CANADA-SASKATCHEWAN
SOUTH SASKATCHEWAN RIVER BASIN STUDY

TECHNICAL APPENDIX II

RESOURCE ASSESSMENT

C. WATER USE

PREPARED BY:

CANADA-SASKATCHEWAN
SOUTH SASKATCHEWAN
RIVER BASIN STUDY OFFICE

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ACKNOWLEDGEMENTS

This technical appendix was assembled by the staff of the South Saskatchewan River Basin Study Office. It is based on information from the references cited in the document, the technical reports listed in Appendix A, and extensive consultation with private and government interest groups. The efforts of Ross Herrington, Water Planning and Management Branch, Inland Waters Directorate, Environment Canada in the preparation of this document are appreciated.

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(a) "document the current and emerging water and related issues in the South Saskatchewan River Basin

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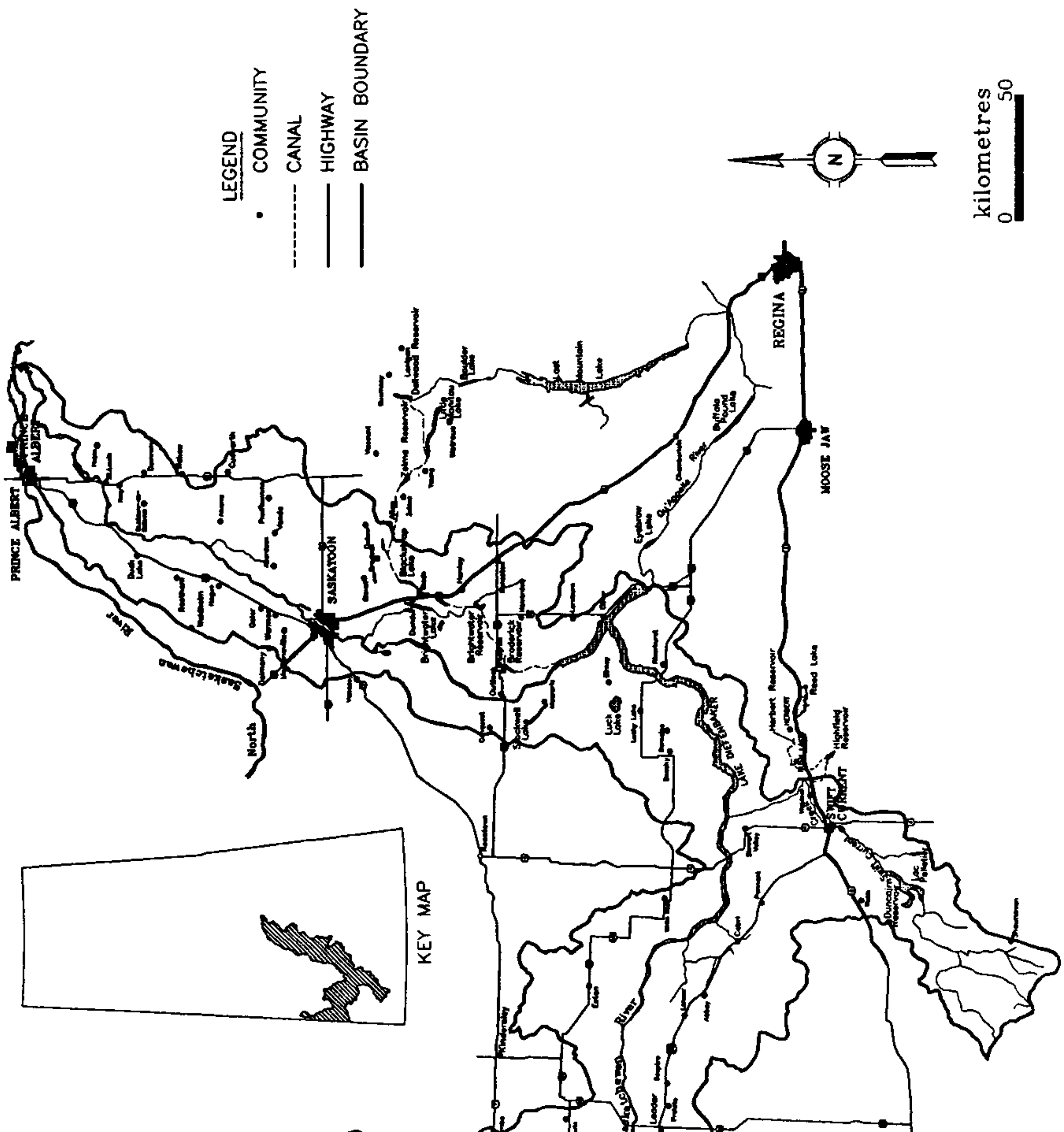


FIGURE 2 SASKATOON SOUTHEAST WATER SUPPLY SYSTEM

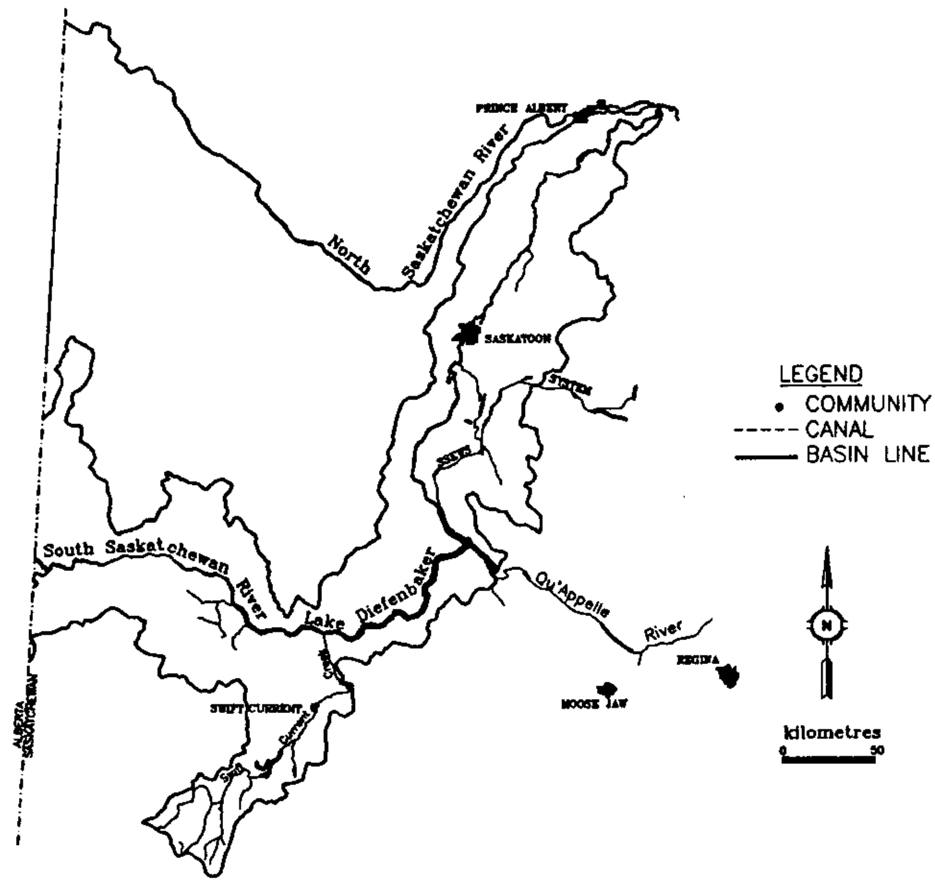
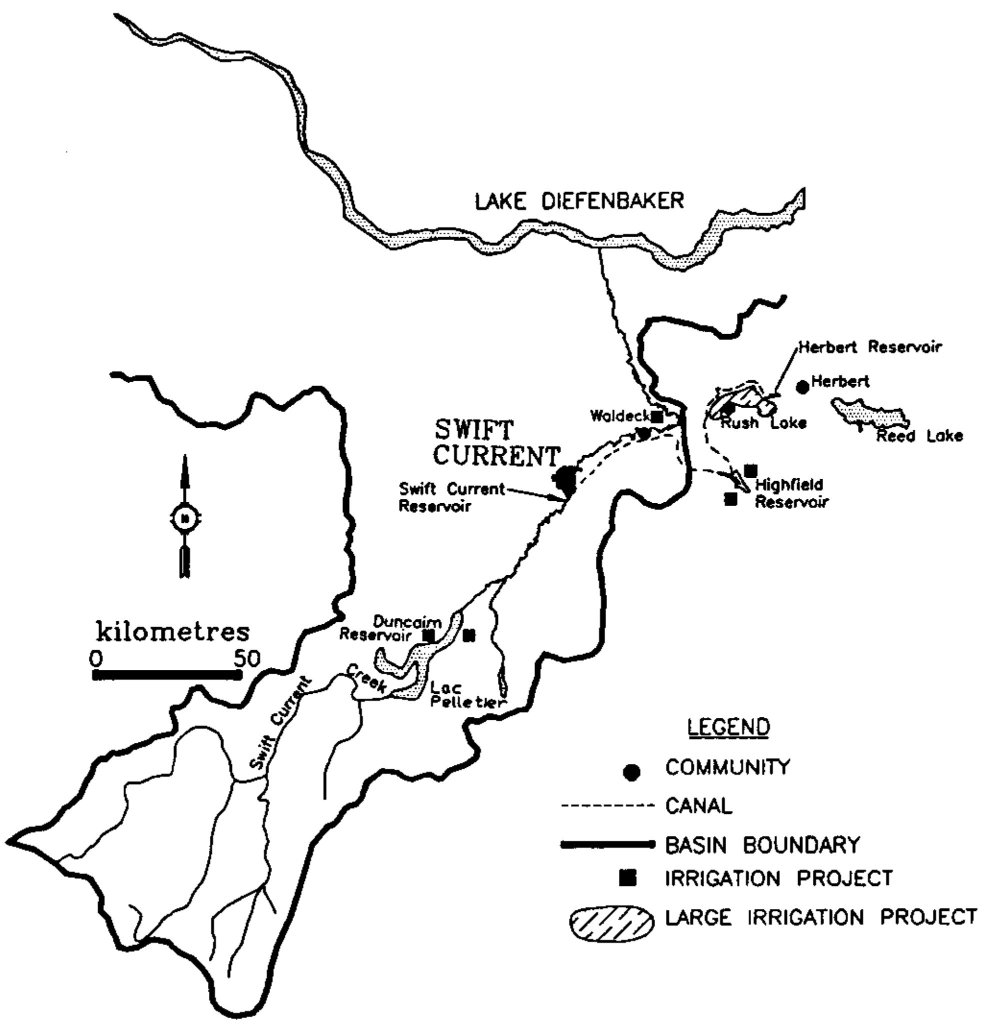


FIGURE 3 SWIFT CURRENT CREEK



2.0 GENERAL METHODOLOGY

2.1 INTRODUCTION

In support of the Canada-Saskatchewan South Saskatchewan River Basin Study Agreement, a Water Use Analysis and Forecasting Technical Committee was established to assist the Study Office in defining the need for technical studies to be undertaken by consultants and in reviewing the results of their studies. This report represents a compilation of many specific water use studies completed since 1986 and under the direction of the South Saskatchewan River Basin Study Office. The main reports used are: Instream Water Use (SSRBS Technical Report E.7); Irrigation Water Use: Pilot Study (SSRBS Technical Report E.8); Irrigation Water Use Survey (SSRBS Technical Report E.11); Municipal and Residential Water Use Study (SSRBS Technical Report E.5); Major Industrial Water Users (SSRBS Technical Report E.10); The Demand for Water-based Recreation (SSRBS Technical Report E.17); and Water Demand Management (SSRBS Technical Report E.18). A complete list of these reports is included in the Reference Section. Additional information may be found by referring to the appropriate reports as well as to the other Technical Appendices on water management, water quantity, water quality and environmental aspects.

The Water Resources Management Model (WRMM) was used to evaluate the implications of future water development and management strategies for the Saskatchewan portion of the study area. The Water Resource Management Model simulates the river system as a series of reservoirs, channels, diversions and nodes. The basin is divided into three sub-systems: South Saskatchewan River mainstem, Swift Current Creek and the Saskatoon Southeast Water Supply (SSEWS) system. A more detailed discussion of WRMM can be found in the Water Management Model Study (SSRBS Technical Report C.1) prepared in 1988.

Because water use can vary significantly from year to year in response to weather conditions, the demand for water and economic trends, the water use estimates for the 1986 level of development were calculated as the average use over a three or four year period rather than the use in any one year. The actual years selected varied by project depending upon data availability; only records which were representative of the project operations were used. For smaller projects where no recorded water use data exist, it was assumed that the projects would use their entire allocated water volume. It is important to note that the water use statistics presented in this report refer to the 1986 level of development and not to any one specific year.

A second model, the Water Use Analysis Model (WUAM) was developed by Acres International Limited under the direction of the Inland Waters Directorate for the Canadian Department of Energy, Mines and Resources. The objective was to provide a tool to assess changes in water use and to estimate their impacts on surface water supplies. The WUAM uses economic and demographic forecasts to estimate future water use. Water balance calculations, using historical hydrometeorological data, identify the imbalances between water demand and water supply. Details on this model are contained in SSRBS Technical Report D.19.

Most of this report discusses the current major water uses in the study area in Saskatchewan by geographic region: South Saskatchewan River mainstem, the Saskatoon Southeast Water Supply (SSEWS) System and Swift Current Creek. Section 8.0 identifies potential future water uses for about the turn of the century and for about two decades into the next century. Section 9.0 introduces the concept of "demand management", whereby attempts are made to influence the demand patterns which society places upon the water resource.

2.2 WATER USE CATEGORIES

Water uses are often referred to as "instream" or "offstream" uses. Instream water uses include recreation and transportation (ferries). In general, these uses are non-consumptive, that is, they do not actually consume any water from a river, lake or reservoir. They also do not usually impair the quality of water for other uses. Hydro-electric power generation is often considered a non-consumptive instream use.

Water is consumed or lost indirectly through evaporation from the reservoir surface. It is difficult to "charge" this use to a particular water use category as many reservoirs serve multiple functions. Table 1 lists estimated annual net evaporation from selected reservoirs in the basin in Saskatchewan.

Offstream water uses withdraw water and use it away from its source. These uses generally return a portion of what they withdraw, with this return flow water being often of poorer quality. The major offstream users of water in the basin include municipalities, industries and irrigation projects.

TABLE 1	ESTIMATED ANNUAL NET RESERVOIR EVAPORATION
RESERVOIR	ANNUAL NET EVAPORATION (dam^3)
MAINSTEM	
Lake Diefenbaker	240 000
SWIFT CURRENT CREEK	
Lac Pelletier	21 000
Duncairn Reservoir	8 800
Swift Current Reservoir	140
Highfield Reservoir	3 000
Herbert Reservoir	350
SSEWS	
Broderick Reservoir	2 300
Brightwater Reservoir	1 500
Blackstrap Lake	6 500
Bradwell Reservoir	950
Zelma Reservoir	2 100
Little Manitou Lake	8 300
Dellwood Reservoir	900

Offstream water users and some forms of instream water users must apply to SaskWater for permission to use water. If the project is feasible and sufficient water is available in the basin, an approval is granted. An annual volume of water is then allocated to the project. These water allocations collectively identify to the water managers how much of the resource is already allocated to specific users.

These allocations are a measure of the maximum amount that a user may draw from the lake or stream. They are not necessarily a measure of the actual water use. Some users, like thermal power stations, may withdraw their allocation, consume a small fraction, and return the majority of the water to the waterway. Municipalities commonly receive an allocation that provides extra capacity to cover anticipated future needs. Some users, such as irrigation are allocated sufficient water to serve their maximum depth or duty of irrigation in dry years but their average use may be substantially less. As a result, the approved allocations only provide a starting point for water use analysis. Additional information on actual water use was needed for this study.

Domestic water use usually refers to use by individual rural water users. If often includes use for residential, garden and stockwatering purposes.

Municipal uses include household and sanitary purposes, the watering of parks, boulevards, lawns and gardens, fire protection, and flushing of sewers. Municipalities also provide water to other types of users. For example, most communities supply water to institutional and commercial users like schools and businesses. Some of the larger communities also provide water to industries like manufacturing plants and dairies.

Industrial uses in the basin include water required for mineral extraction, manufacturing and the Queen Elizabeth II thermal generating station at Saskatoon. Feedlots are also included in this purpose. The mineral extraction industry is comprised entirely of potash mines while the manufacturing category includes chemical plants, breweries, dairies, meat packers and some light manufacturing. Most of these manufacturing industries are located in, and rely on municipalities, to supply their water requirements.

Agricultural water use includes both irrigation and stockwatering. Irrigation is the larger user of water. Water may be supplied directly from a river source or from a reservoir and canal system. On the other hand, stockwatering requires significantly smaller volumes of water and as a result this water use is more widely distributed throughout the basin.

Two types of irrigation projects exist in Saskatchewan. The first is one in which individual farmers own and operate private irrigation schemes. The second type is the group project which is composed of a number of irrigators who are supplied by a common delivery system and who jointly operate and maintain that system. Both types of irrigation schemes are allocated water by SaskWater.

SaskWater identifies seven methods of water distribution for these irrigation projects. These include:

1. sprinkler (includes several varieties)
2. border-dyke and border strips
3. gated pipe and corrugations
4. contour dykes
5. backflood
6. freeflood and contour ditches
7. backflood drainage

Water allocation varies with the type of water distribution system. For example, border dyke projects are allocated 305 mm of water, backflood projects 203 mm, and sprinkler irrigation systems a duty of 305 to 610 mm of water. The duty based on irrigation area determines the volume of water allocated to each irrigation project. This is usually expressed in cubic decametre (dam^3) units.

Besides the type and size of irrigation project, the actual water used for irrigation depends on several factors. These include: the availability of the water supply; location of the project within the South Saskatchewan River Basin; and the type of crop irrigated.

3.0 SOUTH SASKATCHEWAN RIVER MAINSTEM

3.1 HISTORICAL WATER USE

3.1.1 Upstream of Study Area: Alberta

Management and use of water in the Saskatchewan portion of the basin has been influenced by utilization of water in Alberta. The historical development of water in Alberta, therefore, has played a significant role in the development of this resource in Saskatchewan.

Irrigation began in Alberta in the late 1800s. The earliest projects relied on the natural base flows of the large rivers. More recent developments have included additional storage reservoirs to store water in high flow periods for later use. Investment in large scale irrigation projects began after the Dominion government passed the Northwest Irrigation Act in 1894. This Act was intended to facilitate the orderly development of irrigation in the area that is now the Provinces of Alberta and Saskatchewan. This act placed the ownership of all water with the Crown and provided a system of allocation of water to specific users. The resulting long-term access to an allocation of water provided the incentive for the high capital investments that were required for irrigation development. Later, in 1930, when management of the water resource was transferred to the provinces, similar provincial legislation was passed.

The most economical opportunities for irrigation were in the area that is now southern Alberta. Water from the Oldman River and the Bow River could be easily diverted by gravity out of the river channels and into canals which carry the water to farmland that is suitable for the types of gravity irrigation techniques that were available.

After the least expensive irrigation developments were built, federal and provincial government assistance programs were introduced which encouraged continued development. By 1920, there were 73 000 hectares irrigated; irrigation in Alberta occupied 544 000 hectares in 1987.

Hydro-electric generation in the basin began in the 1890s. The most recent developments occurred in 1960. There are a total of 11 hydro generation plants in the Bow River Basin with a combined generation capacity of 325 megawatts. These plants provide 6 percent of the total Alberta generating capacity.

Storage reservoirs built for hydro projects change the pattern of flow. In general, water is stored in the spring and early summer and released through the winter when energy demands are higher. The redistribution of the seasonal flow must be taken into account in the management of the river downstream in Saskatchewan. The total active storage volume in the Alberta hydro reservoirs used in an average year is about 500 000 dam^3.

There are over 1 000 000 people living in the South Saskatchewan River Basin in Alberta, mostly in cities and towns which rely on the flows of the South Saskatchewan River and its tributaries. The municipal water and sewer systems which serve these people handle large volumes of water but their net impact is less than might be expected. About 80 percent of the water diverted is returned to the river system after treatment. The net depletion of the flow of the South Saskatchewan River upstream of Saskatchewan for municipal uses is about 60 000 dam^3 per year which is a relatively small quantity of water compared to other uses.

Southern Alberta has a variety of industrial developments. These include: oil and gas extraction; oil refining; coal mining; forestry; food processing; and manufacturing.

Much of the industrial use of water in Alberta is based on the municipal water systems but some of the larger industries have separate water sources and effluent disposal systems. Their effects are similar to the municipal category. They may use significant quantities of water but since most of the water is treated and returned to the rivers, the net impact is small. Net industrial water consumption averages about 40 000 dam^3 per year.

The rivers, reservoirs and other water bodies provide a base for tourism, recreation, fish and wildlife uses of the water. These uses generally take advantage of the available water without directly consuming the resource. Many of the irrigation and other reservoirs support these uses of the water and although some of the evaporation losses caused by these reservoirs might be considered to be a result of the secondary uses, the losses are generally assigned to the primary uses.

Alberta Environment has established desirable and minimum flows and water levels which are maintained in the rivers. The desirable flows are maintained most of the time. The minimum flows are only allowed to occur in extreme droughts when the water supply is inadequate for all users. The flow is never allowed to drop below the minimum flow required for instream uses.

In summary, the average annual depletion of the flows of the South Saskatchewan River in Alberta is about 1 900 000 dam³ with about 95 percent of the water going to irrigation. Alberta uses of the water were insignificant prior to 1890 and have grown at a varying rate since that time. In 1990, Alberta Environment established an upper limit to irrigation expansion in the South Saskatchewan River Basin in Alberta as the demand for water exceeds the supply.

3.1.2 Saskatchewan

With construction of the Gardiner and Qu'Appelle dams as part of the South Saskatchewan River Project in the 1960s, the South Saskatchewan River in Saskatchewan became more intensively utilized. The most important use was the municipal supply for the city of Saskatoon which has a licence for about 61 000 dam³ annually, and several towns along the river. The river is 100 m or more below the surrounding prairie such that there were no convenient opportunities to divert water to large-scale irrigation projects. Irrigation development was limited to a few small projects within the valley. Recreation was affected by the very wide fluctuations in the flow and water level, and by the heavy sediment load of the river.

Other uses of the river had been considered. The cities of Regina and Moose Jaw are located in a region of very limited local water supply. Various methods of using the South Saskatchewan River as a source of supply were proposed. One plan, which involved pumping water from the river into the Thunder Creek valley near Riverhurst where it could run by gravity to Moose Jaw, was attempted in the 1920s but was abandoned because of high losses to ground water.

In 1958, a pumped diversion from the South Saskatchewan River to the Qu'Appelle River valley was built for the supply of water to Regina and Moose Jaw by pipelines from a treatment plant at Buffalo Pound Lake in the Qu'Appelle River valley. This diversion operated until 1965 when the pumps were removed as Lake Diefenbaker was about to flood them. In 1967 this pumped diversion was replaced by gravity releases from Lake Diefenbaker at the Qu'Appelle Dam. The pumped diversion averaged 25 500 dam³ per year or about one-third of one percent of the average flow of the South Saskatchewan River in the years of operation.

Gardiner Dam and the Qu'Appelle Dam were built during the period from 1958 to 1968 to form Lake Diefenbaker. The lake filled between 1965 and 1968. The 9 400 000 dam³ of water that was captured to initially fill the lake in this four year period was the first noticeable depletion of the flow by man-made projects in Saskatchewan, as it took almost one-quarter of the total flow for this period.

Lake Diefenbaker was developed as a multi-purpose water control project. In addition to supplying water for irrigation, municipal, industrial, recreation and wildlife projects, the lake provides flow regulation to provide assured flows downstream, flood control and hydro-electric generation.

Data compiled by the Prairie Provinces Water Board (Prairie Provinces Water Board, 1990) indicate that annual municipal water use for communities in the study area with more than 1 000 people increased from about 12 000 dam³ in 1951 to 47 100 dam³ in 1986 (Figure 4). These quantities include industrial uses from municipal sources. This represents an increase of about 300 percent. The corresponding per capita water use increased by one-third during this period, and is estimated to have increased in volume by about 23 percent and on a per capita basis by 88 percent.

Figure 5 (Prairie Provinces Water Board, 1990) illustrates the growth of district irrigation in the Saskatchewan portion of the Saskatchewan-Nelson River Basin, part of which includes the study area. In 1951, only 75 ha were irrigated by organized irrigation districts. By 1986, over 23 300 ha were irrigated. Irrigators utilizing privately developed water supplies, expanded the irrigated area from 9 500 ha to 83 100 ha during the same period. District irrigation water use increased from 200 dam³ to 97 000 dam³ while private irrigation water use increased from 38 000 dam³ to 223 000 dam³.

Water use monitoring is an essential tool in effective water management. There are several techniques of monitoring water flows and water use. These include using streamflow stations and flow meters. Streamflow or hydrometric stations can be constructed on the bank of a river or canal and are designed to measure streamflow based on the relationship between water elevation and discharge. Water meters are often installed where water is pumped via a distribution system.

There are several hydrometric stations along the mainstem of the South Saskatchewan River. Streamflow is monitored as it enters the province from Alberta, at diversion points from Lake Diefenbaker to the Qu'Appelle River and to the Saskatoon Southeast Water Supply system, at Gardiner Dam, at Saskatoon and at St. Louis before the river joins the North Saskatchewan River. A more complete discussion can be found in the South Saskatchewan River Basin Study Water Quantity Technical Appendix.

FIGURE 4 ANNUAL COMMUNITY WATER USE FOR STUDY AREA, 1951-1986

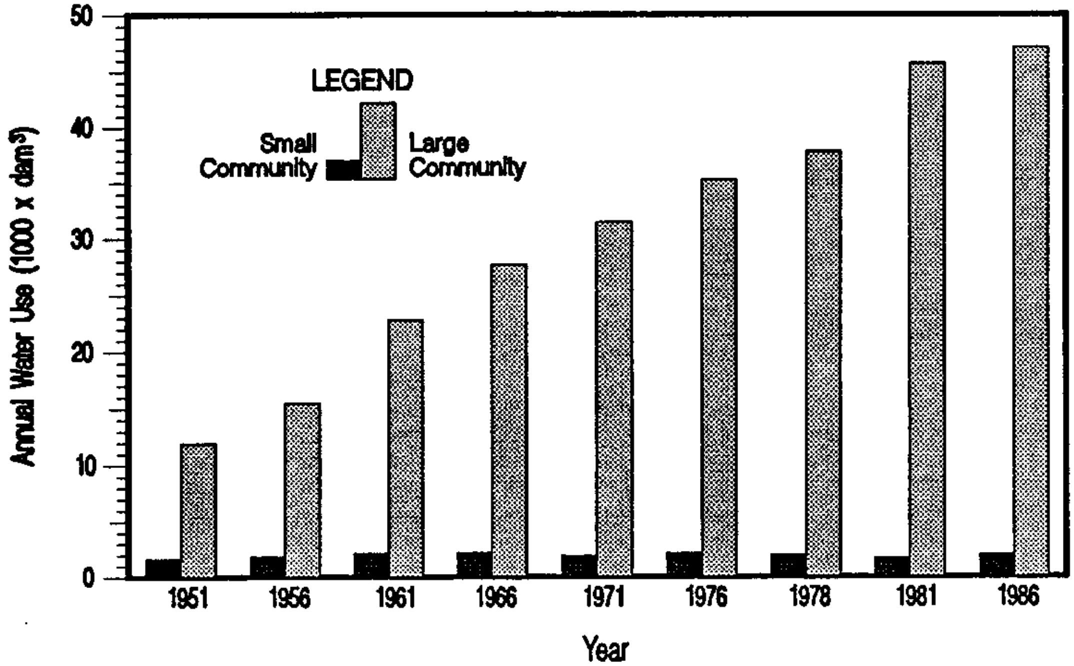
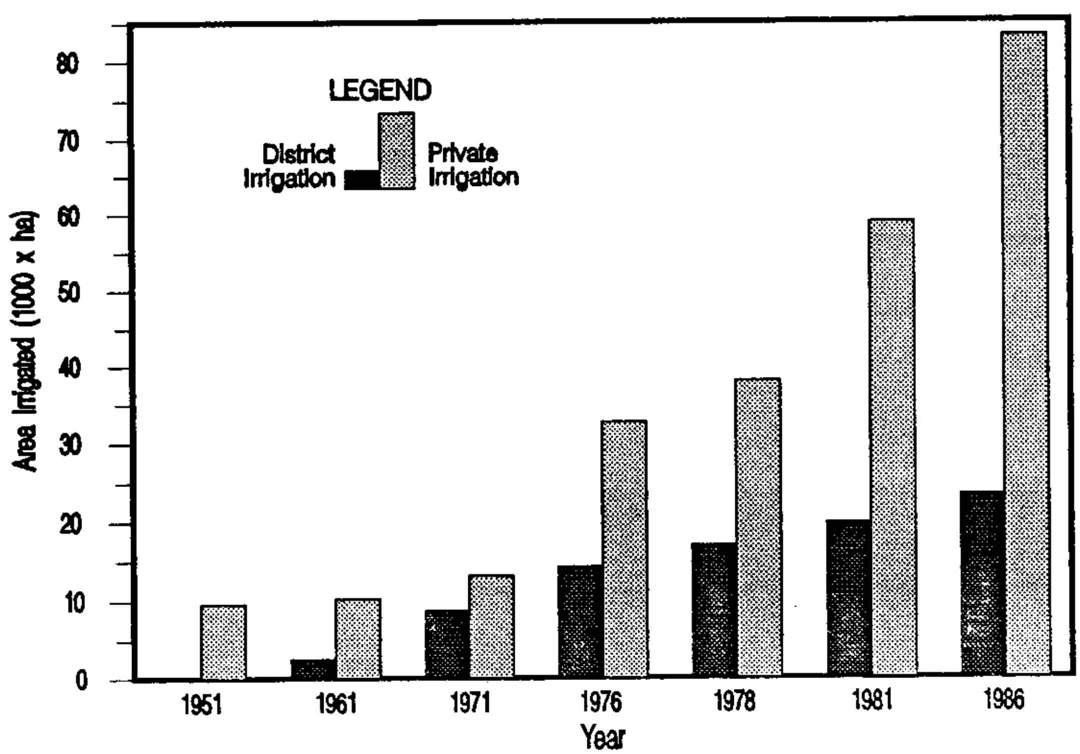


FIGURE 5 DEVELOPMENT OF IRRIGATION IN SASKATCHEWAN, 1951-1986



Monitoring of water pumped to municipal distribution systems occurs at 50 communities in the study area. The database for monitoring municipal water use is maintained by SaskWater. Cards are submitted annually by each community. These consist of monthly volumes of treated water pumped. The data are reviewed for discrepancies and any errors corrected before the data are entered into the database. In addition, the larger communities have installed water meters on individual homes. These meters are monitored by the community.

Many of the industrial water users in the study area are supplied with water through municipal water supply systems. Others such as the potash mines supplied along the SSEWS system are supplied directly.

Monitoring water use for irrigation purposes is more difficult. In most cases, water withdrawn from these projects is not directly monitored. The quantity of water used varies considerably from year to year. Approximations of actual use can only be made by reference to the water licence. One notable exception is the Luck Lake Irrigation Project, which meters the water at the start of the system and at every delivery point. There is an energy charge to cover the operation of the pumps and a water use charge based on hectares irrigated. Contracts with irrigators also provide for a resource management charge that will be used to offset costs such as flow forecasting and hydrometric monitoring.

The determination of irrigation use is sometimes complicated by the existence of return flow. Return flows from irrigation projects can be substantial. These return flows are difficult to monitor and this is not routinely done.

Evaporation from reservoirs is considered to be a water use and must be considered for the South Saskatchewan River. Evaporation cannot be measured directly as it is a flow of water from the water surface to the atmosphere. Therefore, it must be estimated from indirect measurements of temperature, relative humidity and wind speed. The Atmospheric Environment Service of Environment Canada undertakes a program of water temperature measurements and combines that data with atmospheric measurements at nearby locations to estimate the evaporation from Lake Diefenbaker.

3.2 CURRENT WATER USE (1986)

3.2.1 Municipal

Twenty-two communities in the South Saskatchewan River Basin are supplied with water for municipal purposes from the South Saskatchewan River or Lake Diefenbaker. (Seven communities served by the Saskatoon Southeast Water Supply System are discussed in Section 4.0.) Other communities within the basin obtain their municipal water supply from local surface sources or from groundwater. These uses do not impact on the South Saskatchewan River and are not discussed here.

Three of these 22 communities have a second source of supply in addition to the South Saskatchewan River. These include Cabri, Regina and Moose Jaw. No accurate data exists as to the proportion supplied from each source. In Regina, for example, it is estimated that 30 percent of the municipal water requirement is obtained from groundwater sources. Moose Jaw's groundwater supply system is only used under emergency conditions.

The Water Supply Utility of SaskWater operates several multi-purpose water supply projects. The works serve municipal, agricultural, industrial, recreational and wildlife conservation requirements (SaskWater Annual Report, 1989). The largest system, the Saskatoon Southeast Water Supply (SSEWS) system, is a system of canals, reservoirs and pipelines constructed to distribute water from Lake Diefenbaker.

The Saskatoon Treated Water Supply system uses Saskatoon's treated water system as a source of supply. It distributes treated water via pipeline to municipal, domestic and industrial users in the Saskatoon region. The eight municipalities supplied by this system include Allan, Blucher (R.M.), Bradwell, Clavet, Dalmeny, Martensville, Osler and Warman. There are also 69 domestic installations connected to this system. Approximately 920 dam^3 are supplied annually by this system.

The Saskatoon West Water Supply system, using the South Saskatchewan River as a source, supplies untreated water to the town of Vanscoy, the R.M. of Corman Park and to 107 domestic users. Several industrial users are also supplied from this system. Approximately 50 dam^3 are supplied by this system each year.

Water supply intakes exist for Cabri, Leader, Eston-Kindersley, Elbow, Outlook, Saskatoon and St. Louis. All intakes except the one at Cabri are permanent. Some intakes, such as at Outlook and Leader, have experienced problems in the past due to variable river water levels and migrating low flow channels. These problems have largely been eliminated.

Various measures of municipal water use are available. For example, many communities have received a water allocation for municipal purposes from SaskWater. These allocations provide an estimate of gross water use but actual water use may be quite different. Table 2 lists the communities along the mainstem of the South Saskatchewan River which obtain water from the river for municipal purposes. Pumpage records for these communities indicate that in many cases actual water pumped can be much less than the allocation.

For communities with water meter (pumpage) records, municipal water use can be measured in terms of the volume of water pumped into the community's distribution system. Some communities meter the raw water supply prior to treatment while others meter after treatment. When the water is metered raw, the volume of water used annually to backwash filter equipment must be subtracted, if it is known, from the total pumpage to obtain the actual volume of water pumped into the community's distribution system. The volume of water used in backwashing is relatively small, perhaps in the range of 2 to 4 percent of the total pumpage. Table 3 presents data for two communities (SSRBS Technical Report E.3).

These records represent "gross" water use as not all the water pumped into the distribution system is actually consumed. A proportion of the municipal use may be returned to the surface water source and used by others downstream. This quantity would vary depending upon the type of waste collection system (for example, septic tank or sewage lagoon) and the time of year the water is used (for example, park watering or sewer flushing). Records of return flow are not routinely collected for most communities. Therefore, it is difficult to measure "net" water use. Table 4 presents return flow data (net water use) for the city of Saskatoon during the 1980s. On an annual basis the sewage return flow was at least 62 percent and averaged 68 percent over the ten year period. In a "dry" year (1988) water consumption is higher and return flow lower than in a "normal" year (1989). From Table 2 actual municipal water "consumed" by Saskatoon for the 1986 level of development would be 32 percent of 40 700 dam^3, or 13 020 dam^3.

Saskatoon and Regina accounted for 60 000 dam^3 of the volume of water supplied from the South Saskatchewan River in 1986 for municipal purposes along the South Saskatchewan River (Table 3). This represents about 86 percent of the total mainstem municipal use.

The actual diversion of water from Lake Diefenbaker to Buffalo Pound Lake to supply Regina and Moose Jaw varies seasonally (Figure 6) and from year to year (Figure 7). Diversion is high during the summer months due to the greater demand and increased system losses. The mean annual diversion to the Qu'Appelle River is about 55 800 dam^3 but annual diversions have varied from a low of 118 dam^3 in 1966 (the year that no flow was possible due to construction of the Qu'Appelle River Dam) to a high of 142 000 dam^3 in 1981, a drought year in the Qu'Appelle River Basin (Environment Canada, 1989). Although municipal supply is a major purpose of this diversion, the water also serves irrigation, industrial, wildlife and recreation purposes.

Groundwater is the most common source of municipal water supply for various communities in the basin. Thirty-one communities rely entirely upon wells. In another 11 communities, well water is supplemented with surface water. However, because of the small size of many communities in the basin, groundwater accounts for about 6 percent of the total municipal water supply (SSRBS Technical Report E.5). Regionally, communities in the Swift Current Creek Basin are more dependent on groundwater sources than elsewhere in the South Saskatchewan River Basin.

Five water rate structures are utilized in the South Saskatchewan River Basin (Table 5). These include: no charge; flat rate; decreasing block; increasing block; and constant rate. The flat rate is a fixed charge in each billing period regardless of the volume of water used. The decreasing block rate charges successively lower prices for set volumes (blocks) of water as consumption increases. In the increasing block structure, blocks of water become more expensive as more water is consumed. The constant rate charges a fixed price for each unit (e.g. cubic metre) of water consumed.

Table 6 illustrates that the decreasing block pricing system is most common among the communities along the mainstem. This is true regardless of community size. All communities impose a water charge.

The annual per capita municipal water use varies significantly from one community to another. For communities supplied by the mainstem, Martensville has the lowest use at 75 m^3/person/year and Outlook has the highest use at 234 m^3/person/year. The average annual per capita use is about 150 m^3/person. Communities which institute a decreasing block water pricing structure exhibit the greatest variability in municipal water use and the highest average per capita use.

Table 7 illustrates that the largest communities use the most water per capita for municipal purposes. Medium-sized communities apparently use the least amount of water per capita. Although the smallest communities use more water than medium sized communities, no explanation is apparent.

Municipal water use varies significantly from year to year, as discussed previously, but also from one season to the next. Summer use may be as much as twice that of winter use. This increased water use reflects lawn and garden watering.

TABLE 2	MUNICIPAL WATER USERS (1986) SUPPLIED FROM THE SOUTH SASKATCHEWAN RIVER (EXCLUDING THE SSEWS SYSTEM)	
COMMUNITY	SASKWATER ALLOCATION (dam³)	WATER PUMPAGE+ (dam³)
UPSTREAM OF LAKE DIEFENBAKER		
Eston	} 1 492	250
Kindersley	}	640
Leader	178	170
LAKE DIEFENBAKER AREA		
Cabri	123	100
Elbow	53	60
DIVERSION TO QU'APPELLE RIVER		
Moose Jaw	}	7 290
Regina	}	**19 300
Marquis	} *123 348	20
Pense	}	70
Tuxford	}	20
DOWNSTREAM OF LAKE DIEFENBAKER		
Allan	-	90
Blucher (R.M.)	-	50
Bradwell	-	20
Clavet	-	40
Dalmeny	-	120
Martensville	-	210
Osler	-	60
Outlook	697	500
Saskatoon	68 328	40 700
St. Louis	-	50
Vanscoy	-	50
Warman	-	230
TOTAL	194 219	70 040

* Licensed for Regina, Moose Jaw and other approved users in the Qu'Appelle River system.
** An additional 10 000 dam³ is pumped from groundwater sources.
\+ Values are rounded and represent the 1986 level of development.

TABLE 3 VOLUME OF MUNICIPAL WATER REQUIRED FOR BACKWASHING FILTERS

COMMUNITY	PUMPED (1985) (dam^3)	BACKWASH (dam^3)	NET MUNICIPAL SUPPLY (dam^3)
Cabri	100	4	96
Outlook	509	9	500

TABLE 4 CITY OF SASKATOON SEWAGE FLOW RETURNED TO THE RIVER

YEAR	TREATED WATER PUMPED (dam^3)	SEWAGE TREATED (dam^3)	NET WATER USE (dam^3)	RETURN FLOW PERCENT
1980	41 832	25 665	16 167	62
1981	40 233	25 641	14 592	64
1982	37 734	25 913	11 821	69
1983	43 229	27 950	15 279	65
1984	44 362	29 110	15 252	66
1985	41 192	30 350	10 842	74
1986	41 361	31 000	10 361	75
1987	45 827	31 600	14 227	69
1988	47 318	30 380	16 938	64
1989	44 433	30 910	13 523	70
Average	42 752	28 852	13 900	68

FIGURE 6 MEAN MONTHLY RELEASE FROM LAKE DIEFENBAKER TO THE QU'APPELLE RIVER

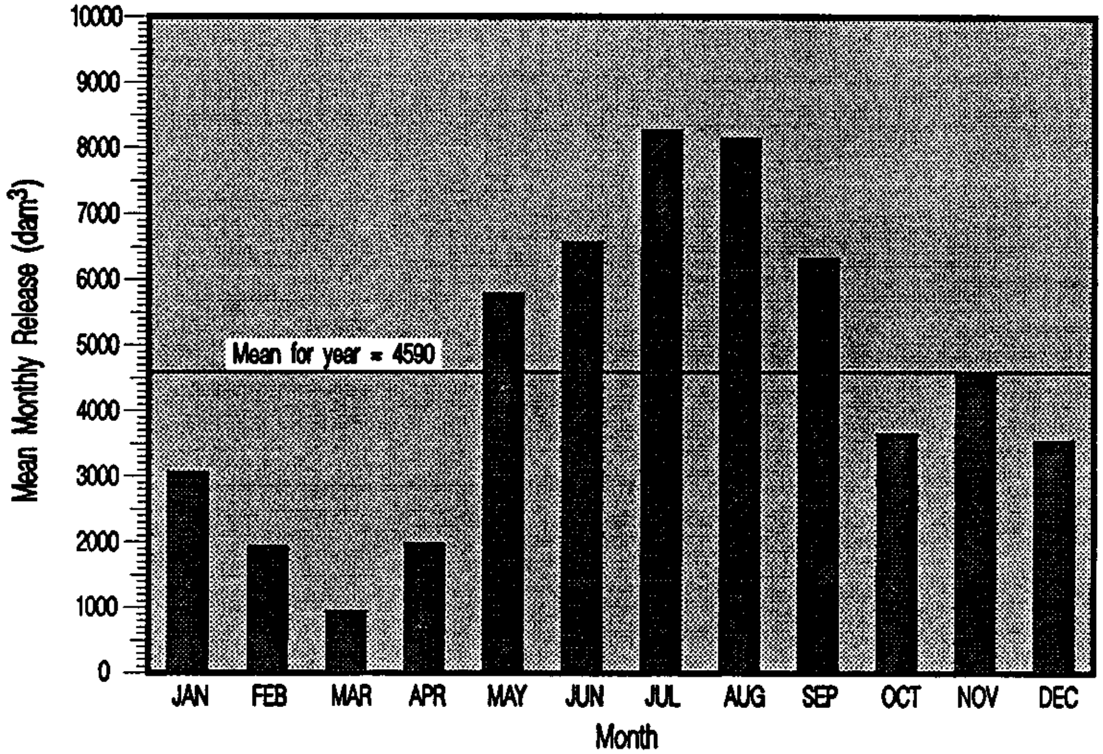


FIGURE 7 TOTAL ANNUAL RELEASE FROM LAKE DIEFENBAKER TO THE QU'APPELLE RIVER

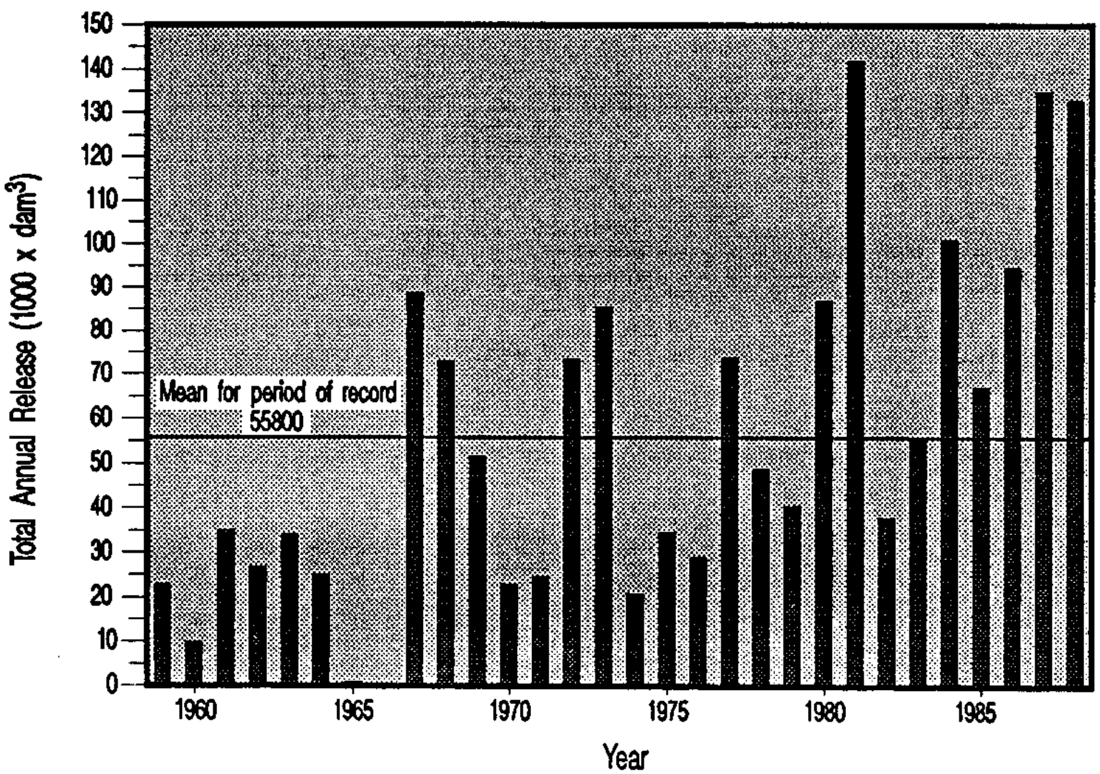


TABLE 5	MUNICIPAL RATE STRUCTURE AND WATER USE FOR COMMUNITIES ALONG THE MAINSTEM SYSTEM		
COMMUNITY	POPULATION (1986)	MUNICIPAL RATE STRUCTURE	ANNUAL PER CAPITA USE (m^3/person)
Eston	1 380	Constant Rate	184
Kindersley	4 910	Decreasing Block	130
Leader	1 130	Decreasing Block	151
Cabri	630	Decreasing Block	159
Elbow	320	Decreasing Block	180
Moose Jaw	35 070	Decreasing Block	208
Regina	175 070	Constant Rate	167
Marquis	100	Constant Rate	175
Pense	520	Decreasing Block	124
Tuxford	80	Decreasing Block	224
Allan	810	Decreasing Block	107
Blucher (R.M.)	470	Flat Rate	110
Bradwell	160	Constant Rate	105
Clavet	340	Constant Rate	113
Dalmeny	1 330	Decreasing Block	88
Martensville	2 760	Constant Rate	75
Osler	590	Constant Rate	98
Outlook	2 140	Decreasing Block	234
Saskatoon	177 640	Decreasing Block	222
St. Louis	650	Increasing Block	117
Vanscoy	320	Decreasing Block	158
Warman	2 460	Decreasing Block	93

TABLE 6 COMMUNITY SIZE AND MUNICIPAL WATER PRICING STRUCTURE FOR MAINSTEM COMMUNITIES					
RATE STRUCTURE	POPULATION OF COMMUNITY				TOTAL NUMBER OF COMMUNITIES
	<250	251 - 1 000	1 001 - 5 000	>5 000	
No Charge					
Flat Rate		1			1
Decreasing Block	1	5	5	2	13
Increasing Block		1			1
Constant Rate	2	2	2	1	7
Total	3	9	7	3	22

TABLE 7 AVERAGE ANNUAL PER CAPITA MUNICIPAL WATER USE BY POPULATION FOR MAINSTEM COMMUNITIES		
POPULATION OF COMMUNITY	AVERAGE ANNUAL WATER USE (m^3/person)	NUMBER OF COMMUNITIES
<250	168	3
251 - 1 000	130	9
1 001 - 5 000	136	7
>5 000	199	3
	146	22

3.2.2 Industrial

Industrial water uses in the basin include mineral extraction industries (potash mines), manufacturing, feedlot operations and the Queen Elizabeth II thermal generating station at Saskatoon. Most of these industries are supplied with water through municipal water supply systems.

SSRBS Technical Report E.10 identified major industrial water users both within and outside the South Saskatchewan River Basin, that use the South Saskatchewan River as the main source of supply. As only limited data were available for industries using less than 100 dam^3 of water annually, only the major industrial water users were examined. Out of a total of 201 industrial users within the basin, only 24 were identified as being major water users. Actual water use data for all firms are not presented for reasons of confidentiality.

Seven potash mining companies utilize water from surface sources. Three of these are supplied through the Saskatoon Southeast Water Supply system and are discussed in Section 4.2.3. The other four are Cominco Ltd. near Vanscoy, Potash Corporation of Saskatchewan-Cory Division (PCS-Cory) west of Saskatoon, Potash Corporation of America (which withdraws water from Patience Lake, east of Saskatoon and not directly from the South Saskatchewan River) and Kalium Chemicals Ltd. near Belle Plaine. The location of these potash mines is illustrated on Figure 8.

Cominco and PCS-Cory potash mines are supplied with water by pipeline from the Saskatoon West Water Supply system. This system utilizes the South Saskatchewan River as the water source and supplies untreated water to various domestic, municipal and industrial users in the Saskatoon area. Kalium Chemicals obtains its water from Buffalo Pound Lake, which in turn is maintained by flows from Lake Diefenbaker. It should also be noted that some water is supplied to PCS-Cory Division by the Saskatoon Treated Water Supply system.

The Saskatoon West Water Supply system provides piped water to three other users: Cedar Villa Estates, Petrill Golf and the Saskatoon Golf and Country Club. The Saskatoon Treated Water Supply System delivers treated water to six industrial users: AKZO Chemicals; Canron Hyprescon West; Royal View Cattle Ltd.; Saskatoon Chemicals; and United Chemical Company. Simplot Canada Ltd. withdraws water from Buffalo Pound Lake and Birsay Hog Farm Inc. obtains water from Lake Diefenbaker.

Table 8 identifies the industrial water users. For example, the Saskatoon West Water Supply system utilizes approximately 1 660 dam^3. This is distributed among the five industrial plants noted earlier. The actual water used by each specific plant is not readily available and in some cases is considered confidential. However, data obtained by the authors of SSRBS Technical Report E.10 do break down the water use by industrial category. Based on the 1987 survey of 21 major industrial water users in the South Saskatchewan River Basin, the potash industry represents the largest industrial water use category (Table 9). Much of the water demand for this industry is in the form of a base load which is used in plant processes. This load is relatively constant during the year and would not vary except during plant expansion or shut-down. Water used in processing the potash requires little or no treatment. None of the water used is returned to the river. The water is recycled and eventually lost through evaporation.

The meat packing industry is the next largest industrial water user, followed by breweries and the manufacturing sector. In the case of the dairy industry, more water can be discharged than is supplied due to dehydration processes. Some of the industries, such as the breweries, provide additional on-site water treatment to ensure high quality water. Most industries rely on the municipal waste treatment systems; the two chemical plants in Saskatoon provide their own sewage treatment.

The Queen Elizabeth II thermal power station in Saskatoon is considered to be an industrial water user. SaskPower holds a water allocation for 417 108 dam^3. This plant is operated to meet peak power demands. Water is required for cooling purposes. The actual water withdrawn from the South Saskatchewan River can vary considerably from year to year depending on the amount of energy generated by hydro plants. For example, in a high flow or "wet" year, withdrawals may be as little as 4 000 dam^3 but in a low flow or "dry" year the thermal plant may withdraw 75 000 dam^3. Most of the water withdrawn returns to the river after use. It is estimated that actual plant consumption may be only about 270 dam^3 per year (Table 8). Evaporation of the warmer return flow water may utilize an additional 600 dam^3 each year.

3.2.3 Agricultural

There are a total of 229 licensed irrigation projects along the mainstem of the South Saskatchewan River in Saskatchewan (Table 10). The majority of these projects are located in the Lake Diefenbaker area and have been developed since the creation of the lake.

FIGURE 8 LOCATION OF POTASH MINES IN THE STUDY AREA

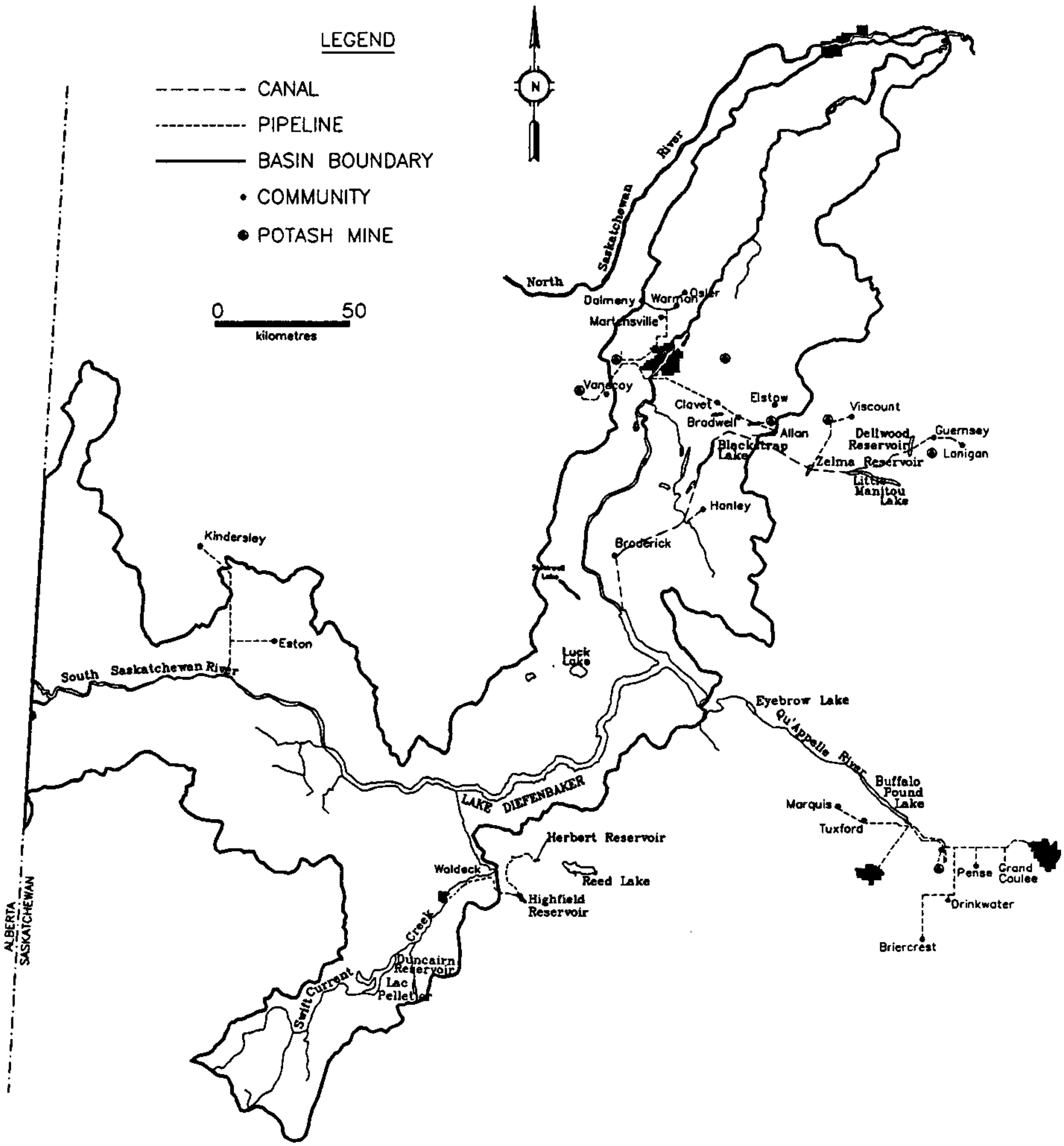


TABLE 8 INDUSTRIAL WATER USE (1986) FOR THE MAINSTEM	
WATER USER	WATER USE (dam³)
Chinook Enterprises	40
Saskatoon West Water Supply system	1 658
Potash Corporation of America	540
Queen Elizabeth II Power Station	267
Saskatoon Treated Water Supply system	702
Total	3 207

TABLE 9 INDUSTRIAL WATER USE IN THE STUDY AREA				
CATEGORY	NUMBER OF INDUSTRIES PER CATEGORY	AVERAGE ANNUAL WATER USE (dam³)	BASE LOAD (dam³)	BASE LOAD/ANNUAL WATER USE (PERCENT)
Potash Mining	6	4 520	2 580	57
Chemical	3	Confidential Information		
Manufacturing	3	750	360	48
Breweries	3	845	630	75
Dairies	4	275	200	73
Meat Packing	2	1 600	800	50
Miscellaneous	3	415	600	--
Total	24	8 405	5 170	

Source: SSRBS Technical Report E.2

TABLE 10 LICENSED IRRIGATION PROJECTS ALONG THE SOUTH SASKATCHEWAN RIVER AND LAKE DIEFENBAKER						
REACH	PROJECTS		IRRIGATED AREA		LICENSED USED	
	NUMBER	PERCENT	HA	PERCENT	dam³	PERCENT
Upstream of Lake Diefenbaker	35	16	1 737	9	8 020	7
Lake Diefenbaker	96	42	11 133	60	57 790	48
Gardiner Dam to Saskatoon	55	24	3 387	18	42 941	36
Downstream of Saskatoon	43	18	2 475	13	11 339	9
Total	229	100	18 732	100	120 090	100

These projects tend to be larger than projects elsewhere along the mainstem system. Water use per project around Lake Diefenbaker tends to be two or three times that of projects upstream of the lake or downstream of Saskatoon. This may reflect the assured water supply and the fact that group projects are usually better equipped to accommodate breakdowns and have a flat rate fee structure (SSRBS Technical Report E.8). Irrigation has expanded considerably recently with the development of the Luck Lake Project.

The same study determined that projects which have metered water tend to utilize more water than non-metered projects. The difference is particularly significant between metered and non-metered individual projects, as opposed to group projects. This difference appears to be more than 60 percent.

Other conclusions from the study are:

1. the highest water consumption usually occurs in July upstream of Lake Diefenbaker and in June in other mainstem areas;

2. irrigation water use generally is less than the allocation permitted by SaskWater; and

3. water utilization for forage crops is considerably higher than for grains.

The types of irrigation projects, whether backflood or sprinkler, vary along the mainstem usually in response to an assured source of supply. Where an assured supply of irrigation water exists, intensive sprinkler irrigation systems are common. Sprinkler irrigation predominates around Lake Diefenbaker and below Gardiner Dam. Backflood projects are more common upstream of Lake Diefenbaker.

Irrigation projects which withdraw water directly from the South Saskatchewan River, its tributaries or Lake Diefenbaker, rely on pump intakes. SSRBS Technical Report E.6 completed a survey of all water rights files maintained by SaskWater. The intakes may be portable or permanent. Portable intakes are temporary structures which can be adjusted to operate under a range of river or reservoir elevations. Permanent intakes, on the other hand, are not designed to be movable. Along the South Saskatchewan River mainstem there are 44 permanent irrigation intakes and 186 temporary irrigation intakes.

Many permanent intakes are designed to function during either periods of low stream flow or low reservoir levels. To ensure that the intake problems of irrigators around Lake Diefenbaker are minimized, SaskWater has established a May 1 target elevation of 550.5 m above sea level for Lake Diefenbaker. This elevation, however, is not always achieved. For example, in the 21 years of operation, nine years were below this elevation. In 1982 the May 1 water level was actually 1.5 m below the desirable level. SaskWater also advises all new irrigators of expected water level fluctuations.

Water quality along the mainstem is generally very good and does not impact on irrigation. One exception is the bacteriological quality of the mainstem immediately below Saskatoon. Fecal coliform levels are reported to be high in the reach below the Saskatoon sewage treatment plant. This renders the water unsuitable for irrigation in this reach. Although fecal coliform levels decline 22 km downstream at Clarkboro Ferry, irrigation would still be impaired (South Saskatchewan River Basin Study Water Quality Technical Appendix).

While agricultural water use for irrigation purposes is the largest consumer of water in the study area, water for livestock purposes also represents an important use of this resource. This activity is distributed more widely throughout the basin as it does not rely on the main tributaries for a supply source. Data for the study area suggest that livestock water use would be approximately 4 000 dam^3.

3.2.4 Recreation

Recreational use of water includes swimming, wading, fishing, boating, water-skiing, sailing, board sailing, houseboating, paddleboating, canoeing, kayaking and rowing. In winter recreational uses of the ice surface include ice fishing, snowmobiling and cross-country skiing.

The South Saskatchewan River provides a focus for recreational activities for the province. Recreational sites range from provincial, regional and city parks, to cottage subdivisions, institutional camps, heritage and historic sites and conservation areas. Table 11 lists the water-based recreational activities and facilities located at parks and other developments along the mainstem. Figure 9 identifies the recreational sites in the South Saskatchewan River Basin in Saskatchewan.

FIGURE 9 **LOCATION OF RECREATIONAL SITES IN THE STUDY AREA**

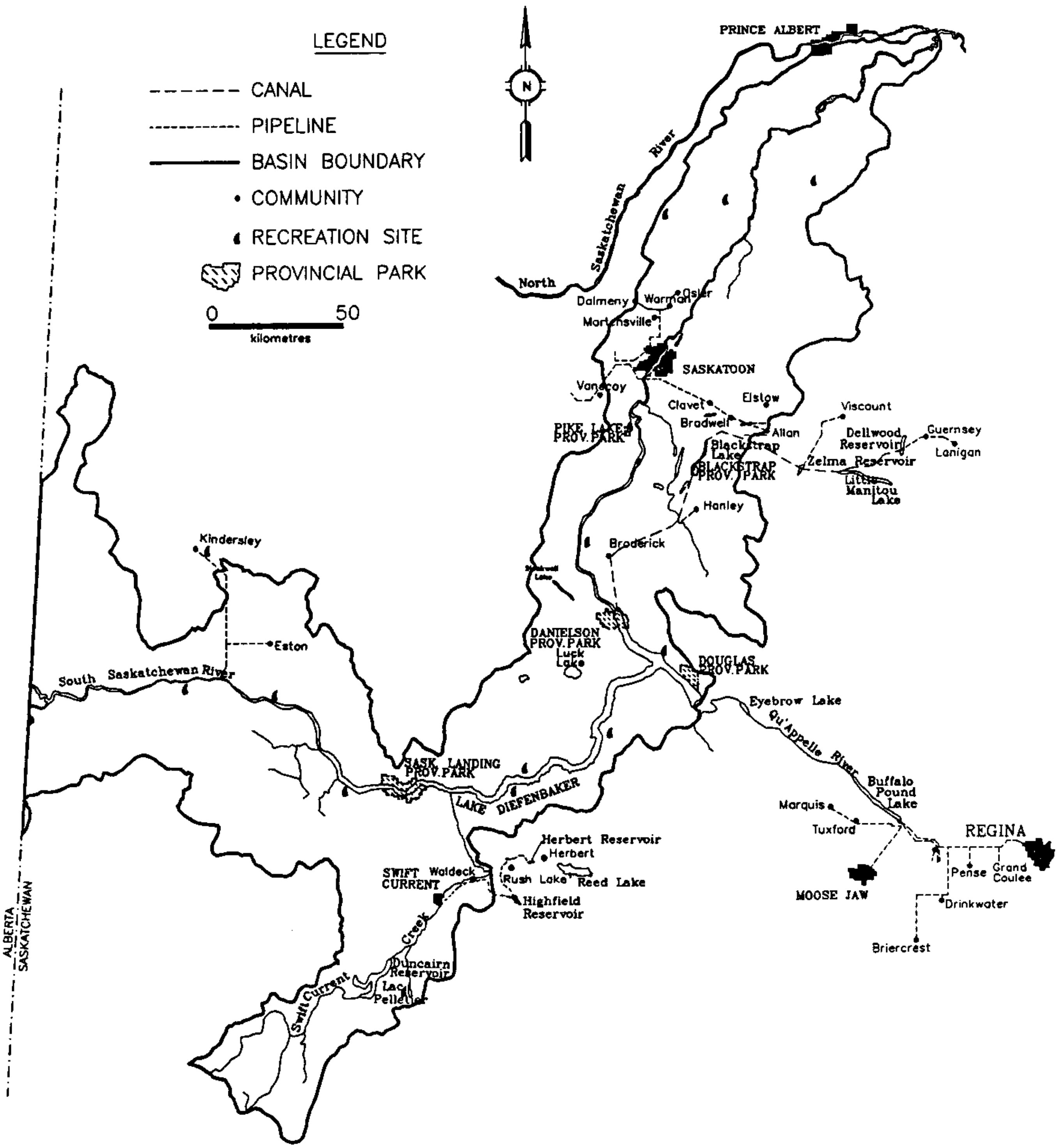


TABLE 11 **WATER-BASED RECREATIONAL FACILITIES AND ACTIVITIES ALONG THE MAINSTEM**

	Beach	Pool	Marina	Boat Launch	Swimming	Boating	Houseboat Rental	Tourboat	Boat/Canoe Rental	Paddleboat Rental	Waterskiing	Board Sailing	Sailing	Rowing	Canoe/Kayak Racing	Recreational Canoeing	Fishing
UPSTREAM OF LAKE DIEFENBAKER																	
Eston Riverside Regional Park		X		X	X											X	X
Lemsford Ferry Regional Park		X		X	X											min	
LAKE DIEFENBAKER AREA																	
Danielson Provincial Park	X			3	X	X					X	X	X			X	X
Douglas Provincial Park	X			X	X	X					X	X	X				X
Elbow Harbour Rec Site	2		X	2		X	X				X	X	X				X
Palliser Regional Park	X	X	X	X	X	X			X	X	X	X	X				X
Prairie Lake Regional Park	X			X	X	X							X				X
Herbert Ferry Regional Park	X			X	X	X							X			X	
Camp Rayner	X				X								X			X	
Provincial Girl Guides Camp	X				X								X			X	
Boy Scouts Camp	X				X								X			X	
Coteau Beach Subdivision				X													

TABLE 11 **WATER-BASED RECREATIONAL FACILITIES AND ACTIVITIES ALONG THE MAINSTEM**

	Beach	Pool	Marina	Boat Launch	Swimming	Boating	Houseboat Rental	Tourboat	Boat/Canoe Rental	Paddleboat Rental	Waterskiing	Board Sailing	Sailing	Rowing	Canoe/Kayak Racing	Recreational Canoeing	Fishing
Mistusinne Subdivision				X													
Hitchcock Bay Subdivision				X													
Saskatchewan Landing Provincial Park	2		P	X	X	X	X		X	X	X	X				X	X
Beaver Flat Subdivision				X		X											
Cabri Regional Park			X	X	X												
DOWNSTREAM OF LAKE DIEFENBAKER																	
Outlook Regional Park		X			X											X	X
Downstream Saskatoon Weir	X				X											X	X
Saskatoon	X	X		X	X	X		2			X	X		X	X	X	X
Upstream of Saskatoon	X				X	X										X	

Source: SSRBS Technical Report E.7
Legend: X - present; P - proposed; numbers indicate multiple facilities

The majority of water-based recreational activities are located at Lake Diefenbaker but the Meewasin Valley Authority, administers a variety of "green space" areas in and near Saskatoon. Some activities, such as fishing and canoeing, occur along the mainstem wherever access and water conditions permit.

Certain conditions are required for particular recreation activities regardless of their location. These include water depth (or elevation), water flow rate (velocity or discharge), water quality (or aesthetics) and season of the year. For example:

- Preferred conditions for swimming include a sandy beach and bottom, a gentle even gradient providing relatively shallow depths, and slow moving water. The water must also be aesthetically appealing (free of obnoxious floating or suspended substances, objectionable colour and/or foul odours). It must also lack any substance which is toxic upon ingestion or irritating to human skin and must be free of fecal contamination and pathogenic organisms. The season for swimming is generally June to August.

- Power boating, waterskiing, houseboating, sailing and tour boat operation require sufficient depth for launching, lack of sandbars and rocks, and protected overnight docking areas or easily accessible launch areas. Water quality conditions would be similar to those for swimming. The season for boating, waterskiing, houseboating, tour boat operation, sailing, board sailing, canoeing and related activities is generally from mid-May to mid-September or October. Some enthusiasts may be on the water as soon as the ice has melted.

- Winter recreationists use the ice surface of the river and reservoir for ice fishing, snowmobiling, cross-country skiing, bike and car racing and skating. Ice conditions may be considered as a hazard to use. The formation of a safe, stable ice cover on the river is dependent upon steady flows during early winter. This is especially a concern downstream of Lake Diefenbaker. The operating guidelines of Coteau Creek Generating Station were designed to produce constant flows during freeze-up so a complete ice cover may be formed as quickly as possible. When water levels or flows decrease, the surface of the ice may become dish-shaped. This may make getting onto the ice difficult (SSRBS Technical Report E.7).

Water quality criteria for various types of recreational use are summarized in Table 12. Specific water quality concerns are discussed in Section 6.

3.2.4.1 Upstream of Lake Diefenbaker. Due to the hazardous river current and the constantly changing sandbars, recreational use of the river is minimum upstream of Lake Diefenbaker. There are, however, two regional parks: Eston Riverside and Lemsford Ferry.

At Eston Riverside Regional Park water levels are too low for boating and currents are a hazard for swimming. There is a limited amount of fishing in the park. Swimming in the river has been minimized by the construction of a pool and the lack of beach development on the river. Canoeing is probably the most popular river based activity near the park. There is a cottage development associated with the park. The floating intake for the cottages and the golf course experiences no problems with variable flows. Winter recreational activities include ice fishing, cross country skiing and snowmobiling.

At Lemsford Ferry Regional Park a pool is used for swimming rather than the river. Some canoeing and boating occurs as well as summer and winter fishing. There are also 15 to 20 cottages at the park.

Table 13 summarizes the river flow criteria identified for instream recreational uses in this region of the mainstem.

3.2.4.2 Lake Diefenbaker Area. Lake Diefenbaker is the largest waterbody available for water-based recreation in southern Saskatchewan. There are three provincial parks, four regional parks, four institutional camps, a recreational site, four cottage subdivisions and two picnic grounds adjacent to the reservoir (see Figure 9). All of the regional parks were created in the 1960s except Prairie Lake Regional Park which was established in 1984. The provincial parks were established in the early 1970s. Swimming, fishing and boating, in association with picnicking and relaxing on the beach, tend to be the most popular recreational instream uses. Other water-based activities include waterskiing, sailing, board sailing, paddleboating, canoeing and houseboat holidays.

Danielson Provincial Park has a beach, boat launch, and camping and picnicking facilities. Boating, swimming, fishing, waterskiing and board sailing are popular. Attendance at this park declines when water levels on Lake Diefenbaker are low as the bottom of the swimming area is mud. Erosion during low years may result in a hazardous drop-off of the lake bed in the swimming area when the lake levels later increase.

TABLE 12 WATER QUALITY CRITERIA FOR RECREATION AND AQUATIC LIFE IN THE STUDY AREA		
USE AND PARAMETER	CRITERIA	
	MINIMUM	MAXIMUM
WATER CONTACT RECREATION		
Fecal Coliforms	–	200/100 ml
Turbidity	–	50JT
Clarity (Secchi disc)	1.2 m	–
Aquatic Plant Growth	–	less than eutrophic*
NON CONTACT RECREATION		
Fecal Coliforms	–	1 000/100 ml
Aquatic Plant Growth	–	less than hypereutrophic**
AQUATIC FAUNA		
Dissolved Oxygen	5 mg/L	–
Unionized Ammonia Concentrations	–	0.04 mg/L
Water Temperature		
- Warm water fish species	–	29°C
- Cold water fish species	–	23°C

Source: Health and Welfare Canada, 1983.

* Eutrophic indicates 8 - 25 mg/m^3 average chlorophyll content (OECD 1982).
** Hypereutrophic indicates $\geq$25 mg/m^3 average chlorophyll content (OECD 1982).

TABLE 13 FLOW CRITERIA IDENTIFIED FOR INSTREAM RECREATIONAL USERS UPSTREAM FROM LAKE DIEFENBAKER			
	CRITERIA (m^3/s)		
	Minimum	Preferred	Maximum
Eston Riverside Regional Park	68	–	700 - 845 (1 700 before park floods)
Lemsford Ferry Regional Park	not applicable	not applicable	not applicable
Canoeing near Alberta Border	100	–	–

Douglas Provincial Park has a beach and boat launch. Extreme variations in lake level from year to year can create problems. Silt deposited near the boat launch area had to be dredged in 1987 and snow fences had to be erected to keep the silt from blowing (SSRBS Technical Report E.7).

Palliser Regional Park has a beach, pool, boat launch and marina. Canoes, boats and paddleboats are available for rental. There is also a cottage development in the park. Some of these cottages are used as winter homes. When the lake level is low, launching of boats is difficult and access to the marina is restricted. Also, at these low levels, much of the beach area is exposed and the sand readily drifts. The swimming area itself is not adversely affected by low reservoir levels as the bottom remains sandy and the beach gradient remains gentle.

Prairie Lake Regional Park has beach and boat launch facilities. There is no cottage development but 35 unserviced trailer lots are rented on a seasonal basis. Fishing is common here.

Although Herbert Ferry Regional Park has a beach and boat launch facilities and supports swimming, boating and fishing, water levels for most years are too low for these activities to occur.

Saskatchewan Landing Provincial Park has two beaches, a boat launch, houseboat rental and docking facilities, and a boat rental agency which rents boats, canoes and paddleboats. Additional activities include board sailing, swimming and fishing.

Cabri Regional Park lies within the influence of Lake Diefenbaker. Fluctuations in lake levels are caused by wind and reservoir operation. The park has a boat launch and swimming area and an overnight docking area located in a nearby bay.

There are four institutional camps located on Lake Diefenbaker. These camps are used during the summer months. Swimming, fishing and canoeing are the primary recreational activities. Difficulties are encountered in maintaining beaches and boat launch facilities at several of these sites due to the variance in water levels from year to year.

Cottage developments exist at Palliser Regional Park, Eston Regional Park, Mistusinne Subdivision, Hitchcock Bay Subdivision, Coteau Beach Subdivision and Beaver Flats Subdivision. All of these developments have boat launches. Their use is restricted during low lake levels. Two additional developments are proposed: Garth Subdivision on the east side of the lake near Loreburn and at Saskatchewan Landing Provincial Park.

Saskatchewan Parks and Renewable Resources have developed a list of preferred water levels for their parks on Lake Diefenbaker (Table 14). These levels are designed to support boat launch facilities at these parks, to provide sufficient depth for navigation and manoeuvring, and to access sheltered harbours. The table indicates that the bottom of the launch ramps should be under at least one metre of water. All launch ramps can be used between 552.00 m and full supply level (556.87 m) but only two ramps can be used when the reservoir drops to 550.00 m.

SSRBS Technical Report E.7 have summarized the criteria and operating levels identified for each of the recreational user groups and recreational facilities on Lake Diefenbaker (Table 15). All sites listed except Cabri Regional Park are directly influenced by Gardiner Dam. Their criteria are expressed in terms of lake levels. These criteria apply to the general season of use. The season is June, July and August for swimming by the institutional camps. Mid-May to mid-October is the season of use for other water-based recreation activities.

The minimum criteria span the greatest range of water levels (548.73 to 554.36 m). The very lowest criteria are the minimum operating levels for boat launches. The majority of the criteria fall between 552 and 554 m. A recreation water level target of 555.0 to 555.3 m for July 1 has been established by SaskWater and appears to be very satisfactory for most recreationists.

All but one of the maximum desirable lake levels identified are within one metre of full supply level. Palliser Regional Park, for which a preferred level of 555.04 to 555.35 m was identified, is the exception. In general, boat launches and other boating facilities are designed to be operable at full supply level. The Provincial Girl Guides Camp and Herbert Ferry Regional Park have also identified full supply level as maximum. Sailing, board sailing and boating activities generally require maximum lake levels of 556.62 m, while multi-purpose use facilities require levels less than 556.62 m. It is important to note that while recreational uses of the lake are not optimized at full supply level, high lake levels from time to time are beneficial to maintaining the quality of most beaches around the lake.

TABLE 14 ELEVATIONS AND OPERATIONAL LEVELS OF RECREATION FACILITIES ON LAKE DIEFENBAKER				
	ELEVATION (m)		OPERATIONAL LEVEL (m)	
	BOTTOM	UPPER	MINIMUM	MAXIMUM
DANIELSON PROVINCIAL PARK				
East Side Boat Launch	547.73	557.79	548.73	556.87 (f.s.l.)
Coteau Bay Boat Launch	— not on plan —			
DOUGLAS PROVINCIAL PARK				
Boat Launch	550.30	558.00	551.30	556.87 (f.s.l.)
ELBOW HARBOUR RECREATION SITE				
Harbour			552.00	556.87 (f.s.l.)
Boat Launch	549.25	557.84	550.25	556.87 (f.s.l.)
Tufts Bay Boat Launch	550.95	557.64	551.95	556.87 (f.s.l.)
HITCHCOCK BAY RECREATION SITE				
Boat Launch	549.56	557.79	550.56	556.87 (f.s.l.)
SASKATCHEWAN LANDING PROVINCIAL PARK				
Boat Launch	— not on plan —			
Proposed Omache Bay Marina				
- Harbour Bottom	548.00	--	550.00	556.87 (f.s.l.)
- Boat Launch	548.00	560.00	549.00	556.87 (f.s.l.)

Source: Saskatchewan Parks, Recreation and Culture, 1978. Design plans of recreational facilities on the South Saskatchewan River

Note: f.s.l. indicates full supply level for Lake Diefenbaker which is 556.87 m

TABLE 15 CRITERIA IDENTIFIED FOR INSTREAM RECREATIONAL USERS ON LAKE DIEFENBAKER			
	CRITERIA (m)		
	MINIMUM	PREFERRED	MAXIMUM
DANIELSON PROVINCIAL PARK			
Swimming/Boating	553.82	554.00 - 555.04	<556.62
Boat Launch (east side)	548.73	--	f.s.l.
ELBOW HARBOUR REC SITE			
Elbow Harbour Marine	552.00	--	f.s.l.
Boat Launch	550.25	--	f.s.l.
Tufts Bay Boat Launch	551.95	--	f.s.l.
DOUGLAS PROVINCIAL PARK			
Swimming	>552.86	554.92	<556.62
Boating	553.56 or less	555.18	556.62
Boat Launch	551.30	--	f.s.l.
HITCHCOCK BAY REC SITE			
Boat Launch	550.56		f.s.l.
PALLISER REGIONAL PARK	554.36	554.74	555.04 - 555.35
PRAIRIE LAKE REGIONAL PARK	553.18	554.20	<556.87
HERBERT FERRY REGIONAL PARK	554.00	556.62	no maximum (f.s.l.)
CAMP RAYNER	could go <551.53	553.13, 554.90 (mean 554.02)	<556.62
PROVINCIAL GIRL GUIDES CAMP	552.63 - 553.91 (mean 553.02)	--	no maximum
BOY SCOUTS CAMPSITE	553.21	--	<556.62
MISTUSINNE BOAT LAUNCH	>553.06	556.62	--
SASKATCHEWAN LANDING PROVINCIAL PARK	--	554.46 - 554.62 (mean 554.54)	556.26
Proposed Marina			
- harbour	550.0	--	f.s.l.
- launch	549.0	--	f.s.l.
CABRI REGIONAL PARK	553.81	555.17	556.83
GENERAL LAKE USE			
- Sailing	551.96	555.45	556.62
- Houseboating	552.56	554.31	<f.s.l.
- Board Sailing	"low"	--	556.62

Note: f.s.l. indicates full supply level for Lake Diefenbaker which is 556.87 m.

3.2.4.3 **Below Lake Diefenbaker**. Four recreation sites are located between Saskatoon and the junction of the North and South Saskatchewan Rivers. Three sites are picnic grounds. The fourth site, Batoche National Historic Site, located just upstream of the St. Laurent ferry, does not cater to water-based recreation although a few canoeists stop at the site each summer. Fishing is popular along the river, particularly at the ferry crossings. Swimming activity is not common downstream of Saskatoon. Water quality standards for non-contact water recreation downstream of Saskatoon are generally met. Fecal coliform concentrations at the Clarkboro Ferry east of Warman have often exceeded the water quality criteria for water contact recreation established for the basin during the 1977 to 1986 summer and fall periods (SSRBS Technical Report E.7).

Recreation and interpretive areas are located within the boundaries of Meewasin Valley Authority. Meewasin Valley Authority was established in 1979 to co-ordinate resource management and development of 80 km of the South Saskatchewan River and valley which is centred on Saskatoon. Within the city limits, the river is intensively used. Upstream of Saskatoon, recreational use is considerably more popular than downstream of the city. Accessible sandbar areas such as those at Cranberry Flats and Paradise Beach are used for wading and sunbathing on hot summer days. Beaver Creek Conservation Area promotes education and enjoyment of the river and valley. Downstream of the Saskatoon weir, there is fishing at the weir, swimming at Sutherland Beach and canoeing. Recreational activities include waterskiing, motorboating, windsurfing, canoeing, rowing, jetskiing and swimming. Two tour boat companies, Northcote River Cruises and W.W. River Cruises, provide river cruises in the Saskatoon area from May to September.

Pike Lake Provincial Park upstream from Saskatoon has been developed around an oxbow of the South Saskatchewan River. Water is pumped from the river to maintain the lake level. Considerable cottage development has occurred in this area in spite of generally poor water quality. Records obtained from 1985 to 1987 indicate that the annual water quantity pumped has varied from 1 250 dam^3 to 2 180 dam^3. The water use based on the 1986 level of development is 1 660 dam^3.

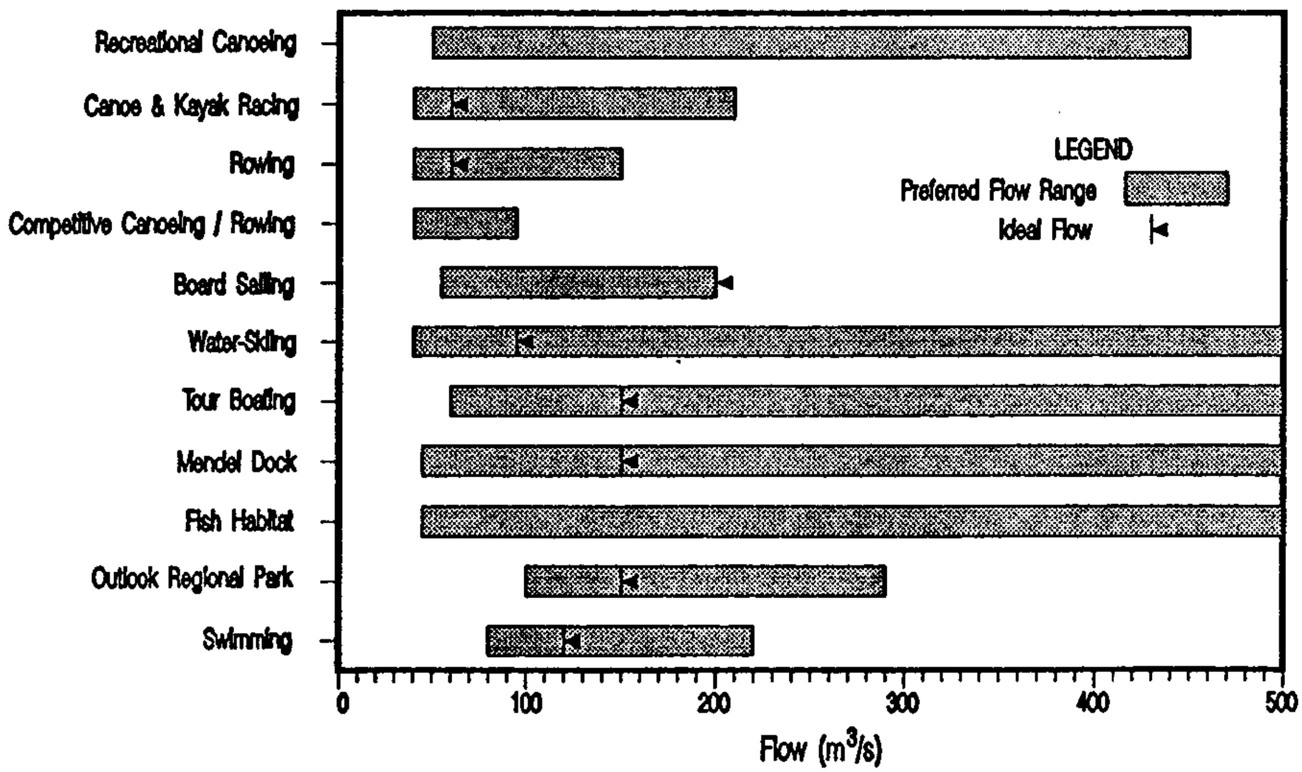
Recreational use of the river between Lake Diefenbaker and the upstream boundary of Meewasin Valley Authority is minimal. An important recreational site in this area is Outlook Regional Park. Very little recreational activity in Outlook Regional Park directly involves river use. This is largely due to the fluctuations in water levels generated by the operation of the Coteau Creek Generating Station. Fecal coliform concentrations at Outlook for the 1979 to 1986 period were lower than the water quality criteria established for the basin for water contact recreation.

Coldwell Park Recreation Site is located on the floodplain of the South Saskatchewan River but does not support recreational use of the river itself. It is used primarily for picnicking and camping. Oxbows located between the river and Coldwell Park Recreation Site discourage people from walking to the river.

In summary, Figure 10 depicts the flow criteria identified for recreational uses downstream of Lake Diefenbaker. This figure can be summarized by the following general comments:

- The majority of the minimum flow criteria identified fall within 42.5 and 80 m^3/s.
- Many users indicated preferred flows ranging from 50 to 120 m^3/s.
- Tour boats are most tolerable of high flows and require deeper water for navigation. Their preferred flows surpass the maximum flows identified by most other recreational uses.
- Maximum flows are 470 m^3/s for waterskiing and less than 665 m^3/s for tour boat operation.
- Canoeists require maximum flows of less than 450 m^3/s.
- The maximum flow criteria for swimming, canoe and kayak racing, rowing and board sailing range from 150 to 220 m^3/s. Maximum flows for rowing and canoeing competitions (e.g. Jeux Canada Games 1989) is 75 m^3/s. River flows often exceed this.
- The flow criteria needed at Outlook Regional Park are somewhat higher than the criteria identified by a majority of the users at Saskatoon. This discrepancy relates to the fact that Saskatoon has a weir which keeps the water higher than it would otherwise be during low flows. Outlook is much closer to Gardiner Dam, consequently it experiences much greater variations in flow as a result of dam operation. Also, Outlook does not have a weir and must therefore rely on flows to achieve particular water levels. The result is that the flows necessary to generate the desired water levels at Outlook are much higher than those desired by Saskatoon users.

FIGURE 10 SUMMARY OF PREFERRED FLOWS FOR RECREATION ALONG THE MAINSTEM BELOW LAKE DIEFENBAKER



3.2.4.4 **Recreation Demand.** The demand for water-based recreation along the South Saskatchewan River mainstem was investigated and is documented in SSRBS Technical Report E.17. The survey was done during the 1988 summer recreation season from the long weekend in May to the Labour Day weekend in September. The visitation estimates (vehicles and people) are summarized for 11 recreation sites along the mainstem in Table 16. Only those parks in the basin with water-based recreation which are relatively well-known and with significant visitations were included in the analysis.

The visitation data were collected using traffic counters and a survey questionnaire to eliminate double-counting vehicles which re-entered a park site during the same visit. The data indicate that Pike Lake recorded the highest number of visitations; Danielson Camp had the lowest recorded numbers. One cautionary note should be mentioned with the regard to estimates for Rotary Park. As Rotary is an urban park located in the centre of Saskatoon, walk-on visitation is substantial. This study did not account for such visitation. It should also be noted that it was not possible to compare the recreation sites in terms of the services offered at each. Nor was it possible to determine the preference for a recreation site given changes in the river flow regime and water quality.

Table 17 identifies the estimated number of visitations in 1988 from four major population centres to each of the parks located along the mainstem. As expected, most of the visitations originated from Saskatoon; there is a negative correlation between visitation and travel distance. The popularity of Pike Lake as a recreational destination is also evident.

3.2.5 Transportation

Transportation use refers to the operation of ferries. There are nine ferries operating on the South Saskatchewan River. Five are downstream of Lake Diefenbaker, one is on Lake Diefenbaker and three are upstream of Lake Diefenbaker. Clarkboro and Lancer were established in 1950; the remainder were in operation by 1925 (Figure 11).

Ferries begin operating as soon as the ice clears in the spring (usually mid-April) and do not close until the crossings begin to freeze over in the fall (early to mid-November). Once the ice is considered thick enough, local residents usually cross on the ice. However, use of ice bridges is dependent on the weather. Winter drawdown or reduced flows may result in the ice surface dropping and becoming dish shaped and river approaches becoming steeper.

Ferry operations downstream of Lake Diefenbaker have had occasional operational difficulties since the creation of Gardiner Dam. A minimum release of 42.5 m^3/s from the dam resulted in temporary shut downs of the Weldon, Hague, St. Laurent and Fenton ferries in 1977, due to weed buildup on cables (Weldon), formation of sandbars (Hague), obstruction by rocks (St. Laurent) or inefficiency of old approaches (Fenton). In general, through, sharp changes in flows and water depths pose greater problems to ferry operation. The development of Gardiner Dam has, therefore, been beneficial to ferry operation as the ferries do not have to contend with an annual summer flood. In some cases, these problems have been minimized by modifying the crossing or approach.

Table 18 summarizes the criteria established for ferry operation downstream of Gardiner Dam (SSRBS Technical Report E.7). Some general comments can be made about these criteria:

- Minimal flows are in the order of 50 m^3/s. In most cases, problems occur below such flows.
- Preferred flows range from 120 to 310 m^3/s.
- At maximum flows of 150 - 500 m^3/s, operating difficulties are expected. The lower limit would appear to be somewhat low compared to the preferred values. Values of 300 to 500 m^3/s are expected to be more accurate.
- At flows of about 1 600 m^3/s or greater, ferries generally become inoperable.

The Riverhurst Ferry on Lake Diefenbaker experiences its peak traffic volumes in July. At lake levels less than 551.38 m ferry operation is restricted to light loads due to sandbars on the east side. The preferred level is approximately 554.1 m.

The Lancer and Estuary Ferries upstream of Lake Diefenbaker experience operational problems due to low flows and sandbar formation. The criteria for operation of these ferries are summarized in Table 19.

TABLE 16 VISITATION ESTIMATES (VEHICLES AND PEOPLE) BY SITE, 1988

SITE	COMPLETED SAMPLE*		RESTRICTED SAMPLE** (used in travel cost model)					
			ALL STAYS		1 DAY VISITS		2 + DAY VISITS	
	VEHICLES	PEOPLE	VEHICLES	PEOPLE	VEHICLES	PEOPLE	VEHICLES	PEOPLE
Danielson Provincial Park (beach)	12 365	53 666	9 101	39 500	6 430	27 907	2 671	11 593
Danielson Provincial Park (camp)	3 908	12 270	3 266	10 254	1 017	3 193	2 249	7 061
Douglas Provincial Park	4 575	16 059	3 730	13 093	950	3 335	2 780	9 758
Pike Lake Provincial Park	30 690	120 610	29 369	115 419	16 938	66 566	12 431	48 853
Saskatchewan Landing Provincial Park	24 694	76 550	18 236	56 529	6 712	20 806	11 524	35 723
Eston Riverside Regional Park	5 247	22 616	5 006	21 577	3 317	14 297	1 689	7 280
Outlook Regional Park	15 630	44 232	13 513	38 241	12 517	35 422	996	2 814
Palliser Regional Park	8 329	33 817	7 978	32 392	3 331	13 524	4 647	18 868
Cranberry Flats	6 061	23 578	5 906	13 231	5 906	13 231		
Elbow Harbour Recreation Site	19 014	51 148	18 026	48 490	14 944	40 199	3 082	8 291
Rotary Park	17 882	34 870	17 298	33 731	17 298	33 731		

* Includes all visitors

** Includes only visitors used for estimation of the travel cost model (i.e. 1 day visitors from over 250 km away are excluded as are all visitors from over 500 km away.

Source: SSRBS Technical Report E.17

TABLE 17 ESTIMATED VISITATION FROM MAJOR POPULATION CENTRES, 1988				
PARK/CITY	MOOSE JAW	REGINA	SASKATOON	SWIFT CURRENT
Danielson (beach)	1 729	15 188	25 272	4 846
Danielson (camp)	1 342	4 552	7 603	108
Douglas	5 627	10 417	11 150	490
Pike Lake	936	3 965	156 248	2 718
Saskatchewan Landing	5 697	27 096	8 357	52 806
Cabri	N/A	N/A	N/A	N/A
Eston	0	0	592	240
Lemsford	N/A	N/A	N/A	N/A
Outlook	2 215	1 804	9 095	0
Palliser	8 450	6 666	6 920	3 247
Cranberry	14	70	12 686	0
Elbow Harbour	7 559	9 189	20 874	1 222
Rotary	84	125	32 428	457
TOTAL	33 563	69 072	291 225	66 134

Source: SSRBS Technical Report E.17

FIGURE 11 LOCATION OF FERRIES IN THE STUDY AREA

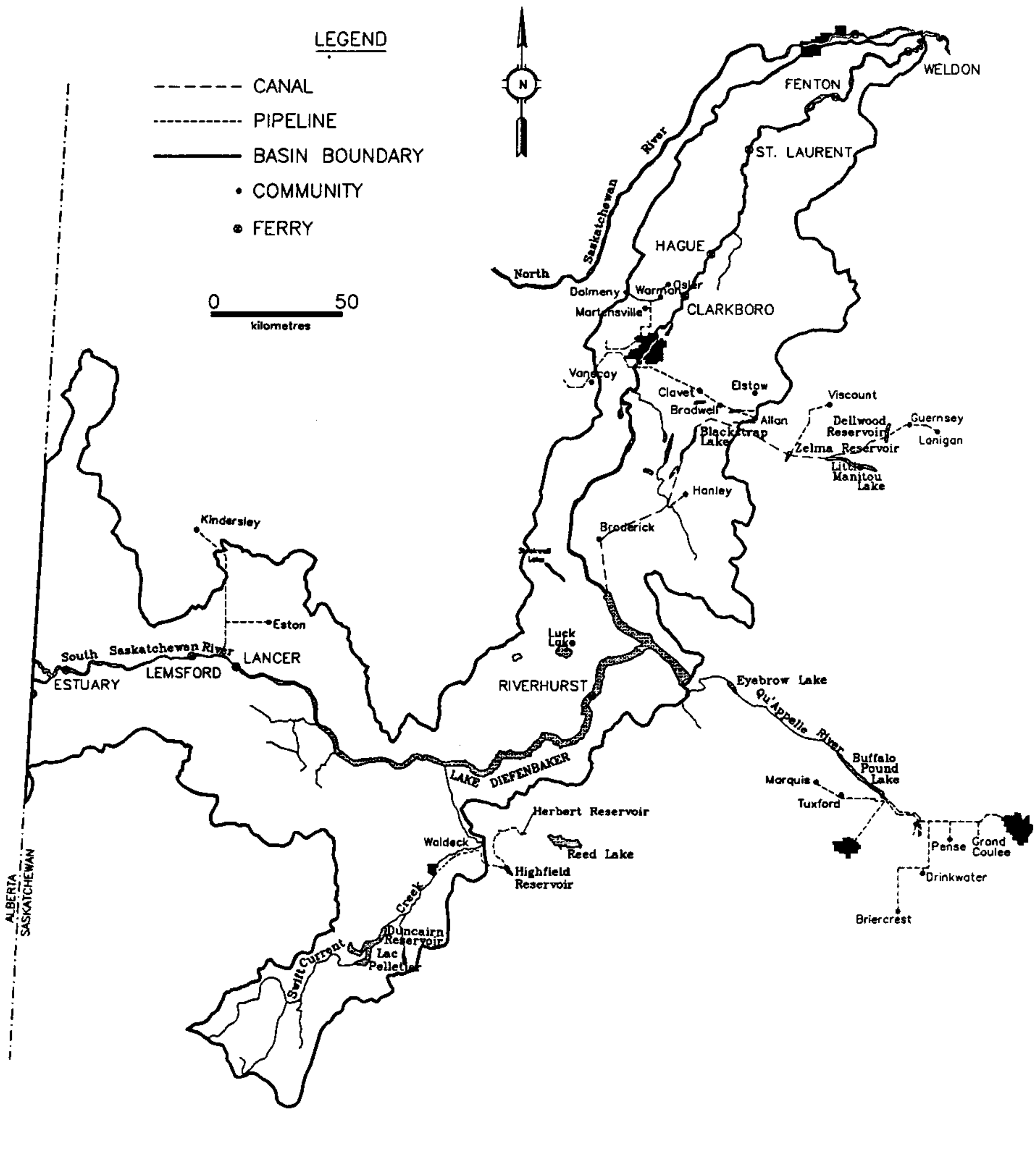


TABLE 18 FLOW CRITERIA IDENTIFIED FOR FERRY OPERATION DOWNSTREAM OF LAKE DIEFENBAKER			
CROSSING	FLOW CRITERIA (m^3/s)		
	MINIMUM	PREFERRED	MAXIMUM
General - Saskatchewan Rural Development	50	120	Between 150 - 500 m^3/s problems will occur. No upper limit given.
- Weldon Ferry	53	210	Cannot operate beyond 1 580 m^3/s. Between 300 and 1 580 there will probably be problems.
- Fenton Ferry	50	310	Information unavailable. This ferry is now privately operated (1991).
- St. Laurent Ferry	<50	210	1 150 - 1 580 m^3/s; between 210 m^3/s and 1 580 m^3/s there will be problems.
- Hague Ferry	52	190	<1900
- Clarkboro Ferry	50	150	At about 300 m^3/s, problems will probably occur; no upper limit given.

Source: SSRBS Technical Report E.7

TABLE 19 FLOW CRITERIA IDENTIFIED FOR FERRY OPERATION UPSTREAM OF LAKE DIEFENBAKER			
	FLOW CRITERIA (m^3/s)		
CROSSING	MINIMUM	PREFERRED	MAXIMUM
General - Saskatchewan Rural Development	100	200	300
- Lancer Ferry	50 - 200 (depending on sandbars)	250 - 300	1 100
- Lemsford Ferry	--	175	<1 200
- Estuary Ferry	>55	75 - 340 (mean 184)	<2 700

3.2.6 Hydro-electric Power Generation

The Coteau Creek Generating Station at Gardiner Dam is the only hydro-electric generating station in the study area. A second generating station, the Queen Elizabeth II, is an offstream thermal power plant located at Saskatoon and is discussed in Section 3.2.2. SaskPower owns and operates these stations.

The Coteau Creek Generating Station has been in operation since 1968. Five gated diversion tunnels are located in Gardiner Dam. Water from Lake Diefenbaker passes through turbines located in three of the five tunnels to generate electricity. The fourth tunnel could be used as a "waste gate" for the release of excess water. The remaining tunnel may be used in the future for a fourth turbine but is currently unused. The station produces an average of 500 million kilowatt-hours each year.

Downstream on the Saskatchewan River, there are two additional generating stations at the Nipawin and E.B. Campbell dams. Water released from Lake Diefenbaker can also be used for energy production at the two downstream stations. Consequently, the operation at the Coteau Creek Generating Station must be co-ordinated with the operations at the other generating stations.

The basic objective identified by SaskPower for the Coteau Creek Generating Station is to maximize the use of the water resource, that is, to produce electricity when it is in highest demand. This results in a reduced demand on more expensive methods of power generation (i.e. gas-fired turbines) which are otherwise required to meet demand.

In order to meet the peak electrical demands, the flows through the Coteau Creek Generating Station are altered on a daily and seasonal basis. SaskWater has established that releases from Gardiner Dam should provide a mean daily flow of at least 42.5 m^3/s. In winter the discharge through the generating station on a daily basis may vary between about 210 m^3/s and 370 m^3/s depending on available water supply and demand for power with an average daily release of about 300 m^3/s (Figure 12). Summer demands are lower and may vary from zero flow to about 300 m^3/s during the day. The average daily flow in the summer would be about 100 m^3/s (Figure 13). During summer, SaskPower operates the Coteau Creek Generating Station at higher discharges during the peak electrical demand periods of 09:00 to 19:00. This corresponds to building cooling demands and generally higher demands during daylight hours. In winter, electrical demand is higher throughout the day and peaks during mealtime hours.

The generating plant needs only to operate approximately three hours per day to release a mean daily flow of 42.5 m^3/s. This, however, would negatively impact the operation of downstream users. During winter, electrical demands are high and daily flows through the plant increase. These daily flows again fluctuate to meet daily peak electrical demands.

In summer, when electrical demands are lower, station discharges range from the minimum to maximum allowable releases depending upon inflow. The net result is a refilling of Lake Diefenbaker. Much of the filling occurs during peak runoff from April to June. Releases are generally lowest in this period to maximize filling. Inflow during the July to September period is less accurately forecast because it results from rainfall and not snow melt. Full supply level (556.87 m) is targeted to be reached by September 30, if sufficient water is available.

A concern of SaskPower is the operating output of the turbines under various conditions of upstream water levels on Lake Diefenbaker and downstream water levels on the South Saskatchewan River. As the head differential across the turbines increases (Lake Diefenbaker water level minus South Saskatchewan River water level), the output of the turbine increases. This allows greater hydro-electric production as illustrated in Figure 14. It is, therefore, in SaskPower's best interest, from a production view, to maintain higher water levels in Lake Diefenbaker.

During freeze-up (October to December), constant releases from Lake Diefenbaker are important to allow the formation of a stable ice cover downstream of Lake Diefenbaker. This reduces the possibility of ice jamming and flooding in the fall, a phenomenon that is caused by fluctuations in releases from the plant. SaskWater has prepared the following guidelines to ensure relatively constant flow during freeze-up:

- Hourly flows should not vary by more than 25 percent of mean daily flows.
- Mean daily flows must not vary more than 10 percent of the flow from one day to the next.

During the peak electrical demand season (i.e. freeze-up to March), discharge through the generating station should be near maximum providing sufficient water supply is available.

When the water supply is low, the discharge pattern is determined by the energy demands of the province. Winter operation results in the drawdown of Lake Diefenbaker. The amount of drawdown is largely dependent upon the expected spring and summer runoff.

FIGURE 12 TYPICAL DAILY OPERATING SCHEDULE FOR DECEMBER FOR COTEAU CREEK GENERATING STATION

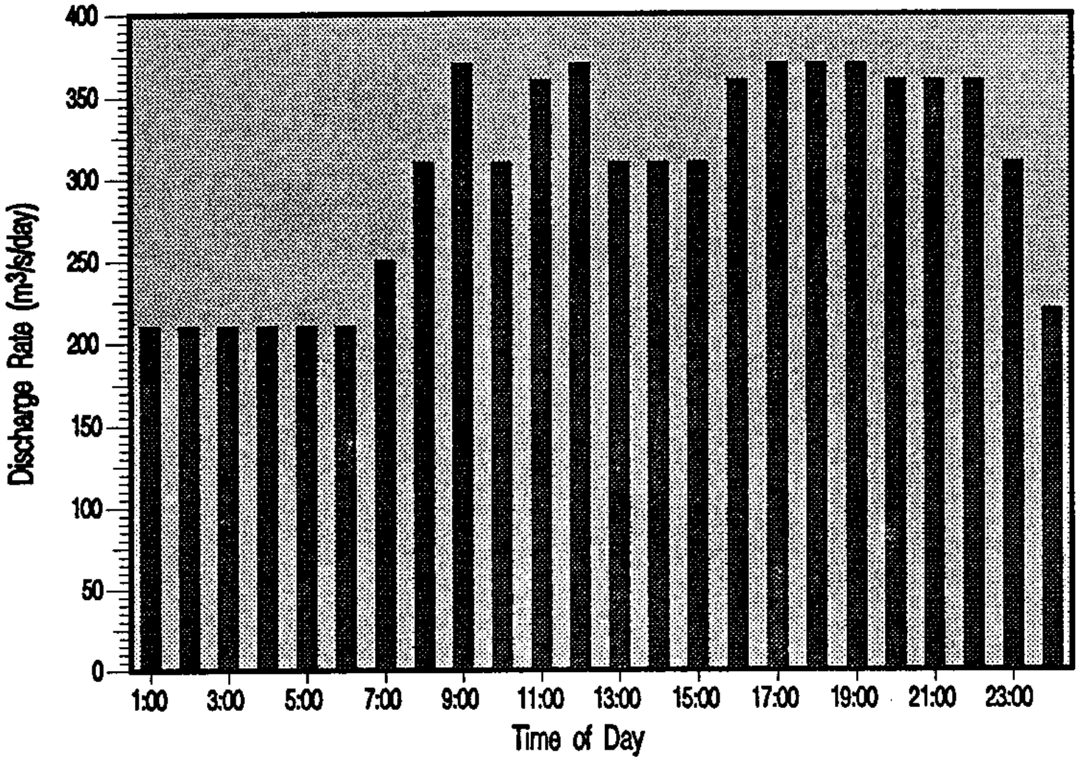


FIGURE 13 TYPICAL DAILY OPERATING SCHEDULE FOR JUNE FOR COTEAU CREEK GENERATING STATION

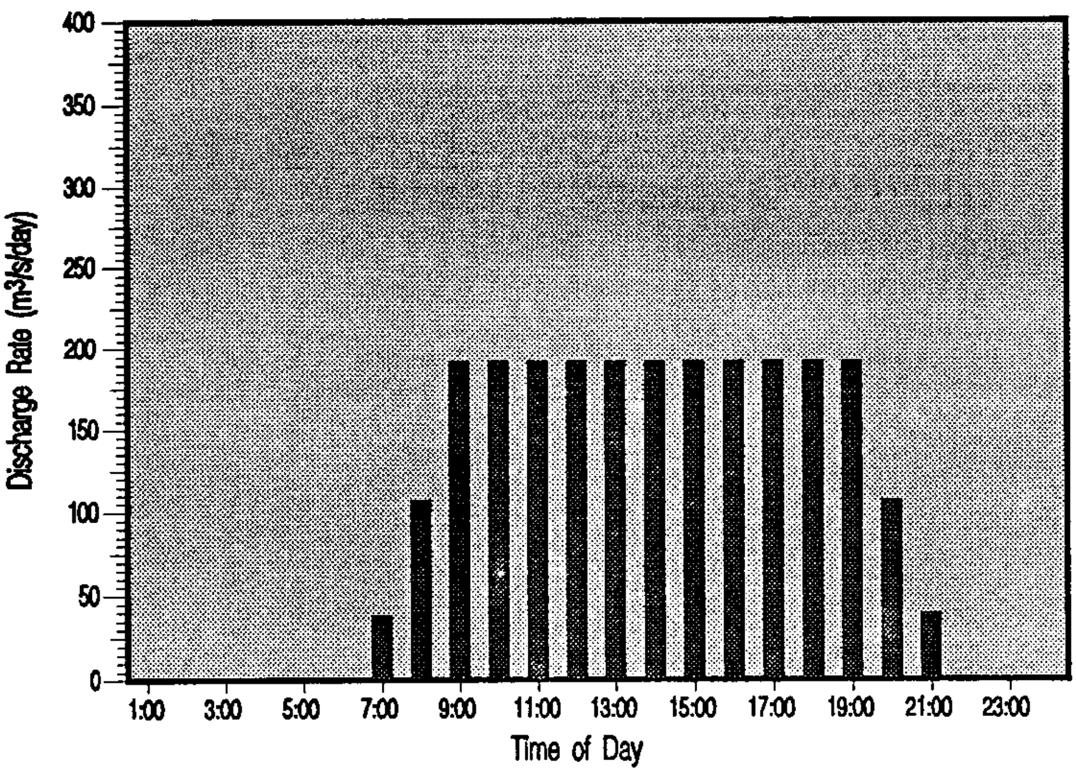
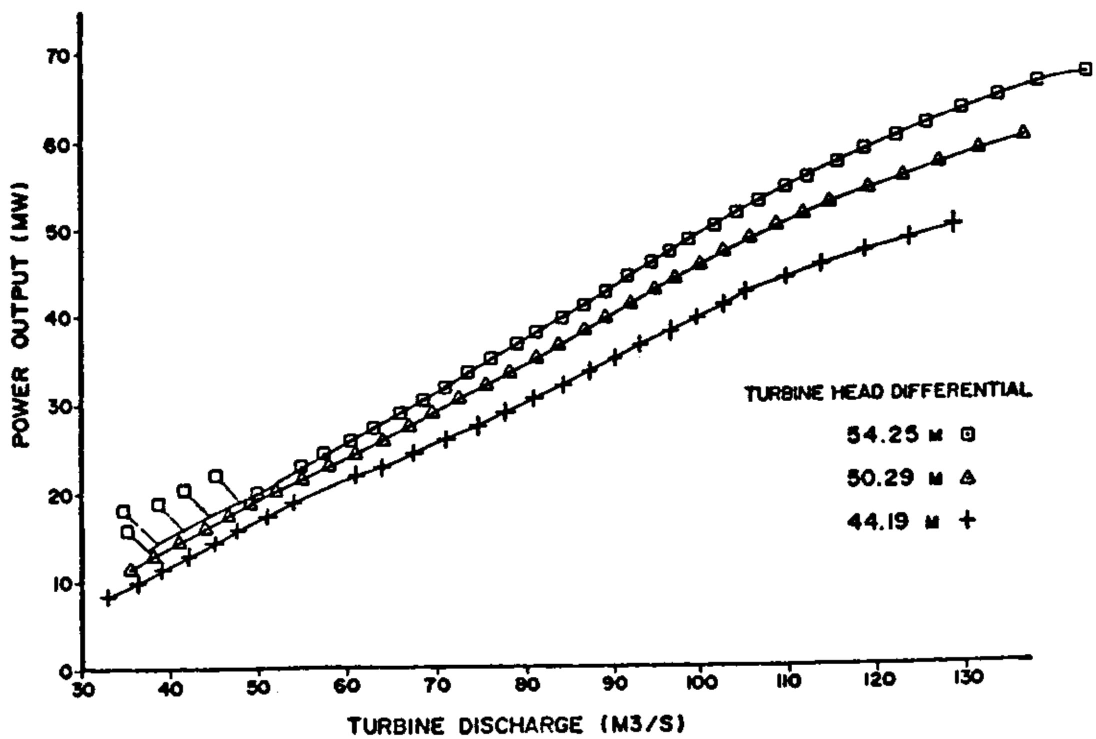


FIGURE 14 POWER OUTPUT, COTEAU CREEK GENERATING STATION



Supplied courtesy of SaskPower

Various other water level limitations affect the operation of the Coteau Creek Generating Station. They are as follows:

- o The lower limit of rip-rap protection is at 544.98 m. Should water levels fall below this elevation, the upstream face of the reservoir would be unprotected and subject to damage. This results in a minimum allowable water level for Lake Diefenbaker of 546.6 m.
- o The generating station requires water levels to be at least 549 m to operate.
- o Water levels are targeted to be between 555.04 and 555.65 m by July 1 to facilitate recreational use of Lake Diefenbaker.

3.2.7 Other Water Uses

There are three other water use permits held by the Water Supply Utility of SaskWater along the mainstem. These uses are not specifically identified as municipal, industrial, agricultural or recreation.

The total water use in this category based on the 1986 level of development is 1 830 dam^3 (Table 20).

3.2.8 Summary

Twenty-two communities in the South Saskatchewan River Basin are supplied with water for municipal purposes from either the South Saskatchewan River or Lake Diefenbaker. Based on the 1986 level of development in the basin; gross municipal water use accounts for 70 000 dam^3. Saskatoon is the largest user with approximately 58 percent of the total municipal use. Regina and Moose Jaw account for an additional 38 percent. Thus, these three cities account for approximately 96 percent of the municipal water withdrawn from the mainstem. The actual water consumed, however, is considerably less. For example, Saskatoon returns an average of 68 percent of water withdrawn back to the South Saskatchewan River.

There are 24 major industrial water uses in the South Saskatchewan River Basin. The average annual industrial water use is 3 200 dam^3. The Queen Elizabeth II thermal power station is Saskatoon may withdraw as much as 75 000 dam^3 annually from the South Saskatchewan River but it is estimated that actual water consumption is less than 900 dam^3.

Water is supplied to 229 licensed irrigation projects along the mainstem. The licensed use is 120 090 dam^3 and the irrigated area is over 18 700 hectares. About 60 percent of the irrigated area is supplied directly from Lake Diefenbaker.

Recreational use of water along the mainstem is very significant. These sites include provincial parks, regional parks and local recreational areas. Much of this recreational activity is centred on Lake Diefenbaker. Each recreational activity has a preferred range of reservoir elevation on river flow; problems occur from time to time when these preferred conditions are not met.

There are nine ferries operating on the South Saskatchewan River, five downstream of Lake Diefenbaker, three upstream and one on the lake. Operating difficulties are experienced at many of these sites during very low flows or lake level, as well as during very high flows.

Hydro-electric power is produced at the Coteau Creek Generating Station at Gardiner Dam. Lake Diefenbaker is operated to maximize the use of the water resource in the basin.

Table 21 and Figure 15 summarize the current (1986 level of development) water use along the mainstem of the South Saskatchewan River, excluding the diversion to the SSEWS system. Total water use along the mainstem is approximately 195 000 dam^3. Over 60 percent of this water is used in irrigation while a further 36 percent is municipal use.

Figure 16 indicates that the average annual water use along the mainstem accounts for about 2 percent of the mean annual natural flow of the South Saskatchewan River in Saskatchewan.

TABLE 20	OTHER WATER USES (1986) ALONG THE SOUTH SASKATCHEWAN RIVER MAINSTEM
WATER USER	WATER USE (1986) (dam^3)
Pike Lake	1 660
Saskatoon West Water Supply system	90
Saskatoon Treated Water Supply system	80
	1 830

TABLE 21	CURRENT (1986) WATER USE ALONG THE MAINSTEM (EXCLUDING DIVERSIONS TO THE SSEWS SYSTEM)	
	WATER USE (1986)	
USE CATEGORY	dam^3	Percent
Municipal	70 000	36
Industrial	3 200	2
Irrigation*	120 100	61
Other	1 800	1
	195 100	100

* licensed use (Table 10)

Note: Net evaporation from Lake Diefenbaker accounts for an additional use of 240 000 dam^3 each year.

FIGURE 15 CURRENT (1986) WATER USE BY CATEGORY ALONG THE MAINSTEM (EXCLUDING DIVERSIONS TO THE SSEWS SYSTEM)

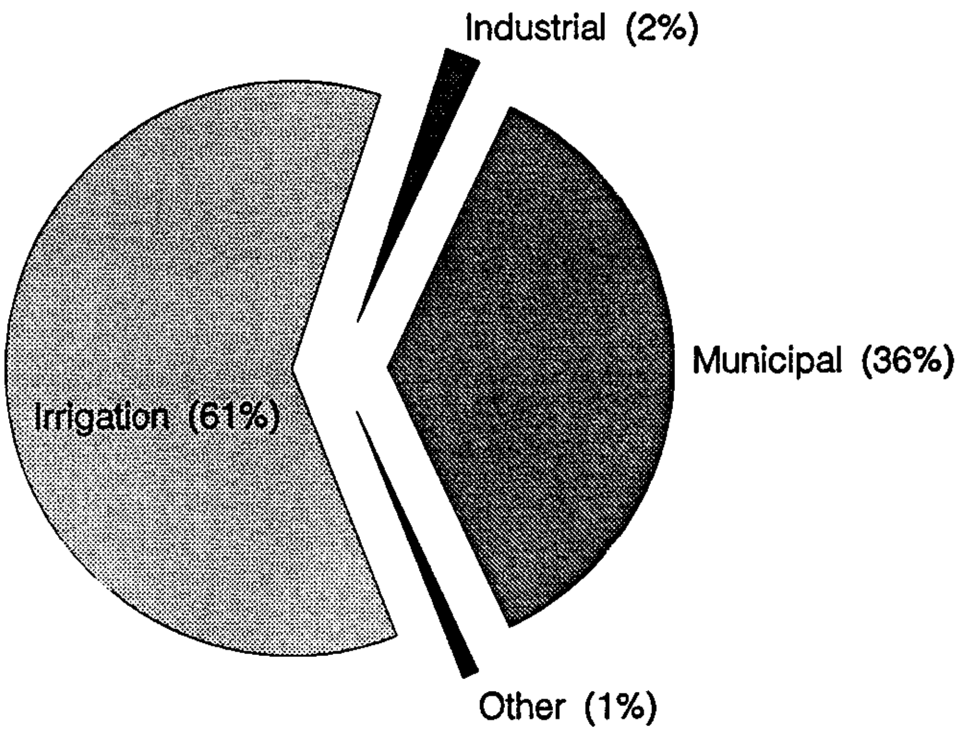
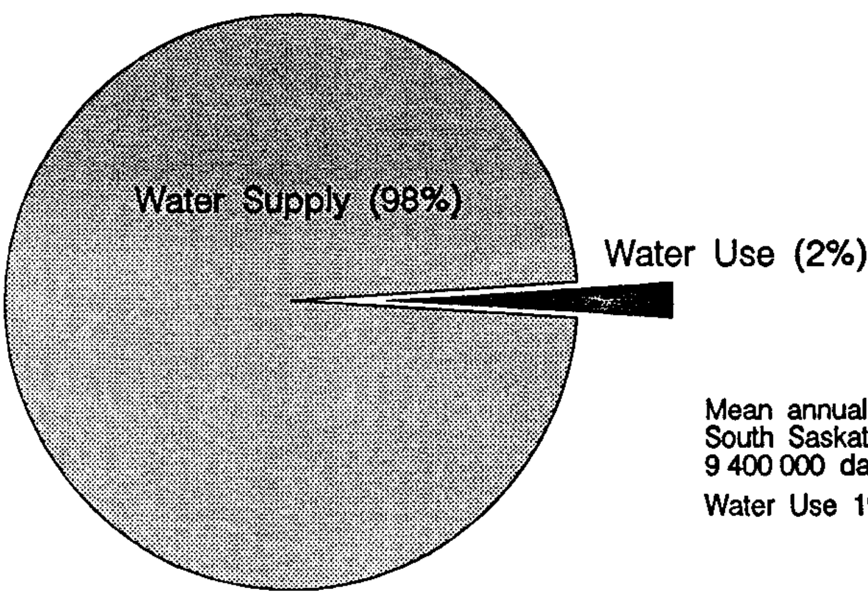


FIGURE 16 WATER USE ALONG THE MAINSTEM AS A PERCENTAGE OF AVAILABLE SUPPLY



Mean annual natural flow of South Saskatchewan River 9 400 000 dam^3

Water Use 195 100 dam^3

4.0 SASKATOON SOUTHEAST WATER SUPPLY (SSEWS) SYSTEM

4.1 HISTORICAL WATER USE

As construction of Gardiner Dam neared completion and Lake Diefenbaker filled in the mid and late 1960s, the Province of Saskatchewan developed works to permit the diversion of water from the lake for uses in an area northeast of the lake. The works were originally developed by the Department of Agriculture which built the East Side Pumping Station, the Main Canal and Broderick Reservoir to serve the South Saskatchewan River Irrigation District No. 1 near Outlook. The Saskatchewan Water Supply Board built the canal, reservoirs and pipelines downstream of Broderick Reservoir to serve additional irrigation, waterfowl, municipal and industrial water uses. The downstream system was originally known as the Saskatoon Southeast Water Supply system or SSEWS system. In 1984, the agencies responsible for the two systems were consolidated in SaskWater. For this report, the entire diversion scheme is referred to as the SSEWS system (refer to Figure 2).

The Water Rights Licence for the South Saskatchewan River Irrigation District No. 1 allocates an annual volume of 114 713 dam^3 of water to the district for the irrigation of 18 800 ha of land with a 610 mm duty of water. Irrigation development which began in 1968 had levelled off at 16 280 ha by 1986. The water use, including losses, varies from year to year. The average depth of water applied from 1984 to 1986 was 430 mm, resulting in the average annual demand of 69 860 dam^3. The peak demand in dry years based on experience in 1984 could be 530 mm for an annual use of 86 200 dam^3. The actual consumption in 1984 was slightly less because the system was shut down for three days in the peak season but if the shut down had not occurred, the seasonal total would have been 530 mm. The lowest use in recent years was about 44 000 dam^3 in 1983 or about 270 mm.

The system below Broderick Reservoir was licensed in 1972 to divert 109 780 dam^3 of water per year. The licence lists the following uses and allocations:

Use	Allocation (dam^3)
Municipal	2 690
Industrial	11 470
Irrigation	40 460
Recreation*	11 350
Wildlife	4 930
Reservoir Evaporation	2 900
Channel Losses	35 980
Total	109 780

* represents evaporation from recreational lakes

4.2 SYSTEM DESCRIPTION

The East Side Pump Station is located on the east end of Gardiner Dam. The pump station draws water from Lake Diefenbaker and lifts the water about 13 m above the full supply level of the lake to the Main Canal (M1). The pump station has four pumps with sufficient capacity to supply the canal plus reserve capacity in case a pump fails. Although it serves a number of different users, including some year-round users, the SSEWS system withdraws water from Lake Diefenbaker in a distinctly seasonal pattern. Peak demands occur during mid-summer. Figure 17 shows the pumping pattern for the East Side Pump Station.

The Main Canal carries water to Broderick Reservoir. About one-third of the South Saskatchewan River Irrigation District No. 1 draws water directly from the canal. The reservoir is the source of water for about two-thirds of the South Saskatchewan River Irrigation District and the town of Broderick. The reservoir has a total capacity of 16 400 dam^3. Because it was anticipated that the water level of this reservoir will fluctuate over a wide range, no shoreline recreation development has been permitted and no stocking of fish has occurred.

Environment Canada data (Figure 18) show that the mean annual recorded discharge from the East Side Pumping Station to the Main Canal from 1978 to 1986 was 93 200 dam^3. Values ranged from a high of 134 000 dam^3 in 1984 to a low of 63 700 dam^3 in 1979.

FIGURE 17 MEAN MONTHLY DISCHARGE OF THE EAST SIDE PUMP STATION

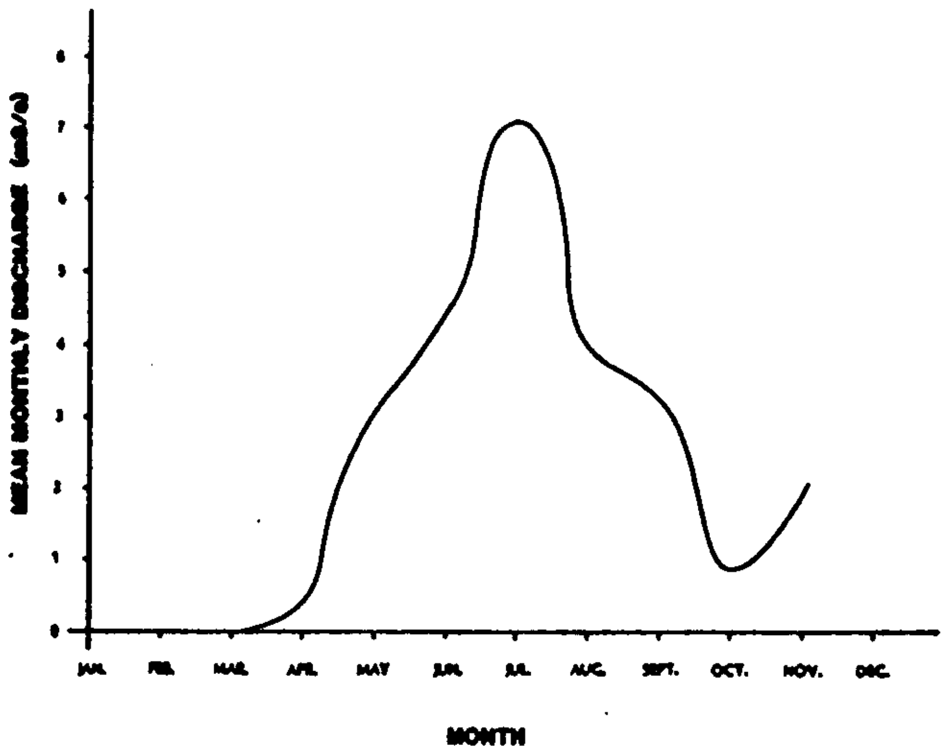
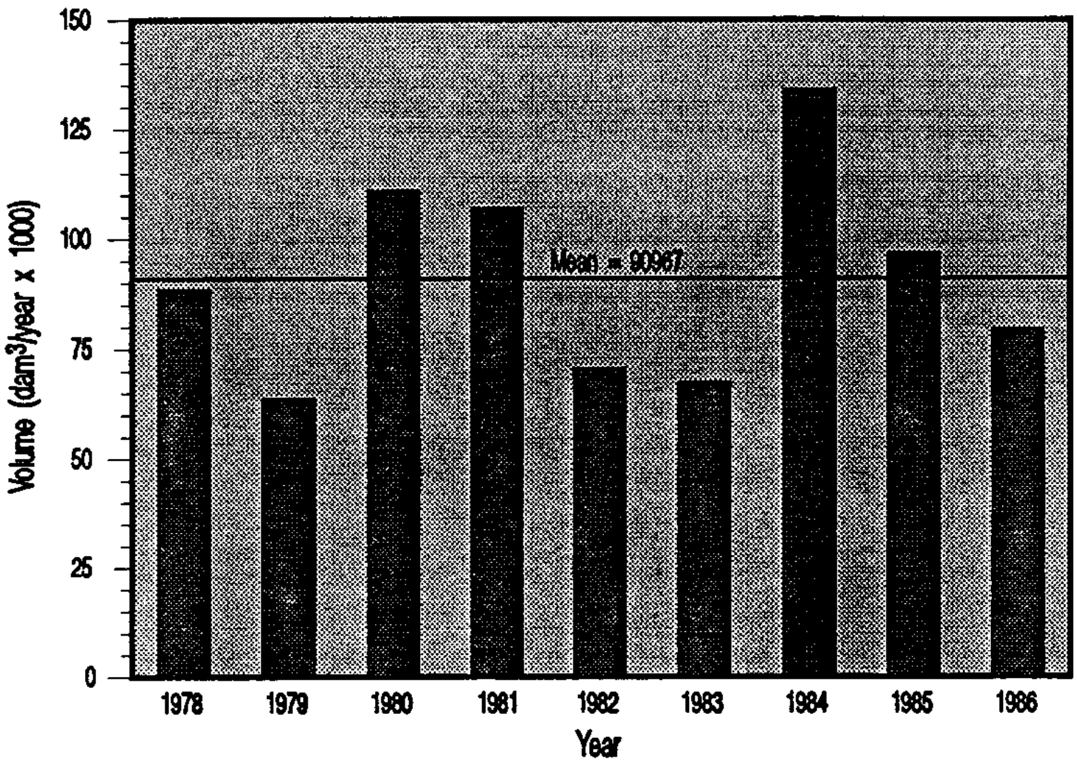


FIGURE 18 RECORDED ANNUAL FLOW FOR SSEWS SYSTEM MAIN CANAL, 1978-1986



In 1986, there were 16 170 ha under irrigation in the South Saskatchewan River Irrigation District. About one-third is irrigated by gravity methods and two-thirds by sprinklers. Most of the potential area is developed. There are about 5 300 ha at or near existing supply points which could be added and an additional 6 000 ha within the district could be developed with additional delivery systems. The existing irrigated area was mostly developed from 1967 to 1982. The rate of new development in recent years has been low.

A canal carries water from Broderick Reservoir to Brightwater Reservoir. This reservoir was created by damming Brightwater Creek and provides additional storage capacity to meet peak irrigation demands. The reservoir also permits the integrated management of the natural runoff on Brightwater Creek and it is a point of diversion for irrigation projects near the reservoir and downstream on Brightwater Creek. Large waterfowl marshes in the Brightwater Creek valley are also supplied. A pipeline carries water to the town of Hanley.

The capacity of Brightwater Reservoir is 8 000 dam^3 with 2 300 dam^3 available for flow regulation. This reservoir has not been stocked with fish and has not been developed for recreation because of its water supply function. A canal outlet on the east side of the valley carries water to the downstream supply system. A few irrigators draw water from the canal.

Blackstrap Lake was formed in a glacial spillway valley by constructing two dams to isolate a 14 km reach of the valley. The natural valley provides an opportunity to avoid construction of a canal, to provide storage capacity for flow regulation and to develop a recreation area.

In addition to developing the lake, the province created two resort villages adjacent to the lake to encourage recreational uses. The resort villages of Thode and Shields provide for seasonal use cottages and a few permanent residences. The lake is operated within a narrow range of levels to improve its recreation capabilities. Fish have been stocked in the lake and fishing is an important recreational activity.

Several irrigation projects draw water from Blackstrap Lake and there is potential for significant additional development.

The canal downstream of Blackstrap Lake provides water to several irrigators and waterfowl projects. Water is diverted from the canal to Bradwell Reservoir. This reservoir serves local irrigators and the Allan potash mine. The reservoir is used for local recreational activities.

Zelma Reservoir is the next reservoir in the system. It is designed to meet peak demands of the downstream system, local irrigation and the Central Canada potash mine near Colonsay.

From Zelma the canal flows by gravity to a location north of Watrous where water can be diverted to Little Manitou Lake or lifted by pumping to a canal that extends to Dellwood Reservoir.

From the 1920s to the 1950s Little Manitou Lake was a popular resort area with a well known mineral spa. Although recreation at the resort village of Manitou Beach continued through the 1960s and 1970s, activity declined. There has been substantial redevelopment of the mineral spa in recent years with successful re-establishment of the tourist industry. Little Manitou Lake is too highly mineralized for sport fish.

Dellwood Reservoir is at the downstream end of the canal system. It was formed by damming Dellwood Brook. The reservoir permits the integrated management of the canal flows and the natural runoff. The main users of Dellwood Reservoir are the communities of Guernsey and Lanigan and the Potash Corporation of Saskatchewan mine near Guernsey. These users are supplied by pipeline from a pump station at Dellwood Reservoir. Water can also be released through the dam via Dellwood Brook to Last Mountain Lake.

Monitoring of water use in the SSEWS system begins with the diversion of water from Lake Diefenbaker to the Broderick Main Canal. Pumping records are maintained for the East Side Pump Station. The volume of water pumped is metered based on pumping records with pumping rates verified by canal discharge measurements. Some of this pumped water is returned via the west side canal at Broderick Reservoir, however, most of it is diverted through the SSEWS system via the outlet located on the east side of Broderick Reservoir.

SaskWater also operates hydrometric stations at various locations from Brightwater Reservoir to Dellwood Reservoir. Irrigators are charged on the basis of their licensed duty of 450 mm on the area irrigated. Exact water use by individual farmers is not metered.

Industrial water use by the potash mines on the SSEWS system is metered at the mine site. The mines are charged for the volume used in excess of a base amount.

Evaporation from the reservoirs removes a substantial quantity of water during the summer. Municipal and industrial water use is generally located downstream on the system. These uses are more uniformly spread over the year. Waterfowl projects require water early in the spring to provide nesting habitat.

Since all of these uses were anticipated in the planning and development of this system, there has been little problem meeting all needs. The main challenge in operation is to minimize the operating costs by taking advantage of local runoff, minimizing evaporation and channel losses and minimizing pumping.

4.3 CURRENT WATER USE (1986)

4.3.1 Municipal

Municipal water allocations within the SSEWS system exist for Broderick, Guernsey, Hanley, Lanigan, Shields and Thode (combined) and Viscount. These allocations are listed in Table 22. All municipal users draw their water directly from reservoirs in the SSEWS system. Hanley also uses groundwater to supplement their water supply.

Two other communities, Allan and Bradwell, are located within the SSEWS system area but these towns are supplied with municipal water from the Saskatoon Treated Water Supply system. Municipal water use for these two towns is discussed in Section 3.

The municipal water use category includes water supplied for residential, commercial, light industrial or public purposes. Most communities do not collect these types of data. Data for Hanley for 1985 indicate that residential water use accounted for 73 percent of the municipal use and commercial and light industrial use accounted for 18 percent. Nine percent was unaccounted. In comparison, data for the entire basin suggest that households were the major users, accounting for 56 percent of the total municipal water use. Light industrial and commercial water use accounts for about 36 percent of the municipal water use in the entire basin (SSRBS Technical Report E.5).

Municipal water use within the SSEWS system equivalent to the 1986 level of development (based on data for 1984 to 1986) is approximately 500 dam^3 per year. The total municipal water use accounts for less than one percent of the average 1978 to 1986 annual volume of water delivered by the East Side Pump Station of 93 200 dam^3. This reflects the rural nature of this part of the basin.

Table 23 identifies the annual per capita water use and water pricing strategies used by each of the communities within the SSEWS system. While per capita water use varies considerably, no clear relationship is apparent between use and water pricing strategy. The average annual per capita use of 139 m^3 per person (380 L per person per day) is very similar to the 146 m^3/person average for the mainstem communities. It is perhaps interesting to note that only one community, Hanley, encourages water conservation through a constant rate pricing structure. The per capita water use for this community is below the average for the towns located along the SSEWS system.

4.3.2 Industrial

There are three industrial permit holders on the SSEWS system. All three are potash companies. These include PCS Allan, PCS Lanigan and Central Canada Potash. Water is supplied by pipeline from Bradwell Reservoir (PCS Allan), Dellwood Reservoir (PCS Lanigan) and Zelma Reservoir (Central Canada Potash).

Water use consists of a base load and process load, as described in Section 3.2.2. The water allocation for these three industries totals 5 456 dam^3. The individual allocations and water use quantities are listed in Table 24. Industrial water use by the three mines is about 49 percent of their allocation.

TABLE 22 MUNICIPAL WATER USERS SUPPLIED FROM THE SSEWS SYSTEM			
COMMUNITY	RESERVOIR SOURCE	SASKWATER ALLOCATION (dam^3)	WATER PUMPAGE (dam^3)
Broderick	Broderick	15	20
Guernsey	Dellwood	24	30
Hanley	Brightwater	203	60
Lanigan	Dellwood	454	260
Shields & Thode	Blackstrap	84	90
Viscount	Zelma	60	40
TOTAL		840	500

* Values are rounded and represent the 1986 level of development

TABLE 23 RATE STRUCTURE AND ANNUAL PER CAPITA WATER USE FOR COMMUNITIES ALONG THE SSEWS SYSTEM			
COMMUNITY	POPULATION (1986)	MUNICIPAL RATE STRUCTURE	ANNUAL PER CAPITA USE (m^3/person)
Broderick	120	flat rate	167
Guernsey	190	flat rate	158
Hanley	490	constant rate	123
Lanigan	1 700	decreasing block	153
Shields & Thode	750	flat rate	120
Viscount	360	decreasing block	111
	3 610		

TABLE 24 INDUSTRIAL WATER USE (1986) IN THE SSEWS SYSTEM			
WATER	WATER ALLOCATION (dam^3)	WATER USE (dam^3)	USE AS PERCENT OF ALLOCATION
PCS Allan	2 046	1 418	69
Central Canada Potash	2 046	805	59
PCS Lanigan	1 364	453	22
	5 456	2 676	49

4.3.3 Agricultural

The largest use of water in the SSEWS system is irrigation. Irrigation requires water from May to September with peak demands from late June to early August. Almost one-half of the annual demand occurs in the month of July. The typical monthly distribution of the annual demand is:

May	8%
June	24%
July	46%
August	16%
September	6%

The largest irrigation concentration is near the upstream end of the system in the South Saskatchewan River Irrigation District but additional irrigation is scattered along the system.

The South Saskatchewan River Irrigation District No. 1 is a local authority established to manage the operation of the common works of the irrigators in the district. In 1986, there were approximately 16 170 ha under irrigation in the district. About one-third is irrigated by gravity methods and two-thirds by sprinklers.

Table 25 summarizes the irrigation water use equivalent to the 1986 level of development in the SSEWS system. Annual irrigation water use is approximately 91 400 dam^3.

The irrigation water use is not measured. It is based on the licensed duty on the irrigated area. The average use is likely less than this estimated value since the duty reflects the maximum irrigation water use in dry years.

Water quality along the SSEWS system is generally good near Lake Diefenbaker but deteriorates in a downstream direction. For example, the high total dissolved solids concentrations at Blackstrap Lake may affect some crops which are sensitive to salinity; Bradwell and Zelma reservoirs are even more saline. High sodium levels in the lower reservoirs also may affect irrigation.

4.3.4 Recreation

Other uses of water along the SSEWS system include recreation and waterfowl conservation projects operated by Ducks Unlimited (DU). These water uses are summarized in Table 26. The total water use of 12 664 dam^3 represents 12 percent of the SSEWS system and 4 percent of the total basin water use. The Ducks Unlimited projects use a total of 3 941 dam^3. Water is also "used" in the canal system to maintain the necessary depth of flow for various canal users.

Water use within the SSEWS system supports recreational sites such as Blackstrap Lake and Little Manitou Lake. Boating, waterskiing, sailing, board sailing, fishing and swimming are the principal water-based recreational activities at Blackstrap Provincial Park. There are also two cottage developments and three institutional camps at Blackstrap Reservoir. Little Manitou Lake has been a popular resort village since the 1920s. The lake is used for swimming, boating, waterskiing, sailing, board sailing and paddleboating.

Water levels on Blackstrap Lake tend to be highest in the spring and decrease gradually over the summer. Lake levels are maintained within a range of 533.40 to 534.47 m based on existing operating agreements and operating practices of the SSEWS system. Measurements taken throughout the operating seasons of 1985 and 1986 showed water levels to fluctuate relatively little (approximately 0.2 m variation). These water levels are considered adequate and sufficient for fish and recreation.

Water quality, particularly algae blooms and aquatic plants, represent the largest constraint on recreation on Blackstrap Lake. Shallow depths, nutrient rich reservoir bottom and runoff from adjacent farming operations all contribute to the eutrophic nature of the reservoir. Other reservoirs in the SSEWS system also have algae blooms for similar reasons. By mid-summer, the algae becomes very thick and discourages some users. Nevertheless, numerous waterskiers and board sailors continue to use the reservoir in mid-summer. The Saskatoon Windsurfing Club generally uses Blackstrap Lake from April to June and September to November. Many members go to Lake Diefenbaker in July and August.

Table 27 summarizes data on the 1988 demand for summer water-based recreation at Blackstrap Lake. This table illustrates that this recreation site is well utilized on a daily basis. In fact, only Pike Lake is more frequently visited by day visitors. Table 28 identifies the estimated number of visitations from four major population centres to Blackstrap Lake in 1988. As expected, virtually all visitors came from Saskatoon as this is the closest main centre.

TABLE 25 IRRIGATION WATER USE (1986) ALONG THE SSEWS SYSTEM			
WATER USER	IRRIGATION REQUIREMENT (mm)	AREA IRRIGATED (ha)	TOTAL IRRIGATION USE (dam³)
SSRID* No. 1	408	16 170	65 974
Brightwater Reservoir	408	1 406	5 736
Broderick to Brightwater	408	2 403	9 804
Blackstrap Reservoir	408	1 165	4 753
Brightwater to Blackstrap	408	361	1 473
Bradwell Reservoir	408	597	2 436
Zelma	408	134	547
Blackstrap to Zelma	408	172	702
Total		22 408	91 425

*SSRID: South Saskatchewan River Irrigation District

TABLE 26 OTHER WATER USES ALONG THE SSEWS SYSTEM	
WATER USER	WATER USE (dam³)
Little Manitou Lake	4
Ducks Unlimited near Dundurn	2 071
Brightwater - Blackstrap DU	814
Blackstrap - Zelma DU	817
Zelma - Little Manitou Lake DU	239
Diefenbaker - Broderick Canal	1 710
Broderick - Brightwater Canal	2 572
Brightwater - Blackstrap Canal	1 137
Bradwell Canal	149
Blackstrap - Zelma Canal	1 646
Zelma - Little Manitou Canal	546
Little Manitou - Dellwood Canal	959
Total	12 664

TABLE 27 VISITATION ESTIMATES (VEHICLES AND PEOPLE) FOR BLACKSTRAP LAKE, 1988

	COMPLETE SAMPLE*		RESTRICTED SAMPLE** (used in travel cost model)					
	VEHICLES	PEOPLE	VEHICLES	PEOPLE	VEHICLES	PEOPLE	VEHICLES	PEOPLE
Blackstrap	18 879	70 975	17 559	66 013	16 124	60 618	1 435	5 395

* Includes all visitors

** Includes only visitors used for estimation of the travel cost model (i.e. 1 day visitors from over 250 km away are excluded as are all visitors from over 500 km away).

TABLE 28 ESTIMATED VISITATION FROM MAJOR POPULATION CENTRES TO BLACKSTRAP LAKE, 1988

PARK	MOOSE JAW	REGINA	SASKATOON	SWIFT CURRENT	TOTAL
Blackstrap	114	1 208	58 300	230	59 852

Winter activities on the ice include biking and snowmobile drag races as well as ice fishing. These activities are not restricted because lake levels are maintained at full supply level during the winter which enables the establishment of a solid, safe ice layer.

When extra water is available in the SSEWS system, Little Manitou Lake is recharged. This keeps water levels within approximately a 0.40 m range. Levels usually peak in the spring and decrease throughout the summer as evaporation occurs. Data from 1984, the last year in which water levels were measured daily, typifies current operations. That year, water levels ranged from 493.99 m in April to 493.69 m in August, a difference of 0.30 m. The addition of fresh water to the lake does not appear to be affecting the water quality of the lake. Salt water moss grows in the shallows along the shore. This is easily cleared and does not affect recreation.

In summary, present operating agreements and operating practices are resulting in water levels which are considered good by the recreationists using Blackstrap Lake and Little Manitou Lake. Table 29 presents the usual range of water levels.

4.3.5 Summary

Seven communities are supplied with water from the SSEWS system of canals and reservoirs. One of these communities, Hanley, also utilizes groundwater. Two other communities are located within the SSEWS system area but water is supplied via the Saskatoon Treated Water Supply system. Municipal water use within the SSEWS system equivalent to the 1986 level of development is approximately 500 dam^3 per year.

There are three industrial users of water along the system. All are potash mines and withdraw water from reservoirs. Industrial water use by these mines based on the 1986 level of development is about 2 680 dam^3.

Irrigation represents the largest use of water in the SSEWS system. Approximately 22 400 ha of land are irrigated. The total irrigated water use is about 91 400 dam^3. The poor water quality, in the lower portions of the SSEWS system, may affect the irrigation of certain crops.

Other uses of water occur along the SSEWS system of canals and reservoirs. Recreation is a very important use, with recreational sites such as Blackstrap Lake and Little Manitou Lake, being very popular. There are also four waterfowl conservation projects operated by Ducks Unlimited in the region.

Table 30 and Figure 19 summarize the current water use in the SSEWS system. Total annual water use is about 95 000 dam^3 with almost 97 percent of this being utilized in irrigation.

Figure 20 illustrates that the average annual water use by the SSEWS system is about 1 percent of the mean annual natural flow of the South Saskatchewan River in Saskatchewan.

TABLE 29 THE GENERAL RANGE OF WATER LEVELS FOR BLACKSTRAP LAKE AND LITTLE MANITOU LAKE		
	WATER LEVELS (m)	
	MINIMUM	MAXIMUM
Blackstrap Lake (operating schedule)	533.40	534.47
Little Manitou Lake (mean monthly levels of April and August 1984)	493.69	493.99

TABLE 30 CURRENT (1986) WATER USE ALONG THE SSEWS SYSTEM		
	WATER USED (1986)	
USE CATEGORY	dam^3	percent
Municipal	500	0.5
Industrial	2 680	2.8
Irrigation	91 400	96.7
Total	94 580	100.0

Note: Evaporation accounts for an additional use of 22 550 dam^3 each year.

FIGURE 19 CURRENT (1986) WATER USE BY CATEGORY, SSEWS SYSTEM

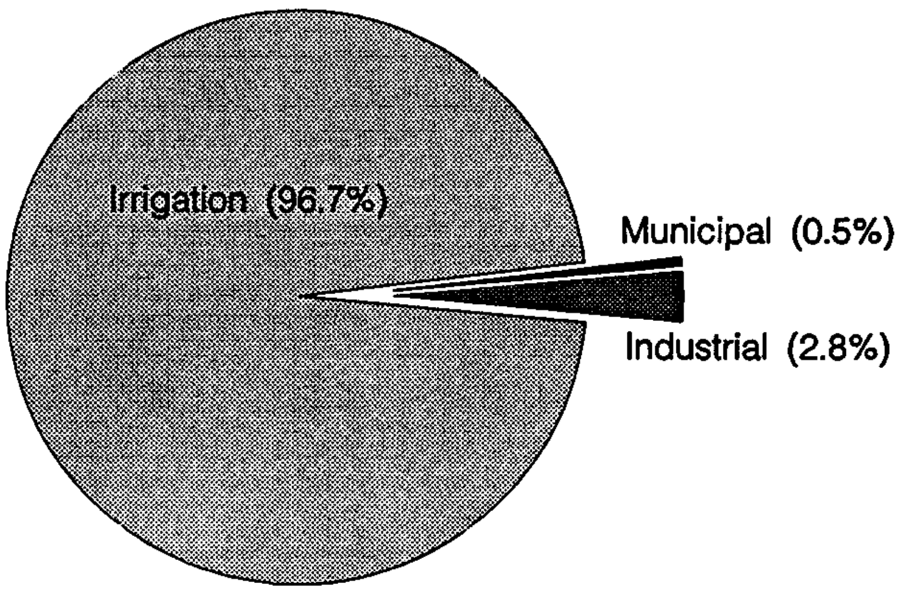
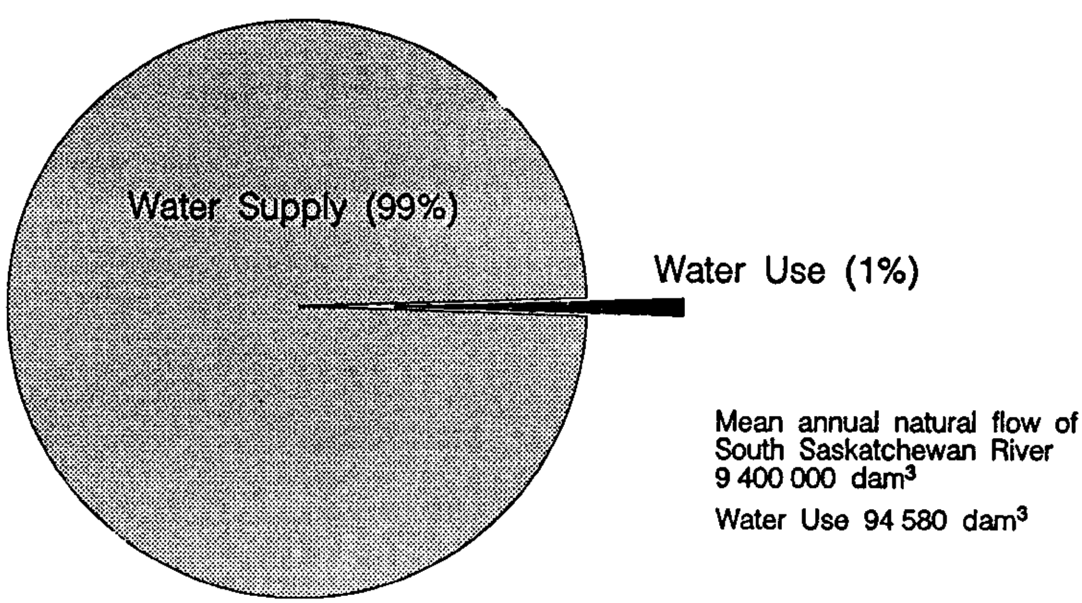


FIGURE 20 WATER USE BY THE SSEWS SYSTEM AS A PERCENTAGE OF MAINSTEM FLOW



5.0 SWIFT CURRENT CREEK

5.1 HISTORICAL WATER USE

Swift Current Creek is the largest tributary to the South Saskatchewan River in Saskatchewan but its average flow of about 1 percent of the total river flow has never been considered critical to the management of the South Saskatchewan River. The flow of Swift Current Creek traditionally has been managed as an independent unit.

From the late 1800s to the present, the water of Swift Current Creek has been increasingly diverted for human uses. In the early years most of the use was for individually-developed private irrigation, stockwatering and municipal uses along the creek and its tributaries. In 1942, PFRA completed the Duncairn Dam and began development of a comprehensive system of canals and reservoirs which serve group and individual irrigation projects in the Swift Current Creek Basin and in the adjacent Rushlake Creek Basin. In addition to serving irrigation development, the creek provides municipal water for the city of Swift Current and other smaller communities. Several of the water bodies provide fish, wildlife and recreation opportunities.

Duncairn Reservoir, Highfield Reservoir and Herbert Reservoir are operated by PFRA as part of the water management system. Swift Current Reservoir is used jointly by PFRA, as the head pond for the diversion canal to Rushlake Creek, and by the city, as a raw water source. Lac Pelletier is a natural lake that has been raised about one metre by a control dam that is operated by a Regional Park Board.

Rushlake Creek is a small stream that runs roughly parallel to Swift Current Creek about 15 km to the east. Rushlake Creek drains to a marshy area known as Rush Lake. Rush Lake drains through Lizard Creek to Reed Lake. Reed Lake is a shallow closed lake whose only outlet is evaporation. If the elevation of Reed Lake is high enough, outflow occurs to the east through Chaplin Lake to Old Wives Lake. Although this drainage basin is not part of the Swift Current Creek Basin, its water management is intimately tied to Swift Current Creek by an integrated system of canals and reservoirs. Therefore the combined basin is commonly referred to as the Swift Current Creek Basin. The combined basin covers an area of nearly 5 000 km^2 as shown in Figure 3.

The five largest reservoirs in the basin are described in Table 31.

Environment Canada monitors inflow and outflow of Duncairn Reservoir with recording hydrometric stations. Continuous water levels are recorded at Duncairn Reservoir. There is also a hydrometric gauging station on Swift Current Creek at Leinan to monitor flow volumes into Lake Diefenbaker.

Agriculture Canada (PFRA) has developed a hydrometric network to monitor flows at strategic points in the Swift Current Canal system to assist in water management. It provides an immediate picture of flows at critical times during the irrigation season. Return flow to Reed Lake and Swift Current Creek are monitored. The network also provides an indication of losses through earth canal banks.

A major problem in managing the system in its length. Approximately one month prior to the irrigation schedule all landowners are notified when water will be available. The entire system is then primed and irrigation commences. The users on the canal system then take water to satisfy irrigation requirements.

A problem that can arise during the irrigation season is that rainfall can alter the amount of water required. However, because the entire system is so long it takes about a week for any adjustments at Duncairn Reservoir to affect the entire system. Consequently once the system is operational, major adjustments are difficult to implement. Another problem, particularly on the mainstem of the creek between Duncairn Reservoir and Swift Current is that some users may not take their withdrawals when they are available and additional water may have to be released later in the season. Below Swift Current the water users nominate a contact. This individual remains in close contact with PFRA and a more beneficial use of the water can be made because users are aware of the hydrologic conditions.

5.2 CURRENT WATER USE (1986)

5.2.1 Municipal

The city of Swift Current is the only municipal water user in the Swift Current Creek Basin withdrawing water from surface sources. Other communities within the basin area rely on groundwater for municipal needs. These include Shaunavon, Stewart Valley, Waldeck and Webb. The village of Herbert in the Rushlake Creek Basin also relies on water diverted from Swift Current Creek for its water supply.

TABLE 31

SWIFT CURRENT CREEK RESERVOIRS

DRAINAGE BASIN	RESERVOIR NAME	FSL (m)	CAPACITY (dam^3)	AREA (ha) (at fsl)	CONSTRUCTION DATE	USE
Swift Current Creek	Duncairn Reservoir	807.72	103 150	1 451	1942	Irrigation, Municipal, Recreation, Flood
	Lac Pelletier	828.90	16 733	300	1938	Recreation
	Swift Current Reservoir	743.60	421	32	1984	Municipal, Irrigation
Rushlake Creek	Highfield Reservoir	722.99	14 934	519	1941	Irrigation, Recreation
	Herbert	710.12	2 590	63	1953	Irrigation, Municipal

Water for Swift Current is released from Duncairn Reservoir and flows down Swift Current Creek to Swift Current Reservoir. The annual city demand has averaged 3 160 dam³ in recent years. SaskWater has allocated 5 640 dam³ annually to the city of Swift Current.

Significant channel losses occur between Duncairn Dam and the city. In summer, the city release is commonly part of the irrigation release but in non-irrigation periods, the release from Duncairn Reservoir is usually twice the city use to ensure that the city's needs are met. Higher release rates are required in the winter to ensure that sufficient water reaches downstream users. The total winter release is about 5 900 dam³.

To ensure a firm supply for Swift Current and protect the fishery, withdrawals for irrigation have been limited to elevation 803.72 m. Below that elevation withdrawals are only permitted for municipal use from the remaining storage of 52 000 dam³.

Municipal water rate structures vary among the five communities listed in Table 32. It is interesting to note that Swift Current's annual per capita municipal water use is twice as high as the small community of Waldeck.

A comparison of Table 32 with Table 5 illustrates that annual per capita municipal water use at Swift Current is similar to other major cities in the South Saskatchewan River Basin - Regina (167 m³/person), Moose Jaw (208) and Saskatoon (222).

5.2.2 Industrial

Industrial development within the Swift Current Creek Basin is insignificant. SaskWater has issued four permits to industrial water users. These include the city of Swift Current (two permits), the Canadian Pacific Railway and SaskPower. The total allocation is 528 dam³. The minor industrial use is included in the municipal water use category.

5.2.3 Agricultural

Irrigation is the largest consumer of water in the Swift Current Creek Basin. There are a total of 1 041 licensed irrigation projects in the drainage basin as summarized in Table 33. In total, about 8 700 hectares are licensed for irrigation purposes by SaskWater. The total licensed diversion is approximately 26 900 dam³.

The availability of water for irrigation in the Swift Current Creek Basin is less certain than along the mainstem. As a result, the type of irrigation practised here is different. Irrigation in the Swift Current Creek Basin tends to be on a much smaller scale and includes a high percentage of back flood projects. These projects tend to be along the headwaters of tributary streams and are designed to capture spring runoff from local areas and to spread the water by means of a system of dykes. These projects tend to have a lower capital cost compared to sprinkler irrigation systems and are, therefore, more economical in areas where water variability is high. In general these projects are upstream of the major storage reservoirs in the basin.

Duncairn Reservoir supplies irrigation water to 947 hectares of land. Water is released from the reservoir to irrigate 1 622 ha of land along the creek between Duncairn Dam and Lake Diefenbaker.

Water is diverted from Swift Current Reservoir via the Swift Current Canal to irrigation projects east of Swift Current. This canal provides water to the Waldeck group irrigation project which is within the Swift Current Creek Basin. Farther east, the canal delivers water to Highfield Reservoir located in the Rushlake Creek basin. The canal supplements the local runoff from Rushlake Creek. Highfield Reservoir has a storage capacity of about 15 000 dam³ which is used to supply water to irrigation projects by releases to Rushlake Creek and the Herbert Canal. The Herbert Canal also delivers water to Herbert Reservoir which provides an additional 2 500 dam³ of storage capacity for irrigation and for the town of Herbert.

TABLE 32 MUNICIPAL WATER RATE STRUCTURE AND ANNUAL WATER USE, SWIFT CURRENT CREEK BASIN			
COMMUNITY	POPULATION (1986)	MUNICIPAL RATE STRUCTURE	ANNUAL PER CAPITA WATER USE (m^3/person)
Shaunavon*	2 150	flat rate	181
Stewart Valley*	130	decreasing block	131
Swift Current	15 670	constant rate	202
Waldeck*	340	decreasing block	100
Webb*	90	flat rate	N/A

* These communities are supplied from groundwater sources.
N/A = information on water use not available.
Note: Shaunavon is located adjacent to the Swift Current Creek Basin

TABLE 33 SWIFT CURRENT CREEK IRRIGATION WATER ALLOCATION			
LOCATION	NUMBER OF PROJECTS	LICENSED IRRIGATED AREA (ha)	TOTAL LICENSED DIVERSION* (dam^3)
Upstream of Duncairn Reservoir	495	2 500	4 897
From Duncairn Reservoir	15	947	2 887
Pelletier Creek	9	45	1 835
Local Drainage Area from Duncairn Reservoir and Swift Current	59	488	1 563
From Swift Current Creek between Duncairn Reservoir and Swift Current	10	129	393
From Swift Current Reservoir	2	27	83
Swift Current Effluent	10	217	663
From Swift Current Creek Downstream of Swift Current	48	1 466	4 677
Local Drainage Areas Downstream of Swift Current	106	304	1 104
Swift Current Diversion Canal	8	242	936
Upstream of Highfield Reservoir	22	61	152
From Highfield Reservoir	3	123	3 287
Local Drainage Area Below Highfield Reservoir	16	134	341
From Canal and Creek Below Highfield Reservoir	16	558	1 697
From Herbert Canal and Reservoir	7	167	508
Reed Lake Drainage Area	178	873	453
Lizard Creek Drainage Area	33	49	277
From Lizard Creek	4	368	1 109
TOTAL	1 041	8 698	26 862

* Diversion refers to the licensed withdrawal of water to the project and includes the water allocation and expected water losses.

In most years there is sufficient runoff to supply all of the existing water uses. In years when runoff is low, water may be withdrawn from storage if the reservoirs are high to overcome the shortage. In about one-quarter of the years, the supply is inadequate and there is insufficient water in the reservoirs to make up the shortage. In these very dry years the supply is rationed among the users in order to provide some production to all users and to protect the forage crops from root damage which could reduce subsequent crops. Irrigation has not expanded in this basin over the last ten years because the existing supply system is fully utilized.

Water allocation varies with the type of water distribution system. For example, border dyke and backflood projects are generally allocated 203 mm and sprinkler irrigation systems are currently allocated 305 mm of water. The duty based on irrigation area determines the volume of water allocated to each irrigation project. This is usually expressed in dam^3 units.

A pilot study in the basin was undertaken to examine sprinkler irrigation water use. The complete study is documented in SSRBS Technical Report E.8. The study conclusions may be summarized as follows:

1. Sprinkler water use is higher in the Swift Current Creek Basin than in other parts of the South Saskatchewan River Basin. The average use appears to be more than 350 mm compared to 200 mm below Lake Diefenbaker. The inference is that more water is utilized in windier and drier areas.

2. The highest water consumption usually occurs in July in the Swift Current Creek Basin and upstream of Lake Diefenbaker and in June in other areas.

3. Irrigation water use in the Swift Current Creek Basin exceeds the allocation. All other irrigation areas utilize less than their allocations.

4. Water utilization for forage production (alfalfa, barley/alfalfa, oats/alfalfa and forage cereals) is considerably higher than for grains (wheat, barley, canola, flax, lentil and oat crops).

5. Although no group sprinkler irrigation projects exist in the Swift Current Creek Basin, the Cochrane Lavalin study observed that these projects use perhaps 30 percent more water than individually operated projects. The reasons for this include the group's ability to accommodate breakdowns, the assured supply of water and a flat rate fee structure.

The actual irrigation water use equivalent to the 1986 level of development in the Swift Current Creek Basin are summarized in Table 34 for various segments of the basin. Comparing this table to Table 33 it can be seen that the irrigated area and total water use values are not consistent. Table 33 summarizes data in the surface water data files maintained by SaskWater. Table 34 is based on various studies prepared in the 1980s by PFRA and based on the actual operation of each project. In effect, therefore, water allocations provide estimates of water use for administrative purposes and may not accurately reflect water use patterns from one season to the next. The best estimate is that at the 1986 level of development in the Swift Current Creek Basin, approximately 7 600 ha were irrigated. Annual irrigation water use was approximately 28 200 dam^3.

Although the quality of surface water in the Swift Current Creek Basin is generally not as favourable as in the mainstem of the South Saskatchewan River, the quality is considered to be suitable for most irrigated crops. However, some problems have been noticed with high mean summer total dissolved solids concentrations in Duncairn Reservoir water. These high values indicate that the water may be unsuitable occasionally for the irrigation of certain crops.

While agricultural water use for irrigation purposes is the largest consumer of water in the Swift Current Creek Basin, water for livestock use also represents an important use of this resource. This activity is distributed more widely throughout the basin as it does not rely on the main tributaries for a supply source. Data for the South Saskatchewan River Basin in Saskatchewan suggest that livestock water use would be approximately 4 000 dam^3. The actual use in the Swift Current Creek Basin is unknown. The quality of this water is suitable for all livestock uses.

5.2.4 Recreation

The major recreation site near Swift Current Creek is Lac Pelletier Regional Park which operates a reservoir with a capacity of 16 275 dam^3. Lac Pelletier Regional Park has a beach and boat launch which facilitate swimming, boating, waterskiing, sailing,and fishing. The lake has in the past been stocked with northern pike and fishing is popular in both winter and summer.

TABLE 34 SWIFT CURRENT CREEK IRRIGATION WATER USE (1986)			
WATER USER	IRRIGATION REQUIREMENT (mm)	AREA IRRIGATED (ha)	TOTAL IRRIGATION USE (dam³)
Herbert Irrigation Project	610	150	915
Rush Lake Irrigation Project	610	1 377	8 400
Rush Lake Backflood Project	203	1 255	2 548
Waldeck Irrigation Project	610	673	4 105
Highfield Reservoir	295	123	363
Canal Below Highfield Reservoir	295	36	106
Rushlake Creek Below Highfield Reservoir	295	307	905
Rushlake Creek Below Highfield Reservoir	245	62	153
Duncairn Reservoir	295	947	2 794
Swift Current Creek Between Duncairn Reservoir and Proposed SC2 Reservoir	295	265	782
Herbert Canal	295	156	460
Herbert Reservoir	295	11	32
Swift Current Creek Between Proposed SC2 Reservoir and Swift Current Reservoir	195	129	381
Swift Current Reservoir	195	27	80
Swift Current Creek Between Swift Current Reservoir and Proposed 8B Reservoir	295	513	1 513
Swift Current Creek Between Proposed 8B Reservoir & 7B Reservoir	295	807	2 381
Lizard Creek	295	368	1 086
Swift Current Creek Between Proposed 7B Reservoir and Lake Diefenbaker	295	146	431
Swift Current Creek Diversion Canal Between Swift Current Reservoir and Waldeck	295	113	333
Swift Current Creek Diversion Canal Between Waldeck and Highfield Reservoir	295	153	451
		7 618	28 219

Operating guidelines recommended by the Lac Pelletier Regional Park Board are as follows:

- Lake levels should go no lower than approximately 828.75 m. Such low lake levels occurred during 1985. Weeds at that time were worse than usual.
- Preferred lake levels are approximately 828.87 m.
- Maximum levels should be less than 829.04 m. If lake levels are too high, the beach is flooded and the shoreline erodes.

The outlet of the lake is controlled by a stop log structure which the Regional Park Board has operated since 1975. In recent years, the Park Board has kept the reservoir water levels above the full supply level (828.76 m). Preferred and maximum levels identified by members of the Park Board are above the full supply level. Fluctuations in levels are created by groundwater inflow from springs and the amount of water released to an irrigation project in the north. In the past, winds from the south have caused lake levels to set-up approximately 0.3 m.

There are also four cottage developments on the lake. Some cottage owners would prefer levels to be higher than those recommended by the Park Board.

Duncairn Reservoir was constructed by PFRA in 1942 to supply water for municipal and irrigation purposes. Boating and summer and winter fishing, are common at Duncairn Reservoir. The lake has a capacity of 103 000 dam^3 at full supply level (807.72 m). In order to protect the fishery and recreation and to reserve sufficient water for the city of Swift Current, no withdrawal of water is permitted if Duncairn Reservoir is lower than elevation 803.72 m. This reserves a volume of 52 000 dam^3 of water.

Highfield Reservoir on Rushlake Creek was constructed in 1941 primarily for irrigation but it also provides sport fishing opportunities. No preferred elevation for recreation has been identified but it is likely that elevations approaching full supply level (722.99 m) would be most suitable for maintenance of the fishery.

Swift Current Creek winds through the city of Swift Current and many of the city's parks are located along its banks. At one time, there was a supervised swimming area on the creek. Today, swimming, canoeing and fishing are minimal. Such activities are more popular downstream. Low flows of approximately 0.7 m^3/s (August 1987) result in canoes scraping bottom and extensive weed and algae growth. Such flows may be considered as a minimum.

Other instream water users include Ducks Unlimited projects which possess permits but have no allocation because of the nature of these projects. Table 35 summarizes the criteria identified for instream recreational uses in the Swift Current Creek Basin.

Swift Current Creek experiences high nutrient concentrations throughout the year due to the normal low flows and the agricultural nature of the watershed. Algae and aquatic plant densities are higher than those of the mainstem. While water quality in the Swift Current Creek Basin may create some aesthetic concerns, instream water uses are not impaired.

The demand for and value of water-based recreation in the Swift Current Creek Basin for the 1988 summer recreation season was investigated and is documented in SSRBS Technical Report E.17. The only recreational site examined in this study was Lac Pelletier.

The visitation estimates (vehicles and people) are summarized for Lac Pelletier in Table 36 and the visitation by major population centres is identified in Table 37. The number of visitors to Lac Pelletier exceeded visitors at several other parks in the South Saskatchewan River Basin with most of these visitors driving from Swift Current. Only Saskatchewan Landing was a more popular destination for Swift Current residents. Approximately 25 percent of the Swift Current based visitors travelled to Lac Pelletier.

5.2.5 Other Water Uses

A total of 636 dam^3 of water is utilized in the basin for other than municipal, industrial or agricultural purposes. Domestic uses are 45 dam^3 while the Agriculture Canada Research Station in Swift Current utilizes 591 dam^3 annually. This information is summarized in Table 38.

TABLE 35 FLOW CRITERIA IDENTIFIED FOR INSTREAM RECREATIONAL USES IN THE SWIFT CURRENT CREEK BASIN			
	CRITERIA		
	MINIMUM	PREFERRED	MAXIMUM
Swift Current Creek	0.7 m^3/s	–	–
Lac Pelletier Regional Park	828.57 m	828.87 m	<829.04 m
Duncairn Reservoir	803.72 m	–	807.72 m
Highfield Reservoir	–	–	722.99 m

TABLE 36 VISITATION ESTIMATES (VEHICLES AND PEOPLE) FOR LAC PELLETIER REGIONAL PARK								
	COMPLETE SAMPLE*		RESTRICTED SAMPLE** (used in travel cost model)					
			ALL STAYS		1 DAY VISITS		2 + DAY VISITS	
	Vehicles	People	Vehicles	People	Vehicles	People	Vehicles	People
Lac Pelletier	7 250	24 361	7 188	24 153	1 938	6 512	5 250	17 641

* Includes all visitors

** Includes only visitors used for estimation of the travel cost model (i.e. 1 day visitors from over 250 km away are excluded as are all visitors from over 500 km away).

TABLE 37 ESTIMATED VISITATION FROM MAJOR POPULATION CENTRES TO LAC PELLETIER REGIONAL PARK					
PARK	MOOSE JAW	REGINA	SASKATOON	SWIFT CURRENT	TOTAL
Lac Pelletier	375	0	592	21 625	22 000

TABLE 38 WATER USES (1986) OTHER THAN FOR MUNICIPAL, INDUSTRIAL OR AGRICULTURAL PURPOSES		
WATER USER	PURPOSE	WATER USE (dam^3)
Rushlake Creek Below Highfield Reservoir	Domestic	33
Swift Current Creek Between Swift Current Reservoir and Proposed 8B Reservoir	Domestic	7
CDA Research Station	Research	591
Lizard Creek	Domestic	5
		636

5.2.6 Summary

The city of Swift Current is the only municipal water user in the Swift Current Creek Basin withdrawing water from surface sources. The annual city demand has averaged 3 160 dam^3 in recent years. A volume of 5 867 dam^3 is reserved from Duncairn Reservoir to provide for future city growth.

There are no major industrial water users in the Swift Current Creek Basin. SaskWater has allocated 528 dam^3 to four industrial permit holders in the basin but the actual water use is minor and is included in the municipal water use category.

Irrigation is the largest consumer of water in the Swift Current Creek Basin. At the 1986 level of development there were 1 041 irrigation projects with a total irrigated area of 7 600 ha. Approximately 28 200 dam^3 of water are used for irrigation purposes. Irrigation has not been allowed to expand in the last ten years because the existing water supply system is fully utilized.

Other uses of water in the Swift Current Creek Basin include domestic users and the Agriculture Canada Research Station in Swift Current. Their combined water use is 636 dam^3.

Table 39 summarizes the 1986 water use in the Swift Current Creek Basin. The total water use is approximately 32 000 dam^3. Eighty-eight percent of this is used by the irrigation sector and 10 percent is consumed by municipal users. This is shown graphically in Figure 21.

Figure 22 indicates that water use equivalent to the 1986 level of development is approximately 37 percent of the average available supply. Actual water use would have consumed the entire basin natural flow during the driest years on record.

TABLE 39 CURRENT (1986) WATER USE IN THE SWIFT CURRENT CREEK BASIN		
	WATER USED (186)	
USE CATEGORY	dam^3	percent
Municipal	3 160	10
Industrial	0	0
Irrigation	28 219	88
Other	636	2
	32 015	100

Note: Evaporation from four reservoirs and one lake accounts for an additional 33 290 dam^3 each year.

FIGURE 21 CURRENT (1986) WATER USE BY CATEGORY, SWIFT CURRENT CREEK BASIN

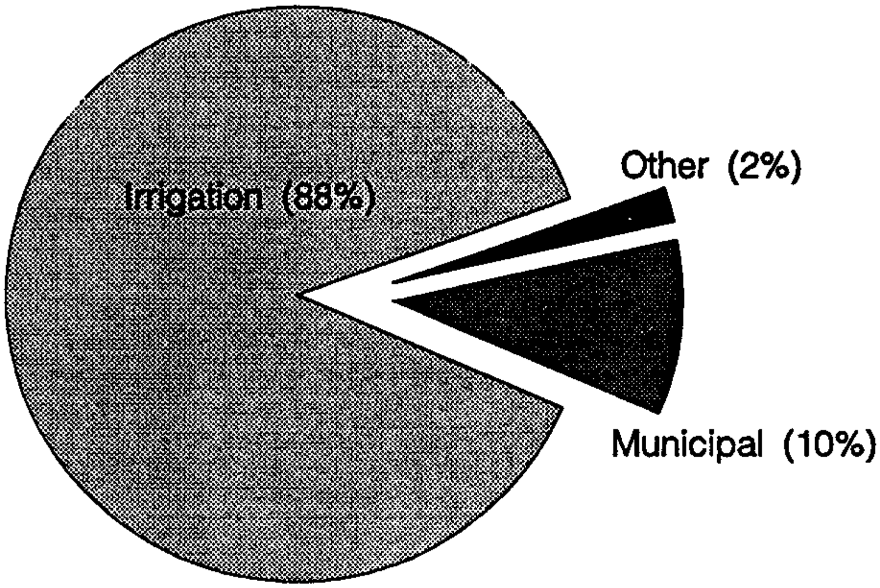
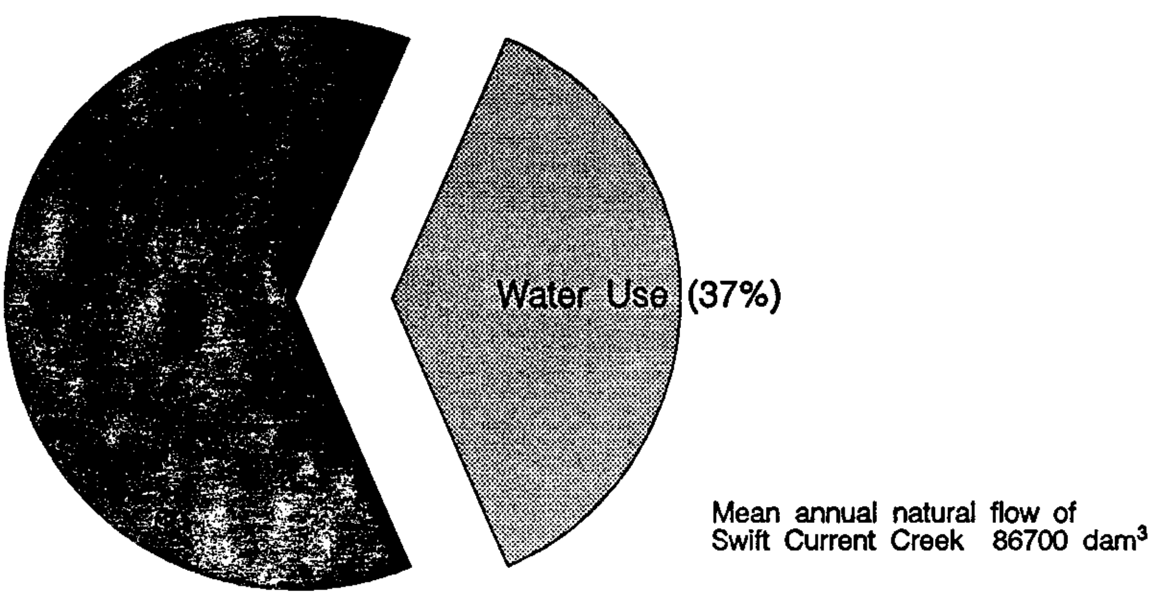


FIGURE 22 CURRENT (1986) WATER USE AS A PERCENTAGE OF AVAILABLE SUPPLY, SWIFT CURRENT CREEK BASIN



6.0 WATER QUALITY AND WASTE ASSIMILATION

6.1 SOUTH SASKATCHEWAN RIVER MAINSTEM

Most communities along the mainstem provide some form of water treatment before water distribution. The most common process is chlorination but other forms of treatment are required by many communities. These include sand and carbon filtration, alum or potassium permanganate treatment, and aeration.

In spite of water treatment 18 communities report some continuing problems with water quality (Table 40). Hardness and/or iron content seem to be the most prevalent problems. In general, these problems are more likely to occur where communities rely on wells as the source of water.

Water quality issues in the mainstem of the river include nutrient enrichment (particularly at the upstream end of Lake Diefenbaker and downstream of Saskatoon), salinity and contaminants, as well as localized issues such as industrial effluents and irrigation return flows. These are discussed in detail in the South Saskatchewan River Basin Study Water Quality Technical Appendix. In general, water quality parameters along the mainstem are within acceptable standards for all municipal uses.

Fifty-five communities in the mainstem drainage of the South Saskatchewan River have wastewater treatment facilities (Table 41). Forty-nine of these utilize a lagoon system for sewage treatment. Eleven of these communities discharge either directly to the South Saskatchewan River or via a tributary; three other communities discharge effluent directly to Lake Diefenbaker. All the effluent from the treatment plant in Saskatoon is discharged into the river. Saskatoon is upgrading the treatment facility in order to meet the standards set by Saskatchewan Environment and Public Safety. Five communities use their wastewater for irrigation.

The volume of wastewater returned to the South Saskatchewan River for most communities is very small. For the city of Saskatoon, however, it is estimated that approximately 68 percent of water withdrawn by the water treatment plant is returned directly to the South Saskatchewan River via their water treatment plant (Table 4). A minimum mean daily flow of 42.5 m^3/s is available in the South Saskatchewan River for effluent dilution purposes at Saskatoon and instream water uses.

The percentage of return flow for Outlook is comparable to Saskatoon. Quantification of the volume of return flow effectively returned to the river for reuse from communities which discharge to tributaries of the South Saskatchewan River or ditches is difficult due to problems estimating physical parameters such as soil moisture content and evaporation losses. Small communities generally release wastewater from lagoons in the spring and fall for only a few days at a time. Most of the discharged effluent will infiltrate into the dry ditch. However, some of this water may recharge underlying aquifers.

Of all the communities discharging wastewater into the South Saskatchewan River, Saskatoon represents the most significant contributor. A series of studies have been conducted by the city of Saskatoon in order to assess the impacts of the effluent plume from the wastewater treatment plant.

Effluent is discharged at the centre of the channel from Saskatoon's sewage treatment plant through an outlet. The effluent forms a plume which dilutes by mixing with the flowing river waters. Depending on river flow conditions (i.e. discharge, open water versus ice covered, riverbed conditions) the location at which the plume reaches the bank may vary. For example, one study indicated that under open water conditions and a discharge of 49 m^3/s, the location of the plume's intersection with the bank was approximately 13 km downstream with complete mixing occurring by 22 km. These distances would be reduced under ice cover.

Because of the importance of Lake Diefenbaker to water management in the prairies, water quality of the lake has been closely monitored by provincial and federal agencies. Of particular interest are the level of nutrients, salinity, water temperature, dissolved oxygen and fecal coliform densities.

The concentration of nutrients in Lake Diefenbaker is low but nutrient levels are consistently higher in the shallower upstream locations than in deeper water areas. Total phosphorus and nitrogen concentrations peak in the spring in association with local runoff, and peak again in association with mountain runoff. Limiting the phosphorus load to the lake will be required to maintain the present status of the lake and to avoid undesirable enriched conditions.

The salinity of the lake is relatively constant from Leader to Outlook. The ion concentrations are well below guidelines and objectives for all water uses.

Water temperature has been observed to decrease with depth during July and August but no distinct thermoclines have been observed. Dissolved oxygen concentrations are usually high and uniform with depth.

TABLE 40 WATER QUALITY PROBLEMS OF MUNICIPAL WATER DISTRIBUTION SYSTEMS (EXCLUDING SWIFT CURRENT CREEK AND SSEWS SYSTEM)					
	WATER QUALITY PROBLEMS				
COMMUNITY	ODOUR	TASTE	TURBIDITY	HARDNESS	MINERALS
UPSTREAM OF LAKE DIEFENBAKER					
Abbey					
Alsask					
Burstall (Wells)			X		
Eston	X	X			
Kindersley					
Lanier (Wells)				X	X
Leader					
Marengo					
Prelate					
Sceptre (Wells)			X	X	X
LAKE DIEFENBAKER AREA					
Beechy (Wells)				X	
Cabri	X	X			
Demaine					
Elbow					
Loreburn					
Lucky Lake (Wells)	X	X			
Pennant					
Riverhurst					
White Bear					
DOWNSTREAM OF LAKE DIEFENBAKER					
Aberdeen					
Allan					
Alvena					
Birsay	X	X			
Bradwell					
Clavet					
Conquest					
Cudworth (Wells)				X	X
Dalmeny					

TABLE 40 WATER QUALITY PROBLEMS OF MUNICIPAL WATER DISTRIBUTION SYSTEMS (EXCLUDING SWIFT CURRENT CREEK AND SSEWS SYSTEM)					
	WATER QUALITY PROBLEMS				
COMMUNITY	ODOUR	TASTE	TURBIDITY	HARDNESS	MINERALS
Domremy					
Duck Lake (Wells)					X
Dundurn					
Elston (Wells)					X
Flaxcombe					
Glenside					
Hagen			X		
Hague (Spring)			X	X	
Hawarden					
Hoey					
Kenaston					
Laporte (Wells)					X
Macrorie					
Martensville					
Osler					
Outlook					
Prudhomme (Wells)				X	
Blucher (RM)					
Rosthern					
Saskatoon					
St. Isidore	X	X			
St. Louis					
Vanscoy					
Vonda (Wells)				X	
Wakaw (Wells)				X	X
Waldheim (Wells)				X	X
Warman					
	5	5	4	9	8

Source: SSRBS Technical Report E.3

TABLE 41 WASTEWATER TREATMENT FACILITIES FOR COMMUNITIES ALONG THE MAINSTEM (EXCLUDING SWIFT CURRENT CREEK AND SSEWS SYSTEM)

COMMUNITY	TYPE OF SEWAGE TREATMENT	METHOD OF EFFLUENT DISPOSAL
UPSTREAM OF LAKE DIEFENBAKER		
Abbey	Lagoon	local drainage
Alsask	Lagoon	local drainage
Burstall	Lagoon	local drainage
Eston	Lagoon	local drainage
Lancer	Lagoon	local drainage
Leader	Lagoon	local drainage
Marengo	Lagoon	local drainage
Prelate	Lagoon	local drainage
Sceptre	Lagoon	no discharge
LAKE DIEFENBAKER AREA		
Beechy	Lagoon	local drainage
Cabri	Lagoon	to Lake Diefenbaker
Demaine	Septic Tank	local drainage
Elbow	Lagoon	to Lake Diefenbaker
Loreburn	Lagoon	local drainage
Lucky Lake	Lagoon	local drainage
Pennant	Lagoon	local drainage
Riverhurst	Lagoon	to Lake Diefenbaker
White Bear	Lagoon	local drainage
DOWNSTREAM OF LAKE DIEFENBAKER		
Aberdeen	Lagoon	local drainage
Allan	Lagoon	local drainage
Alvena	Lagoon	local drainage
Birch Hills	Lagoon	tributary to South Saskatchewan River
Birsay	Septic Tank	local drainage
Bradwell	Lagoon	local drainage
Clavet	Lagoon	local drainage
Conquest	Lagoon	tributary to South Saskatchewan River
Cudworth	Lagoon	local drainage

TABLE 41	WASTEWATER TREATMENT FACILITIES FOR COMMUNITIES ALONG THE MAINSTEM (EXCLUDING SWIFT CURRENT CREEK AND SSEWS SYSTEM)	
COMMUNITY	TYPE OF SEWAGE TREATMENT	METHOD OF EFFLUENT DISPOSAL
Dalmeny	Lagoon	irrigation
Domremy	Lagoon	local drainage
Duck Lake	Lagoon	local drainage
Dundurn	Lagoon	Beaver Creek
Elston	Lagoon	local drainage
Flaxcombe	Lagoon	local drainage
Glenside	Lagoon	local drainage
Hagen	Lagoon	local drainage
Hague	Lagoon	tributary to South Saskatchewan River
Hawarden	Lagoon	local drainage
Hoey	Septic Tank	local drainage
Kenaston	Lagoon	tributary to Beaver Creek
Laporte	Septic Tank	local drainage
Macrorie	Lagoon	local drainage
Martensville	Lagoon	to South Saskatchewan River/irrigation
Osler	Lagoon	irrigation
Outlook	Lagoon	to South Saskatchewan River
Prudhomme	Lagoon	local drainage
Blucher (RM)	Lagoon	to South Saskatchewan River
Rosthern	Lagoon	tributary to South Saskatchewan River/ irrigation
Saskatoon	Primary	to South Saskatchewan River
St. Isidore	Lagoon	local drainage
St. Louis	Septic Tank	to South Saskatchewan River
Vanscoy	Lagoon	local drainage
Vonda	Lagoon	local drainage
Wakaw	Lagoon	local drainage
Waldheim	Lagoon	local drainage
Warman	Lagoon	to South Saskatchewan River/irrigation

Mean total and fecal coliform densities in the off-shore areas of the lake are low, meeting provincial objectives for contact and non-contact recreation most of the time. Fecal coliform levels exceed provincial objectives near Saskatchewan Landing and Coteau beaches on an occasional basis, indicating localized contamination possibly due to suspension of bottom sediments or from livestock or human-related activities.

6.2 SASKATOON SOUTHEAST WATER SUPPLY (SSEWS) SYSTEM

All communities utilizing water from the SSEWS system chlorinate their water supply. Carbon filtration is also common. In spite of water treatment, however, five of the seven communities experience water quality problems. Odour and taste problems are most common (Table 42). Problems with turbidity and mineral content also occur.

Water quality issues in the SSEWS system include salinity and nutrient enrichment. The nutrient levels of the SSEWS system reservoirs increase with distance away from Lake Diefenbaker. High occurrences of algae are observed in Bradwell, Zelma and Dellwood reservoirs.

The concentration of total dissolved solids (TDS) which provides a measure of salinity also increases with distance from the source. For example, values for Bradwell and Zelma reservoirs approach municipal drinking water objectives. The highest concentration of sulphates occurs at Bradwell Reservoir. Water from the reservoir is not suitable for drinking. Zelma Reservoir, which also has high sulphate concentrations, is marginal as a drinking water supply.

Annual and seasonal variations in total dissolved solids levels are also common. The least variation (best quality) is in Broderick and Brightwater reservoirs. Being close to Lake Diefenbaker, a relatively rapid flushing rate during the May to October release and low evaporative losses relative to inflows result in total dissolved solids levels similar to those in Lake Diefenbaker. Dellwood Reservoir at the end of the system exhibits the greatest annual and seasonal variability in total dissolved solids. Most reservoirs exhibit a significant increase in total dissolved solids during the formation of the ice in winter.

Data for Brightwater, Bradwell, Blackstrap and Dellwood reservoirs indicate that fecal coliforms do not present a problem. Alkalinity is only slightly higher in the SSEWS system than in the mainstem. Dissolved oxygen levels vary considerably in the reservoirs. Levels have been observed for Brightwater and Bradwell reservoirs which are below the level required to protect aquatic life.

A more complete discussion of water quality issues may be found in the South Saskatchewan River Basin Study Water Quality Technical Appendix.

All seven communities in the SSEWS system utilize a lagoon system for treating sewage (Table 43). These lagoons are drained periodically but only Hanley discharges back to the river (via Beaver Creek). No data are available on the quantity of return flow.

6.3 SWIFT CURRENT CREEK

While no significant water quality issues exist for the Swift Current Creek Basin, the natural water quality of surface waters is generally lower than water in the mainstem of the South Saskatchewan River. This reflects the lower flows, small basin size and the agricultural nature of the watershed. For example, high nutrient concentrations are common, particularly during summer months. Values of total dissolved solids (TDS) are sufficiently high during summer months to adversely affect irrigation of non-tolerant crops. Values of total dissolved solids increase substantially during the winter. Alkalinity is slightly higher in Swift Current Creek than in the mainstem. Dissolved oxygen levels have been observed to fall below the guideline to protect aquatic life.

Most of the communities in the Swift Current Creek Basin provide some form of water treatment prior to water distribution. Chlorination and manganese greensand filtration are most common. The city of Swift Current also uses carbon filtration, alum, coagulation and fluoridation (SSRBS Technical Report E.5). Perhaps because of this treatment no water quality problems have occurred (Table 44). Shaunavon has problems with high alkalinity, Waldeck with high sodium concentrations and Webb with hardness.

Table 45 identifies the sewage treatment and effluent disposal methods for the five communities in the Swift Current Creek Basin. The smaller communities utilize lagoon systems. Drainage from Shaunavon and Stewart Valley returns to Swift Current Creek but the quantities of return flow are unknown. The city of Swift Current utilizes tertiary treatment and disposes of the effluent through irrigation. This is one of six communities in the South Saskatchewan River which disposes of its effluent through irrigation.

TABLE 42	WATER QUALITY PROBLEMS OF MUNICIPAL WATER DISTRIBUTION SYSTEM IN THE SSEWS SYSTEM				
	WATER QUALITY PROBLEMS				
COMMUNITY	ODOUR	TASTE	TURBIDITY	HARDNESS	MINERALS
Broderick					
Guernsey	X	X			
Hanley			X		X
Lanigan					
Sheilds & Thode	X	X			
Viscount					X

Source: SSRBS Technical Report E.3

TABLE 43	WASTEWATER TREATMENT FACILITIES FOR COMMUNITIES ALONG THE SSEWS SYSTEM	
COMMUNITY	TYPE OF SEWAGE TREATMENT	METHOD OF EFFLUENT DISPOSAL
Broderick	Lagoon	Local drainage
Guernsey	Lagoon	Local drainage
Hanley	Lagoon	Beaver Creek/South Saskatchewan River
Lanigan	Lagoon	Local drainage
Sheilds & Thode	Lagoon	Local drainage
Viscount	Lagoon	Local drainage

TABLE 44	MUNICIPAL WATER QUALITY PROBLEMS FOR COMMUNITIES IN THE SWIFT CURRENT CREEK BASIN				
	WATER QUALITY PROBLEMS				
COMMUNITY	ODOUR	TASTE	TURBIDITY	HARDNESS	MINERALS
Shaunavon					X
Stewart Valley					
Swift Current					
Waldeck					X
Webb				X	

Source: SSRBS Technical Report E.3

TABLE 45	COMMUNITIES WITH WASTEWATER TREATMENT FACILITIES WITHIN THE SWIFT CURRENT CREEK BASIN	
COMMUNITY	TYPE OF SEWAGE TREATMENT	METHOD OF EFFLUENT DISPOSAL
Shaunavon	Lagoon	to Rock Creek
Stewart Valley	Lagoon	to Swift Current Creek
Swift Current	Tertiary	Irrigation
Waldeck	Lagoon	Local drainage
Webb	Lagoon	Local drainage

7.0 SUMMARY OF CURRENT BASIN WATER USES

Table 46 summarizes the water uses at the 1986 level of development for the South Saskatchewan River Basin in Saskatchewan. It can be seen that utilization of available water within the South Saskatchewan River in Saskatchewan is primarily for irrigation purposes. Over three times as much water is used for this purpose compared to municipal uses. Industrial uses are very small and account for approximately 10 percent of the total water use. Evaporation from reservoirs is approximately equal to the total used for municipal, industrial and irrigation purposes.

In terms of utilization geographically, the mainstem uses account for about half of the total use. The SSEWS system accounts for about one quarter of the total.

Water use for the Saskatchewan portion of the basin is very small, accounting for about 4 percent of the mean annual natural flow. Evaporative losses in the basin consume an additional 3 percent of the flow of the South Saskatchewan River in Saskatchewan.

Water required for recreation, transportation and hydro-electric generation represent very important non-consumptive uses in the basin. Various conditions of river flow and river and reservoir depth are required to optimize these uses.

Water quality, particularly along the South Saskatchewan River mainstem, is generally excellent for all uses. Some problems do arise, however, during periods of low flows. Water quality along the SSEWS system canal and reservoir network is less than optimum from time to time for a variety of uses such as municipal and irrigation. Water quality is also a concern in the Swift Current Creek Basin. Various water treatment processes are required for municipal water uses, particularly for communities which rely predominantly on groundwater resources. Water-contact recreation and irrigation of certain crops are adversely affected periodically by poor water quality in parts of the Swift Current Creek valley.

TABLE 46

SUMMARY OF WATER USES (1986)
FOR THE SOUTH SASKATCHEWAN RIVER BASIN IN SASKATCHEWAN

	MUNICIPAL		INDUSTRIAL		IRRIGATION		OTHER		TOTAL	
	dam^3	percent	dam^3	percent	dam^3	percent	dam^3	percent	dam^3	percent
Mainstem	43 300	12.3	3 200	0.9	120 100	34.2	1 800	0.5	168 400	47.9
SSEWS	500	0.1	2 680	0.8	91 400	26.1	-	-	94 580	27.0
Swift Current Creek	3 160	0.9	-	-	28 200	8.0	640	0.2	3 200	9.1
Qu'Appelle River System	26 700	7.6	29 100	8.4	-	-	-	-	55 800	16.0
TOTAL	73 660	20.9	34 980	10.1	239 700	68.3	2 440	0.7	350 780	100.0

Note: Actual use for Industrial dam^3 includes industrial, irrigation and recreation purposes.
Evaporation from reservoirs accounts for an additional 295 840 dam^3 each year.

8.0 WATER USE FORECASTS

8.1 INTRODUCTION

The previous chapters detail the current water uses in the study area. In order to evaluate the management of the water resource in the future, estimates of the potential future uses of the resource were required. As detailed in the South Saskatchewan River Basin Study Framework Plan Technical Appendix, two planning horizons were evaluated. The short-term planning horizon considered the decade after completion of this study ending in the year 2000. In this period developments which were under construction and planned at the time of the study can be expected to be completed and fully operational. The long-term planning horizon provides for a period of several decades after the study is completed to the year 2020. In this time frame substantial new infrastructure could be developed to use the water beyond the current situation.

Although specific years have been assigned to these planning horizons, it would be unrealistic to assume that any forecast can precisely project how much water will be used in a specific year. Rather, the forecasts should be considered to be an indication of average water use that might be anticipated around the turn of the century and about two decades into the new century.

8.2 FORECAST METHODS

A first step in the analysis was to develop an overview of the economic structure and trends in the study area. Sauve (1988) provided a review in SSRBS Technical Report E.9 of the historical trends of population, agriculture and industry and provided forecasts of the potential trends into the next few decades. Population trends appeared to provide consistent results but, agricultural and industrial trends were found to be extremely variable, reflecting world markets rather than local conditions.

Following this economic overview, short-term water use forecasts for specific key points in the basin for municipal, industrial and irrigation water use were prepared and were documented in SSRBS Technical Report E.14. An integrated water use and economic computer model (WUAM) was used to generate water use forecasts corresponding to theoretical economic growth scenarios and is described in SSRBS Technical Report D.19. It was found that, because the Saskatchewan economy is so dominated by export markets, the economic stimuli of the local economy does not produce significant changes in the water use. The major water users, such as irrigation and potash mines, depend upon national and international influences that a local economic model cannot handle.

The Study Office assimilated this background material, adjusted the data to the study points needed for analysis and to the planning horizons used in the evaluation of management strategies; and developed the trend projections of water use described in this report.

8.2.1 Municipal

In order to understand municipal water use trends, it is useful to understand the underlying components of the water demands. A survey of municipalities in the study area was undertaken in SSRBS Technical Report E.3. An analysis of the municipal water use data to determine the proportion of the demand which arises from the various sectors was undertaken in SSRBS Technical Report E.5. The population trends and the per capita use of water in 30 urban communities in the study area were analyzed in SSRBS Technical Report E.14. Saskatchewan Environment and Public Safety and SaskWater maintain a data base on water use by all municipalities in the province.

The Study Office assembled these data for each of the communities in the study area and developed estimates of the future water requirements based on projected trends. Although municipal water use is one of the most critical uses, after allowance for the 70 percent of the water that is returned to the stream after treatment, the net effect on the total water supply is not large. Therefore, refinements to the estimates such as estimates of high or low growth options were not needed.

8.2.2 Industrial

There are two types of industrial water use in the study area.

Many manufacturing industries are located in the urban centres. Although it might be possible to segregate these industries from the other municipal water uses, it was determined that the per capita consumption and total use data adequately provides for this industrial use.

The second type of industrial water use is for industries which have intakes separate from the urban centres. Within the study area, small industries near urban centres, thermal power generation and potash extraction are the industrial water users with separate intakes.

It was assumed that the future changes in water use by industries near urban centres could be included in the municipal water demand projections. Whether the changes occur in or near the urban centre, the net effect on the water resource is the same.

One thermal power station, the Queen Elizabeth II in Saskatoon, uses the river for cooling water. This station pumps variable amounts of water each year, but virtually all of the water is returned to the river, slightly warmed, after cooling the generation turbines. The heat in the water results in extra evaporation of water per year. There are no plans for change to this use, therefore, it was assumed to remain constant in future years.

There are seven potash mines that obtain their water supply in whole or partly from the study area. A survey of industries to collect data on water use compared to production was carried out in 1988, and is described in SSRBS Technical Report E.10. It was determined that water use varied with production, but not in direct proportion. For the six mines surveyed, the average annual total water use was 5 520 dam^3. Based on regression analysis comparing production to water use it was found that about 2 580 dam^3 per year was base demand and 1 940 dam^3 per year varied with production. The water use coefficient varied from mine to mine depending on the production process. This coefficient ranged from 0.2 to 0.9 cubic metres of water per tonne of potash.

Although a relationship between production and water use was defined, the critical parameter for water use forecasting, future production, is difficult to define. Since virtually all of the product is exported, future demand relates to international factors which cannot be predicted within the context of a regional water management study. Analysis of the historical production and water use suggest that on average there is a modest growth but the variability indicates that the range of potential future demands might be anywhere from a 70 percent drop to a 150 percent increase in the next ten years. Variability might be even greater in the long run.

Since the potash water demand is so dependent on factors beyond the realm of this study, and since the demand is small relative to the total water use, the projection used was based on the average historical use and the average historical growth in water use by this industry.

8.2.3 Irrigation

Irrigation is the largest consumptive user of water in the study area.

Irrigation projects include individual farm projects owned and operated by a single farmer and larger group projects where common works provide water for irrigation of a number of farms.

The water use by irrigation depends on two factors, the area irrigated and the depth of water applied.

The area of irrigation is the variable that is most difficult to forecast. The area will depend to a large extent on the programs of government to assist development and on the prices of commodities which are largely established by international prices and policies.

In the short-term, to the year 2000, the main influences are fairly well established. In the Swift Current Creek Basin, existing irrigation projects are experiencing occasional water shortages and a moratorium on significant new developments has been in place for about a decade. Therefore, it was assumed that no new areas will be added in the short term. Around Lake Diefenbaker where the main opportunities for major growth exist, irrigation projects require major physical works to lift the water from the lake. In the short term the projects that are built or committed at the present time will be utilized. Uptake in these areas was assumed to progress at a rate similar to that experienced on similar projects in the past. Modest growth in area along the SSEWS system, similar to the recent past was assumed.

In the long-term, there could be a wide range of potential irrigated areas. If commodity prices and assistance programs encourage irrigation, it could expand substantially. Without incentives, it could stagnate. Since irrigation is the major water use in the study area, and since its long term role could vary widely, three potential future use levels were evaluated. The low option assumed that no significant increase would occur after the short-term projects are developed. The medium option assumed that the long-term average of past growth trends would continue. The high option was based on the peak rates of growth that have occurred and would correspond to high commodity prices and strong support programs. Most of the growth potential is around Lake Diefenbaker where several potential major projects have been identified. For this area, the irrigation specialists at SaskWater were consulted to generate projections. For the rest of the basin, projections were based on historical trends.

The second factor, the water requirement, varies from year to year with weather conditions but the average value likely only varies slowly with technology. It was assumed that no change in the average water requirement will occur in the short-term. Agricultural and economic research indicates that crop production could be enhanced by increasing the water applied beyond current rates and by utilizing more forage crops might produce greater economic returns. Therefore, it was assumed that, in the long-term, the water requirement will increase modestly.

8.2.4 Qu'Appelle River Diversion

Water is released from Lake Diefenbaker to serve several uses in the Qu'Appelle River Basin. The water provides a reliable municipal supply for the cities of Regina and Moose Jaw, a growing number of small communities and rural domestic needs. Industrial enterprises such as the Kalium Chemicals potash mine and the proposed Saferco fertilizer plant, now under construction, rely on this water. Irrigation along the Qu'Appelle River uses this water. The diversion has also stabilized the level of the series of recreational lakes located along the river.

The diversion to the Qu'Appelle River has varied sharply from year to year because the supply from local runoff is highly variable. For this study, efforts were concentrated on defining the average demand.

The average annual diversion in the mid-1980s was 87 571 dam^3. This water was used for a combination of direct withdrawal demands and for lake stabilization. Since average lake stabilization needs in the future can be expected to be similar to past needs, the changes in the future will result from changes in the municipal, industrial and irrigation requirements.

Municipal demands for Regina, Moose Jaw and the small communities in the area have averaged about 42 000 dam^3 per year and have been growing by about 1 200 dam^3 per year. A portion, about 10 000 dam^3 per year is provided by groundwater at Regina but this source is at its limit so all the growth is expected to come from surface sources.

Industrial water use, independent of the municipal systems, is concentrated at the Kalium Chemicals potash mine which uses about 3 700 dam^3 per year. Developments such as the Saferco fertilizer plant will add to this demand in the future. An allowance for a growth of 300 dam^3 per year in industrial demand was used.

Irrigation use in the Qu'Appelle River Valley is mostly downstream of the municipal effluent discharges where increases in irrigation can take advantage of the reusable, treated effluent. Therefore, a modest growth allowance for new water specifically for irrigation of 100 dam^3 per year was assumed. This water may be needed for irrigation developments upstream of the main effluent return flows.

A total growth of 1 600 dam^3 per year was assumed. This growth may be generous because it ignores the fact that the increased diversion water for municipal use is mostly available through treated sewage effluent to replace water that was diverted in the past for lake level stabilization.

As a check on this rate of growth, a regression analysis on the recorded diversions from 1968 to 1988 versus time and versus the local runoff was calculated. The regression coefficient was 0.83. After adjusting for the variation in the local supply as indicated by recorded flows on Moose Jaw River, it was found that the diversion flow has been rising about 1 950 dam^3 per year with a standard error range of 800 dam^3. This is in reasonable agreement with the 1 600 dam^3 per year estimated from the separate uses.

8.2.5 Other

8.2.5.1 Domestic. Domestic water use by farms in the study area is locally important but the quantity of water used does not affect the total supply. The number of farms has been diminishing which likely balances against increasing living standards to generate insignificant change in the domestic water use.

8.2.5.2 Recreation. Recreation use of the water resource has tended to rise as living standards rise and more people have increasing amounts of leisure time. Recreation use does not usually consume water, it requires acceptable levels and velocities. In some cases, maintaining lake levels for recreation results in greater surface area and losses to evaporation. For this study, these losses have been modelled as system losses rather than losses attributed to a particular use. Since the same areas will generally exist in the future, these losses will continue at similar rates. Therefore projections of consumption attributable to recreation were not developed. Evaluation of future recreation opportunities were based on water levels and flows rather than consumption.

8.2.5.3 Hydro-electric Power Generation. Hydro-electric power generation takes advantage of the energy of falling water without consuming the resource. The demand for energy already greatly exceeds the hydro power generation capabilities of this river. Ninety-five percent of the province's electric energy comes from sources other than the Coteau Creek Generating Station at Gardiner Dam. Future demand is expected to grow. Therefore, any growth in the energy available from hydro power generation will be desirable. The present and future demand could be considered to be unattainable and evaluation of hydro-electric power generation is best related to the amount produced as it displaces other expensive and more environmentally damaging power sources.

8.2.5.4 Fish and Wildlife. Fish take advantage of the water of the study area. Changes to the water resource have generally enhanced the fishery opportunities. The large reservoirs such as Lake Diefenbaker and Duncairn Reservoir form extensive fish habitat that did not formerly exist. The operation of these water bodies can affect their value as fish habitat, but in general, the operations that suit fish also suit other uses. Therefore, fish do not place a major demand on the system and future needs of fish should be met if they continue to receive consideration in the operation and planning of water resource developments.

Waterfowl habitat projects do consume water as a result of evaporation from the water surface of ponds. Most waterfowl projects are developed in conjunction with other water delivery schemes and are a minor water user, often taking advantage of return flows from other users. It has been assumed that this use will be covered in the projections for the uses such as irrigation.

8.3 FORECAST RESULTS

8.3.1 Municipal

Table 47 lists the current and projected water use of the communities in the study area.

8.3.2 Industrial

Potash mines were identified as the industry outside of the urban centres that presently uses significant quantities of water and has the greatest potential for growth. Within the study area, potash mines receive water from various locations on the water system as listed in Table 48.

Since it is not possible to project which mines might expand, it was assumed that industrial water use growth will occur uniformly at each withdrawal point. Table 49 lists the projected growth in industrial water use.

8.3.3 Irrigation

8.3.3.1 Mainstem Upstream of Gardiner Dam. Although there are a few small irrigation projects along the river upstream of Lake Diefenbaker, most of the existing and potential irrigation are at the lake. At present there are 11 800 ha under irrigation in this reach (8 900 ha from the lake and 1 900 ha upstream) using about 37 760 dam^3 of water per year. As a result of projects that have been initiated in the last few years, this area is expected to expand to about 28 360 ha (25 000 ha from the lake and 3 360 ha upstream) and a use of 89 334 dam^3 per year by the year 2000.

TABLE 47	PROJECTED MUNICIPAL WATER USE (dam^3)		
COMMUNITY	YEAR		
	1986	2000	2020
MAINSTEM			
Leader	171	180	200
Cabri	100	100	100
Eston and Kindersley	893	1 020	1 170
Elbow	58	70	85
Outlook	499	590	710
Saskatoon West*	49	62	76
Saskatoon	40 724	52 000	64 000
Saskatoon Treated**	801	1 910	3 380
St. Louis	53	90	130
Subtotal	43 348	56 022	69 851
SSEWS			
Broderick	12	18	20
Hanley	55	70	90
Shields	45	90	190
Thode	20	75	150
Viscount	37	40	40
Guernsey	30	30	30
Lanigan	263	290	340
Subtotal	462	613	860
SWIFT CURRENT CREEK			
Swift Current	3 159	4 200	5 500
Herbert	33	33	33
Subtotal	3 192	4 200	5 500
TOTAL	47 002	60 868	76 244

* Saskatoon West provides water to Vanscoy and urban subdivisions in the R.M. of Corman Park.

** The Saskatoon Treated water pipelines serve Allan, the RM. of Blucher, Bradwell, Clavet, Dalmeny, Martensville, Osler and Warman.

TABLE 48	POTASH MINE INTAKE LOCATIONS
INTAKE LOCATION	MINE
South Saskatchewan River, Saskatoon	PCS-Cory Cominco
Bradwell Reservoir	PCS-Allan
Zelma Reservoir	Central Canada Potash
Dellwood Reservoir	PCS-Lanigan

TABLE 49 PROJECTED INDUSTRIAL WATER USE (dam^3)

INTAKE LOCATION	YEAR		
	1986	2000	2020
South Saskatchewan River, Saskatoon	2 360	3 138	3 490
Bradwell Reservoir	1 418	1 885	2 090
Zelma Reservoir	805	1 070	1 190
Dellwood Reservoir	453	602	670
TOTAL	5 036	6 695	7 440

In the long-term (by the year 2020) the amount of land under irrigation in this reach could vary greatly, depending on assistance programs and commodity prices. If prices remain low and no major projects are initiated, the irrigation area could stagnate at the year 2000 level. If there are high prices and active government assistance programs, the irrigated area might grow to as much as 68 000 ha (64 000 ha from the lake and 4 000 ha upstream). The moderate growth estimate assuming similar programs to the past, indicates that the area might reach about 49 000 ha (45 000 ha from the lake and 4 000 ha upstream). The long-term water requirement could rise if a greater portion of the irrigated area is used for forage and specialty crops. In all case the water requirement was assumed to reach 457 mm in the long term. The water use for the low, moderate and high growth estimates was calculated to be 129 600 dam^3, 224 000 dam^3 and 310 000 dam^3 respectively.

8.3.3.2 Mainstem Downstream of Gardiner Dam. In this reach there are about 4 793 ha under irrigation from the river. These projects use about 13 000 dam^3 per year. Projects under development will increase this to 5 563 ha and a use of about 15 000 dam^3 by the year 2000. The potential for development is limited in this reach. The year 2020 projection included 5 707 ha and a use of about 26 000 dam^3. No projection of high or low development was calculated for this reach.

8.3.3.3 SSEWS System. This system provides water to about 22 400 ha which use about 91 000 dam^3 of water per year. This is expected to grow to about 28 200 ha and 115 000 dam^3 by the year 2000 and to about 32 000 ha and 147 000 dam^3 by the year 2020.

8.3.3.4 Swift Current Creek. Irrigation development in the Swift Current Creek Basin has been stopped for about ten years because the existing system cannot support more area. Therefore, projected growth was assumed to be zero in the short-term. At present 7 618 ha are irrigated, using 28 250 dam^3/year of water when it is available. This rate of use is expected to continue in the short-term. In the long-term, additional irrigation might proceed if additional works to store water were built. The amount of growth would depend on the amount of capital investment. There is substantial demand for added capacity. Since this capital investment cannot be forecast, the long-term forecast was based on the past growth trend. If additional supplies were developed, the area might expand to 8 830 ha, using about 34 000 dam^3/year of water.

8.3.4 Qu'Appelle River

The Qu'Appelle River demand which averaged 87 571 dam^3/year in the 1980s is expected to average 110 000 dam^3/year by the year 2000 and 142 000 dam^3/year by 2020.

8.3.5 Summary of Future Water Use

TABLE 50 SUMMARY OF FUTURE WATER USE (dam^3/year)

USE	YEAR		
	1986	2000	2020
Municipal*	47 002	69 868	76 244
Industrial	5 036	6 695	7 440
Irrigation	170 000	248 000	431 000
Qu'Appelle River System	87 571	110 000	142 000
TOTAL	310 000	426 000	657 000

* Depletion is about 70 percent of these amounts after return flows.
Evaporation will add about 270 000 dam^3 to this water use.

8.4 DEMAND MANAGEMENT

The projections in Table 50 assume that past trends in water use continue. A review of the opportunities for reducing the demand for water through conservation strategies in the South Saskatchewan River Basin were examined in SSRBS Technical Report E.18. Through programs of public education, water pricing and other initiatives, the demand for water could be reduced. Various degrees of reduction in demand could be achieved. For example, the largest consumptive use, irrigation, is currently selling its products at extremely low prices and would not be able to pay any significant price for the water used. At present, irrigators are reluctant to proceed with development while paying only operating costs to deliver water, without paying anything for the intrinsic value of the water or capital costs of dams and reservoirs. Municipal and industrial water users could also reduce water use.

For this study, demand management scenarios which conserve up to 20 percent of the long-term water use were evaluated.

9.0 DEMAND MANAGEMENT

9.1 INTRODUCTION

Water resource development and management on the prairies has traditionally been viewed as a problem of managing a variable supply to meet demands in periods when naturally-available supplies are deficient. This involved substantial public investment in water infrastructure such as dams and canals. It is now recognized, however, as most of the easily developed sources have been tapped, that the traditional supply management concept must be complemented with a demand management approach. This approach to water management attempts to influence the demand patterns which society places upon the resource.

This section briefly reviews the concept of water demand management and particularly how it relates to issues within the South Saskatchewan River Basin in Saskatchewan. Withdrawal uses (municipal, agriculture and industrial) and instream uses (hydro power, waste assimilation, fish and wildlife, recreation and navigation) are discussed in this context. A more thorough treatment of this concept can be found in SSRBS Technical Report E.18.

9.2 WITHDRAWAL WATER USES

9.2.1 Irrigation

Various economic measures can be implemented in the study area to manage the demand for irrigation water. For example, the primary factor determining the amount of irrigation water used is the amount of crop land under irrigation. The most direct way of managing the demand for irrigation water is to manage the development of irrigation lands. From a planning perspective this requires assessing the impact of expanding irrigation development at the possible expense of the reliable supply of water.

Water demands in the basin can also be managed by raising the price of irrigation water. The present modest user pay policies in the basin may foster inefficiencies in applying water to irrigation projects. Increases in the price of water may favour water conservation but a trade-off occurs as a full-cost user pay policy would curtail perhaps all future and present irrigation development. Such an outcome would pose an unacceptable social cost on rural communities in the basin.

A change from a water charge structure based on irrigated acreage to one based on the volume of water used would provide incentives to use water more efficiently if unit charges are based on the marginal cost of supply. Current water charges are based on delivery costs with no charge being levied for the water itself.

A final user-pay policy option involves creating the opportunity for holders of water permits to either buy or sell these permits or to trade in the annual allocations associated with a permit. Trading could be allowed across user groups so that a municipality would, for example, be able to purchase water rights from irrigators. Water could then be reallocated to other uses.

Various technological options exist for improving irrigation water use efficiency. These include improved sprinkler design, lined canals, and pipeline distribution systems. It is important to recognize, however, that if the price for water understates the value of this resource, there is little incentive to adopt more water-efficient devices. Realistic pricing tends to accelerate technological change and action to conserve water.

9.2.2 Industrial and Municipal Water Buyers

Several demand management strategies are available to either SaskWater or water managers (the end user in municipalities is discussed in Section 9.2.3). Industrial users include manufacturing operations, mining interests and special agricultural users such as large feedlots. These users are considered to be wholesale buyers of water and in most cases the operations are managed by SaskWater's Water Supply Utility.

User pay policies and tradeable water rights can act both to promote a more efficient allocation of water resources at the permit-issuing stage and to promote the efficient use of water by permitted users. At the permitting stage, user charges will discourage any applicants who propose uses that have a low value relative to the user charge. For existing permit holders, a charge will provide an incentive to eliminate waste.

A charge at the permitting stage would amount to a fee for an allocation of water. It could be levied directly by SaskWater or it could be the cost of water rights in a system involving tradeable rights. In either case, a significant fee would only make economic sense in a situation in which available supplies in a supply system or in a watershed were fully allocated to instream and off-stream uses. Otherwise, there are surplus supplies which should be free, since there is no benefit to be gained from limiting new water uses.

With tradeable water rights, valuable future uses are not precluded when supplies are fully allocated since new users will have the option of purchasing an allocation from existing users. While there would have to be government oversight of the trading process, the provincial government would avoid the need to make contentious reallocations of water if tradeable rights were in place.

Any conservation policy or program for wholesale and self supplied users can be enhanced by efforts to provide technical advice to users. For example, SaskWater staff should work closely with industrial customers to identify and evaluate conservation options such as new technologies or in-plant house keeping measures; this program would facilitate an effective response by industrial customers and establish goodwill for the conservation program. While engineering and other technical assistance is already provided to towns, villages and rural municipalities when new works are being planned and built, the provision of advice on water conservation to smaller municipalities would be beneficial as these administrative areas do not normally have extensive staff resources to plan or implement conservation programs.

9.2.3 Municipal Water Use

The majority of urban residents in the basin are already subject to a commodity charge for water, so that basic water use metering and a commodity-based rate setting are no longer significant demand management options. It is likely, however, that the existing rate or unit charge levels are so low that many urban consumers are insensitive to their water cost. From an economic perspective, however, it is more important to establish a rate setting which reflects the true costs of water withdrawal from source, treatment and delivery so that consumers obtain complete information on the social cost of water when decisions to use water are made.

In any rate structure it is necessary that water costs be fully accounted for and properly evaluated. This means, for example, that all costs should be considered, including depreciation costs, and that rates should accurately reflect the cost of pending water system expansions. It is possible, using simple economic rules, to set water rates at such a level as to assure economic efficiency, to recover costs, and to convey to users a correct message about the value of water being used. For example, a rate setting system based on marginal cost pricing could be implemented. Marginal cost is simply the cost of producing an extra unit of a commodity or service, in this case, for example, an extra cubic metre of water. The rate structure would include a fixed and a variable component.

All users would pay a volumetric charge based on the marginal cost of supplying water plus a fixed connection charge. The rate schedule will vary between neither customer classes nor individual customers, since the marginal cost of "producing" and delivering water services is essentially the same across all groups.

This marginal cost-based system of rate setting is significantly different from the declining block rate system which is used by most of the communities in the study area. In the declining block system users face lower unit rates in the higher blocks of the rate schedule.

Institutional water conservation measures can include a number of programs designed to promote conservation by means of coercion or persuasion and good will. The program options include:

- water saving device measures (give aways, free installation);
- lawn watering restrictions (odd/even street number programs, time of day restrictions, prohibitions);
- conservation plumbing codes;
- contractor rebates to encourage the installation of conservation fixtures;
- promotion of conservation practices (plumbing repairs, moderate lawn watering, etc.);
- advisory services for industrial users; and
- public information and promotion campaigns (daily water use index, curriculum materials, water bill inserts, etc.)

9.3 INSTREAM WATER USES

Instream water uses comprise a varied number of activities, ranging from those of an industrial nature (e.g. hydro power generation) to those of an environmental nature. The common thread tying these uses together is their reliance on water as it occurs in the watercourse. This contrasts markedly with the withdrawal or off stream uses.

Addressing instream uses in the context of water demand management is a more difficult task than analyzing the withdrawal uses, for various reasons. Measuring many of these uses is often a frustrating exercise. The measurement of supply and demand for water-based recreation is currently poorly defined. Valuation problems are common when dealing with most instream uses. The benefits occurring from many instream uses are widely dispersed across society. In the river basin context, these benefits may occur locally, provincially or even federally. This section briefly discusses some of the general objectives for water demand management in each of the principal instream water use categories.

Several possible demand management measures are available in the hydro power sector. These involve energy conservation and trade-offs between uses.

With respect to energy conservation, clearly, the lower the demand for energy, the lower the demand on the water resource. The benefits of demand management in water (e.g. lowering the need for capital expenditures) also apply to the energy field. In situations of water scarcity, it will become necessary to consider energy conservation measures.

With respect to trade-offs between uses, hydro-electric power generation at the Coteau Creek Generating Station is a major use of Lake Diefenbaker waters. It is treated as a residual use that has access to waters not otherwise allocated. The amount of release is constrained by minimum downstream flow and flood protection requirements, and by reservoir operating rules.

The resource use trade-offs associated with power production include:

- possible conflict with irrigation and other consumptive uses of Lake Diefenbaker water, due to a diminution of flow. (On the other hand, there may be complementarities because, for example, both power and irrigation require substantial storage capacity.);
- impairment of upstream recreation and wildlife uses as water levels get too low during summer months due to reservoir drawdowns;
- enhancement of downstream flood protection and waste assimilation; and
- potential interference with irrigators and ferry boat operations downstream due to rapidly fluctuating flows.

For example, it may be necessary from an economic point of view, to answer such questions as to whether irrigation or power production yields the greater benefit to the public. A decision to shift the current allocation could imply either the need for conservation measures in irrigation, or conversely, a need to use more thermal power or to reduce energy consumption using conservation measures in the field.

In the case of waste assimilation within the study area, demand management approaches to the waste management problem include effluent discharge fees, extra-strength sewer surcharges and marketable effluent permits. The general characteristic of all of these economic instruments is to provide incentives for conserving on waste discharges. Economic instruments for pollution control have not been developed to their full potential any place in Canada. However, a complete program of water demand management should include a consideration of discharge-side management instruments.

The value of water in recreational uses (including the support of fish and wildlife) in the basin is very high, although this is difficult to quantify. A comprehensive water demand management program must include a review of federal and provincial policies that, either directly of indirectly, encourage the destruction of recreational lands of fish and wildlife habitats. The benefits of these policies must be traded off against the value of destroying or damaging these environmental resources.

The application of demand management principles to the navigation sector is even more difficult than for other instream water uses. Like recreation, navigation can, in some respects, be viewed as the beneficiary of demand management with respect to other water use sectors. In the context of commercial navigation, including the use of ferries and tour boat operators, some form of user charge for water might be considered. Given the relatively low value in the basin of this resource use, however, implementing user charges may not be of significant economic merit to consider.

10.0 REFERENCES

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APPENDIX A
SOUTH SASKATCHEWAN RIVER BASIN STUDY
LIST OF TECHNICAL REPORTS

SOUTH SASKATCHEWAN RIVER BASIN STUDY TECHNICAL REPORTS		
TITLE	SSRB TECHNICAL REPORT	DATE
Annual Report to December 31, 1986	A.3	11.87
Annual Report to December 31, 1987	A.4	07.88
Annual Report to December 31, 1988	A.5	05.89
Annual Report to December 31, 1989	A.6	03.90
Compendium of Water Quality Objectives Development Methodologies	D.9	06.88
Contaminant Organic Compounds in the Surface Waters of the South Saskatchewan River Basin	D.4	12.87
Crop Damage and Associated Economic Impact of Flooding, South Saskatchewan River Downstream of Lake Diefenbaker	E.13	12.89
Data Collection and Date Base Development: South Saskatchewan River Basin Recreation Survey	E.1	11.86
The Delphi Report	B.3	08.90
Demand for Water-Based Recreation in the South Saskatchewan River Basin	E.17	08.90
Economic Profile and Trends 1951-1986	E.9	06.88
Erosion and Sedimentation in the South Saskatchewan River Basin	C.9	12.89
Farm-Level Drought Analysis Model	E.15	08.90
Fishery Survey of the South Saskatchewan River and Its Tributaries in Saskatchewan	D.8	11.88
Flood Frequencies in the South Saskatchewan River Basin	C.5	08.88
Flooding Gardiner Dam to the Forks	C.8	10.89
Framework Plan Working Definition	B.1	09.87
Frequency Analysis of Meterological Drought in the Saskatchewan Portion of the South Saskatchewan River Basin	C.4	07.88
Ground Water and the South Saskatchewan River Basin: Recommendations to the Study Board	C.2	03.88
Ground Water Study: South Saskatchewan River Basin	C.2	03.88
Heritage Resources	E.16	08.90
A Hydraulic Study of the South Saskatchewan River	E.12	05.89
Hydro System Simulation (HYDSIM) Model Study Report	C.7	05.89
Hydrologic Drought Analysis of Simulated Flows - South Saskatchewan River Basin	C.6	02.89
Information Base: Surface Water Hydrology and Water Use	E.2	03.87
Instream Water Use: South Saskatchewan River Basin	E.7	12.87
Irrigation Water Use Pilot Study	E.8	04.88
Irrigation Water Use Survey (South Saskatchewan River Basin Study)	E.11	12.88
Lake Diefenbaker Trophic State Model	D.5	01.88
Land Use in the Effective Drainage Area of the South Saskatchewan River Basin	D.2	10.87

SOUTH SASKATCHEWAN RIVER BASIN STUDY TECHNICAL REPORTS		
TITLE	**SSRB TECHNICAL REPORT**	**DATE**
Legal and Administrative Analysis Interim Report	B.2	03.88
Legal and Administrative Summary	B.4	02.91
Low Flow Frequency Analysis for the South Saskatchewan River	C.10	05.91
Major Industrial Water Users in the South Saskatchewan River Basin	E.10	10.88
Mass Loading of Phosphorus to Lake Diefenbaker	D.13	09.89
Municipal and Residential Water Use Study	E.5	08.87
Municipal Water Use Survey	E.3	07.87
Nutrient Quality Review and Objectives Development for the South Saskatchewan River Basin	D.14	01.90
Phosphorus Loading from Non-Point Sources Relevant to the Lake Diefenbaker Basin	D.1	09.87
Proposed Water Quality Objectives for the South Saskatchewan River Basin	D.12	08.89
Public Involvement Program Position Paper	F.1	10.86
Public Opinion Survey, 1988 Survey Design	F.2	03.88
Recreational Data Analysis Report South Saskatchewan River Basin	E.4	07.87
Reservoir Salinity Model: Application to the Saskatoon Southeast Water Supply System	D.16	05.90
Reservoir Salinity Study Phase 1	D.7	10.88
Short-term Water Use Forecast South Saskatchewan River Basin Study	E.14	12.89
Study Plan and Annual Work Plans - 1987	A.2	02.87
Study Proposal for the South Saskatchewan River Basin	A.1	04.86
Style Guides for Reports	A.7	03.90
Summary and Evaluation of the Public Information and Awareness Strategy	F.3	09.89
Summary and Evaluation of the Public Information and Awareness Strategy, April 1990	F.4	04.90
Summary and Evaluation of the Public Information and Awareness Strategy, November 1990	F.5	12.90
Water Demand Management: An Application to the South Saskatchewan River Basin	E.18	08.90
Water Intake and Outfall Survey South Saskatchewan River Basin	E.6	12.87
Water Management Model Study South Saskatchewan River Basin	C.1	01.88
Water Quality Data Review	D.6	03.88
Water Quality Modelling South Saskatchewan River	D.10	04.89
Water Quality Monitoring Plan for the South Saskatchewan River Basin	D.15	04.90
Water Quality Monitoring Review South Saskatchewan River Basin	D.11	06.89
Water Quality Trend Analysis and Data Base Summary	D.3	11.87
Water Use Analysis Model Study: South Saskatchewan River Basin Study	D.19	05.91