for the residents of the Yukon Territory and Northwest Territories in particular (MacLeod, 1977, p. 17).

All water users, including the federal government (except pursuant to those rights and privileges already granted under the Dominion Water Power Act), must derive their right to use water or deposit waste in water from the Northern Inland Waters Act (MacLeod, 1977, p.39). A user is entitled to precedence if his class of water use is said, in the regulation, to be of higher priority than other users . However, priorizing of water use has not been established by law, in the water management areas. Licences must also comply with water quality standards, however, none have been prescribed (MacLeod, 1977, p.39). The Northwest Territories Water Board is now in the process of establishing standards for municipal water use. (Billing, Department of Renewable Resources, Government of Northwest Territories, personal communication, 1980).

The federal government has established water quality objectives for the protection of aquatic resources. One would think the Northwest Territories should be striving for these objectives. However, since almost all settlements in the Northwest Territories use surface water for drinking purposes, water quality objectives are based on the Canadian Drinking Water Quality Standards (see Appendix B-I). (Billing, personal communication, July 29, 1980). These standards express the water quality requirements for renewable resources and recreational water use. It is not likely that water quality standards or objectives will be established on a local level because of the need for detailed resource inventories.

No water resource projects have been established, in the Arctic drainage area, expressly for recreational or renewable resource use; thus there have been no water quantity effects of these two water uses on the flow regime. Again, with respect to water quality, renewable resource and recreational water uses have not had an appreciable effect on other water uses.

It can be expected that, in the near future, Inuit will continue to depend on renewable resources of the north for their livelihood. It can generally be concluded that at least the status quo should be achieved in water quality. Water quantity will need to be at a level sufficient to protect fish spawning grounds.

Sports fishing is also expected to be important in the Northwest Territories, in the future. "In future years there will undoubtedly be an abundance of high quality angling in the Northwest Territories in terms of general North American standards. In effect, the appeal of the environment and the exotic species will continue to draw non-resident anglers".

(Baker, 1973, p. 38). With the building of roads, however, this unique experience may be somewhat diminished. The tent-camp and outfitters operations are likely to increase. Since supply prospects are good, and an untapped market exists at the mid-price range, the potential of profit is increasingly attractive and feasible (Baker, 1973, p.46). Because of the potential for sports fishing in the Arctic drainage area, and because this potential may be at a premium in the future, it is important that water quantity and quality requirements be determined for aquatic resources.

The major constraint to recreational use of the Arctic drainage basin, by non-residents, is the vast distance of the area from populated regions of North America. There is therefore, a reluctance of people to partake of the recreational experience because of high travel costs.

There is no physical constraint , at present, to Inuit use of renewable resources in the Arctic drainage area. Land claims settlements could place a constraint on renewable resources explotation, if hunting and fishing rights and/or proprietary rights are not guaranteed on traditional lands. Future non-renewable resource development proposals, if adopted, could seriously constrain Inuit water use. For instance, the Polar Gas pipeline, which will cross numerous streambeds, could seriously disrupt fish migration and spawning activities. The establishment of water quantity and quality standards; if not completed expeditiously, could disrupt renewable resource exploitation.

4.5 MISSOURI DRAINAGE

The extreme southern portions of Alberta and Saskatchewan are traversed by the Saskatchewan River-Missouri River divide. Compared to the total area of western Canada, the area draining to the Missouri is quite minimal (Table 1.1). Two rivers--the Milk and the Poplar--contribute most to the flow of the Missouri system. The Milk River, which flows through southeastern Alberta and Montana, has three tributaries originating in Canada--Lodge Creek, Battle Creek and the Frenchman River (by far the most important tributary)--all of which join the Milk River in Montana. (see Figure 4.5.1).

The Missouri drainage area in Canada, is characterized by a semi-arid climate with long, hot summer days and bright cold winter weather. Geographically, the area is part of the interior plains and receives 12-16 inches (31-41 cm) of precipitation annually. The area is totally dependent on agriculture. The present land uses in the Alberta portion of the basin include dryland farming, irrigation farming and ranching (Canada Land Inventory, Capability for Wildlife, Map 72E); whereas in Saskatchewan, mixed grain-cattle enterprises are commonplace (Canada Land Inventory, Capability for Wildlife, Map 72G). Both river systems--the Milk and the Poplar--although not large in drainage area, are significant because of their international importance; both are subject to regulation by the IJC.

4.5.1 Milk River Basin

As indicated in Table 4.5.1, the Milk River contributes the majority of Canada's drainage to the Missouri River system. At present, artificial regulation of the Milk River is conducted in order to satisfy Canada's

Table 4.5.1 Missouri River Drainage (Area in km^2)

	Canada	U.S.A.
Milk River	21,600	39,627
Others	5,076	

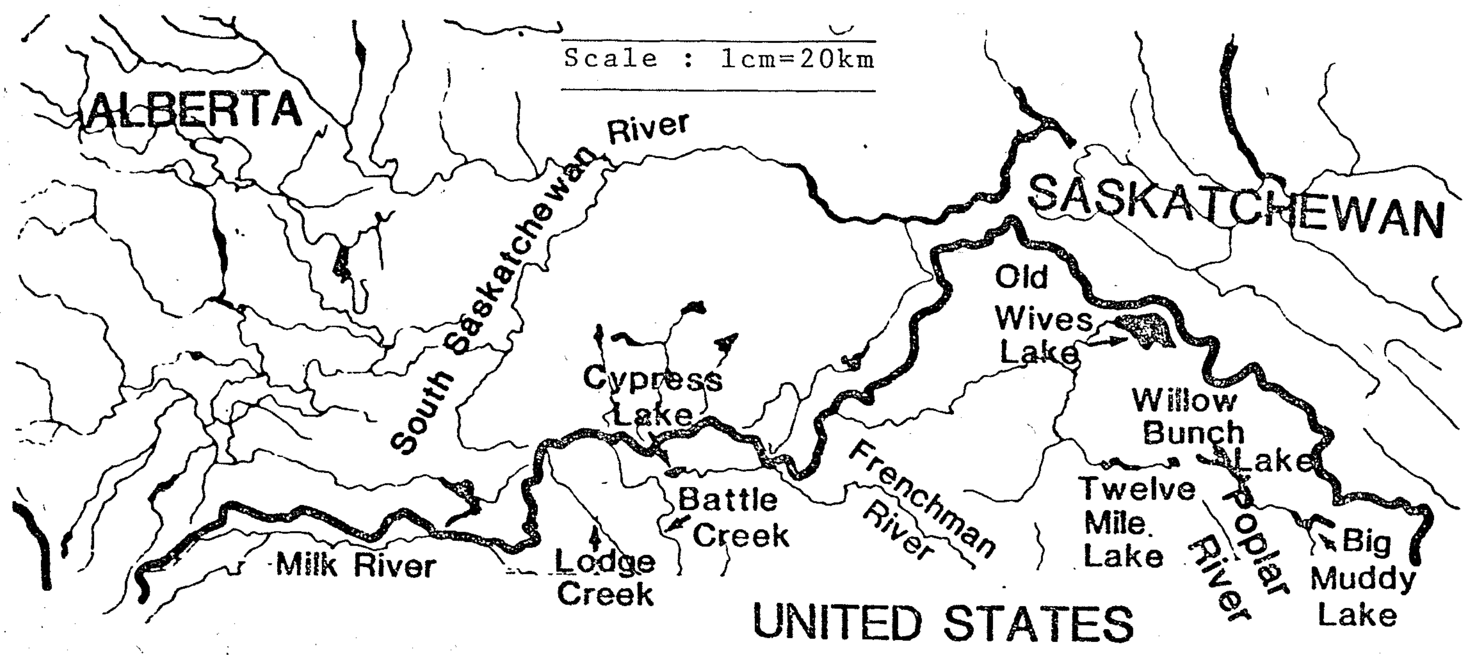


Figure 4.5.1 Missouri River Drainage

Source: Environment Canada

drainage to the Missouri River system. This regulation of the flow of the Milk River is conducted in order to satisfy Canada's commitment to an IJC agreement. The flow of the Milk River is divided between the U.S.A. and Canada by IJC order; the Milk River and the St. Mary River are treated as one, under the IJC agreement. The 1921 agreement states that: during irrigation season, the United States is entitled to three-quarters of the natural flow of the Milk River up to a total of 666 cfs (18.86 m^3/sec) with any flows above this amount to be divided equally between the two countries. The agreement also states that during the non-irrigation season the flow shall be divided equally between the two countries. Any shortages that Canada may have in meeting its requirements are met by augmenting the flow of the Milk River from the St. Mary River (International Joint Commission, 1977b, p. 13). The division of the flow of the St. Mary River is the converse to that of the Milk River. Because of such an agreement; and because the St. Mary River drains into the Oldman River system, serious consideration should be given to the extensive Oldman River Basin study, before management plans are considered for the entire Milk River Basin.

For the last 48 km of its journey through Canada the Milk River flows through wild and rugged country, a land of vast rolling grasslands, cut deeply by numerous stream valleys, coulees and badlands. The area is unique because of its combination of both rare and common species. As it meanders through the valley the river creates a number of oxbow lakes, which are inhabited by a variety of aquatic animals, including the rare painted turtle and several amphibian species. Preliminary studies have indicated the existence of some species in the valley, which are found nowhere else in Canada. Minimum flows and water quality objectives have yet to be determined for this unique area (Canadian Nature Federation, 1979, p. 40).

Milk River Basin Study

At present, Alberta Environment is conducting a "preliminary planning study of reservoir sites in the Milk River basin to identify reservoir sites and to determine, in a preliminary manner, their engineering feasibility and costs" (Alberta Environment, 1979, p. 44).

The study is not only an engineering feasibility study. Baseline information, on a variety of topics, is being compiled and synthesized. Where existing data is lacking, select studies are being completed. The basic questions that researchers want to answer with data collecting exercises are:

- What is the quality of water?
- What is the quantity of water?
- What are the demands being placed on water resources?

The apportionment agreement with the United States must first be allocated before other demands on the river are considered. Minimum flow requirements for recreational and biological uses of the river are also to be determined in the study. An interim report should be released in May of 1981. (Hagerman, Alberta Environment, March 24, 1981, personal communication). Before the requirements can be determined, baseline information concerning water-related resources of the basin must first be collected.

Resources of the Basin

Within the Saskatchewan portion of the Milk River basin, sport fishing areas have been created by the demand for irrigation--several small lakes have been created by damming stream valleys. The only significant fishing stream in the south is the Frenchmen River, in which brown and brook trout may be caught. A few areas in the Milk River basin have high to very high waterfowl capability--Buttermilk Lakes, Neptune Lake and Tatawaga Lake to mention a few.

In the Southern Saskatchewan portion of the Milk River Basin angling is good to excellent, particularly in the streams (Canada Land Inventory, Capability for Recreation, Map 72F). Reed Lake, a reservoir, supports pike, pickerel, and perch. Most of the basin in Alberta, is characterized by low to very low potential for waterfowl. In fact, one site--Pakowki Lake, has at times dried up. Thousands of migrating ducks, geese and swans congregate in the numerous water bodies, however, local waterfowl production is limited because of a lack of adequate habitat (Canada Land Inventory, Capability for Wildlife and Waterfowl, Map 72E).

The natural capability of the Milk River Basin in Saskatchewan, to support outdoor recreation is generally low. Two lakes--Thompson Lake and Lac Pelletier contribute to the recreational capability of the area as they have the ability to support some types of water-based outdoor recreation. Generally, the Alberta section of the Milk River basin has little potential for intensive water-based recreation. Several sections of the Milk River Valley have historical significance, Indian writings, interesting landforms and caves (Canada Land Inventory, Capability for Recreation, Map 72E).

Quantity and Quality Concerns

Quantity requirements for water in the Milk River basin have yet to be determined. In some river basins--the Oldman for instance--flows of greater than 10 percent of the mean annual flow were recommended as necessary to protect fish habitat resources.

More intensive studies need to be carried out within the basin before water quality requirements can be determined for recreational and renewable water users.

Neither non-consumptive use (recreation or renewable resources) has any significant effect on the quantity or quality of the Milk River. Its flow requirements are at present, determined in order to fulfill apportionment responsibilities, or to meet agricultural needs.

The major constraint to the use of the Milk River basin as a water-based recreation area is lack of available water. Waterfowl production in the area is also limited because of lack of water, which implies that there is less habitat. Periods of drought may last anywhere from one to five years; thus wetlands may dry up completely causing ducks and other species to find new habitats (Canadian Nature Federation, 1979, p.40).

Lack of available water in the Milk River basin also constrains agricultural activity. For example: within the basin there are 190,000 irrigable acres (76,890 ha) and yet there is only enough water available to irrigate 25-30,000 acres (10,117 to 12,141 ha) (Hagerman, Alberta Environment, March 24, 1981, personal communication).

4.5.2 Poplar River Basin

In southeastern Saskatchewan, two water courses--the Poplar River and Big Muddy Creek--flow into the Missouri River. The Poplar River has been the most extensively studied and it will be dealt with in this section of the report.

International Joint Commission Report

The Poplar River basin, though quite small in area, is quite important because of its international significance. The basin itself is situated in the semi-arid region of southern Saskatchewan and northeastern Montana. The basin straddles the International boundary; the total basin area is 8620 km^2 (3330 mi^2) of which 3150 km^2 (1215 mi^2) are in Canada. In 1977 the International Poplar River Water Quality Board (IPRWQB) undertook an intensive water quality study of the Poplar River drainage in Saskatchewan and Montana to assess the water quality effects of Saskatchewan Power Corporation's (SPC) proposed 600 megawatt coal-fired plant at Cormack, Saskatchewan. It is because of this study that a great deal of information exists concerning the river basin. The board considered the effects of the plant on surface water quality, ground water quantity and quality, biological resources, and downstream uses. The study was conducted under the direction of the International Joint Commission.

The Poplar River basin is quite similar to the Milk River basin in that lack of available water constrains water-related activities; and water apportionment agreements must be met with the United States, before other water demands can be allocated.

Quantity and Quality Concerns

As Table 4.5.2 indicates, the existing consumptive uses of water in the Poplar River basin have been well documented. Clearly, there has been an upward trend in consumptive water uses in the basin principally for agricultural purposes.

Renewable resources and recreation do not place great demands on the Poplar River regime. The principal instream uses are related to recreation and the maintenance of stream flows sufficient to support existing aquatic organisms. There is no commercial fishing in the basin, and in the Canadian portion of the basin no subsistence fishing or hunting takes place. The major instream uses within the basin are fish and waterfowl: the biological resources include aquatic invertebrates, fish and wildlife. The fish resource in the Poplar River is diverse with more species in the lower portion of the stream. The IPRWQB suggested that the degree of resource use was difficult to assess.

The International Joint Commission is seriously concerned with quantity and quality aspects of water use. In February 1976 an International Poplar River Basin Task Force submitted to the IJC a number of recommendations with respect to the apportionment of flows in the Poplar River basin. Basically, the Task Force recommended that the natural flow of all streams and tributaries in the Poplar River basin, crossing the International Boundary, shall be divided between Canada and the United States subject to a number of conditions. It was also suggested that the natural flow and division periods of apportionment purposes shall be determined, unless otherwise specified, for periods of time commensurate with the uses and requirements of both countries (International Joint

Table 4.5.2

Existing Consumptive Water Uses in the Poplar River Basin[(a)]
(acre feet)*

	MUNICIPAL	DOMESTIC	IRRIGATION			RESERVOIR EVAPORATION	
			Water Spreading	Sprinkling	Flooding		Subtotals
Saskatchewan							
West Poplar River Subbasin	0	46	25	0	0	230	301
Poplar River Subbasin	0	136	0	*	52	0	188
East Poplar River Subbasin	36	376	137	*	85	390	1024
Column Subtotals	36	558	162	*	137	620	1513
Montana							
Exclusive of Reservation							
West Poplar River Subbasin	0	381	331	630	90	-	1432
Poplar River Subbasin (middle fork)	0	122	73	460	772	-	1427
Poplar River Subbasin	350	334	306	551	2048	-	3589
East Poplar River Subbasin	0	105	852	0	147	-	1104
Column Subtotals	350	942	1562	1641	3057	-	7552
Fork Peck Indian Reservation							
West Poplar River Subbasin	0	88	39	0	0	-	127
Poplar River Subbasin	0	802	260	222	519	-	1803
Column Subtotals	0	890	299	222	519	-	1930
Grand Totals	386	2390	2023	1863	3713	620	10 995

(a) Limited sprinkling irrigation may be practiced in Saskatchewan; however, a distinction was not made between flooding and sprinkling irrigation in the information provided. It is presumed the use figures provided for flooding include all existing full service irrigation.

Source : International Joint Commission (1979), Appendix D. pg. 7

* To obtain dam^3 multiply acre feet by 1.233

Commission 1979, Main Report, p. 60).

The IPRWQB determined flow requirements to maintain certain types of biological life in the Poplar River basin. Although these requirements also refer to needs on the United States side of the international boundary they must be seen as demands on the Canadian system: through water apportionment agreements with the U.S., Canada must maintain specific minimum flows at the international boundary. Table 4.5.3 indicates the water quantity requirements for various biological objectives; the IPRWQB also explained the rationalization for certain flow requirements pertaining to fisheries. Increased flow in spring, provides a suitable current over gravel beds utilized by spawning walleye. Sufficient water depth must be maintained throughout incubation and hatching to prevent stranding of eggs and larvae (this period occurs in April and May in the Poplar River).

The IJC study determined water quality requirements for the Poplar River--both for indigenous biota and for primary contact recreation.

Appendix B-9 indicates the requirements for a number of different chemical characteristics. Water quality requirements for primary contact recreation dealt only with pH values and coliform counts; a pH of 6.5 to no more than 0.5 units greater than normal was recommended. Because there was a lack of evidence of significant risk from coliforms, no upper limit was set. Renewable resource and recreational use of water resources within the Poplar River basin, are not extensive and therefore in themselves do not place great demands on the River regime. Also, because there is not extensive outdoor recreational use of the river and because waterfowl are not significant users of the system, there are no quality effects of such instream water users.

Table 4.5.3

Water requirements for East Poplar River necessary to achieve various biological objectives, and consequences.

Biological Objective	Hydrological Requirements April[1] (m^3/s)	May[1] (m^3/s)	Annual[2] (m^3/s)	Dominant Discharge[3] (m^3/s)	Annual Flow (dam^3)	Annual Flow (AF)	% Mean Annual Flow to U.S.	Biological Consequences
1. 100% restoration of habitat game-fish.	0.4	0.3	0.1	3.5 - 20 (18 d) (2 d)	13,075	10600	92	- as was prior to 1977 i.e. no impact.
2. Maintain channel integrity.	x	x	0.1	3.5 - 20 (18 d) (2 d)	11,457	9288	81	- spawning and rearing will not occur most years. - good for wildlife, plants and invertebrates. - therefore affords some reduction in impact, but not much for some fish.
3. Maintain gamefish spawning and rearing and adult survival.	0.4	0.3	0.1	x	3,873	3140	27	- severe degradation of most habitat and therefore most of the naturally reproducing gamefish populations over project life. - no lessening of impacts on wildlife, plants and invertebrates.
4. Maintain minimum stream flow.	0.1 m^3/s year round			x	2,541	2060	18	- spawning and rearing will not occur in most years. - loss of most of game fish population.

[1]Minimum instantaneous flows at the International Border should not be allowed to drop below 0.4 m^3/s (15 cfs) in April and 0.3 m^3/s (10 cfs) in May.

[2]Minimum instantaneous flows at the International Border should never be less than 0.1 m^3/s (3 cfs) during normal or above-normal water years.

[3]A release or spill of water from Cookson Reservoir with discharge exceeding 3.5 m^3/s (123 cfs) for 18 days and 20 m^3/s (700 cfs) for two days within that period at the International Border; this release should gradually build up to the 20 m^3/s peak and then recede over a period of several days; the release should occur between March 15 and April 5.

International Joint Commission (1979), Appendix C. 52-53

Concerning future requirements of water, Ducks Unlimited has identified potential uses for wildlife. Of these projected uses, the IPRWQP estimated that 25 percent were feasible and thus 300 ac.ft. (370 dam^3) of water would be required annually. Future uses by the Fort Peck Indian Reservation were also considered by the IPRWQB. The Indian Band has suggested that it needs a guaranteed supply of water for various uses; and that the natural flow of the Poplar River to meet such needs is their right.

The use of water resources within the Poplar River basin--as within any of the basins in the Missouri drainage area--is constrained by the dry climate, which greatly reduces any opportunities for water-based recreation or waterfowl habitats. Artificial fluctuations in the stream levels within the basin, also place significant constraints on water use.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

The major objective of this study was to evaluate existing information, concerning recreational and renewable resource use of water resources in western Canada. A general conclusion can be made that a great deal of information does exist on the topic, although the source of the information is rather scattered. Through the river basin planning approach, quantity and quality aspects of water use have been readily applied to consumptive water uses. The approach, however, is not so easily applied to non-consumptive uses. Because concerns of water use are multifaceted, involving geographical, jurisdictional, economic and biological aspects, a consistent source of information concerning the topic of the study cannot be suggested.

Generally, it was concluded that in all three major drainage basins - Arctic, Missouri and Hudson Bay - renewable resources and recreation had minimal effect on water quantity and quality. The major constraints, to water use, for the above-mentioned uses, were found to be:

(a) in the prairie region, an unreliable water supply, resulting from both inadequate rainfall and artificial regulation of flows;

(b) in other regions of the study area, artificial regulation of flows.

Specific conclusions and recommendations, concerning each of the major drainage areas, are considered in the following sections. The conclusions pertain both to the water quantity and quality concerns of recreational and renewable users as well as to the information existing on these topics.

5.1 HUDSON BAY DRAINAGE

5.1.1 Conclusions

As late as the 1960's renewable resource and recreational use of water resources were assessed in studies pertaining to single-purpose water resources projects (irrigation or hydroelectric dams). With the establishment of the Canada Water Act; and with the acceptance of the river basin concept by provincial agencies, recreational and renewable resource water use has been assessed in concert with other water users.

In the agricultural areas of the Hudson Bay drainage basin appropriate summer water levels, for the maintenance of recreational areas and waterfowl habitats are of concern to water resources managers. In other areas of the basin, maintenance of fish and waterfowl habitats is important to native subsistence lifestyles.

Native groups, by assessing their own water needs (as they have done in the Qu'Appelle River basin), are adding greatly to data needs concerning recreational and renewable resource water use.

Water quality requirements, in the Hudson Bay drainage basin, as in any of the major basins, are mainly a question of economics, and of data availability. In order to assess requirements, extensive resource inventories must be completed. The requirements are then based on uses which society wishes to protect.

Waterfowl habitats can influence water quantity. In semi-agricultural areas (eg. Saskeram Marsh) it has been suggested that waterfowl occupy valuable pasture land; whereas, in other regions, waterfowl habitats may act as headwater storage areas.

Waterfowl habitats may add to the nutrient load of watercourses, but that has yet to be proven in the basin. In remote regions of the basin available information suggests that renewable resource and recreational water use has minimal effect on water quality.

In the future, demand for water related outdoor recreation, in the Saskatchewan-Nelson basin, is expected to increase steadily with population. Both the Qu'Appelle River Basin Study (1972) and the Garrison Diversion Study Board concluded this. This need may have to be met, in the southern portions, of the basin, by impounding water.

The future effects of renewable resource and recreational water use have not been well documented. On a negative note it can be inferred, from section 4.1.4, that forestry practises - clear cutting in particular - could damage fish spawning grounds and considerably alter flows.

In the Saskatchewan-Nelson basin, in spring and summer, sufficient river flows are required for the maintenance of waterfowl habitats and for recreational purposes. A major constraint to supplying these water needs is the difficulty in coordinating flows; because of artificial water regulation within provinces and because of apportionment agreements between provinces.

5.1.2 Recommendations

It is recommended that quantity and quality aspects of <u>all</u> water users be incorporated into river basin plans. This may be feasible where data pertaining to water use exists. However, in cases where data does not exist extensive inventories may need to be compiled.

It is recommended that because numerous studies have been completed, dealing with the Saskatchewan River basin; and because of the importance of that river to Saskatchewan's future prosperity, a basin plan be initiated under the auspices of the Canada Water Act.

It is recommended that native reports dealing with water use be incorporated into river basin plans.

It is recommended that, in the near future, water quality objectives be established for river basins, such as the Milk and Qu'Appelle where water supply constrains water use. In the long term, quality objectives should be established for all basins.

5.2 ARCTIC DRAINAGE

5.2.1 Conclusions

In the Arctic drainage basin there is a lack of data with which to prepare detailed river basin management plans. Although the Northwest Territories Water Board does have the power to establish water management areas, it is unlikely that extensive river basin studies will be conducted due to the prohibitive cost.

In the Arctic coastal regions, where extensive land use information has been compiled by Milton Freeman Research Ltd. (1976), the potential for preparing water quality objectives does exist.

With a growing population in northern Alberta and northeastern British Columbia, conflicts in water use will become more pronounced, necessitating a clear identification of all water users.

Major water quantity concerns in the Arctic drainage basin are: the protection of fish habitat (particularly in the Mackenzie and Athabasca Rivers) and the maintenance of adequate water levels in Lake Athabasca, to protect fishing and trapping.

Neither recreational nor renewable resource water use has an appreciable impact on water quality.

The major constraint (past and foreseeable), to recreational and renewable resource water use is unnatural regulation of flows. Mitigation measures that had to be implemented, as a result of the Bennett Dam, illustrate this conclusion.

5.2.2 Recommendations

In the Mackenzie basin - especially in the Peace, Liard and Slave River basins - there is a need for joint action by Alberta, British Columbia and Canada in planning for all water users.

It is recommended, that because of strong dependence of the Inuit on renewable resources, stringent water quality objectives be maintained in the northern areas of the basin.

It is recommended that efforts be made to protect wild rivers in the basin. Those singled out by Parks Canada (see Appendix A) are of immediate concern.

5.3 MISSOURI DRAINAGE

5.3.1 Conclusions

Assuming that adequate baseline data is collected, the Milk River Basin Study should answer water quantity and quality concerns in that basin.

The Poplar River basin is capable of meeting the quantity and quality needs of its water users. Increased demands by any one user could, however, create water supply problems (as is the case in many river basins).

In the Milk River basin, apportionment agreements with the United States are not presently established with Canadian needs for renewable resource and recreational water use.

Recreational and renewable resource water users are not likely to be the determinants of basin management plans, because of the already severe supply constraints on agricultural water needs.

5.3.2 Recommendations

It is recommended that because the Milk River is supplied by water from the Oldman River, the Milk River Basin Study be incorporated into the South Saskatchewan Basin Study.

It is recommended that,although all water users are constrained in the Missouri basin, unique areas such as the Milk River Canyon and the Frenchman River be preserved for recreational use.

5.4 Concerns of Water Use

Recreational and renewable resource water use is of great importance to the people of western Canada. It is therefore important that the issues concerned with these water uses be addressed. The major issues will be discussed as they pertain to quantity and quality aspects of water use.

5.4.1 Water Quantity

Water quantity concerns are most visible in the agricultural areas of the study region. One major issue that concerns both recreational and renewable resource users is interprovincial and international agreements concerning water flow. These agreements are not based on the needs of recreational or renewable resource water users. A basic question must therefore be answered by governments in western Canada: Should water supplies be augmented for recreation or renewable resources?

a) Recreation

Recreational water use is significant throughout Canada but nowhere is it more constrained than it is in southeastern Alberta and southern Saskatchewan. With increasing industrialization and population, water supplies, for all uses, are becoming severely constrained. Because many reservoirs serve other purposes, before recreation, their value as recreational resources may disappear in times of low flow. Fluctuations in water levels, of too great a magnitude, may cause concern if recreational shorelines are diminished. Smaller dams, which require much less storage, seem to be one solution to the problem. The disappearance of wild rivers, due to the building of hydroelectric dams, elicits a strong stewardship responsibility of the federal government.

b) Renewable Resources

Major issues concerning renewable resource use of water concern the preservation of waterfowl habitat and fish spawning grounds. Waterfowl habitats may be destroyed by water levels that are insufficient or too great. In the agricultural areas a major concern is the loss of waterfowl habitat by on-farm practices which seem to encourage the draining of wetlands. In the eastern slopes of the Rocky Mountains, clear cutting in the forestry industry causes increased flow leading to increased sedimentation and the eventual destruction of fish spawning areas. In periods of drought, or during man-caused periods of low flows, fish spawning grounds may be exposed and thus destroyed. A major concern in the fishing industry is the need to guarantee instantaneous minimum flows. This raises the question of whether the needed flows can be defined, and if so, can they be implemented by legislation.

5.4.2 Water Quality

a) Recreation

In areas of high recreational use (within the major cities of western Canada) water is not fit for primary contact recreation. Nevertheless, in some cities (Winnipeg for example), rivers are used extensively as recreational resources. A major issue can thus be seen to arise: What level of water quality can we afford and what level should be strive for? Another issue concerns: What water uses are compatible within cities? In high density, water-related recreational areas--the Qu'Appelle River Basin for example--cottagers could add significantly to the nutrient level of water bodies.

b) Renewable Resources

Renewable resources are important to the individuals who exploit them and to our economy as a whole. It is therefore important that water quality be maintained at an acceptable level. First spawning grounds have been shown to be in serious danger due to improper land use practices--particularly by road building and clear cutting, in the forest industry. Chemicals such as calcium, nitrogen and phosphorus, which appear to come from agricultural run-off, can lead to eutrophication of watercourses. Water quality objectives must be coordinated, both interprovincially and internationally, if renewable resources are to remain a viable part of our economy

5.4.3 Quantity and Quality

Quantity and quality requirements of water use depend upon one another and therefore there is a need to coordinate them in basin management plans. In the North, there is a need to identify quantity and quality water needs, so that those who wish to preserve their lifestyles can do so before non-renewable resources development commences. At the international level--in the Poplar River Basin and in the Garrison Diversion Study area--quantity and quality requirements have been suggested for recreational and renewable resource water users. This begs the question: Can such requirements be the substance of international agreements or will they only remain as "objectives"?

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APPENDIX A

(Wild Rivers of Western and Northern Canada)

Parks Canada has made surveys of many wild rivers across the country. The results of these surveys have been published in a series of ten booklets. which provide a practical guide for experienced canoeists. The map on the following page indicates the areas which have been surveyed by Parks Canada. Booklets which pertain to the Canada West Foundation Study are : Wild Rivers : Saskatchewan ; Wild Rivers : Alberta; Wild Rivers : Barrenlands and Wild Rivers: Northwest Mountains.

Following is a list of the wild rivers, indicated on the map, which are found within the study area:

1. Saskatchewan
   a. Clearwater River -- from Lloyd Lake Saskatchewan to Fort McMurray, Alberta
   b. Fond du Lac River -- Wallaston Lake to Stony Rapids Saskatchewan.
   c. Churchill River -- Ile-a-la Cross to Sandy Bay
   d. Sturgeon Weir River--Frog Portage to Malingne Lake
2. Wild Rivers : Alberta
   a. Smokey River-- from Grand Cache to Peace
   b. Brazeau River -- from Nigel Pass to Brazeau Reservoir
   c. Clearwater River -- Trudent Lake to Rocky Mountain
   d. North Saskatchewan -- Alexander River to Edmonton
   e. Red Deer -- Rocky Mountains to Saskatchewan River
3. Wild Rivers : The Barren Lands
   a. Hare Indian River -- Headwater Lakes to Mackenzie River
   b. Snare River -- Winsten Lake to the Power Plant and Dam Site
   c. Coppermine River
   d. Hanbury and Thelon Rivers -- from Sifton Lake to Baker Lake Settlement
4. Wild Rivers : Northwest Mountains
   a. Mountain River
   b. Natla and Keele Rivers
   c. South Redstone River
   d. Frances and Liard Rivers
   e. Dease River
   f. Gataga and Kechika Rivers

APPENDIX A: WILD RIVERS OF WESTERN AND NORTHERN CANADA

SOURCE: Parks Canada, 1980, Conservation Canada, Vol. 5, No. 4, 1980
Published under authority of the Minister of the Environment.

APPENDIX B

WATER QUALITY OBJECTIVES AND GUIDELINES

TABLE 1-
MAXIMUM ACCEPTABLE LEVELS IN WATER USED FOR DOMESTIC CONSUMPTION

PARAMETER		LEVEL		REFERENCE
ALKALINITY, TOTAL, as $CaCO_3$	GE	30	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
	LE	500	mg/L	
AMMONIA, as N	LE	0.5	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
ARSENIC, as As	LE	0.05	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
BACTERIA, FECAL COLIFORM		ND	No./dL	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
BACTERIA, TOTAL COLIFORM	LE	10	No./dL	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
BARIUM, as Ba	LE	1.0	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
BORON, as B	LE	5.0	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
CADMIUM, as Cd	LE	0.005	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
CALCIUM, as Ca	LE	200	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
CESIUM-137	LE	50	Bq/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
CHLORIDE, as Cl	LE	250	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
CHROMIUM, as Cr	LE	0.05	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
COLOUR	LE	15	TCU	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
COPPER, as Cu	LE	1.0	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
CYANIDE, as CN	LE	0.2	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
FLUORIDE, as F	LE	1.5	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
HARDNESS, TOTAL, as $CaCO_3$	LE	120	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
IODINE-131	LE	10	Bq/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
IRON, as Fe	LE	0.3	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
LEAD, as Pb	LE	0.05	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
MAGNESIUM, as Mg	LE	150	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
MANGANESE, as Mn	LE	0.05	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
MERCURY, as Hg	LE	1.0	µg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
NITRATE + NITRITE, as N	LE	10.0	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
NITRITE, as N	LE	1.0	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
NTA, as H_3NTA	LE	50.0	µg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
OIL AND GREASE		ND	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA R3 73 033
pH	GE	6.5		DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
	LE	8.5		
PHENOLIC SUBSTANCES, as PHENOL	LE	0.002	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
PHOSPHATE, TOT.INORG., as P	LE	0.065	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
PHOSPHATE, TOTAL, as P	LT	0.100	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
PHOSPHORUS, as P	LE	0.2	mg/L	HART, 1974, AUSTR. WAT. RES. COUNCIL, TECH PAPER 7
α– RADIATION, TOTAL	LE	0.02	Bq/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA R3 73 033
β– RADIATION, TOTAL	LE	0.19	Bq/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA R3 73 033
RADIUM-226	LE	1.0	Bq/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
SELENIUM, as Se	LE	0.01	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
SILVER, as Ag	LE	0.05	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
SODIUM, as Na	LE	270	mg/L	HART, 1974, AUSTR. WAT. RES. COUNCIL, TECH PAPER 7
STRONTIUM-90	LE	10	Bq/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
SULPHATE, as SO_4	LE	500	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
SULPHIDE, as H_2S	LE	0.05	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
SURFACTANTS, as MBAS	LE	0.5	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
TEMPERATURE	LE	15	°C	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
TOTAL DISSOLVED SOLIDS	LE	500	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
TRIHALOMETHANES	LE	0.35	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
TRITIUM	LE	40 000	Bq/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
TURBIDITY	LE	5	NTU	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
URANIUM, as U	LE	20	µg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
ZINC, as Zn	LE	5.0	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979

Sources : B1-B7 Environment Canada (1979a)

B8 Alberta Environment Council (1979c)

B9 International Joint Commission 1979

TABLE - 2
OBJECTIVE LEVELS IN WATER USED FOR DOMESTIC CONSUMPTION

PARAMETER	LEVEL			REFERENCE
AMMONIA, as N	LE	0.01	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
ANTIMONY, as Sb	LE	0.2	µg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
ARSENIC, as As	LE	0.005	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
BACTERIA, FECAL COLIFORM		ND	No./dL	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
BACTERIA, FECAL STREPTOCOCCI	LT	1	No./dL	ONTARIO MINISTRY OF THE ENVIRONMENT, 1974
BACTERIA, TOTAL COLIFORM		ND	No./dL	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
BARIUM, as Ba	LE	0.1	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
BORON, as B	LE	0.01	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
CADMIUM, as Cd	LE	0.001	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
CALCIUM, as Ca	LT	75	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
CESIUM-137	LE	5	Bq/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
CHLORIDE, as Cl	LT	250	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
CHROMIUM, as Cr	LE	0.2	µg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
COLOUR	LT	15	TCU	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
COPPER, as Cu	LT	1.0	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
CYANIDE, as CN	LE	0.002	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
FLUORIDE, as F	LE	1.0	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
HARDNESS, TOTAL, as $CaCO_3$	LT	120	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
IODINE-131	LE	1	Bq/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
IRON, as Fe	LT	0.05	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
LEAD, as Pb	LE	0.001	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
MAGNESIUM, as Mg	LT	50	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
MANGANESE, as Mn	LT	0.01	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
MERCURY, as Hg	LE	0.2	µg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
NITRATE + NITRITE, as N	LE	0.001	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
NITRITE, as N	LE	0.001	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
NTA, as H_3NTA	LE	0.2	µg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
ODOUR		ND	TON	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
PHENOLIC SUBSTANCES, as PHENOL	LT	0.002	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
PHOSPHATE, TOT.INORG., as P	LT	0.065	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
RADIATION, TOTAL	LT	0.37	Bq/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
RADIUM-226	LE	0.1	Bq/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
SELENIUM, as Se	LE	0.002	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
SILVER, as Ag	LE	0.005	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
STRONTIUM-90	LE	1	Bq/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
SULPHATE, as SO_4	LT	150	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
SULPHIDE, as H_2S	LT	0.05	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
SURFACTANTS, as MBAS	LT	0.2	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
TASTE		ND		DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
TEMPERATURE	LT	15	°C	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
TRIHALOMETHANES	LE	0.5	µg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
TRITIUM	LE	4000	Bq/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
TURBIDITY	LT	1	NTU	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
URANIUM, as U	LE	1.	µg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979
ZINC, as Zn	LT	5.0	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1979

TABLE 3
GUIDELINES FOR THE PROTECTION OF FRESHWATER AQUATIC LIFE

PARAMETER		LEVEL		REFERENCE
ALDRIN + HEOD (DIELDRIN)	LE	0.001	µg/L	INTERNATIONAL JOINT COMMISSION, 1977
ALKALINITY, as $CaCO_3$	GT	20	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
ALUMINIUM, as Al	LE	0.100	mg/L	GREAT LAKES WATER QUALITY BOARD, 1976
AMMONIA, UN-IONIZED, as NH_3	LE	0.02	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
ARSENIC, as As	LE	0.05	mg/L	ENVIRONMENT CANADA, 1979
BERYLLIUM, as Be	LE	0.011	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
γ– BHC, (LINDANE)	LE	0.01	µg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
CADMIUM, as Cd	LE	0.2	µg/L	ENVIRONMENT CANADA, 1979
CHLORDANE, TOTAL	LE	0.01	µg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
CHROMIUM, as Cr	LE	0.04	mg/L	ENVIRONMENT CANADA, 1979
COPPER, as Cu	LE	0.005	mg/L	GREAT LAKES WATER QUALITY BOARD, 1976
CYANIDE, as CN	LE	0.005	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
DDT, TOTAL	LE	0.001	µg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
DIAZINON	LE	0.08	µg/L	GREAT LAKES WATER QUALITY BOARD, 1976
α– ENDOSULFAN	LE	0.003	µg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
β– ENDOSULFAN	LE	0.003	µg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
ENDRIN	LE	0.002	µg/L	INTERNATIONAL JOINT COMMISSION, 1977
GUTHION	LE	0.005	µg/L	GREAT LAKES WATER QUALITY BOARD, 1976
HEPTACHLOR	LE	0.001	µg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
IRON, as Fe	LE	0.300	mg/L	GREAT LAKES WATER QUALITY BOARD, 1976
LEAD, as Pb	LE	0.03	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
MALATHION	LE	0.1	µg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
MERCURY, TOTAL, as Hg	LE	0.1	µg/L	ENVIRONMENT CANADA, 1979
p,p'– METHOXYCHLOR	LE	0.03	µg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
MIREX	LE	0.001	µg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
NICKEL, as Ni	LE	0.025	mg/L	GREAT LAKES WATER QUALITY BOARD, 1976
OXYGEN, DISSOLVED, as O_2	GE	4.0	mg/L	ENVIRONMENT CANADA, IWD., TECH. BULL. 67, 1972
PARATHION	LE	0.008	µg/L	GREAT LAKES WATER QUALITY BOARD, 1976
pH	GE	6.5		INTERNATIONAL JOINT COMMISSION, 1977
	LE	9.0		
PHENOLIC SUBSTANCES, as PHENOL	LE	0.001	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
PHOSPHATE, TOTAL, as P	LT	0.025	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
POLYCHLORINATED BIPHENYLS	LE	0.001	µg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
SUSPENDED SOLIDS	LE	25	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
SULPHIDE, as H_2S	LE	0.002	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
SURFACTANTS, as MBAS	LE	0.5	mg/L	LITTLE, 1977
CAMPHECHLOR (TOXAPHENE)	LE	0.005	µg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
ZINC, as Zn	LE	0.030	mg/L	GREAT LAKES WATER QUALITY BOARD, 1976

TABLE - 4
GUIDELINES FOR MINIMAL RISK OF ADVERSE EFFECTS TO MARINE AQUATIC LIFE

PARAMETER	LEVEL			REFERENCE
ALUMINUM, as Al	LT	0.2	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
AMMONIA, UN-IONIZED, as NH_3	LT	0.01	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
ARSENIC, as As	LT	0.01	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
BARIUM, as Ba	LT	0.5	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
BERYLLIUM, as Be	LT	0.1	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
BORON, as B	LT	5.0	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
CHROMIUM, as Cr	LT	0.05	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
COPPER, as Cu	LT	0.01	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
FLUORIDE, as F	LT	0.5	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
IRON, as Fe	LT	0.05	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
LEAD, as Pb	LT	0.01	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
MANGANESE, as Mn	LT	0.02	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
NICKEL, as Ni	LE	0.002	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
SELENIUM, as Se	LT	0.005	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
SILVER, as Ag	LT	0.001	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
THALLIUM, as Tl	LT	0.05	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
URANIUM, as U	LT	0.1	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
ZINC, as Zn	LT	0.02	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033

TABLE 5 -
GUIDELINES FOR RECREATIONAL WATERS

PARAMETER	LEVEL			REFERENCE
ARSENIC, as As	LE	0.05	mg/L	ENVIRONMENT CANADA, 1979
BACTERIA, FECAL COLIFORM	LT	100	No./dL	ONTARIO MINISTRY OF THE ENVIRONMENT, 1974
BACTERIA, TOTAL COLIFORM	LT	500	No./dL	DEPT. OF THE ENVIRONMENT, 1972, TECH. BULL. 67
CADMIUM, as Cd	LE	0.01	mg/L	ENVIRONMENT CANADA, 1979
CHROMIUM, as Cr	LE	0.1	mg/L	ENVIRONMENT CANADA, 1979
COLOUR	LE	100	TCU	DEPT. OF THE ENVIRONMENT, 1972, TECH. BULL. 67
LIGHT PENETRATION	GE	1.2	M	DEPT. OF THE ENVIRONMENT, 1972, TECH. BULL. 67
MERCURY, as Hg	LE	0.001	mg/L	ENVIRONMENT CANADA, 1979
ODOUR	LE	16	TON	DEPT. OF THE ENVIRONMENT, 1972, TECH. BULL. 67
OIL AND GREASE	LE	5	mg/L	DEPT. OF THE ENVIRONMENT, 1972, TECH. BULL. 67
pH	GT	6		DEPT. OF THE ENVIRONMENT, 1972, TECH. BULL. 67
	LT	9		
RADIATION, TOTAL	LT	0.37	Bq/L	DEPT. OF THE ENVIRONMENT, 1972, TECH. BULL. 67
SURFACTANTS, as MBAS	LE	2	mg/L	DEPT. OF THE ENVIRONMENT, 1972, TECH. BULL. 67
TEMPERATURE	LT	30	^oC	DEPT. OF THE ENVIRONMENT, 1972, TECH. BULL. 67
TURBIDITY	LE	50	JTU	DEPT. OF THE ENVIRONMENT, 1972, TECH. BULL. 67

TABLE 6
GUIDELINES FOR LIVESTOCK AND WILDLIFE WATERING

PARAMETER	LEVEL			REFERENCE
ALUMINUM, as Al	LE	5	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
ARSENIC, as As	LE	0.05	mg/L	ONTARIO MINISTRY OF THE ENVIRONMENT, 1974
BACTERIA, ENTEROCOCCI	LT	40	No./dL	ONTARIO MINISTRY OF THE ENVIRONMENT, 1974
BORON, as B	LE	5.0	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
CADMIUM, as Cd	LE	0.010	mg/L	ONTARIO MINISTRY OF THE ENVIRONMENT, 1974
CALCIUM, as Ca	LE	1000	mg/L	HART, 1974, AUSTR. WAT. RES. COUNCIL, TECH.PAPER 7
CHROMIUM, as Cr	LE	0.05	mg/L	ONTARIO MINISTRY OF THE ENVIRONMENT, 1974
COBALT, as Co	LE	1.0	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
COPPER, as Cu	LE	0.5	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
FLUORIDE, as F	LE	2.0	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
LEAD, as Pb	LE	0.05	mg/L	ONTARIO MINISTRY OF THE ENVIRONMENT, 1974
MERCURY, as Hg	LE	3.	µg/L	ENVIRONMENT CANADA, 1979
MOLYBDENUM, as Mo	LE	0.01	mg/L	HART, 1974, AUSTR. WAT. RES. COUNCIL, TECH.PAPER 7
NITRATE + NITRITE, as N	LE	20	mg/L	ONTARIO MINISTRY OF THE ENVIRONMENT, 1974
NITRITE, as N	LE	10	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
α– RADIATION, TOTAL	LE	0.02	Bq/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
β– RADIATION, TOTAL	LE	0.19	Bq/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
SELENIUM, as Se	LE	0.01	mg/L	ONTARIO MINISTRY OF THE ENVIRONMENT, 1974
SULPHATE, as SO_4	LE	1000	mg/L	ONTARIO MINISTRY OF THE ENVIRONMENT, 1974
TOTAL DISSOLVED SOLIDS	LE	2500	mg/L	ONTARIO MINISTRY OF THE ENVIRONMENT, 1974
VANADIUM, as V	LE	0.1	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
ZINC, as Zn	LE	25	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033

TABLE 7
GUIDELINES FOR IRRIGATION OF ACIDIC SOILS / CONTINUOUS USE (ALL SOILS)

PARAMETER	LEVEL			REFERENCE
ALUMINUM, as Al	LE	5.0	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
ARSENIC, as As	LE	0.10	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
BACTERIA, ENTEROCOCCI	LE	20	No./dL	ONTARIO MINISTRY OF THE ENVIRONMENT, 1974
BACTERIA, FECAL COLIFORM	LE	100	No./dL	ONTARIO MINISTRY OF THE ENVIRONMENT, 1974
BERYLLIUM, as Be	LE	0.10	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
BORON, as B	LE	0.5	mg/L	ONTARIO MINISTRY OF THE ENVIRONMENT, 1974
CADMIUM, as Cd	LE	0.010	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
CHLORIDE, as Cl	LE	150	mg/L	ONTARIO MINISTRY OF THE ENVIRONMENT, 1974
CHROMIUM, as Cr	LE	0.1	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
COBALT, as Co	LE	0.050	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
COPPER, as Cu	LE	0.20	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
FLUORIDE, as F	LE	1.0	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
IRON, as Fe	LE	5.0	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
LEAD, as Pb	LE	5.0	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
LITHIUM, as Li	LE	2.5	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
MANGANESE, as Mn	LE	0.20	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
MOLYBDENUM, as Mo	LE	0.010	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
NICKEL, as Ni	LE	0.20	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
pH	GE	4.5		ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
	LE	9.0		
α– RADIATION, TOTAL	LE	0.02	Bq/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
β– RADIATION, TOTAL	LE	0.19	Bq/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
SELENIUM, as Se	LE	0.020	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
SODIUM ABSORPTION RATIO	LT	6		ONTARIO MINISTRY OF THE ENVIRONMENT, 1974
TOTAL DISSOLVED SOLIDS	LE	500	mg/L	ONTARIO MINISTRY OF THE ENVIRONMENT, 1974
VANADIUM, as V	LE	0.10	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
ZINC, as Zn	LE	2.0	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033

Table 8

Prairie Provinces Water Board Objectives for Regularly Monitored Surface Water Quality Parameters

Water Quality Parameter	Maximum or Minimum Value
Coliform Bacteria (Total)	1000* or 5000**/100 ml max.
Faecal Coliform Bacteria	200* or 1000**/100 ml max.
Dissolved Oxygen	5.0 mg/l min.
Suspended Solids	10 mg/l over natural background level
pH Value	6.5 min., 8.5 max., 0.5 units from natural background level
Temperature	3^{0} C over natural background level
Turbidity	25 Jackson units over natural background level
Odour	8 Units
Surfactants (MBAS)	0.5 mg/l max.
Phenolics	0.005 mg/l max.
Fluoride	1.5 mg/l max.
Iron	0.3 mg/l max.
Manganese	0.05 mg/l max.
Nitrogen (Total)	0.5 mg/l max.
Phosphorus (Total as PO_4)	0.15 mg/l max. 0.05 mg/l as P
Sodium (per cent of cations)	30 min., 75 max.
Zinc	0.05 mg/l max.
Cadmium	0.01 mg/l max.
Chromium	0.05 mg/l max.
Lead	0.05 mg/l max.
Mercury	0.0001 mg/l max.
Silver	0.05 mg/l max.
Copper	0.02 mg/l max.

* Geometric mean of not less than 5 samples per month in waters to be used for direct contact recreation or vegetable crop irrigation.

** At least 90 per cent of samples in a month in waters to be withdrawn for treatment and distribution as a potable supply or used for outdoor recreation other than direct contact.

Source: Alberta Environment, Pollution Control Division

Table 9

Water Quality Requirements
For Indigenous Biota

Parameter		Not to Exceed Limit	Referenced Annex
Chemical Characteristics			
Aluminum, dissolved	mg/L	0.1	B
Ammonia (NH_3), free	mg/L	0.02	B
Arsenic, total	mg/L	0.1	B
Cadmium, total	mg/L	0.0012	B
Chromium, total	mg/L	0.1	B
Copper, dissolved	mg/L	0.005	B
Iron, dissolved	mg/L	0.6	B
Lead, total	mg/L	0.03	B
Mercury, dissolved	mg/L	0.0002	B
Mercury, fish (wet wt., whole fish)	mg/Kg	0.5	B
Nitrates (N)	mg/L	10% above natural	B
Oxygen, dissolved	mg/L	Footnote[1]	B
Phosphates (P)	mg/L	10% above natural	B
pH	mg/L	6.5 - 9.0	B
Total Dissolved Solids (TDS)	mg/L	2500	B
Zinc, total	mg/L	0.03	B
Physical Characteristics			
Temperature	^{o}C	Footnote[2]	B
Turbidity	N.T.U.	±20% and footnote[3]	B

Footnotes

1 Greater than 5 mg/L between April 10 and May 15; greater than 4 mg/L during remainder of year.

2 Water temperature from April 10 to May 15 should not be increased above natural. The maximum water temperature shall not be caused to exceed 30^{o}C.

3 Turbidity shall not be caused to deviate more than ±20% of historic values based on correlations of historical stream flow vs turbidity measurements.

VI.—DISTRIBUTION OF LEGISLATIVE POWERS.

Powers of the Parliament.

Legislative Authority of Parliament of Canada.

91. It shall be lawful for the Queen, by and with the Advice and Consent of the Senate and House of Commons, to make Laws for the Peace, Order, and good Government of Canada, in relation to all Matters not coming within the Classes of Subjects by this Act assigned exclusively to the Legislatures of the Provinces; and for greater Certainty, but not so as to restrict the Generality of the foregoing Terms of this Section, it is hereby declared that (notwithstanding anything in this Act) the exclusive Legislative Authority of the Parliament of Canada extends to all Matters coming within the Classes of Subjects next herein-after enumerated; that is to say,—

1. The amendment from time to time of the Constitution of Canada, except as regards matters coming within the classes of subjects by this Act assigned exclusively to the Legislatures of the provinces, or as regards rights or privileges by this or any other Constitutional Act granted or secured to the Legislature or the Government of a province, or to any class of persons with respect to schools or as regards the use of the English or the French language or as regards the requirements that there shall be a session of the Parliament of Canada at least once each year, and that no House of Commons shall continue for more than five years from the day of the return of the Writs for choosing the House: provided, however, that a House of Commons may in time of real or apprehended war, invasion or insurrection be continued by the Parliament of Canada if such continuation is not opposed by the votes of more than one-third of the members of such House. (39)

1A. The Public Debt and Property. (40)
2. The Regulation of Trade and Commerce.
2A. Unemployment insurance. (41)
3. The raising of Money by any Mode or System of Taxation.
4. The borrowing of Money on the Public Credit.
5. Postal Service.
6. The Census and Statistics.
7. Militia, Military and Naval Service, and Defence.
8. The fixing of and providing for the Salaries and Allowances of Civil and other Officers of the Government of Canada.
9. Beacons, Buoys, Lighthouses, and Sable Island.
10. Navigation and Shipping.
11. Quarantine and the Establishment and Maintenance of Marine Hospitals.
12. Sea Coast and Inland Fisheries.

13. Ferries between a Province and any British or Foreign Country or between Two Provinces.
14. Currency and Coinage.
15. Banking, Incorporation of Banks, and the Issue of Paper Money.
16. Savings Banks.
17. Weights and Measures.
18. Bills of Exchange and Promissory Notes.
19. Interest.
20. Legal Tender.
21. Bankruptcy and Insolvency.
22. Patents of Invention and Discovery.
23. Copyrights.
24. Indians, and Lands reserved for the Indians.
25. Naturalization and Aliens.
26. Marriage and Divorce.
27. The Criminal Law, except the Constitution of Courts of Criminal Jurisdiction, but including the Procedure in Criminal Matters.
28. The Establishment, Maintenance, and Management of Penitentiaries.
29. Such Classes of Subjects as are expressly excepted in the Enumeration of the Classes of Subjects by this Act assigned exclusively to the Legislatures of the Provinces.

And any Matter coming within any of the Classes of Subjects enumerated in this Section shall not be deemed to come within the Class of Matters of a local or private Nature comprised in the Enumeration of the Classes of Subjects by this Act assigned exclusively to the Legislatures of the Provinces. (42)

Exclusive Powers of Provincial Legislatures.

92. In each Province the Legislature may exclusively make Laws in relation to Matters coming within the Classes of Subject next herein-after enumerated; that is to say,— Subjects of exclusive Provincial Legislation.

1. The Amendment from Time to Time, notwithstanding anything in this Act, of the Constitution of the Province, except as regards the Office of Lieutenant Governor.
2. Direct Taxation within the Province in order to the raising of a Revenue for Provincial Purposes.
3. The borrowing of Money on the sole Credit of the Province.
4. The Establishment and Tenure of Provincial Offices and the Appointment and Payment of Provincial Officers.
5. The Management and Sale of the Public Lands belonging to the Province and of the Timber and Wood thereon.

6. The Establishment, Maintenance, and Management of Public and Reformatory Prisons in and for the Province.
7. The Establishment, Maintenance, and Management of Hospitals, Asylums, Charities, and Eleemosynary Institutions in and for the Province, other than Marine Hospitals.
8. Municipal Institutions in the Province.
9. Shop, Saloon, Tavern, Auctioneer, and other Licences in order to the raising of a Revenue for Provincial, Local, or Municipal Purposes.
10. Local Works and Undertakings other than such as are of the following Classes:—
    (*a*) Lines of Steam or other Ships, Railways, Canals, Telegraphs, and other Works and Undertakings connecting the Province with any other or others of the Provinces, or extending beyond the Limits of the Province;
    (*b*) Lines of Steam Ships between the Province and any British or Foreign Country;
    (*c*) Such Works as, although wholly situate within the Province, are before or after their Execution declared by the Parliament of Canada to be for the general Advantage of Canada or for the Advantage of Two or more of the Provinces.
11. The Incorporation of Companies with Provincial Objects.
12. The Solemnization of Marriage in the Province.
13. Property and Civil Rights in the Province.
14. The Administration of Justice in the Province, including the Constitution, Maintenance, and Organization of Provincial Courts, both of Civil and of Criminal Jurisdiction, and including Procedure in Civil Matters in those Courts.
15. The Imposition of Punishment by Fine, Penalty, or Imprisonment for enforcing any Law of the Province made in relation to any Matter coming within any of the Classes of Subjects enumerated in this Section.
16. Generally all Matters of a merely local or private Nature in the Province.

Education.

Legislation respecting Education.

93. In and for each Province the Legislature may exclusively make Laws in relation to Education, subject and according to the following Provisions:—

(1) Nothing in any such Law shall prejudicially affect any Right or Privilege with respect to Denominational Schools which any Class of Persons have by Law in the Province at the Union:

APPENDIX D

METRIC - BRITISH CONVERSION TABLE

Abbreviations

ac	acre	gal	gallon
ac ft	acre feet	ha	hectare
C°	centigrade degrees	in	inch
cfs	cubic feet per second	km	kilometer
dam	decameter	L	litre
F°	fahrenheit degrees	m	meter
ft	feet	m	mile

CONVERSIONS

Multiply	by		To Obtain
acre feet	1.233	=	decameters^3
acres	.4047	=	hectares
centigrade degrees	1.8	=	degrees fahrenheit
centimeter	.3937	=	inches
decameter^3	.8107	=	acre feet
hectares	2.471	=	acres
inches	2.54	=	centimeters
kilometer	.6214	=	miles
kilometer^2	.3861	=	miles^2
meters	3.2808	=	feet
meter^3/sec	35.314	=	cubic feet per second