CANADA-SASKATCHEWAN
SOUTH SASKATCHEWAN RIVER BASIN STUDY

TECHNICAL APPENDIX II

RESOURCE ASSESSMENT

A. WATER QUANTITY

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1.0 INTRODUCTION

1.1 THE SOUTH SASKATCHEWAN RIVER BASIN STUDY

The results of the Canada-Saskatchewan South Saskatchewan River Basin Study (SSRBS) are documented in a series of reports. The final report provides a summary of the findings in a form suitable for use by the general public. The final report is supported by seven technical appendices: Issues Documentation, Water Quantity, Water Quality, Water Use, Environment, Water Management and The Framework Plan. The technical appendices provide sufficient detail for use by water management professionals. The technical appendices are based on detailed studies reported in more than 60 technical reports prepared for the basin study and various reports on the study area prepared for other purposes. A complete list of the technical reports has been included in Appendix A of this report.

This technical appendix, "WATER QUANTITY", documents the magnitude and variability of the water supply and flood flows of the Saskatchewan portion of the South Saskatchewan River Basin. In order to provide some context for this report, sections have been included on the background to the study and on the water resources of the study area.

1.2 STUDY BACKGROUND

The South Saskatchewan River is the most reliable supply of good quality water in the southern half of Saskatchewan. It contributes significantly to the social and economic well-being of the people of the region. During the early 1980s, several events led to increasing concern about the ability of the river to meet future needs.

The water resources of the South Saskatchewan River are intensively used by Alberta. Alberta irrigates more than a half million hectares of land in its portion of the basin. During the mid-1980s, Alberta completed a planning study which identified a range of future development options. Several of the options provided for significant expansion of irrigation which would further reduce the amount of water passed to Saskatchewan.

Since its joint development by the federal and provincial governments more than 20 years ago, Lake Diefenbaker has become a focus for development in the Saskatchewan portion of the basin. This multi-purpose reservoir supports irrigation, hydro-electric energy generation, recreation, industrial and municipal water supply. In Saskatchewan, plans were also laid during the 1980s for further development based on the water resources of the South Saskatchewan River, particularly Lake Diefenbaker.

These plans included significant irrigation development. At the same time, proposals were made to further develop the recreation potential of the reservoir. Such developments would place additional demands on the water resources of the South Saskatchewan River.

While further development was being considered for the South Saskatchewan River Basin in both Alberta and Saskatchewan, there were several drought years in the 1980s. The droughts led to increased demand for water while the supply was reduced. In Saskatchewan, this caused problems for most water uses. There was concern regarding the ability of Lake Diefenbaker to support continued development. Weed growth at the upstream end of Lake Diefenbaker also led to concerns that the high quality water in Lake Diefenbaker was at risk.

The possibility of increased development, coupled with a reduced supply, led to greater concern about diverting water from the basin. Prior to the study, there had been a number of options identified for increased diversion of water from the South Saskatchewan River. However, when such diversions were identified, existing users expressed concern about the possible impacts. There was a clear need to determine the importance of the water in the basin to existing and future users.

The Canada-Saskatchewan South Saskatchewan River Basin Study was undertaken to provide information to guide water management. It will help ensure that the water resources of the basin can meet the needs of existing and future users.

1.2.1 The Study Agreement

On May 16, 1986, Federal Environment Minister Tom McMillan and Minister Responsible for Sask Water, Eric Berntson, signed the Canada-Saskatchewan South Saskatchewan River Basin Study Agreement. The agreement set aside 1.6 million dollars for the study with expenses shared equally by Sask Water and Environment Canada. The agreement established policies and procedures for a study of the Saskatchewan portion of the South Saskatchewan River Basin.

The Agreement identified three objectives for the study:

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

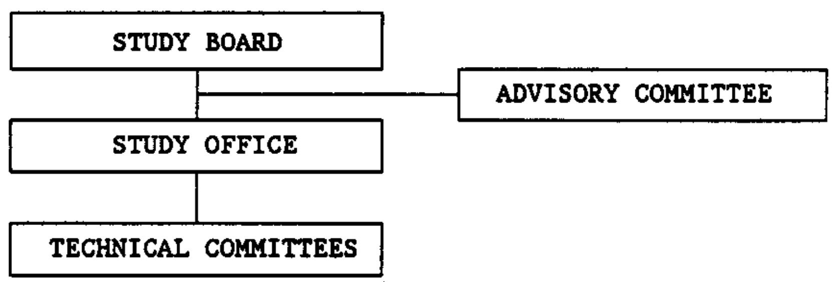
(b) "carry out an assessment of the water and related resources of the South Saskatchewan River Basin, and their current and future use;

(c) "develop a framework plan for the conservation and management of the water in the South Saskatchewan River Basin in Saskatchewan which allows for the evaluation of water resource projects."

1.2.2 Study Organization

The South Saskatchewan River Basin Study Board was responsible for the completion of the study. The board had one representative from each of the two sponsoring agencies: Environment Canada and Sask Water.

STUDY ORGANIZATION



An advisory committee provided policy information to the study board. Senior officials, representing agencies with water management responsibilities or interests in the basin, made up the advisory committee.

The study board set up the South Saskatchewan River Basin Study Office and staffed it with a director, assistant director and secretary. The director was responsible to the study board for the day-to-day administration of the study.

Technical committees assisted the study office. Representatives for the committees were drawn from agencies with responsibilities for water management. The agencies included federal and provincial departments, crown corporations and municipalities.

The technical committees provided the study office with expert advice on water quantity, water quality, water use and public involvement. A management strategies technical committee was responsible for drawing together the information produced by the other technical committees and identifying management options.

The technical committees also helped develop terms of reference for work carried out by consultants. More than 20 different consultants participated in the study. The consultants played a role in compiling the basic information needed to carry out the study.

PARTICIPATING AGENCIES

Environment Canada
SaskWater

Agriculture Canada
  Agri-Food Development Branch
  Prairie Farm Rehabilitation Administration
Western Economic Diversification

Saskatchewan Environment and Public Safety
Saskatchewan Parks and Renewable Resources
Saskatchewan Culture, Multiculturalism and Recreation
Saskatchewan Rural Development
Saskatchewan Agriculture and Food

SaskPower
City of Saskatoon
Meewasin Valley Authority

1.2.3 Planning Process

Early in the study, the study board defined the planning process and eight planning principles. These principles guided the study.

THE PLANNING PROCESS

establish goals and objectives
↓
identify issues
↓
assess the resource
↓
identify management strategies
↓
evaluate management strategies
↓
develop recommendations and prepare the framework plan

PLANNING PRINCIPLES

THE WISE AND EFFICIENT MANAGEMENT AND USE OF WATER SHOULD BE PROMOTED THROUGH ALL POSSIBLE MEANS.

THE ECOLOGICAL INTEGRITY OF WATER RESOURCE SYSTEMS SHOULD BE MAINTAINED.

PUBLIC INVOLVEMENT IS ESSENTIAL FOR THE STUDY TO ACHIEVE ITS OBJECTIVES.

ALL WATER USES THAT HAVE SOCIAL, ECONOMIC OR ENVIRONMENTAL VALUE SHOULD BE CONSIDERED.

DOMESTIC WATER USE SHOULD BE THE HIGHEST PRIORITY AMONG ALL USES.

THE WATER RESOURCES OF THE BASIN SHOULD BE MANAGED FOR THE BENEFIT OF ALL PEOPLE IN THE PROVINCE.

WATER RESOURCES SHOULD BE DEVELOPED AND MANAGED CONSISTENT WITH THE CONCEPT OF SUSTAINABLE DEVELOPMENT.

INTERPROVINCIAL SHARING OF WATER IS BASED ON THE MASTER AGREEMENT ON APPORTIONMENT.

The planning process included the use of a base year as the reference point for the analysis of future conditions. The base year for the South Saskatchewan River Basin Study was 1986 – the year the study began.

There were three separate planning exercises undertaken. They related to three different time horizons. The short-term planning exercise focused on the year 2000 and dealt with water management issues in the basin. The long-term planning exercise looked at the year 2020 and established a range of development options. The third and final planning exercise was the system-limit. It helped put the long-term planning exercise in perspective by identifying the development limits of the basin.

There are three main components to the study area: Mainstem South Saskatchewan River, Saskatoon Southeast Water Supply (SSEWS) system and Swift Current Creek. Although water management in these components is interrelated, the interrelationships are minor. Therefore most aspects or the study considered each component separately. The Mainstem includes the South Saskatchewan River from the Alberta border to the confluence with the North Saskatchewan at the downstream end of the study area. Lake Diefenbaker is included in the Mainstem component. The effects of actions on this mainstem area on the Saskatchewan River downstream of the study are were also considered in the mainstem section of the report. For this study, the SSEWS system was considered to include all of the works downstream of the East Side Pump Station near Gardiner Dam on Lake Diefenbaker. The Swift Current Creek Basin includes the Rushlake Creek basin.

1.3 SYSTEM DESCRIPTION

The following is a brief introduction to the water resources of the study area. More details are provided in the body of this report and in the other reports of this series.

1.3.1 Mainstem

The South Saskatchewan River rises in southern Alberta where it receives runoff from about 120 000 km^2 of drainage area. A portion of this drainage basin is located on the eastern slopes of the Rocky Mountains and foothills. This portion is a highly productive runoff area, producing virtually all of the flow received at the Alberta - Saskatchewan border where the average annual natural flow is 9 200 000 dam^3. This natural flow has ranged from lows of about 4 800 000 dam^3 in dry years to 16 000 000 dam^3 in wet years. On average, about two-thirds of the runoff occurs in the May to August period and less than 10 percent occurs in the December to March period.

In Alberta the water is used for irrigation, municipal, industrial, hydro-electric, fish, wildlife and recreation uses. On average, the flow is reduced by about 1 900 000 dam^3 per year, with irrigation taking about 95 percent of the water.

In Saskatchewan the river flows through a region of very low runoff. On average, the local runoff augments the natural flow by about two percent with half of this local flow originating in Swift Current Creek. Figure 1 shows the drainage area in Saskatchewan.

The largest water uses in Saskatchewan are centred around Lake Diefenbaker and the city of Saskatoon. Total water consumption averages about 500 000 dam^3 per year. Evaporation from Lake Diefenbaker accounts for about half of this total, irrigation is the second largest user and municipal and industrial users take a relatively small portion of the flow. Although less than 10 percent of the water is consumed, the remaining water is used for important instream purposes, including hydro-electric generation, recreation and fish and wildlife.

Downstream of the study area the South Saskatchewan River joins the North Saskatchewan River and their combined flow continues east as the Saskatchewan River. Within Saskatchewan the flow is used to generate electric energy at the Nipawin and E. B. Campbell Power Stations. Downstream of the Saskatchewan - Manitoba border, the Grand Rapids Power Station uses the river before the water discharges to Lake Winnipeg. At Lake Winnipeg the water joins other flows from the south and east as it flows down the Nelson River to Hudson Bay. Along the Nelson River, there are additional power stations. In addition to the power stations the rivers downstream of the study area serve as local transportation routes, provide habitat for fish and wildlife and serve the water supply needs of several communities.

The quality of the water in the mainstem is very good, meeting the requirements of all of the existing and projected users. Upstream of Lake Diefenbaker the quality varies from season to season with the rate of flow but in the lake the seasonal variations are mixed, producing a very uniform quality downstream. Within the study area the greatest pollution threat arises from municipal and industrial effluents in the Saskatoon area where effluent treatment requirements are regularly under review.

1.3.2 SSEWS System

The SSEWS is a manmade water delivery system which draws water from Lake Diefenbaker and delivers it to an area northeast of the lake as far as Lanigan as shown on Figure 2. The major uses of the water are irrigation, industries, municipalities, recreation and wildlife. The largest irrigation project is the South Saskatchewan River Irrigation District which serves over 16 000 ha. Potash mines are the main industrial users.

The quality of the water at the upstream end of this system is equal to the mainstem, since it is drawn from Lake Diefenbaker. As the water moves downstream in the system, local surface and ground water inflows of less desirable quality are added and evaporation concentrates impurities resulting in a lower quality of water. The quality is satisfactory for the uses made of it, but is less than ideal.

1.3.3 Swift Current Creek

Swift Current Creek is the largest tributary to the mainstem in Saskatchewan. This creek drains a portion of the Cypress Hills as shown on Figure 3. The average natural flow is about 80 000 dam^3 and the annual flow ranges from about 20 000 dam^3 to 265 000 dam^3.

Swift Current Creek water is used for irrigation and as a source of supply for municipal water at the city of Swift Current and the town of Herbert. The irrigation and municipal systems rely on Duncairn Reservoir for flow regulation to overcome natural periods of low flow. The water supply system from Swift Current Creek extends to areas of the neighbouring Rushlake Creek Basin. In addition to the consumptive water uses, the water of this creek is used for recreation, fish and wildlife. Although the quality of the water in this area is not as good as that in the mainstem, it has been satisfactory for the current uses.

FIGURE 1 THE STUDY AREA

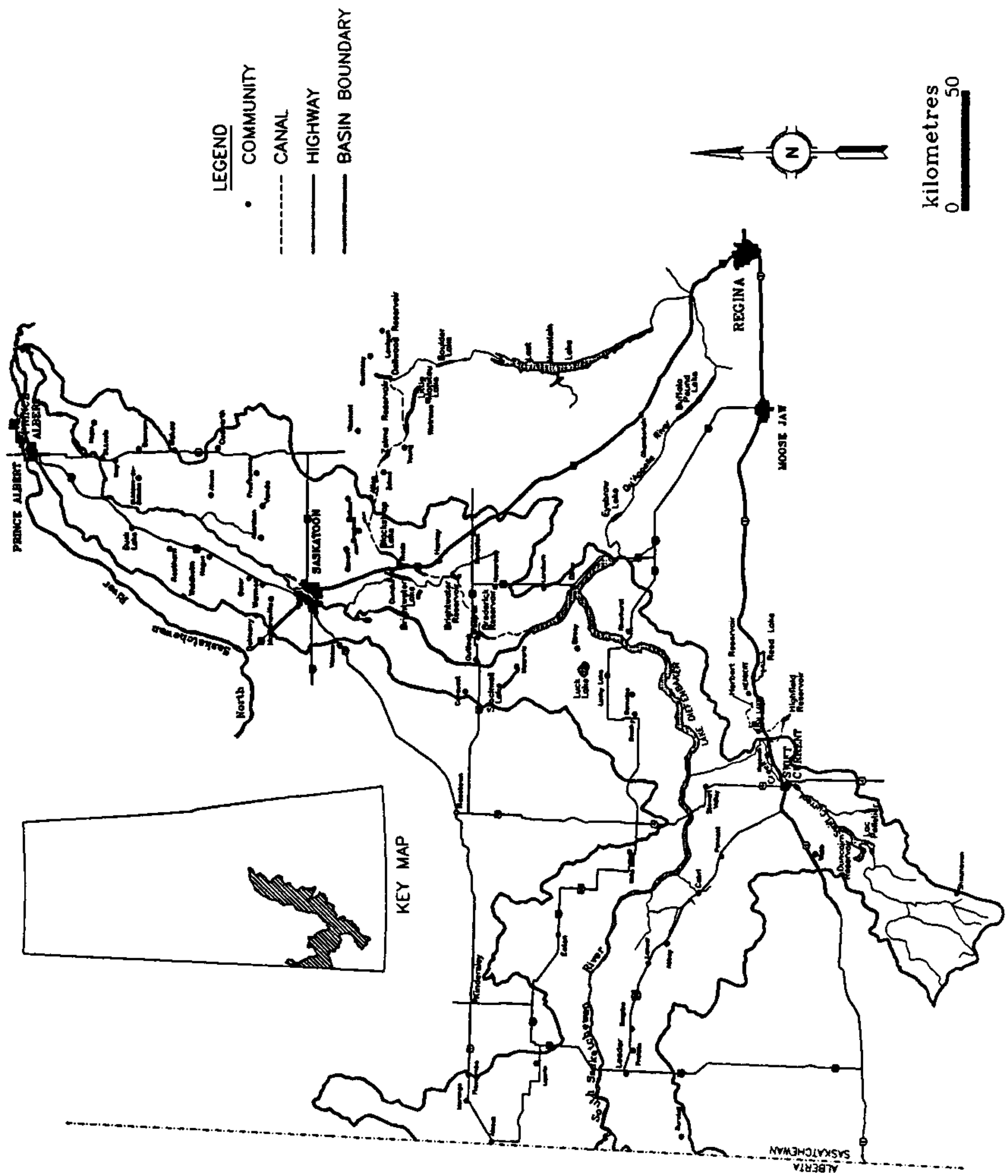


FIGURE 2 SASKATOON SOUTHEAST WATER SUPPLY SYSTEM

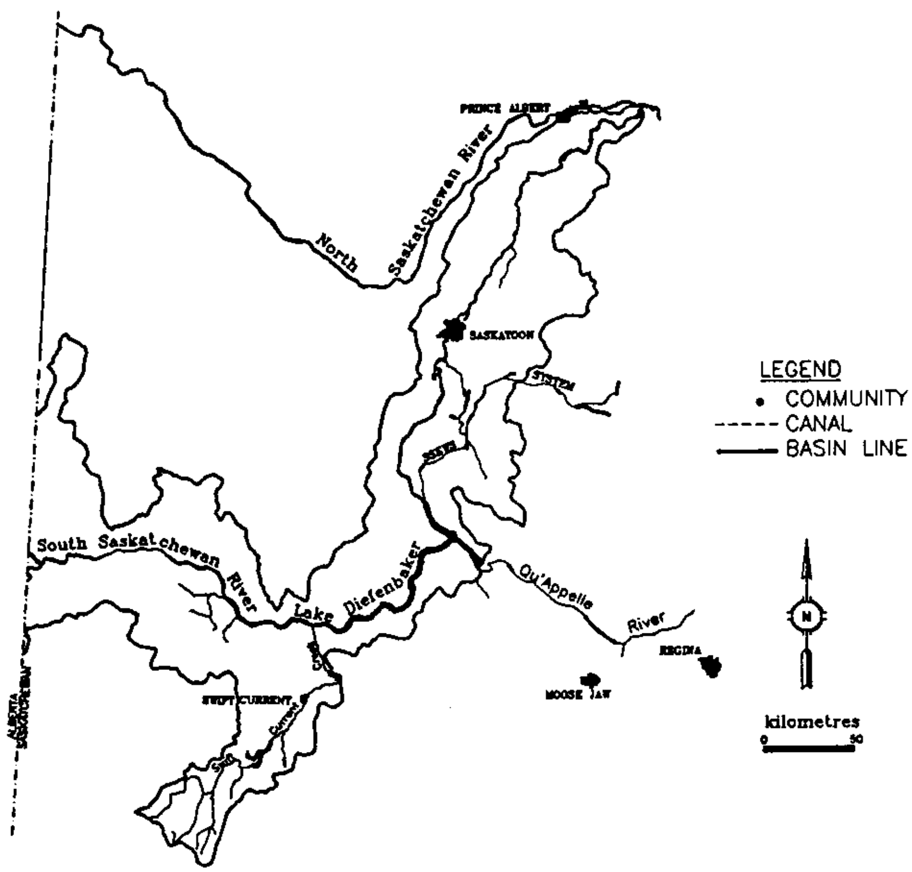
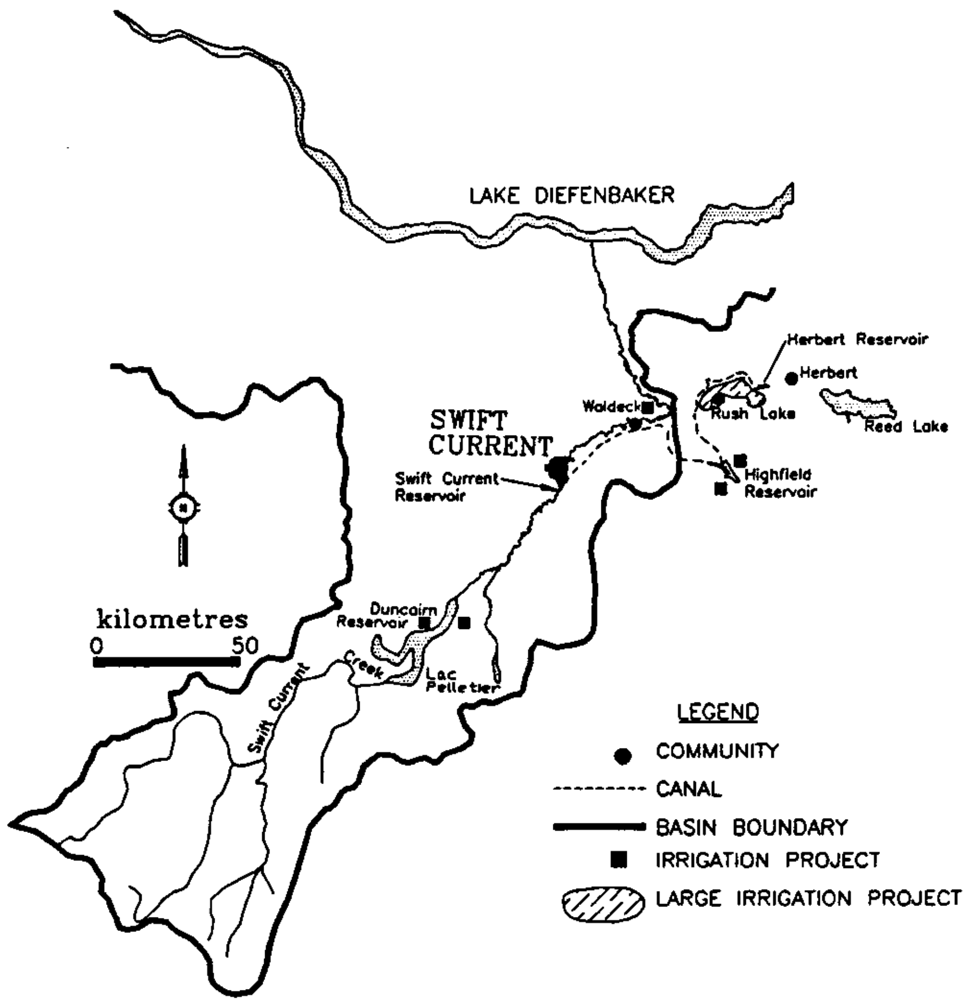


FIGURE 3 SWIFT CURRENT CREEK



2.0 PHYSICAL SETTING

2.1 GENERAL

The South Saskatchewan River Basin in Saskatchewan is a component of the larger Saskatchewan-Nelson River Basin which drains a large portion of southern Alberta, Saskatchewan and Manitoba as well as areas in North Dakota, Minnesota, Montana and Ontario as shown on Figure 4. The total drainage area within the Saskatchewan-Nelson River Basin is more than 1 000 000 km². Although the Canada-Saskatchewan South Saskatchewan River Basin Study is limited to the portion of the South Saskatchewan River Basin which lies within the Province of Saskatchewan as shown on Figure 1 and comprises only 45 000 km², water management must take into account the upstream and downstream regions. Therefore, this chapter includes discussion of the study area and the areas upstream and downstream of the study area.

2.2 UPSTREAM DRAINAGE BASIN

In 1984, Alberta Environment completed the South Saskatchewan River Basin Planning Program which provided detailed information on the Alberta portion of the basin. Detailed evaluations of the natural flows and water use developments were completed. In 1989, Alberta Environment updated this information and included the expected impact of developments which have been completed or initiated since the 1984 study was completed.

The Prairie Provinces Water Board completes detailed calculations of the natural flows and water uses in the basin each year. These studies and calculations are based on data collected by Environment Canada through the Atmospheric Environment Service and Water Survey of Canada.

Based on information from these sources and the operating experience of provincial and federal agencies the following description of the basin upstream of the study area has been assembled.

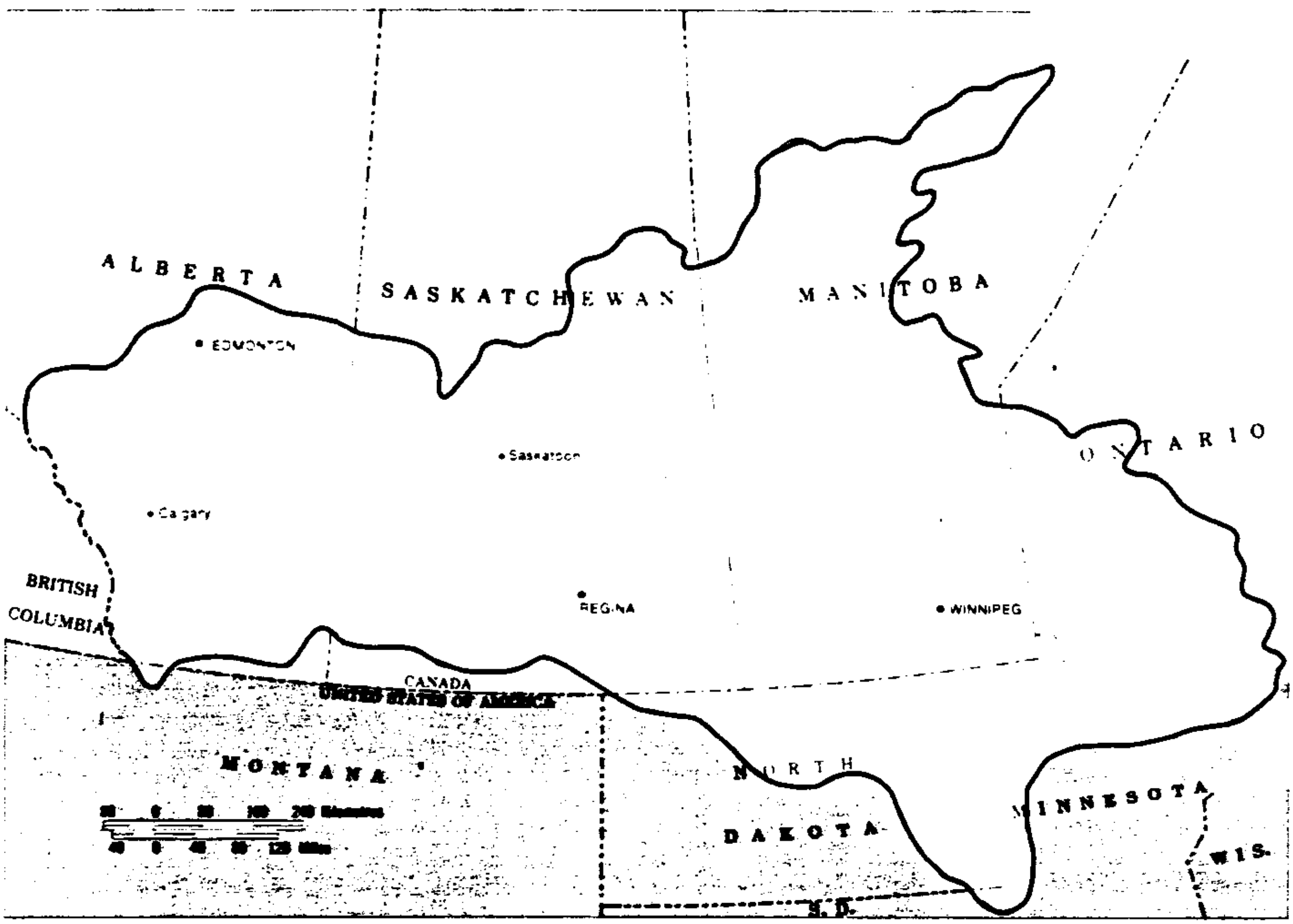
2.2.1 Drainage Basin Description

The South Saskatchewan River receives runoff from about 120 000 km² of southern Alberta. A tiny portion of the extreme southwest corner of the basin, about 1 400 km², is drained by the St. Mary River from south of the international boundary in Montana. There are four major drainage basin areas in Alberta. The Red Deer River drains the northern 41 percent of the total area. The Red Deer River joins the South Saskatchewan River a short distance east of the Alberta-Saskatchewan border. The Bow River drains 21 percent of the central area of the basin. The Oldman River drains 22 percent of the southern portion of the basin. The confluence of the Bow and Oldman Rivers is the upstream end of the South Saskatchewan River which drains the remaining 16 percent of the drainage area.

The topography, geology, climate and vegetation of this drainage area varies widely. The headwaters of all three major tributaries are located on the eastern slopes of the Rocky Mountains where the topography consists of steep slopes at high elevations. The ground surface is largely exposed bedrock or relatively thin and coarse soils at the higher elevations and the valleys tend to have large accumulations of coarse soils. The climate varies with elevation, with the greatest precipitation and coolest temperatures at the highest elevation. The average annual precipitation is as much as 800 mm at the high elevations and decreases to about 500 mm along the east side of the mountains. The temperatures are cool enough at the highest elevations that all the snowfall does not melt every summer. The highest peaks are barren with no vegetation. The lower slopes are sparsely forested and the valleys heavily vegetated.

The steep slopes, impervious bedrock surface, high precipitation, cool temperatures which reduce evaporation, and lack of water use by growing vegetation combine to make the higher mountain elevations very productive sources of runoff. The rate of runoff per unit of area decreases as the elevation drops because the slopes become flatter, there are more pervious soils to hold water, the amount of precipitation is lower, temperatures are higher and plant growth increases as do losses to the atmosphere. A comparison of the hydrometric records of the Bow River at Lake Louise and near Seebe demonstrates the variation of runoff potential. Both locations are upstream of any significant diversions. The Bow River near Lake Louise has a drainage area of 421 km² which produces an average of 789 dam³/km² of runoff per year. Further downstream on the Bow River, near Seebe, the river has a drainage area of 5 170 km² which includes the high elevations at Lake Louise and additional lower areas. This area produces an average of 485 dam³/km² of runoff per year which is a generous flow but substantially less than the runoff at the higher elevations.

FIGURE 4 SASKATCHEWAN-NELSON RIVER BASIN



In addition to producing relatively high total runoff, the mountain geography tends to spread the flow over the annual cycle to some degree. The variation in elevation results in an extended spring snowmelt. The spring thaw progresses up the mountains through the spring and early summer. Although the snowmelt is most rapid in April and May, it continues at the high elevations through June, July and August resulting in a long snowmelt runoff season. Summer rainfall at higher elevations tends to produce runoff which also keeps the rivers running for a longer period of time. The soils of the mountains tend to be sand, gravel and cobbles with large water holding capacity and high transmissivity. The large volumes of storage in these coarse soils tend to absorb a portion of the rainfall and snowmelt and outflows from the ground water system tend to provide very reliable base flows through the fall and winter when all of the precipitation is stored in the accumulated snow.

As the runoff flows east from the mountains, it is augmented by flow from the foothills region. The foothills are the transitional area between the extremes of the very steep and high mountains and the flat low lying prairie. The foothills precipitation which ranges from 400 mm to 500 mm per year is much lower than in the mountains and losses to evaporation and transpiration at the warmer lower elevations are much higher. Therefore, the runoff per unit of area is much lower than in the mountains.

The downstream portion of the basin in Alberta is on the prairies. In this area precipitation averages 300 mm to 400 mm per year while the potential for evaporation and transpiration by plants exceeds 1000 mm per year. The flat slopes and deep soils retard and capture precipitation and snowmelt. Most of the moisture is returned to the atmosphere without reaching the rivers. The only runoff results from brief periods of heavy snowmelt or extreme rainstorms. Average annual runoff ranges from two dam^3 to 20 dam^3/km^2.

The Red Deer, Bow and Oldman Rivers rise in the mountains and foothills along the continental divide formed by the Rocky Mountains. About 75 percent of the streamflow of these rivers originates in the mountain region. The average annual natural flow of the South Saskatchewan and Red Deer Rivers at the Alberta-Saskatchewan border from 1912 to 1986 was 9 300 000 dam^3. The natural flow has varied from a minimum in 1941 of 4 820 000 dam^3 to a maximum in 1951 of 16 600 000 dam^3. On average, the Red Deer River contributes 21 percent, the Bow River 43 percent and the Oldman River 36 percent of the natural flow. Virtually all of the flow originates in the mountains and foothills in the western headwaters. The prairie region downstream of the cities of Lethbridge, Calgary and Red Deer contributes very little runoff.

There are no significant natural lakes to store or attenuate the runoff but there is substantial ground water contribution to the flow which results in a reliable base flow. Since the runoff originates from melting snow and early summer rains, the majority of runoff occurs in May, June and July. The flows typically recede through late summer, fall and winter then begin to rise through March and April.

2.3 MAINSTEM SOUTH SASKATCHEWAN RIVER

Through Saskatchewan, the South Saskatchewan River is essentially a conveyance channel carrying mountain and foothill runoff from western Alberta to the confluence with the North Saskatchewan River. The two streams then form the Saskatchewan River. The total distance transversed by the South Saskatchewan River in Saskatchewan as measured along the centre of the river valley is 716 km.

The river flows in a valley that is incised into the surrounding prairie. Geologic evidence indicates that the valley was created by a larger river during the glacial retreat a little over 10 000 years ago. The original valley, which was up to 50 m deeper than the present valley in places, is partially filled with river sediments. The valley is a very significant feature of the prairie region.

From the Alberta boundary, the river flows in a generally eastward direction about 331 km to near the town of Elbow where it turns sharply north for 385 km to the confluence with the North Saskatchewan River. The valley ranges from 50 to 150 m deep and is generally from one to four kilometres wide. The valley bottom is mainly taken up by the river bed. There is one short reach upstream of Saskatoon where the valley widens to about seven kilometres and a limited floodplain exists.

Prior to development of Lake Diefenbaker, the annual flow volume at the upstream end of this river reach was essentially the same as at the downstream end. Local inflows and water depletions were insignificant. Recorded flows from the upstream to downstream end indicated a slight gain some years and a slight loss other years but the differences were smaller because of the precision of the measurements. Detailed calculations based on the drainage area and measured flows on tributaries indicates that, on average, the local inflow is about 2 percent of the total flow and it varies from 0 to about 4 percent. The largest local inflow tributary is Swift Current Creek which contributes about half of the total local flow in Saskatchewan.

As it flows through Saskatchewan, the South Saskatchewan River receives runoff from a band of prairie as shown on Figure 2. This local drainage area is about 45 000 km² in area or about 25 percent of the total drainage area of the river but it contributes only two percent to the natural flow of the river.

The area has relatively flat slopes and large depressions. The climate is arid with the average annual potential evaporation of over 1 000 mm, substantially exceeding the average annual precipitation of 300 mm to 400 mm. A very large proportion of precipitation is captured by the soil where it is returned to the atmosphere through evaporation and transpiration from plants. Of the small proportion of precipitation that flows from the fields, most only flows a short distance to local sloughs, potholes or depressional areas where it is returned to the atmosphere through evaporation.

In the roughly 10 000 years since the last glacial period, the relatively dry climate has resulted in little runoff. Natural drainage patterns have not been well developed by erosion. The drainage area that is effective in delivering water to the mainstem of the river is therefore very small.

In defining the drainage boundaries for the South Saskatchewan River Basin Study, only the portion of the basin that might contribute to the mainstem of the river under wet conditions was included. There are additional areas that form part of the South Saskatchewan River Basin but which can never contribute to the flow because of local topographic features. The north slopes of the Cypress Hills west of Swift Current Creek are a relatively high runoff area but the streams from that area drain to large depressions where all of their runoff is trapped and returned to the atmosphere by evaporation. The Great Sand Hills are a geographic feature with undulating terrain and porous soils which prevent any outflow. Since these areas never contribute runoff to the South Saskatchewan River, they have not been included in the drainage basin for the purposes of this study. Similarly, areas north of the South Saskatchewan River which drain to closed depression areas that never contribute flow to the river have also been excluded from the study.

2.4 SWIFT CURRENT CREEK

Swift Current Creek rises on the northeast slope of the Cypress Hills and flows northeast then north into the South Saskatchewan River Valley as shown on Figure 3. The mean annual natural flow of Swift Current Creek is 86 700 dam³ and it has varied from a low of 20 600 dam³ in 1937 to a maximum of 286 000 dam³ in 1952.

The Cypress Hills, which are as much as 600 m above the surrounding prairie, receive more precipitation and are cooler so evaporation losses are lower than on the surrounding prairie region. As a result of the greater water availability and steep basin slopes, the runoff yield is substantially higher in these hills. The Cypress Hills are underlain by a large volume of relatively porous geologic formation known as the Cypress Formation which stores a substantial volume of water and tends to drain at a fairly steady rate. This ground water discharge stabilizes the runoff, making the 3 900 km² Swift Current Creek drainage basin a much more productive and reliable water source than most of the prairie region in southern Saskatchewan.

2.5 DOWNSTREAM AREA

2.5.1 North Saskatchewan River

At the downstream end of the study area the South Saskatchewan River is joined by the North Saskatchewan River and their combined flows are carried east into Manitoba as the Saskatchewan River. The North Saskatchewan River is similar to the South Saskatchewan River in size and distribution of flows. The drainage basin is slightly smaller at 131 000 km² and the average natural flow volume of 7 800 000 dam³ per year is 82 percent of the natural flow of the South Saskatchewan River.

As was described for the South Saskatchewan River, most of the runoff originates in the mountains and foothills of western Alberta. The North Saskatchewan River headwaters are in the Rocky Mountains. The river receives runoff from the Clearwater and Brazeau rivers in the foothills before becoming a conveyance channel carrying the mountain runoff across Alberta and Saskatchewan. Because it is further north where evaporation losses are lower, this prairie region has higher runoff potential than the South Saskatchewan River Basin, but the prairie runoff is still a small part of the total basin runoff. Downstream of Edmonton, the river gains about 12 percent of its total flow from about 80 percent of its drainage area.

From 1912 to 1986, the natural annual flow of the North Saskatchewan River has varied from a low of 4 930 000 dam^3 in 1931 to a high of 17 000 000 dam^3 in 1951. The headwaters area of the North Saskatchewan River is very close to that of the South Saskatchewan River and is generally subject to similar weather conditions. Both rivers tend to have high or low runoff in the same years, producing a simple linear coefficient of correlation of annual natural flow volumes of 0.7.

Water development in the North Saskatchewan River Basin has had modest impacts on the flows in the river. The largest effects have arisen from storage reservoirs at Brazeau Reservoir and Lake Abraham in the Rocky Mountains. These reservoirs store water in spring and summer for release in fall and winter to generate hydro-electric power and to augment the low winter flows. As a result, summer flows are lower and winter flows are higher than natural. Small irrigation projects and urban use at centres including Edmonton and Prince Albert modestly deplete the flow. The average annual water use is less than 2 percent of the natural flow. The water use will likely grow modestly as municipal, industrial and individual irrigation developments expand but the growth would only become significant if major irrigation diversions occurred and at present no significant diversions are expected.

2.5.2 Saskatchewan River

From the confluence of the North and South Saskatchewan rivers, the Saskatchewan River carries the flow in a generally easterly direction to the Saskatchewan/Manitoba Border and into the north end of Lake Winnipeg. The combined average annual natural flow of 17 280 000 dam^3 from the two tributaries is augmented by a negligible 170 000 dam^3 of inflow upstream of Tobin Lake.

Downstream of Tobin Lake, the Saskatchewan River enters a geographic region known as the Saskatchewan River Delta. This area is not presently a delta as it was some 10 000 years ago. At that time, glacial Lake Aggasiz covered much of southern Manitoba and extended into Saskatchewan. The Saskatchewan River deposited its sediments as the velocity of the river flow slowed upon entering the glacial lake, forming the large flat area that remains. In this former delta area, the river is characterized by its braided channel. During high flow periods, large areas of the delta became flooded. In this area, the Torch River, Gooseberry River and Sturgeon-Weir River contribute runoff from the north. The natural flow is augmented by an average of 3 230 000 dam^3 in this reach, bringing the total natural flow at the Manitoba border to an average of 20 680 000 dam^3 per year. The 9 300 000 dam^3 average annual natural flow of the South Saskatchewan River is about 45 percent of the flow of the Saskatchewan River at the Saskatchewan/Manitoba border.

The main hydropower developments on the Saskatchewan River in Saskatchewan are the E. B. Campbell and Nipawin Generating Stations and the water bodies assocated with them: Tobin Lake and Codette Reservoir.

In Manitoba, the Grand Rapids hydropower dam built in the early 1960s created the large storage reservoir of Cedar Lake.

After combining with eastern and southern rivers in Lake Winnipeg, the water of the Saskatchewan River is carried by the Nelson River into Hudson Bay. The Nelson River has several hydro-electric stations located on it.

The Nelson River carries an average of about 52 000 000 dam^3 of water per year out of Lake Winnipeg and farther downstream, at the Kelsey Generating Station, the average annual flow has been measured at 72 000 000 dam^3. The 9 300 000 dam^3 average annual natural flow of the South Saskatchewan River is about 13 percent of the total flow of the Nelson River at the Kelsey Generating Station.

3.0 MAINSTEM SOUTH SASKATCHEWAN RIVER

3.1 DEVELOPMENT HISTORY

The South Saskatchewan River begins in the Rocky Mountains where it gathers a relatively large and reliable flow of water before it passes through the foothills and on to the very arid prairie of southern Alberta and southern Saskatchewan. This reliable source of good quality water has played a major role in the human occupation of this arid region. Archaeologic evidence suggests that the river banks were actively occupied even in prehistoric times and that the river was used as a natural navigation route.

From the beginning of the relatively short recorded history of the prairie region, the river has been a focus of human activities. Henry Kelsey of the Hudson's Bay Company was probably the first European to see the South Saskatchewan River in 1691 and the explorer Louis-Joseph LaVerendrye reached the confluence of the North and South Saskatchewan rivers in 1749. For the next century and a half, the river was a part of the main transportation system in this frontier area as the commerce of the fur trade generated early scattered settlement of the region.

By the mid-1800s, projects to use the water of this river were proposed. Captain John Palliser, a geographer, headed an expedition from Britain to explore western Canada in 1857. A year later, Professor Henry Yule Hind was commissioned to explore the Assiniboine and South Saskatchewan river valleys. Both Palliser and Hind noted that the Qu'Appelle River Valley and South Saskatchewan River Valley were joined at the point that the South Saskatchewan River turns north near the Town of Elbow. They suggested that a dam could be built on the South Saskatchewan River which would divert water to the Qu'Appelle River creating a navigable channel across the southern prairie.

When the Canadian Pacific Railway was built across the prairies in 1882-85, the interest in rivers as transportation routes disappeared. Thearailway brought settlers to the prairie region. As the population of the prairies grew, the importance of the river as a secure source of water increased.

3.1.1 Water Development in Alberta

Since almost all of the flow of the South Saskatchewan River originates in Alberta, water management of the Saskatchewan portion of the basin must take into account water developments in Alberta. Water developments in Alberta change both the total quantity of flow entering Saskatchewan and the timing of that flow.

3.1.1.1 Irrigation. In the late 1800s, settlers and land development companies in southern Alberta noted the limitations on agricultural productivity due to the arid climate. The potential to increase the region's productivity by using water from the large and easily diverted rivers was recognized. The Common Law concept of water management that prevailed at that time, assured undiminished flows for downstream riparian users. This discouraged potential investments in high-cost irrigation developments until 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. The act placed the ownership of all water with the Crown and provided a system of water allocation 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 was suitable for the types of gravity irrigation techniques that were available.

After the least expensive irrigation developments were built, assistance programs of the federal and provincial governments were introduced which encouraged continued development. Alberta irrigation development began in the late 1800s. By 1920, there were 73 000 ha irrigated and irrigation development has continued since that time as summarized in Table 1.

The earliest projects were able to rely on the natural base flows of the rivers. More recent developments have included additional storage reservoirs to store water in high flow periods for later use. The major reservoirs are listed in Table 2.

The quantity of water used each year varies modestly in relation to the precipitation. The average annual irrigation water use in recent years has been about 1 800 000 dam^3. This use includes evaporation at supply reservoirs and other losses as well as the water applied to the fields.

TABLE 1	ALBERTA IRRIGATION DEVELOPMENT
YEAR	AMOUNT OF LAND IRRIGATED
1920	73 000 hectares
1930	138 000 hectares
1940	166 000 hectares
1950	182 000 hectares
1960	143 000 hectares
1970	259 000 hectares
1980	356 000 hectares
Present (1987)	544 000 hectares

TABLE 2 — MAJOR STORAGE RESERVOIRS IN THE SOUTH SASKATCHEWAN RIVER BASIN IN ALBERTA

DAM		RESERVOIR	STREAM	DATE BUILT	STORAGE VOLUME ($dam^3 x 10^3$)	PURPOSE
RED DEER RIVER	Dickson	Gleniffer Lake	Red Deer	1983	205	Flow Regulation
BOW RIVER	Cascade	Lake Minnewanka	Cascade	1942	381	Hydro
	Three Sisters	Spray Lakes	Spray	1949	269	Hydro
	Intake	Upper Kananaskis Lake	Kananaskis	1942	245	Hydro
	Pocaterra	Lower Kananaskis Lake	Kananaskis	1955	70	Hydro
	Barrier	Barrier	Kananaskis	1947	26	Hydro
	Kananaskis	–	Kananaskis	1913	Pondage	Hydro
	Horseshoe	Horseshoe	Bow	1911	Pondage	Hydro
	Ghost	Ghost	Bow & Ghost	1929	159	Hydro
	Bearspaw	Bearspaw	Bow	1954	Pondage	Municipal/Hydro
	Glenmore	Glenmore	Elbow	1932	23	Municipal
OLDMAN RIVER	Waterton	Waterton	Waterton	1964	173	Irrigation
	St. Mary	St. Mary	St. Mary	1952	395	Irrigation
	Belly R. Diversion	–	Belly	1956	Pondage	Irrigation
	Murray	Murray Lake	Seven Persons Creek	1921	31	Irrigation
	Travers	Travers	Little Bow	1953	326	Irrigation
	Oldman	Oldman River Reservoir	Oldman	Under construction	480	Irrigation
OFFSTREAM	Crawling Valley	Crawling Valley	Matzhiwin Creek (Red Deer)	1984	130	Irrigation
	McGregor North	McGregor Lake	Snake Creek (Oldman)	1920	333	Irrigation
TOTAL					3 246	

Source: Mitchell, Patricia and Ellie Prepas (editors), (1990), Atlas of Alberta Lakes, University of Alberta Press, Edmonton.

Irrigation development in Alberta is expected to continue. When commitments made by the Alberta Government in the early 1980s are completed early in the next century, there will be 686 000 ha (1 695 000 acres) under irrigation and average annual water requirements may be about 2 272 000 dam³.

In the long-term, if Alberta chooses to develop all of its share of the water resources of the basin for irrigation, the irrigated area could reach 850 000 hectares (2 100 000 acres) and average water use might reach about 3 600 000 dam³ per year. However, current plans of the Alberta government include limiting irrigation development to the 686 000 ha for which infrastructure now exists or is committed.

3.1.1.2 Hydro-electric. Hydro-electric generation based on the flows of the rivers 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 six percent of the total Alberta generating capacity and on average they generate about five percent of the province's power.

Hydro-electric power generation does not consume water, but rather uses the energy of falling water to produce electricity. In order to generate power when it is needed, the hydro projects rely on storage of the flow in high runoff periods and releases of the water when the energy is needed. Thus, the 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 hydro reservoirs result in some depletion of the total water supply due to evaporation but because most of these reservoirs are located at high elevations where the climate is cooler, evaporation has a modest impact. The main impact of the hydro reservoirs is a redistribution of the seasonal flow which 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 dam³. This is not a sufficient volume to have a major effect on either the total flows or the seasonal distribution of the water entering Saskatchewan. There is a modest impact in the fall and winter seasons when the low flows are augmented by releases from these reservoirs. Table 2 includes the hydro reservoirs in the Alberta portion of the basin.

3.1.1.3 Municipal. 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 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 70 to 80 percent of the water diverted is returned to the river system after treatment and disposal. The net depletion of the flow of the South Saskatchewan River upstream of Saskatchewan for municipal uses is about 60 000 dam³ per year which is a relatively small quantity of water compared to other uses.

3.1.1.4 Industrial. Southern Alberta has a variety of industrial developments including oil and gas extraction, refining, transportation, coal mining, timber extraction, 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 impact is similar to the municipal impact. 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 dam³ per year.

3.1.1.5 Tourism, Recreation, Fish and Wildlife. 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 attributed to the secondary uses, the losses are generally assigned to the primary uses.

The Alberta Department of the 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 specific flows vary from reach to reach.

3.1.1.6 **Summary of Alberta Uses.** 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 but have grown at a varying rate since that time. Uses are expected to continue to grow and will likely average about 2 400 000 dam³, that is, about 26 percent of the average natural flow, by early in the next century. Studies of potential storage development have shown that it would be possible to increase average water use to about 3 700 000 dam³ per year with addition of very expensive storage, but current planning in Alberta indicates that growth in water use will be small in the next century.

In addition to depleting the flow for irrigation use in the summer, Alberta reservoirs store a portion of the flow for later release for hydro-electric generation and low flow augmentation. Figure 5 compares average monthly flow conditions under natural conditions and various development levels.

3.1.2 Apportionment

The natural topography of the southern prairie region slopes from west to east. Therefore, water which arises in Alberta naturally flows into Saskatchewan. In the early development of the prairie region, there was ample water for the limited users but by the 1960s water development had progressed to the point that potential conflicts were anticipated if an agreement on equitable sharing was not reached. Irrigation Developments in Alberta were consuming a steadily increasing portion of the flows. Saskatchewan, with federal assistance, was building the Lake Diefenbaker project to develop irrigation and other water uses. Saskatchewan was also building hydro-electric plants at Gardiner Dam on Lake Diefenbaker and the E. B. Campbell project on the Saskatchewan River. Alberta, Saskatchewan and Manitoba could foresee development potentials for the eastward flowing rivers of the prairies that could only be achieved if each jurisdiction could be assured of an equitable share of the natural flow. Therefore, the three Prairie Provinces and the Federal Government negotiated and agreed to the Master Agreement on Apportionment (October 30, 1969) and established the Prairie Provinces Water Board to administer the agreement and co-ordinate activities which are of mutual benefit.

Since this agreement effects the water supply available in the study area, the full text of the agreement is provided in Appendix B. The following points summarize the key features of the agreement related to the water supply in the study area:

1. Apportionment applies to eastward flowing rivers which cross the provincial boundary between Alberta and Saskatchewan or Saskatchewan and Manitoba. The South Saskatchewan River and Red Deer River entering the study area from Alberta are subject to apportionment. The North Saskatchewan River and Battle River are subject to apportionment at the Alberta-Saskatchewan border and the Saskatchewan River at the Saskatchewan-Manitoba border.

2. In general, Alberta must permit at least one half of the natural flow to reach Saskatchewan in each calender year. Saskatchewan must permit at least one half of the flow received from Alberta plus one half of natural flow arising in Saskatchewan to reach Manitoba. The agreement uses the calender year for the Alberta sharing and April 1 to March 31 for the Manitoba sharing.

3. Even though they cross the border separately, the South Saskatchewan River and Red Deer River flows can be combined for apportionment, at the option of Alberta. This provision improves Alberta's flexibility for developing water projects.

4. On the South Saskatchewan River, Alberta may divert or store a minimum of 2 590 000 dam³ (2 100 000 acre-feet) in any year even if it is more than 50 percent of the natural flow. However, Alberta may not reduce the flow to less than 42.5 m³/s (1 500 cfs) except when half the natural flow is less than 42.5 m³/s, in which case, the flow may be reduced to half of the natural flow. This limit of 2 590 000 dam³ was established to protect uses in Alberta that had been developed prior to 1969. The 42.5 m³/s limit was set to protect riparian water uses in Saskatchewan. Under this apportionment formula, Saskatchewan is assured of receiving at least 50 percent of the natural flow in almost all years. The minimum 2 590 000 dam³ diversion set aside for Alberta would only have been a factor in 3 years since 1912 as shown in Table 3.

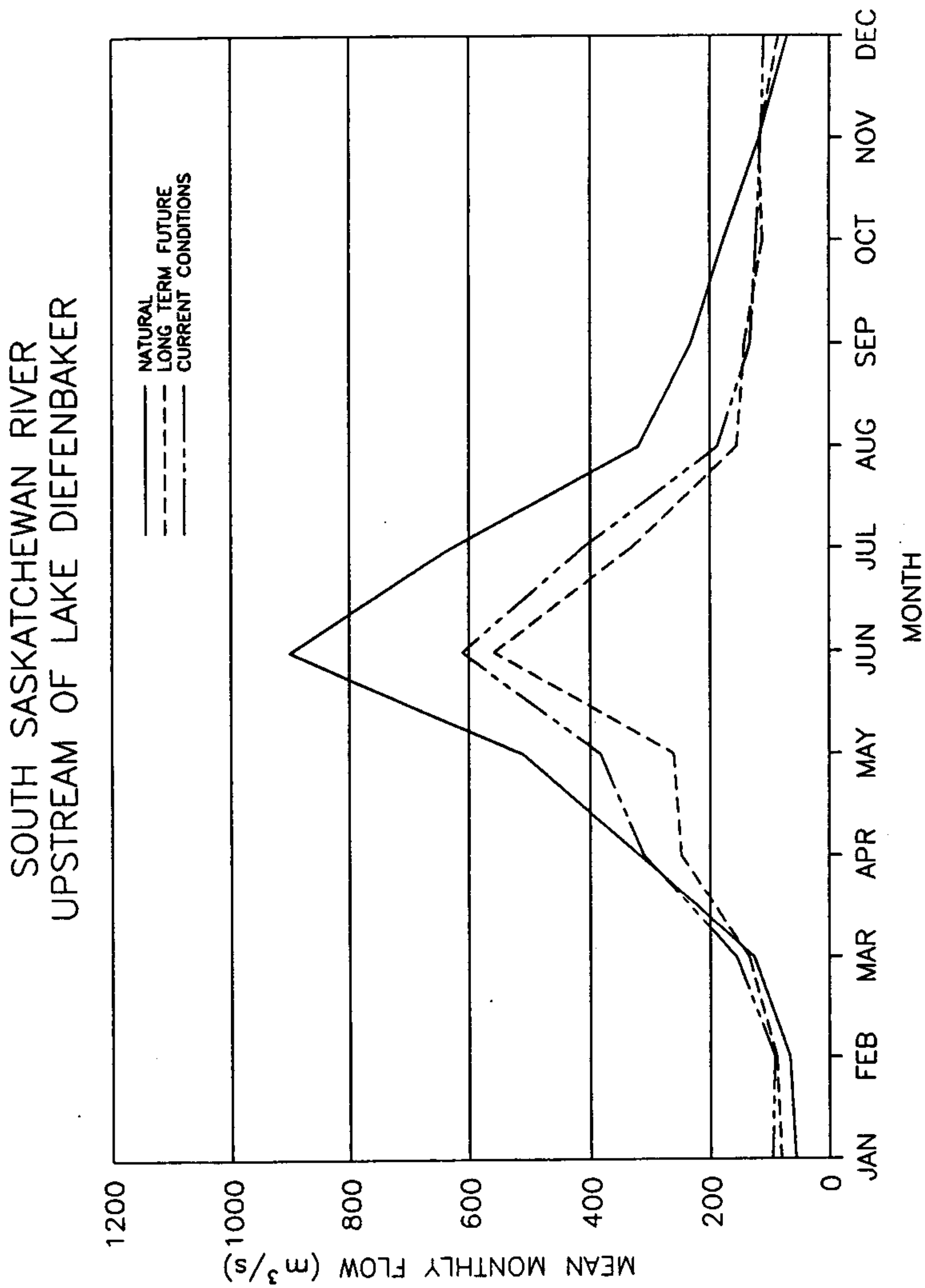
Even in these driest years, Saskatchewan would have received close to 50 percent of the flow.

Because of the impracticality of developing uses for flows that will not be satisfied virtually every year, Alberta cannot utilize its full 50 percent in normal or wet years. As a result, in recent years Alberta has passed an average of 83 percent of the natural flow to Saskatchewan. Water supply studies indicate that even with the development of the maximum practical storage works in Alberta, the average delivery of water to Saskatchewan will be in the 60 to 65 percent range.

TABLE 3	APPORTIONMENT IN LOW FLOW YEARS			
YEAR	NATURAL FLOW (dam³)	ALBERTA SHARE (dam³)	SASK. SHARE (dam³)	PERCENT RECEIVED BY SASKATCHEWAN
1931	4 970 000	2 590 000	2 280 000	48
1941	4 820 000	2 590 000	2 230 000	46
1944	5 140 000	2 590 000	2 550 000	49

FIGURE 5

AVERAGE SEASONAL FLOW PATTERN
SOUTH SASKATCHEWAN RIVER
UPSTREAM OF LAKE DIEFENBAKER



In 1984, the driest year in recent times, the calculated natural flow was 5 220 000 dam³. The recorded flow of 3 093 000 dam³ was 59 percent of the natural flow. With developments as they existed in 1984, Alberta did not use 50 percent of the flow in a drought year that was very nearly as dry as the extreme droughts in the 1930s and the 1940s. Since 1984, Alberta has developed additional storage and it is reasonable to assume that Alberta uses will consume very close to 50 percent of the flow in future droughts, probably about once in every 25 years on the average by the late 1990s. In the long-term, uses and storage might bring Alberta use to 50 percent of the natural flow as frequently as once in 5 years on the average. This means that Saskatchewan can anticipate receiving more than 50 percent of the flow in 96 percent of the years in the short-term and in about 80 percent of the years in the long-term. The average annual streamflow reaching Saskatchewan can be expected to diminish from about 80 percent of the natural in the recent past to about 70 percent in the short-term and to about 67 percent of the natural in the long-term.

3.1.3 South Saskatchewan River in Saskatchewan

Prior to construction of the South Saskatchewan River Project in the 1960s which created Lake Diefenbaker, the South Saskatchewan River in Saskatchewan was very lightly used. The most important use was the municipal supply for several towns along the river and the city of Saskatoon, which has a license for about 61 000 dam³ per year. The river was 100 m or more below the surrounding prairie so 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 and the fishery were limited 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 seepage losses. 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. This pumped diversion was replaced by gravity releases from Lake Diefenbaker in 1967. 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 (1958 to 1965).

The present minor water uses along the river are summarized in Table 4. Many of these uses, particularly the irrigation along Lake Diefenbaker, have been developed since the project was built.

The total depletion of the flow of the South Saskatchewan River by man-made projects in Saskatchewan was less than 1 percent of the average annual flow prior to development of Lake Diefenbaker.

Gardiner Dam and the Qu'Appelle River Dam were built during the period from 1958 to 1968 forming Lake Diefenbaker. Figure 6 shows the area and storage capacity of 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 has an area of about 40 000 ha which is exposed to evaporation. The average annual net evaporation from this lake is about 240 000 dam³ (based on the period 1969 to 1989) and has been the largest use of water in the basin in Saskatchewan.

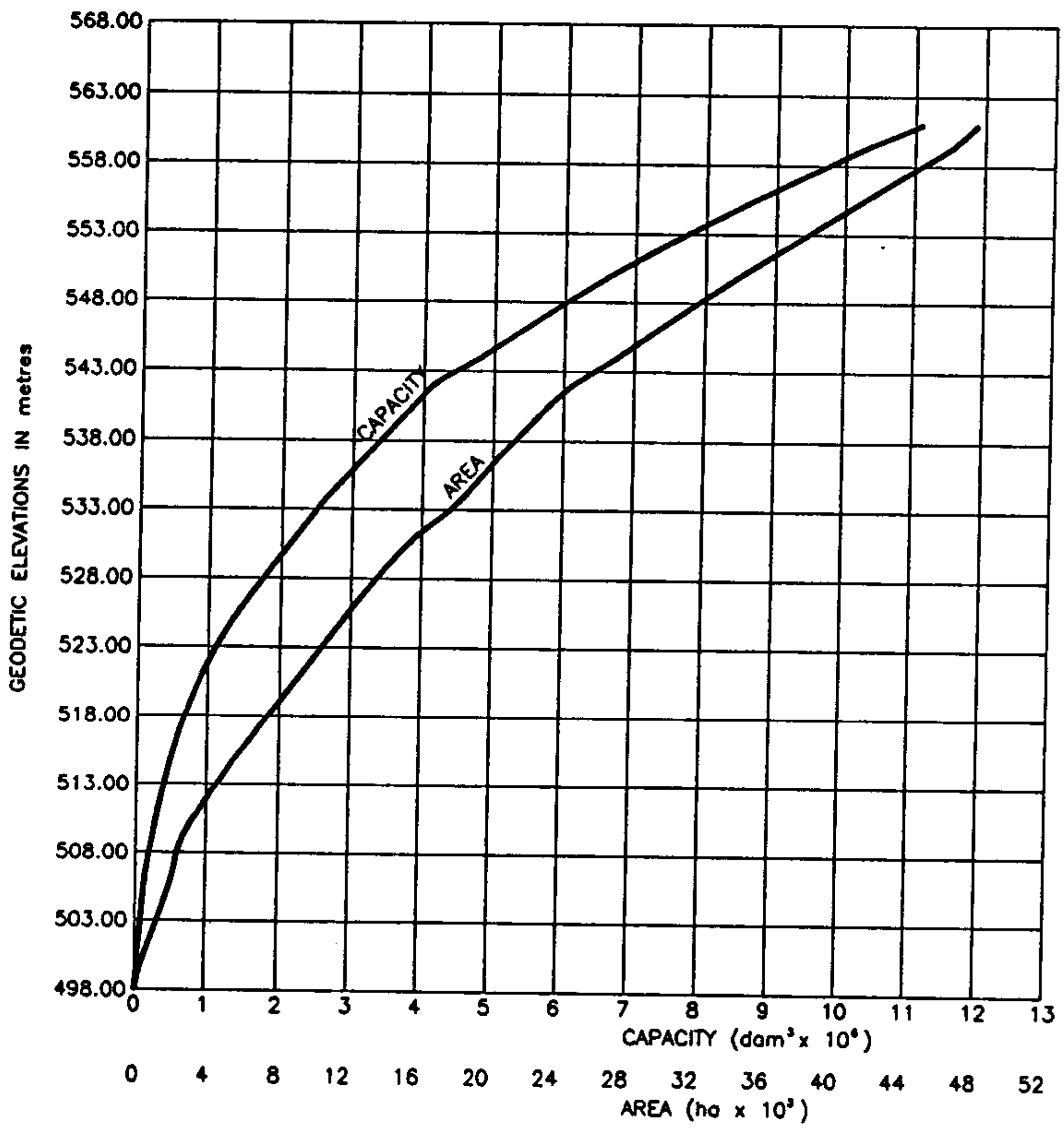
Lake Diefenbaker was developed as a multipurpose water control project. In addition to supplying water for irrigation, municipal, industrial, recreation and wildlife projects, the lake provides flow regulation for assured downstream flows, flood control and hydro-electric generation.

The average flow of the South Saskatchewan River downstream of Gardiner Dam from 1969 to 1986 was 209 m³/s which is about 11 percent less than the average inflow to Lake Diefenbaker of 235 m³/s. Evaporation and uses at Lake Diefenbaker account for most of the difference. Evaporation is one of the largest water uses and this use will not change appreciably with time. The other major water use is irrigation which is expanding and could use a larger portion of the flow in the future.

More details on the quantities and locations of water uses can be found in the South Saskatchewan River Basin Study Water Use Technical Appendix.

TABLE 4 SOUTH SASKATCHEWAN RIVER AND LAKE DIEFENBAKER MINOR WATER USES			
REACH	NO. OF USERS	IRRIGATED AREA (ha)	TOTAL USES (dam^3)
Upstream of Lake Diefenbaker	35	1 737	8 020
Lake Diefenbaker	96	11 133	57 790
Gardiner Dam to Saskatoon	55	3 387	42 941
Downstream of Saskatoon	43	2 475	11 339
TOTAL	229	18 732	120 090

FIGURE 6 AREA AND STORAGE CAPACITY OF LAKE DIEFENBAKER



3.2 WATER SUPPLY HYDROLOGY

3.2.1 Study Period

Since it is not possible to know what sequence of runoff events will occur in the future, it is necessary to base planning of water resource management on the best indication of the runoff potential that can be derived from information on past runoff. Analysis of historic data can identify the magnitude and variability of flows from year to year and season to season. The longer the historic record is, the more reliable the resulting analysis will be.

The water supply available for management on the South Saskatchewan River depends upon the natural flows of the river and the changes to the natural flow that can be expected to occur due to upstream developments. Flows, diversions and storage within the drainage basin have been measured and recorded by Water Survey of Canada and by various provincial agencies and water users at many locations since the early 1900s. All of the measurements have not been continuous and many different periods of record exist for various measurements as priorities have changed over the years. The most comprehensive records at key locations, such as the South Saskatchewan River at Saskatoon, Oldman River at Lethbridge, Bow River at Calgary and Banff, the Red Deer River at Red Deer and Swift Current Creek at Swift Current begin in 1912. The latest complete year of record available when the South Saskatchewan River Basin Study was started was 1986. Therefore, the 75 year period from 1912 to 1986 was selected as the study period for the basin study.

In some past basin studies a concept referred to as synthetic hydrology has been proposed in an attempt to produce a longer record of data for analysis. This method analyzes the recorded flows in order to extract the statistical characteristics of these flows. These statistical characteristics can then be appropriately applied with random distributions to create long sequences of flows that have the same characteristics as the original record. Synthetic hydrology studies were not completed for this study because the 75 year historic record was considered to provide a reliable basis for water supply planning. This historic record includes a wide variety of high and low runoff and a variety of combinations of annual sequences which provide a realistic indication of the water supply potential.

3.2.2 Natural Flows

In the 1970s, Canada and the three Prairie Provinces jointly undertook detailed studies of methods of calculating the natural flow of the South Saskatchewan River under the supervision of the Prairie Provinces Water Board. The project depletion method of calculation, which considers the recorded river flows and adds the depletion resulting from upstream projects or the augmentation resulting from releases from storage, was used. Methods were developed for calculating the natural flow which were satisfactory to the technical representatives of all three provinces and Canada. These methods have been applied to the South Saskatchewan River by Environment Canada on behalf of the Prairie Provinces Water Board each year in order to monitor the annual apportionment of the flow under the Master Agreement on Apportionment.

Alberta Environment completed detailed studies of the natural flow of the South Saskatchewan River Basin in 1984 and in subsequent updates have continued to estimate the natural flows. The methods used are essentially the same as the methods of the Prairie Provinces Water Board, and the resulting estimated natural flows are nearly identical. Therefore, in order to avoid duplicating effort, the Alberta Environment natural flow results have been used for the portion of the flow arising upstream of the Saskatchewan study area.

For the area within Saskatchewan, there are small tributary streams which carry small quantities of water to the South Saskatchewan River. Hydrometric data collection for most of the local runoff is very limited but the scattered flow records were used along with data on water development from the water rights licensing to develop an estimate of the natural flow for the years when data were available. In order to obtain an estimate for the full 75 year study period, the calculated natural flows for the years of record were compared by statistical correlation to flows measured on nearby streams which are in the same area and have similar climates to develop estimates of the natural flow for the missing months. For areas which have no useful measured flow data, estimates of runoff were prepared based on runoff on the nearest stream adjusted on the basis of the drainage area.

Although these natural flows are calculated indirectly rather than being direct measurements, they are a fairly reliable estimate, particularly for the mainstem. The largest factor in the calculations is the recorded flows which have been measured throughout the study period at Saskatoon and on all of the main tributaries. The largest adjustments to the measured flows are also based on direct measurements. The storage in all the large reservoirs is calculated from measured water levels and accurate capacity curves based on preconstruction surveys. The large irrigation diversions and return flows are regularly measured and irrigated acreage is recorded so that uses can be estimated. Evaporation losses are estimated from climatic data and although the estimates are known to have some potential for error, since evaporation is a relatively small loss, even large errors in its calculation will have a small influence on the total natural flow calculation. The least accurate portion of the calculation, due to data limitations, is the local runoff but since the local runoff is only about 1 percent of the total flow, even large errors in its estimate are not critical.

Appendix C contains a monthly listing of the estimated natural runoff of the South Saskatchewan River. Tables 5 and 6 summarize the flow at the upstream end (near Lemsford), and at the downstream end (near St. Louis), of the study area.

Several features of the natural flow regime are worthy of special comment:

1. The natural flows near the Alberta border are very similar to the natural flows at the downstream end of the study area. The difference, an average of 2.4 percent of the flow, arises from runoff in Saskatchewan. The largest contributor, Swift Current Creek, is discussed in detail in Chapter 4 of this report.

2. Although the river is naturally a good source of supply, it experiences wide extremes of flow. The minimum monthly flows are about 5 percent of the mean and maximum monthly flows are about seven times the mean. As discussed later in this chapter, variations in daily peak flows are even greater.

3. The majority of the runoff, about 60 percent, occurs in 25 percent of the year from May to July. By contrast, only about 5 percent of the annual runoff occurs in 25 percent of the year from December to February.

3.2.3 Current (1986) Flow Regime

Although the natural flows provide the basic information about the natural hydrology of the drainage basin, they are not good indications of the current flows in the river. The present flows are influenced by major man-made projects in Alberta and in Saskatchewan.

In order to determine the probability of various levels of supply under the current regime, the natural flows for the 75 year study period were adjusted by the quantity of water that is currently being used or stored each year. In order to take into account the effects of storage and carry over water from wet periods to dry periods, a computer-based water balance model was used to simulate the flows. The particular model used was the Water Resource Management Model (WRMM). In this model, the river system is described by a series of reservoirs, channels, diversions and nodes and the operation of the system is controlled by penalty points which define desirable and undesirable performance of the system. The computer program calculates the optimum operation of all components of the system for each month of the study period taking into account the supply available, the defined water uses and the storage left from the previous month. Alberta Environment used the same model configured for the Alberta portion of the basin, to provide inflow data. More details on the Water Resource Management Model can be found in the Project Evaluation Procedures section of the South Saskatchewan River Basin Study Framework Plan Technical Appendix.

For this study, it was assumed that Lake Diefenbaker would be operated as it was operated in the mid 1980s.

When the resulting arrays of monthly flows which are attached in Appendix C are compared to the natural flow arrays, substantial differences can be seen. Tables 7 and 8 summarize the flow regime as it would have been if the developments that were in place in 1986, had been in place throughout the study period.

Tables 5, 6, 7 and 8 show some dramatic changes in the flow pattern:

1. The average annual flow reaching Saskatchewan is reduced from 290 m^3/s to 227 m^3/s, a reduction of 63 m^3/s. On average, Saskatchewan would receive 78 percent of the natural flow. This percentage ranges from 58 percent in dry years to 88 percent in wet years.

2. The average annual flow leaving the downstream end of the study area is reduced from 297 m^3/s to 211 m^3/s, a reduction of 86 m^3/s. On average Saskatchewan is diverting 23 m^3/s of water or 10 percent of the available flow. The 90 percent that is not used consumptively is used for hydro-electric generation and maintaining downstream river flows.

3. With Alberta and Saskatchewan uses combined, the total average water use in the basin of 86 m^3/s is about 30 percent of the average supply.

TABLE 5 NATURAL FLOWS SOUTH SASKATCHEWAN RIVER NEAR LEMSFORD (m^3/s)
(Alberta Border)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Minimum	15	22	54	102	175	333	224	158	112	61	57	19	153
Lower Quartile	44	48	80	181	382	657	389	227	153	117	91	49	229
Median	55	61	107	263	462	823	542	295	192	149	107	63	263
Upper Quartile	62	80	146	403	594	1053	772	339	239	193	132	81	342
Maximum	168	133	350	1006	1500	2059	1568	778	802	508	236	157	528
Average	56	65	125	313	504	888	623	315	229	175	116	69	290

TABLE 6 NATURAL FLOWS SOUTH SASKATCHEWAN RIVER NEAR ST. LOUIS (m^3/s)
(Confluence with the North Saskatchewan River)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Minimum	17	19	57	105	175	311	252	171	119	72	57	27	156
Lower Quartile	47	47	86	185	366	628	431	264	173	126	97	59	233
Median	57	59	118	272	440	777	590	332	206	160	113	72	271
Upper Quartile	68	75	153	418	585	1004	799	413	259	203	139	88	349
Maximum	169	139	339	1169	1429	1917	1577	858	765	545	273	173	538
Average	59	63	131	322	486	842	657	356	243	186	125	79	297

TABLE 7 CURRENT DEVELOPMENT (1986) FLOWS SOUTH SASKATCHEWAN RIVER NEAR LEMSFORD (m^3/s)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Minimum	54	48	85	99	54	57	43	43	43	35	54	50	90
Lower Quartile	84	73	113	179	262	381	186	103	55	64	90	89	169
Median	94	88	143	266	343	547	329	166	93	95	106	104	200
Upper Quartile	101	106	177	400	473	777	560	210	141	141	127	121	279
Maximum	207	159	381	1003	1379	1783	1356	649	703	455	235	197	464
Average	96	92	156	310	384	611	412	187	130	122	114	109	227

TABLE 8 CURRENT DEVELOPMENT (1986) FLOWS SOUTH SASKATCHEWAN RIVER NEAR ST. LOUIS (m^3/s)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Minimum	100	100	117	43	43	43	43	43	43	43	100	100	84
Lower Quartile	325	237	146	43	43	43	43	44	55	60	155	355	147
Median	340	250	180	118	120	73	125	68	60	173	234	374	179
Upper Quartile	350	268	212	231	255	284	349	235	78	249	264	374	179
Maximum	400	400	390	699	860	1273	1239	680	633	539	400	400	448
Average	326	254	190	154	174	201	237	153	96	181	220	339	211

4. The seasonal variability of the flow arriving from Alberta has been reduced. The average low-flow month is now 40 percent of the average instead of 20 percent. The average high-flow month is 270 percent of the average instead of 300 percent.

5. Attenuation of flows through Lake Diefenbaker further reduces the seasonal variation. The average low flow downstream of the lake is 60 percent of the annual average and the average high flow month is only 160 percent of the annual average.

6. Downstream of Lake Diefenbaker the flow pattern has been reversed in most years. The winter flows are usually higher than the summer flows. Figure 7 shows the mean monthly flow pattern.

7. In very wet years, all the uses and water controls cannot fully manage flood flows. Summer floods will still occur.

3.2.4 Future Flow Regime

Alberta is presently in the process of developing additional works to store water, regulate the flow of the rivers and expand irrigation development. It is anticipated that the rate of water development growth in Alberta will slow in the future. The existing users experience shortages in drought years, therefore, the potential for economically viable additional projects is limited. The government of Alberta has adopted a policy which will limit developments to the projects that are currently planned. Alberta Environment has completed modelling of their portion of the river basin, including these anticipated developments. The results of this modelling, designated run number OD05, were used in the Saskatchewan study as an indication of the long-term future (year 2020), upstream flow conditions.

An estimate of the short-term (year 2000) conditions was generated by interpolation between the current conditions and the long-term conditions.

Although development of water use projects beyond those envisioned in the long-term would require storage or water use strategies that are presently not economical, in the far-future (well past the year 2020) water developments might reach the point where Alberta uses its full share of the water under the Master Agreement on Apportionment or 50 percent of the natural flow. Since the Master Agreement indicates 50 percent of the natural flow must be passed to Saskatchewan, that is the absolute upper limit of Alberta water development. The Master Agreement specifies an annual sharing, therefore the ultimate development flows are not simply the monthly natural flows divided by two but rather allowance must be made for storage and seasonal variations in use.

An estimate of the far-future flows into Saskatchewan which reflects a pattern of seasonal water use and storage in Alberta similar to present trends was developed.

Appendix C lists detailed flow arrays for short-term (year 2000), long-term (year 2020) and far-future conditions. Tables 9, 10, and 11 summarize these flow patterns.

Comparison of Tables 5, 7, 9, and 10 provides the following insights:

1. Alberta developments are expected to consume an increasing portion of the natural flow with time. On average, Saskatchewan will receive about 70 percent of the natural flow in the short-term and about 67 percent of the natural flow in the long-term.

2. The seasonal variability of the flow arriving from Alberta will tend to reduce with time as future projects utilize the high summer flows.

One of the purposes of the study was to generate information which will assist Saskatchewan in determining how the water resources available might be used in the future. Flow patterns downstream of Lake Diefenbaker will depend on future decisions regarding operation which are discussed in the South Saskatchewan River Basin Study Framework Plan Technical Appendix.

3.3 FLOOD HYDROLOGY

Although the major water management concern for the South Saskatchewan River is the quantity of water available for use, in occasional wet years there are damaging floods. Optimum management must include consideration of both flood and drought management.

FIGURE 7 **COMPARISON OF AVERAGE INFLOW AND OUTFLOW AT LAKE DIEFENBAKER UNDER CURRENT DEVELOPMENT CONDITIONS**

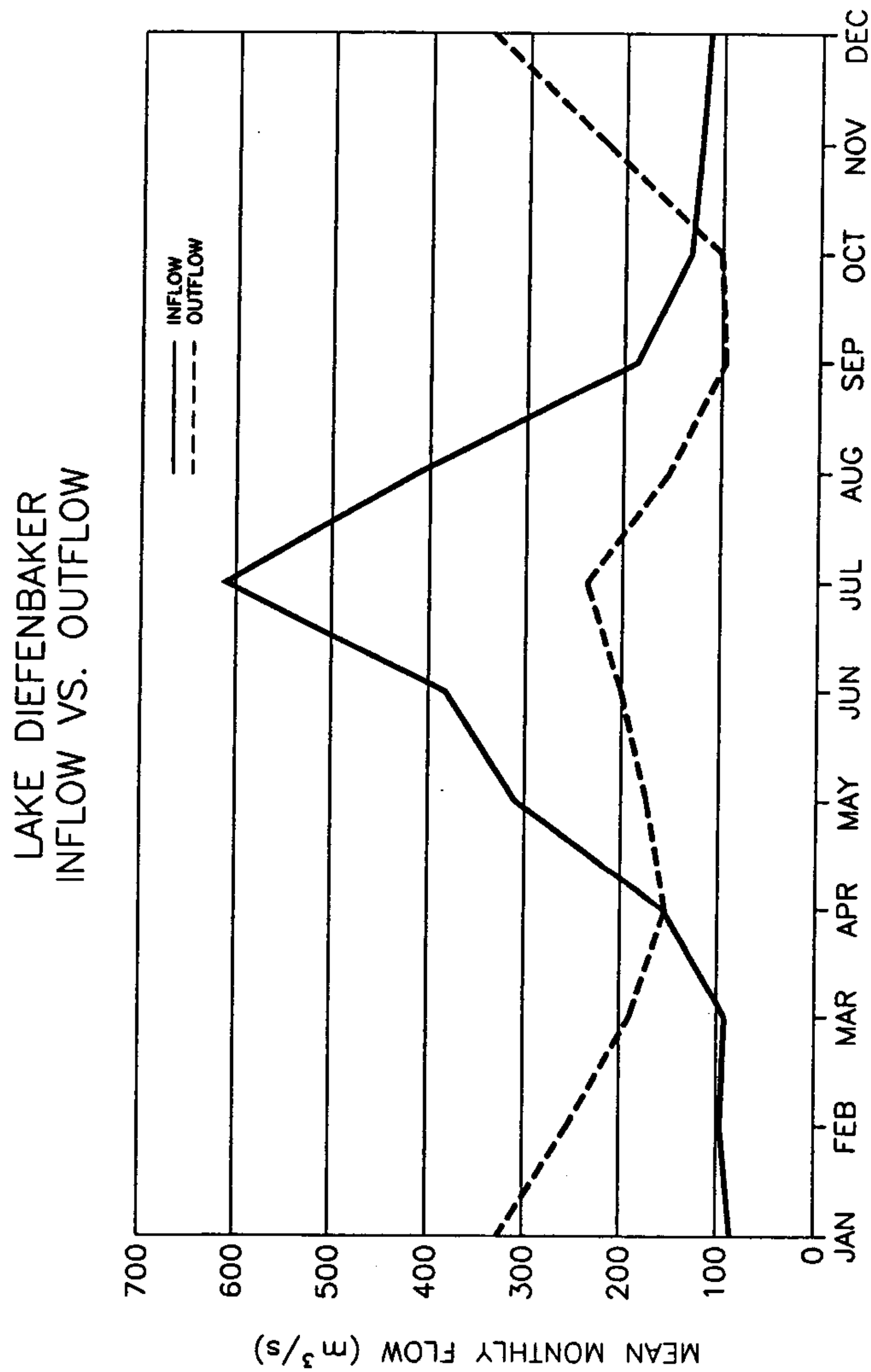


TABLE 9 SHORT-TERM FUTURE FLOWS (YEAR 2000) SOUTH SASKATCHEWAN RIVER NEAR LEMSFORD (m^3/s)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Minimum	46	48	84	90	48	67	57	45	43	37	56	51	84
Lower Quartile	75	74	105	146	166	367	161	99	69	58	88	82	152
Median	86	86	131	230	273	502	276	136	92	88	106	92	179
Upper Quartile	93	99	161	369	422	731	446	186	132	137	128	107	258
Maximum	255	179	366	963	1421	1746	1423	642	730	454	266	176	467
Average	88	90	145	279	323	585	373	171	137	116	115	97	210

TABLE 10 LONG-TERM FUTURE FLOWS (YEAR 2020) SOUTH SASKATCHEWAN RIVER NEAR LEMSFORD (m^3/s)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Minimum	39	48	79	54	43	77	72	43	43	43	58	52	78
Lower Quartile	66	73	97	124	82	293	1558	93	72	59	87	71	133
Median	76	82	121	192	203	436	248	111	93	75	104	80	163
Upper Quartile	87	95	151	339	377	702	391	168	144	107	127	95	228
Maximum	302	201	352	923	1463	1709	1516	635	757	453	292	154	470
Average	81	88	135	248	261	558	333	155	142	111	117	85	193

TABLE 11 FAR-FUTURE FLOWS (FULL APPORTIONMENT) SOUTH SASKATCHEWAN RIVER NEAR LEMSFORD (m^3/s)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Minimum	27	33	55	43	43	54	51	43	43	31	45	39	62
Lower Quartile	46	51	70	87	78	198	114	72	59	46	76	58	99
Median	54	60	87	137	153	355	218	100	76	59	91	74	131
Upper Quartile	64	70	109	245	268	528	326	151	106	83	109	89	178
Maximum	212	213	246	646	1024	1534	1362	550	598	317	251	137	418
Average	61	67	100	182	196	418	268	127	113	86	98	77	150

As one component of the Canada-Saskatchewan Flood Damage Reduction Program, Sask Water completed a detailed study of the flood potential of the South Saskatchewan River in 1983. The study included detailed analysis of the flood peak potential of the river upstream of Lake Diefenbaker and downstream of the lake, with allowance for operation of the lake as it was operated in 1983.

Gardiner Dam is one of the largest earth-fill dams in the world. The immense size of the dam and the volume of water impounded by it, have resulted in slow structural adjustments within the foundation. When the dam was built, instruments were installed in the foundation and embankment to measure movements. During its early years of operation, the engineering consultants and staff of PFRA considered it prudent to limit the rate of filling of the reservoir each year as a precaution against damaging the structure. By 1985, the results of the monitoring showed that the foundation conditions were stabilizing and the rate of fill precautions could be relaxed.

The 1983 study results allowed for the rate of rise limits which were in place prior to 1985. The flood attenuation potential of the project was significantly improved after the rate of rise limits were removed in 1985. Therefore, the reservoir flood routing component of the flood hydrology was recalculated as a part of the South Saskatchewan River Basin Study.

The major floods on the South Saskatchewan River occur as a result of high snowmelt and rainfall runoff coinciding in late May and June. The elevation of Lake Diefenbaker in mid May at the start of a flood will determine the flood storage available, which will influence the amount of possible flood control. The historic lake levels for May 15 were reviewed. The lake has generally been above 549.5 m on May 15, the average May 15 elevation has been about 551.3 m and the high May 15 elevation was about 553.05 m. All three starting elevations were evaluated. The highest elevation, 553.05 m, which results in the highest flood potential downstream, was used to generate the flood potential estimate in Table 12. Figure 8 illustrates the flood potential for all starting elevations.

In the future, Lake Diefenbaker might be operated at a higher level than in the past. The flood peak potential for a May 15 level of 554.05 m was therefore also considered. The flood peak potential would be increased as a result of this higher operation, as shown in Table 12. In extreme floods, the difference is only about one percent but in the more frequent floods the difference could be as much as 10 percent or more.

In addition to evaluating the spring and early summer floods, the potential for summer floods in July, August and September was also evaluated. Although the flood potential later in the year is smaller than in May and June because the snowmelt component is reduced and the frequency and severity of extreme rains is less, these late floods present a special management concern. Lake Diefenbaker is normally filled by the early flows and has limited flood storage capacity in the late summer.

It was found that severe floods after July 1 are rare with only eight having occurred in 77 years. Flood peaks and volumes were found to be much smaller than those in May and June.

The late summer floods were also routed through Lake Diefenbaker to determine the routing effect at the higher elevations. Figures 9 and 10 show the late summer flood potential.

3.4 RIVER SYSTEM OPERATION

On the Saskatchewan portion of the South Saskatchewan River there is only one project which provides significant opportunity to control the rates of flow and water levels. This is the South Saskatchewan River Project, which includes Gardiner Dam, the Qu'Appelle River Dam and appurtenant works. They form a large water storage reservoir at Lake Diefenbaker which substantially changes the seasonal flow pattern of the river downstream.

3.4.1 South Saskatchewan River Project Description

The South Saskatchewan River Project was built by PFRA under a cost-sharing agreement between Canada and Saskatchewan. The two major components of the project were construction of the Gardiner and Qu'Appelle River dams. The Gardiner Dam closed off the South Saskatchewan River Valley and raised the water level in it. The Qu'Appelle River Dam was necessary to prevent the water of the South Saskatchewan River from spilling down the Qu'Appelle River Valley because the two valleys are connected. Figure 11 shows the location of these dams and the resulting reservoir, named Lake Diefenbaker.

Gardiner Dam has an earth-fill embankment, a gate controlled concrete chute spillway and five concrete lined gated tunnel outlets. Three of the five tunnel outlets have been developed as penstocks which provide water to the Coteau Creek Generating Station. Table 13 lists the main dimensions of Gardiner Dam.

TABLE 12 — DAILY MEAN FLOOD PEAK POTENTIAL SOUTH SASKATCHEWAN RIVER

Probability in Any One Year	FLOOD PEAK POTENTIAL (m^3/s)		
	Upstream of Lake Diefenbaker	Downstream of Lake Diefenbaker May 15 elevation 553.05 m	Downstream of Lake Diefenbaker May 15 elevation 554.05 m
1:10	3 200	1 600	1 780
1:25	4 400	2 700	2 910
1:50	5 300	3 500	3 650
1:100	6 300	4 300	4 500
1:500	8 500	6 000	6 040

FIGURE 8 DAILY MEAN FLOOD PEAK POTENTIAL DOWNSTREAM OF GARDINER DAM

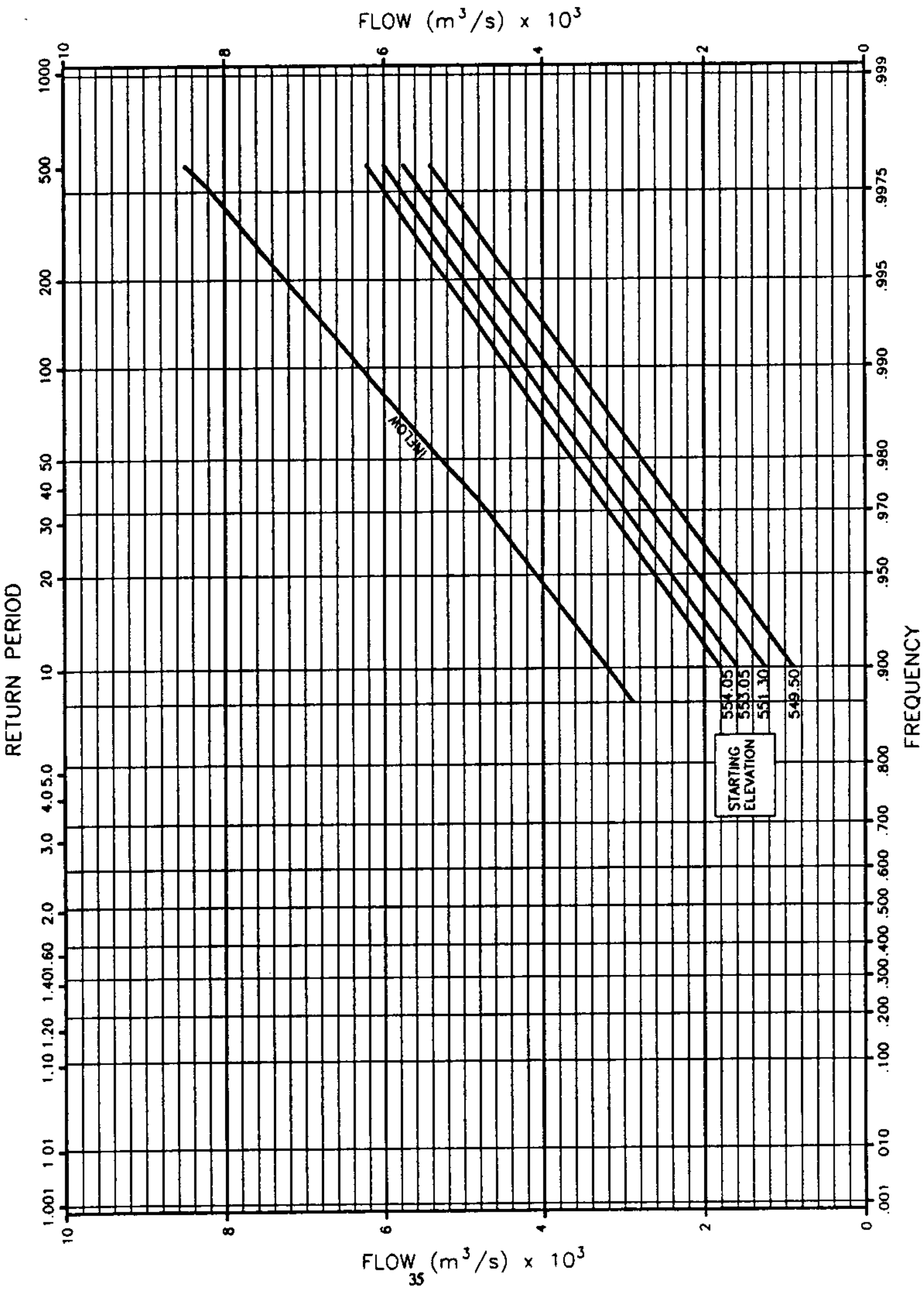


FIGURE 9 JULY FLOOD PEAK POTENTIAL IMPACT OF LAKE DIEFENBAKER

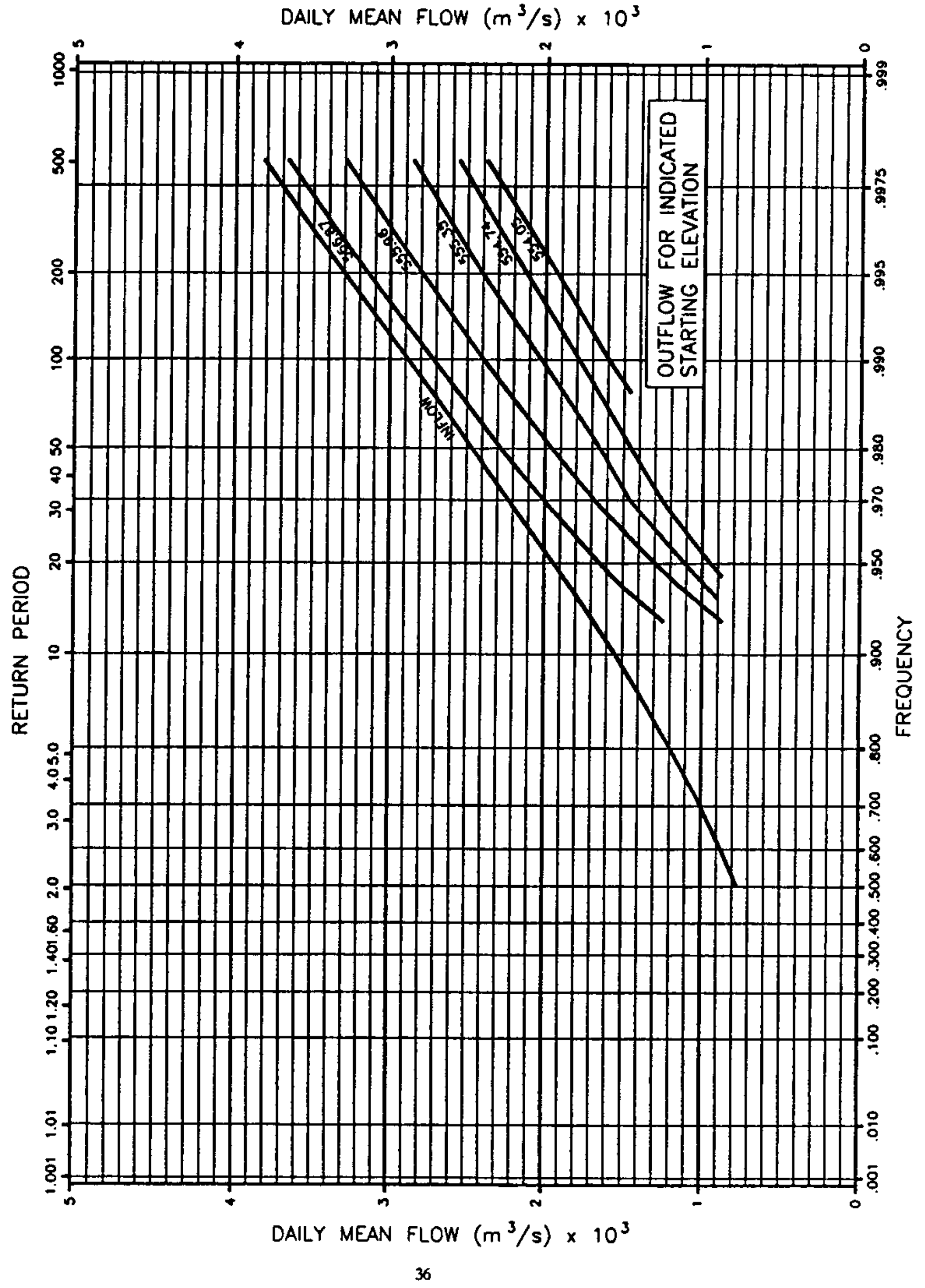


FIGURE 10 AUGUST AND SEPTEMBER FLOOD PEAK POTENTIAL
IMPACT OF LAKE DIEFENBAKER

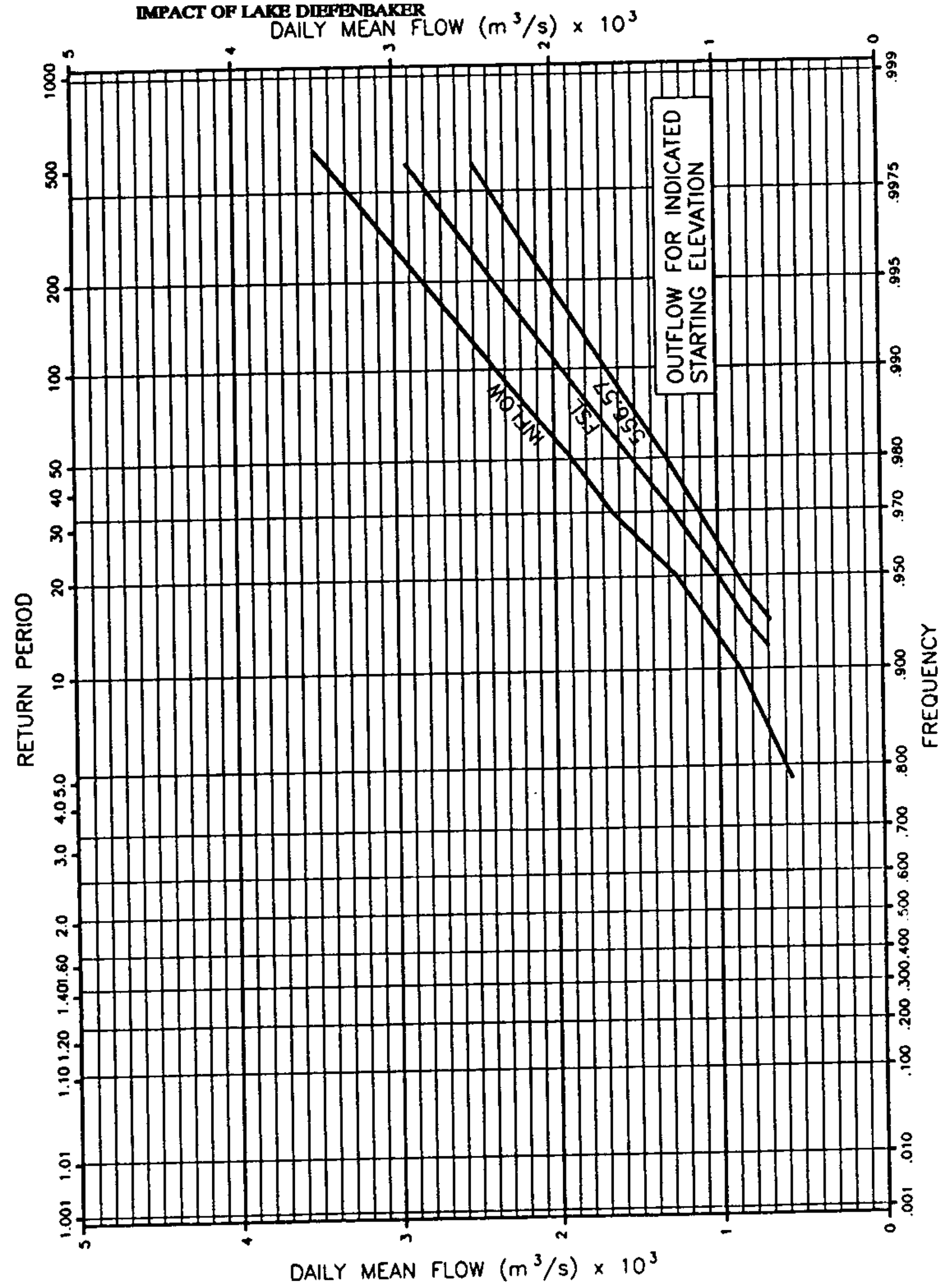


FIGURE 11 LOCATION OF GARDINER DAM, QU'APPELLE RIVER DAM AND LAKE DIEFENBAKER

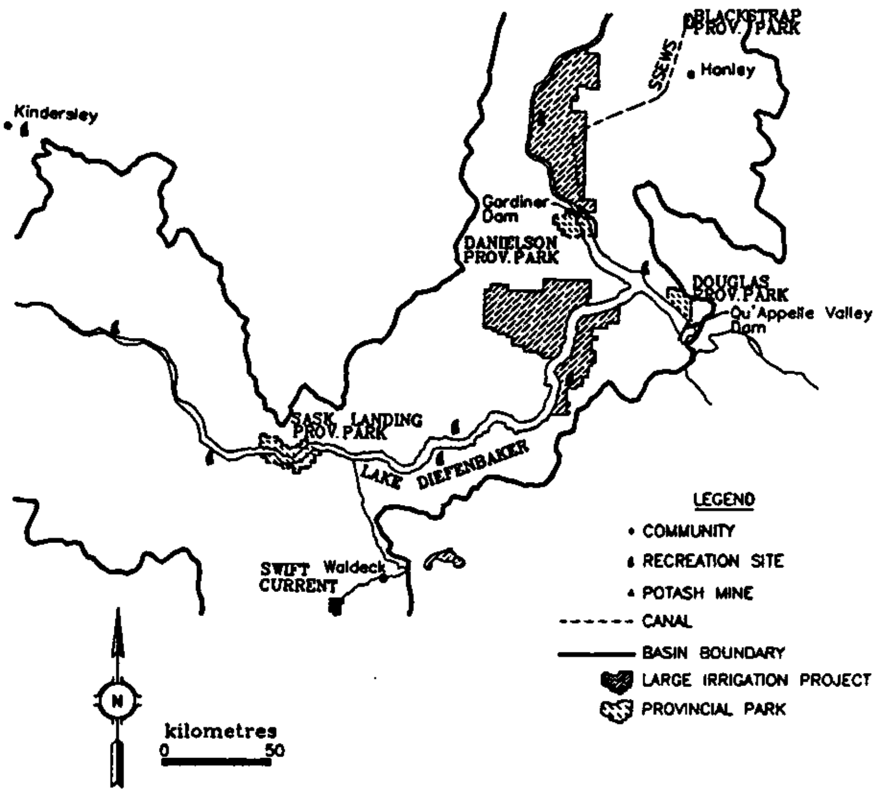


TABLE 13	GARDINER DAM DIMENSIONS
GARDINER DAM - Embankment	
Height	64 m
Length	5 000 m
Width at Base	1 600 m
Volume of Embankment	65 000 000 m^3
Volume of Excavation	86 000 000 m^3
Volume of Concrete	501 000 m^3
Volume of Rip Rap	352 000 m^3
Full Supply Level	556.87 m
Minimum Supply Level	544.98 m
SPILLWAY - Gate Controlled Concrete Chute	
Length of Chute	1 170 m
Length of Crest	161 m
Discharge Capacity	7 500 m^3/s
Spillway Crest Level	548.64 m
DIVERSION WORKS - Concrete lined, gated tunnels	
Number of Tunnels	5
Average Length	1 320 m
Diameter	6.1 m
Inlet Elevation	522.73 m
POWER HOUSE	
Number of Turbines	3
Total Rated Capacity	187.5 Mw
RESERVOIR	
Area at Full Supply Level	43 000 ha
Total Storage	9 400 000 dam^3
Usable Storage	4 000 000 dam^3
Length of Shoreline	760 km
Length of Reservoir	225 km
Depth at Dam	58 m
DRAINAGE BASIN	
Upstream of Gardiner Dam	135 500 km^2

The Qu'Appelle River Dam is also an earth-fill embankment but it does not have any spillway because all flood flows are intended to be released at Gardiner Dam. A gated concrete outlet conduit permits controlled releases to the Qu'Appelle River which are recorded at the hydrometric station known as the Elbow Diversion Structure. Table 14 lists the main dimensions of the Qu'Appelle River Dam.

Construction of the project was started in 1958. By the fall of 1964, sufficient progress had been made that the flow of the river at Gardiner Dam was closed and the water was diverted to the diversion tunnels. The reservoir was filled during the period 1965 to 1968 as construction on the dam progressed. Figure 12 shows the recorded water levels of Lake Diefenbaker from 1965 to 1989. The first hydro-electric power was generated in the fall of 1968 and the project was officially certified as complete on April 1, 1969 when it was turned over to the provincial government.

The project design establishes certain physical limitations on operation. The water level of Lake Diefenbaker must not exceed the full supply level (FSL) of 556.87 m asl and must not drop below 544.98 m. Water levels outside these limits might permanently damage the dams. In order to use the energy of the water, it is desirable that water released from Gardiner Dam be released through the power station. The maximum capacity of the power station varies from 370 to 400 m^3/s, depending on the water level. By operating only one of the three power turbines, lesser flows can be released. The power turbines begin to function inefficiently at flows below about 50 m^3/s. Releases to the Qu'Appelle River can be controlled at rates from 0 to 68 m^3/s. Actual releases to the Qu'Appelle River have been limited by channel capacity to about 11 m^3/s or less.

3.4.2 Forecasting

Operation of Lake Diefenbaker requires estimates of future water supplies and demands. The demands are well established through the licensing of water uses and policies which specify flow objectives. Details of the water demands are documented in the South Saskatchewan River Basin Study Water Use Technical Appendix.

The water supply can be highly variable so the system operators cannot be certain of the exact long-term water supply that will occur in the future. However, the operators do have a substantial amount of information that can be applied to forecasting water supply.

3.4.2.1 Water Supply Probabilities. Assuming that past climatic conditions are a reasonable indication of future conditions, the historic natural flows listed in Appendix C and summarized in Tables 5 and 6 provide the long-term probability of runoff. After adjustment for known and projected water uses, the historic data provides the basis for evaluating the long-term water supply probabilities. Using these flows and a water balance model, the operators can test alternative operating scenarios to determine the best balance among operating patterns over the long-term.

For example, the operators must balance the benefits in terms of improved recreation on Lake Diefenbaker, lower irrigation pumping costs and higher operating head on the power turbines that can be obtained by keeping Lake Diefenbaker at a high elevation all year against the loss of flood control and loss of power generation due to spillage that would result from the reduced usable storage capacity. Using a computer model and 75 years of data, many scenarios can be modelled to provide the operators with a wide range of operating experience to establish the general operating pattern of the project.

3.4.2.2 Seasonal Water Supply Forecasts. Certain aspects of the hydrology of the South Saskatchewan River Basin permit the operators of the system to project flows over periods several months into the future with greater accuracy than simply using the historic normals.

A large portion of spring and early summer runoff originates as mountain snowpack. Using precipitation measurements and snow surveys from the mountain headwaters and comparing the data to measurements and runoff of previous years, it is possible to estimate the probable magnitude of the snowmelt season runoff. The quantity of snow is not the only determinant of the spring and early summer flows. The rate of melt and precipitation during the runoff season also affect runoff. Therefore, the seasonal forecasts are used to project a probable range of flows rather than the specific flows.

The flow of the river at any time is a direct indication of the quantity of water in storage in the river upstream and, to some extent, the quantity of water in storage in the ground water system. There is a strong tendency for high flow periods to be followed by high flows as water comes out of storage. Table 15 summarizes the linear arithmetic serial correlation of the monthly natural flows of the South Saskatchewan River.

FIGURE 12 **LAKE DIEFENBAKER LEVELS 1965 TO 1989**

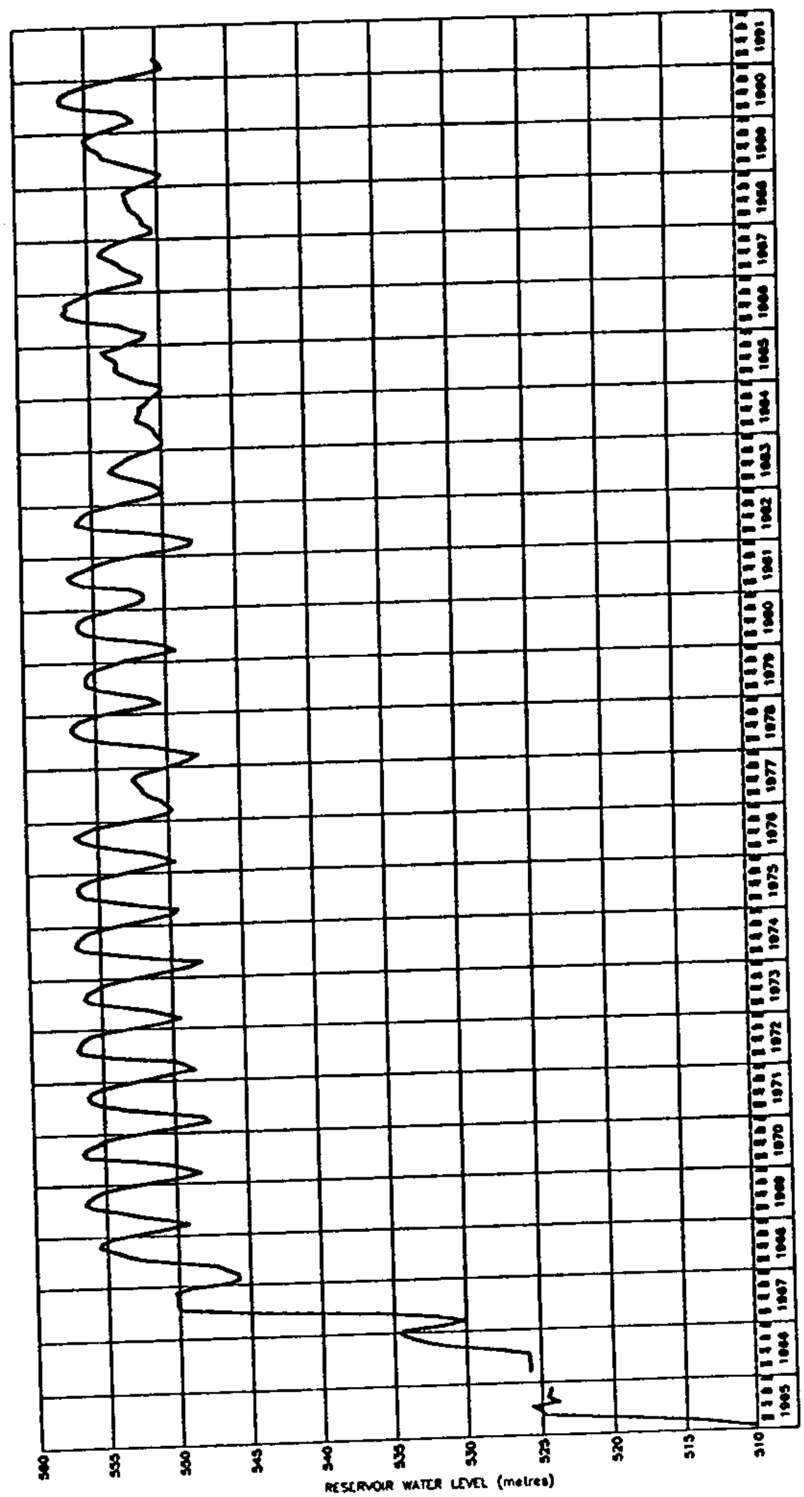


TABLE 14	QU'APPELLE RIVER DAM DIMENSIONS
Height	27 m
Length	3300 m
Width at Base	580 m
Volume of Embankment	10 000 000 m^3
Volume of Excavation	12 200 000 m^3
Volume of Concrete	8 400 m^3
Volume of Rip Rap	215 000 m^3

TABLE 15 LINEAR SERIAL CORRELATION MONTHLY NATURAL FLOWS SOUTH SASKATCHEWAN RIVER AT SASKATOON

Independent Variable	Dependent Variable	Constant	Standard Error	R^2	Coefficient	Standard Error of Coefficient
JAN	FEB	16.3	15.5	.54	.80	.09
FEB	MAR	46.4	52.0	.27	1.36	.27
MAR	APR	226.5	174.0	.05	.68	.34
APR	MAY	285.3	164.0	.33	.64	.11
MAY	JUN	355.9	264.7	.37	1.01	.15
JUN	JUL	164.7	209.2	.47	.58	.07
JUL	AUG	86.3	69.3	.73	.40	.03
AUG	SEP	20.4	88.7	.47	.63	.08
SEP	OCT	22.3	40.5	.80	.67	.04
OCT	NOV	44.7	15.2	.87	.42	.02
NOV	DEC	3.6	13.5	.78	.60	.04
DEC	JAN	17.0	14.3	.54	.55	.06

The strongest serial correlation of natural flows of subsequent months occurs from late summer through winter when all of the flow is the result of outflow from storage. The weakest serial correlation occurs in spring when the runoff is changing rapidly in response to snowmelt and rainfall. The serial correlation can provide some indication of runoff from one month to the next.

Each month SaskWater develops a projection for the following season and project the suitable operation of Lake Diefenbaker.

3.4.2.3 Short-term Forecasts. It takes as much as eight days for water to flow from the headwater area to Lake Diefenbaker. In high flow periods the travel time reduces to about six days. The Sask Water Forecast Centre receives daily water flow measurements from hydrometric stations in Alberta and calculates the flow that will arrive at the lake in the next few days from that data. In addition to the upstream flows, the rate of recession is also known so the minimum flow projection can extend beyond a week. A weekly forecast of daily flows is produced covering a ten day period. In extreme events, the daily flow projection is updated each day or as necessary.

3.4.3 Typical Operation Patterns

Whenever the water supply permits, an attempt is made to have Lake Diefenbaker full in the autumn. This operation provides the maximum water supply for winter hydro-electric generation and the maximum head for the generating turbines. Through the peak power demand months of December, January and February the lake level drops because of power generation.

By late February, information on the snow accumulation in the headwaters permits preliminary estimates of the spring runoff. If heavy snow accumulations are in place, the high release rates are continued through late February and March to evacuate storage so the anticipated high runoff can be better utilized. If snow is light, the March releases are reduced in order to retain the remaining water as a hedge against potential drought.

The lowest lake levels generally occur around April 1, then, as the spring snowmelt causes increasing inflows, the lake begins to fill. The rate of filling must be timed to balance the risk of heavy rains and flooding against the risk of low rainfall and failure to fill the lake. In addition to obtaining desirable lake levels, the operation must provide for adequate but not excessive flows downstream. Flows in the 60 to 150 m^3/s range are preferred. In drought years flows as low as 42.5 m^3/s are permitted but are avoided when possible. In flood years higher flows become necessary if the storage is inadequate to provide desirable flood attenuation.

3.5 SEDIMENT

The South Saskatchewan River carries a substantial quantity of sediment into Saskatchewan. The sediment enters the river mainly in the western plains area of Alberta where the fine grained soils are readily erodible and runoff volumes are sufficient to erode the soils. In eastern Alberta and Saskatchewan, the soils are erodible but runoff rates are too low to cause major erosion. The Red Deer River tends to carry a larger sediment load in relation to the flow than the South Saskatchewan River.

The sediment load tends to be greatest during periods of high flow when overland runoff and high channel velocities occur. During low-flow periods, when much of the flow is from ground water, the sediment load is light. Additional variation arises as a result of seasonal influences. Rainfall runoff from the prairie tends to carry more sediment than snowmelt runoff in the mountains. The annual suspended sediment load reaching Saskatchewan averages about 6 100 000 tonnes and varies from 2 000 000 to 10 000 000 tonnes. In Saskatchewan, the small local inflows add modestly to the suspended sediment load and sediment which rolls along the bed of the river, which is not measured, also contributes to this load. These sources likely add less than 10 percent. The total average sediment inflow to Lake Diefenbaker averages about 6 700 000 tonnes per year.

Lake Diefenbaker is a very efficient sediment trap. Its volume exceeds the average annual flow of the river so its retention time exceeds one year. No sediment reaches the outlet at Gardiner Dam. Suspended sediment sampling at the outlet of the lake confirms that no sediment is passing through the lake.

Sediment in lakes tends to settle to a maximum density of about 1 000 kg/m^3. The sediment reaching Lake Diefenbaker is depleting the storage by about 6 700 dam^3 per year, on average. At this rate, over a period of about 1 400 years, the total storage of Lake Diefenbaker would be filled. The actual filling may be even slower since inflows are anticipated to be reduced by upstream developments and additional Alberta reservoirs may further reduce the sediment load.

Downstream of Lake Diefenbaker, the water has a substantially stronger erosion potential because of its lack of suspended material. This clear water is slowly eroding the river channel. However, the sandy bottom resists erosion and the lack of high flood flows reduces the erosion. The river bed immediately downstream of Gardiner Dam has dropped more than 2 m as a result of this scour by the clear water releases. It has been estimated that the river bed could erode as much as 7 m over a period of hundreds of years. Most of the scour is occurring in the first few kilometres downstream of the dam.

Between the dam and Saskatoon the river regains less than five percent of sediment load carried above Lake Diefenbaker.

The section of the river from the Alberta-Saskatchewan border to Saskatoon has a deep alluvial sand and gravel bottom. Downstream of Saskatoon, the river has thin alluvial bottom over local glacial till. The river is naturally quite active as a result of its generally erodible bed and, as a result, man-made structures along the river can encounter problems that can only be avoided by careful planning and design.

4.0 SWIFT CURRENT CREEK

4.1 DEVELOPMENT HISTORY

From the late 1800s to the present, the water of Swift Current Creek has been progressively diverted to human uses. In the early years, most of the use was for individually developed private irrigation, stock watering and municipal uses along the creek and its tributaries. In 1942, PFRA completed the Duncairn Dam forming Duncairn Reservoir 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.

Swift Current Creek is the largest tributary to the South Saskatchewan River in Saskatchewan but its average flow of about one 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 has traditionally been managed as an independent unit.

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 with evaporation the only outlet. If conditions were ever wet enough to fill Reed Lake, outflow would occur 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 nearly 5 000 km^2 of area as shown on Figure 13. There are a total of 1 042 water use projects in the drainage basin as summarized in Table 16. This list includes all of the irrigation, domestic and other uses. The main use of water is for irrigation with the city of Swift Current being the other large user. There are a large number of domestic projects, mainly stock watering ponds, but their combined use is small. The five largest reservoirs in the Basin are listed in Table 17. Duncairn, Highfield and Herbert reservoirs are operated by PFRA as part of the water management system. Swift Current Reservoir is operated jointly by PFRA, as the head pond for the diversion canal to Rushlake Creek, and by the city of Swift Current, as a raw water source. Lac Pelletier is a natural lake that has been raised about 1 m by a control dam that is operated by a Regional Park. Because all of the available water in many low flow years is committed to existing uses, additional development of irrigation has not been permitted in recent years.

4.2 WATER SUPPLY HYDROLOGY

4.2.1 Natural Flows

PFRA completed a detailed study of water supplies in the Swift Current Creek Basin in 1984 for which the natural flows for the period 1911 to 1981 were calculated. The calculations were completed using the project depletion method in which the recorded flows were adjusted for the upstream water uses and releases from storage. The PFRA calculations were updated to 1989 using data up to 1986. The three main steps were as follows:

1. Recorded flows were adjusted by computing the volume of water stored, diverted and lost to evaporation upstream of the hydrometric station within each month.

2. Because Swift Current Creek flows vary sharply from month to month, a significant error can be introduced due to the travel time from upstream to downstream stations. Therefore a transfer factor was used to account for the travel time between Duncairn Reservoir and Swift Current, (2.75 days), and between Swift Current and the mouth of Swift Current Creek, (1.63 days), based on average travel times.

3. The first two steps only considered the major diversion and storage works. A less detailed adjustment for the many minor projects was completed. It was assumed that the minor projects control a consistent portion of the drainage basin. As long as the runoff from that portion of the basin exceeded the minor uses, they were assumed to use their full allotment. If less runoff was available, they would use all of the flow. Calculated monthly water uses for the minor uses were added to the partially naturalized flows calculated above to obtain the final natural flow.

FIGURE 13 SWIFT CURRENT CREEK AND RUSH LAKE DRAINAGE BASIN

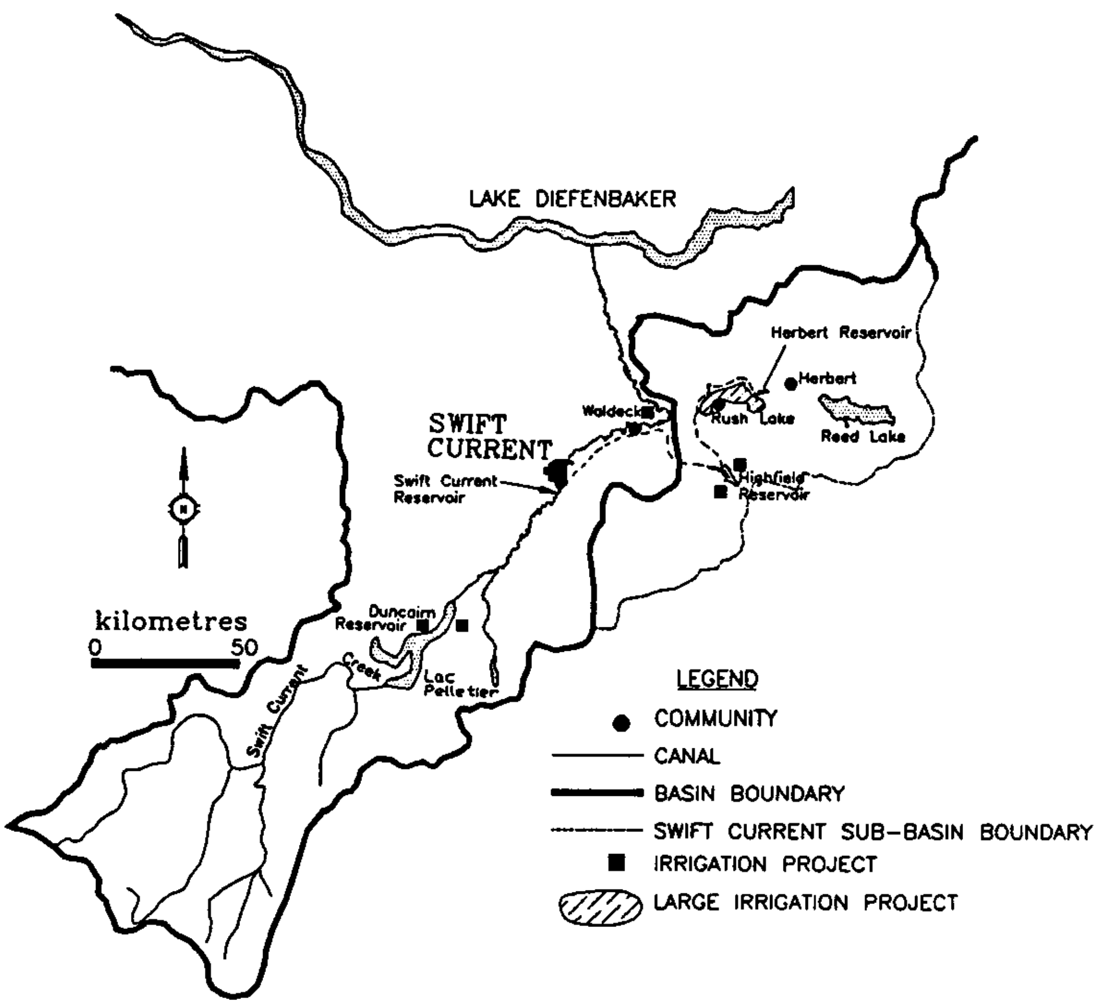


TABLE 16 SWIFT CURRENT CREEK WATER USE

LOCATION	NO. OF PROJECTS	IRRIGATED AREA (ha)	TOTAL ALLOCATION (dam³)
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 to 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
City of Swift Current	1	–	5 867
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	1 042	8 698	32 729

TABLE 17

SWIFT CURRENT CREEK RESERVOIRS

DRAINAGE BASIN	RESERVOIR NAME	FSL (m asl)	CAPACITY (dam^3)	AREA (ha)	CONSTRUCTION DATE	USE
Swift Current Creek	Duncairn Reservoir	807.72	103 150	1451	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 Reservoir	710.12	2 590	63	1953	Irrigation Municipal

After the recorded flows were naturalized at the main hydrometric stations, estimates of flows at other study points in the drainage basin were estimated based on the drainage areas. The estimated natural flows for points in the Swift Current Creek Basin are listed in Appendix C. Table 18 and Table 19 summarize the natural water supply of Swift Current Creek and Rushlake Creek.

4.2.2 Current Conditions

Man-made projects in the Swift Current Creek Basin substantially alter the natural flow regime. In order to define how the flows might be expected to vary under existing conditions, the Water Resource Management Model was used to adjust the natural flows over the study period by the quantity of water that is currently being used or stored. The resulting flow and water level arrays are detailed in Appendix C. Tables 20 and 21 summarize the flow patterns.

4.3 FLOOD HYDROLOGY

4.3.1 Introduction

The city of Swift Current is located on Swift Current Creek. The city has occasionally experienced flood problems. The drainage area upstream of the city is 3 200 km^2 of which 2 300 km^2 is effective in contributing flow to the creek. Duncairn Reservoir captures runoff from about 75 percent of this drainage basin. Duncairn Reservoir controls the flow of Swift Current Creek most years but in very wet years floods still occur.

Serious flood damages occurred during a major flood in 1952, the largest flood recorded in this basin. The city was on flood alert for two weeks with 139 families evacuated from the floodplain. The flood severely damaged Duncairn Dam, washing out the spillway chute and stilling basin. An emergency spillway channel was excavated to protect the main dam embankment from overtopping.

The peak inflow to Duncairn Reservoir was 182 m^3/s on April 16, 1952. Duncairn Reservoir captured the early runoff and a portion of the peak outflow. The peak of the flooding at the city of Swift Current resulted from local runoff arising downstream of Duncairn Reservoir which produced a peak flow of 167 m^3/s on April 12. Based on studies completed in 1981, PFRA estimated that the flood peak would have been about 244 m^3/s under natural conditions.

4.3.2 Flood Hydrology Studies

As a component of the Canada/Saskatchewan Flood Damage Reduction Program (FDRP), the PFRA Hydrology Division completed a study of the flood hydrology of Swift Current Creek in 1981. This study was based on a 67 year historic record of flows in the drainage basin. No large floods have occurred since this study was completed. As part of a dam safety evaluation, PFRA reviewed the flood potential estimate in 1988 and concluded that it was still valid. Therefore, the results have been accepted for the South Saskatchewan River Basin Study.

Because Duncairn Reservoir has a major influence on the flood hydrology, the study analyzed the flows in two components: upstream and downstream of Duncairn Reservoir. The flood hydrographs of the two components were calculated and combined by a stream routing computer model.

Duncairn Reservoir is primarily a water supply reservoir but flood reduction is also considered in its operation. The following objectives are used in planning Duncairn Reservoir operation during the spring runoff period:

1. Fill Duncairn Reservoir to FSL if possible to provide for its primary water supply function.
2. Do not surcharge above elevation 808.63 m (0.91 m above FSL) in order to provide freeboard below the top of the dam for wave action. The top of the dam is at 810.16 m with a low section of the spillway at 809.24 m.
3. When possible, limit flows at Swift Current to 85 m^3/s.

TABLE 18 — NATURAL FLOWS SWIFT CURRENT CREEK NEAR THE MOUTH (m^3/s)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Minimum	0.00	0.00	0.08	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.62
Lower Quartile	0.06	0.05	2.83	4.51	1.76	1.15	0.47	0.30	0.16	0.45	0.28	0.19	1.64
Median	0.14	0.13	6.19	7.55	2.16	1.61	0.88	0.73	0.45	0.65	0.50	0.27	2.27
Upper Quartile	0.20	0.56	10.76	15.32	3.39	2.44	1.41	1.19	0.69	0.97	0.65	0.37	3.17
Maximum	6.19	7.92	32.80	88.04	12.45	8.06	11.57	2.43	2.16	1.76	1.48	1.41	8.39
Average	0.25	0.64	7.95	12.55	3.01	2.02	1.28	0.77	0.49	0.68	0.49	0.29	2.54

TABLE 19 — NATURAL FLOWS RUSHLAKE CREEK AT HIGHFIELD RESERVOIR (m^3/s)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Minimum	0.000	0.000	0.000	0.048	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Lower Quartile	0.000	0.000	0.738	0.352	0.000	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.015
Median	0.000	0.008	1.027	0.950	0.036	0.052	0.001	0.000	0.000	0.000	0.000	0.000	0.283
Upper Quartile	0.000	0.061	1.843	2.602	0.148	0.187	0.108	0.000	0.000	0.000	0.000	0.000	0.408
Maximum	0.000	2.022	5.513	13.220	0.860	1.252	2.288	0.287	0.049	0.026	0.000	0.000	1.190
Average	0.000	0.090	1.389	1.881	0.115	0.128	0.111	0.004	0.004	0.001	0.000	0.000	0.310

TABLE 20 CURRENT CONDITION FLOWS SWIFT CURRENT CREEK NEAR THE MOUTH (m^3/s)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Minimum	0.20	0.07	00.20	0.20	0.15	0.03	0.00	0.00	0.00	0.00	0.20	0.14	0.30
Lower Quartile	0.50	0.50	00.82	0.37	0.20	0.20	0.20	0.20	0.20	0.26	0.54	0.52	0.51
Median	0.53	0.52	01.90	1.25	0.23	0.20	0.20	0.20	0.20	0.37	0.64	0.57	0.79
Upper Quartile	0.55	0.63	04.38	8.24	0.37	0.20	0.20	0.20	0.20	0.59	0.71	0.62	1.64
Maximum	5.45	2.83	32.30	88.61	8.48	3.65	9.25	0.54	0.29	1.32	0.94	0.89	7.95
Average	0.58	0.64	3.85	7.16	0.69	0.30	0.31	0.18	0.19	0.42	0.62	0.55	1.32

TABLE 21 CURRENT CONDITION FLOWS RUSHLAKE CREEK AT HIGHFIELD RESERVOIR (m^3/s)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Minimum	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007
Lower Quartile	0.000	0.000	0.385	0.034	0.000	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.090
Median	0.000	0.006	0.571	0.520	0.023	0.034	0.001	0.000	0.000	0.000	0.000	0.000	0.165
Upper Quartile	0.000	0.040	1.090	1.614	0.097	0.121	0.069	0.000	0.000	0.000	0.000	0.000	0.249
Maximum	0.000	1.293	3.518	8.784	0.564	0.822	1.517	0.188	0.032	0.017	0.000	0.000	0.783
Average	0.000	0.058	0.810	1.134	0.075	0.083	0.073	0.003	0.000	0.000	0.000	0.000	0.186

The flood routing at Duncairn Reservoir was completed based on the following operating rules:

1. The starting elevation was assumed to be 807.67 m, the average level based on records for the period 1971-79.

2. No release was assumed until Duncairn Reservoir filled to 806.2 m.

3. When the level of Duncairn Reservoir reaches elevation 806.2 m, determine the appropriate release pattern based on either a) or b).

    a) if inflow is greater than 57 m^3/s and increasing (reservoir rising faster than 18 cm/12 hr) then release 28 m^3/s until the lake reaches FSL or stops rising. If the water level stops rising, the release would be stopped until the lake is full, then resumed to hold the lake at FSL.

    b) if inflow is less than 57 m^3/s (reservoir is rising lower than 18 cm/12 hrs) or if inflow is decreasing, then no water would be released until the lake is full.

4. When the level exceeds FSL but is below the maximum safe surcharge level of 808.63 m, the release would be 85 m^3/s until the lake returns to FSL.

5. If the lake reaches 808.63 m, the outflow would equal inflow to insure the safety of the dam.

Routing results for Duncairn Reservoir are summarized in Table 22.

The Duncairn Dam releases were routed downstream and combined with the local inflows arising below the dam to estimate the flood potential at Swift Current as summarized in Table 23.

Duncairn Reservoir controls floods up to the 1:50 year event. Even in the larger events, the lake reduces the flow during the early part of the runoff so that the flood peak is substantially reduced. The local runoff flood which cannot be controlled at Duncairn Reservoir contributes most of the regulated flood crest.

4.3.3 Hydraulic and Damage Potential Studies

As part of the Canada/Saskatchewan Flood Damage Reduction Program, PFRA calculated backwater profiles through the city of Swift Current for the estimated 1:10 to 1:500 year floods.

Based on these flood levels an inventory of the potentially damaged property in Swift Current and an estimate of the damage potential was derived for the Flood Damage Reduction Program.

A total of 263 homes and 12 commercial, industrial and institutional buildings could be affected by the 1:500 year flood. The potential damage in moderate floods is not large but the damage could be severe in extreme floods. Tables 24, 25 and Figure 13 summarize the damage potential.

The average annual flood damage potential has been reduced by about 40 percent as a result of Duncairn Reservoir. Since these values were based on a 1981 inventory, the damage potential would now be somewhat higher due to inflation but the relative values are comparable since no new development has been permitted in the flood plain in recent years.

4.3.4 Possible Flood Control Operation

The potential for additional flood control using Duncairn Reservoir is very limited. For the 1:10, 1:50 and 1:100 year floods, the local runoff from downstream of Duncairn Reservoir causes the flood peak. Therefore, additional flood control operation at Duncairn Reservoir would not improve the flood levels significantly. In the 1:500 year flood, the volume of runoff exceeds the capacity of Duncairn Reservoir and the operation of the dam must ensure its safety.

TABLE 22 — DUNCAIRN RESERVOIR FLOOD ROUTING

	INFLOW					
PROBABILITY	VOLUME (dam^3)	DAILY PEAK (m^3/s)	INSTANTANEOUS PEAK (m^3/s)	OUTFLOW PEAK (m^3/s)	PERCENT REDUCTION	MAXIMUM RESERVOIR LEVEL (m)
1:2	23 000	32	35	0	100	806.29
1:5	45 400	61	68	8	88	807.72
1:10	63 600	84	93	28	70	807.72
1:50	109 600	144	159	85	47	808.51
1:100	131 900	173	191	174	9	808.63
1:500	191 640	251	277	277	0	808.63

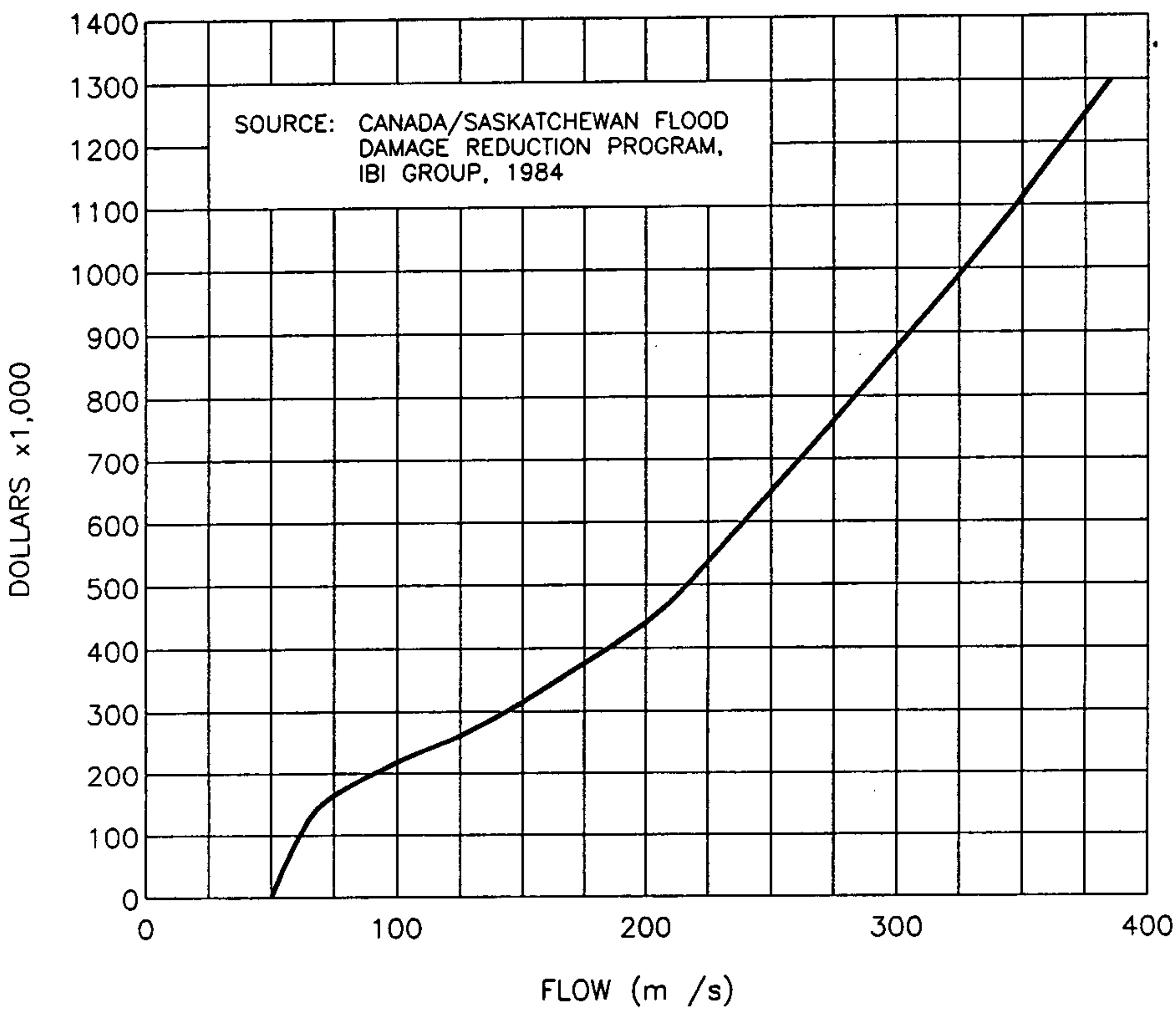
TABLE 23 — CITY OF SWIFT CURRENT FLOOD POTENTIAL

		SWIFT CURRENT	
PROBABILITY	LOCAL PEAK (m^3/s)	REGULATED (m^3/s)	NATURAL (m^3/s)
1:10	82	82	135
1:50	139	153	230
1:100	164	193	270
1:500	229	334	384

TABLE 24 CITY OF SWIFT CURRENT FLOOD DAMAGE POTENTIAL		
PROBABILITY	DAMAGE POTENTIAL ($)	FLOW (m^3/s)
1:10	162 600	82
1:50	317 200	153
1:100	444 500	193
1:500	1 076 500	334

TABLE 25 CITY OF SWIFT CURRENT NATURAL CONDITIONS DAMAGE POTENTIAL		
PROBABILITY	DAMAGE POTENTIAL ($)	FLOW (m^3/s)
1:10	270 000	82
1:50	600 000	230
1:100	800 000	270
1:500	1 200 000	384
Average Annual	53 000	

FIGURE 14 SWIFT CURRENT FLOOD DAMAGE POTENTIAL VS. FLOW



4.4 OPERATION

Swift Current Creek Basin developments include simple single purpose projects and a complex, multipurpose diversion system.

The simplest projects are the many stock watering and small irrigation projects along the headwaters of tributary streams. These projects consist of excavated dugouts, dykes or small dams which capture the runoff as it occurs. In general, these projects are upstream of the major storage reservoirs and they rely upon the runoff from a small local area each spring to meet the uses for the year.

Lac Pelletier is one of the largest water bodies in the basin but it requires little operation. This lake was a natural pond. The control dam is a low dyke which was built to raise the lake about 1 m above its natural level to enhance its recreation value. The dam requires very little operation since all of the outflow occurs through an overflow spillway.

Duncairn Reservoir, which was created by construction of Duncairn Dam by PFRA in 1942, is the largest reservoir in the basin with a total storage capacity of 103 000 dam^3. This reservoir was built to capture the runoff during high flow periods in order to make water available in dry periods. The reservoir helps to improve the water supply in two ways. The natural flow regime provides most of the runoff in the spring snowmelt season and very little water in the rest of the year. The reservoir captures the spring flows and permits controlled releases to meet needs in the rest of the year. The natural flow regime provides variable amounts of water from one year to the next. The reservoir can store water in wet years for subsequent use in dry years.

Duncairn Dam was designed to store water to a maximum elevation of 807.72 m asl corresponding to a volume of 103 000 dam^3. It is possible to surcharge the lake to 808.63 m for a brief period for flood control but it cannot be held at this surcharged level for long periods. Therefore, for water supply purposes, the lake has a maximum capacity of 103 000 dam^3.

Some water is withdrawn from Duncairn Reservoir by pumps to irrigate 947 ha of land. Water is also released from the lake through Duncairn Dam to flow down Swift Current Creek. The released water provides supply to 1 622 ha of irrigated land along the creek between Duncairn Dam and Lake Diefenbaker; municipal water for the city of Swift Current; and water for diversion via the Swift Current Canal to irrigation projects east of Swift Current.

In addition to meeting these consumptive water uses, Duncairn Reservoir is a significant local recreation lake and waterfowl staging area and it supports a sport fishery.

In order to protect the fishery and recreation and to reserve sufficient water for the city of Swift Current, no withdrawal of water from Duncairn Reservoir for irrigation is permitted if the lake is lower than elevation 803.72 m. This reserves a volume of 52 000 dam^3 of water.

The city of Swift Current is the largest demand on Duncairn Reservoir after irrigation. The city demand has averaged 3 159 dam^3 in recent years and in order to provide for future city growth, 5 867 dam^3 of water per year has been reserved for the city. The city water is delivered from Duncairn Reservoir by releases from Duncairn Dam. The water flows down Swift Current Creek to the Swift Current Reservoir. In order to ensure that sufficient water reaches the city reservoir, extra water must be released to provide for channel losses. In winter, from November 1 to February 28, a release rate of 0.566 m^3/s is required to keep a live flow under the ice. The total winter release is about 5 900 dam^3 to meet a net use of about 1 000 dam^3. In summer, the city release is commonly a part of the irrigation release but in periods when no irrigation release is needed, the minimum release is kept at 0.283 m^3/s, which is over twice the city use in order to ensure the city needs are met.

Since 1977, the city of Swift Current treated effluent has been used entirely for irrigation. No effluent releases are currently made to Swift Current Creek.

In addition to being the supply point for the city of Swift Current, the Swift Current Reservoir is the turn-out from Swift Current Creek to the Swift Current Main Canal. This canal can transport up to 5.1 m^3/s of flow which originated at Duncairn Reservoir on Swift Current Creek for irrigation and other uses.

The Swift Current Main 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 to supplement the local runoff from Rushlake Creek. Highfield Reservoir has a storage capacity of about 15 000 dam^3 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 2 600 dam^3 of storage capacity for irrigation and for the municipal supply to the town of Herbert.

In most years, there is sufficient runoff to supply all of the existing water uses but occasionally the supply is inadequate. In years when the supply is inadequate, 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.

4.5 SEDIMENT

Swift Current Creek is in a geologically young region with naturally erodible soils. The creek is slowly eroding its valley.

The rate of erosion is highly dependant on the rate of flow, which is relatively small on average. The volume of soil moved is, therefore, not rapidly changing the topography. Based on suspended sediment measurements from 1965 to 1972, the average annual sediment load on Swift Current Creek near the mouth was about 59 000 tonnes per year, and it varied from about 1 000 to 153 000 tonnes per year.

The upstream portion of Swift Current Creek is controlled by Duncairn Reservoir and other reservoirs which trap the upstream sediment. The sediment reaching the downstream end of the creek arises from erosion downstream of Duncairn Reservoir. Assuming that the upstream basin produces as much sediment per km^2 as the downstream basin, it would take over 1 000 years to fill Duncairn Reservoir with sediment.

5.0 SASKATOON SOUTHEAST WATER SUPPLY (SSEWS)

5.1 DEVELOPMENT HISTORY

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 to the northeast. 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 (SSRID) near Outlook. The Saskatchewan Water Supply Board built the canal and reservoirs 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. In 1984, the agencies responsible for the two systems were consolidated in Sask Water. For this appendix, the entire diversion scheme is referred to as the SSEWS system. Figure 15 shows the SSEWS system.

5.2 PROJECT DESCRIPTION

5.2.1 East Side Pump Station

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 level of the lake to a canal. The pump station has four pumps with sufficient capacity to fully supply the canal plus reserve capacity in case a pump fails.

5.2.2 Main Canal (M1)

The first 23 km of canal downstream of the East Side Pump Station has a maximum capacity of 14.4 m^3/s. This canal carries water to Broderick Reservoir and about one-third of the South Saskatchewan River Irrigation District draws water directly from the canal. Broderick Reservoir is the source of supply for about two-thirds of the South Saskatchewan River Irrigation District and the town of Broderick.

Broderick Reservoir was also developed to cushion the effect of peak demands so that the East Side Pump Station and M1 Canal could be designed with a capacity smaller than the instantaneous peak demand. The reservoir has a total capacity of about 16 400 dam^3. The upper limit of operation is at elevation 563.88 m based on the height of the dam and dykes that form the reservoir. The minimum operating level is 559.62 m. At this level the outlet structure to the east begins to lose capacity. The usable storage capacity is 14 000 dam^3. Broderick Reservoir is not located on a natural stream. There is little natural runoff to this reservoir.

Because this reservoir fluctuates over a wide range to serve its primary water supply purpose, no shoreline recreation development has been permitted and no stocking of fish has occurred. There is modest local use of the reservoir for fishing and recreation when conditions permit.

5.2.3 M2 Canal

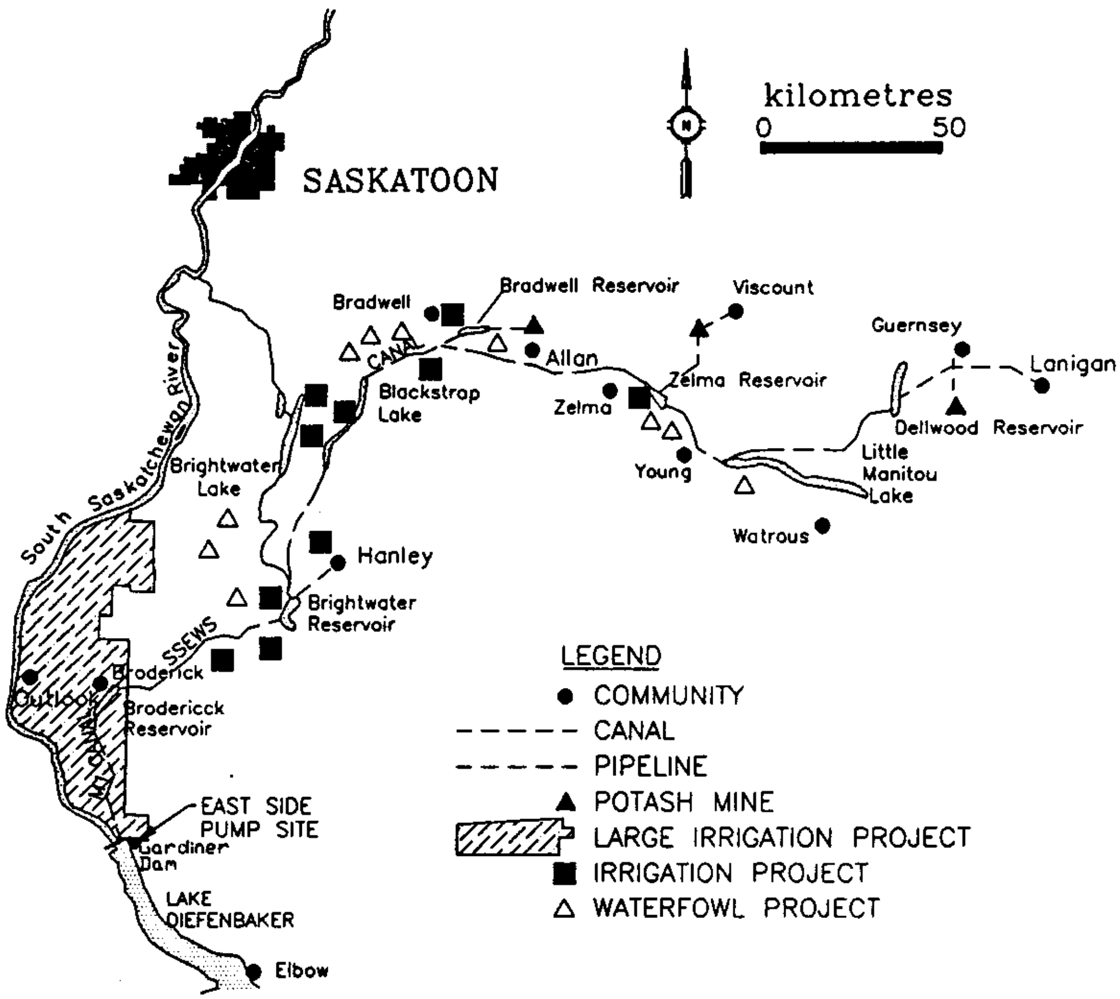
The M2 Canal receives water from a control structure near the west end of Broderick Reservoir and serves the northern portion of the South Saskatchewan River Irrigation District. The canal has a capacity of 11.9 m^3/s.

5.2.4 South Saskatchewan River Irrigation District

The South Saskatchewan River Irrigation District is a local authority established to manage the operation of the common works of the irrigators in the district. The operation is managed by an elected board that hires staff to carry out the work required to operate and maintain the canals, gates and drains for the district.

In 1986, there were 16 278 ha under irrigation in the 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 small.

FIGURE 15 PLAN OF SASKATOON SOUTHEAST WATER SUPPLY SYSTEM



5.2.5 Broderick to Brightwater Canal

This canal receives water from Broderick Reservoir by controlled gravity release. It has a capacity of 6.8 m^3/s at its upstream end and 6.5 m^3/s at the downstream end. This reach is 34.6 km in length. The canal follows the natural contours of the land to avoid deep cuts or fills. The canal provides water to irrigators within a strip about 3 km on each side of the canal and delivers water to Brightwater Reservoir.

5.2.6 Brightwater Reservoir

The Brightwater Reservoir was created by damming Brightwater Creek. The reservoir allows water to move from one side of the creek valley to the other and provides additional storage capacity to meet peak demands. The reservoir also permits the integrated management of the natural runoff on Brightwater Creek. 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 reservoir capacity is 8 000 dam^3 with 2 300 dam^3 usable 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.

5.2.7 Brightwater to Blackstrap Canal

This canal conveys water at a maximum capacity of 5.1 m^3/s a distance of 15.4 km north to Blackstrap Lake. A few irrigators draw water from the canal.

5.2.8 Blackstrap Lake

Blackstrap Lake was formed in a glacial valley by constructing two dams to isolate a 14 km reach of the valley. This natural valley provides an opportunity to avoid construction of 14 km of canal; storage capacity for flow regulation and an opportunity for recreation development.

In addition to developing the lake, the province created two resort villages adjacent to the lake to encourage recreation 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 recreation activity.

The lake has a total capacity of 61 650 dam^3. It is usually operated within a 0.3 m range and its maximum design fluctuation is about 1 m. The relatively large lake area provides a substantial storage volume in spite of its limited operating range. The live storage capacity is 11 000 dam^3.

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

5.2.9 Blackstrap to Zelma Canal

The canal downstream of Blackstrap Lake has a capacity of 2.8 m^3/s. The canal serves several irrigators, waterfowl projects and a diversion to Bradwell Reservoir. The canal extends 13.7 km to the Bradwell turnout where the capacity drops to 2.3 m^3/s for the 30.6 km to Zelma Reservoir.

5.2.10 Bradwell Reservoir

Bradwell Reservoir is supplied by a tributary canal from the Blackstrap to Zelma Canal. It serves local irrigators and the Allan Potash Mine. It has a total capacity of 4 600 dam^3 and live storage capacity of 2 200 dam^3.

This reservoir is used for limited recreation activities but has no permanent facilities.

5.2.11 Zelma Reservoir

Zelma Reservoir is located along the main canal route. Its total storage capacity is 14 500 dam^3 and 5 900 dam^3 of storage is available to meet peak demands of the downstream system, local irrigation and the Central Canada Potash Mine near Colonsay.

5.2.12 Zelma to Dellwood Canal

From Zelma, the canal flows by gravity 14.7 km with a capacity of 1.4 m^3/s to a point north of Watrous where water can be diverted to Little Manitou Lake or lifted by pumping to a canal with a capacity of 0.7 m^3/s that carries on 25.8 km to Dellwood Reservoir.

5.2.13 Little Manitou Lake

Little Manitou Lake is a natural lake in a deep local depression. The lake receives runoff from a small natural drainage area and ground water discharge. There is no outflow from the lake except through evaporation, hence, the lake is highly mineralized. The lake level varies with the balance of runoff and evaporation. In its natural state, the lake level fluctuated widely. The availability of diverted water in dry years has eliminated the extreme low lake levels and has helped to stabilize the lake level.

At its optimum level of 494.39 m, the lake has an area of 1 500 ha. The average annual evaporation loss is about 7 500 dam^3. On average, about half of this loss is met by natural runoff and half by diversion water.

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 Little Manitou 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.

5.2.14 Dellwood Reservoir

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 reservoir has a total capacity 5 800 dam^3 and a live storage capacity of 3 500 dam^3.

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 pumpstation at Dellwood Reservoir.

Water can also be released through the dam where it flows by gravity to Last Mountain Lake.

5.3 WATER SUPPLY HYDROLOGY

The SSEWS system is a man-made supply system designed to carry water to users in an area of limited natural water supplies. The main water supply source is the diversion of water from Lake Diefenbaker but the system was designed to conserve the modest natural inflows to the system reservoirs when they occur.

The natural flows of the local streams which can be managed by SSEWS system are listed in Appendix C and summarized in Table 26.

The natural runoff is an unreliable source of supply that is used when it is available to reduce pumping costs and to minimize the total diversion quantity. The water developments in the SSEWS system must rely on the diverted supply in low runoff years.

The canals of the system were not intended for winter operation. The longest reasonable season for their operation is about five months. Table 27 summarizes the maximum diversion that could occur each. It must be emphasized that these are the theoretical upper limits of the system capacity which could only be met if demands occurred uniformly for the six month delivery periods or if large volumes of storage were available to hold the water for later use. The usable storage of the system is summarized in Table 28.

TABLE 26 TOTAL NATURAL FLOWS OF STREAMS TRIBUTARY TO SSEWS SYSTEM (m^3/s)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Lower Quartile	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
Median	0.00	0.00	0.01	0.87	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27
Upper Quartile	0.00	0.00	0.95	5.52	0.17	0.05	0.11	0.00	0.00	0.00	0.00	0.00	0.56
Maximum	0.00	0.00	3.22	50.03	3.13	15.99	4.61	1.25	0.01	0.01	0.00	0.00	4.29
Average	0.00	0.00	0.53	4.45	0.27	0.41	0.48	0.13	0.00	0.00	0.00	0.00	0.52

TABLE 27 THEORETICAL ANNUAL CANAL CAPACITY

	ANNUAL DIVERSION CAPACITY	
CANAL	(m^3/s)	(dam^3)
M1	14.4	224 000
M2	11.9	185 000
Broderick to Brightwater	6.8	106 000
Blackstrap to Blackstrap	5.1	79 000
Blackstrap to Zelma	2.3	35 000
Little Manitou to DelLwood	0.7	10 000
Zelma to Little Manitou	1.4	21 000

TABLE 28 SSEWS SYSTEM STORAGE CAPACITIES (dam^3)

RESERVOIR	TOTAL CAPACITY	USABLE CAPACITY
Broderick	16 400	14 000
Brightwater	8 000	2 300
Blackstrap	61 650	11 000
Bradwell	4 600	2 200
Zelma	14 500	5 900
Dellwood	5 800	3 500
TOTAL	110 950	38 900

5.4 OPERATION

The SSEWS system is operated to meet a wide range of uses. The largest use is irrigation. Irrigation requires water from May to September with peak demands from late June to early August. The largest irrigation concentration is near the upstream end of the system in the SSRID but additional irrigation is scattered along the system. 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.

Details on the quantity and timing of these water demands are provided in the South Saskatchewan River Basin Study Water Use Technical Appendix.

Since all of these users 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.

6.0 LOCAL DRAINAGE AREA SURFACE WATER

6.1 DEVELOPMENT HISTORY

The study area includes a strip of local drainage area that averages about 30 km along each side of the South Saskatchewan River. This area generally slopes toward the river and is drained by many small tributaries. Large portions of the area are not within the effective drainage area of the South Saskatchewan River.

Because the runoff on these small streams only occurs on an intermittent basis major investments in surface water use development is impractical. Most of the development takes the form of small stock watering ponds and small irrigation projects. There are a total of 893 registered water use projects in this tributary area, 752 upstream of Gardiner Dam and 141 downstream. The total licensed diversion is 9 675 dam^3 per year. The largest use is for irrigation. The total irrigated area is 4 815 ha. Few of the irrigation projects exceed 50 ha in area because local runoff volumes are inadequate for larger projects.

6.2 WATER SUPPLY

The local runoff from the entire drainage basin in Saskatchewan represents about 1 percent of the natural water supply of the South Saskatchewan River and is therefore insignificant to the management of the main river system. However, within the drainage basin, this water is very important in providing water for stockwater and domestic water supplies, small irrigation projects and natural and man-made ponds used by wildlife.

7.0 GROUND WATER

As one component of the South Saskatchewan River Basin Study, a ground water study (SSRBS Technical Report C.3) was completed. This chapter summarizes the results of that study.

7.1 DEVELOPMENT HISTORY

7.1.1 Background

Ground water resources are interrelated with the surface water resources in many ways but ground water management requires special consideration because of the physical processes involved. Ground water originates as surface water which percolates through the soil voids. Most of the water that enters the ground in the semiarid regions of southern Saskatchewan is gathered by the roots of plants and returned to the atmosphere through transpiration. A small fraction of the water percolates past the root zone and becomes part of the ground water resource. Over thousands of years of accumulating a very small part of the total precipitation, the soil voids become filled with water and the ground water regime reaches a balance where the inflow in the form of percolated precipitation balances the outflow which includes flow to the surface in low areas and plant root extraction.

Because the voids in the soil are very small, the movement of water in the soil is resisted by large friction forces and is very slow. Even relatively coarse soils only permit water to flow a few metres per year and the more common fine grained soils of the study area result in movements measured in centimetres. This slow rate of movement results in characteristics of the ground water resource which require very different management than surface water.

A small portion of the precipitation percolates into the ground everywhere and moves downward until it reaches the saturated soil. The top of the saturated soil is commonly referred to as the water table. In response to the pull of gravity, water flows from high areas toward low areas but the high friction in the soil makes the rate of flow extremely slow so the water table is not horizontal, like water surface above ground . The water table generally follows the topography except that it is slightly deeper under hills and shallower in low areas. The water table is generally a suppressed reflection of the surface topography. The water table, with a variable depth of saturated soil, is present throughout the study area. However, the presence of saturated soil does not necessarily assure a usable water supply. The fine grained soils that dominate the study area have relatively little void space to hold water and the very tiny flow channels do not permit the ground water movement of water out of the soil. The only usable ground water is that contained in pockets of coarse grained sands and gravels which are not common in the study area. These localized areas of relatively mobile ground water are referred to as aquifers. Each aquifer is almost entirely independent of other water resources and therefore, requires separate management. Ground water management is therefore not a basin wide activity like surface water. It is a local activity, requiring information on the local aquifer conditions.

The very small portion of total precipitation that reaches the ground water regime and the very slow horizontal movement of ground water results in relatively small quantities of usable ground water in any local area. As opposed to surface water streams that accumulate water from large areas, ground water aquifers generally receive water only locally and any movement from great distances is too slow to deliver large volumes of water. Where surface water management deals with flows in cubic metres per second, ground water management usually deals with litres per minute; many orders of magnitude smaller.

Although the rates of flow are small, ground water is generally a much more reliable source of water supply than surface water. The water within an aquifer generally represents many years of relatively small inflows. The aquifer is a storage reservoir and as long as outflows and pumped withdrawals from an aquifer do not exceed the long-term average recharge, the aquifer will continue to provide water even during short-term drought periods. Deeper aquifers tend to provide greater security of supply than shallow aquifers because they are less sensitive to short-term changes in the surface moisture conditions. This subsurface water storage is not subject to evaporation losses as is the case with surface lakes or reservoirs.

As water moves through the soil, two changes affect the water's usefulness. The soil removes many undesirable impurities from the water. By filtration and biologic and chemical processes, most of the organic material, bacteria and other constituents of the water are removed, resulting in relatively good quality water for many uses. However, water also gains dissolved minerals as it passes through the soil. Excess mineral content reduces the usefulness of the water for some uses.

In spite of its limited quantity and its variable quality, ground water is a very important resource in the study area. Most farms and small communities depend on ground water for domestic and municipal supplies because of the lack of reliable surface water supplies. For household uses, ground water is often ideal. It requires little or no treatment and the tendency to mineralization is only a problem in extreme cases. The rate of use is low and compatible with the slow movement of ground water and the natural storage capacity of the aquifer protects the user from short-term drought.

Ground water is not generally used for large-scale irrigation. The quantity of supply at any location is inadequate and the dissolved minerals in ground water could damage crops.

7.1.2 Current Ground Water Use

In the South Saskatchewan River Basin, the ground water resource is relatively lightly used. The main uses are for municipal water supply for towns and villages, and domestic water for households and stock watering on farms. Under the ground water licensing regulations, private wells for domestic purposes are not registered. The ground water use for these purposes was therefore estimated indirectly from livestock and population statistics. The larger wells used by municipalities and industries are licensed and their water use was estimated from the water use records or from allocations. The ground water use in the study area was estimated to be approximately 23 000 dam^3 per year. About 13 300 dam^3 or 60 percent of the use is for rural domestic purposes and the remainder is mainly municipal. About 13 000 dam^3 comes from major aquifers and the rest comes from small aquifers. When compared to the basin area of 45 000 km^2, this total use only requires an average recharge of about 0.5 mm of water over the basin or less than 0.2 percent of the total precipitation.

The ground water use is not uniformly distributed. The use tends to follow the pattern of the human population. The two cities, Saskatoon and Swift Current, obtain their water from surface sources so they do not place a demand on the ground water system but the fringe of population concentrated around the cities tends to result in concentrated ground water development. Other areas of concentrated use are located at the towns and villages that rely on the local ground water. In some areas, the ground water use is at the limit of the local resource and increased demand will require the transport of water over substantial distances.

7.2 WATER SUPPLY HYDROLOGY

7.2.1 Geologic Conditions

In order to understand the ground water regime, it is useful to briefly review the geologic processes that formed the soils and bedrock of the region.

Until about 60 million years ago, southern Saskatchewan was part of a shallow inland sea. Rivers carried sediment into this sea and slowly built up the sea floor. The coarse sand and gravel sediments were deposited near the shore while the fine clay and silt settled further from shore. Over periods of thousands of years, the sea level varied and the location of the shore varied. As a result, the sediments formed alternating layers of coarse material and fine grained material. With time, these layers consolidated to form the sandstone and shale bedrock of the study area. The sandstone is quite permeable and forms aquifers in the bedrock. These bedrock aquifers underlie most of the study area.

Above the bedrock, there are sediments which were deposited in more recent times but which have not yet consolidated into bedrock. These sediments are generally identified as pre-glacial or post-glacial in origin. The pre-glacial sediments contain deposits of sand and gravel which were created by water in ancient lakes or rivers. Aquifers have been identified within the pre-glacial deposits under about 9 000 km^2 or about one-fifth of the study area. These aquifers generally lie 65 to 110 metres below the present ground surface.

Over time, the study area was subjected to several periods of deep continental glaciation. Geologist have identified at least three different types of glacial drift in the study area. The last glaciers disappeared about 10 000 years ago. Glacial drift is highly variable. In most locations, the glaciers melted and the material in the ice was left unsorted. The resulting soil is a mixture of particle sizes with fine clay, silt, sand, gravel and boulders mixed together. This mixture is referred to as glacial till. The action of flowing water tends to sort this mixture into its components. Where a glacial river has sorted the sand or gravel into large pockets, an aquifer may exist. These aquifers in the glacial drift are referred to as intertill aquifers. There are many small intertill aquifers in the study area. Three large intertill aquifers, that underlie about 3 000 km^2 of the study area, have been mapped.

In the period during the retreat of the glaciers and the roughly 10 000 years since they disappeared, the present prairie surface and shallow soils were formed. These soils have been shifted and reworked by the erosion of wind and water. In some locations coarse textured soils have been concentrated in sufficient volume to form aquifers. Five large post-glacial aquifers covering almost 6 000 km^2 have been mapped and many smaller aquifers are locally important. The aquifers in post-glacial soils are shallow.

With the various types of aquifers, most of the study area is underlying by one or more types. Some of the deeper aquifers are too deep for economical development and the water quality is not suitable for many uses in some aquifers.

7.2.2 Sustainable Yield

The ground water system holds a large quantity of water in storage but the long-term sustainable yield that can be met from this system is limited by the rate of recharge. If use exceeds the recharge, eventually the storage would be depleted and the use would not be sustainable.

In its natural state, the aquifer system was presumably in a balance with inflow and outflow equal over the long-term. The inflow in the form of recharge water flowing from the surface varies widely with the season and from wet to dry years but the large storage capacity of the deep prairie soils would even out these short-term variations so the ground water regime could be expected to be fairly stable.

When artificial use of water is introduced on an aquifer, the natural water balance must adjust to the new outflow. The first adjustment that occurs is the reduction of the storage volume which lowers the water table at the point of withdrawal. The lowered water table results in flow toward the depression which reduces the surrounding water table. Outflow from the aquifer in other directions is reduced and the lower water level increases the pressure gradient from the surface and encourages recharge.

The main factor controlling the sustainable yield is the recharge. An estimate of the additional recharge that might be induced by ground water use in the study area was calculated. The estimate was based on the permeability of the soils, the change in water table and depth of the major aquifers. Using a simplified calculation, it was estimated that the known major aquifers could yield about 450 000 dam^3/year of water and the minor aquifers might add 50 000 dam^3/year for a total of roughly 500 000 dam^3/year. This is an average of about 11 mm of water per year over the study area or about 3 percent of the total precipitation.

This estimate does not consider the quality of the water which may not be suitable for many uses and it does not consider the logistics of developing a sufficient number of wells to harvest the total potential. Therefore, the 500 000 dam^3/year is an indication of the upper limit of potential ground water development in the basin.

In terms of the total basin water management, this upper limit of the ground water resource is equal to about 5 percent of the natural flow of the South Saskatchewan River.

7.3 INTERACTION BETWEEN GROUND AND SURFACE WATER

Although ground water and surface water have different characteristics which necessitate different management approaches, there are certain interactions between the two which should not be ignored.

7.3.1 Recharge

The source of ground water is recharge from the surface. The quantity of water reaching the aquifer is lost to surface runoff and to plant roots. In general, the surface soils of the study area are fairly impermeable and recharge takes a small fraction of the total precipitation. Most of the precipitation is caught in the root zone and returned to the atmosphere through evaporation and transpiration.

The total recharge has been affected by human activities. The practice of summerfallow which eliminates plant growth on large portions of the study area each year decreases transpiration and increases percolation to the water table. Drainage of depressions which trap surface water reduces the ground water recharge while man-made ponds, reservoirs and irrigation increase the recharge. Care must be exercised when designing works to ensure that the water table is not changed in ways that cause damages or to mitigate impacts of damage if necessary.

7.3.2 Ground Water Discharge

Although the rate of ground water recharge is small, this water must still discharge for the system to be balanced. Human uses withdraw a small portion of the resource. Additional discharge occurs through plant transpiration where root systems intersect the water table. This subterranean irrigation can be seen in the topographic low areas where vegetation tends to be more lush than on the hills. Where ground water flows to the surface and evaporates, the dissolved salts are left behind creating saline soils and alkali sloughs. Where ground water flows to the surface faster than the water can evaporate, a surface flow from a spring can result.

In the study area, ground water seldom discharges to the surface fast enough to exceed the transfer to the dry atmosphere through evaporation and transpiration. Along the South Saskatchewan River Valley, Swift Current Creek and some of the deeper tributary valleys where the topographic slope is steep so that the ground water gradient and rate of flow is high, there are modest outflows of ground water. It has been estimated that the South Saskatchewan River might receive about 3 litres of inflow per second per kilometre of length from ground water which would amount to about 2 m^3/s, less than 1 percent of the natural flow, in its 716 km length in the study area.

7.4 LAKE DIEFENBAKER

Lake Diefenbaker is a surface water reservoir but it has had a significant impact on the ground water of the study area. Where the river valley at Lake Diefenbaker was about 100 m below the surrounding prairie and provided a natural low for the discharge of the surrounding ground water, the portion of the valley at Gardiner Dam now has about 60 m of water so that the gradient from the prairie to the valley has been greatly reduced. The water table in the surrounding prairie is consistently higher than the lake so ground water continues to flow toward the lake, but at a decreased rate. In order to monitor the changes in ground water regime, piezometers were installed in the sandstone bedrock to monitor water pressures in a cross section roughly 3 km south and 6 km north of the valley. The piezometers were installed in the period from 1962 to 1964 before the lake filled. When the lake filled, the piezometers near the lake showed a rapid rise in pressure in direct proportion to the lake level while the piezometers farther from the lake rose a small amount over a longer period of time. As a result of Lake Diefenbaker, the water table along the valley is closer to the surface.

The ground water will enhance the storage capacity of Lake Diefenbaker through "bank storage". As Lake Diefenbaker rises when it fills in the summer it stores water in the lake and it also stores some water in the soil of the valley banks. As the lake is lowered in winter this water flows out of the banks, adding to the reservoir storage. Although the quantity is likely small relative to the total flows, this bank storage adds to the effectiveness of the lake in regulating flows.

8.0 DOWNSTREAM OF THE STUDY AREA

8.1 DEVELOPMENT HISTORY

The downstream end of the study area is located at the confluence of the South Saskatchewan and North Saskatchewan rivers which is the upstream end of the Saskatchewan River. Although it was not intended to complete a detailed study of the downstream area as part of the South Saskatchewan River Basin Study, it is necessary to recognize that management decisions within the study area will impact on downstream conditions. Therefore, an understanding of the quantities of water available in downstream reaches from other streams will be useful in comparing alternative management strategies for the South Saskatchewan River.

8.1.1 North Saskatchewan River

The North Saskatchewan River is very similar to the South Saskatchewan River in terms of its mountain origin and conveyance of water across the prairies. However, the North Saskatchewan River is very different in terms of its development. There is very little consumptive use of water from the North Saskatchewan River. Municipal water is used by the city of Edmonton and other urban centres, and industries use the river water, but after treatment, most of the water is returned to the river. There are no large group irrigation projects, only individual irrigators who use limited amounts of water.

There are two large reservoirs in the mountain headwaters of the North Saskatchewan River which were built for hydro-electric generation and flow regulation: the Brazeau Dam and Reservoir on the Brazeau River and the Big Horn Dam which created Lake Abraham on the Big Horn River. These reservoirs do not cause any significant flow depletion but they alter the seasonal flow regime by storing summer runoff and releasing water in winter to augment the low winter flows.

8.1.2 Saskatchewan River

Downstream of the confluence of the North and South Saskatchewan rivers, the Saskatchewan River carries the combined flows east across the Manitoba border and into the north end of Lake Winnipeg. This reach of river and the tributaries that join it transverse a region of low population and limited industrial activity. The consumptive water use is insignificant. Hydro-electric generation is the major water use.

The Codette Reservoir upstream of Nipawin creates a head pond for the Nipawin hydro-electric generation station. This reservoir was designed for a maximum water level fluctuation of 1 m which provides a usable storage capacity of 29 000 dam^3, or, less than the flow on an average day. This storage is used to control the instantaneous flow through the power station but has no affect on the seasonal flow pattern. The Nipawin power station has been in operation since 1986.

Tobin Lake, which was created by the E. B. Campbell Dam, creates a head pond for the E. B. Campbell Hydro-electric Generating Station east of Nipawin. The reservoir was designed for a maximum water level fluctuation of 2.1 m which provides a usable storage capacity of 560 000 dam^3, or, about 10 times the average daily flow. This storage is used to control the instantaneous flow through the power station and it can change the daily or weekly flow pattern but has little impact on the seasonal flow pattern.

Downstream of the Saskatchewan/Manitoba border, the Grand Rapids power station controls a very large reservoir at Cedar Lake. This lake permits Manitoba to regulate the seasonal flows for power generation. Manitoba has additional flow control at Lake Winnipeg and hydro generation capacity along the Nelson River.

Although hydro-electric generation is the major use of the water downstream of the study area, it is not the only use. The water is very important to the local residents for municipal and domestic water supplies; as a transportation system; and, to support fish and wildlife populations.

8.2 NATURAL FLOW

8.2.1 North Saskatchewan River

Using calculations similar to those described for the South Saskatchewan River, estimates of the natural flow of the North Saskatchewan River at Prince Albert for the 75 year study period were made. Since the flows have been recorded and uses throughout most of the period were insignificant, an accurate estimate of the natural flow is not difficult to calculate. Even in recent years, when the Brazeau and Big Horn projects have changed the flow pattern, their operation has been recorded so that calculation of the natural flows will be very reliable. The resulting monthly flow array is listed in Appendix C and summarized in Table 29.

8.2.2 Saskatchewan River

The Saskatchewan River receives little inflow between the confluence and Tobin Lake. The natural flow in this reach was therefore estimated based on the routed natural flows of the North Saskatchewan and South Saskatchewan rivers with a minor adjustment for local inflow.

Downstream of Tobin Lake, the river receives flow from several fairly large rivers from the north. There are no long-term records of flow for these tributary flows. The earliest records begin about 1960. There is a nearly continuous record of flows of the Saskatchewan River at The Pas, Manitoba, a short distance downstream of the provincial border. By subtracting the calculated natural flows at Tobin Lake from the calculated natural flows at The Pas, an estimate of the natural inflow from the 58 000 km^2 local drainage area between these two locations was determined. This local inflow was adjusted on the basis of the local drainage area upstream of the border and added to the Tobin Lake flow to obtain the natural flows at the provincial border.

Detailed monthly flow arrays for points along the Saskatchewan River and for the local inflows are provided in Appendix C. Tables 30 to 32 summarize the natural flow regime of the Saskatchewan River.

8.3 CURRENT DEVELOPMENT FLOWS

8.3.1 North Saskatchewan River

In order to provide an indication of the expected flow regime of the North Saskatchewan River with existing developments, a water balance model of the river system was developed. This model used the natural flows and the current (1986) uses and reservoirs, assuming that operation of the reservoirs will follow the same seasonal pattern as in recent years. An estimate of the flow of the North Saskatchewan at Prince Albert that would have occurred if existing projects had been in place throughout the study period was calculated. The detailed monthly flows are listed in Appendix C. Table 33 summarizes the flow regime.

The annual natural flow has been depleted by less than 0.5 percent of the natural flow. The winter flow has roughly tripled and the summer flow has been modestly reduced.

8.3.2 Saskatchewan River

Developments on the Saskatchewan River system have little impact on the overall flows of the river system. Codette Reservoir and Tobin Lake storage capacities are small compared to total flows so they regulate the flows modestly. They also cause a small depletion of the flow due to evaporation. The major flow changes occur upstream on the South and North Saskatchewan rivers. In order to determine how these combined changes affect the Saskatchewan River the Water Resource Management Model was used to calculate the flows on the Saskatchewan River that would have occurred over the study period under existing conditions. Detailed monthly flow arrays are contained in Appendix C. Tables 34 to 36 summarize the flow regime.

The consumptive water uses which are concentrated on the South Saskatchewan River and which depleted it by about 28 percent have less impact; 15 percent at The Forks and 14 percent at the Manitoba border. The change in the seasonal flow pattern is a much larger change than the total depletion. Typical winter flows are about four times the natural flows and summer flows are about half of the natural values.

TABLE 29 NATURAL FLOWS NORTH SASKATCHEWAN RIVER AT PRINCE ALBERT (m^3/s)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Minimum	15	19	24	90	83	200	264	277	173	100	30	18	137
Lower Quartile	25	27	30	148	198	402	455	352	234	130	60	32	199
Median	34	34	37	230	320	485	572	406	280	157	77	41	235
Upper Quartile	43	42	47	321	398	630	726	513	321	196	92	54	267
Maximum	77	60	100	729	1513	1110	1706	851	1115	353	174	97	410
Average	33	34	40	255	351	530	615	448	310	175	80	43	244

TABLE 30 NATURAL FLOW SASKATCHEWAN RIVER AT THE FORKS (m^3/s)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Minimum	30	38	81	220	262	507	605	497	325	193	118	38	297
Lower Quartile	76	77	125	374	609	1052	960	640	416	267	159	93	445
Median	90	95	162	515	753	1302	1198	755	493	316	195	113	511
Upper Quartile	110	115	206	715	977	1533	1473	935	566	406	224	146	614
Maximum	245	189	405	1702	2922	2687	3196	1671	1643	811	412	238	886
Average	93	97	171	589	838	1365	1274	811	556	365	207	125	543

TABLE 31 NATURAL FLOW SASKATCHEWAN RIVER BELOW TOBIN LAKE (m^3/s)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Minimum	35	38	78	226	272	506	610	504	331	202	122	46	301
Lower Quartile	77	77	124	374	604	1060	970	644	427	274	164	97	448
Median	90	94	158	509	760	1290	1210	760	500	324	199	117	512
Upper Quartile	111	115	201	728	988	1538	1475	949	575	412	232	149	615
Maximum	244	190	397	1689	2886	2698	3169	1702	1633	825	422	246	892
Average	95	96	169	594	839	1354	1280	823	564	373	213	129	546

TABLE 32 NATURAL FLOW SASKATCHEWAN RIVER AT SASKATCHEWAN/MANITOBA BORDER (m^3/s)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Minimum	48	46	87	280	298	531	661	525	348	215	130	84	321
Lower Quartile	102	98	147	462	686	1202	1157	794	518	337	215	124	539
Median	125	124	199	625	951	1505	1404	898	606	399	239	149	629
Upper Quartile	152	155	2398	856	1217	1698	1677	1087	693	508	300	200	718
Maximum	270	257	419	1851	3045	2899	3300	1873	1956	1010	570	366	1053
Average	131	133	207	698	1017	1533	1481	976	673	344	269	165	647

TABLE 33 CURRENT DEVELOPMENT (1986) FLOWS NORTH SASKATCHEWAN RIVER PRINCE ALBERT (m^3/s)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Minimum	90	94	97	142	98	77	100	128	100	94	76	91	136
Lower Quartile	112	109	111	236	214	279	291	203	161	133	122	119	198
Median	121	116	118	319	336	362	408	257	206	160	139	128	234
Upper Quartile	131	124	128	410	414	507	562	364	248	199	154	141	266
Maximum	165	143	180	818	1528	987	1542	702	1042	356	236	184	410
Average	120	117	121	344	366	407	449	299	236	178	142	130	243

TABLE 34 CURRENT DEVELOPMENT (1986) FLOWS SASKATCHEWAN RIVER AT THE FORKS (m^3/s)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Minimum	213	210	225	237	149	116	188	183	170	157	213	211	245
Lower Quartile	441	352	265	331	286	343	365	282	231	212	308	474	361
Median	460	370	301	451	475	474	582	379	283	350	365	507	423
Upper Quartile	481	390	346	661	697	787	912	571	326	446	409	538	530
Maximum	564	536	534	1370	2364	2099	2498	1356	1452	776	646	592	803
Average	451	372	311	517	542	599	697	468	341	368	369	476	460

TABLE 35 CURRENT DEVELOPMENT (1986) FLOWS SASKATCHEWAN RIVER BELOW TOBIN LAKE (m^3/s)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Minimum	214	212	236	235	151	135	163	187	176	164	218	218	243
Lower Quartile	444	353	279	330	282	322	332	290	230	220	315	481	359
Median	460	370	315	435	452	455	562	378	286	357	375	513	423
Upper Quartile	484	390	358	664	692	763	873	578	346	454	417	545	527
Maximum	562	538	542	1311	2312	2099	2431	1382	1435	810	650	601	810
Average	453	373	324	516	536	581	667	476	348	377	377	483	460

TABLE 36 CURRENT CONDITIONS (1986) FLOWS SASKATCHEWAN RIVER AT SASKATCHEWAN/MANITOBA BORDER (m^3/s)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Minimum	218	216	244	281	175	156	212	227	196	203	233	227	263
Lower Quartile	472	372	304	409	406	496	484	419	312	305	346	507	447
Median	496	400	354	556	627	630	755	515	384	424	422	542	530
Upper Quartile	528	438	394	781	908	945	1054	777	449	556	465	585	629
Maximum	617	561	564	1472	2467	2297	2560	1555	1755	1081	773	733	969
Average	487	409	362	618	713	758	864	624	454	458	432	518	559

9.0 PRECIPITATION AND EVAPORATION

Earlier chapters of this report describe the horizontal flow of water down the rivers and the movement of water below the ground surface. The flow of water at lake and reservoir surfaces to or from the atmosphere can also be a significant component of the water balance. In southern Saskatchewan, evaporation is commonly one of the largest consumptive uses of water from lakes. Although precipitation is generally less than evaporation, it must also be considered in the net balance of flows.

9.1 PRECIPITATION

Precipitation in the form of rain or snow is measured at many locations across Saskatchewan. The Atmospheric Environment Service of Environment Canada records and publishes this data. This data is measured by volunteer observers at climate stations and by Environment Canada staff at synoptic stations. The climate stations are scattered across the province and the length and completeness of the records varies with the level of interest of the volunteer observers. The synoptic stations are generally farther apart and they usually provide a continuous record for long periods.

All the precipitation records in and near the study area were reviewed. Those stations with the longest period of record and located near the reservoirs and lakes were selected for detailed study. Few individual station records extend over the entire 75 year study period. However, based on correlation, estimates of missing data were made by means of correlation analysis.

For each reservoir and lake, an estimate of the monthly precipitation for each month of the study period was calculated by averaging nearby measured precipitation. The station data were weighted by the inverse of the distance to the reservoir. The resulting precipitation arrays are listed in Appendix D. The average annual precipitation for the study period varies from a low of 345 mm at Lake Diefenbaker to 425 mm at the Codette and Tobin Lake projects.

9.2 EVAPORATION

Evaporation from lakes and reservoirs cannot be readily determined by direct measurements. Detailed studies of evaporation from small water bodies have resulted in empirical relationships which define water temperatures based on air temperature and evaporation based on water temperature, relative humidity of the air, wind speed and elevation. The relationships used were proposed by Meyer for the United States in 1942 and modified by PFRA for the Canadian Prairies in 1988.

The PFRA-modified Meyer method requires detailed weather data that is only measured at the synoptic weather stations. The detailed data requirements are met at Swift Current and Saskatoon in the study area and at Prince Albert which is near the north end of the study area. Evaporation estimates for the various reservoirs required for the study were estimated from the evaporation calculated for these synoptic weather stations based on a transfer factor as listed in Table 37. The transfer factor is based on an interpolation among the annual evaporation amounts at the synoptic stations. The detailed monthly evaporation estimates at the synoptic stations for the study period are listed in Appendix D.

The evaporation calculations by PFRA are intended for use on small to medium sized water bodies, not large and deep lakes such as Lake Diefenbaker. Evaporation on large water bodies is lower because of the large heat storage effect which alters the water temperature pattern. The Lake Diefenbaker transfer factor was set at 90 percent of the small water body value.

The average annual evaporation for the study period ranges from 1 015 mm in the Swift Current area through 886 mm at Saskatoon and 686 mm at Prince Albert.

9.3 NET EVAPORATION

The difference between the evaporation and precipitation is referred to as the net evaporation.

In the study area, evaporation generally exceeds the precipitation from April to October. Precipitation exceeds evaporation from December to March. Occasional high rainfall months in summer or warm weather in November reverses the seasonal trend but these abberations are rare. The annual evaporation throughout the study period always exceeds the annual precipitation at Swift Current and Saskatoon and in all but two years (1942 and 1954) at Prince Albert.

The average annual net evaporation for the study period ranges from 641 mm at Swift Current to 536 mm at Saskatoon and 286 mm at Prince Albert.

TABLE 37	EVAPORATION TRANSFER FACTORS	
FROM THE GROSS EVAPORATION STATION AT	TO	TRANSFER FACTOR
Swift Current	(Proposed) SC1 Reservoir	0.96
	Duncairn Reservoir	1.00
	Swift Current Reservoir	1.00
	(Proposed) SC2 Reservoir	1.00
	Lac Pelletier	0.98
	(Proposed) RL1 Reservoir	0.96
	Herbert Reservoir	0.96
	Reed Lake	0.94
	Lake Diefenbaker	0.98x(9/10)*
Saskatoon	(Proposed) Dundurn Reservoir	1.02
	Broderick Reservoir	1.13
	Brightwater Reservoir	1.07
	Blackstrap Reservoir	1.04
	Bradwell Reservoir	1.00
	Zelma Reservoir	0.99
	Dellwood Reservoir	0.97
	Little Manitou Lake	0.98
Prince Albert	(Proposed) St. Louis Reservoir	1.06
	(Proposed) Forks Reservoir	1.00
	Codette Reservoir	1.00
	Tobin Lake	1.00

* The gross evaporation transfer factor to Lake Diefenbaker was multiplied by a ratio of 9/10 to account for the smaller empirical coefficient of 9 that is used by Atmospheric Environment Service (AES) for Lake Diefenbaker instead of an empirical coefficient of 10 normally used for smaller water bodies (Environment Canada, 1973).

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

APPENDIX B
MASTER AGREEMENT ON APPORTIONMENT

MASTER AGREEMENT ON APPORTIONMENT

THIS AGREEMENT is made in quadruplicate this THIRTIETH day of OCTOBER, 1969, A.D.

BETWEEN:

HER Majesty, the Queen, in right of Canada, represented herein by the Minister of Energy, Mines and Resources

(Hereinafter called "Canada")

- and -

HER Majesty, the Queen, in right of Alberta, represented herein by the Minister in charge of Water Resources for Alberta

(Hereinafter called "Alberta")

- and -

HER Majesty, the Queen, in right of Saskatchewan, represented herein by the Minister in charge of The Water Resources Commission Act of the said Province

(Hereinafter called "Saskatchewan")

- and -

HER Majesty, the Queen, in right of Manitoba, represented herein by the Minister in charge of The Water Control and Conservation Branch Act of the said Province

(Hereinafter called "Manitoba")

WHEREAS under natural conditions the waters of the watercourses hereinafter referred to arising in or flowing through the Province of Alberta would flow into the Province of Saskatchewan and under the said conditions the waters of some of the said watercourses arising in or flowing through the Province of Saskatchewan would flow into the Province of Manitoba;

AND WHEREAS the Governor-in-Council has authorized Canada to enter into this agreement by Order-in-Council P.C. 1969-8/2051 dated October 29, 1969, and the Lieutenant Governors-in-Council for Alberta, Manitoba and Saskatchewan, respectively, have authorized them to enter into this agreement by the following Orders-in-Council:

Alberta	- O.C. 2053-69
Manitoba	- O.C. 1359/69
Saskatchewan	- O.C. 1612/69

AND WHEREAS the parties hereto deem it to be in their mutual interest that an agreement be reached among the four parties as to the apportionment as described in the schedules attached hereto of such interprovincial waters among the three Provinces;

AND WHEREAS Alberta and Saskatchewan have entered into an agreement, which agreement is attached to this agreement as Schedule A, that permits the Province of Alberta to make a net depletion of one-half the natural flow of water arising in or flowing through the Province of Alberta and that permits the remaining one-half of the natural flow of each such watercourse to flow into the Province of Saskatchewan, subject to certain exceptions as are set forth in the said agreement;

AND WHEREAS Saskatchewan and Manitoba have entered into an agreement which agreement is attached to this agreement as Schedule B, that permits the Province of Saskatchewan to make a net depletion of one-half the natural flow of water arising in, and one-half of the water flowing into the Province of Saskatchewan, and that permits the remaining one-half of the flow of each such watercourse to flow into the Province of Manitoba, subject to such conditions and agreements as therein contained;

AND WHEREAS the parties are desirous that the Prairie Provinces Water Board (referred to herein as the Board), reconstituted by this agreement will be responsible for the administration of this agreement;

AND WHEREAS the parties hereto recognize the continuing need for consultation and co-operation as between themselves with respect to the matters herein referred to so that the interests of all the parties are best served;

NOW THEREFORE, THIS AGREEMENT (hereinafter known as the Master Agreement) witnesseth that each party agrees as follows:

Interprovincial Agreements

1. Alberta and Saskatchewan agree that the agreement between them (hereinafter called the First Agreement), a copy of which is set out in Schedule A to the Master Agreement, will become binding upon them upon the date that the Master Agreement is executed.

2. Saskatchewan and Manitoba agree that the agreement between them (Hereinafter called the Second Agreement), a copy of which is set out in Schedule B to the Master Agreement, will become binding upon them upon the data that the Master Agreement is executed.

3. The parties agree to the apportionment of water between Alberta and Saskatchewan and Manitoba as provided in the First and Second Agreements and each party agrees to be bound by the said agreements as they relate to apportionment as if it were a party thereto.

4. The parties agree that the First or Second Agreement, or both, may be altered by an agreement in writing among the four parties to the Master Agreement, but not otherwise.

5. The parties agree that the First and Second Agreements will continue in force and effect until cancelled by an agreement in writing among the four parties to the Master Agreement.

Water Quality

6. The parties mutually agree to consider water quality problems; to refer such problems to the Board; and to consider recommendations of the Board thereon.

Monitoring

7. The parties agree that the monitoring of the quantity and quality of waters as specified in the First and Second Agreements, the collection, compilation and publication of water quantity and quality data required for the implementation and maintenance of the provisions of this agreement shall be conducted by Canada, subject to provision of funds being voted by the Parliament of Canada.

Administration

8. The parties agree, subject to Clause 9 of this agreement that it at any time, any dispute, difference or question arises between the parties with respect to this agreement or the construction, meaning and effect thereof, or anything therein, or the rights and liabilities of the parties thereunder or otherwise in respect thereto, then every such dispute, difference or question will be referred for determination to the Exchequer Court under the provisions of the Exchequer Court Act of Canada and each of the parties hereto agrees to maintain or enact the necessary legislation to provide the Exchequer Court with jurisdiction to determine any such dispute, difference, or question in the manner provided under the Exchequer Court Act.

9. The parties also agree that the Board, with the consent of the parties in dispute, may cause to be prepared, a factual report of the dispute for consideration by the parties hereto prior to the referral of the dispute to the Exchequer Court.

10. The parties agree that the Prairie Provinces Water Board shall monitor and report on the apportionment of waters as set out in the provisions of the First and Second Agreements and ratified by this Master Agreement.

11. The parties agree to revoke the agreement data July 28, 1948, establishing the Prairie Provinces Water Board and to reconstitute the Prairie Provinces Water Board in the form of Schedule C hereto and the said Schedule shall form and become part of this Master Agreement.

12. Because the Orders-in-Council referred to in Schedule D hereto will become redundant upon the execution of this Master Agreement, the parties agree to take steps to have them revoked.

13. The parties agree for the future application of the provisions of the Master Agreement (and the First and Second Agreements thereunder), to work together and to cooperate to the fullest extent each with the other for the integrated development and use of water and related resources to support economic growth according to selected social goals and priorities and to participate in the formulation and implementation of comprehensive planning and development programs according to their national, regional and provincial interest and importance.

14. No Member of the Parliament of Canada or Member of the Legislative Assemblies of the Provinces party to this agreement shall hold, enjoy, or be admitted to any share or part of any contract, agreement, commission or benefit arising out of this agreement.

IN WITNESS HEREOF Canada has caused its presents to be executed by its Minister of Energy, Mines and Resources, and Alberta has caused its presents to be executed by its Minister in charge of Water Resources, and Saskatchewan has caused its presents to be executed by its Minister in charge of The Water Resources Commission Act, and Manitoba has caused its presents to be executed by its Minister in charge of The Water Control and Conservation Branch Act of the day and year first mentioned above.

"A. Davidson"
Witness to the signature of the Minister
(Energy, Mines and Resources) for Canada

"J.J. Greene"
Minister (Energy, Mines and Resources) for Canada

October 30, 1969
Date

"R.E. Bailey"
Witness to the signature of the Minister in
charge of Water Resources for Alberta

"Henry A. Ruste"
Minister in charge of Water Resources for
Alberta

October 30, 1969
Date

"Harold W. Pope"
Witness to the signature of the Minister
in charge of The Water Resources Commission
Act for Saskatchewan

"Allan R. Guy"
Minister in charge of The Water Resources
Commission Act for Saskatchewan

October 30, 1969
Date

"Thomas E. Weber"
Witness to the signature of the Minister in
charge of The Water Control and Conservation Branch Act
for Manitoba

"Leonard S. Evans"
Minister in charge of The Water Control
and Conservation Branch Act for Manitoba

October 30, 1969
Date

4th Recital Clause amended on July 5, 1984

SCHEDULE A

THIS AGREEMENT is made in quadruplicate this THIRTIETH day of OCTOBER, 1969, A.D.

BETWEEN:

HER Majesty, the Queen, in right of Alberta, represented herein by the Minister in charge of Water Resources for Alberta

(Hereinafter called "Alberta")

- and -

HER Majesty, the Queen, in right of Saskatchewan, represented herein by the Minister in charge of The Water Resources Commission Act of the said Province

(Hereinafter called "Saskatchewan")

WHEREAS under natural conditions the waters of the watercourses hereinafter referred to arising in or flowing through the Province of Alberta would flow into the Province of Saskatchewan and under the said conditions the waters of some of the said watercourses arising in or flowing through the Province of Saskatchewan would flow into the Province of Manitoba;

AND WHEREAS the parties hereto deem it to be in their mutual interest and in the interest of Manitoba that an agreement in principle be reached among the said three Provinces as to the apportionment of such interprovincial waters among them;

AND WHEREAS the parties hereto are of the opinion that an equitable apportionment of such waters as between the adjoining Provinces of Alberta and Saskatchewan would be to permit the Province of Alberta to make a net depletion of one-half the natural flow of water arising in or flowing through the Province of Alberta and to permit the remaining one-half of the natural flow of water of each such watercourse to flow into the Province of Saskatchewan, subject to certain prior rights as are hereinafter set forth or may hereafter be mutually agreed upon in writing;

AND WHEREAS on the basis of the foregoing apportionment as between the Provinces of Alberta and Saskatchewan the parties hereto are of the opinion that in a similar manner, an equitable apportionment of the remainder of the natural flow of the said watercourses that flow into the Province of Manitoba after permitting the Province of Alberta to make its depletion of one-half thereof would be to permit the Province of Saskatchewan to make a net depletion of one-half of the said remainder and to permit the other one-half thereof to flow into the Province of Manitoba; and that the natural flow of any tributaries to the said watercourses which tributaries join the said watercourses in the Province of Saskatchewan without arising in or first flowing through the Province of Alberta could be apportioned one-half to the Province of Saskatchewan and one-half to the Province of Manitoba in a manner similar to the apportionment of waters as between the Provinces of Alberta and Saskatchewan, in all cases subject to such prior rights as may be mutually acknowledged by the said Provinces of Manitoba and Saskatchewan;

AND WHEREAS the parties hereto recognize the continuing need for consultation and cooperation as between themselves and with Manitoba with respect to the matters herein referred to so that the best and most beneficial use of the said waters may be made and the interests of all said provinces best served:

NOW THIS AGREEMENT witnesseth as follows:

1. IN THIS AGREEMENT:

(a) "Natural flow" means the quantity of water which would naturally flow in any watercourse had the flow not been affected by human interference or human intervention, excluding any water which is part of the natural flow in Alberta but is not available for the use of Alberta because of the provisions of any international treaty which is binding on Alberta.

(b) "Watercourse" means any river, stream, creek, or other natural channel which from time to time carries a flowing body of water from the Province of Alberta to the Province of Saskatchewan and includes all tributaries of each such river, stream, creek or natural channel which do not themselves cross the common boundary between the Provinces of Alberta and Saskatchewan. Such tributaries as do themselves cross the said common boundary between the Provinces of Alberta and Saskatchewan shall be deemed to be "watercourses" for the purpose of this agreement.

2. (a) The parties hereto shall mutually establish a method by which to determine the natural flow of each watercourse flowing across their said common boundary.

   (b) For the purpose of this agreement, the said natural flow shall be determined at a point as near as reasonably may be to their said common boundary.

   (c) Notwithstanding sub-paragraph (b) the point of which the natural flow of the watercourses known as the South Saskatchewan and Red Deer Rivers is to be determined may be, at the option of Alberta, a point at or as near as reasonably may be below the confluence of the said two rivers.

3. Alberta shall permit a quantity of water equal to one-half the natural flow of each watercourse to flow into the Province of Saskatchewan, and the actual flow shall be adjusted from time to time on an equitable basis during each calendar year, but this shall not restrict or prohibit Albert from diverting or consuming any quantity of water from any watercourse provided that Alberta diverts water to which it is entitled of comparable quality from other streams or rivers into such watercourse to meet its commitments to Saskatchewan with respect to each watercourse.

4. Notwithstanding paragraph 3 hereof, the following special provisions shall apply as between the parties hereto with respect to the watercourse known as the South Saskatchewan River.

   (a) Alberta shall be entitled in each year to consume, or to divert or store for its consumptive use a minimum of 2 100 000 acre-feet net depletion out of the flow of the watercourse known as the South Saskatchewan River even though its share for the said year, as calculated under paragraph 3 hereof, would be less than 2 100 000 acre-feet net depletion, provided however Alberta shall not be entitled to so consume or divert, or store for its consumptive use, more than one-half the natural flow of the said South Saskatchewan watercourse if the effect thereof at any time would be to reduce the actual flow of the said watercourse at the common boundary of the said Provinces of Saskatchewan and Alberta to less than 1,500 cubic feet per second.

   (b) The consumption or diversion by Alberta provided for under the preceding sub-paragraph shall be made equitably during each year, depending on the actual flow of water in the said watercourse and the requirements of each Province, from time to time.

5. The parties hereto shall work together and co-operate to the fullest extent, each with the other, for the most effective, economical and beneficial use of waters flowing from the Province of Alberta into the Province of Saskatchewan, including the construction and operation of approved projects of mutual advantage to our Provinces on a cost-share basis proportionate to the benefits derived therefrom by each Province, (the approval of which projects shall not be unreasonably withheld by either of the parties hereto) and shall enter into such other arrangements, agreements or accords with each other, and with the Governments of Canada and other Provinces to best achieve the principles herein agreed upon.

6. Notwithstanding paragraph 3 hereof, with respect to each of the three watercourses known as Battle Creek, Lodge Creek, and Middle Creek, the annual flow shall be apportioned such that, in each of the said watercourses, Alberta permits a quantity of water equal to 75 percent of the natural flow to pass the interprovincial boundary from Alberta to Saskatchewan.

7. If at any time any dispute, difference or question shall arise between the parties or their representatives touching this agreement or the construction, meaning and effect thereof, or anything therein, or the rights or liabilities, of the parties or their representatives thereunder or otherwise in respect thereto then every such dispute, difference or question shall be referred for determination to the Exchequer Court under the provisions of The Exchequer Court Act of Canada, and each of the parties hereto agrees to enact the necessary legislation to provide the Exchequer Court with jurisdiction to determine any such dispute, difference or question in the manner provided under Section 30 of The Exchequer Court Act.

8. This agreement shall become effective upon the execution of an agreement by Canada, Alberta, Manitoba and Saskatchewan relative to the apportionment of waters referred to in this agreement.

IN WITNESS WHEREOF Alberta has caused these presents to be executed on its behalf by its Minister in charge of Water Resources, and Saskatchewan has caused these presents to be executed by its Minister in charge of The Water Resources Commission Act, both on the day and year first above mentioned.

"R.E. Bailey"

Witness to the signature of the Minister
in charge of Water Resources for Alberta

"Henry A. Ruste"

Minister in charge of Water Resources for Alberta

"Harold W. Pope"

Witness to the signature of the Minister
in charge of The Water Resources Commission Act

"Allan R. Guy"

Minister in charge of The Water Resources Commission Act

Section 6 amended on July 5, 1984.

SCHEDULE B

THIS AGREEMENT is made in quadruplicate this THIRTIETH day of October, 1969, A.D.

BETWEEN:

HER Majesty, the Queen, in right of Saskatchewan, represented herein by the Minister in charge of The Water Resources Commission Act of the said Province

(Hereinafter called "Saskatchewan)

- and -

HER Majesty, the Queen, in right of Manitoba, represented herein by the Minister in charge of The Water Control and Conservation Branch Act of the said Province

(Hereinafter called "Manitoba")

WHEREAS under natural conditions the waters of the watercourses hereinafter referred to arising in or flowing through the Province of Saskatchewan would flow into the Province of Manitoba;

AND WHEREAS the parties hereto deem it to be in their mutual interest and in the interest of Alberta that an agreement in principle be reached among the said three Provinces as to the apportionment of interprovincial waters among them;

AND WHEREAS the parties hereto are of the opinion that an equitable apportionment of such waters as between the adjoining Provinces of Saskatchewan and Manitoba would be to permit the Province of Saskatchewan to make a net depletion of one-half the natural flow of water arising in, and one-half the flow of water flowing into, the Province of Saskatchewan, and to permit the remaining one-half of the flow of water of each such watercourse to flow into the Province of Manitoba, subject to certain rights as may hereafter be mutually agreed upon in writing;

AND WHEREAS on the basis of the forgoing apportionment as between the Provinces of Saskatchewan and Manitoba, the parties hereto are of the opinion that in a similar manner, an equitable apportionment of the natural flow of the said watercourses arising in or flowing through the Province of Alberta would be to permit the Province of Alberta to make a net depletion of one-half thereof, subject to such prior rights as may be mutually acknowledged by the said Provinces of Alberta, Saskatchewan and Manitoba;

AND WHEREAS the parties hereto recognize the continuing need for consultation and co-operation as between themselves and with Alberta with respect to the matters herein referred to so that the interests of all said Provinces are best served;

NOW THIS AGREEMENT witnesseth as follows:

1. IN THIS AGREEMENT:

   (a) 'Natural flow' means the quantity of water which would naturally flow in any watercourse had the flow not been affected by human interference or human intervention.

   (b) "Watercourse" means any river, stream, creek, o r other natural channel which from time to time carries a flowing body of water from the Province of Saskatchewan to the Province of Manitoba and includes all tributaries of each such river, stream, creek or natural channel which do not themselves cross the common boundary between the Provinces of Saskatchewan and Manitoba. Such tributaries as do themselves cross the said common boundary between the Provinces of Saskatchewan and Manitoba shall be deemed to be "watercourses" for the purpose of this agreement.

2. (a) The parties hereto shall mutually establish a method by which to determine the natural flow of each watercourse flowing across their said common boundary.

   (b) For the purpose of this agreement, the said natural flow shall be determined at a point as near as reasonably may be to their said common boundary.

3. Saskatchewan shall permit in each watercourse the following quantity of water to flow into Manitoba during the period from April 1 of each year to march 31 of the year following: A quantity of water equal to the natural flow for that period determined at the point referred to in paragraph 2(b) hereof, less

(a) one-half the water flowing into Saskatchewan in that watercourse from Alberta, and

(b) any water which would form part of the natural flow in that watercourse but does not flow into Saskatchewan because of the implementation of any provision of any subsisting water apportionment agreement made between Alberta and Saskatchewan and approved by Manitoba, and

(c) one-half the natural flow arising in Saskatchewan.

The actual flow shall be adjusted from time to time by mutual agreement on an equitable basis during such period but this shall not restrict or prohibit Saskatchewan from diverting, storing or consuming any quantity of water from any watercourse provided that Saskatchewan diverts water to which it is entitled of comparable quality from other streams or rivers into such watercourse to meet its commitments to Manitoba with respect to each watercourse.

4. Saskatchewan shall be entitled during such period to consume or to divert or store for its consumptive use the water it is not required to permit to flow into Manitoba in each watercourse under paragraph 3 hereof, but such consumption or diversion shall be made equitably depending on the actual flow of water in each watercourse and the requirements of each Province from time to time, but Saskatchewan shall permit sufficient water to flow into Manitoba to meet its commitments during such period under paragraph 3 hereof.

5. The parties hereto shall work together and co-operate to the fullest extent, each with the other, for the use of waters flowing from the Province of Saskatchewan into the Province of Manitoba, including the construction and operation of approved projects of mutual advantage to the said Provinces on a cost-share basis proportionate to the benefits derived therefrom by each Province (the approval of which projects shall not be unreasonably withheld by either of the parties hereto) and shall enter into such other arrangements, agreements or accords with each other, and with the Governments of Canada and other Provinces to best achieve the principles herein agreed upon.

6. If at any time any dispute, difference or question shall arise between the parties or their representatives touching this agreement or the construction, meaning and effect thereof, or anything therein, or the rights or liabilities of the parties or their representatives thereunder or otherwise in respect thereto then every such dispute, difference or question shall be referred for determination to the Exchequer Court under the provisions of The Exchequer Court Act of Canada, and each of the parties hereto agrees to maintain or enact the necessary legislation to provide the Exchequer Court with jurisdiction to determine any such dispute, difference or question in the manner provided under The Exchequer Court Act.

7. This agreement shall become effective upon the execution of an agreement by Canada, Alberta, Manitoba and Saskatchewan relative to the apportionment of waters referred to in this agreement.

IN WITNESS WHEREOF Saskatchewan has caused these presents to be executed by its Minister in charge of The Water Resources Commission Act, and Manitoba has caused these presents to be executed by its Minister in charge of The Water Control and Conservation Branch Act on the day and year first above mentioned.

"Harold W. Pope"
Witness to the signature of the Minister
in charge of The Water Resources Commission Act

"Allan R. Guy"
Minister in charge of The Water Resources Commission Act

"Thomas E. Weber"
Witness to the signature of the Minister
in charge of The Water Control and Conservation Branch Act

"Leonard S. Evans"
Minister in charge of The Water Control and Conservation Branch Act.

SCHEDULE C

PRAIRIE PROVINCES WATER BOARD AGREEMENT

THIS AGREEMENT made this THIRTIETH day of OCTOBER, 1969, A.D.

BETWEEN:

THE GOVERNMENT OF CANADA, hereinafter called "Canada"

- and -

THE GOVERNMENT OF MANITOBA, hereinafter called "Manitoba"

- and -

THE GOVERNMENT OF SASKATCHEWAN, hereinafter called "Saskatchewan"

- and -

THE GOVERNMENT OF ALBERTA, hereinafter called "Alberta"

1. Manitoba, Saskatchewan, Alberta and Canada agree to establish and there is hereby established a Board to be known as the Prairie Provinces Water Board to consist of five members to be appointed as follows:

   (a) two members to be appointed by the Governor General in Council, one of whom shall be Chairman of the Board, on the recommendation of the Minister of Energy, Mines and Resources,

   (b) one member to be appointed by the Lieutenant Governor in Council of each of the Provinces of Manitoba, Saskatchewan and Alberta.

2. Functions

The Board shall oversee and report on the Master Agreement (including the First and Second Agreements thereunder) executed by Canada, Alberta, Manitoba and Saskatchewan for the apportionment of waters flowing from one Province into another province; shall take under consideration, comprehensive planning, water quality management and other questions pertaining to water resource management referred to it by the parties hereto; shall recommend appropriate action to investigate such matters and shall submit recommendations for their resolution to the parties hereto.

3. Composition of Board

The members of the Board shall be chosen from those engaged in the administration of water resources or related duties for Manitoba, Saskatchewan, Alberta or Canada, as the case may be, and shall serve as members of the Board in addition to their other duties.

4. Duties of the Board

In accordance with its functions, the duties of the Board shall be as follows:

   (a) to review, collate, and analyze streamflow data and prepare reports and recommendations on the apportionment of water,

   (b) to review water quality problems, particularly such problems located at the interprovincial boundaries, and to recommend to the parties hereto, appropriate management approaches for their resolution including the establishment of new institutional arrangements,

   (c) to develop recommendations on other water matters, in addition to problems on water quality, referred to the Board by any party hereto including the review and analysis of existing information and the requesting of additional studies and assistance by appropriate governmental agencies to provide information for formulating its recommendations,

(d) to promote through consultation and the exchange of information the integrated development of water resources of interprovincial streams,

(e) to cause to be prepared with the consent of the parties involved factual reports on disputes arising out of the water apportionment for consideration by the parties hereto,

(f) to ensure the co-ordination of such technical programs as water quantity and quality monitoring and streamflow forecasting required for the effective apportionment of water.

5. Confirmation of the Board's Recommendations

A recommendation of the Board with respect to any matters referred to it under Section 2 shall, subject to the Master Agreement for the apportionment of water, become effective when adopted by Orders-in-Council passed by Canada and each of the Provinces.

6. Authority of Board

The Board shall have authority to correspond with all Governmental organizations and other sources of information in Canada or abroad concerned with the administration of water resources, and such other authority as may be conferred on the Board rom time to time by agreement between the parties hereto; all agencies of the four governments having to do with the water and associated resources in the area covered by the Agreement shall be required to supply the Board with all data in their possession requested by the Board.

7. Records

The records relating to the water resources of the three provinces collected and compiled by the P.F.R.A. organization at Regina shall be made available to the Board.

8. Meetings of the Board

The Board shall meet at the call of the Chairman and meetings shall be called at least twice annually; the expenses of the members shall be borne by their respective governments.

9. Reports

The Board shall submit an annual progress report outlining work done and work contemplated in the agreed program to each of the responsible Ministers of the parties hereto and such other reports as may be requested by any one of such Ministers.

10. Operation of the Board

The Secretary for the Board and such other technical and clerical staff as may be required, with a headquarters at Regina, shall be Federal or Provincial public servants. The cost of administration, excluding the cost of monitoring as described in Section 7 of the Master Agreement, but including staff, accommodation, supplies and incidental expenses of the Board, shall be borne by the parties hereto on the basis of one-half by Canada and one-sixth by each of the Provinces. The Board shall prepare for approval of the parties hereto, work program, staff requirements, annual budgets and five-year forecasts and such other reports as may be required in the operation of the Board.

11. Any water development project already constructed or to be constructed by any one of the parties shall be so operated as to maintain the apportionment of water as set out in the Master Agreement (and the First and Second Agreements thereunder) for the apportionment of waters of interprovincial streams.

SCHEDULE D

PREVIOUS ALLOCATIONS OF INTERPROVINCIAL WATERS
APPROVED BY ORDERS-IN-COUNCIL BY THE GOVERNMENTS OF
CANADA, ALBERTA, MANITOBA, AND SASKATCHEWAN

Item	Order-in-Council			
	Canada	Alberta	Saskatchewan	Manitoba
Allocation of water for specific projects in Alberta	4030/49	857/49	1307/51	1121/49
Allocation of water for specific projects in Saskatchewan	1874/51	1091/51	1310/51	1264/51
Allocation of water for South Saskatchewan River Project in Saskatchewan	973/53	991/53	1271/53	924/53

APPENDIX C
FLOW DATA

TABLE C1
NATURAL FLOWS
SOUTH SASKATCHEWAN RIVER
NEAR LEMSFORD
MEAN MONTHLY FLOWS (m3/s)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	VOLUME Kdam³
1912	50.2	62.3	131.4	317.3	447.2	629.1	968.9	549.5	392.0	260.7	179.6	96.8	342.3	10 801
1913	58.0	77.2	81.7	490.6	472.2	972.4	695.0	465.4	290.5	215.8	153.7	84.6	338.7	10 682
1914	69.3	56.9	123.6	208.5	447.8	657.4	523.9	250.5	182.6	284.6	169.8	71.3	254.9	8 039
1915	64.9	59.8	187.1	229.4	690.9	1 122.2	1 542.6	778.0	395.0	323.7	171.2	112.9	476.5	15 026
1916	57.2	129.5	212.8	327.6	435.5	1 589.3	1 567.6	689.2	618.5	343.1	214.0	128.9	527.6	16 638
1917	79.2	108.6	90.8	435.8	899.6	1 458.9	772.3	324.2	224.4	192.8	127.9	53.5	397.9	12 548
1918	84.8	85.6	221.9	275.5	341.5	718.6	388.5	264.3	194.6	153.0	103.0	61.0	241.4	7 613
1919	52.2	55.2	64.0	260.0	438.9	522.7	314.2	334.4	171.4	84.3	70.4	56.7	202.6	6 391
1920	51.9	77.0	125.0	474.7	802.4	705.7	935.6	343.0	170.0	146.3	93.0	55.1	333.4	10 515
1921	51.6	59.4	85.0	312.9	491.2	796.7	465.9	233.2	123.3	86.3	74.5	44.0	235.8	7 435
1922	42.3	22.9	57.1	184.2	458.7	771.3	430.3	263.2	158.8	90.5	71.4	33.8	216.1	6 814
1923	37.3	26.5	54.0	154.7	338.7	1 849.3	820.8	429.2	238.7	159.2	107.3	64.5	356.9	11 254
1924	40.8	61.0	69.2	129.4	440.4	705.8	516.0	412.7	193.3	114.4	99.3	68.0	238.5	7 521
1925	60.1	55.7	155.4	536.2	533.9	768.0	455.4	319.7	238.9	260.5	150.9	119.7	305.3	9 627
1926	66.0	87.8	189.7	266.6	245.7	340.6	378.0	186.8	629.6	440.0	192.7	140.8	264.1	8 329
1927	86.4	73.3	139.9	470.0	662.3	1 471.3	927.8	553.3	587.9	348.5	181.2	133.1	470.6	14 840
1928	167.9	132.7	350.4	329.0	616.0	1 075.0	1 151.3	340.3	239.9	207.7	126.4	68.4	402.2	12 682
1929	55.2	46.6	131.2	140.1	469.4	1 128.2	310.7	164.8	114.7	62.8	63.2	53.4	228.4	7 203
1930	44.7	119.5	140.1	276.9	421.0	699.2	497.9	185.7	129.9	91.7	80.8	63.6	229.4	7 235
1931	50.5	51.7	68.7	102.3	228.1	450.7	317.4	179.4	147.6	102.1	90.7	58.4	154.3	4 867
1932	56.0	61.1	93.8	182.3	560.5	1 123.9	435.0	238.6	198.8	128.5	109.1	74.2	272.1	8 581
1933	58.7	46.6	81.4	278.4	545.2	855.9	515.0	219.3	154.4	117.4	147.9	80.5	259.0	8 169
1934	91.6	95.9	165.3	468.3	595.0	716.2	313.5	178.3	124.6	106.5	138.0	64.6	255.0	8 040
1935	58.8	79.5	82.7	192.8	318.4	696.8	562.8	305.0	142.3	96.7	66.8	45.3	221.2	6 977
1936	39.2	32.6	103.1	431.8	419.0	541.6	224.0	158.1	111.6	61.1	55.6	18.5	183.1	5 775
1937	14.9	21.5	64.6	157.2	251.0	718.2	360.0	216.2	125.3	107.2	112.3	62.3	184.5	5 819
1938	60.8	34.9	110.8	243.8	520.3	863.0	624.8	233.4	173.8	136.2	85.1	48.0	262.2	8 269
1939	39.9	30.4	112.1	179.2	297.1	638.8	484.7	189.7	120.7	96.4	110.2	65.6	197.7	6 235
1940	32.3	39.1	97.9	399.3	470.1	417.1	286.8	179.3	205.3	161.1	93.6	63.1	204.3	6 442
1941	43.5	49.0	123.1	153.8	174.8	332.8	247.4	182.3	176.7	168.9	105.8	70.4	152.8	4 818
1942	49.4	37.1	62.0	143.4	632.7	1 075.7	927.0	464.3	342.8	240.9	118.0	81.6	349.7	11 027
1943	46.7	68.6	135.5	763.2	382.4	733.5	773.3	302.9	151.1	98.8	73.2	50.3	298.7	9 421
1944	44.4	37.3	57.4	127.4	196.7	425.9	318.9	324.5	163.9	109.5	84.2	57.2	162.9	5 137
1945	43.1	49.0	112.5	121.8	391.2	957.8	608.2	226.5	215.3	188.7	111.6	92.5	260.6	8 218

1946	72.2	72.8	165.7	246.8	404.0	879.8	513.1	217.2	268.1	178.6	113.3	98.5	269.6	8 502
1947	74.7	90.8	321.9	476.2	740.3	837.7	557.5	268.7	266.7	348.6	168.6	105.9	356.1	11 229
1948	70.7	60.0	99.8	801.4	1 499.7	1 771.8	655.7	446.3	190.6	124.6	93.5	49.2	489.7	15 442
1949	56.5	46.6	68.9	237.7	397.7	493.5	267.9	174.0	117.1	97.8	101.1	56.0	176.6	5 570
1950	42.4	49.7	80.2	247.9	369.8	970.5	742.9	296.7	147.8	139.8	94.9	48.4	270.0	8 515
1951	54.8	51.3	77.3	507.5	979.8	1 193.7	1 270.4	462.2	802.0	508.4	236.4	156.7	527.2	16 625
1952	98.6	110.8	165.1	1 006.4	565.0	763.1	696.5	384.2	202.0	144.4	98.7	64.1	358.5	11 307
1953	53.5	80.2	96.1	272.2	698.7	2 059.3	981.0	393.7	243.8	157.8	117.9	79.5	436.5	13 764
1954	58.7	96.2	94.3	302.5	794.4	1 053.4	989.9	597.6	521.7	312.1	190.4	111.5	428.6	13 517
1955	61.9	82.5	69.1	493.2	609.3	946.2	808.9	292.5	172.7	173.3	107.4	62.9	324.1	10 222
1956	73.3	63.2	169.0	482.0	593.8	926.1	680.0	313.0	183.8	133.0	97.8	76.1	316.8	9 992
1957	56.4	56.6	148.1	252.2	754.7	699.9	342.9	212.5	152.7	134.7	144.5	89.3	254.7	8 032
1958	49.9	55.6	93.1	522.0	657.1	745.5	652.1	280.5	175.5	134.4	106.9	74.0	296.5	9 351
1959	54.5	46.0	155.5	208.0	445.4	949.3	702.7	322.6	231.4	256.0	144.2	115.3	303.8	9 581
1960	63.0	81.6	221.6	402.7	419.7	653.0	546.3	283.1	146.5	100.4	76.9	53.3	254.7	8 032
1961	57.6	45.7	93.6	119.9	429.6	1 014.3	323.8	253.5	142.6	165.2	113.2	50.8	234.5	7 394
1962	52.1	87.0	64.0	327.2	357.5	647.4	430.4	265.7	190.7	122.7	113.5	77.8	228.2	7 195
1963	43.4	60.0	151.6	180.6	273.1	789.7	817.2	310.9	187.1	117.1	88.4	39.7	255.9	8 070
1964	67.3	68.6	64.0	136.1	555.0	1 277.2	687.1	248.0	175.1	184.1	132.3	43.1	303.7	9 577
1965	71.8	82.5	133.6	459.5	422.0	1 156.6	1 131.8	422.6	349.9	321.2	177.5	118.5	405.2	12 777
1966	60.8	75.2	237.2	385.6	461.0	969.8	698.1	338.3	210.4	156.4	100.4	81.7	315.4	9 947
1967	61.2	63.1	131.0	378.4	764.6	1 678.1	778.4	317.1	174.3	123.2	119.9	62.7	388.1	12 240
1968	58.1	72.7	131.9	125.9	298.6	775.9	508.3	307.8	248.7	264.3	140.4	45.7	248.8	7 847
1969	60.8	67.0	140.6	632.5	609.4	871.5	1 165.4	325.2	195.1	151.1	115.6	65.4	368.1	11 610
1970	38.6	61.8	83.4	255.1	408.4	1 083.0	526.9	217.8	140.3	117.4	86.3	31.1	254.3	8 018
1971	50.6	93.8	103.6	567.1	576.4	1 015.3	536.5	296.8	164.6	126.0	102.3	43.9	306.4	9 664
1972	32.5	46.3	259.0	309.8	581.5	1 329.0	793.5	419.0	259.6	187.9	126.7	48.5	367.2	11 580
1973	70.1	73.7	146.4	278.6	474.9	757.1	492.0	268.2	199.6	121.1	99.4	79.1	255.6	8 062
1974	53.8	80.3	88.5	516.8	729.4	1 258.2	754.1	336.6	223.1	154.4	99.4	59.5	363.4	11 460
1975	45.0	47.5	62.7	251.2	549.9	1 103.4	713.5	308.5	197.0	145.7	107.1	69.1	300.9	9 488
1976	61.7	80.1	131.0	238.7	443.0	524.4	526.2	534.4	276.5	163.0	94.5	53.3	261.8	8 256
1977	46.5	63.6	84.8	137.4	284.7	365.3	231.5	261.1	227.4	150.9	85.9	44.6	165.7	5 226
1978	48.9	49.0	142.5	305.3	476.8	847.2	672.4	339.1	294.2	194.9	102.9	80.5	297.2	9 372
1979	32.9	33.6	175.3	191.6	466.6	607.9	379.7	205.2	145.2	88.2	73.9	40.8	204.3	6 442
1980	29.6	40.6	74.6	313.4	546.2	837.6	371.5	253.5	210.3	175.3	114.5	67.2	253.3	7 989
1981	89.6	112.7	144.4	146.2	880.0	945.4	775.3	540.1	217.4	140.3	110.9	45.5	347.5	10 957
1982	16.8	41.4	67.2	247.3	318.7	809.0	703.9	283.7	188.9	153.9	71.9	45.1	246.4	7 771
1983	40.9	56.6	102.6	166.5	317.2	545.3	474.7	239.8	143.6	99.4	91.0	20.5	192.1	6 059
1984	25.0	65.9	76.2	122.7	190.2	508.5	361.4	218.4	150.1	140.8	84.9	37.7	165.4	5 216
1985	31.4	52.5	73.6	253.1	336.8	495.4	259.9	215.1	336.8	244.6	164.7	47.4	209.4	6 604
1986	72.1	61.6	273.7	176.3	463.0	939.0	537.6	298.3	231.5	353.6	131.6	94.1	303.9	9 585
AVERAGE	56.1	64.8	124.6	312.6	503.7	888.3	622.9	315.4	228.7	174.6	115.7	69.0	290.5	9 161

TABLE C2
NATURAL FLOWS
SOUTH SASKATCHEWAN RIVER
AT ST. LOUIS
MEAN MONTHLY FLOWS (m3/s)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	VOLUME Kdam³
1912	50	59	148	334	438	607	933	597	413	283	193	113	349	11 015
1913	66	73	102	451	477	912	731	496	314	230	163	98	344	10 837
1914	73	58	119	202	418	628	542	288	194	273	185	90	257	8 100
1915	68	60	174	230	638	1 069	1 504	858	444	339	193	125	478	15 088
1916	68	116	225	353	428	1 460	1 577	785	630	383	234	145	536	16 888
1917	89	102	101	457	865	1 396	851	384	243	202	139	69	409	12 896
1918	81	83	236	298	339	670	430	284	205	163	112	70	248	7 822
1919	55	54	66	236	417	509	343	334	194	102	75	60	204	6 443
1920	53	77	129	446	770	714	915	413	198	154	102	64	338	10 659
1921	53	58	88	286	471	757	508	267	142	96	77	51	238	7 516
1922	44	26	71	202	427	731	474	289	175	104	76	42	223	7 021
1923	38	28	63	170	317	1 684	931	483	266	175	117	74	363	11 432
1924	46	57	70	130	399	669	541	428	223	131	103	75	240	7 582
1925	62	56	167	530	543	741	496	340	250	261	167	127	312	9 854
1926	76	83	202	261	251	327	375	214	570	464	227	153	267	8 435
1927	96	75	149	477	652	1 384	994	601	584	382	206	144	480	15 136
1928	169	139	339	345	585	1 019	1 149	435	259	216	139	81	408	12 866
1929	59	47	122	145	428	1 047	408	192	124	74	64	56	231	7 277
1930	47	110	151	268	405	662	526	230	141	101	84	68	233	7 352
1931	54	51	71	105	211	419	336	201	154	112	93	66	156	4 931
1932	57	63	96	185	513	1 054	517	270	206	142	113	82	275	8 681
1933	62	54	84	266	513	815	558	261	167	126	143	93	263	8 283
1934	91	93	177	448	582	700	368	201	134	112	133	78	260	8 203
1935	61	77	100	191	304	647	582	340	167	107	73	51	226	7 116
1936	41	34	109	418	425	526	270	171	119	72	57	27	189	5 970
1937	17	19	57	144	239	655	404	239	140	112	111	72	185	5 824
1938	62	39	117	236	488	818	656	286	185	144	94	56	266	8 393
1939	42	32	122	176	283	598	506	231	134	103	108	74	202	6 356
1940	40	38	101	375	465	423	307	197	201	169	105	70	208	6 565
1941	48	47	141	175	175	311	261	193	177	172	116	79	158	4 994
1942	54	39	68	158	571	1 022	949	520	360	259	138	91	354	11 166
1943	54	63	179	769	442	696	772	362	176	111	79	56	314	9 899
1944	46	38	62	133	199	395	334	325	186	121	89	63	167	5 252
1945	46	51	137	172	361	887	651	279	219	195	124	98	269	8 486

1946	76	71	171	254	388	819	557	260	263	194	125	103	274	8 646
1947	79	86	319	508	716	825	596	308	268	339	193	119	364	11 493
1948	78	62	115	741	1 429	1 738	779	479	226	139	99	58	496	15 655
1949	56	47	75	222	377	479	300	192	127	103	100	65	179	5 647
1950	46	47	86	329	366	898	770	354	173	144	102	59	282	8 895
1951	55	51	77	555	948	1 169	1 268	554	765	545	273	173	538	16 976
1952	109	108	167	1 169	663	755	711	425	230	158	107	72	390	12 296
1953	57	74	123	310	655	1 917	1 093	470	268	174	125	88	447	14 091
1954	63	93	107	301	740	1 021	1 001	644	532	344	209	127	434	13 678
1955	72	78	98	542	613	909	839	359	193	176	118	73	340	10 725
1956	72	64	179	480	585	886	711	361	204	144	104	81	324	10 211
1957	61	56	153	248	695	701	393	234	162	140	143	100	258	8 141
1958	58	55	100	494	648	732	667	330	193	145	112	82	302	9 534
1959	59	48	152	205	417	886	734	372	246	256	160	123	306	9 655
1960	73	78	249	428	423	623	561	320	168	111	82	59	265	8 373
1961	58	47	94	121	388	940	406	270	159	164	121	64	236	7 456
1962	53	79	82	297	355	609	460	290	202	136	116	85	231	7 276
1963	51	57	159	184	263	723	817	373	207	131	94	50	260	8 206
1964	63	67	71	137	501	1 191	753	308	189	186	140	61	306	9 659
1965	68	79	132	491	439	1 071	1 138	506	364	329	198	131	413	13 040
1966	72	72	248	375	456	908	731	386	230	168	110	87	321	10 132
1967	65	62	130	388	735	1 577	876	380	198	135	121	74	396	12 484
1968	60	71	138	136	278	713	541	337	258	265	158	65	252	7 962
1969	60	64	134	671	625	840	1 139	422	219	162	122	76	379	11 965
1970	45	56	103	321	400	1 004	593	264	155	124	92	43	267	8 419
1971	48	84	104	578	585	964	595	332	186	136	107	56	315	9 928
1972	36	43	234	338	452	719	526	300	211	136	104	84	266	8 397
1974	59	74	96	583	734	1 199	813	392	242	169	109	69	379	11 953
1975	49	46	62	275	526	1 037	759	363	216	157	114	77	308	9 702
1976	64	77	173	270	421	537	532	535	309	184	107	63	274	8 636
1977	49	60	84	130	265	352	252	259	231	165	97	54	167	5 265
1978	49	48	140	293	461	800	695	383	302	212	118	87	300	9 466
1979	43	34	167	262	448	588	411	232	156	100	77	48	215	6 767
1980	33	38	78	284	517	799	431	274	217	183	124	78	255	8 057
1981	88	111	145	146	788	932	799	570	260	157	117	59	349	11 020
1982	24	37	79	261	318	752	721	339	206	163	86	52	254	8 012
1983	43	56	110	168	302	514	498	276	160	110	93	35	198	6 235
1984	26	57	81	117	182	463	380	240	162	145	94	48	167	5 259
1985	34	47	97	287	332	473	293	225	319	259	177	69	218	6 871
1986	70	69	257	192	429	878	587	333	243	340	162	104	307	9 668
AVERAGE	59	63	131	322	485	836	654	355	242	185	125	79	296	9 327

TABLE C3
CURRENT DEVELOPMENT FLOWS (1986)
SOUTH SASKATCHEWAN RIVER
NEAR LEMSFORD
MEAN MONTHLY FLOW (m3/s)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	VOLUME Kdam³
1912	89.4	88.9	162.2	314.2	326.5	352.8	756.8	420.4	293.0	207.1	178.3	137.0	278.7	8 789
1913	97.2	103.8	112.5	487.5	351.5	696.1	482.9	336.3	191.5	162.2	152.4	124.8	275.1	8 676
1914	108.5	83.5	154.4	205.4	327.1	381.1	311.8	121.4	83.6	231.0	168.5	111.5	191.3	6 034
1915	104.1	86.4	217.9	226.3	570.2	845.9	1 330.5	648.9	296.0	270.1	169.9	153.1	412.9	13 021
1916	96.4	156.1	243.6	324.5	314.8	1 313.0	1 355.5	560.1	519.5	289.5	212.7	169.1	464.0	14 633
1917	118.4	135.2	121.6	432.7	778.9	1 182.6	560.2	195.1	125.4	139.2	126.6	93.7	334.3	10 543
1918	124.0	112.2	252.7	272.4	220.8	442.3	176.4	135.2	95.6	99.4	101.7	101.2	177.8	5 608
1919	91.4	81.8	94.8	256.9	318.2	246.4	102.1	205.3	72.4	30.7	69.1	96.9	139.1	4 385
1920	91.1	103.6	155.8	471.6	681.7	429.4	723.5	213.9	71.0	92.7	91.7	95.3	269.8	8 509
1921	90.8	86.0	115.8	309.8	370.5	520.4	253.8	104.1	24.3	32.7	73.2	84.2	172.2	5 430
1922	81.5	49.5	87.9	181.1	338.0	495.0	218.2	134.1	59.8	36.9	70.1	74.0	152.5	4 809
1923	76.5	53.1	84.8	151.6	218.0	1 573.0	608.7	300.1	139.7	105.6	106.0	104.7	293.3	9 249
1924	80.0	87.6	100.0	126.3	319.7	429.5	303.9	283.6	94.3	60.8	98.0	108.2	174.9	5 516
1925	99.3	82.3	186.2	533.1	413.2	491.7	243.3	190.6	139.9	206.9	149.6	159.9	241.7	7 622
1926	105.2	114.4	220.5	263.5	125.0	64.3	165.9	57.7	530.6	386.4	191.4	181.0	200.5	6 324
1927	125.6	99.9	170.7	466.9	541.6	1 195.0	715.7	424.2	488.9	294.9	179.9	173.3	407.0	12 834
1928	207.1	159.3	381.2	325.9	495.3	798.7	939.2	211.2	140.9	154.1	125.1	108.6	338.6	10 677
1929	94.4	73.2	162.0	137.0	348.7	851.9	98.6	35.7	15.7	9.2	61.9	93.6	164.8	5 197
1930	83.9	146.1	170.9	273.8	300.3	422.9	285.8	56.6	30.9	38.1	79.5	103.8	165.8	5 229
1931	89.7	78.3	99.5	99.2	107.4	174.4	105.3	50.3	48.6	48.5	89.4	98.6	90.7	2 861
1932	95.2	87.7	124.6	179.2	439.8	847.6	222.9	109.5	99.8	74.9	107.8	114.4	208.5	6 576
1933	97.9	73.2	112.2	275.3	424.5	579.6	302.9	90.2	55.4	63.8	146.6	120.7	195.4	6 163
1934	130.8	122.5	196.1	465.2	474.3	439.9	101.4	49.2	25.6	52.9	136.7	104.8	191.4	6 035
1935	98.0	106.1	113.5	189.7	197.7	420.5	350.7	175.9	43.3	43.1	65.5	85.5	157.6	4 971
1936	78.4	59.2	133.9	428.7	298.3	265.3	11.9	29.0	12.6	7.5	54.3	58.7	119.5	3 770
1937	54.1	48.1	95.4	154.1	130.3	441.9	147.9	87.1	26.3	53.6	111.0	102.5	120.9	3 814
1938	100.0	61.5	141.6	240.7	399.6	586.7	412.7	104.3	74.8	82.6	83.8	88.2	198.6	6 264
1939	79.1	57.0	142.9	176.1	176.4	362.5	272.6	60.6	21.7	42.8	108.9	105.8	134.1	4 230
1940	71.5	65.7	128.7	396.2	349.4	140.8	74.7	50.2	106.3	107.5	92.3	103.3	140.7	4 437
1941	82.7	75.6	153.9	150.7	54.1	56.5	42.5	53.2	77.7	115.3	104.5	110.6	89.8	2 832
1942	88.6	63.7	92.8	140.3	512.0	799.4	714.9	335.2	243.8	187.3	116.7	121.8	286.1	9 022
1943	85.9	95.2	166.3	760.1	261.7	457.2	561.2	173.8	52.1	45.2	71.9	90.5	235.1	7 415
1944	83.6	63.9	88.2	124.3	76.0	149.6	106.8	195.4	64.9	55.9	82.9	97.4	99.3	3 131
1945	82.3	75.6	143.3	118.7	270.5	681.5	396.1	97.4	116.3	135.1	110.3	132.7	197.0	6 212

1946	111.4	99.4	196.5	243.7	283.3	603.5	301.0	88.1	169.1	125.0	112.0	138.7	206.0	6 497
1947	113.9	117.4	352.7	473.1	619.6	561.4	345.4	139.6	167.7	295.0	167.3	146.1	292.5	9 224
1948	109.9	86.6	130.6	798.3	1 379.0	1 495.5	443.6	317.2	91.6	71.0	92.2	89.4	426.1	13 436
1949	95.7	73.2	99.7	234.6	277.0	217.2	55.8	44.9	18.1	44.2	99.8	96.2	113.0	3 565
1950	81.6	76.3	111.0	244.8	249.1	694.2	530.8	167.6	48.8	86.2	93.6	88.6	206.4	6 509
1951	94.0	77.9	108.1	504.4	859.1	917.4	1 058.3	333.1	703.0	454.8	235.1	196.9	463.6	14 620
1952	137.8	137.4	195.9	1 003.3	444.3	486.8	484.4	255.1	103.0	90.8	97.4	104.3	294.9	9 301
1953	92.7	106.8	126.9	269.1	578.0	1 783.0	768.9	264.6	144.8	104.2	116.6	119.7	372.9	11 759
1954	97.9	122.8	125.1	299.4	673.7	777.1	777.8	468.5	422.7	258.5	189.1	151.7	365.0	11 512
1955	101.1	109.1	99.9	490.1	488.6	669.9	596.8	163.4	73.7	119.7	106.1	103.1	260.5	8 217
1956	112.5	89.8	199.8	478.9	473.1	649.8	467.9	183.9	84.8	79.4	96.5	116.3	253.2	7 986
1957	95.6	83.2	178.9	249.1	634.0	423.6	130.8	83.4	53.7	81.1	143.2	129.5	191.1	6 026
1958	89.1	82.2	123.9	518.9	536.4	469.2	440.0	151.4	76.5	80.8	105.6	114.2	232.9	7 346
1959	93.7	72.6	186.3	204.9	324.7	673.0	490.6	193.5	132.4	202.4	142.9	155.5	240.2	7 575
1960	102.2	108.2	252.4	399.6	299.0	376.7	334.2	154.0	47.5	46.8	75.6	93.5	191.1	6 027
1961	96.8	72.3	124.4	116.8	308.9	738.0	111.7	124.4	43.6	111.6	111.9	91.0	170.9	5 388
1962	91.3	113.6	94.8	324.1	236.8	371.1	218.3	136.6	91.7	69.1	112.2	118.0	164.6	5 190
1963	82.6	86.6	182.4	177.5	152.4	513.4	605.1	181.8	88.1	63.5	87.1	79.9	192.3	6 064
1964	106.5	95.2	94.8	133.0	434.3	1 000.9	475.0	118.9	76.1	130.5	131.0	83.3	240.1	7 572
1965	111.0	109.1	164.4	456.4	301.3	880.3	919.7	293.5	250.9	267.6	176.2	158.7	341.6	10 772
1966	100.0	101.8	268.0	382.5	340.3	693.5	486.0	209.2	111.4	102.8	99.1	121.9	251.8	7 942
1967	100.4	89.7	161.8	375.3	643.9	1 401.8	566.3	188.0	75.3	69.6	118.6	102.9	324.6	10 235
1968	97.3	99.3	162.7	122.8	177.9	499.6	296.2	178.7	149.7	210.7	139.1	85.9	185.2	5 841
1969	100.0	93.6	171.4	629.4	488.7	595.2	953.3	196.1	96.1	97.5	114.3	105.6	304.6	9 604
1970	77.8	88.4	114.2	252.0	287.7	806.7	314.8	88.7	41.3	63.8	85.0	71.3	190.7	6 013
1971	89.8	120.4	134.4	564.0	455.7	739.0	324.4	167.7	65.6	72.4	101.0	84.1	242.9	7 659
1972	71.7	72.9	289.8	306.7	460.8	1 052.7	581.4	289.9	160.6	134.3	125.4	88.7	303.6	9 575
1973	109.3	100.3	177.2	275.5	354.2	480.8	279.9	139.1	100.6	67.5	98.1	119.3	192.1	6 057
1974	93.0	106.9	119.3	513.7	608.7	981.9	542.0	207.5	124.1	100.8	98.1	99.7	299.8	9 455
1975	84.2	74.1	93.5	248.1	429.2	827.1	501.4	179.4	98.0	92.1	105.8	109.3	237.3	7 483
1976	100.9	106.7	161.8	235.6	322.3	248.1	314.1	405.3	177.5	109.4	93.2	93.5	198.2	6 251
1977	85.7	90.2	115.6	134.3	164.0	89.0	42.5	132.0	128.4	97.3	84.6	84.8	104.1	3 283
1978	88.1	75.6	173.3	302.2	356.1	570.9	460.3	210.0	195.2	141.3	101.6	120.7	233.6	7 366
1979	72.1	60.2	206.1	188.5	345.9	331.6	167.6	76.1	46.2	34.6	72.6	81.0	140.7	4 436
1980	68.8	67.2	105.4	310.3	425.5	561.3	159.4	124.4	111.3	121.7	113.2	107.4	189.7	5 984
1981	128.8	139.3	175.2	143.1	759.3	669.1	563.2	411.0	118.4	86.7	109.6	85.7	283.9	8 952
1982	56.0	68.0	98.0	244.2	198.0	532.7	491.8	154.6	89.9	100.3	70.6	85.3	182.8	5 765
1983	84.1	100.9	143.4	171.3	208.5	267.6	298.1	121.2	45.1	43.3	89.8	50.3	135.5	4 272
1984	79.2	101.0	114.3	134.0	60.2	246.3	185.5	94.1	63.1	83.1	82.5	68.4	109.1	3 442
1985	74.2	57.3	153.9	270.9	238.7	217.5	65.6	102.6	235.6	196.8	122.1	112.6	154.1	4 861
1986	109.4	100.0	271.3	182.8	377.0	586.3	319.0	182.2	139.9	280.0	133.2	142.0	236.1	7 446
AVERAGE	95.6	91.6	155.8	310.2	383.8	611.1	412.3	186.9	129.9	120.7	113.8	109.4	227.2	7 164

TABLE C4
CURRENT DEVELOPMENT FLOWS (1986)
SOUTH SASKATCHEWAN RIVER
AT ST. LOUIS
MEAN MONTHLY FLOWS (m3/s)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	VOLUME Kdam³
1912	324.8	249.4	210.1	180.6	115.5	57.4	327.3	382.1	244.8	349.4	319.1	400.0	264.2	8 337
1913	362.2	264.2	157.7	313.3	154.4	189.0	282.9	273.6	140.4	298.3	290.5	400.0	260.8	8 231
1914	355.8	248.4	177.6	47.4	93.3	60.0	60.0	60.0	60.0	191.2	311.7	393.2	171.5	5 412
1915	348.5	249.0	233.1	77.9	320.7	345.1	971.4	679.8	321.4	400.0	325.3	400.0	391.8	12 366
1916	376.8	309.1	277.4	185.1	108.1	549.1	1 239.3	607.4	509.4	400.0	400.0	400.0	448.3	14 148
1917	400.0	328.0	162.7	309.9	384.5	619.5	495.1	257.6	72.8	270.2	265.5	372.1	328.3	10 360
1918	362.5	274.2	300.6	153.4	42.5	60.0	42.5	43.2	60.0	60.0	186.2	374.8	163.0	5 142
1919	335.7	243.9	127.1	90.0	89.7	42.5	42.5	42.5	42.5	42.5	100.0	243.3	119.7	3 779
1920	334.4	268.4	185.4	289.5	306.2	120.0	377.8	277.0	60.0	187.9	229.3	368.4	251.0	7 922
1921	334.2	248.0	146.4	139.5	145.1	60.0	60.0	60.0	60.0	60.0	202.9	355.9	155.7	4 913
1922	324.7	215.5	130.6	42.5	96.2	60.0	60.0	60.0	60.0	60.0	165.3	346.9	135.1	4 262
1923	318.9	217.7	123.5	42.5	42.5	689.8	580.0	350.6	86.6	239.2	243.5	378.4	276.7	8 732
1924	326.7	247.6	129.9	42.5	42.5	60.0	60.0	76.1	60.0	194.1	230.8	379.9	154.0	4 860
1925	343.3	245.6	218.5	231.5	354.8	60.0	60.0	60.0	78.5	330.8	293.1	400.0	223.4	7 051
1926	387.8	273.5	254.1	111.7	42.5	42.5	42.5	42.5	42.5	169.2	350.6	400.0	179.7	5 670
1927	400.0	301.7	211.7	313.7	212.1	583.4	645.0	426.3	466.5	400.0	386.3	400.0	395.9	12 492
1928	398.0	400.0	390.1	239.2	262.1	295.3	605.2	294.2	86.0	284.9	265.8	384.7	326.0	10 287
1929	339.6	237.8	182.3	42.5	53.1	309.5	60.0	43.5	42.5	59.2	100.0	298.0	146.8	4 634
1930	327.8	298.0	207.2	112.5	74.4	60.0	60.0	60.0	56.6	60.0	100.0	354.3	147.0	4 640
1931	334.5	241.2	128.3	42.5	42.5	42.5	42.5	42.5	42.5	42.5	100.0	100.0	99.4	3 138
1932	100.0	142.7	154.0	42.5	178.9	329.7	62.9	60.0	60.0	177.4	241.0	386.6	161.4	5 093
1933	343.0	243.6	141.2	113.9	191.2	76.8	96.4	60.0	60.0	110.3	272.5	397.0	175.4	5 536
1934	372.3	283.2	230.8	286.3	255.3	60.0	42.5	42.5	42.5	42.5	100.0	335.0	174.1	5 494
1935	342.1	268.7	154.6	42.5	42.5	42.5	60.0	60.0	60.0	60.0	185.0	355.8	139.0	4 388
1936	322.1	224.2	167.7	250.4	93.5	42.5	42.5	42.5	42.5	42.5	100.0	100.0	121.8	3 845
1937	137.4	209.4	116.9	42.5	42.5	42.5	42.5	42.5	42.5	42.5	100.0	150.5	83.6	2 638
1938	343.1	228.9	170.8	82.5	162.6	85.4	201.7	60.0	60.0	165.6	221.2	361.2	178.9	5 645
1939	323.3	221.6	174.7	42.5	42.5	42.5	42.5	42.5	42.5	42.5	100.0	287.9	116.9	3 689
1940	319.7	228.1	163.1	222.3	136.0	42.5	42.5	42.5	42.5	42.5	100.0	100.0	122.9	3 877
1941	316.0	237.3	193.5	42.5	42.5	42.5	42.5	42.5	42.5	42.5	100.0	100.0	103.1	3 254
1942	100.0	100.0	118.0	42.5	221.1	306.8	410.6	395.1	191.3	325.3	263.0	395.0	240.6	7 593
1943	334.1	254.5	229.6	294.6	393.5	60.0	227.9	132.0	60.0	125.4	206.2	361.2	223.7	7 060
1944	327.3	229.4	123.1	42.5	42.5	42.5	42.5	42.5	42.5	42.5	100.0	100.0	97.5	3 076
1945	153.9	241.9	192.9	42.5	42.5	131.5	190.8	60.0	60.0	250.4	250.6	400.0	168.0	5 301

1946	360.1	261.3	223.2	94.9	63.9	94.2	106.4	60.0	78.3	263.5	251.4	400.0	188.1	5 937
1947	368.6	276.9	380.2	340.1	391.0	98.4	139.1	88.7	100.7	400.0	328.6	400.0	276.7	8 731
1948	381.2	251.7	178.0	376.8	860.8	1 273.5	422.5	346.3	60.0	188.4	226.7	363.0	411.2	12 978
1949	337.4	236.9	129.7	72.5	54.9	42.5	42.5	42.5	42.5	42.5	100.0	100.0	103.0	3 250
1950	231.0	238.0	147.9	140.4	42.5	174.5	327.2	131.7	60.0	157.3	229.9	363.0	186.9	5 899
1951	336.0	242.0	140.6	311.0	387.4	566.2	929.0	400.0	633.1	539.5	400.0	400.0	441.6	13 936
1952	397.3	400.0	277.7	698.5	400.0	231.9	261.6	200.6	60.0	216.0	234.8	377.1	312.3	9 856
1953	337.4	266.9	183.3	157.3	341.5	999.5	732.2	331.0	92.0	238.4	252.7	392.6	361.0	11 392
1954	343.9	283.9	167.6	151.1	371.4	241.1	567.7	478.4	409.9	400.0	342.3	400.0	347.6	10 970
1955	382.2	268.8	160.2	267.3	252.0	340.2	389.9	125.9	60.0	201.7	244.5	376.9	256.0	8 079
1956	353.7	254.0	240.2	225.4	315.0	194.2	262.1	134.8	60.0	184.2	231.6	386.6	237.3	7 489
1957	341.2	245.9	209.0	97.7	374.6	60.0	42.5	42.5	42.5	60.0	151.9	400.0	172.6	5 448
1958	342.4	244.2	156.9	345.6	317.1	60.0	153.5	100.1	60.0	170.6	240.1	386.4	214.9	6 783
1959	339.6	236.5	208.8	53.3	95.6	159.7	276.5	144.6	80.1	328.2	286.7	400.0	218.1	6 883
1960	380.1	268.8	301.7	264.4	96.8	60.0	60.0	60.0	60.0	60.0	168.0	364.4	178.4	5 629
1961	338.9	236.3	152.5	42.5	42.5	154.7	60.0	60.0	60.0	60.0	201.4	367.5	147.7	4 660
1962	334.2	270.4	134.7	146.8	42.5	43.1	42.5	59.9	60.0	60.0	155.0	390.3	144.4	4 557
1963	330.8	246.6	213.7	42.5	42.5	60.0	200.1	145.4	60.0	163.2	221.8	354.6	173.7	5 481
1964	345.2	257.4	128.7	42.5	115.4	386.0	355.2	78.3	60.0	208.8	267.7	364.0	217.4	6 861
1965	350.0	269.5	194.3	295.2	136.0	351.5	595.1	371.4	191.3	393.2	323.6	400.0	323.4	10 205
1966	386.3	262.0	311.7	225.2	128.5	182.3	278.1	154.6	60.0	223.9	236.9	391.9	237.2	7 487
1967	346.0	253.9	190.3	242.6	397.2	641.0	505.3	235.4	60.0	165.3	249.6	378.4	305.9	9 654
1968	341.2	260.4	194.3	42.5	42.5	42.5	42.5	60.0	60.0	248.7	284.0	367.3	165.4	5 218
1969	340.9	255.3	193.0	293.0	400.0	209.8	595.7	274.6	60.0	226.4	249.6	380.4	291.1	9 188
1970	325.2	247.6	161.8	155.0	76.9	283.9	131.9	60.0	60.0	85.5	219.5	347.0	179.0	5 648
1971	329.6	275.4	163.1	356.5	323.1	235.6	130.0	95.9	60.0	150.1	235.0	360.3	225.9	7 128
1972	316.8	233.4	291.7	155.2	226.1	377.0	435.9	333.0	109.5	268.2	264.0	367.9	282.6	8 917
1973	349.4	261.8	202.1	115.7	124.3	60.0	60.0	60.0	60.0	114.1	231.8	389.5	168.9	5 329
1974	339.5	265.8	152.5	131.5	239.0	729.7	464.9	264.9	65.7	232.8	236.3	373.1	291.5	9 200
1975	329.3	237.4	126.0	123.3	201.1	310.3	307.1	138.7	60.0	209.3	241.4	381.7	222.4	7 019
1976	344.5	268.0	235.9	113.2	101.8	42.5	42.5	132.4	129.2	249.0	233.5	367.1	188.3	5 942
1977	329.5	250.3	141.7	42.5	42.5	42.5	42.5	42.5	42.5	42.5	100.0	100.0	100.8	3 182
1978	136.7	237.3	196.6	142.3	135.5	68.7	240.3	154.2	129.3	277.0	244.4	391.6	196.4	6 198
1979	322.0	222.8	222.2	75.0	115.0	42.5	42.5	42.5	42.5	42.5	100.0	226.4	124.5	3 929
1980	313.3	228.0	135.0	128.9	191.0	70.3	60.0	60.0	60.0	144.3	251.4	382.1	168.6	5 322
1981	368.9	298.7	202.2	42.5	400.0	232.4	348.8	341.0	83.6	225.2	244.3	362.6	263.4	8 314
1982	304.0	227.1	135.9	114.6	42.5	60.0	194.5	113.0	60.0	204.2	212.6	357.1	168.9	5 331
1983	326.8	260.5	185.1	42.5	42.5	42.5	42.5	42.5	42.5	42.5	100.0	261.1	118.8	3 748
1984	317.2	258.2	146.5	42.5	42.5	42.5	42.5	42.5	42.5	42.5	100.0	100.0	100.8	3 182
1985	162.7	221.5	192.7	120.5	42.5	42.5	42.5	42.5	42.5	60.0	113.6	387.5	122.2	3 858
1986	352.4	263.2	288.4	46.8	139.0	87.0	120.5	124.0	85.5	393.8	286.7	400.0	216.2	6 822
AVERAGE	326.5	253.6	190.4	153.5	174.2	201.2	237.3	153.1	95.8	181.3	220.0	339.2	210.6	6 647

TABLE C5
SHORT TERM FUTURE FLOWS (2000)
SOUTH SASKATCHEWAN RIVER
NEAR LEMSFORD
MEAN MONTHLY FLOWS (m3/s)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	VOLUME Kdam³
1912	90.7	90.0	152.0	276.7	283.8	371.5	772.9	404.3	318.1	215.1	183.5	114.8	274.0	8 647
1913	85.1	97.1	105.2	452.8	325.3	680.4	434.2	298.6	193.4	150.3	154.9	118.0	257.9	8 139
1914	109.0	80.1	148.7	195.4	292.6	374.4	278.1	106.4	78.3	169.1	167.4	99.5	175.3	5 532
1915	100.1	87.3	208.2	204.5	545.7	942.0	1 423.3	642.3	318.8	286.5	179.2	129.4	424.9	13 409
1916	85.5	178.7	225.8	307.8	305.0	1 358.9	1 294.5	558.6	582.0	319.7	231.3	148.7	466.9	14 733
1917	109.6	116.8	111.2	424.9	796.9	1 197.3	483.0	171.0	126.2	137.2	127.7	75.0	323.0	10 194
1918	106.3	99.6	232.9	249.6	161.8	399.3	156.9	114.0	92.1	87.2	100.1	90.9	157.4	4 968
1919	83.4	78.8	91.0	232.1	208.2	217.9	107.7	182.8	78.1	45.7	72.6	87.1	123.8	3 908
1920	80.3	92.9	147.9	420.2	638.0	366.6	629.0	193.0	69.1	81.8	95.6	89.5	243.2	7 674
1921	85.3	85.5	105.1	267.6	302.3	499.1	217.3	96.1	53.5	42.5	78.7	81.6	159.4	5 031
1922	79.7	59.0	84.3	175.2	195.6	470.6	183.2	119.9	72.4	44.2	74.7	70.6	135.7	4 281
1923	72.1	58.6	88.7	139.6	130.3	1 549.2	563.0	285.2	150.7	105.9	104.8	91.6	277.7	8 763
1924	72.4	88.6	96.6	117.3	262.2	421.5	266.0	255.1	83.4	58.1	97.5	93.6	159.7	5 038
1925	92.6	85.8	183.2	468.7	394.9	500.6	211.4	179.1	148.5	205.9	153.8	138.6	230.4	7 270
1926	93.6	99.2	232.1	236.3	104.7	101.2	161.0	59.2	528.2	341.0	199.4	155.1	192.5	6 074
1927	118.1	100.1	159.0	459.0	539.0	1 184.9	678.4	422.8	514.1	301.3	194.3	153.0	402.2	12 693
1928	254.7	153.0	366.5	308.2	472.2	937.6	900.1	186.2	149.7	159.4	131.0	93.7	343.7	10 846
1929	86.9	76.2	150.9	127.5	310.3	841.7	86.2	45.4	43.7	37.0	63.0	85.9	162.4	5 124
1930	76.7	145.7	156.1	177.6	246.7	415.4	264.1	74.1	53.3	44.6	77.5	97.6	152.2	4 803
1931	82.7	76.2	96.8	109.7	75.0	156.9	131.7	65.5	57.7	46.6	87.2	83.4	89.1	2 811
1932	86.1	81.3	112.3	130.1	286.9	809.7	193.2	91.1	91.7	72.6	106.4	98.2	179.5	5 666
1933	87.3	74.4	106.7	249.8	341.3	532.7	232.3	66.4	52.7	53.2	138.4	116.7	170.9	5 394
1934	138.5	141.8	176.2	438.6	439.4	412.0	99.8	63.2	54.4	54.0	133.6	94.9	186.7	5 893
1935	93.4	125.1	105.1	154.8	126.4	340.7	309.4	153.4	54.0	49.8	71.2	78.0	138.3	4 366
1936	71.1	58.9	133.9	368.7	185.1	243.6	60.5	47.7	47.8	36.5	55.9	55.4	113.5	3 580
1937	46.3	47.9	87.8	136.5	86.4	329.8	139.2	104.1	74.5	60.0	108.7	89.5	109.1	3 443
1938	89.1	57.0	131.2	194.7	228.2	503.9	360.7	98.9	102.5	78.6	87.8	81.1	168.1	5 303
1939	69.6	56.1	125.6	142.2	109.5	366.6	256.5	60.0	42.5	42.7	108.0	91.7	122.6	3 869
1940	61.4	68.7	121.7	364.7	256.3	147.7	84.3	55.5	99.7	95.7	95.3	91.7	128.5	4 054
1941	72.9	74.2	143.0	142.8	48.3	66.6	57.3	47.9	74.7	87.7	98.0	95.2	84.0	2 651
1942	77.5	67.7	92.6	128.0	422.0	766.6	662.5	312.0	255.8	193.9	119.0	102.5	267.6	8 445
1943	75.7	95.7	149.9	725.6	211.5	430.9	446.1	139.3	65.0	47.0	72.8	81.6	211.4	6 672
1944	76.9	64.0	83.7	101.7	59.3	197.7	128.9	187.3	64.6	54.3	80.7	82.6	98.6	3 111
1945	70.3	67.8	131.9	114.9	164.3	551.9	346.0	86.1	108.3	126.0	102.0	111.7	165.2	5 215

1946	100.8	88.4	183.0	216.2	230.4	611.7	262.2	79.1	167.8	113.4	110.7	125.4	190.6	6 015
1947	103.4	119.9	327.5	434.7	584.5	573.4	299.9	121.1	162.5	275.4	179.7	125.1	276.1	8 712
1948	100.7	79.9	126.6	761.2	1 421.0	1 441.1	382.5	281.0	88.7	72.3	92.2	79.1	411.0	12 970
1949	90.4	69.9	90.5	202.2	217.3	210.0	75.7	52.9	47.3	45.0	87.5	78.8	105.5	3 331
1950	75.0	80.7	108.9	202.1	165.8	563.9	435.7	135.1	61.2	72.1	89.7	89.3	173.4	5 471
1951	89.8	81.4	108.0	466.9	812.3	916.8	985.3	320.6	729.8	453.9	263.5	175.6	451.5	14 249
1952	138.5	136.3	182.7	963.1	414.7	537.8	445.1	217.9	106.6	92.2	96.3	89.6	284.6	8 982
1953	82.0	101.1	112.1	246.3	528.0	1 745.9	694.2	232.0	153.9	106.5	117.2	102.8	351.4	11 088
1954	87.6	119.1	113.1	278.7	652.2	822.7	695.5	460.0	499.8	266.6	199.8	125.4	360.9	11 388
1955	89.2	93.5	91.0	469.7	482.6	651.3	518.6	130.6	79.7	98.9	113.8	100.5	243.5	7 683
1956	112.7	83.4	182.8	453.1	445.3	638.7	398.1	150.3	89.4	74.1	92.4	99.3	235.2	7 423
1957	85.7	78.3	165.1	233.8	586.4	396.6	123.7	90.2	64.6	68.4	135.1	111.4	178.7	5 639
1958	79.6	78.9	115.7	434.7	422.9	431.5	385.4	125.6	74.1	69.7	110.2	108.3	203.3	6 417
1959	83.7	79.8	156.0	164.7	252.7	628.3	411.7	150.3	103.5	141.0	151.7	138.5	205.5	6 484
1960	96.5	101.5	223.2	369.4	227.4	334.7	274.3	125.8	66.3	53.3	81.1	88.3	170.2	5 371
1961	91.7	77.6	122.9	90.0	179.6	617.7	102.8	113.6	85.6	89.2	116.1	85.8	147.4	4 650
1962	92.6	120.7	104.7	243.2	139.7	287.4	190.3	138.4	121.3	65.0	104.9	98.7	141.9	4 477
1963	73.7	93.0	171.3	146.2	97.5	380.5	514.3	151.9	92.7	56.1	86.7	85.6	162.8	5 138
1964	93.8	91.9	88.8	131.4	322.3	930.8	387.0	107.7	73.5	101.4	127.9	76.3	210.8	6 653
1965	93.5	103.6	139.2	436.5	262.0	889.7	855.4	267.5	252.1	277.6	187.0	133.1	325.1	10 260
1966	88.9	89.7	257.6	382.1	320.9	697.9	435.8	178.5	106.7	100.5	109.2	106.0	239.7	7 564
1967	89.3	85.8	146.0	350.6	607.5	1 334.1	478.5	147.9	73.5	69.1	114.5	80.6	297.8	9 399
1968	90.1	88.6	159.3	114.6	121.5	468.0	252.5	145.5	104.1	195.1	143.6	83.8	164.0	5 175
1969	90.8	92.7	160.9	587.0	438.0	573.9	857.2	161.4	96.7	91.6	109.2	92.0	280.0	8 836
1970	72.2	86.5	110.0	223.8	187.7	731.1	267.5	93.4	55.1	66.4	87.8	63.5	169.9	5 362
1971	80.6	121.8	122.9	524.3	328.8	692.4	239.8	136.4	68.9	68.0	103.6	69.8	212.3	6 701
1972	64.3	71.9	252.8	235.1	401.3	976.8	481.7	235.8	132.0	120.2	126.7	81.4	265.3	8 373
1973	97.0	93.0	158.6	266.7	284.7	457.6	253.2	120.3	99.6	68.2	85.6	107.1	174.3	5 501
1974	78.8	101.0	106.4	441.9	525.2	894.6	440.0	175.8	108.8	92.6	98.2	88.5	262.5	8 284
1975	74.6	69.0	92.1	215.0	358.7	768.9	441.4	147.2	108.8	98.2	107.2	107.5	215.9	6 813
1976	105.5	112.4	148.9	213.0	294.1	220.5	243.5	341.6	160.8	104.1	90.1	86.0	177.3	5 594
1977	77.6	91.2	108.9	121.8	120.8	117.2	69.1	108.9	112.1	88.2	83.8	74.3	97.7	3 085
1978	70.6	70.2	151.2	250.8	238.6	492.2	388.2	175.4	187.2	148.2	105.2	114.6	199.7	6 302
1979	64.8	60.5	181.5	175.4	294.2	307.2	146.3	86.2	64.0	54.1	76.3	70.9	132.1	4 167
1980	63.4	70.1	100.1	227.3	304.6	537.7	149.6	112.8	91.4	104.9	112.0	87.1	163.3	5 152
1981	117.1	129.8	165.5	122.4	638.3	643.1	488.9	386.3	106.7	86.3	112.2	75.4	257.1	8 112
1982	50.0	67.2	89.6	219.5	141.6	461.0	442.9	135.8	85.8	98.7	72.9	75.7	161.9	5 109
1983	73.3	90.5	128.5	151.0	145.0	236.3	251.5	115.6	62.3	56.7	88.6	50.9	120.9	3 816
1984	61.0	95.2	105.4	99.6	64.7	172.6	156.9	113.7	99.4	77.3	80.2	65.2	99.1	3 129
1985	61.2	55.6	139.4	218.6	140.6	190.1	104.0	111.6	202.8	140.1	105.9	104.0	131.2	4 141
1986	101.4	84.1	255.8	118.2	238.7	572.5	321.4	171.6	126.3	267.1	129.7	125.5	210.0	6 627
AVERAGE	88.2	89.8	145.3	279.3	322.6	584.6	372.9	171.0	137.0	116.3	115.2	97.3	210.1	6 630

TABLE C6
LONG TERM FUTURE FLOWS
SOUTH SASKATCHEWAN RIVER
NEAR LEMSFORD
MEAN MONTHLY FLOWS (m3/s)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	VOLUME Kdam³
1912	91.9	91.0	141.9	239.1	241.0	390.3	789.0	388.3	343.3	223.1	188.8	92.5	269.4	8 503
1913	73.0	90.4	97.9	418.1	299.1	664.7	385.4	261.0	195.4	138.3	157.5	111.3	240.8	7 600
1914	109.5	76.7	142.9	185.4	258.1	367.6	244.5	91.4	73.0	107.2	166.4	87.5	159.4	5 029
1915	96.1	88.1	198.5	182.7	521.1	1 038.1	1 516.1	635.7	341.6	303.0	188.5	105.6	437.2	13 796
1916	74.6	201.2	208.0	291.1	295.2	1 404.9	1 233.6	557.1	644.4	349.8	249.9	128.3	469.9	14 829
1917	100.8	98.4	100.8	417.1	814.9	1 211.9	405.8	147.0	126.9	135.3	128.9	56.3	311.9	9 842
1918	88.7	87.0	213.0	226.7	102.9	356.4	137.5	92.9	88.6	75.1	98.5	80.6	137.1	4 326
1919	75.5	75.9	87.3	207.2	98.2	189.5	113.4	160.4	83.9	49.3	76.1	77.3	107.7	3 399
1920	69.5	82.1	140.0	368.9	594.3	303.9	534.6	172.0	67.2	71.0	99.5	83.6	216.6	6 836
1921	79.8	85.0	94.4	225.4	234.2	477.8	180.8	88.2	64.6	42.5	84.2	79.1	144.4	4 556
1922	77.8	68.5	80.6	169.4	53.2	446.1	148.1	105.8	85.0	45.9	79.4	67.1	118.5	3 738
1923	67.8	64.0	92.6	127.6	42.5	1 525.5	517.2	270.2	161.7	106.1	103.6	78.5	262.2	8 276
1924	64.7	89.6	93.2	108.2	204.7	413.6	228.0	226.6	72.6	55.3	97.0	79.0	144.5	4 559
1925	85.8	89.2	180.3	404.4	376.6	509.4	179.5	167.5	157.2	204.9	158.0	117.4	219.2	6 917
1926	82.0	83.9	243.6	209.0	84.4	138.1	156.1	60.7	525.9	295.7	207.4	129.2	184.5	5 822
1927	110.6	100.3	147.3	451.1	536.4	1 174.8	641.2	421.5	539.2	307.7	208.6	132.6	397.7	12 550
1928	302.4	146.8	351.8	290.5	449.2	1 076.5	861.1	161.2	158.5	164.6	136.8	78.9	349.0	11 013
1929	79.4	79.1	139.9	117.9	272.0	831.4	73.7	48.2	44.9	42.5	64.1	78.1	155.3	4 902
1930	69.5	145.4	141.4	81.4	193.0	407.9	242.4	91.7	64.1	46.6	75.6	91.4	137.2	4 331
1931	75.8	74.1	94.1	120.3	42.5	139.4	158.0	80.7	66.9	44.7	85.0	68.2	87.4	2 758
1932	77.0	74.8	99.9	81.0	133.9	771.8	163.4	72.7	83.6	70.2	105.0	82.0	150.7	4 754
1933	76.6	75.7	101.2	224.2	258.2	485.8	161.7	42.5	50.0	42.5	130.3	112.6	146.5	4 623
1934	146.1	161.0	156.2	412.0	404.5	384.1	98.1	77.3	66.3	55.1	130.5	85.0	180.8	5 705
1935	88.8	144.2	96.7	119.9	55.0	260.9	268.0	130.8	64.6	56.5	76.8	70.6	119.1	3 758
1936	63.8	58.5	133.9	308.6	72.0	221.8	78.5	52.9	53.1	42.5	57.6	52.2	99.3	3 132
1937	38.5	47.6	80.1	118.9	42.5	217.8	130.5	121.1	106.5	66.5	106.4	76.5	96.0	3 029
1938	78.2	52.5	120.8	148.8	56.9	421.1	308.7	93.4	130.2	74.7	91.8	74.1	137.6	4 341
1939	60.2	55.3	108.2	108.2	42.5	370.7	240.4	59.3	42.5	42.5	107.2	77.7	109.4	3 454
1940	51.3	71.7	114.8	333.2	163.2	154.5	94.0	60.7	93.1	83.9	98.4	80.2	116.3	3 671
1941	63.1	72.8	132.2	134.9	42.5	76.7	72.2	42.5	71.8	60.2	91.6	79.8	78.2	2 468
1942	66.5	71.7	92.4	115.7	332.0	733.9	610.0	288.9	267.8	200.5	121.2	83.1	249.3	7 867
1943	65.6	96.3	133.5	691.0	161.3	404.7	331.1	104.8	78.0	48.7	73.7	72.7	187.8	5 926
1944	70.3	64.2	79.2	79.1	42.5	245.8	151.0	179.2	64.2	52.6	78.4	67.8	97.9	3 090
1945	58.2	60.1	120.4	111.1	58.2	422.3	296.0	74.8	100.3	117.0	93.7	90.7	133.6	4 216

1946	90.2	77.5	169.4	188.6	177.6	619.9	223.5	70.1	166.5	101.9	109.4	112.2	175.2	5 530
1947	92.9	122.4	302.2	396.4	549.4	585.3	254.4	102.6	157.2	255.8	192.1	104.2	259.8	8 199
1948	91.4	73.3	122.7	724.2	1 463.1	1 386.7	321.4	244.8	85.8	73.7	92.1	68.9	396.2	12 502
1949	85.2	66.5	81.3	169.9	157.6	202.8	95.6	61.0	52.1	45.7	75.2	61.3	96.1	3 032
1950	68.4	85.2	106.9	159.3	82.4	433.7	340.6	102.6	73.6	58.0	85.9	90.0	140.4	4 432
1951	85.7	85.0	107.8	429.3	765.5	916.2	912.2	308.1	756.5	453.1	292.0	154.3	439.7	13 876
1952	139.2	135.3	169.4	922.9	385.0	588.8	405.8	180.6	110.2	93.7	95.2	74.8	274.4	8 661
1953	71.4	95.5	97.3	223.4	477.9	1 708.7	619.6	199.3	163.0	108.7	117.8	86.0	330.0	10 415
1954	77.2	115.3	101.1	257.9	630.7	868.3	613.2	451.4	576.9	274.8	210.5	99.1	356.8	11 261
1955	77.2	77.8	82.0	449.4	476.5	632.7	440.5	97.9	85.6	78.2	121.5	98.0	226.5	7 148
1956	112.9	77.0	165.9	427.3	417.6	627.7	328.3	116.8	94.0	68.9	88.4	82.3	217.3	6 857
1957	75.8	73.4	151.2	218.5	538.8	369.6	116.6	97.0	75.5	55.6	127.0	93.2	166.4	5 250
1958	70.0	75.6	107.4	350.5	309.3	393.7	330.8	99.9	71.8	58.6	114.8	102.5	173.8	5 486
1959	73.7	87.0	125.8	124.4	180.8	583.6	332.7	107.1	74.5	79.6	160.6	121.5	170.9	5 392
1960	90.7	94.9	193.9	339.2	155.8	292.8	214.5	97.6	85.1	59.8	86.5	83.0	149.3	4 713
1961	86.6	82.9	121.3	63.3	50.4	497.3	93.8	102.8	127.6	66.7	120.3	80.6	123.9	3 911
1962	93.9	127.7	114.5	162.2	42.5	203.8	162.3	140.2	150.9	60.9	97.5	79.3	119.2	3 762
1963	64.7	99.3	160.2	115.0	42.5	247.5	423.5	122.1	97.3	48.8	86.3	91.3	133.4	4 211
1964	81.2	88.6	82.8	129.7	210.3	860.6	299.1	96.4	70.8	72.3	124.8	69.3	181.6	5 731
1965	75.9	98.1	114.0	416.5	222.6	899.1	791.0	241.4	253.4	287.5	197.7	107.5	308.9	9 747
1966	77.8	77.6	247.2	381.6	301.5	702.3	385.6	147.9	102.1	98.3	119.2	90.2	227.6	7 184
1967	78.1	81.9	130.3	325.8	571.1	1 266.4	390.7	107.8	71.7	68.7	110.4	58.3	271.3	8 562
1968	83.0	78.0	155.9	106.4	65.0	436.4	208.9	112.3	58.5	179.5	148.2	81.7	142.8	4 506
1969	81.6	91.8	150.5	544.6	387.3	552.6	761.1	126.7	97.2	85.7	104.1	78.3	255.6	8 066
1970	66.6	84.6	105.8	195.6	87.8	655.5	220.2	98.1	67.6	69.0	90.7	55.8	149.1	4 706
1971	71.5	123.3	111.3	484.7	201.9	645.9	155.2	105.0	72.3	63.7	106.2	55.5	181.9	5 741
1972	56.9	70.8	215.8	163.5	341.7	900.8	382.0	181.7	103.4	106.2	128.0	74.0	227.2	7 169
1973	84.8	85.8	139.9	257.9	215.1	434.4	226.4	101.6	98.5	68.9	73.0	95.0	156.6	4 943
1974	64.6	95.1	93.5	370.1	441.8	807.2	337.9	144.0	93.5	84.4	98.3	77.4	225.4	7 112
1975	65.0	63.9	90.8	181.9	288.1	710.7	381.5	114.9	119.7	104.2	108.6	105.7	194.6	6 142
1976	110.2	118.2	136.0	190.3	265.9	193.0	173.0	277.8	144.2	98.9	87.0	78.5	156.4	4 935
1977	69.4	92.3	102.2	109.3	77.6	145.3	95.7	85.8	95.7	79.1	83.0	63.8	91.4	2 884
1978	53.0	64.8	129.1	199.4	121.1	413.5	316.1	140.8	179.3	155.1	108.7	108.5	165.9	5 236
1979	57.4	60.8	157.0	162.3	242.5	282.8	125.0	96.2	81.8	65.8	79.9	60.8	122.8	3 876
1980	58.0	73.1	94.8	144.3	183.7	514.1	139.8	101.3	71.5	88.1	110.9	66.7	136.9	4 319
1981	105.3	120.3	155.8	101.6	517.4	617.1	414.6	361.6	95.0	86.0	114.8	65.2	230.4	7 269
1982	44.1	66.3	81.3	194.7	85.1	389.3	394.1	117.0	81.7	97.2	75.2	66.1	141.1	4 452
1983	62.5	80.1	113.6	130.8	81.6	205.1	204.9	109.9	79.6	70.0	87.5	51.5	106.4	3 358
1984	42.7	89.3	96.6	65.3	69.1	98.8	128.4	133.2	135.6	71.5	78.0	62.0	89.2	2 813
1985	48.2	53.9	124.9	166.4	42.5	162.6	142.4	120.6	170.1	83.5	89.8	95.4	108.3	3 419
1986	93.4	68.2	240.4	53.6	100.5	558.7	323.8	160.9	112.6	254.2	126.2	109.0	184.0	5 807
AVERAGE	80.8	88.0	134.8	248.3	261.4	558.0	333.0	154.8	141.8	110.7	116.5	85.1	192.8	6 083

TABLE C7
FAR FUTURE FLOWS (50% OF NATURAL)
SOUTH SASKATCHEWAN RIVER
NEAR LEMSFORD
MEAN MONTHLY FLOWS (m3/s)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	VOLUME Kdam³
1912	64.3	63.7	99.3	167.4	168.7	273.2	552.3	271.8	240.3	156.2	132.2	64.8	188.6	5 952
1913	51.1	63.3	75.7	383.6	170.0	489.8	230.9	198.9	145.3	107.9	134.4	119.8	180.6	5 699
1914	122.4	88.9	148.1	150.9	129.0	192.7	214.7	125.3	91.3	142.3	100.0	61.3	130.8	4 129
1915	67.3	61.7	139.0	127.9	364.8	772.8	1 361.6	550.2	295.4	269.2	189.2	114.1	361.8	11 417
1916	87.5	213.4	213.2	256.6	166.1	1 230.0	1 079.1	471.6	598.2	316.0	250.6	136.8	418.0	13 191
1917	113.7	110.6	106.0	382.6	685.8	1 037.0	251.3	100.0	88.8	94.7	90.2	63.3	259.9	8 203
1918	101.6	99.2	218.2	192.2	72.0	182.2	194.3	132.2	97.3	76.5	68.9	56.4	124.3	3 923
1919	52.8	53.1	61.1	145.1	126.1	261.4	157.1	167.2	85.7	42.2	53.2	54.1	105.0	3 312
1920	48.7	57.5	98.0	258.2	416.0	238.8	467.8	171.5	85.0	73.2	69.6	58.5	171.2	5 401
1921	55.9	59.5	66.1	157.8	163.9	398.1	233.0	111.7	45.2	42.5	59.4	55.3	120.7	3 808
1922	54.5	47.9	56.4	118.5	92.0	271.2	100.0	74.0	59.5	42.5	80.1	75.6	89.2	2 815
1923	47.4	44.8	64.8	89.3	42.5	1 054.7	362.0	189.1	113.2	74.3	72.5	54.9	183.6	5 793
1924	45.3	62.7	65.2	75.7	143.3	333.8	258.0	206.4	62.5	42.5	97.7	55.3	120.9	3 815
1925	60.1	62.4	126.2	283.0	263.6	356.6	133.4	159.9	119.5	130.3	100.0	82.2	156.5	4 938
1926	57.4	58.8	170.5	146.3	59.1	105.9	100.3	42.5	459.0	220.0	100.0	90.4	134.0	4 229
1927	77.4	70.2	103.1	315.8	375.5	822.4	448.8	295.0	377.4	215.4	146.0	92.8	278.4	8 785
1928	211.7	102.7	246.2	203.4	314.4	778.5	706.6	100.0	100.0	118.5	137.5	87.4	259.6	8 192
1929	92.3	91.3	145.1	83.4	142.9	656.5	51.6	42.5	42.5	31.4	44.9	54.7	122.6	3 868
1930	48.6	101.7	99.0	57.0	196.2	349.6	249.0	92.9	65.0	45.9	52.9	64.0	118.5	3 738
1931	53.0	51.9	65.8	84.2	42.5	180.7	158.7	89.7	73.8	51.1	59.5	47.7	79.9	2 521
1932	53.9	52.4	70.0	56.7	244.9	562.0	202.9	50.9	58.5	49.1	105.7	90.5	133.0	4 198
1933	53.6	53.0	70.9	157.0	180.7	396.7	100.0	42.5	42.5	42.5	131.0	121.1	115.7	3 651
1934	102.3	112.7	109.3	288.4	283.2	268.9	68.7	54.1	46.4	42.5	126.6	59.5	129.8	4 095
1935	62.2	100.9	67.7	83.9	56.9	163.6	187.6	91.6	45.2	42.5	77.5	79.1	88.1	2 780
1936	44.6	41.0	93.7	216.0	103.4	100.5	55.0	42.5	42.5	30.6	58.3	60.7	74.0	2 335
1937	27.0	33.3	56.1	83.2	42.5	139.3	91.3	84.8	74.6	46.5	107.1	85.0	72.5	2 289
1938	54.8	36.7	84.5	104.1	42.5	292.0	216.1	65.4	91.1	52.3	92.5	82.6	101.2	3 194
1939	42.1	38.7	75.8	75.8	42.5	246.3	168.2	42.5	42.5	42.5	107.9	86.2	84.2	2 658
1940	35.9	50.2	80.3	233.2	123.8	100.0	65.8	42.5	65.1	58.7	99.1	88.7	86.8	2 739
1941	44.2	50.9	92.5	94.4	42.5	53.7	50.5	42.5	50.2	42.5	92.3	88.3	62.0	1 957
1942	46.5	50.2	64.7	81.0	232.4	528.4	463.5	232.2	171.4	120.5	84.9	58.2	178.4	5 628
1943	45.9	67.4	93.4	483.7	112.9	283.3	368.8	151.5	75.6	42.5	51.6	50.9	152.1	4 801
1944	49.2	44.9	55.5	55.3	42.5	158.9	105.7	125.4	44.9	42.5	79.1	76.3	73.4	2 318
1945	40.7	42.1	84.3	77.8	42.5	293.8	207.2	52.4	70.2	83.2	94.4	99.2	99.0	3 125

1946	63.1	54.2	118.6	132.0	124.3	433.9	156.4	49.0	120.3	71.3	110.1	120.7	129.3	4 081
1947	65.0	85.7	211.6	277.5	384.6	409.7	178.1	76.7	133.4	174.3	111.0	72.9	181.9	5 739
1948	64.0	51.3	85.9	506.9	1 024.2	970.7	225.0	171.4	60.1	51.6	64.5	48.2	277.3	8 751
1949	59.6	46.6	56.9	118.9	123.9	246.8	134.0	87.0	58.6	48.9	52.6	42.9	89.7	2 831
1950	47.9	59.6	74.8	111.5	104.1	485.3	371.5	136.5	51.5	42.5	86.6	63.0	136.3	4 301
1951	60.0	59.5	75.5	300.5	535.8	641.4	638.6	215.6	529.6	317.1	204.4	108.0	307.8	9 713
1952	97.5	94.7	118.6	646.1	269.5	412.1	284.1	126.4	77.2	65.6	66.6	52.4	192.1	6 063
1953	50.0	66.8	68.1	181.5	348.8	1 533.8	465.1	113.8	116.8	76.1	117.3	94.5	268.5	8 474
1954	90.1	127.5	106.3	223.4	501.6	693.4	458.7	365.9	530.7	241.0	211.2	107.6	304.9	9 622
1955	90.1	90.0	87.2	414.9	347.4	457.8	286.0	68.5	59.9	54.7	85.1	68.6	175.6	5 543
1956	113.3	89.2	171.1	392.8	288.5	452.8	173.8	81.7	65.8	48.2	61.9	57.6	166.1	5 242
1957	67.2	85.6	156.4	184.0	409.7	194.7	81.6	84.8	76.4	67.4	88.9	65.3	130.4	4 116
1958	49.0	52.9	75.2	245.3	268.3	372.8	326.1	140.3	87.8	67.2	80.4	71.7	153.3	4 839
1959	51.6	60.9	88.0	87.1	170.2	474.7	351.4	161.3	115.7	128.0	100.0	85.1	156.5	4 937
1960	63.5	66.4	135.8	237.4	109.1	311.8	273.2	141.6	59.5	42.5	60.6	58.1	130.0	4 103
1961	60.6	58.0	84.9	44.3	79.4	322.4	65.7	72.0	89.3	46.7	121.0	89.1	94.2	2 972
1962	65.7	89.4	80.2	113.5	53.3	118.3	113.6	98.2	105.6	42.6	98.2	87.8	88.6	2 797
1963	45.3	69.5	112.1	80.5	42.5	160.1	296.4	85.4	68.1	42.5	87.0	99.8	99.3	3 135
1964	56.8	62.0	58.0	90.8	181.3	638.6	196.7	67.5	49.6	50.6	125.5	77.8	137.5	4 340
1965	53.1	68.6	79.8	291.6	155.8	629.4	553.7	169.0	177.4	201.3	138.4	75.3	216.2	6 823
1966	54.5	54.3	173.0	267.1	211.0	491.6	269.9	103.5	97.2	78.2	83.5	63.1	162.3	5 121
1967	54.7	57.3	91.2	228.1	399.7	886.5	273.5	100.2	87.2	61.6	77.3	40.8	196.2	6 192
1968	58.1	54.6	109.1	74.5	49.5	388.0	254.2	153.9	124.4	132.2	100.0	57.2	129.7	4 094
1969	57.1	64.3	105.3	381.2	271.1	386.8	532.8	141.0	97.6	75.6	72.9	54.8	187.1	5 905
1970	46.6	59.2	74.0	136.9	109.9	541.5	263.5	108.9	70.2	58.7	63.5	39.1	130.7	4 126
1971	50.0	86.3	77.9	339.3	147.8	507.7	268.3	117.9	50.6	44.6	106.9	47.6	153.2	4 834
1972	39.9	49.6	151.0	114.4	260.9	664.5	396.8	100.0	72.4	74.3	128.7	82.5	178.1	5 622
1973	59.3	60.0	97.9	180.5	150.6	354.8	109.4	71.1	69.0	48.2	73.7	103.5	114.7	3 618
1974	45.2	66.6	65.5	259.1	309.3	620.2	374.9	100.0	65.5	59.1	99.0	85.9	179.1	5 653
1975	45.5	44.7	63.5	127.3	201.7	549.1	284.1	80.4	83.8	73.0	109.3	114.2	148.1	4 673
1976	77.1	82.7	95.2	133.2	186.1	135.1	121.1	194.5	100.9	69.2	87.7	87.0	114.4	3 610
1977	48.6	64.6	71.5	76.5	54.3	101.7	67.0	60.0	67.0	55.3	83.7	72.3	68.4	2 160
1978	37.1	45.3	90.4	139.6	117.8	255.3	221.3	98.6	133.1	121.3	109.4	117.0	124.1	3 915
1979	40.2	42.6	109.9	113.6	169.7	197.9	87.5	67.3	57.3	46.0	80.6	69.3	90.3	2 849
1980	40.6	51.1	66.4	101.0	157.8	339.2	97.8	70.9	50.0	61.7	111.6	75.2	101.8	3 212
1981	73.7	84.2	109.1	71.1	362.2	461.1	387.7	270.1	72.0	60.2	102.5	45.6	175.6	5 542
1982	30.8	46.4	56.9	136.3	78.2	253.3	275.9	81.9	57.2	68.0	75.9	74.6	103.1	3 253
1983	43.8	56.1	79.5	91.5	60.7	139.9	143.4	76.9	55.7	49.0	88.2	60.0	78.7	2 484
1984	29.9	62.5	67.6	45.7	48.4	69.2	89.9	93.3	94.9	50.1	78.7	70.5	66.7	2 104
1985	33.8	37.8	87.4	116.5	42.5	100.6	99.7	84.4	123.9	58.5	90.5	103.9	81.7	2 577
1986	65.4	47.8	168.3	42.5	96.5	383.8	202.8	112.6	78.8	220.4	126.9	117.5	139.1	4 389
AVERAGE	60.8	66.6	100.3	181.7	196.5	418.1	268.2	126.8	113.4	86.3	98.2	76.6	149.5	4 718

TABLE C8
NATURAL FLOWS
SWIFT CURRENT CREEK
AT THE MOUTH
MEAN MONTHLY FLOWS (m3/s)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	VOLUME Kdam³
1912	.2	.1	10.6	15.6	4.3	2.8	.9	.8	.9	1.3	1.0	.4	3.2	102.3
1913	.3	.2	10.7	13.6	1.7	1.4	1.1	.4	.1	.6	.5	.3	2.6	81.2
1914	.1	.1	2.8	7.2	1.4	1.0	.3	.1	.7	1.1	.7	.3	1.3	41.5
1915	.1	.1	3.9	7.7	2.3	2.3	2.7	.9	.7	1.0	.6	.3	1.9	59.9
1916	.1	.3	19.2	8.1	3.3	3.5	5.9	1.5	.9	1.4	.6	.4	3.8	120.6
1917	.3	.1	.1	43.4	11.3	2.7	1.7	1.0	2.2	1.8	1.5	.3	5.5	173.2
1918	.1	.4	32.8	7.8	1.9	1.1	.4	.3	.2	1.6	.7	.3	4.0	126.7
1919	.2	.4	.6	5.6	1.8	.4	.1	.1	.2	.4	1.0	.2	.9	29.0
1920	.0	.0	8.0	10.1	3.2	1.6	1.0	.2	.3	.7	.7	.4	2.2	69.1
1921	.2	1.6	4.8	5.6	2.5	1.0	.6	.4	.5	.7	.7	.6	1.6	50.2
1922	.1	.1	5.7	21.9	3.3	1.3	.9	.7	.4	.5	.6	.4	3.0	93.5
1923	.3	.1	2.2	9.7	1.9	8.1	1.9	.7	.3	.6	.6	.5	2.2	70.3
1924	.2	.5	.4	3.3	1.3	1.3	.5	1.0	.2	.8	.6	.5	.9	27.9
1925	.1	.4	22.4	13.4	2.1	1.6	.5	.3	.4	1.0	.7	.2	3.6	114.2
1926	.2	.3	18.5	2.5	1.4	.9	.4	.2	.5	1.0	.7	.2	2.2	71.0
1927	.1	.0	1.7	21.3	9.8	5.0	4.7	1.0	.7	1.0	.6	.3	3.8	121.3
1928	6.2	2.4	10.9	3.9	1.8	2.4	2.1	.7	.4	.8	.7	.4	2.7	86.4
1929	.3	.1	3.9	5.2	2.3	1.6	.6	.2	.2	.5	.5	.2	1.3	40.7
1930	.1	7.2	4.7	7.6	1.8	1.2	.7	.2	.6	1.0	1.1	.7	2.2	69.4
1931	.5	.7	.8	5.2	1.1	1.4	.8	.5	.5	.8	.6	.4	1.1	35.1
1932	.2	.1	5.7	6.9	1.5	1.7	.9	.5	.5	.7	.6	.4	1.6	51.7
1933	.2	.1	5.6	3.2	1.8	.8	1.1	.3	.7	.6	.5	.3	1.3	39.9
1934	.1	.1	11.2	3.4	1.0	1.2	.3	.1	.1	.5	.4	.3	1.6	49.8
1935	.1	.1	10.4	7.4	2.0	1.1	1.2	.4	.1	.2	.1	.1	1.9	61.3
1936	.0	.0	8.1	15.3	2.1	.6	.2	.1	.0	.1	.1	.1	2.2	70.3
1937	.0	.0	.9	4.7	1.0	.5	.2	.1	.0	.0	.0	.0	.6	19.6
1938	.0	.0	11.2	8.6	2.6	1.0	.5	.3	.1	.2	.2	.1	2.1	65.1
1939	.0	.0	14.0	2.7	1.9	6.4	1.2	.4	.2	.2	.1	.1	2.3	72.5
1940	.0	.0	4.5	20.5	1.9	1.1	.2	.3	.1	.2	.2	.1	2.4	76.0
1941	.0	.0	16.7	7.1	1.0	1.5	.7	.3	.3	.6	.5	.3	2.5	77.4
1942	.2	.1	2.8	6.9	1.3	2.4	3.3	.5	.7	.8	.6	.4	1.7	52.5
1943	.2	.1	16.9	14.5	1.3	1.6	.4	.5	.2	.6	.5	.3	3.1	98.0
1944	.2	.1	3.9	15.0	2.9	1.7	1.4	1.0	.7	.0	.9	.6	2.4	74.4
1945	.3	.3	19.6	4.7	2.5	1.6	1.3	.7	.0	.3	.3	.2	2.7	84.5

1946	.1	.1	11.2	2.7	2.0	.0	.3	1.1	1.0	.8	.5	.3	1.7	52.8
1947	.1	.2	7.7	16.8	2.6	1.8	1.8	.0	.3	.3	.2	.1	2.7	84.4
1948	.1	.0	5.3	13.5	2.2	1.8	.0	.0	.0	.0	.0	.0	1.9	59.9
1949	.0	.0	4.1	4.5	.0	.8	.0	2.0	.6	.1	.0	.0	1.0	32.2
1950	.0	.0	1.6	30.1	3.4	1.4	.0	.0	.4	.4	.4	.2	3.1	98.7
1951	.1	.1	1.4	34.6	11.2	2.3	1.1	1.4	1.5	.1	.0	.0	4.4	140.2
1952	.0	.0	2.5	88.0	3.0	3.6	.9	1.1	1.7	.6	.3	.2	8.4	264.7
1953	.1	.2	21.2	12.2	3.9	7.0	1.4	1.5	1.0	.3	.2	.1	4.1	129.6
1954	.1	.7	.7	19.6	4.1	3.2	1.0	1.2	1.1	1.1	.8	.5	2.8	89.2
1955	.3	.1	4.5	39.8	5.8	2.8	11.6	1.3	.0	.0	.4	.2	5.5	175.0
1956	.1	.0	8.2	9.7	2.7	1.8	.8	.7	.0	.3	.3	.2	2.1	65.7
1957	.1	.6	10.8	7.3	1.9	1.5	.8	.3	.0	.7	.5	.3	2.1	65.3
1958	.1	.8	11.2	19.2	1.8	.6	.5	1.5	.4	1.1	.8	.5	3.2	101.1
1959	.3	.8	8.3	4.5	1.9	2.3	1.6	.8	.1	.6	.6	.3	1.8	58.3
1960	.2	.2	29.5	4.5	1.6	.5	.7	2.4	.0	.7	.4	.3	3.5	109.5
1961	.1	.7	6.2	2.6	1.9	1.1	.2	1.4	.0	.2	.4	.2	1.3	39.7
1962	.1	.3	6.9	7.5	1.1	1.4	.6	.3	.4	.5	.4	.3	1.7	52.2
1963	.1	.7	11.7	3.7	1.5	2.1	1.4	.3	.0	.1	.2	.1	1.8	58.1
1964	.1	.0	3.2	4.3	2.1	2.9	.0	.5	.7	.6	.5	.3	1.3	40.4
1965	.1	.3	.5	36.4	5.4	1.8	2.5	1.4	1.2	1.4	.8	.5	4.3	136.6
1966	.2	.3	19.1	5.8	3.3	2.8	1.6	1.2	.5	.5	.1	.1	3.0	94.3
1967	.0	.1	4.1	31.8	12.5	3.0	1.3	.9	.9	.7	.5	.3	4.6	146.7
1968	.2	2.6	7.3	3.5	1.7	1.5	1.4	1.2	.8	1.0	.0	.0	1.8	55.5
1969	.0	.0	4.6	27.7	3.8	1.9	3.1	1.3	.7	1.0	.8	.5	3.8	118.7
1970	.2	.1	10.3	28.0	4.0	3.3	1.6	1.2	.7	1.1	.4	.2	4.3	134.9
1971	.1	.6	.4	30.9	3.7	2.5	1.3	1.1	.8	1.1	.8	.5	3.6	114.3
1972	.3	.1	7.0	2.8	2.6	1.3	.6	1.0	.0	.9	.5	.3	1.5	46.4
1973	.2	1.3	2.0	3.4	1.6	1.2	.9	.0	.3	.5	.4	.5	1.0	32.4
1974	.2	.2	7.6	17.2	5.7	2.2	1.3	1.3	.7	1.0	.7	.3	3.2	100.7
1975	.1	.0	.5	14.5	7.9	2.5	.8	1.2	.6	1.1	.3	.3	2.5	77.6
1976	.7	1.1	16.4	6.0	1.8	3.6	1.4	1.4	.6	.8	.4	.2	2.9	91.4
1977	.3	1.0	.9	2.8	2.3	.7	.6	.5	.4	1.0	.2	.1	.9	28.0
1978	.0	.0	9.2	8.0	3.5	1.7	1.5	.9	.8	.8	.6	.3	2.3	72.3
1979	.0	.0	13.8	12.6	5.7	2.0	1.1	1.0	.4	.5	.5	.3	3.2	100.0
1980	.2	.2	4.5	4.4	1.4	1.1	1.3	1.1	.5	.6	.6	1.4	1.5	46.2
1981	1.2	5.2	2.2	.6	2.5	2.6	.8	.8	.2	.5	.7	.3	1.4	45.3
1982	.0	1.7	9.9	17.2	4.3	5.1	3.8	1.4	.6	1.3	.3	.5	3.8	120.7
1983	.4	2.8	6.2	6.8	4.0	1.8	2.2	1.3	.4	.6	.6	.5	2.3	72.7
1984	.2	.9	2.0	3.1	2.1	1.2	.0	.8	.6	.5	.5	.2	1.0	31.8
1985	.0	.0	8.0	10.7	2.5	1.1	.5	1.1	.6	.9	.2	.0	2.1	67.5
1986	.5	7.9	7.0	2.8	3.8	1.3	1.1	1.2	.9	1.3	.6	.2	2.3	74.1
AVERAGE	.2	.6	7.9	12.6	3.0	2.0	1.3	.8	.5	.7	.5	.3	2.5	80.0

TABLE C9
NATURAL FLOWS
RUSHLAKE CREEK
AT HIGHFIELD RESERVOIR
MEAN MONTHLY FLOWS (m3/s)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	VOLUME Kdam³
1912	0	.00	1.35	2.01	.24	.05	.01	.00	.00	.00	0	0	.30	9.62
1913	0	.00	1.97	1.72	.00	.19	.00	.00	.00	.00	0	0	.32	10.21
1914	0	.03	.62	1.17	.00	.07	.00	.00	.00	.00	0	0	.16	4.92
1915	0	.00	.72	1.65	.00	.11	.30	.00	.00	.00	0	0	.23	7.28
1916	0	.00	3.14	.16	.00	.25	.00	.00	.00	.00	0	0	.30	9.49
1917	0	.01	.79	8.19	.64	.04	.21	.00	.00	.00	0	0	.82	25.74
1918	0	.06	4.10	.88	.01	.00	.00	.00	.00	.00	0	0	.43	13.45
1919	0	.06	.66	.52	.00	.00	.00	.00	.00	.00	0	0	.10	3.27
1920	0	.00	1.04	1.00	.02	.05	.07	.00	.00	.00	0	0	.18	5.75
1921	0	.22	.95	.33	.01	.04	.00	.00	.00	.00	0	0	.13	4.07
1922	0	.01	1.02	3.07	.00	.32	.01	.00	.00	.00	0	0	.37	11.57
1923	0	.02	.63	1.64	.02	.54	.23	.00	.00	.00	0	0	.25	8.04
1924	0	.07	.40	.05	.00	.09	.00	.00	.00	.00	0	0	.05	1.59
1925	0	.06	3.17	1.73	.04	.00	.00	.00	.00	.00	0	0	.42	13.21
1926	0	.04	2.31	.15	.00	.07	.00	.00	.00	.00	0	0	.22	6.85
1927	0	.00	.91	2.93	.35	.00	.49	.00	.00	.00	0	0	.39	12.30
1928	0	.33	1.64	.60	.05	.33	.28	.00	.00	.00	0	0	.27	8.47
1929	0	.01	.84	.87	.08	.15	.04	.00	.00	.00	0	0	.17	5.23
1930	0	1.01	.75	1.34	.04	.25	.05	.00	.00	.00	0	0	.28	8.84
1931	0	.10	.47	.57	.00	.08	.00	.00	.00	.00	0	0	.10	3.18
1932	0	.00	1.04	.80	.00	.10	.00	.00	.00	.00	0	0	.16	5.14
1933	0	.00	.91	.46	.04	.13	.11	.00	.00	.00	0	0	.14	4.34
1934	0	.01	1.62	.49	.00	.34	.00	.00	.00	.00	0	0	.21	6.49
1935	0	.01	1.96	1.29	.06	.21	.12	.00	.00	.00	0	0	.30	9.62
1936	0	.00	1.57	1.75	.00	.10	.00	.00	.00	.00	0	0	.29	9.01
1937	0	.00	.34	.76	.00	.00	.00	.00	.00	.00	0	0	.09	2.87
1938	0	.00	1.94	1.53	.11	.07	.01	.00	.00	.00	0	0	.31	9.66
1939	0	.00	1.98	.35	.05	.39	.13	.00	.00	.00	0	0	.25	7.75
1940	0	.00	.87	3.87	.05	.15	.00	.00	.00	.00	0	0	.41	12.86
1941	0	.00	2.23	.84	.00	.06	.00	.00	.00	.00	0	0	.26	8.30
1942	0	.01	.63	.81	.00	.52	.21	.00	.00	.00	0	0	.18	5.70
1943	0	.00	2.27	1.85	.00	.00	.00	.00	.00	.00	0	0	.34	10.87
1944	0	.01	1.37	4.03	.28	.05	.31	.00	.00	.00	0	0	.50	15.82
1945	0	.04	3.19	1.27	.21	.00	.42	.00	.00	.00	0	0	.43	13.59

1946	0	.00	.83	.22	.15	.08	.04	.00	.00	.00	0	0	.11	3.50
1947	0	.04	.93	3.91	.09	.16	.51	.00	.00	.00	0	0	.47	14.72
1948	0	.00	1.12	2.69	.03	.02	.00	.00	.00	.00	0	0	.32	10.10
1949	0	.00	1.01	.35	.00	.00	.00	.00	.00	.00	0	0	.11	3.60
1950	0	.00	.80	4.55	.16	.17	.00	.00	.00	.00	0	0	.47	14.82
1951	0	.00	1.28	4.35	.86	.26	.18	.00	.00	.00	0	0	.58	18.17
1952	0	.00	.96	13.22	.00	.21	.06	.00	.00	.00	0	0	1.19	37.54
1953	0	.02	3.59	2.60	.15	.25	.31	.00	.00	.00	0	0	.58	18.28
1954	0	.10	.74	2.88	.35	.25	.04	.00	.00	.00	0	0	.36	11.38
1955	0	.01	1.02	5.87	.24	.05	2.29	.00	.00	.00	0	0	.79	24.85
1956	0	.00	1.30	1.96	.08	.21	.00	.00	.00	.00	0	0	.30	9.31
1957	0	.08	1.61	.90	.01	.04	.08	.00	.00	.00	0	0	.23	7.17
1958	0	.12	2.22	2.44	.04	.00	.00	.00	.00	.00	0	0	.40	12.68
1959	0	.12	1.14	.44	.02	.44	.19	.00	.00	.00	0	0	.20	6.19
1960	0	.03	4.30	.78	.00	.15	.07	.00	.00	.00	0	0	.45	14.15
1961	0	.12	.89	.23	.05	.00	.00	.00	.00	.00	0	0	.11	3.42
1962	0	.04	1.05	1.23	.00	.08	.00	.00	.00	.00	0	0	.20	6.31
1963	0	.11	1.51	.33	.00	.38	.16	.00	.00	.00	0	0	.21	6.57
1964	0	.00	.79	.31	.01	.05	.00	.00	.00	.00	0	0	.10	3.07
1965	0	.04	.63	7.01	.55	.25	.17	.00	.05	.03	0	0	.72	22.71
1966	0	.03	3.26	.17	.08	.12	.01	.00	.00	.00	0	0	.31	9.81
1967	0	.00	.88	2.58	.78	.03	.00	.00	.00	.00	0	0	.36	11.22
1968	0	.39	1.66	.24	.04	.00	.00	.00	.00	.00	0	0	.20	6.17
1969	0	.00	.35	6.35	.15	.01	.01	.00	.00	.00	0	0	.56	17.83
1970	0	.02	2.00	3.56	.15	1.25	.09	.00	.00	.00	0	0	.59	18.51
1971	0	.07	.28	4.64	.03	.00	.00	.00	.00	.00	0	0	.41	13.03
1972	0	.02	.49	.11	.04	.00	.00	.00	.00	.00	0	0	.06	1.78
1973	0	.19	.16	.13	.02	.00	.00	.00	.00	.00	0	0	.04	1.30
1974	0	.03	.04	5.07	.65	.03	.00	.00	.00	.00	0	0	.48	15.14
1975	0	.00	.06	3.27	.37	.05	.00	.00	.00	.00	0	0	.31	9.76
1976	0	.00	5.51	.78	.03	.02	.01	.00	.00	.00	0	0	.54	16.95
1977	0	.09	.00	.10	.03	.01	.00	.00	.00	.00	0	0	.02	.58
1978	0	.00	1.78	.82	.16	.02	.00	.00	.00	.00	0	0	.23	7.34
1979	0	.00	1.84	1.28	.33	.01	.00	.00	.00	.00	0	0	.29	9.15
1980	0	.00	1.69	.23	.00	.00	.00	.00	.00	.00	0	0	.16	5.13
1981	0	.80	.05	.14	.00	.01	.01	.00	.00	.00	0	0	.08	2.49
1982	0	.00	2.62	2.62	.11	.27	1.02	.29	.00	.01	0	0	.58	18.32
1983	0	.13	2.19	.88	.33	.01	.11	.00	.00	.00	0	0	.31	9.67
1984	0	.05	.04	.30	.01	.00	.00	.00	.00	.00	0	0	.03	1.05
1985	0	.00	1.40	.60	.01	.00	.00	.00	.00	.00	0	0	.17	5.33
1986	0	2.02	.78	.31	.24	.00	.01	.00	.00	.00	0	0	.27	8.49
AVERAGE	0	.09	1.39	1.88	.12	.13	.11	.00	.00	.00	0	0	.31	9.77

TABLE C10
CURRENT CONDITIONS FLOWS
SWIFT CURRENT CREEK
AT THE MOUTH
MEAN MONTHLY FLOWS (m3/s)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	VOLUME Kdam³
1912	.5	.5	9.7	15.5	.4	.2	.2	.2	.2	.4	.8	.6	2.5	78.5
1913	.6	.5	7.5	13.0	.2	.2	.2	.2	.2	.3	.6	.5	2.0	64.6
1914	.5	.6	.3	.7	.2	.2	.2	.2	.2	.2	.7	.6	.4	12.3
1915	.5	.5	1.6	1.1	.2	.2	.3	.2	.2	.2	.5	.6	.5	16.3
1916	.6	.5	7.2	2.2	.2	.2	.2	.2	.2	1.3	.9	.7	1.2	39.2
1917	.6	.5	.4	43.5	7.7	.2	.2	.2	.2	.7	.9	.6	4.7	149.2
1918	.5	.6	32.3	7.1	.2	.2	.2	.2	.2	.7	.7	.6	3.8	118.5
1919	.6	.6	.3	.3	.2	.2	.2	.1	.1	.3	.8	.6	.4	11.2
1920	.5	.5	2.2	.5	.2	.2	.2	.2	.1	.4	.7	.6	.5	17.2
1921	.6	1.0	1.6	.2	.2	.2	.1	.1	.2	.3	.7	.7	.5	15.6
1922	.5	.5	2.5	5.6	.2	.2	.2	.2	.2	.3	.7	.6	1.0	31.3
1923	.6	.5	.7	1.0	.2	.9	.2	.2	.2	.3	.7	.6	.5	16.7
1924	.6	.7	.2	.2	.2	.2	.2	.1	.1	.4	.7	.6	.4	11.1
1925	.5	.6	7.8	6.4	.2	.2	.2	.2	.2	.4	.7	.6	1.5	48.6
1926	.5	.6	7.9	.2	.2	.2	.2	.2	.2	.5	.7	.6	1.0	32.7
1927	.5	.5	.3	8.2	5.4	2.1	.3	.2	.2	.3	.7	.6	1.6	51.6
1928	5.5	2.4	10.8	2.2	.2	.2	.3	.2	.2	.4	.7	.6	2.0	64.1
1929	.6	.5	1.3	.6	.3	.2	.2	.2	.2	.4	.6	.5	.5	15.2
1930	.5	2.8	1.6	.9	.2	.2	.2	.2	.2	.5	.8	.7	.7	23.5
1931	.7	.7	.2	.4	.2	.1	.1	.1	.1	.3	.6	.6	.3	10.8
1932	.5	.5	1.9	.5	.2	.1	.1	.1	.1	.3	.7	.6	.5	15.2
1933	.5	.5	1.8	.4	.2	.1	.1	.1	.2	.4	.7	.6	.5	15.3
1934	.6	.5	3.7	.4	.2	.1	.1	.1	.1	.4	.7	.6	.6	20.0
1935	.6	.5	3.5	.8	.2	.2	.2	.1	.1	.2	.5	.5	.6	20.1
1936	.5	.5	2.9	1.5	.2	.2	.2	.2	.2	.2	.5	.5	.7	20.7
1937	.5	.5	.3	.5	.1	.1	.1	.1	.1	.2	.5	.5	.3	9.5
1938	.5	.5	3.7	1.0	.3	.2	.2	.1	.1	.3	.6	.5	.7	21.5
1939	.5	.5	4.6	.3	.2	.4	.2	.2	.2	.3	.5	.5	.7	23.0
1940	.5	.5	1.5	7.9	.2	.2	.2	.2	.2	.3	.6	.5	1.1	34.2
1941	.5	.5	5.5	.5	.2	.2	.2	.2	.2	.4	.7	.6	.8	26.5
1942	.6	.5	.9	.5	.2	.2	.2	.2	.2	.3	.7	.6	.4	13.7
1943	.5	.5	5.7	7.4	.2	.2	.2	.2	.2	.4	.7	.6	1.4	45.4
1944	.6	.5	2.3	8.5	.5	.2	.2	.2	.2	.2	.7	.6	1.2	39.3
1945	.5	.6	10.2	3.6	.3	.2	.2	.2	.2	.2	.5	.5	1.5	47.1

1946	.5	.5	1.8	.2	.4	.2	.2	.2	.3	.6	.7	.6	.5	16.8
1947	.6	.6	1.2	10.1	.3	.2	.4	.2	.2	.4	.6	.5	1.3	40.6
1948	.5	.5	2.9	7.1	.2	.2	.2	.2	.2	.2	.3	.4	1.1	34.5
1949	.4	.5	2.8	.3	.2	.1	.0	.3	.2	.3	.5	.5	.5	16.4
1950	.5	.5	.8	8.9	.4	.2	.2	.2	.2	.3	.6	.6	1.1	35.7
1951	.5	.5	.7	24.5	8.5	.2	.2	.2	.2	.2	.2	.2	3.1	96.7
1952	.3	.4	1.6	88.6	.5	.4	.2	.2	.3	.6	.6	.6	8.0	251.0
1953	.5	.5	15.8	12.2	.3	3.7	.2	.3	.3	.2	.6	.5	3.0	95.0
1954	.5	.7	.2	14.3	.7	.6	.2	.2	.2	.5	.8	.7	1.7	52.4
1955	.6	.5	1.5	41.2	1.7	.2	9.2	.2	.2	.2	.2	.3	4.8	150.2
1956	.4	.4	5.0	9.3	.2	.2	.2	.2	.2	.2	.5	.5	1.5	46.5
1957	.5	.7	3.6	2.5	.2	.2	.2	.2	.2	.7	.8	.7	.9	28.5
1958	.6	.8	6.8	11.2	.2	.2	.2	.3	.2	.8	.9	.8	2.0	61.8
1959	.6	.8	3.0	.3	.2	.2	.2	.2	.2	.2	.6	.6	.6	19.2
1960	.5	.6	16.1	2.8	.2	.2	.2	.5	.2	.7	.8	.7	2.0	63.7
1961	.6	.8	2.2	.2	.2	.2	.2	.2	.0	.0	.5	.5	.5	15.0
1962	.5	.6	1.7	.6	.2	.2	.1	.0	.1	.3	.6	.6	.5	14.6
1963	.5	.7	4.3	.2	.2	.2	.1	.0	.0	.1	.5	.5	.6	20.2
1964	.5	.1	1.8	.2	.2	.3	.0	.0	.2	.4	.7	.6	.4	13.3
1965	.5	.6	.2	15.7	.9	.2	.2	.2	.2	.7	.7	.6	1.8	55.5
1966	.6	.6	18.6	2.4	.4	.2	.2	.2	.2	.2	.2	.4	2.1	66.0
1967	.4	.5	.2	27.4	7.9	.2	.2	.2	.2	.6	.8	.7	3.3	105.0
1968	.6	1.4	3.6	.3	.2	.2	.2	.2	.2	.6	.2	.3	.7	21.6
1969	.4	.4	.2	19.2	.5	.2	.2	.2	.2	.5	.7	.7	2.0	62.1
1970	.6	.5	5.8	28.2	.2	1.7	.3	.2	.2	.6	.4	.5	3.3	104.7
1971	.5	.7	.2	26.5	.6	.2	.2	.2	.2	.7	.9	.8	2.7	84.3
1972	.6	.6	1.1	.2	.4	.2	.2	.2	.2	.6	.7	.6	.5	15.0
1973	.6	.9	.2	.3	.2	.0	.0	.0	.2	.4	.6	.7	.4	11.1
1974	.6	.6	1.5	10.3	.7	.2	.2	.2	.2	.7	.7	.6	1.4	43.7
1975	.5	.5	.2	4.4	.4	.2	.2	.2	.2	.6	.5	.2	.7	21.6
1976	.2	.2	15.4	4.5	.2	.2	.2	.2	.2	.8	.6	.5	2.0	63.5
1977	.3	.7	.2	.2	.3	.2	.2	.1	.2	.6	.5	.4	.3	10.3
1978	.4	.4	1.0	.8	.5	.2	.2	.2	.2	.4	.6	.5	.4	14.2
1979	.2	.2	2.2	5.0	.6	.2	.2	.2	.2	.7	.4	.3	.9	28.0
1980	.3	.4	2.0	.3	.2	.2	.2	.2	.2	.6	.6	.9	.5	16.3
1981	1.0	1.9	.8	.2	.2	.2	.2	.2	.1	.4	.7	.5	.5	17.3
1982	.4	.2	4.4	5.8	.6	.2	.7	.2	.2	.7	.7	.6	1.2	39.4
1983	.4	1.2	6.5	5.7	.5	.2	.3	.2	.2	.5	.6	.6	1.4	45.5
1984	.3	.6	1.0	.2	.2	.2	.2	.2	.2	.4	.6	.4	.4	12.3
1985	.5	.3	2.7	.4	.3	.2	.2	.2	.2	.4	.4	.1	.5	16.0
1986	.3	1.5	2.2	.4	.4	.2	.2	.2	.2	.2	.3	.2	.5	16.9
AVERAGE	.6	.6	3.9	7.2	.7	.3	.3	.2	.2	.4	.6	.6	1.3	41.6

TABLE C11
CURRENT CONDITIONS FLOWS
RUSHLAKE CREEK
AT HIGHFIELD RESERVOIR
MEAN MONTHLY FLOWS (m3/s)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	VOLUME $Kdam^3$
1912	.00	.00	.78	1.20	.16	.03	.01	.00	.00	.00	.00	.00	.18	5.69
1913	.00	.00	1.17	1.01	.00	.12	.00	.00	.00	.00	.00	.00	.19	6.09
1914	.00	.02	.30	.65	.00	.04	.00	.00	.00	.00	.00	.00	.08	2.66
1915	.00	.00	.37	.96	.00	.07	.19	.00	.00	.00	.00	.00	.13	4.17
1916	.00	.00	1.93	.01	.00	.16	.00	.00	.00	.00	.00	.00	.18	5.60
1917	.00	.01	.43	5.34	.43	.02	.14	.00	.00	.00	.00	.00	.53	16.59
1918	.00	.04	2.57	.48	.01	.00	.00	.00	.00	.00	.00	.00	.26	8.25
1919	.00	.04	.33	.24	.00	.00	.00	.00	.00	.00	.00	.00	.05	1.60
1920	.00	.00	.57	.55	.01	.03	.04	.00	.00	.00	.00	.00	.10	3.19
1921	.00	.14	.52	.12	.01	.03	.00	.00	.00	.00	.00	.00	.07	2.11
1922	.00	.01	.57	1.89	.00	.21	.01	.00	.00	.00	.00	.00	.22	6.99
1923	.00	.01	.31	.95	.01	.35	.14	.00	.00	.00	.00	.00	.15	4.65
1924	.00	.04	.17	.00	.00	.06	.00	.00	.00	.00	.00	.00	.02	.69
1925	.00	.04	1.97	1.03	.03	.00	.00	.00	.00	.00	.00	.00	.26	8.09
1926	.00	.02	1.39	.00	.00	.05	.00	.00	.00	.00	.00	.00	.12	3.89
1927	.00	.00	.50	1.80	.23	.00	.32	.00	.00	.00	.00	.00	.24	7.47
1928	.00	.21	.96	.29	.03	.21	.18	.00	.00	.00	.00	.00	.16	4.93
1929	.00	.01	.45	.46	.05	.10	.02	.00	.00	.00	.00	.00	.09	2.85
1930	.00	.65	.39	.77	.03	.16	.03	.00	.00	.00	.00	.00	.16	5.17
1931	.00	.06	.21	.27	.00	.05	.00	.00	.00	.00	.00	.00	.05	1.55
1932	.00	.00	.58	.42	.00	.07	.00	.00	.00	.00	.00	.00	.09	2.80
1933	.00	.00	.49	.20	.03	.08	.07	.00	.00	.00	.00	.00	.07	2.28
1934	.00	.00	.94	.22	.00	.22	.00	.00	.00	.00	.00	.00	.12	3.66
1935	.00	.00	1.17	.74	.04	.13	.08	.00	.00	.00	.00	.00	.18	5.69
1936	.00	.00	.91	1.03	.00	.07	.00	.00	.00	.00	.00	.00	.17	5.28
1937	.00	.00	.12	.39	.00	.00	.00	.00	.00	.00	.00	.00	.04	1.35
1938	.00	.00	1.16	.89	.07	.04	.01	.00	.00	.00	.00	.00	.18	5.72
1939	.00	.00	1.18	.13	.03	.25	.09	.00	.00	.00	.00	.00	.14	4.46
1940	.00	.00	.47	2.42	.03	.10	.00	.00	.00	.00	.00	.00	.25	7.86
1941	.00	.00	1.34	.44	.00	.04	.00	.00	.00	.00	.00	.00	.15	4.82
1942	.00	.01	.31	.42	.00	.33	.13	.00	.00	.00	.00	.00	.10	3.15
1943	.00	.00	1.37	1.10	.00	.00	.00	.00	.00	.00	.00	.00	.21	6.52
1944	.00	.01	.80	2.54	.18	.03	.20	.00	.00	.00	.00	.00	.31	9.84
1945	.00	.02	1.98	.73	.14	.00	.27	.00	.00	.00	.00	.00	.26	8.35

1946	.00	.00	.44	.05	.10	.05	.02	.00	.00	.00	.00	.00	.06	1.75
1947	.00	.02	.52	2.45	.06	.10	.34	.00	.00	.00	.00	.00	.29	9.11
1948	.00	.00	.63	1.64	.02	.01	.00	.00	.00	.00	.00	.00	.19	6.01
1949	.00	.00	.56	.13	.00	.00	.00	.00	.00	.00	.00	.00	.06	1.82
1950	.00	.00	.43	2.87	.11	.11	.00	.00	.00	.00	.00	.00	.29	9.17
1951	.00	.00	.75	2.76	.56	.17	.12	.00	.00	.00	.00	.00	.36	11.44
1952	.00	.00	.56	8.78	.00	.14	.04	.00	.00	.00	.00	.00	.78	24.72
1953	.00	.01	2.26	1.61	.10	.17	.20	.00	.00	.00	.00	.00	.36	11.51
1954	.00	.06	.39	1.77	.23	.16	.03	.00	.00	.00	.00	.00	.22	6.86
1955	.00	.01	.58	3.80	.16	.03	1.52	.00	.00	.00	.00	.00	.51	15.99
1956	.00	.00	.74	1.16	.05	.14	.00	.00	.00	.00	.00	.00	.17	5.48
1957	.00	.05	.94	.48	.01	.02	.05	.00	.00	.00	.00	.00	.13	4.09
1958	.00	.08	1.35	1.49	.03	.00	.00	.00	.00	.00	.00	.00	.25	7.73
1959	.00	.08	.64	.19	.01	.28	.12	.00	.00	.00	.00	.00	.11	3.47
1960	.00	.02	2.71	.41	.00	.10	.04	.00	.00	.00	.00	.00	.28	8.72
1961	.00	.07	.48	.06	.03	.00	.00	.00	.00	.00	.00	.00	.05	1.70
1962	.00	.03	.58	.69	.00	.05	.00	.00	.00	.00	.00	.00	.11	3.55
1963	.00	.07	.88	.12	.00	.24	.10	.00	.00	.00	.00	.00	.12	3.71
1964	.00	.00	.41	.11	.01	.03	.00	.00	.00	.00	.00	.00	.05	1.48
1965	.00	.03	.33	4.54	.36	.16	.11	.00	.03	.02	.00	.00	.46	14.52
1966	.00	.02	2.00	.01	.05	.07	.01	.00	.00	.00	.00	.00	.18	5.81
1967	.00	.00	.47	1.57	.50	.02	.00	.00	.00	.00	.00	.00	.21	6.75
1968	.00	.25	.97	.06	.03	.00	.00	.00	.00	.00	.00	.00	.11	3.45
1969	.00	.00	.13	4.07	.10	.01	.00	.00	.00	.00	.00	.00	.36	11.20
1970	.00	.01	1.22	2.24	.10	.82	.06	.00	.00	.00	.00	.00	.37	11.67
1971	.00	.05	.09	2.92	.02	.00	.00	.00	.00	.00	.00	.00	.25	7.97
1972	.00	.02	.22	.00	.03	.00	.00	.00	.00	.00	.00	.00	.02	.71
1973	.00	.12	.01	.00	.01	.00	.00	.00	.00	.00	.00	.00	.01	.37
1974	.00	.02	.00	3.21	.42	.02	.00	.00	.00	.00	.00	.00	.30	9.55
1975	.00	.00	.00	2.01	.24	.03	.00	.00	.00	.00	.00	.00	.19	5.93
1976	.00	.00	3.52	.42	.02	.01	.01	.00	.00	.00	.00	.00	.34	10.60
1977	.00	.06	.00	.00	.02	.01	.00	.00	.00	.00	.00	.00	.01	.21
1978	.00	.00	1.05	.43	.10	.01	.00	.00	.00	.00	.00	.00	.13	4.20
1979	.00	.00	1.09	.72	.21	.01	.00	.00	.00	.00	.00	.00	.17	5.38
1980	.00	.00	.99	.05	.00	.00	.00	.00	.00	.00	.00	.00	.09	2.79
1981	.00	.51	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.04	1.29
1982	.00	.00	1.63	1.63	.07	.17	.67	.19	.00	.01	.00	.00	.37	11.54
1983	.00	.08	1.32	.47	.21	.01	.07	.00	.00	.00	.00	.00	.18	5.72
1984	.00	.03	.00	.10	.01	.00	.00	.00	.00	.00	.00	.00	.01	.36
1985	.00	.00	.81	.29	.01	.00	.00	.00	.00	.00	.00	.00	.09	2.92
1986	.00	1.29	.40	.10	.16	.00	.01	.00	.00	.00	.00	.00	.16	4.94
AVERAGE	.00	.06	.81	1.13	.08	.08	.07	.00	.00	.00	.00	.00	.19	5.87

TABLE C12
NATURAL FLOWS
TOTAL INFLOW TO
BRIGHTWATER BLACKSTRAP LITTLE MANITOU AND DELWOOD RESERVOIRS
MEAN MONTHLY FLOWS (m3/s)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	VOLUME Kdam³
1912	0	0	1.94	6.90	.11	.00	.06	.00	.00	.00	0	0	.75	23.53
1913	0	0	1.36	.52	.00	.00	.00	.00	.00	.00	0	0	.16	4.98
1914	0	0	.50	.06	.00	.00	.00	.00	.00	.00	0	0	.05	1.49
1915	0	0	.00	.07	.00	.13	.00	.00	.00	.00	0	0	.02	.51
1916	0	0	.02	11.23	.00	.00	.00	.00	.00	.00	0	0	.92	29.17
1917	0	0	.01	.01	.00	.00	3.95	1.07	.00	.00	0	0	.43	13.50
1918	0	0	.74	.70	.05	.00	.00	.00	.00	.00	0	0	.12	3.92
1919	0	0	1.11	.06	.00	.00	.00	.00	.00	.00	0	0	.10	3.12
1920	0	0	2.92	1.26	.00	.00	.00	.00	.00	.00	0	0	.35	11.09
1921	0	0	.50	.07	.00	.00	.00	.00	.00	.00	0	0	.05	1.51
1922	0	0	.01	.01	.00	.00	4.18	1.14	.00	.00	0	0	.45	14.31
1923	0	0	.00	5.95	.24	.99	.12	.00	.00	.00	0	0	.60	18.95
1924	0	0	1.52	.58	.00	.00	.00	.00	.00	.00	0	0	.18	5.58
1925	0	0	.00	5.52	.22	.92	.11	.00	.00	.00	0	0	.56	17.59
1926	0	0	.56	.07	.00	.00	.00	.00	.00	.00	0	0	.05	1.67
1927	0	0	.02	10.84	.00	.00	.00	.00	.00	.00	0	0	.89	28.16
1928	0	0	1.98	.22	.01	.00	.00	.00	.00	.00	0	0	.19	5.89
1929	0	0	.02	.08	.01	.00	.11	.00	.00	.00	0	0	.02	.57
1930	0	0	1.05	.06	.00	.00	.00	.00	.00	.00	0	0	.09	2.96
1931	0	0	1.20	.06	.00	.00	.00	.00	.00	.00	0	0	.11	3.38
1932	0	0	2.03	.22	.01	.00	.00	.00	.00	.00	0	0	.19	6.04
1933	0	0	3.18	1.37	.00	.00	.00	.00	.00	.00	0	0	.38	12.07
1934	0	0	.01	.01	.00	.00	4.42	1.20	.00	.00	0	0	.48	15.10
1935	0	0	1.49	.57	.00	.00	.00	.00	.00	.00	0	0	.17	5.45
1936	0	0	.01	.01	.00	.00	4.55	1.23	.00	.00	0	0	.49	15.56
1937	0	0	.00	.06	.00	.13	.00	.00	.00	.00	0	0	.02	.49
1938	0	0	1.19	.06	.00	.00	.00	.00	.00	.00	0	0	.11	3.36
1939	0	0	.00	.90	.15	.00	.00	.00	.00	.00	0	0	.09	2.74
1940	0	0	.03	.09	.01	.00	.12	.00	.00	.00	0	0	.02	.65
1941	0	0	.01	.01	.00	.00	4.03	1.09	.00	.00	0	0	.44	13.79
1942	0	0	.00	6.18	.11	.00	.00	.00	.00	.00	0	0	.52	16.31
1943	0	0	.00	13.06	.07	15.99	.48	.00	.00	.00	0	0	2.43	76.76
1944	0	0	3.22	1.39	.00	.00	.00	.00	.00	.00	0	0	.39	12.23
1945	0	0	2.11	.23	.01	.00	.00	.00	.00	.00	0	0	.20	6.26

1946	0	0	.01	.01	.00	.00	3.73	1.01	.00	.00	0	0	.40	12.76
1947	0	0	.00	11.91	.04	.00	.00	.00	.00	.00	0	0	.98	30.98
1948	0	0	.01	.01	.00	.00	4.61	1.25	.00	.00	0	0	.50	15.76
1949	0	0	.00	1.09	.69	.00	.00	.00	.00	.00	0	0	.15	4.67
1950	0	0	.00	19.77	.55	.03	.00	.00	.00	.00	0	0	1.67	52.77
1951	0	0	.00	17.77	.49	.03	.00	.00	.00	.00	0	0	1.50	47.45
1952	0	0	.00	50.03	2.01	.18	.00	.00	.00	.00	0	0	4.29	135.52
1953	0	0	.02	9.84	.00	.00	.00	.00	.00	.00	0	0	.81	25.55
1954	0	0	.00	3.10	.13	.03	.00	.00	.00	.00	0	0	.27	8.46
1955	0	0	.00	19.97	.55	.03	.00	.00	.00	.00	0	0	1.69	53.33
1956	0	0	.02	10.26	.00	.00	.00	.00	.00	.00	0	0	.84	26.65
1957	0	0	1.19	.06	.00	.00	.00	.00	.00	.00	0	0	.11	3.36
1958	0	0	.22	.79	.03	.01	.00	.00	.00	.00	0	0	.09	2.74
1959	0	0	.01	.51	.02	.01	.07	.00	.00	.00	0	0	.05	1.60
1960	0	0	.02	5.62	.02	.01	.00	.00	.00	.00	0	0	.46	14.67
1961	0	0	.01	.32	.02	.01	.00	.00	.00	.00	0	0	.03	.90
1962	0	0	.01	.56	.02	.01	.00	.00	.00	.00	0	0	.05	1.54
1963	0	0	.79	.36	.02	.01	.00	.00	.00	.00	0	0	.10	3.10
1964	0	0	.01	.50	.02	.01	.07	.00	.00	.00	0	0	.05	1.57
1965	0	0	.01	3.35	.14	.51	.06	.00	.00	.00	0	0	.33	10.55
1966	0	0	1.62	1.29	.03	.02	.00	.00	.00	.00	0	0	.25	7.79
1967	0	0	.00	.84	.55	.05	1.04	.38	.00	.00	0	0	.24	7.61
1968	0	0	1.94	.63	.03	.02	.00	.00	.00	.00	0	0	.22	6.93
1969	0	0	.00	8.38	.82	.07	.13	.02	.00	.00	0	0	.78	24.53
1970	0	0	.95	4.78	.77	.07	.14	.02	.00	.00	0	0	.56	17.58
1971	0	0	.00	2.27	.15	.08	1.19	.43	.00	.00	0	0	.34	10.82
1972	0	0	.54	3.49	2.55	.23	.06	.01	.01	.01	0	0	.57	18.11
1973	0	0	.03	1.82	.88	.08	.26	.02	.00	.00	0	0	.26	8.10
1974	0	0	.00	27.86	1.39	.06	.00	.00	.00	.00	0	0	2.41	76.08
1975	0	0	.00	3.36	2.37	.20	.05	.01	.01	.01	0	0	.50	15.81
1976	0	0	.00	10.77	.29	8.31	.30	.02	.00	.00	0	0	1.62	51.10
1977	0	0	.00	.00	.05	.03	.00	.00	.00	.01	0	0	.01	.26
1978	0	0	.26	1.52	.15	.01	.07	.00	.00	.00	0	0	.17	5.28
1979	0	0	.00	15.88	3.13	.17	.00	.00	.00	.00	0	0	1.58	50.00
1980	0	0	1.01	4.49	.18	.00	.00	.00	.00	.00	0	0	.47	14.82
1981	0	0	.00	.05	.00	.10	.00	.00	.00	.00	0	0	.01	.37
1982	0	0	.00	1.60	.17	.23	1.00	.37	.00	.00	0	0	.28	8.85
1983	0	0	.01	1.53	.77	.07	2.67	.71	.00	.00	0	0	.48	15.29
1984	0	0	.52	.29	.01	.01	.00	.00	.00	.00	0	0	.07	2.19
1985	0	0	.00	15.25	.78	.01	.00	.00	.00	.00	0	0	1.32	41.66
1986	0	0	1.93	1.11	.05	.00	.01	.00	.00	.00	0	0	.26	8.26
AVERAGE	0	0	.53	4.42	.28	.38	.50	.13	.00	.00	0	0	.52	16.32

TABLE C13
NATURAL FLOWS
NORTH SASKATCHEWAN RIVER
AT PRINCE ALBERT
MEAN MONTHLY FLOWS (m3/s)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	VOLUME Kdam³
1912	42.6	44.8	44.7	231.0	319.0	421.0	1 000.0	851.0	631.0	284.0	139.0	65.6	341.5	10 777
1913	47.2	44.9	56.2	462.7	344.2	539.8	741.8	710.9	413.1	201.5	85.7	51.6	309.5	9 769
1914	34.6	33.7	36.7	123.2	375.1	859.5	834.4	412.2	292.0	219.9	105.8	71.8	284.4	8 976
1915	49.8	46.9	48.3	256.2	198.4	708.6	1 706.0	796.3	425.0	216.7	110.3	63.4	388.2	12 249
1916	40.3	31.7	36.6	210.4	265.2	683.1	932.6	710.5	651.9	327.0	173.7	89.2	347.5	10 965
1917	62.3	57.1	50.4	246.5	746.9	855.1	635.2	405.8	286.9	196.3	114.2	40.9	309.3	9 760
1918	53.2	47.3	49.0	246.4	216.3	446.7	479.3	352.0	231.3	180.2	78.0	39.7	202.2	6 382
1919	34.0	34.6	24.7	154.5	154.3	215.9	335.7	424.4	318.9	125.5	58.7	45.7	161.2	5 088
1920	41.1	35.5	36.6	107.4	893.9	692.7	828.2	502.2	251.8	149.9	93.1	42.7	308.5	9 736
1921	27.0	31.7	27.4	402.3	437.0	484.3	447.7	405.7	208.0	100.0	63.0	39.6	223.5	7 054
1922	24.5	22.1	28.7	145.8	317.8	413.3	402.7	446.6	318.1	161.5	75.0	21.7	199.0	6 281
1923	25.2	23.8	23.6	98.4	177.9	744.5	828.6	582.3	384.3	197.0	95.8	77.4	272.8	8 608
1924	28.9	43.1	49.4	109.6	337.6	372.8	452.7	441.2	325.4	147.6	63.1	53.2	203.1	6 409
1925	42.8	38.8	36.0	508.3	305.9	477.6	490.7	642.1	508.6	293.1	112.2	71.9	294.7	9 301
1926	48.5	34.8	51.3	282.8	204.5	281.0	484.9	328.6	731.8	339.4	154.6	74.3	251.8	7 946
1927	42.9	41.6	62.0	296.3	631.4	601.5	827.0	618.0	400.0	242.5	107.5	59.0	329.4	10 394
1928	77.4	48.9	68.9	291.9	268.7	747.1	969.8	508.2	264.8	131.9	63.9	45.7	291.9	9 210
1929	34.2	27.5	39.2	119.3	225.6	531.2	263.6	301.9	198.7	119.1	56.4	37.5	163.2	5 149
1930	33.9	35.7	43.8	160.8	194.1	410.4	504.2	393.6	251.4	123.9	50.4	38.4	187.5	5 917
1931	27.6	26.3	31.8	111.7	155.1	336.0	651.3	434.6	300.8	142.2	74.1	51.1	196.4	6 197
1932	42.6	34.2	30.0	278.2	407.8	814.0	487.2	401.0	321.0	144.9	57.0	46.2	255.8	8 072
1933	46.5	39.5	31.5	142.3	506.9	493.8	497.3	353.3	293.8	110.3	52.6	41.5	218.5	6 894
1934	38.1	42.7	56.7	223.5	268.5	462.4	334.6	302.0	215.0	127.9	68.8	42.5	182.3	5 752
1935	20.7	23.9	30.6	130.1	355.3	496.8	808.1	590.8	269.7	138.2	81.0	58.6	252.1	7 955
1936	35.6	30.6	26.6	379.0	582.8	527.3	358.5	351.1	241.9	117.6	59.4	40.3	229.9	7 256
1937	19.7	19.1	24.6	121.9	153.2	306.6	455.2	351.8	200.2	153.2	93.5	32.2	161.8	5 106
1938	27.8	23.9	38.5	165.8	124.0	420.7	637.7	400.7	359.2	190.9	79.2	48.1	210.6	6 646
1939	39.6	34.0	40.2	166.5	143.6	303.8	501.9	348.1	228.2	127.3	82.4	48.7	172.8	5 453
1940	29.8	27.1	27.2	242.8	398.4	321.6	360.7	309.9	258.0	142.2	69.1	39.9	186.3	5 881
1941	27.1	29.6	25.2	124.0	82.9	200.5	367.1	308.1	231.0	138.3	76.0	20.9	136.5	4 306
1942	20.7	23.7	25.4	125.3	128.3	507.8	725.8	528.6	362.9	187.9	81.8	62.1	232.8	7 348
1943	54.5	43.2	44.9	477.2	280.0	397.9	660.7	424.6	248.5	150.7	78.6	32.0	241.9	7 634
1944	24.2	29.3	33.3	171.6	161.5	1 054.7	738.5	543.1	375.9	192.1	84.7	31.3	287.1	9 062
1945	30.3	36.4	38.7	90.7	172.9	402.1	410.5	333.4	258.7	197.3	72.7	60.1	176.0	5 555

1946	48.5	44.0	52.7	202.7	159.8	627.7	561.9	319.9	239.0	125.8	69.0	41.3	208.1	6 567
1947	37.9	35.2	34.1	280.8	324.8	457.1	508.9	366.5	278.2	190.5	96.5	70.7	224.3	7 077
1948	50.6	41.5	39.6	196.4	1 512.9	946.1	572.0	563.1	304.4	151.5	62.9	38.2	375.7	11 857
1949	40.0	33.0	34.4	168.3	152.6	253.8	303.1	354.9	211.2	105.4	47.5	28.0	144.9	4 573
1950	19.5	26.6	27.4	139.6	183.1	429.4	605.1	377.7	234.4	129.7	51.5	33.1	189.0	5 965
1951	33.3	26.4	26.0	384.7	539.4	409.6	579.8	405.6	328.1	163.4	77.6	60.3	254.0	8 017
1952	44.1	38.7	37.0	464.6	254.2	711.4	824.3	502.5	259.3	178.1	98.7	40.6	288.6	9 108
1953	29.9	31.9	39.3	113.1	371.1	710.2	673.7	520.9	409.1	156.2	88.7	43.6	266.7	8 416
1954	34.2	37.3	38.5	90.9	468.1	1 110.4	744.0	675.9	1 115.2	353.0	157.0	96.7	410.6	12 958
1955	54.8	60.0	43.7	412.1	560.1	626.2	561.0	336.2	215.2	122.1	45.3	31.9	256.4	8 092
1956	33.5	31.5	29.1	491.0	501.4	528.7	486.4	393.4	259.0	162.6	80.1	38.7	253.7	8 005
1957	35.3	25.7	27.2	222.1	425.4	417.5	305.2	292.7	238.7	156.0	103.0	53.8	192.5	6 076
1958	36.9	40.1	36.8	348.4	354.1	571.6	695.2	392.2	267.3	132.9	81.7	28.1	249.6	7 877
1959	25.1	32.2	30.4	156.1	139.7	485.5	626.8	384.3	230.1	182.4	86.2	52.8	203.5	6 422
1960	28.7	38.6	37.6	293.1	217.4	349.1	673.5	396.8	180.8	142.6	71.1	30.9	206.1	6 503
1961	36.1	33.0	31.0	163.3	190.3	540.4	363.0	513.3	251.2	115.0	51.7	25.9	193.4	6 104
1962	45.8	45.4	53.0	223.4	260.6	430.7	538.7	460.6	239.8	121.3	102.8	67.6	216.7	6 839
1963	17.2	25.5	47.3	497.6	386.8	460.0	541.6	452.8	309.3	174.3	52.2	26.8	250.1	7 892
1964	30.7	36.1	30.2	159.6	359.1	616.9	671.5	330.6	286.3	312.3	92.0	57.2	249.7	7 880
1965	41.4	17.3	36.9	437.5	521.2	950.5	1 347.4	600.8	385.3	344.2	114.6	74.9	408.2	12 882
1966	43.0	56.8	50.9	287.7	284.0	405.0	627.7	602.9	352.6	211.1	72.7	49.2	254.8	8 042
1967	37.6	44.9	45.5	53.4	391.8	636.4	571.3	379.6	259.6	166.5	67.1	11.8	223.1	7 041
1968	1.7	21.5	100.0	216.1	141.7	383.9	519.1	510.3	288.9	171.3	84.2	24.2	206.2	6 507
1969	24.5	44.3	28.9	431.6	347.2	435.9	761.8	530.0	288.7	190.7	70.2	35.2	267.0	8 425
1970	23.3	30.9	47.3	316.9	306.8	540.5	570.9	353.4	207.2	104.2	42.1	14.7	213.9	6 749
1971	34.8	35.3	30.5	406.7	463.7	663.0	593.0	533.9	231.4	129.2	44.7	19.7	266.4	8 408
1972	23.0	20.7	27.5	357.2	367.6	677.7	873.9	404.6	173.1	158.5	75.0	12.5	265.5	8 378
1973	41.8	20.2	52.6	321.3	420.0	541.7	561.0	384.4	256.5	148.6	48.6	43.3	237.7	7 501
1974	19.9	60.0	72.2	729.4	1 141.1	786.3	751.0	439.1	282.1	180.2	86.5	40.4	383.8	12 112
1975	4.9	29.7	38.5	115.6	386.4	338.4	455.1	283.7	173.3	90.7	14.0	4.4	162.2	5 119
1976	25.3	27.6	43.0	238.1	220.5	266.2	424.3	472.5	280.7	133.9	30.4	4.8	181.5	5 728
1977	7.8	27.8	42.7	179.2	355.8	551.2	381.1	385.0	311.8	185.6	55.0	16.9	209.0	6 594
1978	14.8	44.9	41.1	285.8	290.7	630.1	706.9	413.7	413.0	208.8	87.3	36.2	265.1	8 366
1979	.0	12.9	68.9	237.5	520.3	395.1	422.5	344.7	218.4	123.4	59.9	8.7	202.1	6 379
1980	3.1	11.0	17.0	355.1	308.6	837.7	669.8	366.1	321.4	219.3	117.7	61.7	274.5	8 664
1981	47.7	53.0	62.2	229.4	362.9	468.5	575.2	762.3	296.4	147.6	90.7	42.7	263.0	8 300
1982	3.4	22.4	16.7	147.5	429.5	450.7	902.6	456.1	292.3	212.2	81.7	48.6	257.2	8 116
1983	40.9	28.4	40.9	244.3	332.3	324.9	612.4	345.8	201.4	110.3	69.6	7.0	197.6	6 237
1984	13.6	33.8	35.1	251.1	177.2	399.9	386.5	276.9	221.1	177.2	65.4	41.5	173.7	5 480
1985	12.5	12.2	33.7	506.4	334.5	343.1	354.8	321.1	335.2	202.3	48.8	35.7	212.1	6 695
1986	49.1	34.6	69.4	341.8	322.8	536.6	947.9	556.6	317.3	337.3	126.8	62.2	310.4	9 794
AVERAGE	33.0	34.1	40.2	254.7	351.0	530.4	613.5	447.7	309.6	175.3	79.7	43.3	243.7	7 691

TABLE C14
NATURAL FLOWS
SASKATCHEWAN RIVER
AT THE FORKS
MEAN MONTHLY FLOWS (m3/s)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	VOLUME Kdam³
1912	93	103	194	585	756	1 025	1 923	1 453	1 052	577	336	182	694	21 888
1913	115	117	162	904	828	1 443	1 473	1 210	733	437	252	152	654	20 645
1914	109	92	155	322	786	1 478	1 379	709	490	493	294	165	541	17 088
1915	119	106	220	481	832	1 765	3 196	1 671	878	562	308	191	866	27 341
1916	110	147	260	599	692	2 125	2 506	1 506	1 284	720	412	238	886	27 970
1917	153	158	153	715	1 603	2 244	1 495	799	533	401	256	113	720	22 736
1918	133	130	285	546	556	1 108	913	640	439	345	193	112	451	14 234
1919	90	88	93	388	569	722	680	757	516	233	135	107	366	11 554
1920	95	111	164	565	1 653	1 409	1 740	925	457	307	197	109	648	20 456
1921	81	89	116	694	910	1 237	960	677	355	199	142	92	464	14 638
1922	69	49	99	358	741	1 147	888	739	497	271	153	67	425	13 399
1923	63	52	86	290	492	2 404	1 766	1 073	656	378	215	153	637	20 110
1924	77	99	119	249	729	1 038	995	871	553	284	168	129	445	14 034
1925	106	94	201	1 049	856	1 213	991	983	762	557	284	201	609	19 229
1926	126	117	252	546	458	605	858	547	1 291	811	388	230	520	16 412
1927	141	116	209	798	1 282	1 978	1 823	1 226	987	631	319	206	813	25 641
1928	245	189	405	648	852	1 754	2 116	957	529	352	206	128	701	22 133
1929	94	75	159	271	648	1 566	684	497	325	197	122	94	395	12 459
1930	81	143	197	430	598	1 066	1 031	629	396	228	136	108	421	13 297
1931	82	77	104	220	363	748	985	641	457	258	169	118	353	11 153
1932	100	97	126	466	920	1 856	1 015	676	529	291	172	129	532	16 797
1933	109	93	116	423	1 014	1 305	1 059	621	463	241	196	136	483	15 242
1934	129	135	233	688	852	1 158	710	507	351	242	202	123	445	14 032
1935	83	100	130	326	659	1 136	1 388	937	444	250	155	111	479	15 113
1936	78	64	135	809	1 009	1 052	635	524	364	193	118	69	422	13 305
1937	38	38	81	262	390	953	861	595	344	267	206	107	346	10 931
1938	90	63	155	403	609	1 230	1 293	695	546	339	176	106	477	15 065
1939	83	66	162	344	426	894	1 007	586	365	233	191	125	375	11 828
1940	71	65	127	608	861	746	670	509	460	314	176	112	395	12 452
1941	76	76	165	318	262	507	626	503	410	312	194	102	297	9 372
1942	76	63	92	304	695	1 518	1 673	1 056	728	452	224	154	589	18 589
1943	110	106	221	1 302	749	1 088	1 430	795	430	265	159	90	564	17 785
1944	71	68	96	320	362	1 434	1 078	871	566	318	176	97	456	14 379
1945	77	86	174	271	535	1 278	1 065	619	480	394	200	159	446	14 083

1946	126	115	222	473	550	1 434	1 124	588	503	323	196	146	484	15 283
1947	118	121	350	821	1 043	1 278	1 107	681	548	531	293	192	592	18 690
1948	130	104	154	949	2 922	2 687	1 366	1 046	537	295	165	99	874	27 594
1949	96	80	113	393	528	729	605	548	342	211	149	95	325	10 254
1950	66	73	112	507	551	1 317	1 377	740	412	277	156	93	475	14 994
1951	88	77	103	973	1 486	1 578	1 846	970	1 091	715	356	235	796	25 129
1952	155	146	203	1 702	949	1 459	1 535	935	496	339	209	115	688	21 711
1953	87	105	161	448	1 020	2 609	1 776	1 000	682	337	216	134	716	22 597
1954	99	128	146	415	1 203	2 120	1 751	1 325	1 643	710	372	227	847	26 726
1955	129	137	143	992	1 178	1 531	1 403	704	413	300	166	106	602	18 990
1956	106	96	206	991	1 091	1 411	1 201	761	467	310	187	122	581	18 321

TABLE C15
NATURAL FLOWS
SASKATCHEWAN RIVER
AT TOBIN LAKE
MEAN MONTHLY FLOWS (m3/s)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	VOLUME Kdam³
1912	93	102	196	582	756	1 028	1 905	1 465	1 071	601	344	189	698	22 026
1913	119	116	161	886	842	1 426	1 474	1 217	745	448	259	157	656	20 708
1914	111	92	153	316	772	1 460	1 383	727	496	495	301	171	542	17 104
1915	121	106	215	470	823	1 740	3 169	1 702	897	573	316	197	866	27 344
1916	115	144	256	624	694	2 100	2 503	1 528	1 290	743	422	246	892	28 143
1917	157	157	156	712	1 587	2 237	1 516	818	542	408	261	120	724	22 862
1918	132	129	280	550	558	1 091	919	648	445	349	199	117	452	14 279
1919	91	87	94	385	565	716	682	755	523	245	140	109	367	11 590
1920	95	110	162	572	1 633	1 414	1 735	946	471	313	202	114	651	20 543
1921	83	88	115	728	931	1 233	970	685	365	206	144	95	472	14 881
1922	70	50	96	354	733	1 170	924	746	505	282	158	72	432	13 619
1923	63	52	84	303	488	2 355	1 783	1 091	667	390	222	157	640	20 182
1924	82	97	119	259	718	1 031	998	875	562	296	173	132	447	14 105
1925	107	94	196	1 045	869	1 203	1 001	984	767	565	293	205	612	19 320
1926	130	117	247	554	466	600	855	558	1 268	825	401	238	522	16 487
1927	146	117	205	809	1 288	1 967	1 829	1 241	992	643	329	211	818	25 801
1928	244	190	397	664	850	1 730	2 110	985	542	361	212	133	704	22 225
1929	96	76	155	289	639	1 540	709	504	331	205	125	96	398	12 546
1930	82	139	196	433	598	1 051	1 033	641	404	236	140	110	423	13 348
1931	84	77	104	226	359	735	979	651	462	266	173	121	355	11 191
1932	101	97	125	461	919	1 832	1 038	687	533	301	177	132	534	16 866
1933	111	93	117	426	1 003	1 305	1 069	634	468	251	198	139	486	15 343
1934	130	134	231	691	855	1 158	725	514	357	249	203	127	448	14 150
1935	85	98	130	326	660	1 122	1 383	949	459	258	159	113	481	15 177
1936	79	65	133	804	1 011	1 060	650	529	370	202	122	72	426	13 430
1937	40	38	78	253	386	935	865	603	352	271	208	112	346	10 932
1938	91	64	151	404	604	1 211	1 293	711	550	347	183	110	479	15 104
1939	84	66	158	346	425	878	1 005	598	373	239	192	128	376	11 858
1940	74	65	124	589	855	749	673	514	461	321	182	116	395	12 462
1941	78	76	162	330	272	506	625	508	413	318	199	107	301	9 483
1942	77	63	91	318	688	1 503	1 673	1 072	737	466	232	158	593	18 702
1943	112	106	217	1 367	793	1 080	1 425	812	442	274	164	94	575	18 151
1944	72	67	96	327	368	1 410	1 090	877	575	329	182	101	459	14 481
1945	79	85	170	277	539	1 257	1 072	632	484	398	208	162	448	14 146

1946	127	115	219	481	555	1 417	1 135	604	506	332	201	149	488	15 391
1947	120	120	343	838	1 051	1 285	1 116	694	553	535	301	197	598	18 866
1948	133	104	154	941	2 886	2 698	1 399	1 054	553	306	170	102	879	27 725
1949	96	80	112	397	526	722	610	550	349	217	152	98	327	10 308
1950	68	72	111	509	554	1 294	1 380	758	422	283	161	97	477	15 067
1951	88	77	102	973	1 492	1 581	1 842	992	1 086	727	367	241	801	25 264
1952	159	146	201	1 689	988	1 452	1 536	951	509	346	214	120	694	21 886
1953	89	103	159	459	1 011	2 571	1 797	1 019	690	350	221	138	719	22 686
1954	100	126	146	472	1 207	2 102	1 762	1 335	1 633	736	383	234	855	26 990
1955	134	136	143	995	1 189	1 538	1 414	724	423	307	171	110	609	19 208
1956	106	96	201	995	1 107	1 408	1 209	773	476	317	191	126	585	18 472
1957	98	82	176	478	1 103	1 131	721	536	407	303	248	160	455	14 365
1958	100	94	136	837	1 008	1 291	1 363	748	473	289	199	117	556	17 556
1959	87	79	175	374	553	1 337	1 368	782	489	442	257	181	512	16 167
1960	107	115	277	763	670	965	1 227	738	367	261	159	96	480	15 160
1961	94	80	123	290	570	1 441	799	783	427	288	179	97	432	13 628
1962	98	121	135	510	615	1 020	1 002	761	456	270	221	158	449	14 157
1963	75	80	201	674	659	1 159	1 354	847	530	318	156	83	513	16 197
1964	93	102	102	299	837	1 770	1 440	670	483	498	246	127	557	17 590
1965	111	96	164	940	972	1 982	2 477	1 154	763	679	330	214	827	26 094
1966	122	126	291	675	749	1 289	1 360	1 003	600	391	194	140	580	18 318
1967	106	105	172	431	1 100	2 173	1 475	786	472	312	195	94	620	19 567
1968	64	89	231	358	420	1 065	1 063	856	562	446	253	101	461	14 539
1969	85	105	160	1 114	985	1 263	1 881	986	527	365	202	118	652	20 575
1970	72	85	147	685	723	1 515	1 194	642	375	238	140	65	491	15 495
1971	81	115	134	976	1 051	1 604	1 213	881	437	275	159	83	585	18 467
1972	61	63	248	766	940	1 883	1 736	905	474	368	220	88	648	20 459
1973	107	92	187	570	866	1 288	1 130	706	479	298	161	130	503	15 867
1974	83	128	167	1 354	1 899	1 999	1 601	867	540	362	205	116	779	24 579
1975	59	73	99	404	921	1 371	1 226	670	401	258	136	86	477	15 057
1976	89	102	208	504	637	794	951	1 005	607	334	149	74	457	14 408
1977	58	84	125	296	606	889	646	644	547	362	164	78	376	11 866
1978	65	89	176	583	751	1 404	1 406	820	718	438	218	130	568	17 929
1979	50	45	222	584	992	989	843	589	384	234	143	64	430	13 573
1980	39	47	92	628	819	1 603	1 123	660	543	412	251	148	531	16 771
1981	136	160	207	372	1 119	1 388	1 377	1 334	588	320	213	110	613	19 357
1982	35	56	93	400	734	1 182	1 610	826	511	384	180	107	513	16 174
1983	88	97	159	441	648	830	1 132	656	377	228	166	46	407	12 856
1984	48	95	124	390	372	868	806	539	400	326	168	89	353	11 136
1985	51	43	158	916	728	819	673	568	649	477	207	126	452	14 266
1986	121	112	293	542	780	1 327	1 517	924	582	659	307	182	615	19 406
AVERAGE	95	96	169	594	839	1 354	1 280	823	564	373	213	129	546	17 227

TABLE C16
NATURAL FLOWS
SASKATCHEWAN RIVER
AT THE MANITOBA BORDER
MEAN MONTHLY FLOWS (m3/s)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	VOLUME Kdam³
1912	108	120	218	693	876	1 202	2 220	1 717	1 253	696	403	218	815	25 706
1913	148	146	196	1 070	1 129	1 698	1 798	1 530	986	582	334	200	821	25 910
1914	136	113	171	419	955	1 645	1 622	892	599	580	370	207	645	20 361
1915	129	115	224	511	864	1 815	3 301	1 860	1 006	630	351	209	924	29 158
1916	135	161	276	755	865	2 338	2 866	1 873	1 559	938	537	285	1 053	33 228
1917	188	186	185	798	1 913	2 621	1 920	1 087	693	508	352	155	887	27 978
1918	159	161	318	774	742	1 292	1 226	905	626	477	276	149	594	18 738
1919	114	113	116	466	678	864	835	888	639	345	168	124	448	14 123
1920	102	117	169	583	1 783	1 584	1 886	1 076	538	351	224	128	716	22 596
1921	104	108	140	795	1 378	1 664	1 383	976	578	349	231	155	658	20 753
1922	115	85	129	462	1 050	1 530	1 274	1 018	753	433	257	116	604	19 067
1923	81	69	101	354	618	2 549	2 116	1 358	849	485	260	179	754	23 796
1924	93	108	132	280	832	1 148	1 146	988	663	353	199	153	510	16 099
1925	126	110	213	1 142	1 041	1 386	1 219	1 139	934	686	358	241	718	22 667
1926	155	139	275	631	607	699	993	660	1 406	1 006	520	269	615	19 397
1927	176	140	229	879	1 543	2 226	2 135	1 523	1 207	835	437	268	970	30 623
1928	270	214	419	730	977	1 843	2 300	1 147	618	397	230	142	777	24 529
1929	99	78	159	302	672	1 591	756	525	348	215	130	99	415	13 101
1930	87	144	202	493	669	1 143	1 146	719	454	267	163	122	469	14 797
1931	103	95	125	311	437	823	1 165	794	576	362	229	144	432	13 643
1932	122	114	153	571	1 109	2 082	1 333	861	667	385	236	162	651	20 543
1933	145	125	147	528	1 287	1 609	1 371	817	606	336	262	188	621	19 582
1934	180	193	300	889	1 310	1 575	1 198	807	550	386	328	213	662	20 903
1935	116	121	164	412	828	1 296	1 605	1 149	560	311	184	135	576	18 188
1936	94	77	145	864	1 232	1 234	771	602	437	238	144	84	495	15 614
1937	48	46	87	325	476	1 023	997	704	407	314	239	132	401	12 667
1938	104	75	165	495	675	1 322	1 442	809	620	394	215	126	539	17 007
1939	105	85	176	454	538	995	1 240	733	449	289	229	152	456	14 380
1940	90	79	136	685	1 026	879	767	597	518	379	208	131	460	14 501
1941	85	81	167	371	298	531	661	539	441	337	217	113	321	10 133
1942	82	68	97	356	736	1 606	1 819	1 207	822	520	260	174	649	20 472
1943	132	123	236	1 499	969	1 209	1 608	952	523	318	198	110	658	20 768
1944	92	86	114	435	457	1 568	1 355	1 073	716	408	221	126	556	17 537
1945	99	110	198	384	712	1 511	1 365	816	606	508	270	202	567	17 897

1946	152	139	247	624	657	1 556	1 329	723	588	393	236	166	569	17 946
1947	139	138	363	936	1 228	1 445	1 275	796	635	612	358	231	682	21 527
1948	152	119	166	964	3 045	2 899	1 557	1 157	618	337	184	110	946	29 857
1949	114	96	132	539	626	880	750	692	434	275	216	122	407	12 857
1950	80	87	125	562	669	1 396	1 548	887	496	328	187	115	542	17 110
1951	110	96	122	1 066	1 677	1 777	2 057	1 190	1 245	863	455	290	916	28 905
1952	188	178	234	1 851	1 239	1 638	1 787	1 154	634	419	266	141	812	25 633
1953	101	114	173	506	1 121	2 717	1 982	1 153	782	396	249	151	789	24 905
1954	122	147	176	521	1 413	2 408	2 099	1 612	1 956	1 010	570	366	1 036	32 707
1955	216	212	204	1 253	1 594	1 956	1 774	991	557	401	208	142	794	25 071
1956	136	131	238	1 120	1 500	1 761	1 495	987	613	411	253	156	736	23 218
1957	124	101	200	593	1 400	1 405	903	652	509	379	325	202	568	17 926
1958	122	117	165	995	1 188	1 469	1 539	882	546	342	232	135	646	20 400
1959	107	98	196	501	640	1 463	1 558	903	554	505	297	216	589	18 585
1960	132	136	297	886	786	1 086	1 353	832	413	293	181	113	544	17 179
1961	102	88	132	323	610	1 511	848	821	450	302	189	102	457	14 437
1962	112	137	154	553	735	1 111	1 097	841	501	283	232	170	495	15 633
1963	89	94	216	788	801	1 295	1 548	1 011	633	390	205	108	601	18 952
1964	115	132	132	371	949	1 897	1 643	768	550	574	300	149	634	20 002
1965	149	134	206	1 062	1 230	2 274	2 903	1 495	945	839	437	273	1 000	31 561
1966	194	174	366	856	994	1 549	1 677	1 244	715	463	239	169	723	22 811
1967	132	151	219	466	1 217	2 300	1 595	866	522	350	220	112	681	21 488
1968	138	126	278	458	509	1 144	1 157	950	647	507	315	145	533	16 820
1969	125	151	202	1 204	1 091	1 330	2 003	1 079	584	416	233	145	716	22 608
1970	157	189	225	773	958	1 671	1 425	822	475	320	222	132	615	19 420
1971	155	204	217	1 100	1 235	1 741	1 350	1 007	504	332	226	135	685	21 622
1972	118	113	308	850	1 133	2 017	1 901	1 036	544	434	264	119	739	23 325
1973	227	226	317	735	1 120	1 583	1 379	854	620	417	239	224	664	20 939
1974	192	257	311	1 585	2 457	2 445	1 934	1 094	741	532	336	219	1 011	31 918
1975	170	216	238	545	1 204	1 635	1 465	805	504	361	237	163	631	19 898
1976	154	187	299	628	718	855	1 028	1 084	684	408	193	120	532	16 785
1977	137	171	183	386	686	989	714	705	620	422	206	123	446	14 079
1978	101	128	216	641	875	1 499	1 499	884	785	517	263	169	633	19 984
1979	146	155	342	700	1 326	1 228	957	671	457	301	206	117	552	17 435
1980	70	101	146	706	883	1 678	1 210	708	583	465	294	172	586	18 487
1981	167	197	239	431	1 163	1 457	1 435	1 418	642	360	246	129	660	20 832
1982	64	93	127	446	802	1 229	1 663	869	541	416	205	128	551	17 397
1983	185	212	267	564	881	985	1 310	770	468	329	262	110	530	16 741
1984	147	211	232	649	578	1 081	967	644	510	447	259	171	492	15 524
1985	140	142	273	1 213	1 158	1 097	861	704	786	605	306	223	627	19 782
1986	191	176	368	673	909	1 454	1 642	1 081	666	762	384	249	716	22 599
AVERAGE	131	133	207	698	1 017	1 533	1 481	976	673	455	269	165	647	20 418

TABLE C17
CURRENT CONDITIONS FLOWS
NORTH SASKATCHEWAN RIVER
AT PRINCE ALBERT
MEAN MONTHLY FLOWS (m3/s)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	VOLUME Kdam³
1912	130	128	125	320	334	298	836	702	558	287	201	152	341	10 751
1913	135	128	137	552	360	417	578	562	340	204	148	138	309	9 742
1914	122	116	117	212	390	736	670	263	219	223	168	159	284	8 950
1915	137	130	129	345	214	585	1 542	647	352	220	172	150	388	12 222
1916	128	114	117	299	281	560	769	562	578	330	236	176	347	10 939
1917	150	140	131	335	762	732	471	257	213	199	176	128	309	9 733
1918	141	130	129	335	232	323	315	203	158	183	140	127	202	6 355
1919	121	117	105	243	170	93	172	276	245	128	121	133	161	5 062
1920	129	118	117	196	909	569	664	353	178	153	155	130	308	9 709
1921	114	114	108	491	452	361	284	257	135	103	125	126	223	7 027
1922	112	105	109	235	333	290	239	298	245	164	137	109	198	6 255
1923	113	107	104	187	193	621	665	433	311	200	158	164	272	8 582
1924	116	126	130	198	353	250	289	292	252	150	125	140	202	6 382
1925	130	122	116	597	321	354	327	493	435	296	174	159	294	9 275
1926	136	118	132	372	220	158	321	180	658	342	217	161	251	7 919
1927	130	124	142	385	647	478	663	469	327	245	170	146	329	10 367
1928	165	132	149	381	284	624	806	359	191	135	126	133	291	9 184
1929	122	110	120	208	241	408	100	153	125	122	118	124	162	5 123
1930	121	118	124	250	209	287	340	245	178	127	112	125	187	5 891
1931	115	109	112	201	170	213	487	286	227	145	136	138	196	6 171
1932	130	117	110	367	423	691	323	252	248	148	119	133	255	8 045
1933	134	122	112	231	522	371	333	204	220	113	115	128	218	6 868
1934	126	125	137	312	284	339	171	153	142	131	131	129	182	5 726
1935	108	107	111	219	371	374	644	442	196	141	143	145	251	7 929
1936	123	113	107	468	598	404	194	202	168	120	121	127	229	7 229
1937	107	102	105	211	169	183	291	203	127	156	156	119	161	5 079
1938	115	107	119	255	139	297	474	252	286	194	141	135	210	6 620
1939	127	117	121	255	159	181	338	199	155	130	144	136	172	5 427
1940	117	110	108	332	414	198	197	161	185	145	131	127	186	5 854
1941	115	112	106	213	98	77	203	159	158	141	138	108	136	4 280
1942	108	106	106	214	144	385	562	380	289	191	144	149	232	7 322
1943	142	126	125	566	295	275	497	276	175	154	141	119	241	7 607
1944	112	112	114	260	177	931	574	394	302	195	147	118	287	9 035
1945	118	119	119	180	188	279	246	185	185	200	135	147	175	5 528

1946	136	127	133	292	175	504	398	171	166	129	131	128	207	6 540
1947	125	118	114	370	340	334	345	218	205	193	159	158	224	7 050
1948	138	124	120	285	1 528	823	408	414	231	154	125	125	375	11 830
1949	127	116	115	257	168	131	139	206	138	108	110	115	144	4 546
1950	107	109	108	228	198	306	441	229	161	133	114	120	188	5 939
1951	121	109	106	474	555	286	416	257	255	166	140	147	253	7 991
1952	132	121	117	553	270	588	660	354	186	181	161	127	288	9 082
1953	117	115	120	202	386	587	510	372	336	159	151	130	266	8 390
1954	122	120	119	180	483	987	580	527	1 042	356	219	184	410	12 932
1955	142	143	124	501	575	503	397	187	142	125	107	119	256	8 065
1956	121	114	109	580	517	405	322	245	186	165	142	126	253	7 979
1957	123	108	108	311	441	294	141	144	165	159	165	141	192	6 050
1958	124	123	117	437	369	448	531	243	194	136	144	115	249	7 850
1959	113	115	111	245	155	362	463	235	157	185	148	140	203	6 396
1960	116	121	118	382	233	226	509	248	107	145	133	118	205	6 476
1961	124	116	111	252	206	417	199	364	178	118	114	113	193	6 077
1962	133	128	133	312	276	307	375	312	166	124	165	154	216	6 813
1963	105	108	128	586	402	337	378	304	236	177	114	114	249	7 866
1964	118	119	111	248	374	494	507	182	213	315	154	144	249	7 853
1965	129	100	117	526	537	827	1 183	452	312	347	177	162	408	12 856
1966	130	140	131	377	299	282	464	454	279	214	135	136	254	8 015
1967	125	128	126	142	407	513	407	231	186	169	129	99	222	7 014
1968	89	104	180	305	157	261	355	361	215	174	146	111	206	6 481
1969	112	127	109	520	363	313	598	381	215	194	132	122	266	8 398
1970	111	114	128	406	322	417	407	205	134	107	104	102	213	6 722
1971	122	118	111	496	479	540	429	385	158	132	107	107	266	8 382
1972	110	103	108	446	383	554	710	256	100	161	137	99	265	8 352
1973	129	103	133	410	435	418	397	236	183	151	111	130	237	7 475
1974	107	143	153	818	1 156	663	587	290	209	183	149	127	383	12 085
1975	92	112	119	204	402	215	291	135	100	94	76	91	161	5 093
1976	113	110	123	327	236	143	260	324	207	137	92	92	181	5 702
1977	95	111	123	268	371	428	217	236	238	188	117	104	208	6 568
1978	102	128	121	375	306	507	543	265	340	212	149	123	264	8 340
1979	87	96	149	326	536	272	258	196	145	126	122	96	201	6 353
1980	91	94	97	444	324	714	506	217	248	222	180	149	274	8 638
1981	135	136	143	318	378	345	411	613	223	150	153	130	262	8 273
1982	91	105	97	236	445	327	738	307	219	215	144	135	257	8 090
1983	128	111	121	333	348	202	448	197	128	113	132	94	197	6 211
1984	101	117	115	340	193	277	222	128	148	180	127	128	173	5 454
1985	100	95	114	595	350	220	191	172	262	205	111	123	211	6 669
1986	137	117	150	431	338	413	784	408	244	340	189	149	310	9 767
AVERAGE	120	117	121	344	366	407	449	299	236	178	142	130	243	7 665

TABLE C18
CURRENT CONDITIONS FLOWS (1986)
SASKATCHEWAN RIVER
AT THE FORKS
MEAN MONTHLY FLOWS (m3/s)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	VOLUME Kdam³
1912	457	379	336	534	451	352	1 153	1 099	817	652	529	561	612	19 323
1913	503	393	303	850	524	593	869	847	493	513	446	546	575	18 130
1914	482	368	296	257	476	787	739	342	287	416	488	561	459	14 482
1915	490	381	358	419	527	915	2 498	1 356	693	630	508	558	782	24 689
1916	511	423	392	539	391	1 079	2 009	1 194	1 095	748	646	585	803	25 355
1917	556	469	298	661	1 136	1 340	989	536	296	476	449	509	644	20 311
1918	505	406	431	492	278	372	370	258	226	249	333	508	369	11 643
1919	461	363	238	330	257	135	223	321	298	182	226	380	284	8 977
1920	466	387	302	499	1 204	696	1 041	653	253	348	391	505	565	17 820
1921	453	364	257	634	600	416	357	330	206	171	332	488	384	12 120
1922	440	324	239	297	424	351	320	369	315	234	308	463	341	10 749
1923	434	327	228	264	234	1 270	1 267	804	411	450	409	549	555	17 519
1924	449	375	261	256	386	304	357	376	324	356	362	525	361	11 405
1925	477	370	332	846	688	409	400	561	522	633	477	565	524	16 533
1926	530	393	384	487	269	199	365	235	685	524	581	570	435	13 727
1927	537	429	353	737	859	1 047	1 321	913	799	658	567	553	733	23 124
1928	564	536	534	639	544	903	1 411	683	290	428	399	524	623	19 650
1929	466	351	300	259	286	699	188	208	176	190	223	427	314	9 899
1930	453	414	336	364	284	339	409	321	244	195	217	484	338	10 671
1931	454	353	246	249	211	248	534	341	277	196	241	243	299	9 448
1932	234	262	265	417	598	1 003	411	326	314	335	366	525	421	13 299
1933	481	369	255	366	706	442	443	281	288	232	390	532	399	12 598
1934	501	410	367	622	542	396	231	207	192	179	233	471	362	11 433
1935	455	376	267	270	414	406	708	517	271	210	334	507	395	12 480
1936	449	341	273	736	697	448	254	253	218	171	226	233	358	11 294
1937	249	313	221	248	211	213	345	257	179	204	259	277	248	7 821
1938	462	340	291	339	298	371	683	332	354	367	370	502	393	12 405
1939	454	342	295	301	202	213	386	258	207	179	247	429	293	9 245
1940	443	341	269	540	550	247	248	213	231	195	238	233	312	9 845
1941	435	352	297	286	149	116	250	210	205	189	245	215	245	7 738
1942	213	210	225	290	356	676	977	794	491	527	417	550	479	15 121
1943	481	382	352	946	735	328	725	428	248	287	353	486	480	15 151
1944	443	344	238	328	224	957	629	444	356	247	253	224	390	12 307
1945	276	363	310	237	232	394	449	262	252	456	394	552	348	10 988

1946	500	390	354	413	242	582	518	249	248	401	389	533	402	12 677
1947	498	396	488	761	734	430	495	322	311	596	497	565	509	16 056
1948	525	379	298	674	2 364	2 099	864	774	307	353	358	494	793	25 027
1949	468	356	252	331	222	171	192	256	189	157	213	221	252	7 948
1950	342	349	256	435	247	464	776	381	234	296	350	489	385	12 163
1951	460	354	248	838	940	852	1 346	682	885	719	553	555	704	22 232
1952	535	524	395	1 370	728	814	928	571	260	405	402	511	620	19 565
1953	459	382	303	399	720	1 555	1 267	726	439	409	409	530	634	20 019
1954	470	404	289	357	846	1 216	1 159	1 020	1 452	776	572	592	764	24 108
1955	531	413	287	831	837	838	796	335	213	333	359	502	523	16 514
1956	477	371	346	839	839	595	596	396	257	358	380	518	498	15 724
1957	468	357	318	411	805	362	201	197	215	225	320	547	369	11 654
1958	473	369	277	773	690	506	691	363	264	314	389	508	469	14 788
1959	456	354	316	302	249	506	749	399	247	517	443	546	425	13 405
1960	502	392	414	688	341	281	573	324	180	212	307	488	392	12 377
1961	465	355	264	297	242	553	283	431	250	183	321	488	344	10 859
1962	470	399	271	451	322	343	426	383	236	193	324	551	364	11 487
1963	442	356	342	630	449	384	580	468	307	350	343	475	428	13 498
1964	465	378	242	302	479	860	879	283	281	527	430	517	471	14 864
1965	481	372	311	844	682	1 159	1 779	853	514	746	512	569	738	23 278
1966	524	403	442	604	433	452	749	624	351	446	380	533	496	15 661
1967	475	384	317	378	793	1 133	936	488	258	343	384	485	532	16 791
1968	434	365	373	359	199	288	406	433	286	429	439	488	375	11 845
1969	456	383	302	848	773	518	1 187	683	289	428	389	509	566	17 853
1970	441	362	289	620	406	683	560	283	204	199	329	456	402	12 701
1971	454	393	276	851	807	765	577	495	231	290	347	474	497	15 681
1972	431	339	392	683	615	912	1 159	610	222	437	408	476	559	17 634
1973	480	367	335	520	557	480	476	311	252	275	349	524	411	12 966
1974	452	408	307	996	1 401	1 392	1 073	578	286	425	392	507	686	21 647
1975	427	351	246	336	603	518	611	293	170	311	324	479	390	12 306
1976	460	380	357	451	337	184	306	459	350	397	335	466	374	11 798
1977	428	361	266	307	409	468	271	282	286	240	226	211	312	9 860
1978	242	366	316	520	442	564	791	437	475	499	403	521	465	14 678
1979	416	321	365	494	669	316	312	250	196	177	227	329	340	10 723
1980	408	323	232	573	512	772	585	291	314	374	438	538	447	14 099
1981	507	435	346	362	759	575	768	963	326	386	403	500	529	16 704
1982	402	333	233	344	485	376	934	442	290	426	365	499	429	13 538
1983	458	372	306	390	391	240	492	256	181	164	236	365	321	10 136
1984	420	374	265	385	242	312	273	183	197	228	235	236	278	8 782
1985	267	319	302	802	408	262	244	222	304	273	235	517	346	10 916
1986	492	382	438	483	473	490	912	548	339	734	488	556	530	16 724
AVERAGE	451	372	311	517	542	599	697	468	341	368	369	476	460	14 515

TABLE C19
CURRENT CONDITIONS FLOWS (1986)
SASKATCHEWAN RIVER
AT TOBIN LAKE
MEAN MONTHLY FLOWS (m3/s)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	VOLUME Kdam³
1912	457	379	354	525	443	355	1 109	1 113	839	677	539	571	616	19 432
1913	506	393	317	827	531	572	841	852	503	525	455	553	574	18 118
1914	485	369	310	248	457	763	710	356	295	420	497	569	457	14 432
1915	493	381	369	404	514	890	2 431	1 382	718	643	518	566	780	24 627
1916	515	422	405	569	396	1 057	1 974	1 214	1 108	773	658	595	810	25 548
1917	560	469	318	651	1 111	1 314	975	546	301	483	456	518	643	20 285
1918	504	407	441	493	273	345	344	262	229	255	341	515	367	11 586
1919	462	364	254	318	246	150	171	317	308	198	233	384	283	8 946
1920	467	388	317	499	1 164	693	999	668	264	355	397	512	563	17 755
1921	454	367	280	667	613	404	332	334	216	178	337	493	390	12 295
1922	442	328	254	289	412	364	318	372	321	246	315	470	345	10 873
1923	435	328	240	271	224	1 206	1 251	827	421	463	417	554	555	17 505
1924	453	373	279	261	366	287	323	376	334	370	369	530	360	11 376
1925	479	370	343	829	704	397	379	561	526	642	488	571	525	16 562
1926	534	393	394	493	270	184	329	246	667	543	596	579	435	13 741
1927	541	431	366	745	851	1 035	1 286	935	808	672	580	561	736	23 223
1928	562	538	542	650	536	873	1 366	713	299	438	407	531	623	19 646
1929	467	353	314	274	270	663	174	209	182	199	229	431	313	9 886
1930	453	411	351	364	282	322	375	331	257	205	224	488	339	10 687
1931	455	353	260	248	198	225	492	351	285	205	247	249	297	9 384
1932	235	263	282	410	595	981	407	334	318	347	373	530	423	13 352
1933	482	371	272	366	692	435	416	294	299	244	394	537	401	12 643
1934	501	411	382	618	541	389	206	205	194	186	237	478	362	11 425
1935	457	376	283	267	412	384	665	525	286	220	340	511	395	12 460
1936	451	343	286	724	691	445	232	252	223	181	232	239	358	11 290
1937	251	314	236	235	197	180	307	257	187	211	264	284	243	7 676
1938	463	341	302	334	283	342	649	344	357	378	378	509	391	12 336
1939	456	343	306	297	197	194	345	260	210	187	251	435	290	9 160
1940	446	342	281	513	536	241	210	208	229	203	246	239	308	9 707
1941	437	352	310	293	151	135	179	207	206	195	251	222	244	7 709
1942	214	212	243	300	348	663	944	806	500	541	427	556	482	15 198
1943	484	382	362	996	776	308	682	437	259	298	359	492	487	15 371
1944	444	345	252	329	222	921	617	447	364	260	261	231	391	12 328
1945	277	363	324	240	231	366	421	273	257	461	403	557	348	10 980

1946	502	390	366	415	241	559	498	262	250	412	397	538	403	12 704
1947	500	396	496	772	733	425	470	333	316	601	507	572	511	16 127
1948	528	381	317	664	2 312	2 099	871	778	316	364	366	500	794	25 044
1949	468	357	266	330	214	157	163	253	193	164	218	226	250	7 897
1950	344	348	269	431	242	434	747	392	242	305	357	495	384	12 128
1951	460	356	264	826	946	848	1 301	706	880	732	567	563	706	22 277
1952	539	524	406	1 311	796	798	889	578	269	411	409	519	621	19 586
1953	460	384	318	404	704	1 497	1 248	748	445	421	416	536	633	19 978
1954	472	401	307	413	837	1 192	1 148	1 034	1 435	810	585	601	771	24 326
1955	536	412	305	823	835	842	773	348	220	339	367	508	526	16 602
1956	477	375	358	828	843	587	566	402	262	365	387	524	499	15 733
1957	470	362	333	412	783	358	181	198	215	230	324	554	369	11 641
1958	476	369	292	766	682	485	653	373	271	323	394	515	467	14 747
1959	458	354	326	304	238	472	713	412	257	523	452	552	423	13 344
1960	506	393	423	701	357	268	531	330	187	218	313	494	394	12 422
1961	465	356	277	295	223	509	258	420	258	191	327	495	339	10 705
1962	470	398	287	438	309	315	387	380	242	203	327	556	359	11 343
1963	446	357	353	616	447	363	542	477	315	359	352	481	426	13 458
1964	464	378	258	290	448	821	855	302	285	528	442	525	467	14 741
1965	482	372	322	828	689	1 124	1 729	885	520	749	525	577	736	23 230
1966	528	404	451	605	430	430	718	629	359	454	389	538	496	15 652
1967	477	384	329	362	763	1 092	914	496	265	352	390	492	528	16 648
1968	436	364	384	357	191	255	375	436	294	436	448	499	373	11 786
1969	456	382	314	821	773	497	1 136	696	303	441	397	516	563	17 767
1970	444	362	304	625	411	658	541	290	209	208	336	463	404	12 749
1971	452	392	291	821	804	747	562	495	240	297	354	481	495	15 618
1972	433	341	399	698	617	875	1 124	623	230	440	416	486	558	17 618
1973	479	367	345	508	552	504	477	322	258	284	356	528	415	13 111
1974	455	406	321	1 001	1 414	1 391	1 073	602	296	433	400	514	693	21 883
1975	430	350	262	339	606	507	583	304	176	317	332	484	392	12 362
1976	460	380	366	432	327	174	265	446	354	407	344	472	369	11 657
1977	429	360	277	295	393	447	246	281	287	247	236	218	309	9 759
1978	243	365	328	517	436	540	761	452	477	513	413	528	465	14 670
1979	421	324	373	522	678	313	279	251	201	186	233	336	344	10 844
1980	410	325	244	551	495	736	563	301	315	381	446	545	443	13 972
1981	507	432	361	351	727	559	732	955	346	399	409	508	526	16 589
1982	407	332	246	334	466	352	892	458	295	432	376	505	426	13 449
1983	459	372	320	395	384	229	451	264	189	170	240	375	321	10 129
1984	419	371	278	388	251	299	238	187	203	234	244	242	279	8 799
1985	269	321	313	848	433	258	219	221	297	280	248	523	352	11 111
1986	492	383	446	482	461	462	873	557	346	733	502	565	527	16 634
AVERAGE	453	373	324	516	536	581	667	476	348	377	377	483	460	14 512

TABLE C20
CURRENT CONDITIONS FLOWS (1986)
SASKATCHEWAN RIVER
AT THE MANITOBA BORDER
MEAN MONTHLY FLOWS (m3/s)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	VOLUME Kdam³
1912	472	396	375	635	563	526	1 420	1 362	1 018	770	597	599	731	23 054
1913	535	422	352	1 010	816	840	1 162	1 161	741	658	529	596	737	23 263
1914	509	389	328	350	638	946	946	517	395	503	565	604	559	17 631
1915	500	389	378	445	555	962	2 560	1 536	824	698	553	577	836	26 384
1916	535	438	424	699	565	1 292	2 333	1 555	1 375	966	773	634	969	30 576
1917	590	498	347	736	1 435	1 695	1 376	812	449	582	546	552	803	25 343
1918	530	438	480	716	455	544	646	514	407	381	418	547	507	15 987
1919	485	389	275	398	358	295	321	446	421	295	261	399	362	11 422
1920	473	394	323	510	1 313	861	1 146	794	328	391	418	526	626	19 751
1921	475	387	304	733	1 059	833	742	621	425	319	424	552	574	18 109
1922	486	362	286	397	728	721	664	640	566	396	414	513	515	16 263
1923	452	345	256	321	353	1 398	1 581	1 091	600	556	455	577	667	21 062
1924	464	384	292	281	478	401	468	485	431	425	394	550	422	13 313
1925	497	386	360	925	874	577	593	711	691	761	552	607	629	19 852
1926	558	414	421	570	410	279	464	344	802	721	715	610	526	16 594
1927	571	453	389	814	1 105	1 291	1 589	1 213	1 020	862	687	618	887	27 988
1928	588	561	564	715	661	983	1 551	870	373	472	425	540	694	21 892
1929	470	356	317	285	302	711	218	227	196	207	233	433	329	10 384
1930	458	415	357	423	351	412	484	405	305	235	246	500	383	12 078
1931	474	371	281	332	274	311	674	490	395	298	303	271	373	11 778
1932	254	279	310	519	784	1 228	698	505	449	430	431	559	538	16 972
1933	515	402	302	468	974	736	714	472	433	327	457	585	533	16 824
1934	551	470	450	816	994	803	675	495	384	321	361	564	574	18 121
1935	487	398	317	353	579	555	883	722	384	271	364	532	488	15 414
1936	464	354	298	784	911	617	349	321	287	215	254	250	425	13 418
1937	259	321	244	306	285	265	435	354	239	252	294	303	296	9 354
1938	475	352	316	424	353	451	793	438	424	423	410	523	449	14 182
1939	476	360	324	405	310	308	577	391	283	235	287	458	368	11 625
1940	461	355	293	607	706	368	300	287	283	259	271	254	370	11 689
1941	444	356	315	333	175	156	212	235	230	212	269	227	263	8 301
1942	218	216	249	337	395	763	1 086	936	581	593	455	572	536	16 910
1943	503	399	380	1 127	950	435	861	572	337	340	393	507	568	17 931
1944	463	363	270	437	310	1 077	878	639	501	336	299	255	486	15 326
1945	297	387	352	346	402	617	711	452	376	570	465	596	465	14 673

1946	526	414	392	557	342	695	688	377	329	471	431	555	482	15 202
1947	519	414	516	870	908	583	626	432	395	677	563	606	594	18 731
1948	546	395	329	686	2 469	2 297	1 025	876	379	393	379	507	859	27 119
1949	485	371	285	472	313	312	299	391	276	220	282	249	329	10 388
1950	355	362	283	484	356	533	911	517	312	348	382	513	447	14 113
1951	481	374	283	919	1 130	1 040	1 512	900	1 036	867	654	611	819	25 861
1952	567	555	438	1 472	1 046	981	1 137	777	391	482	461	539	738	23 276
1953	472	395	332	449	812	1 641	1 430	878	533	466	444	549	702	22 140
1954	493	422	337	461	1 042	1 495	1 481	1 306	1 755	1 081	772	733	950	29 986
1955	617	488	365	1 080	1 238	1 256	1 130	610	351	432	402	539	710	22 408
1956	507	409	394	951	1 234	937	848	612	397	457	448	554	647	20 421
1957	495	381	357	526	1 079	628	360	310	315	304	400	595	480	15 144
1958	498	392	321	922	860	660	826	503	341	375	427	532	556	17 534
1959	478	372	347	431	324	595	899	529	320	584	492	586	498	15 704
1960	530	413	443	824	472	387	653	419	231	248	335	510	456	14 383
1961	473	363	285	327	261	576	304	454	278	203	336	499	363	11 457
1962	483	413	306	480	428	403	479	456	284	215	338	567	404	12 762
1963	460	370	367	730	588	496	733	637	415	429	400	505	512	16 155
1964	486	408	287	362	558	945	1 054	396	349	601	495	546	542	17 095
1965	520	409	363	949	946	1 412	2 152	1 223	700	907	631	635	908	28 640
1966	599	451	525	786	674	687	1 031	866	472	524	434	567	637	20 088
1967	503	429	375	396	878	1 216	1 031	572	313	388	414	509	587	18 511
1968	509	400	431	456	278	331	465	526	375	495	510	542	444	14 009
1969	496	427	355	910	878	561	1 254	784	357	490	428	542	626	19 742
1970	528	466	382	713	644	811	768	466	307	287	417	529	527	16 616
1971	526	480	372	945	986	881	696	617	304	352	421	532	593	18 716
1972	489	390	459	781	808	1 006	1 285	749	297	504	459	517	647	20 427
1973	598	500	474	672	805	796	722	466	396	401	433	621	574	18 124
1974	563	534	465	1 232	1 972	1 834	1 403	825	493	602	530	617	924	29 164
1975	541	493	400	480	887	768	818	436	276	419	432	560	543	17 146
1976	524	464	456	555	406	232	338	520	429	480	388	518	443	13 977
1977	507	447	335	384	471	544	310	338	358	305	277	262	378	11 915
1978	278	404	368	574	558	632	850	511	541	590	458	566	528	16 668
1979	517	432	493	637	1 011	548	390	329	272	251	295	387	464	14 648
1980	440	378	297	627	558	809	646	345	353	432	489	569	495	15 630
1981	538	468	393	409	769	624	786	1 036	397	437	441	526	571	18 007
1982	435	368	279	379	533	397	941	496	322	462	400	525	463	14 614
1983	555	487	427	518	616	381	626	374	277	269	335	438	442	13 957
1984	518	486	386	646	455	509	395	288	311	353	334	324	416	13 130
1985	358	419	428	1 144	862	533	403	353	431	406	346	620	525	16 569
1986	561	446	521	612	589	586	995	711	427	834	578	631	626	19 770
AVERAGE	487	409	362	618	713	758	864	624	454	458	432	518	559	17 645

APPENDIX D
EVAPORATION AND PRECIPITATION DATA

TABLE D1
GROSS EVAPORATION
SWIFT CURRENT
MONTHLY (mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
1912	0	0	23	89	155	170	157	127	78	28	0	0	826
1913	0	0	28	79	125	163	181	165	96	23	0	0	858
1914	0	0	28	109	163	196	207	161	84	16	0	0	966
1915	0	0	36	116	160	151	150	118	63	24	0	0	817
1916	0	0	32	100	147	160	155	129	77	22	0	0	822
1917	0	0	19	93	159	191	186	128	76	28	0	0	879
1918	0	0	15	81	163	199	197	156	86	24	0	0	921
1919	0	0	20	92	163	214	228	168	90	26	0	0	1000
1920	0	0	28	119	181	181	193	170	99	31	0	0	1001
1921	0	0	26	102	171	208	215	167	97	32	0	0	1017
1922	0	0	27	106	180	196	196	188	123	35	0	0	1051
1923	0	0	23	107	173	177	164	154	122	45	0	0	965
1924	0	0	35	124	180	235	236	157	97	33	0	0	1097
1925	0	0	25	98	163	196	205	149	77	26	0	0	939
1926	0	0	29	113	184	210	204	148	85	32	0	0	1004
1927	0	0	25	107	167	174	174	145	83	22	0	0	898
1928	0	0	39	124	181	194	202	162	83	25	0	0	1008
1929	0	0	33	118	205	259	268	183	83	28	0	0	1178
1930	0	0	42	137	214	229	215	167	87	24	0	0	1115
1931	0	0	36	126	169	204	222	160	102	40	0	0	1060
1932	0	0	27	99	172	203	200	148	77	25	0	0	949
1933	0	0	31	101	165	228	246	175	96	32	0	0	1073
1934	0	0	35	131	180	193	208	162	90	26	0	0	1025
1935	0	0	31	99	154	186	201	181	120	39	0	0	1011
1936	0	0	30	119	186	233	251	190	120	43	0	0	1173
1937	0	0	38	129	210	241	250	207	121	41	0	0	1237
1938	0	0	30	112	174	198	209	182	108	29	0	0	1041
1939	0	0	34	109	145	176	218	186	106	47	14	0	1037
1940	0	0	20	99	165	181	222	194	96	30	0	0	1007
1941	0	0	28	107	181	203	194	147	89	35	0	0	984
1942	0	0	33	96	141	159	158	131	88	33	0	0	839
1943	0	0	41	105	133	191	239	196	114	36	0	0	1056
1944	0	0	26	98	137	164	186	150	107	44	0	0	911
1945	0	0	24	88	144	201	228	168	96	35	0	0	984
1946	0	0	36	103	150	184	194	150	84	26	0	0	926

1947	0	0	22	91	138	196	221	159	94	29	0	0	950
1948	0	0	19	85	136	163	186	169	119	42	0	0	918
1949	0	0	39	109	151	180	210	191	110	46	14	0	1051
1950	0	0	23	95	154	172	163	137	91	28	0	0	864
1951	0	0	24	101	151	169	180	142	78	22	0	0	866
1952	0	0	34	106	161	185	197	167	109	44	0	0	1002
1953	0	0	25	91	139	177	217	190	123	46	0	0	1007
1954	0	0	26	96	153	190	185	133	91	49	13	0	937
1955	0	0	24	93	158	173	193	180	113	43	0	0	977
1956	0	0	28	104	178	192	181	158	103	37	0	0	982
1957	0	0	27	104	154	183	193	158	98	28	0	0	944
1958	0	0	26	110	172	190	219	191	111	38	0	0	1056
1959	0	0	38	110	176	212	220	186	102	27	0	0	1070
1960	0	0	35	113	176	213	216	190	131	42	0	0	1115
1961	0	0	31	105	194	239	249	204	111	36	0	0	1170
1962	0	0	40	112	167	202	214	190	121	38	0	0	1082
1963	0	0	30	103	158	195	214	182	136	57	0	0	1076
1964	0	0	36	129	181	224	257	190	123	54	0	0	1193
1965	0	0	22	106	165	177	193	151	101	48	0	0	964
1966	0	0	30	126	186	200	216	188	124	43	0	0	1113
1967	0	0	24	105	181	243	264	220	135	37	0	0	1210
1968	0	0	44	134	189	222	220	161	103	38	0	0	1111
1969	0	0	29	108	177	197	233	211	101	25	0	0	1081
1970	0	0	26	95	172	199	214	194	112	37	0	0	1049
1971	0	0	31	131	188	199	256	225	120	40	0	0	1191
1972	0	0	42	113	168	187	196	169	98	35	0	0	1009
1973	0	0	23	99	180	228	249	195	112	43	0	0	1129
1974	0	0	25	89	173	225	198	147	112	47	0	0	1017
1975	0	0	19	81	143	191	190	147	98	32	0	0	900
1976	0	0	33	131	176	181	213	194	120	37	0	0	1084
1977	0	0	48	121	172	204	194	143	97	44	0	0	1022
1978	0	0	27	99	160	192	210	183	118	42	0	0	1030
1979	0	0	22	89	164	199	198	176	121	41	0	0	1011
1980	0	0	52	146	183	189	191	163	109	37	0	0	1070
1981	0	0	45	125	161	179	199	186	114	29	0	0	1038
1982	0	0	35	100	144	166	182	163	101	33	0	0	924
1983	0	0	30	98	170	209	234	205	116	38	0	0	1101
1984	0	0	46	133	180	225	271	197	92	35	0	0	1181
1985	0	0	36	125	189	231	237	167	101	40	0	0	1126
1986	0	0	35	109	172	197	205	160	89	35	0	0	1001
AVERAGE	0	0	30	107	167	197	208	170	102	35	1	0	1017

TABLE D2
GROSS EVAPORATION
SASKATOON
MONTHLY (mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
1912	0	0	28	109	172	156	135	115	71	25	0	0	809
1913	0	0	27	91	144	180	178	138	81	21	0	0	860
1914	0	0	21	78	133	183	200	150	80	21	0	0	865
1915	0	0	24	85	137	152	162	127	70	29	0	0	784
1916	0	0	15	73	138	160	149	119	72	22	0	0	747
1917	0	0	18	78	138	185	190	135	80	30	3	0	856
1918	0	0	26	92	163	185	166	133	84	29	0	0	876
1919	0	0	22	94	182	218	199	147	80	24	0	0	965
1920	0	0	0	80	164	192	203	150	83	27	0	0	898
1921	0	0	24	86	134	157	167	128	66	19	0	0	781
1922	0	0	19	74	128	169	174	135	80	21	0	0	799
1923	0	0	24	98	133	127	130	113	77	28	0	0	730
1924	0	0	25	93	147	186	182	130	78	23	0	0	865
1925	0	0	26	100	137	145	167	135	70	21	0	0	801
1926	0	0	32	92	143	170	166	121	66	24	0	0	814
1927	0	0	23	85	133	145	140	117	72	21	0	0	736
1928	0	0	28	111	149	139	153	139	75	16	0	0	810
1929	0	0	16	65	128	173	181	130	66	23	0	0	781
1930	0	0	15	78	127	139	146	112	61	20	0	0	698
1931	0	0	31	97	147	163	151	105	56	20	0	0	770
1932	0	0	22	88	132	146	152	121	67	19	0	0	746
1933	0	0	26	93	160	203	206	147	76	25	0	0	936
1934	0	0	37	131	162	169	191	141	78	28	0	0	935
1935	0	0	30	107	165	201	214	168	100	32	0	0	1017
1936	0	0	29	138	203	233	253	182	101	33	0	0	1173
1937	0	0	36	132	231	279	260	184	97	28	0	0	1246
1938	0	0	27	105	171	198	197	157	91	25	0	0	972
1939	0	0	35	114	153	192	236	182	95	32	0	0	1039
1940	0	0	30	119	182	187	216	179	88	30	0	0	1031
1941	0	0	28	81	128	149	144	118	69	22	0	0	739
1942	0	0	24	85	131	136	132	108	69	27	0	0	713
1943	0	0	28	83	125	154	167	138	76	20	0	0	791
1944	0	0	20	68	109	132	155	136	80	26	0	0	726
1945	0	0	19	80	133	158	165	134	83	27	0	0	799
1946	0	0	36	101	148	185	189	138	74	22	0	0	893

1947	0	0	23	90	149	202	207	140	86	31	0	0	928
1948	0	0	17	88	145	172	192	166	110	37	0	0	926
1949	0	0	35	113	165	175	173	151	93	28	0	0	932
1950	0	0	22	88	152	164	151	132	83	24	0	0	817
1951	0	0	22	89	145	158	157	124	68	20	0	0	782
1952	0	0	34	100	143	165	177	142	85	32	0	0	877
1953	0	0	24	82	137	171	180	149	97	36	0	0	876
1954	0	0	22	87	136	154	141	106	78	31	0	0	755
1955	0	0	20	88	156	173	176	151	89	29	0	0	881
1956	0	0	19	85	156	164	147	128	84	28	0	0	811
1957	0	0	23	94	137	167	171	124	77	24	0	0	817
1958	0	0	25	99	159	174	182	155	91	30	0	0	915
1959	0	0	33	107	160	191	188	138	76	21	0	0	915
1960	0	0	27	96	152	179	186	162	104	32	0	0	937
1961	0	0	27	101	175	207	217	172	89	29	0	0	1016
1962	0	0	25	90	153	178	173	140	84	28	0	0	870
1963	0	0	22	79	122	140	142	118	80	30	0	0	732
1964	0	0	27	97	152	175	185	135	68	23	0	0	861
1965	0	0	22	108	174	176	186	148	89	38	0	0	941
1966	0	0	26	115	164	159	169	152	100	33	0	0	917
1967	0	0	22	103	172	225	252	217	123	24	0	0	1137
1968	0	0	33	112	173	184	162	119	71	23	0	0	876
1969	0	0	26	98	156	169	187	162	81	21	0	0	901
1970	0	0	22	90	150	166	184	164	95	31	0	0	902
1971	0	0	28	117	165	168	192	166	103	37	0	0	977
1972	0	0	39	108	174	187	177	160	102	37	0	0	985
1973	0	0	30	104	159	191	212	173	102	36	0	0	1006
1974	0	0	24	89	159	202	193	146	97	36	0	0	947
1975	0	0	23	87	141	173	183	152	96	30	0	0	886
1976	0	0	31	125	167	166	193	170	102	33	0	0	988
1977	0	0	43	115	169	200	180	123	82	37	0	0	948
1978	0	0	33	105	161	180	177	139	85	32	0	0	912
1979	0	0	22	89	151	185	204	183	111	31	0	0	976
1980	0	0	40	126	183	202	187	141	93	34	0	0	1005
1981	0	0	31	113	163	171	182	163	98	28	0	0	948
1982	0	0	30	97	143	166	170	144	93	29	0	0	872
1983	0	0	26	89	151	175	183	160	93	30	0	0	907
1984	0	0	37	118	169	212	235	165	82	29	0	0	1048
1985	0	0	29	96	151	182	186	143	90	34	0	0	911
1986	0	0	33	108	159	170	175	139	75	26	0	0	884
AVERAGE	0	0	26	97	153	175	180	144	84	27	0	0	887

TABLE D3
GROSS EVAPORATION
PRINCE ALBERT
MONTHLY (mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
1912	0	0	17	78	120	105	92	81	52	16	0	0	559
1913	0	0	16	67	110	139	144	114	66	16	0	0	673
1914	0	0	11	54	89	94	94	80	46	12	0	0	482
1915	0	0	10	48	78	90	104	86	51	18	0	0	485
1916	0	0	11	48	81	98	102	88	60	20	0	0	509
1917	0	0	12	75	136	161	155	110	62	19	1	0	731
1918	0	0	23	75	119	138	129	99	60	19	0	0	663
1919	0	0	18	81	127	112	93	77	48	16	0	0	572
1920	0	0	16	79	136	146	130	109	81	29	0	0	725
1921	0	0	12	78	131	135	137	116	77	28	0	0	715
1922	0	0	13	63	117	147	137	98	63	22	0	0	660
1923	0	0	15	73	110	110	108	91	58	16	0	0	581
1924	0	0	12	65	114	128	127	98	59	20	0	0	623
1925	0	0	16	69	98	101	104	85	53	16	0	0	542
1926	0	0	16	68	122	132	115	90	50	12	0	0	604
1927	0	0	14	61	94	105	114	95	51	12	0	0	546
1928	0	0	13	60	93	97	96	82	53	15	0	0	508
1929	0	0	12	59	107	134	134	95	48	14	0	0	602
1930	0	0	10	59	102	112	114	89	47	14	0	0	548
1931	0	0	16	79	130	146	140	97	54	20	0	0	682
1932	0	0	11	57	99	105	105	98	60	16	0	0	551
1933	0	0	14	53	85	106	116	90	50	15	0	0	529
1934	0	0	23	83	113	130	153	115	66	27	0	0	710
1935	0	0	21	66	95	114	125	93	53	21	0	0	588
1936	0	0	23	79	115	129	133	104	67	26	0	0	675
1937	0	0	13	68	130	163	166	120	61	18	0	0	739
1938	0	0	22	78	119	137	139	105	59	19	0	0	677
1939	0	0	16	69	109	129	149	123	68	21	0	0	684
1940	0	0	22	87	126	134	156	125	61	20	0	0	730
1941	0	0	19	75	117	141	143	102	57	19	0	0	672
1942	0	0	12	65	108	114	111	82	51	20	0	0	563
1943	0	0	24	79	124	143	147	120	69	20	0	0	725
1944	0	0	24	82	117	121	127	104	58	19	0	0	652
1945	0	0	20	74	108	136	144	102	57	18	0	0	658
1946	0	0	24	71	99	115	121	92	52	18	0	0	592

1947	0	0	15	60	102	130	132	100	58	18	0	0	615
1948	0	0	0	47	101	120	115	97	72	24	0	0	576
1949	0	0	26	87	126	135	134	106	63	22	0	0	698
1950	0	0	19	72	115	120	117	105	64	18	0	0	630
1951	0	0	19	71	113	127	128	108	65	19	0	0	649
1952	0	0	32	96	137	163	174	128	72	29	0	0	830
1953	0	0	20	73	116	141	149	116	73	27	0	0	715
1954	0	0	0	56	117	131	125	95	64	24	0	0	611
1955	0	0	18	80	133	141	145	128	79	25	0	0	749
1956	0	0	18	80	139	143	134	113	70	26	0	0	722
1957	0	0	22	81	123	150	150	109	67	22	0	0	724
1958	0	0	21	83	136	149	150	125	73	22	0	0	759
1959	0	0	27	90	127	149	153	113	64	19	0	0	741
1960	0	0	23	79	126	146	146	126	79	23	0	0	749
1961	0	0	23	88	146	166	171	134	72	25	0	0	824
1962	0	0	20	79	134	164	171	136	80	25	0	0	810
1963	0	0	22	86	133	138	123	94	61	22	0	0	678
1964	0	0	22	89	144	162	154	113	65	21	0	0	770
1965	0	0	21	88	138	142	142	112	69	27	0	0	738
1966	0	0	22	90	127	125	132	114	73	25	0	0	708
1967	0	0	19	81	139	156	151	133	81	21	0	0	781
1968	0	0	25	90	140	152	139	106	64	20	0	0	737
1969	0	0	29	101	156	171	175	141	75	22	0	0	870
1970	0	0	27	100	154	163	169	142	85	29	0	0	869
1971	0	0	29	109	154	158	164	140	90	30	0	0	873
1972	0	0	32	99	164	177	159	132	86	33	0	0	882
1973	0	0	27	89	127	136	141	118	72	22	0	0	731
1974	0	0	22	73	122	148	138	105	72	28	0	0	709
1975	0	0	22	79	124	145	150	120	73	24	0	0	735
1976	0	0	28	105	140	141	154	134	86	29	0	0	815
1977	0	0	35	101	141	154	143	100	62	27	0	0	765
1978	0	0	22	80	123	138	135	106	68	25	0	0	697
1979	0	0	20	74	121	146	146	117	73	23	0	0	721
1980	0	0	33	113	163	169	155	115	73	27	0	0	848
1981	0	0	28	98	152	167	159	130	80	23	0	0	836
1982	0	0	25	82	126	147	144	116	72	23	0	0	736
1983	0	0	19	77	127	147	152	121	70	23	0	0	736
1984	0	0	28	89	134	157	159	117	66	23	0	0	774
1985	0	0	25	80	119	133	129	107	71	25	0	0	689
1986	0	0	26	92	137	141	137	110	66	24	0	0	731
AVERAGE	0	0	20	77	122	136	137	108	65	22	0	0	688

TABLE D4
PRECIPITATION
LAKE DIEFENBAKER
MONTHLY (mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
1912	0	3	7	41	64	59	67	56	28	8	0	0	332
1913	0	11	16	19	48	59	54	37	14	6	0	0	263
1914	0	6	13	13	33	35	15	31	57	34	0	0	238
1915	0	0	4	46	75	55	32	25	24	8	0	0	270
1916	0	11	19	29	68	102	81	44	37	19	0	0	409
1917	0	6	17	15	28	31	25	34	27	11	0	0	195
1918	0	8	18	22	24	23	37	34	19	12	0	0	197
1919	0	5	21	34	30	26	52	50	21	10	0	0	248
1920	0	6	16	33	47	49	51	37	25	14	0	0	279
1921	0	8	19	33	43	50	51	73	62	11	0	0	349
1922	0	2	14	48	62	40	43	34	9	4	0	0	256
1923	0	3	11	34	90	96	56	25	6	4	0	0	326
1924	0	6	13	25	39	40	49	38	40	33	0	0	282
1925	0	5	24	31	46	51	34	44	36	9	0	0	281
1926	0	4	6	30	42	29	37	42	22	4	0	0	217
1927	0	11	26	77	81	62	62	42	44	20	0	0	425
1928	0	9	18	18	65	80	32	11	12	8	0	0	253
1929	0	8	17	28	47	37	15	18	16	3	0	0	189
1930	0	2	18	28	47	51	26	33	39	15	0	0	257
1931	0	6	9	11	37	44	34	44	29	5	0	0	218
1932	0	5	15	21	44	72	69	37	17	11	0	0	292
1933	0	3	11	30	44	28	30	52	37	8	0	0	243
1934	0	3	6	8	56	58	18	27	18	2	0	0	195
1935	0	6	22	34	56	66	50	25	11	8	0	0	278
1936	0	10	14	25	53	47	30	23	13	5	0	0	221
1937	0	2	5	20	23	28	30	16	13	6	0	0	143
1938	0	8	14	30	49	40	30	37	35	13	0	0	256
1939	0	5	10	36	108	95	23	10	14	10	0	0	310
1940	0	6	21	25	38	57	32	16	22	9	0	0	227
1941	0	4	13	30	51	54	50	36	12	2	0	0	251
1942	0	4	35	40	93	109	52	47	30	9	0	0	419
1943	0	6	8	38	49	26	31	29	36	26	0	0	247
1944	0	14	18	46	75	62	46	24	10	4	0	0	298
1945	0	10	23	24	35	31	25	51	40	7	0	0	246
1946	0	2	8	15	41	53	46	43	35	16	0	0	260

1947	0	3	15	25	54	54	42	54	30	4	0	0	280
1948	0	7	32	31	19	44	41	12	3	1	0	0	189
1949	0	3	6	17	44	52	33	21	24	14	0	0	215
1950	0	6	19	28	36	57	54	30	24	13	0	0	268
1951	0	13	31	27	71	73	63	82	51	22	0	0	432
1952	0	12	13	22	56	53	42	37	14	1	0	0	250
1953	0	19	39	52	77	72	41	38	27	3	0	0	367
1954	0	5	16	40	67	71	83	82	37	5	0	0	406
1955	0	7	41	67	59	74	50	15	16	3	0	0	331
1956	0	6	12	17	43	64	41	17	22	16	0	0	238
1957	0	5	22	22	30	55	51	27	25	19	0	0	256
1958	0	2	12	15	18	37	41	35	20	2	0	0	182
1959	0	2	10	21	78	80	23	39	55	24	0	0	332
1960	0	6	17	25	53	50	32	21	3	3	0	0	210
1961	0	1	19	36	38	30	11	3	17	14	0	0	169
1962	0	5	8	20	51	62	58	46	25	8	0	0	283
1963	0	3	10	26	76	72	47	45	18	3	0	0	301
1964	0	4	15	29	39	31	27	53	39	3	0	0	239
1965	0	6	18	35	77	72	40	49	27	0	0	0	323
1966	0	2	20	26	60	78	51	30	7	3	0	0	277
1967	0	19	28	16	16	14	17	40	41	13	0	0	201
1968	0	5	8	20	29	28	50	62	36	8	0	0	245
1969	0	10	21	23	27	67	54	21	55	38	0	0	316
1970	0	6	19	26	80	88	26	14	19	8	0	0	288
1971	0	4	10	15	53	68	32	16	10	3	0	0	212
1972	0	2	5	28	43	38	30	29	22	3	0	0	201
1973	0	4	29	36	29	29	26	25	11	3	0	0	190
1974	0	9	23	55	57	37	69	58	13	3	0	0	325
1975	0	11	32	38	54	58	42	36	25	10	0	0	306
1976	0	17	24	13	73	94	45	20	5	1	0	0	293
1977	0	7	9	55	67	43	40	23	16	3	0	0	263
1978	0	1	20	43	50	44	27	33	29	6	0	0	253
1979	0	2	17	32	40	42	27	16	23	15	0	0	215
1980	0	3	11	15	42	60	47	30	19	10	0	0	236
1981	0	3	10	22	64	81	45	23	27	15	0	0	290
1982	0	10	20	63	69	64	66	33	22	8	0	0	355
1983	0	8	22	35	36	69	68	31	21	4	0	0	294
1984	0	7	15	21	45	52	29	41	50	17	0	0	279
1985	0	11	23	30	30	26	32	33	23	8	0	0	217
1986	0	9	14	47	63	61	51	56	53	9	0	0	362
AVERAGE	0	6	17	30	51	54	41	35	25	10	0	0	270

TABLE D5
PRECIPITATION
DUNDURN RESERVOIR
MONTHLY (mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
1912	0	8	9	37	77	78	65	66	41	3	0	0	384
1913	0	3	7	9	43	65	57	57	33	6	0	0	280
1914	0	6	12	25	45	36	18	24	48	31	0	0	245
1915	0	0	2	18	41	50	40	29	21	6	0	0	208
1916	0	12	21	42	62	89	84	38	29	13	0	0	389
1917	0	7	17	13	29	43	40	38	23	7	0	0	218
1918	0	9	30	35	49	77	65	26	8	6	0	0	304
1919	0	13	27	16	29	44	45	56	37	8	0	0	274
1920	0	20	26	25	35	43	60	53	40	18	0	0	321
1921	0	19	42	51	77	92	49	60	59	5	0	0	454
1922	0	10	15	36	44	19	50	50	15	9	0	0	247
1923	0	11	20	33	95	142	97	33	11	3	0	0	445
1924	0	9	20	21	25	22	37	41	35	24	0	0	233
1925	0	12	30	24	80	91	40	45	40	18	0	0	378
1926	0	5	23	57	60	39	39	36	27	12	0	0	298
1927	0	30	43	50	63	86	72	46	47	14	0	0	451
1928	0	9	14	10	67	118	73	18	12	11	0	0	332
1929	0	9	22	33	53	46	15	16	15	2	0	0	211
1930	0	5	15	27	48	50	29	44	56	22	0	0	296
1931	0	7	10	17	56	57	23	48	46	7	0	0	271
1932	0	6	16	17	49	58	40	33	13	4	0	0	235
1933	0	13	20	25	34	37	43	51	45	17	0	0	285
1934	0	5	13	12	54	62	26	30	17	1	0	0	219
1935	0	5	17	22	57	83	56	27	29	22	0	0	318
1936	0	4	11	33	61	41	16	13	13	11	0	0	202
1937	0	1	7	25	25	22	33	31	23	8	0	0	175
1938	0	13	21	26	43	47	37	42	41	14	0	0	283
1939	0	10	14	11	95	106	24	11	16	9	0	0	296
1940	0	8	11	19	47	77	57	20	23	12	0	0	275
1941	0	5	10	24	40	32	28	25	15	7	0	0	185
1942	0	8	40	37	90	114	54	45	22	2	0	0	414
1943	0	6	7	35	40	28	35	21	36	28	0	0	236
1944	0	10	15	52	72	67	49	14	10	4	0	0	293
1945	0	5	26	31	31	34	44	56	25	1	0	0	254
1946	0	4	6	11	36	48	46	54	38	8	0	0	252

1947	0	4	14	23	42	39	40	63	37	5	0	0	268
1948	0	9	19	14	22	30	30	21	4	0	0	0	149
1949	0	6	12	17	49	60	53	38	16	8	0	0	260
1950	0	3	18	28	42	76	66	27	22	15	0	0	297
1951	0	22	37	28	39	59	68	57	30	9	0	0	349
1952	0	11	12	18	50	52	30	20	11	2	0	0	207
1953	0	22	32	45	50	71	73	46	31	3	0	0	372
1954	0	5	28	50	74	75	91	83	25	6	0	0	436
1955	0	11	53	72	43	39	33	30	27	5	0	0	312
1956	0	24	28	7	32	58	53	29	17	12	0	0	259
1957	0	6	21	21	29	41	53	48	26	13	0	0	258
1958	0	6	18	17	11	64	64	39	35	2	0	0	255
1959	0	4	8	12	49	49	20	67	79	24	0	0	313
1960	0	5	12	27	60	49	23	16	4	3	0	0	200
1961	0	3	15	33	40	38	21	9	24	16	0	0	199
1962	0	11	15	15	30	59	83	61	23	4	0	0	301
1963	0	4	18	37	64	72	66	54	21	2	0	0	340
1964	0	4	11	30	32	31	41	48	36	6	0	0	239
1965	0	2	8	22	77	78	31	35	20	0	0	0	273
1966	0	10	21	19	68	81	46	31	8	2	0	0	284
1967	0	23	28	15	28	30	28	37	40	19	0	0	249
1968	0	13	25	39	44	62	95	73	34	10	0	0	395
1969	0	8	11	25	32	39	35	32	69	43	0	0	295
1970	0	11	22	20	66	136	88	12	12	10	0	0	376
1971	0	9	15	10	57	129	84	15	12	6	0	0	338
1972	0	6	9	18	38	48	37	20	11	4	0	0	192
1973	0	4	28	37	60	63	32	34	22	5	0	0	285
1974	0	27	38	57	87	74	62	40	16	4	0	0	404
1975	0	4	24	39	64	63	39	32	23	11	0	0	299
1976	0	11	22	20	65	87	36	15	11	1	0	0	268
1977	0	6	10	69	75	24	25	35	26	3	0	0	274
1978	0	1	17	30	32	42	40	47	41	10	0	0	261
1979	0	8	33	49	74	71	30	18	29	20	0	0	332
1980	0	9	12	13	28	36	51	49	24	9	0	0	231
1981	0	9	25	21	52	67	29	20	30	19	0	0	271
1982	0	8	13	47	66	74	89	77	39	3	0	0	416
1983	0	12	32	47	62	98	79	46	34	3	0	0	412
1984	0	6	12	18	40	35	14	38	60	28	0	0	250
1985	0	3	32	63	43	39	40	31	23	2	0	0	276
1986	0	11	15	34	59	88	72	42	34	4	0	0	359
AVERAGE	0	9	19	29	51	61	48	38	28	10	0	0	292

TABLE D6
PRECIPITATION
ST. LOUIS RESERVOIR
MONTHLY (mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
1912	0	10	16	31	61	103	98	62	36	5	0	0	421
1913	0	6	9	16	38	79	96	76	42	8	0	0	368
1914	0	7	20	41	54	42	28	25	32	19	0	0	269
1915	0	0	4	18	38	65	44	18	19	4	0	0	210
1916	0	11	23	56	74	78	74	37	28	17	0	0	398
1917	0	8	22	21	43	45	31	31	18	9	0	0	230
1918	0	8	28	37	39	47	45	25	9	5	0	0	242
1919	0	15	19	7	31	47	49	68	47	8	0	0	292
1920	0	14	20	24	49	53	49	50	37	14	0	0	309
1921	0	28	62	69	63	80	64	51	42	4	0	0	463
1922	0	12	23	53	69	33	47	54	29	14	0	0	335
1923	0	7	19	26	61	87	76	49	17	3	0	0	346
1924	0	4	14	15	23	31	61	67	41	23	0	0	280
1925	0	6	22	25	63	85	77	69	33	10	0	0	389
1926	0	3	14	52	46	28	47	45	38	18	0	0	291
1927	0	22	40	41	66	102	76	59	58	15	0	0	480
1928	0	6	10	13	35	63	50	17	11	8	0	0	211
1929	0	9	39	44	49	49	29	36	22	1	0	0	278
1930	0	17	24	22	58	69	35	50	79	37	0	0	391
1931	0	13	16	10	45	67	46	49	33	2	0	0	282
1932	0	18	29	24	71	108	82	39	16	8	0	0	397
1933	0	10	16	40	64	50	38	45	39	13	0	0	315
1934	0	12	22	20	82	90	28	24	15	2	0	0	295
1935	0	6	29	33	54	66	62	49	35	26	0	0	359
1936	0	5	11	16	44	44	18	39	42	13	0	0	233
1937	0	3	19	40	38	50	44	28	42	22	0	0	285
1938	0	14	24	26	22	39	64	51	45	24	0	0	308
1939	0	6	20	26	76	81	23	15	15	7	0	0	269
1940	0	4	5	27	61	50	21	19	35	23	0	0	244
1941	0	5	13	26	40	28	21	32	21	4	0	0	190
1942	0	15	50	55	111	136	72	38	16	5	0	0	497
1943	0	7	13	26	36	48	45	29	34	18	0	0	256
1944	0	5	15	35	40	72	79	29	10	4	0	0	289
1945	0	5	23	45	64	55	51	52	23	4	0	0	321
1946	0	6	16	32	29	48	71	51	36	16	0	0	304

1947	0	6	13	18	19	10	48	71	40	15	0	0	239
1948	0	7	27	40	50	56	70	53	12	3	0	0	317
1949	0	8	18	29	53	79	86	45	15	9	0	0	342
1950	0	1	15	32	47	80	74	33	31	21	0	0	334
1951	0	21	27	35	44	48	52	41	39	17	0	0	324
1952	0	6	7	34	65	75	80	53	22	6	0	0	349
1953	0	28	33	23	39	49	59	42	11	1	0	0	286
1954	0	5	26	55	69	88	128	100	34	9	0	0	513
1955	0	13	52	57	32	47	43	31	32	10	0	0	316
1956	0	17	21	10	36	57	44	33	21	4	0	0	241
1957	0	11	31	35	28	40	63	53	23	7	0	0	291
1958	0	8	28	32	22	46	45	37	35	7	0	0	260
1959	0	7	12	11	36	35	33	78	78	27	0	0	317
1960	0	12	19	33	76	64	37	28	11	7	0	0	287
1961	0	16	35	33	38	33	12	16	26	13	0	0	222
1962	0	8	18	16	28	78	79	26	12	10	0	0	274
1963	0	10	26	29	78	109	69	44	28	9	0	0	402
1964	0	5	7	13	14	20	51	64	41	10	0	0	225
1965	0	2	6	18	54	67	57	43	13	0	0	0	260
1966	0	13	18	10	66	93	68	44	12	3	0	0	326
1967	0	9	12	9	21	54	54	27	26	15	0	0	227
1968	0	7	13	48	59	73	98	70	42	14	0	0	424
1969	0	4	7	26	30	48	52	40	68	40	0	0	315
1970	0	20	34	17	65	94	47	21	20	13	0	0	331
1971	0	4	5	8	44	119	103	39	23	4	0	0	350
1972	0	12	23	17	26	44	36	30	21	3	0	0	213
1973	0	2	20	35	86	112	65	54	38	7	0	0	419
1974	0	10	12	47	79	74	119	108	31	2	0	0	482
1975	0	6	26	44	62	66	51	33	17	8	0	0	312
1976	0	7	10	25	61	83	57	14	7	5	0	0	269
1977	0	7	9	69	86	50	63	75	47	4	0	0	409
1978	0	5	21	36	75	82	50	46	43	20	0	0	378
1979	0	11	25	33	54	56	43	37	32	17	0	0	308
1980	0	10	10	19	57	53	60	65	27	7	0	0	309
1981	0	7	25	23	17	52	57	30	34	21	0	0	266
1982	0	5	10	30	40	55	132	104	19	7	0	0	401
1983	0	13	28	29	40	67	62	70	54	4	0	0	367
1984	0	9	19	56	89	62	55	74	65	27	0	0	455
1985	0	14	44	58	53	51	51	41	24	8	0	0	344
1986	0	16	24	40	44	65	78	42	19	1	0	0	328
AVERAGE	0	9	21	31	51	63	58	46	30	11	0	0	321

TABLE D7
PRECIPITATION
THE FORKS RESERVOIR
MONTHLY (mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
1912	0	12	15	40	73	105	108	84	50	6	0	0	493
1913	0	8	12	20	43	87	107	69	31	9	0	0	386
1914	0	8	18	31	41	35	25	27	33	16	0	0	234
1915	0	0	4	15	52	81	45	19	23	8	0	0	247
1916	0	13	27	84	101	81	72	41	40	21	0	0	482
1917	0	11	23	18	48	46	22	24	13	6	0	0	210
1918	0	11	24	40	53	43	52	41	13	8	0	0	285
1919	0	10	13	8	48	69	50	55	46	15	0	0	313
1920	0	17	20	19	37	32	39	46	34	17	0	0	260
1921	0	34	56	50	64	76	54	56	48	6	0	0	444
1922	0	20	29	43	64	37	40	48	33	17	0	0	332
1923	0	4	12	26	54	73	71	60	29	3	0	0	333
1924	0	4	23	21	26	39	48	50	34	17	0	0	263
1925	0	5	14	21	72	93	89	81	37	13	0	0	424
1926	0	2	8	52	54	43	67	70	64	26	0	0	386
1927	0	13	24	30	50	79	74	77	62	10	0	0	419
1928	0	4	10	17	30	38	37	20	10	8	0	0	173
1929	0	10	34	36	48	54	31	31	23	5	0	0	273
1930	0	10	22	30	67	71	31	65	88	32	0	0	416
1931	0	10	12	11	35	43	29	50	41	4	0	0	236
1932	0	10	24	24	87	138	98	49	30	19	0	0	481
1933	0	8	12	36	58	43	31	57	53	10	0	0	308
1934	0	9	20	21	68	75	33	29	16	2	0	0	273
1935	0	5	21	27	58	74	62	48	32	18	0	0	347
1936	0	6	14	19	39	34	19	36	35	10	0	0	213
1937	0	5	20	38	42	38	23	23	42	24	0	0	256
1938	0	6	14	20	22	40	60	39	37	28	0	0	266
1939	0	6	14	22	76	79	27	16	16	10	0	0	266
1940	0	7	8	22	64	57	26	19	25	18	0	0	246
1941	0	4	16	27	42	33	25	37	23	6	0	0	214
1942	0	13	43	44	106	137	67	37	21	6	0	0	475
1943	0	6	10	19	33	49	45	27	34	20	0	0	244
1944	0	5	13	33	48	79	94	48	18	7	0	0	346
1945	0	8	28	44	67	61	49	55	32	7	0	0	351
1946	0	4	14	28	39	62	70	43	29	16	0	0	304

1947	0	6	15	17	13	8	59	78	37	15	0	0	250
1948	0	6	25	31	36	51	68	46	7	4	0	0	274
1949	0	4	11	29	64	87	75	40	22	9	0	0	341
1950	0	1	14	31	45	78	80	36	29	23	0	0	337
1951	0	19	29	38	44	49	54	44	38	14	0	0	329
1952	0	4	5	37	71	78	63	36	22	5	0	0	322
1953	0	29	34	24	42	50	50	41	20	1	0	0	292
1954	0	5	28	52	77	100	112	91	51	18	0	0	533
1955	0	14	54	61	34	57	67	46	33	12	0	0	378
1956	0	21	24	18	56	68	44	32	21	6	0	0	291
1957	0	21	43	43	34	40	73	70	34	10	0	0	367
1958	0	10	29	31	27	47	45	39	41	14	0	0	283
1959	0	5	12	15	43	39	38	78	73	29	0	0	333
1960	0	13	21	44	85	63	45	39	16	9	0	0	335
1961	0	16	31	33	28	19	12	17	29	16	0	0	201
1962	0	11	21	16·	23	32	32	21	19	13	0	0	189
1963	0	16	30	23	54	94	67	36	32	14	0	0	366
1964	0	4	7	8	14	28	50	66	48	12	0	0	237
1965	0	2	5	27	67	69	48	42	21	2	0	0	285
1966	0	16	21	11	73	110	69	36	18	6	0	0	361
1967	0	8	11	12	29	55	46	26	31	15	0	0	235
1968	0	9	22	53	55	60	81	60	36	10	0	0	385
1969	0	5	10	21	36	63	65	44	63	41	0	0	348
1970	0	8	22	25	70	92	49	24	27	19	0	0	335
1971	0	8	8	7	63	140	106	41	26	7	0	0	406
1972	0	10	26	23	37	54	36	30	23	5	0	0	243
1973	0	2	28	51	122	140	75	65	45	12	0	0	540
1974	0	13	15	42	73	73	97	91	38	4	0	0	446
1975	0	3	31	56	69	67	56	48	30	12	0	0	373
1976	0	11	13	22	70	95	57	15	11	7	0	0	300
1977	0	7	9	54	76	54	75	87	47	4	0	0	415
1978	0	6	18	28	52	64	52	58	55	22	0	0	355
1979	0	15	28	48	63	50	42	39	37	18	0	0	341
1980	0	11	12	14	53	54	58	62	29	11	0	0	304
1981	0	3	22	24	34	69	52	32	46	26	0	0	307
1982	0	6	10	35	50	58	96	72	24	8	0	0	359
1983	0	13	29	29	53	82	57	58	48	6	0	0	374
1984	0	12	21	57	92	64	56	79	74	31	0	0	485
1985	0	13	42	69	79	65	49	38	25	10	0	0	390
1986	0	18	30	44	46	67	74	42	24	2	0	0	347
AVERAGE	0	10	21	31	54	65	57	47	34	13	0	0	331

TABLE D8
PRECIPITATION
CODETTE RECERVOIR
MEAN MONTHLY (mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
1912	0	12	15	27	50	96	101	84	60	6	0	0	450
1913	0	8	14	26	48	97	125	76	29	9	0	0	432
1914	0	8	20	28	36	48	39	30	39	19	0	0	266
1915	0	0	4	15	57	90	49	21	30	14	0	0	280
1916	0	13	22	92	116	122	114	48	40	18	0	0	585
1917	0	12	25	18	55	67	33	23	10	3	0	0	245
1918	0	11	24	45	59	53	67	47	18	11	0	0	335
1919	0	11	14	9	59	90	51	42	54	26	0	0	355
1920	0	18	22	20	28	25	39	43	32	17	0	0	243
1921	0	36	77	65	59	75	57	63	51	5	0	0	487
1922	0	21	26	40	77	59	43	40	28	14	0	0	346
1923	0	4	4	21	54	58	60	68	36	3	0	0	308
1924	0	4	32	29	37	47	36	46	44	23	0	0	298
1925	0	5	16	23	66	78	62	59	30	9	0	0	348
1926	0	3	8	58	66	40	56	77	76	29	0	0	412
1927	0	9	22	34	38	41	59	89	65	10	0	0	367
1928	0	5	16	18	32	46	42	23	7	4	0	0	193
1929	0	14	34	32	48	55	26	29	32	10	0	0	280
1930	0	10	16	29	81	90	38	55	75	26	0	0	420
1931	0	9	13	15	45	62	55	73	51	4	0	0	327
1932	0	11	29	31	87	132	103	61	41	25	0	0	518
1933	0	13	18	31	51	54	37	66	69	10	0	0	348
1934	0	16	25	23	68	75	34	27	17	4	0	0	287
1935	0	8	26	35	59	44	27	43	36	18	0	0	296
1936	0	10	19	20	42	44	33	44	34	9	0	0	254
1937	0	5	21	33	40	55	43	29	39	22	0	0	288
1938	0	6	19	24	30	47	68	51	35	24	0	0	305
1939	0	7	16	22	84	100	40	15	17	13	0	0	314
1940	0	12	16	17	59	59	31	23	25	18	0	0	259
1941	0	4	18	29	42	46	37	30	17	4	0	0	229
1942	0	14	47	44	104	131	59	38	22	5	0	0	463
1943	0	8	13	21	36	44	38	29	36	21	0	0	246
1944	0	5	15	41	57	79	85	47	28	12	0	0	368
1945	0	14	43	50	68	74	49	55	45	11	0	0	409
1946	0	2	9	24	47	65	71	46	30	20	0	0	314

1947	0	5	18	21	16	27	61	64	37	15	0	0	265
1948	0	7	25	27	22	37	56	34	5	4	0	0	218
1949	0	6	13	43	75	77	62	38	25	10	0	0	349
1950	0	0	12	28	41	72	73	31	30	25	0	0	310
1951	0	17	26	40	58	58	55	56	45	13	0	0	368
1952	0	5	8	39	70	86	67	33	23	5	0	0	337
1953	0	26	30	26	50	50	51	60	31	1	0	0	324
1954	0	1	23	46	73	94	107	93	44	12	0	0	492
1955	0	8	43	57	29	52	73	49	31	12	0	0	354
1956	0	31	32	15	50	49	46	50	26	9	0	0	308
1957	0	38	58	43	35	43	75	58	23	10	0	0	382
1958	0	7	33	35	27	43	47	54	46	13	0	0	304
1959	0	3	16	26	61	64	42	61	63	27	0	0	365
1960	0	19	27	54	70	59	61	40	22	8	0	0	361
1961	0	8	19	31	22	12	12	17	34	20	0	0	174
1962	0	13	26	18	25	38	47	35	30	23	0	0	255
1963	0	18	31	19	54	88	51	30	31	12	0	0	336
1964	0	7	15	13	15	52	82	74	41	8	0	0	306
1965	0	1	4	36	74	72	53	44	27	4	0	0	315
1966	0	20	29	22	50	78	81	61	26	5	0	0	372
1967	0	14	18	10	24	46	38	35	46	21	0	0	253
1968	0	8	28	63	65	54	74	61	30	10	0	0	392
1969	0	10	15	17	26	63	62	38	66	41	0	0	336
1970	0	15	40	38	80	93	52	39	40	27	0	0	424
1971	0	17	17	8	56	128	107	40	31	18	0	0	422
1972	0	20	37	26	48	54	25	33	27	5	0	0	274
1973	0	2	22	58	117	147	103	69	40	7	0	0	565
1974	0	13	21	51	62	44	73	86	43	4	0	0	397
1975	0	11	39	62	78	64	61	66	34	10	0	0	425
1976	0	11	17	21	73	110	60	13	14	8	0	0	327
1977	0	8	12	65	85	60	77	74	39	7	0	0	427
1978	0	11	30	34	72	89	81	77	52	24	0	0	471
1979	0	26	38	51	83	64	33	35	45	25	0	0	399
1980	0	19	21	16	52	60	67	66	38	18	0	0	357
1981	0	2	23	28	54	93	60	41	55	28	0	0	384
1982	0	12	19	39	41	55	82	56	27	7	0	0	339
1983	0	13	30	29	50	95	71	50	40	4	0	0	381
1984	0	11	16	52	88	64	42	60	68	29	0	0	429
1985	0	13	36	72	91	79	65	45	24	6	0	0	431
1986	0	15	29	43	41	47	55	38	23	5	0	0	296
AVERAGE	0	11	23	34	56	67	59	49	36	13	0	0	348

TABLE D9
PRECIPITATION
TOBIN LAKE
MONTHLY (mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
1912	0	13	16	28	52	101	105	84	59	6	0	0	465
1913	0	8	15	26	49	98	125	76	29	9	0	0	435
1914	0	8	20	28	37	49	39	30	38	19	0	0	270
1915	0	0	4	16	58	91	50	21	30	14	0	0	283
1916	0	14	23	87	112	123	115	48	39	17	0	0	578
1917	0	12	27	19	56	67	33	24	10	3	0	0	251
1918	0	12	24	44	59	54	68	48	18	11	0	0	337
1919	0	11	15	10	60	91	51	42	52	24	0	0	357
1920	0	19	23	20	29	26	40	43	32	16	0	0	248
1921	0	38	81	67	60	76	57	63	51	5	0	0	498
1922	0	22	27	39	77	60	43	40	28	15	0	0	350
1923	0	4	4	21	55	59	61	68	36	3	0	0	311
1924	0	5	32	30	39	48	37	46	45	24	0	0	306
1925	0	6	16	23	67	78	62	59	30	9	0	0	350
1926	0	3	8	55	65	42	57	77	75	27	0	0	408
1927	0	9	24	35	37	35	53	90	65	10	0	0	358
1928	0	6	19	21	37	49	39	23	7	4	0	0	203
1929	0	14	33	31	47	55	26	28	34	12	0	0	281
1930	0	12	18	31	87	95	36	57	78	24	0	0	439
1931	0	9	15	18	50	67	58	80	55	4	0	0	357
1932	0	11	27	31	79	124	102	60	41	24	0	0	499
1933	0	15	19	29	52	49	31	71	73	10	0	0	350
1934	0	19	33	30	73	76	29	24	18	5	0	0	307
1935	0	10	27	37	68	50	26	44	41	20	0	0	322
1936	0	10	21	21	42	50	37	41	33	10	0	0	265
1937	0	6	22	34	42	39	32	34	37	21	0	0	266
1938	0	7	24	30	35	52	73	56	35	22	0	0	334
1939	0	8	15	21	81	103	44	13	18	14	0	0	316
1940	0	12	17	18	59	56	24	22	25	18	0	0	252
1941	0	5	18	29	45	43	30	27	14	4	0	0	214
1942	0	14	46	43	102	127	52	34	22	5	0	0	444
1943	0	9	15	22	39	49	42	31	36	20	0	0	264
1944	0	6	10	37	59	81	99	62	29	13	0	0	396
1945	0	15	39	44	66	84	61	62	49	11	0	0	431
1946	0	2	9	24	50	66	78	54	30	21	0	0	332

1947	0	4	13	17	20	32	69	72	38	14	0	0	280
1948	0	7	26	29	19	32	61	40	5	4	0	0	221
1949	0	6	14	46	78	79	64	41	24	10	0	0	362
1950	0	0	10	27	42	59	58	29	28	23	0	0	277
1951	0	16	24	37	55	62	58	56	47	13	0	0	367
1952	0	6	11	39	67	88	66	30	25	5	0	0	337
1953	0	28	31	24	50	42	43	60	31	1	0	0	309
1954	0	1	16	37	70	81	101	106	46	9	0	0	468
1955	0	7	34	46	25	58	83	50	29	11	0	0	340
1956	0	26	27	14	46	43	38	43	25	9	0	0	271
1957	0	37	52	38	36	42	68	48	18	9	0	0	348
1958	0	5	30	32	27	49	49	51	44	13	0	0	301
1959	0	4	16	25	56	56	31	56	62	25	0	0	330
1960	0	18	24	50	69	58	57	37	20	8	0	0	341
1961	0	6	14	28	23	12	12	16	33	19	0	0	163
1962	0	12	22	16	31	38	41	36	31	23	0	0	250
1963	0	20	29	15	57	97	58	30	28	10	0	0	344
1964	0	6	12	10	17	52	85	75	40	9	0	0	306
1965	0	1	4	38	76	70	44	39	27	4	0	0	303
1966	0	20	23	18	50	79	82	60	27	5	0	0	364
1967	0	13	16	9	25	39	27	32	48	23	0	0	232
1968	0	8	32	66	65	55	81	69	30	10	0	0	417
1969	0	9	14	16	24	68	69	40	65	38	0	0	345
1970	0	14	44	44	88	104	52	36	40	27	0	0	449
1971	0	16	16	8	56	131	107	37	29	17	0	0	417
1972	0	20	37	25	50	57	29	36	26	4	0	0	283
1973	0	3	15	49	113	137	94	65	38	5	0	0	520
1974	0	12	18	50	63	49	82	91	42	4	0	0	410
1975	0	8	27	53	80	64	59	66	33	9	0	0	399
1976	0	11	16	19	78	107	51	14	14	8	0	0	318
1977	0	8	12	68	89	59	78	70	33	7	0	0	425
1978	0	12	29	32	70	84	80	79	52	24	0	0	463
1979	0	26	39	48	83	72	37	33	45	26	0	0	408
1980	0	20	21	15	53	59	67	69	41	19	0	0	364
1981	0	2	22	27	58	99	58	39	56	27	0	0	388
1982	0	12	19	33	37	63	87	55	26	6	0	0	337
1983	0	12	26	25	50	101	78	51	40	4	0	0	386
1984	0	8	13	49	86	67	48	63	63	25	0	0	421
1985	0	13	33	71	95	81	72	53	27	8	0	0	452
1986	0	12	26	46	44	49	55	36	25	6	0	0	298
AVERAGE	0	11	23	32	57	68	59	49	36	13	0	0	348

TABLE D10
PRECIPITATION
BRODERICK RESERVOIR
MONTHLY (mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
1912	0	7	8	35	72	70	61	62	36	2	0	0	353
1913	0	3	6	7	37	57	54	54	29	4	0	0	251
1914	0	6	10	23	39	31	15	20	39	24	0	0	207
1915	0	0	1	16	39	47	34	18	14	7	0	0	176
1916	0	13	21	32	62	92	73	31	33	21	0	0	377
1917	0	3	16	17	22	33	31	29	17	4	0	0	172
1918	0	6	29	35	72	97	75	41	14	10	0	0	378
1919	0	14	24	13	20	34	53	43	10	4	0	0	215
1920	0	19	24	21	34	43	70	61	31	14	0	0	316
1921	0	14	37	47	57	72	49	59	58	9	0	0	401
1922	0	8	12	34	34	14	57	51	7	4	0	0	222
1923	0	9	17	50	107	125	67	8	5	3	0	0	392
1924	0	3	9	18	20	12	40	42	34	28	0	0	205
1925	0	14	30	24	61	66	34	41	31	10	0	0	313
1926	0	6	10	34	51	49	44	29	14	2	0	0	239
1927	0	43	48	71	91	91	87	48	43	15	0	0	536
1928	0	8	14	13	61	126	76	5	11	9	0	0	324
1929	0	6	15	29	50	44	18	16	14	2	0	0	192
1930	0	2	16	30	37	35	17	29	43	17	0	0	224
1931	0	5	8	11	53	61	21	40	42	7	0	0	248
1932	0	6	20	16	36	69	60	32	11	5	0	0	255
1933	0	9	17	31	40	28	36	53	40	13	0	0	268
1934	0	1	4	5	37	42	16	21	12	0	0	0	139
1935	0	4	18	36	83	91	46	19	16	13	0	0	324
1936	0	6	14	37	63	39	13	12	10	7	0	0	200
1937	0	1	6	26	27	24	30	19	12	4	0	0	149
1938	0	10	17	36	53	48	37	35	33	12	0	0	280
1939	0	9	11	33	112	101	23	9	12	7	0	0	317
1940	0	4	7	9	35	79	56	10	13	8	0	0	221
1941	0	1	6	38	54	60	55	22	8	3	0	0	246
1942	0	4	42	44	93	116	48	41	28	4	0	0	421
1943	0	6	9	73	78	26	47	37	37	29	0	0	341
1944	0	10	23	72	92	61	31	4	5	4	0	0	303
1945	0	5	20	34	43	29	10	30	30	3	0	0	204
1946	0	3	8	19	53	54	39	62	50	12	0	0	300

1947	0	5	23	36	53	52	46	55	31	5	0	0	304
1948	0	3	36	45	26	52	50	15	3	0	0	0	230
1949	0	3	5	20	49	45	30	25	17	9	0	0	205
1950	0	0	13	32	34	45	49	24	18	13	0	0	228
1951	0	25	41	28	52	58	72	78	36	12	0	0	403
1952	0	12	16	26	59	59	32	20	11	1	0	0	235
1953	0	22	39	40	46	79	88	65	36	3	0	0	418
1954	0	5	19	44	59	69	83	61	22	4	0	0	367
1955	0	9	42	79	61	136	125	21	18	2	0	0	493
1956	0	16	25	27	47	91	72	15	17	13	0	0	322
1957	0	7	28	34	37	64	65	35	26	16	0	0	311
1958	0	2	18	21	17	43	39	36	28	0	0	0	205
1959	0	3	6	15	69	69	24	54	69	28	0	0	336
1960	0	2	10	23	56	60	35	16	3	3	0	0	208
1961	0	0	16	37	44	36	15	3	16	14	0	0	181
1962	0	11	13	17	43	49	65	67	26	3	0	0	295
1963	0	1	17	41	75	74	59	52	17	1	0	0	336
1964	0	4	15	28	33	28	22	37	31	5	0	0	204
1965	0	2	26	49	90	84	35	35	19	0	0	0	341
1966	0	8	28	33	68	78	47	28	5	1	0	0	295
1967	0	26	27	7	16	19	18	37	49	22	0	0	221
1968	0	11	19	32	36	41	69	65	31	7	0	0	311
1969	0	6	10	19	20	59	59	37	65	33	0	0	306
1970	0	9	29	30	62	102	55	8	12	8	0	0	313
1971	0	8	14	11	59	91	48	16	9	3	0	0	259
1972	0	3	6	30	52	45	38	28	12	2	0	0	217
1973	0	4	30	36	44	47	27	30	17	1	0	0	236
1974	0	23	33	39	83	69	40	40	18	5	0	0	350
1975	0	4	20	29	69	70	33	33	24	11	0	0	294
1976	0	11	22	22	86	105	39	17	8	1	0	0	311
1977	0	8	12	61	79	50	40	31	21	1	0	0	304
1978	0	1	15	40	45	51	43	37	32	7	0	0	271
1979	0	8	26	48	78	59	18	17	30	20	0	0	303
1980	0	6	13	23	32	36	42	42	25	5	0	0	224
1981	0	8	17	18	46	69	40	21	27	14	0	0	261
1982	0	13	23	68	77	55	63	48	26	6	0	0	379
1983	0	12	19	30	69	123	90	42	32	2	0	0	419
1984	0	6	14	22	39	39	20	35	54	25	0	0	253
1985	0	4	30	54	35	25	29	31	23	2	0	0	233
1986	0	16	21	41	60	87	76	47	42	8	0	0	399
AVERAGE	0	8	19	32	54	61	46	34	25	8	0	0	287

TABLE D11
PRECIPITATION
BRIGHTWATER RESERVOIR
MONTHLY (mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
1912	0	7	10	35	69	72	62	64	40	4	0	0	364
1913	0	3	7	14	45	62	54	55	33	6	0	0	279
1914	0	6	11	20	39	36	19	24	45	28	0	0	227
1915	0	0	2	25	47	50	38	25	19	7	0	0	212
1916	0	14	21	39	67	95	80	35	32	18	0	0	400
1917	0	5	11	9	26	41	36	34	21	6	0	0	188
1918	0	7	22	28	49	77	72	35	12	8	0	0	310
1919	0	13	25	18	27	38	50	52	25	6	0	0	254
1920	0	17	22	27	38	44	66	58	36	16	0	0	322
1921	0	13	29	43	67	81	50	62	61	8	0	0	415
1922	0	8	12	35	41	15	51	51	12	7	0	0	231
1923	0	10	18	42	111	150	88	20	8	3	0	0	450
1924	0	8	17	21	25	21	44	43	35	26	0	0	240
1925	0	15	32	23	72	84	40	42	36	16	0	0	359
1926	0	6	18	48	56	32	31	38	25	7	0	0	261
1927	0	37	45	59	75	76	68	46	46	18	0	0	469
1928	0	8	13	10	63	100	52	12	13	10	0	0	283
1929	0	8	20	31	52	44	14	15	14	2	0	0	199
1930	0	5	15	27	44	50	29	34	47	19	0	0	271
1931	0	6	9	14	49	51	21	41	40	7	0	0	238
1932	0	6	17	17	42	61	50	33	12	5	0	0	243
1933	0	10	17	26	41	40	45	57	45	15	0	0	297
1934	0	3	8	8	48	54	19	25	16	1	0	0	181
1935	0	5	15	25	63	82	52	23	19	15	0	0	299
1936	0	6	12	36	65	41	15	12	11	9	0	0	208
1937	0	1	7	26	26	23	32	26	17	6	0	0	166
1938	0	10	17	30	49	49	38	38	36	13	0	0	280
1939	0	10	13	21	102	102	21	10	15	9	0	0	303
1940	0	7	9	14	41	83	61	16	18	10	0	0	258
1941	0	3	8	33	52	47	39	21	11	5	0	0	220
1942	0	7	43	41	90	114	53	45	26	4	0	0	424
1943	0	7	9	53	58	23	43	34	35	27	0	0	289
1944	0	11	20	61	82	66	40	8	7	4	0	0	300
1945	0	7	27	34	37	33	24	41	29	2	0	0	234
1946	0	5	7	13	44	51	38	49	40	11	0	0	259

1947	0	5	17	28	47	43	36	54	33	4	0	0	267
1948	0	6	26	27	25	42	38	17	4	0	0	0	185
1949	0	5	8	17	51	53	37	30	18	10	0	0	230
1950	0	2	17	32	38	57	55	27	21	14	0	0	262
1951	0	24	41	29	53	65	71	73	43	16	0	0	414
1952	0	12	14	21	54	55	34	24	12	2	0	0	226
1953	0	23	37	44	51	80	88	62	36	3	0	0	424
1954	0	5	25	47	69	77	90	78	28	4	0	0	422
1955	0	8	47	77	55	87	78	24	21	3	0	0	399
1956	0	19	26	16	42	78	64	22	21	16	0	0	304
1957	0	7	25	27	32	53	60	42	27	15	0	0	287
1958	0	4	17	18	14	56	55	41	34	1	0	0	240
1959	0	3	8	14	62	62	20	61	79	28	0	0	336
1960	0	5	12	22	56	55	32	19	4	3	0	0	208
1961	0	2	14	32	39	33	15	5	22	17	0	0	178
1962	0	11	14	17	37	52	79	73	27	5	0	0	315
1963	0	2	17	39	68	70	66	62	23	2	0	0	350
1964	0	4	14	30	32	32	33	44	36	5	0	0	230
1965	0	3	17	35	80	78	35	38	22	0	0	0	308
1966	0	10	25	26	65	76	47	32	6	1	0	0	288
1967	0	27	31	12	23	26	19	35	47	21	0	0	242
1968	0	11	20	35	39	49	85	75	33	8	0	0	356
1969	0	9	11	21	26	48	46	33	73	45	0	0	312
1970	0	9	25	27	59	128	87	10	12	8	0	0	365
1971	0	9	14	10	58	113	68	16	13	6	0	0	307
1972	0	5	8	22	39	41	33	25	16	4	0	0	192
1973	0	6	30	35	51	52	29	33	19	4	0	0	261
1974	0	26	38	48	78	67	55	41	16	5	0	0	373
1975	0	5	24	31	60	66	44	40	24	12	0	0	305
1976	0	12	23	20	79	98	37	17	9	1	0	0	296
1977	0	7	11	63	71	32	31	31	22	3	0	0	270
1978	0	1	16	34	38	46	39	42	39	9	0	0	264
1979	0	8	31	53	73	60	26	18	31	22	0	0	322
1980	0	8	14	18	30	37	50	44	20	7	0	0	228
1981	0	10	24	20	58	75	35	24	30	16	0	0	293
1982	0	14	21	56	70	66	79	65	37	5	0	0	414
1983	0	13	28	42	56	108	94	44	32	3	0	0	419
1984	0	7	13	19	40	38	19	41	59	27	0	0	261
1985	0	3	30	58	42	30	31	34	24	3	0	0	255
1986	0	13	17	38	62	92	80	50	40	6	0	0	398
AVERAGE	0	9	19	30	52	61	47	37	27	10	0	0	292

TABLE D12
PRECIPITATION
BLACKSTRAP RESERVOIR
MONTHLY (mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
1912	0	8	9	35	75	78	64	66	42	3	0	0	380
1913	0	3	7	10	44	65	55	56	34	6	0	0	281
1914	0	6	12	25	45	37	19	25	50	32	0	0	252
1915	0	0	2	18	41	51	42	34	24	6	0	0	217
1916	0	13	22	46	64	88	84	39	27	11	0	0	394
1917	0	6	13	10	32	46	41	39	24	8	0	0	220
1918	0	9	28	32	39	69	62	22	7	5	0	0	272
1919	0	16	29	17	32	46	42	62	48	9	0	0	301
1920	0	21	26	26	35	42	56	49	41	20	0	0	316
1921	0	16	37	51	81	95	48	67	66	4	0	0	465
1922	0	11	15	35	45	19	44	45	15	9	0	0	238
1923	0	12	21	35	106	153	101	37	12	3	0	0	479
1924	0	14	27	24	29	26	41	43	33	22	0	0	259
1925	0	15	32	22	92	106	42	44	44	23	0	0	420
1926	0	5	24	60	63	34	33	41	34	15	0	0	310
1927	0	25	37	48	66	81	63	45	47	14	0	0	426
1928	0	8	12	8	74	113	61	20	12	11	0	0	319
1929	0	12	25	32	57	49	12	13	14	2	0	0	215
1930	0	9	16	25	51	55	33	48	59	21	0	0	316
1931	0	7	10	17	52	50	23	48	45	6	0	0	259
1932	0	4	12	17	51	57	38	31	12	4	0	0	226
1933	0	12	19	22	36	46	50	55	48	18	0	0	305
1934	0	5	12	11	55	62	24	32	19	1	0	0	221
1935	0	4	11	15	43	71	56	26	26	20	0	0	271
1936	0	5	10	35	67	42	17	12	12	12	0	0	212
1937	0	1	8	27	25	22	35	35	25	7	0	0	185
1938	0	10	17	25	45	50	36	41	40	13	0	0	277
1939	0	11	15	10	96	106	21	12	16	9	0	0	294
1940	0	10	12	19	47	86	67	26	27	13	0	0	306
1941	0	6	10	28	47	33	28	26	17	9	0	0	204
1942	0	12	45	38	84	110	62	52	22	2	0	0	427
1943	0	8	8	36	40	21	26	17	34	28	0	0	217
1944	0	11	18	51	71	67	48	13	10	3	0	0	292
1945	0	8	33	33	28	33	41	51	24	1	0	0	252
1946	0	6	6	8	33	46	41	43	26	3	0	0	211

1947	0	4	11	21	45	38	35	61	37	3	0	0	256
1948	0	10	18	11	22	31	29	21	4	0	0	0	146
1949	0	6	11	15	55	63	46	36	18	10	0	0	259
1950	0	5	21	31	43	68	62	30	24	15	0	0	299
1951	0	21	38	30	42	60	65	59	34	10	0	0	360
1952	0	13	14	17	50	52	34	24	11	2	0	0	217
1953	0	26	37	48	56	80	80	51	35	3	0	0	417
1954	0	4	30	50	81	88	103	96	29	5	0	0	486
1955	0	7	50	75	47	42	36	30	27	6	0	0	319
1956	0	27	31	7	36	66	60	32	19	14	0	0	292
1957	0	7	23	20	28	43	59	53	26	13	0	0	271
1958	0	7	17	15	9	65	69	48	42	2	0	0	273
1959	0	5	10	13	48	48	16	72	88	24	0	0	324
1960	0	6	12	22	59	53	28	20	5	3	0	0	206
1961	0	4	14	28	31	28	15	9	25	16	0	0	170
1962	0	12	16	17	29	52	87	74	27	4	0	0	317
1963	0	3	17	38	58	63	71	66	26	3	0	0	345
1964	0	5	13	32	29	33	43	50	42	7	0	0	254
1965	0	3	9	22	77	79	32	38	24	0	0	0	284
1966	0	12	24	19	65	77	45	33	12	5	0	0	294
1967	0	25	31	16	29	32	23	32	41	20	0	0	249
1968	0	14	25	38	43	57	99	83	35	10	0	0	402
1969	0	12	13	23	31	38	35	27	75	54	0	0	308
1970	0	8	22	23	58	155	118	13	11	10	0	0	418
1971	0	9	13	8	62	136	86	16	16	8	0	0	354
1972	0	5	9	15	32	40	30	17	12	5	0	0	166
1973	0	5	28	35	63	62	31	36	24	8	0	0	291
1974	0	32	45	56	79	72	65	38	13	4	0	0	405
1975	0	5	27	32	52	62	45	36	24	13	0	0	295
1976	0	13	24	19	67	86	32	16	11	0	0	0	267
1977	0	5	10	65	65	17	23	35	28	4	0	0	252
1978	0	1	16	29	29	39	37	50	48	12	0	0	261
1979	0	8	35	58	80	72	34	19	31	24	0	0	360
1980	0	10	15	14	27	38	60	50	20	10	0	0	245
1981	0	12	29	22	62	73	25	20	32	20	0	0	295
1982	0	8	13	46	67	79	98	95	53	2	0	0	461
1983	0	13	35	52	45	95	97	47	32	4	0	0	419
1984	0	6	11	15	37	34	17	44	63	29	0	0	256
1985	0	1	31	61	45	44	40	31	23	2	0	0	277
1986	0	10	14	34	64	93	75	46	33	2	0	0	370
AVERAGE	0	10	20	29	51	61	49	40	30	10	0	0	298

TABLE D13
PRECIPITATION
BRADWELL RESERVOIR
MONTHLY (mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
1912	0	8	9	37	77	78	65	67	42	3	0	0	387
1913	0	3	7	9	43	65	57	58	34	6	0	0	282
1914	0	6	12	25	44	36	18	25	50	32	0	0	250
1915	0	0	2	18	41	51	41	33	23	6	0	0	215
1916	0	12	20	42	60	87	85	40	28	12	0	0	385
1917	0	9	19	13	32	46	42	41	25	8	0	0	234
1918	0	9	31	35	38	67	62	22	7	5	0	0	276
1919	0	12	26	16	30	45	43	59	44	9	0	0	284
1920	0	19	25	25	34	42	57	52	43	20	0	0	317
1921	0	20	43	51	80	95	48	59	59	4	0	0	460
1922	0	11	15	36	46	22	50	50	17	10	0	0	258
1923	0	11	20	33	98	146	102	41	13	3	0	0	467
1924	0	11	21	21	27	23	35	41	36	23	0	0	238
1925	0	11	29	24	84	95	41	45	41	20	0	0	390
1926	0	5	22	56	59	39	41	40	32	14	0	0	309
1927	0	27	41	50	63	87	72	45	49	15	0	0	448
1928	0	9	15	11	68	120	78	22	13	11	0	0	347
1929	0	10	23	34	54	46	15	16	15	2	0	0	215
1930	0	6	16	27	51	53	30	46	59	23	0	0	312
1931	0	8	11	17	53	54	24	49	47	7	0	0	270
1932	0	7	17	17	51	60	40	34	14	4	0	0	243
1933	0	13	20	25	36	37	42	52	47	18	0	0	291
1934	0	6	14	12	59	68	28	33	19	1	0	0	239
1935	0	5	19	23	53	80	59	30	33	24	0	0	326
1936	0	4	11	32	61	41	17	13	14	12	0	0	204
1937	0	1	7	25	25	22	35	34	26	9	0	0	185
1938	0	14	23	26	43	47	38	44	43	15	0	0	293
1939	0	11	14	11	96	108	24	12	17	9	0	0	303
1940	0	10	12	19	47	77	57	23	25	14	0	0	284
1941	0	6	11	24	40	33	28	24	16	8	0	0	190
1942	0	9	41	37	90	114	56	46	21	2	0	0	416
1943	0	6	7	35	40	28	34	19	36	28	0	0	232
1944	0	9	14	52	71	66	51	18	12	4	0	0	297
1945	0	5	26	31	32	34	53	65	25	0	0	0	271
1946	0	4	7	12	32	45	46	51	35	8	0	0	241

1947	0	4	14	23	39	37	39	64	39	5	0	0	265
1948	0	11	21	15	24	32	31	22	4	0	0	0	159
1949	0	7	13	17	50	61	58	43	15	8	0	0	273
1950	0	3	19	28	47	81	67	28	23	16	0	0	312
1951	0	22	36	27	37	56	63	51	31	10	0	0	335
1952	0	10	11	18	48	50	31	20	12	3	0	0	203
1953	0	21	31	44	47	67	69	41	29	3	0	0	353
1954	0	5	28	50	79	79	96	90	27	6	0	0	459
1955	0	12	54	71	42	38	34	33	29	6	0	0	319
1956	0	25	30	7	31	57	56	33	18	12	0	0	270
1957	0	6	21	21	28	40	56	51	26	13	0	0	262
1958	0	7	19	18	10	62	63	40	35	2	0	0	255
1959	0	4	9	12	46	46	20	71	82	23	0	0	312
1960	0	7	14	27	60	48	23	17	5	3	0	0	204
1961	0	4	16	34	39	38	22	10	27	18	0	0	208
1962	0	11	14	15	27	57	83	59	23	4	0	0	293
1963	0	5	19	37	62	71	67	55	23	3	0	0	342
1964	0	4	11	30	30	28	43	51	37	6	0	0	241
1965	0	2	8	22	74	74	31	35	21	0	0	0	267
1966	0	10	21	18	70	83	46	32	9	2	0	0	291
1967	0	23	28	15	31	33	29	37	38	18	0	0	254
1968	0	13	25	39	45	63	98	76	36	11	0	0	406
1969	0	9	12	25	34	42	35	32	72	46	0	0	306
1970	0	11	22	20	68	134	87	14	12	10	0	0	378
1971	0	9	16	10	56	128	84	14	13	7	0	0	338
1972	0	7	10	18	38	47	36	18	12	5	0	0	193
1973	0	4	28	37	64	67	33	35	24	6	0	0	298
1974	0	27	37	57	81	67	64	41	15	4	0	0	393
1975	0	5	24	40	61	59	40	34	22	11	0	0	296
1976	0	11	23	21	59	81	36	14	11	1	0	0	257
1977	0	5	9	69	72	20	26	36	27	3	0	0	267
1978	0	1	17	30	32	42	42	49	44	11	0	0	268
1979	0	8	33	48	71	69	31	18	28	20	0	0	326
1980	0	9	13	13	29	36	54	50	23	10	0	0	237
1981	0	10	26	21	56	71	31	21	31	19	0	0	286
1982	0	8	13	47	67	75	92	82	42	2	0	0	427
1983	0	13	32	46	58	93	78	47	34	4	0	0	404
1984	0	6	12	18	42	37	15	40	62	29	0	0	260
1985	0	2	32	64	45	40	41	33	23	2	0	0	282
1986	0	10	13	34	60	90	72	42	33	3	0	0	356
AVERAGE	0	9	20	29	51	61	48	39	29	10	0	0	296

TABLE D14
PRECIPITATION
ZELMA RESERVOIR
MONTHLY (mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
1912	0	8	9	35	75	78	64	66	42	3	0	0	380
1913	0	3	7	10	44	65	55	56	34	6	0	0	281
1914	0	6	12	25	45	37	19	25	50	32	0	0	252
1915	0	0	2	18	41	51	42	34	24	6	0	0	217
1916	0	13	22	46	64	88	84	39	27	11	0	0	394
1917	0	6	13	10	32	46	41	39	24	8	0	0	220
1918	0	9	28	32	39	69	62	22	7	5	0	0	272
1919	0 3	16	29	17	32	46	42	62	48	9	0	0	301
1920	0	21	26	26	35	42	56	49	41	20	0	0	316
1921	0	16	37	51	81	95	48	67	66	4	0	0	465
1922	0	11	15	35	47	28	50	55	25	9	0	0	274
1923	0	12	21	28	89	124	75	32	17	5	0	0	404
1924	0	14	27	24	33	35	41	34	25	18	0	0	251
1925	0	15	32	27	71	80	34	35	39	21	0	0	354
1926	0	5	24	59	61	33	33	38	34	16	0	0	303
1927	0	25	37	43	61	77	61	40	38	12	0	0	395
1928	0	8	12	8	74	113	61	20	12	11	0	0	319
1929	0	12	25	34	56	51	22	17	14	2	0	0	232
1930	0	9	16	22	43	57	40	41	51	20	0	0	299
1931	0	7	10	16	46	59	42	43	42	14	0	0	279
1932	0	4	12	18	89	109	54	33	16	8	0	0	345
1933	0	12	19	30	52	58	59	54	41	16	0	0	342
1934	0	5	12	18	60	64	28	33	26	6	0	0	253
1935	0	4	11	15	67	81	51	38	29	18	0	0	313
1936	0	5	10	30	69	55	23	17	17	11	0	0	238
1937	0	1	8	27	28	23	31	28	23	10	0	0	179
1938	0	10	17	27	60	61	38	41	37	13	0	0	305
1939	0	11	15	15	88	94	27	19	17	9	0	0	294
1940	0	10	12	19	52	86	62	22	24	13	0	0	299
1941	0	6	10	28	44	41	49	37	17	9	0	0	240
1942	0	12	45	41	84	104	52	45	24	4	0	0	411
1943	0	8	8	32	44	38	49	33	30	21	0	0	262
1944	0	11	18	43	66	64	52	22	13	7	0	0	296
1945	0	8	33	39	49	48	30	37	24	5	0	0	273
1946	0	6	6	14	42	50	43	42	29	9	0	0	241

1947	0	4	11	21	41	41	45	69	41	3	0	0	278
1948	0	10	18	17	32	43	38	24	9	4	0	0	195
1949	0	6	11	17	43	51	53	40	17	10	0	0	248
1950	0	5	21	32	44	61	54	33	28	16	0	0	292
1951	0	21	38	36	73	82	59	69	61	24	0	0	463
1952	0	13	14	20	50	47	40	42	22	4	0	0	251
1953	0	26	42	59	73	83	78	63	42	3	0	0	470
1954	0	6	25	49	83	97	108	98	41	7	0	0	514
1955	0	10	56	84	56	46	43	37	30	8	0	0	371
1956	0	20	24	16	47	61	52	33	23	17	0	0	292
1957	0	12	30	25	33	52	58	43	25	15	0	0	293
1958	0	7	19	16	10	56	56	37	33	2	0	0	236
1959	0	4	10	14	66	64	20	75	87	26	0	0	364
1960	0	4	13	24	65	55	22	18	6	4	0	0	212
1961	0	4	18	39	39	25	13	6	22	16	0	0	183
1962	0	13	19	22	58	69	69	66	30	6	0	0	351
1963	0	4	18	37	72	89	65	44	24	5	0	0	357
1964	0	4	12	30	32	32	42	48	33	6	0	0	239
1965	0	2	9	29	100	100	32	35	26	0	0	0	334
1966	0	9	26	26	83	97	47	29	6	1	0	0	325
1967	0	25	28	10	19	22	18	37	51	22	0	0	232
1968	0	12	22	35	35	56	94	73	37	13	0	0	375
1969	0	12	13	17	28	52	51	38	77	50	0	0	339
1970	0	12	26	28	52	101	81	22	16	11	0	0	348
1971	0	8	17	11	64	129	77	17	16	8	0	0	346
1972	0	6	13	20	40	44	26	20	20	9	0	0	198
1973	0	6	34	47	83	78	42	41	18	4	0	0	354
1974	0	20	38	59	70	61	72	62	31	9	0	0	423
1975	0	5	29	35	50	62	50	37	23	12	0	0	303
1976	0	9	23	24	73	92	35	15	10	2	0	0	282
1977	0	8	14	76	80	42	44	38	31	5	0	0	339
1978	0	2	12	32	54	57	49	60	47	12	0	0	324
1979	0	6	26	46	64	51	26	21	35	27	0	0	302
1980	0	7	10	17	42	53	59	47	24	13	0	0	272
1981	0	8	25	28	72	86	43	47	55	25	0	0	388
1982	0	9	14	52	71	75	89	73	42	6	0	0	429
1983	0	9	26	47	55	122	111	47	39	5	0	0	460
1984	0	8	19	26	44	38	17	46	64	27	0	0	289
1985	0	4	36	70	57	39	36	41	29	3	0	0	315
1986	0	15	20	37	63	97	79	47	41	8	0	0	406
AVERAGE	0	9	20	31	56	65	49	41	31	11	0	0	313

TABLE D15
PRECIPITATION
LITTLE MANITOU LAKE
MONTHLY (mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
1912	0	8	37	49	62	96	89	66	40	8	0	0	455
1913	0	3	6	9	42	84	59	21	13	3	0	0	240
1914	0	5	9	24	43	40	19	8	21	14	0	0	182
1915	0	0	1	7	23	42	53	30	4	0	0	0	160
1916	0	23	30	28	42	85	79	15	12	12	0	0	325
1917	0	9	14	10	65	69	42	44	18	8	0	0	279
1918	0	9	41	48	25	25	36	23	8	5	0	0	220
1919	0	11	12	3	61	65	9	30	28	0	0	0	220
1920	0	6	19	13	9	16	20	27	27	13	0	0	149
1921	0	16	32	41	67	67	32	20	41	27	0	0	343
1922	0	9	25	74	76	33	55	61	41	19	0	0	393
1923	0	9	14	19	77	105	57	29	19	5	0	0	334
1924	0	7	21	22	32	39	40	29	19	15	0	0	224
1925	0	4	19	26	57	61	28	28	36	19	0	0	278
1926	0	1	10	49	59	32	32	36	33	16	0	0	267
1927	0	18	19	30	58	73	59	36	31	10	0	0	335
1928	0	11	19	15	57	131	106	26	14	13	0	0	391
1929	0	6	22	37	54	51	27	24	17	1	0	0	240
1930	0	5	11	19	37	58	43	35	44	18	0	0	271
1931	0	10	10	12	41	64	54	39	39	19	0	0	289
1932	0	4	16	23	115	143	66	34	18	10	0	0	429
1933	0	23	31	38	61	64	63	52	35	14	0	0	381
1934	0	7	12	21	64	66	30	32	29	9	0	0	269
1935	0	14	20	26	94	87	47	46	30	17	0	0	381
1936	0	16	19	26	69	62	27	20	19	10	0	0	268
1937	0	1	8	28	31	24	27	24	22	10	0	0	177
1938	0	9	21	32	69	67	39	41	40	19	0	0	337
1939	0	11	18	21	82	86	31	22	15	5	0	0	291
1940	0	13	13	17	54	84	56	18	20	12	0	0	288
1941	0	3	12	32	42	46	63	44	17	8	0	0	267
1942	0	2	29	36	82	98	45	40	25	5	0	0	363
1943	0	4	6	30	45	47	64	43	26	16	0	0	281
1944	0	8	15	39	61	61	54	28	14	9	0	0	288
1945	0	14	31	32	62	58	24	29	24	7	0	0	279
1946	0	2	13	27	47	54	45	40	31	12	0	0	271

1947	0	4	9	18	38	42	53	76	43	3	0	0	285
1948	0	12	35	34	37	48	42	25	12	6	0	0	252
1949	0	1	6	17	35	45	57	42	18	11	0	0	233
1950	0	1	8	22	42	54	46	32	30	16	0	0	252
1951	0	24	32	30	90	92	55	75	77	32	0	0	507
1952	0	2	3	21	49	43	44	53	27	4	0	0	247
1953	0	26	44	65	81	79	73	71	46	3	0	0	488
1954	0	8	24	51	83	102	113	99	49	9	0	0	537
1955	0	12	59	86	60	48	46	39	31	9	0	0	389
1956	0	15	18	22	54	59	49	31	24	18	0	0	290
1957	0	16	35	26	34	54	56	36	24	16	0	0	297
1958	0	6	20	18	11	47	46	30	27	3	0	0	208
1959	0	3	10	16	74	70	23	77	84	25	0	0	379
1960	0	4	13	26	67	54	19	17	7	5	0	0	214
1961	0	5	19	43	44	27	13	4	20	17	0	0	193
1962	0	13	21	25	71	75	58	60	32	8	0	0	364
1963	0	6	20	36	80	102	57	29	23	6	0	0	359
1964	0	4	12	27	34	35	46	48	26	4	0	0	237
1965	0	2	8	37	115	110	32	34	28	0	0	0	367
1966	0	7	26	29	93	107	52	32	6	2	0	0	353
1967	0	22	24	6	14	17	15	41	58	24	0	0	220
1968	0	9	10	21	29	57	92	68	39	15	0	0	342
1969	0	10	11	13	27	59	59	45	78	48	0	0	350
1970	0	15	32	34	48	66	55	26	19	11	0	0	306
1971	0	8	19	13	67	124	68	17	17	9	0	0	343
1972	0	6	17	24	44	48	25	21	24	10	0	0	220
1973	0	7	36	52	98	94	50	45	15	2	0	0	399
1974	0	11	32	61	63	53	81	80	41	11	0	0	433
1975	0	5	29	36	48	60	51	38	22	10	0	0	298
1976	0	7	22	26	77	94	36	14	9	2	0	0	288
1977	0	8	15	85	92	54	54	42	34	6	0	0	391
1978	0	2	9	33	67	67	56	62	44	11	0	0	352
1979	0	5	18	35	51	37	22	22	35	28	0	0	252
1980	0	4	6	16	47	59	60	46	24	13	0	0	275
1981	0	6	22	30	78	95	55	62	67	28	0	0	443
1982	0	9	13	54	70	68	79	57	33	8	0	0	390
1983	0	7	19	41	59	133	113	44	41	6	0	0	463
1984	0	10	23	33	49	39	17	46	61	23	0	0	300
1985	0	6	37	73	64	43	38	45	31	4	0	0	341
1986	0	10	17	30	40	99	100	44	31	5	0	0	375
AVERAGE	0	9	20	31	57	66	50	39	30	11	0	0	312

TABLE D16
PRECIPITATION
DELLWOOD RESERVOIR
MONTHLY (mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
1912	0	8	37	49	62	96	89	66	40	8	0	0	455
1913	0	3	6	9	42	84	59	21	13	3	0	0	240
1914	0	5	9	24	43	40	19	8	21	14	0	0	182
1915	0	0	1	7	23	42	53	30	4	0	0	0	160
1916	0	23	30	28	42	85	79	15	12	12	0	0	325
1917	0	9	14	10	65	69	42	44	18	8	0	0	279
1918	0	9	41	48	25	25	36	23	8	5	0	0	220
1919	0	11	12	3	61	65	9	30	28	0	0	0	220
1920	0	6	19	13	9	16	20	27	27	13	0	0	149
1921	0	16	32	41	67	67	32	20	41	27	0	0	343
1922	0	9	25	74	75	33	56	61	41	19	0	0	392
1923	0	9	14	18	77	105	56	28	18	5	0	0	328
1924	0	7	21	22	31	38	40	29	18	15	0	0	219
1925	0	4	19	26	55	60	26	26	35	19	0	0	270
1926	0	1	10	50	60	30	30	35	32	16	0	0	263
1927	0	18	19	31	58	72	58	35	30	10	0	0	330
1928	0	11	19	15	57	131	106	26	14	13	0	0	391
1929	0	6	22	37	53	50	25	23	17	1	0	0	234
1930	0	5	11	18	35	57	42	34	44	18	0	0	263
1931	0	0	0	12	39	62	53	39	39	19	0	0	263
1932	0	4	16	22	114	144	66	34	17	9	0	0	426
1933	0	23	31	38	58	60	60	49	32	12	0	0	362
1934	0	8	13	20	65	68	27	30	26	7	0	0	262
1935	0	13	19	25	95	87	45	46	29	16	0	0	376
1936	0	14	18	27	68	59	26	20	17	9	0	0	256
1937	0	1	9	29	33	27	27	26	24	10	0	0	185
1938	0	9	23	33	67	64	38	41	40	19	0	0	333
1939	0	11	18	19	81	87	30	20	14	5	0	0	286
1940	0	13	14	16	51	81	53	16	19	11	0	0	273
1941	0	3	12	32	43	48	63	44	16	7	0	0	268
1942	0	2	29	35	79	97	47	40	24	5	0	0	356
1943	0	4	5	29	42	44	63	43	24	15	0	0	268
1944	0	8	14	38	59	59	54	28	12	7	0	0	279
1945	0	14	31	31	61	58	25	30	22	5	0	0	276
1946	0	2	14	26	44	57	49	39	28	11	0	0	269

1947	0	4	9	18	37	39	54	78	42	3	0	0	284
1948	0	12	35	33	34	45	41	25	10	5	0	0	241
1949	0	1	6	17	38	48	56	40	18	11	0	0	234
1950	0	1	8	21	40	52	42	28	28	16	0	0	236
1951	0	24	33	31	84	83	54	73	72	31	0	0	485
1952	0	2	3	20	45	43	45	50	24	3	0	0	236
1953	0	26	41	60	74	69	67	70	45	3	0	0	456
1954	0	8	27	55	81	101	111	97	48	8	0	0	535
1955	0	12	57	80	55	49	43	35	28	7	0	0	365
1956	0	15	17	20	52	63	51	29	23	17	0	0	287
1957	0	18	35	24	32	51	54	36	22	15	0	0	287
1958	0	6	21	19	13	45	42	30	28	3	0	0	207
1959	0	2	9	16	68	64	24	76	80	23	0	0	363
1960	0	5	14	28	66	51	21	19	7	5	0	0	214
1961	0	4	17	39	43	30	14	5	20	17	0	0	190
1962	0	13	20	24	62	67	59	57	32	10	0	0	345
1963	0	8	21	36	80	96	51	30	23	6	0	0	351
1964	0	4	11	26	36	43	54	50	26	4	0	0	253
1965	0	2	8	40	111	105	33	36	29	0	0	0	363
1966	0	6	23	27	90	102	59	40	6	2	0	0	355
1967	0	22	24	7	16	19	16	43	58	23	0	0	228
1968	0	9	10	19	30	62	97	70	38	16	0	0	350
1969	0	9	10	14	28	56	54	42	78	48	0	0	338
1970	0	16	35	36	48	68	53	24	19	11	0	0	310
1971	0	9	19	13	70	125	67	16	17	10	0	0	346
1972	0	7	18	26	44	50	29	21	22	9	0	0	227
1973	0	6	31	48	102	101	51	44	17	2	0	0	402
1974	0	10	29	58	61	53	86	82	38	9	0	0	426
1975	0	4	27	35	48	57	49	39	20	8	0	0	288
1976	0	8	21	26	77	93	36	13	8	2	0	0	285
1977	0	7	12	88	94	47	50	45	35	6	0	0	384
1978	0	3	11	31	62	66	54	57	40	11	0	0	335
1979	0	4	16	30	46	36	24	22	33	26	0	0	237
1980	0	3	5	12	42	54	60	46	20	11	0	0	253
1981	0	5	19	29	75	96	55	56	65	28	0	0	429
1982	0	8	12	51	65	62	76	54	30	7	0	0	366
1983	0	8	18	36	55	123	103	40	37	6	0	0	427
1984	0	9	22	33	49	38	17	43	56	20	0	0	288
1985	0	6	35	67	61	43	37	41	29	5	0	0	324
1986	0	10	17	30	40	99	100	44	31	5	0	0	375
AVERAGE	0	8	19	30	56	65	49	38	29	11	0	0	305

TABLE D17
PRECIPITATION
RESERVOIR SC1
MONTHLY (mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
1912	0	2	6	38	66	55	59	48	30	17	0	0	321
1913	0	11	25	23	50	64	56	40	13	7	0	0	289
1914	0	13	17	11	53	52	18	39	49	23	0	0	274
1915	0	1	1	49	105	92	41	26	36	15	0	0	364
1916	0	18	26	38	78	107	92	51	34	16	0	0	461
1917	0	16	34	20	19	29	23	31	30	9	0	0	211
1918	0	5	10	10	17	31	40	27	17	12	0	0	169
1919	0	4	26	32	21	16	22	36	25	6	0	0	189
1920	0	10	19	33	60	72	46	19	29	19	0	0	305
1921	0	15	32	40	43	50	41	48	46	10	0	0	326
1922	0	2	11	32	52	56	66	47	9	2	0	0	278
1923	0	6	11	16	102	123	47	15	9	8	0	0	336
1924	0	11	22	34	60	59	53	38	33	25	0	0	336
1925	0	7	38	43	30	36	44	59	43	10	0	0	309
1926	0	2	3	19	47	38	41	52	23	3	0	0	226
1927	0	12	24	101	110	55	57	40	33	16	0	0	448
1928	0	2	10	19	68	86	39	13	11	9	0	0	257
1929	0	5	17	33	58	51	19	23	23	5	0	0	234
1930	0	1	16	19	48	52	27	56	48	10	0	0	278
1931	0	8	11	11	30	41	47	54	26	0	0	0	228
1932	0	5	17	41	55	65	75	46	18	8	0	0	332
1933	0	3	14	43	74	51	50	54	22	10	0	0	323
1934	0	12	13	8	56	55	11	31	28	2	0	0	216
1935	0	8	20	29	47	82	70	18	11	10	0	0	296
1936	0	6	11	17	39	32	22	25	13	6	0	0	170
1937	0	6	10	14	23	21	20	28	25	8	0	0	155
1938	0	16	25	45	60	31	23	38	28	8	0	0	275
1939	0	8	16	54	136	110	26	9	13	10	0	0	383
1940	0	13	37	38	55	63	24	24	35	13	0	0	303
1941	0	7	14	25	58	62	48	39	15	1	0	0	270
1942	0	11	35	37	84	85	60	68	37	15	0	0	433
1943	0	11	12	27	59	44	19	20	36	23	0	0	250
1944	0	9	10	32	64	61	54	35	14	5	0	0	285
1945	0	2	23	39	46	41	45	62	33	3	0	0	293
1946	0	3	6	10	33	50	54	49	27	9	0	0	239

1947	0	6	19	27	42	44	39	45	28	5	0	0	256
1948	0	6	24	46	51	59	47	11	1	0	0	0	246
1949	0	4	6	18	38	63	65	26	20	18	0	0	257
1950	0	14	24	19	45	59	50	37	18	9	0	0	276
1951	0	22	31	24	74	74	90	109	49	14	0	0	488
1952	0	15	17	29	65	66	54	40	15	1	0	0	303
1953	0	21	40	53	80	59	16	30	28	2	0	0	329
1954	0	25	40	43	71	74	82	91	47	8	0	0	481
1955	0	15	43	52	53	87	60	13	15	4	0	0	344
1956	0	6	12	27	75	77	33	19	25	16	0	0	291
1957	0	9	26	22	32	59	48	21	18	14	0	0	249
1958	0	7	16	15	20	40	50	37	16	2	0	0	203
1959	0	6	19	26	91	96	27	27	30	14	0	0	336
1960	0	4	22	32	45	48	46	31	7	6	0	0	240
1961	0	1	15	36	46	38	18	11	18	11	0	0	196
1962	0	11	15	19	56	93	63	21	28	17	0	0	323
1963	0	3	9	25	89	88	29	19	9	1	0	0	273
1964	0	5	17	35	57	42	27	54	35	0	0	0	272
1965	0	14	23	40	88	92	75	78	39	0	0	0	449
1966	0	1	21	30	73	82	50	32	7	5	0	0	302
1967	0	30	55	37	15	7	12	40	46	14	0	0	257
1968	0	4	7	18	32	30	35	50	33	6	0	0	214
1969	0	13	38	43	39	76	56	10	46	37	0	0	357
1970	0	14	32	30	85	93	23	17	27	13	0	0	334
1971	0	7	16	21	42	41	17	14	12	5	0	0	176
1972	0	5	14	51	74	47	24	35	31	4	0	0	286
1973	0	5	40	42	40	44	23	17	6	2	0	0	219
1974	0	17	34	77	82	52	70	49	9	2	0	0	391
1975	0	22	49	54	67	57	48	50	32	14	0	0	394
1976	0	24	29	14	85	96	41	23	4	1	0	0	317
1977	0	12	14	41	58	48	40	22	13	2	0	0	252
1978	0	3	27	52	53	46	31	38	35	8	0	0	292
1979	0	6	21	40	44	56	54	29	23	12	0	0	284
1980	0	5	9	16	68	80	45	32	27	16	0	0	300
1981	0	8	16	37	89	93	38	14	22	14	0	0	330
1982	0	16	22	62	70	78	96	49	30	13	0	0	435
1983	0	22	35	39	51	76	65	21	9	2	0	0	320
1984	0	9	15	21	46	37	15	38	40	11	0	0	231
1985	0	21	30	31	29	13	27	47	37	12	0	0	248
1986	0	6	13	72	90	58	42	63	69	16	0	0	430
AVERAGE	0	10	21	33	58	60	43	36	26	9	0	0	297

TABLE D18
PRECIPITATION
REID LAKE
MONTHLY (mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
1912	0	2	6	39	67	55	60	49	29	16	0	0	322
1913	0	11	25	23	51	66	57	39	13	6	0	0	291
1914	0	13	17	10	49	49	18	40	51	24	0	0	272
1915	0	1	1	51	104	89	41	26	36	15	0	0	363
1916	0	19	26	37	77	107	92	52	36	17	0	0	463
1917	0	16	32	18	20	30	23	32	30	9	0	0	211
1918	0	5	11	11	18	31	39	27	18	13	0	0	173
1919	0	5	27	32	21	16	24	38	25	6	0	0	194
1920	0	9	18	32	57	69	44	20	28	18	0	0	296
1921	0	15	31	40	44	51	42	50	48	9	0	0	331
1922	0	2	11	33	56	57	63	45	9	2	0	0	277
1923	0	6	11	17	99	121	48	15	8	7	0	0	331
1924	0	11	21	34	61	59	54	39	33	25	0	0	337
1925	0	7	38	42	30	36	44	58	43	10	0	0	308
1926	0	2	3	21	47	38	42	50	22	3	0	0	228
1927	0	12	25	101	108	54	58	40	33	16	0	0	448
1928	0	3	10	18	67	84	38	12	11	9	0	0	253
1929	0	5	17	33	58	52	19	23	23	5	0	0	236
1930	0	1	17	20	49	53	26	52	45	11	0	0	274
1931	0	8	11	11	31	41	46	54	27	1	0	0	229
1932	0	5	18	41	56	69	78	46	18	9	0	0	340
1933	0	3	15	43	74	52	52	56	24	11	0	0	328
1934	0	12	13	8	56	56	13	31	28	2	0	0	218
1935	0	9	23	31	50	82	68	19	10	10	0	0	302
1936	0	6	12	18	41	33	23	25	13	6	0	0	178
1937	0	6	10	14	23	22	21	28	25	8	0	0	157
1938	0	16	25	44	60	33	26	39	29	8	0	0	280
1939	0	8	16	55	132	107	27	10	15	10	0	0	381
1940	0	13	37	39	56	63	24	25	35	12	0	0	305
1941	0	7	14	24	56	61	50	41	14	1	0	0	270
1942	0	11	35	37	84	86	61	68	37	15	0	0	434
1943	0	11	12	27	58	43	19	20	35	22	0	0	246
1944	0	10	10	33	65	62	55	34	14	6	0	0	289
1945	0	2	24	38	43	39	41	61	34	3	0	0	284
1946	0	3	6	10	33	48	54	50	27	9	0	0	239

1947	0	6	19	26	42	43	37	45	29	6	0	0	253
1948	0	6	25	45	49	59	48	12	1	1	0	0	244
1949	0	4	6	18	38	61	63	26	21	18	0	0	254
1950	0	14	23	19	46	63	53	37	19	9	0	0	282
1951	0	22	32	24	72	73	88	110	51	14	0	0	487
1952	0	15	17	29	64	65	54	41	15	1	0	0	300
1953	0	21	40	52	80	58	16	31	29	2	0	0	327
1954	0	24	40	45	72	75	82	92	49	8	0	0	487
1955	0	15	43	54	54	86	60	13	15	4	0	0	345
1956	0	6	12	27	76	77	33	20	25	16	0	0	291
1957	0	8	27	22	31	59	49	21	18	14	0	0	249
1958	0	6	15	15	20	41	51	38	17	2	0	0	206
1959	0	6	19	26	89	94	27	27	31	14	0	0	333
1960	0	3	22	32	46	50	48	31	8	7	0	0	247
1961	0	1	15	36	45	36	18	12	19	11	0	0	195
1962	0	11	14	19	55	92	63	22	29	18	0	0	322
1963	0	3	9	25	89	87	29	20	10	2	0	0	273
1964	0	5	17	35	54	40	28	55	36	0	0	0	270
1965	0	14	23	42	89	89	73	79	40	0	0	0	449
1966	0	2	21	31	73	84	50	32	8	5	0	0	305
1967	0	31	57	39	16	7	12	41	48	14	0	0	265
1968	0	3	7	18	31	29	36	52	34	7	0	0	217
1969	0	13	39	43	38	75	55	10	47	38	0	0	357
1970	0	14	32	31	87	95	23	17	27	13	0	0	339
1971	0	7	16	21	41	42	17	14	13	5	0	0	176
1972	0	5	14	51	72	47	24	36	32	5	0	0	284
1973	0	5	41	42	36	40	23	18	6	2	0	0	213
1974	0	17	34	77	80	49	72	50	9	2	0	0	389
1975	0	22	50	56	65	54	50	51	33	14	0	0	394
1976	0	24	28	14	84	94	41	23	4	2	0	0	314
1977	0	12	14	42	59	48	41	23	14	2	0	0	256
1978	0	3	27	52	53	45	30	38	37	9	0	0	293
1979	0	6	21	40	45	56	54	29	22	11	0	0	284
1980	0	5	9	16	69	83	46	32	27	16	0	0	303
1981	0	8	16	36	89	94	39	14	23	15	0	0	333
1982	0	16	22	63	71	76	94	49	31	13	0	0	435
1983	0	22	35	39	51	74	64	21	10	2	0	0	319
1984	0	9	15	21	49	41	15	39	41	11	0	0	240
1985	0	21	31	32	29	14	28	47	38	12	0	0	252
1986	0	7	13	71	89	57	42	66	74	18	0	0	437
AVERAGE	0	9	21	33	58	60	44	37	26	10	0	0	297

TABLE D19
PRECIPITATION
LAC PELLETIER
MONTHLY (mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
1912	0	2	6	40	68	56	59	48	29	16	0	0	323
1913	0	12	25	23	52	66	56	39	13	6	0	0	291
1914	0	13	17	10	48	48	18	39	52	25	0	0	269
1915	0	1	1	51	102	87	41	26	34	14	0	0	357
1916	0	19	27	36	77	108	93	51	35	16	0	0	463
1917	0	16	33	18	20	30	23	32	30	10	0	0	213
1918	0	6	13	11	19	31	39	27	19	13	0	0	177
1919	0	5	28	33	20	16	27	39	25	6	0	0	200
1920	0	9	17	33	58	68	44	20	28	18	0	0	295
1921	0	14	30	40	45	51	42	52	49	10	0	0	333
1922	0	2	11	35	60	59	61	43	9	2	0	0	281
1923	0	6	11	16	100	124	51	15	8	7	0	0	338
1924	0	10	20	35	61	59	55	39	34	26	0	0	339
1925	0	8	38	42	30	37	44	58	43	11	0	0	311
1926	0	2	3	22	49	41	46	51	22	4	0	0	241
1927	0	13	25	100	108	55	61	42	34	16	0	0	454
1928	0	3	11	18	67	86	39	12	11	9	0	0	256
1929	0	5	17	33	59	52	20	23	23	5	0	0	238
1930	0	2	18	21	50	53	26	54	46	11	0	0	281
1931	0	8	11	11	32	42	45	54	27	1	0	0	231
1932	0	6	19	39	54	73	83	47	18	9	0	0	347
1933	0	3	15	43	73	51	53	59	25	11	0	0	332
1934	0	11	12	8	57	59	14	31	28	2	0	0	222
1935	0	10	24	31	50	83	69	19	10	10	0	0	306
1936	0	7	13	18	41	34	23	25	14	6	0	0	181
1937	0	5	9	14	22	22	21	27	24	8	0	0	153
1938	0	16	25	43	59	33	26	39	29	9	0	0	279
1939	0	8	16	54	131	107	27	10	14	10	0	0	377
1940	0	12	35	37	55	63	24	25	35	12	0	0	298
1941	0	7	13	23	55	60	51	42	14	1	0	0	267
1942	0	10	35	38	85	88	61	67	38	16	0	0	438
1943	0	10	11	29	58	42	20	21	36	23	0	0	251
1944	0	10	11	36	67	63	56	34	14	6	0	0	296
1945	0	2	24	37	42	38	41	61	34	3	0	0	283
1946	0	2	6	10	34	50	56	50	27	10	0	0	246

1947	0	7	20	27	43	45	37	45	29	6	0	0	259
1948	0	6	26	44	47	59	48	12	1	1	0	0	244
1949	0	4	6	18	38	60	61	26	21	18	0	0	251
1950	0	13	23	20	47	67	58	37	19	9	0	0	293
1951	0	22	32	23	72	73	84	104	50	14	0	0	475
1952	0	15	17	29	66	66	54	41	15	1	0	0	304
1953	0	21	40	53	80	58	16	32	30	2	0	0	331
1954	0	23	39	46	74	77	82	90	49	8	0	0	488
1955	0	15	43	54	55	87	60	14	16	4	0	0	349
1956	0	6	12	26	74	76	34	21	26	16	0	0	289
1957	0	8	26	22	31	59	50	22	18	14	0	0	251
1958	0	7	16	16	20	41	52	38	17	3	0	0	209
1959	0	6	19	26	89	94	28	27	31	14	0	0	334
1960	0	4	22	32	47	51	49	32	7	6	0	0	249
1961	0	2	15	36	44	37	19	11	18	11	0	0	194
1962	0	10	14	19	54	91	64	22	28	18	0	0	320
1963	0	4	9	25	89	86	29	21	10	2	0	0	274
1964	0	5	17	34	54	40	28	55	37	1	0	0	269
1965	0	13	22	41	88	88	74	81	40	0	0	0	448
1966	0	2	21	31	73	83	50	32	8	5	0	0	305
1967	0	31	56	38	16	8	13	41	47	14	0	0	263
1968	0	3	7	18	31	29	36	51	34	7	0	0	216
1969	0	13	38	42	37	74	54	10	46	37	0	0	352
1970	0	13	32	31	91	99	23	17	27	13	0	0	346
1971	0	6	16	20	42	43	18	14	13	5	0	0	177
1972	0	5	13	49	72	47	24	36	32	5	0	0	282
1973	0	5	42	42	35	39	23	18	6	2	0	0	213
1974	0	17	34	76	78	48	73	53	9	2	0	0	389
1975	0	22	50	55	64	54	50	51	33	15	0	0	393
1976	0	25	29	15	84	94	41	23	4	1	0	0	315
1977	0	12	14	44	60	48	42	23	13	2	0	0	258
1978	0	2	27	52	53	45	29	38	36	8	0	0	291
1979	0	6	21	40	45	54	52	29	23	12	0	0	281
1980	0	5	9	15	66	80	46	31	28	16	0	0	298
1981	0	8	16	34	86	94	40	14	22	14	0	0	329
1982	0	15	22	60	69	77	93	48	30	13	0	0	429
1983	0	21	34	40	50	74	64	21	10	2	0	0	315
1984	0	9	15	20	48	40	15	38	41	11	0	0	237
1985	0	20	29	30	29	14	26	46	38	12	0	0	244
1986	0	7	14	71	89	56	41	65	73	18	0	0	434
AVERAGE	0	10	21	33	58	60	44	37	26	10	0	0	298

TABLE D20
PRECIPITATION
SWIFT CURRENT RESERVOIR
MONTHLY (mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
1912	0	1	6	48	78	65	61	45	23	9	0	0	336
1913	0	17	25	26	62	71	51	31	11	4	0	0	298
1914	0	10	15	7	32	39	16	34	59	32	0	0	244
1915	0	1	1	54	89	65	40	26	25	9	0	0	310
1916	0	24	32	28	72	119	99	51	33	14	0	0	470
1917	0	18	32	14	26	34	25	34	30	11	0	0	224
1918	0	12	26	19	26	37	31	25	26	17	0	0	219
1919	0	12	38	37	18	16	49	54	20	7	0	0	251
1920	0	4	10	33	54	55	40	26	26	14	0	0	262
1921	0	7	16	36	53	57	47	69	64	10	0	0	358
1922	0	2	11	50	102	74	37	27	6	3	0	0	312
1923	0	7	13	17	97	141	71	17	5	4	0	0	372
1924	0	6	7	36	67	60	60	40	43	35	0	0	354
1925	0	12	42	41	31	43	46	57	46	12	0	0	327
1926	0	4	6	35	63	61	77	59	22	8	0	0	335
1927	0	18	33	98	98	58	80	57	38	17	0	0	497
1928	0	8	16	14	67	96	40	7	12	10	0	0	270
1929	0	7	15	36	67	57	24	24	22	5	0	0	257
1930	0	2	25	30	58	59	27	53	48	14	0	0	316
1931	0	8	11	11	39	46	42	57	32	2	0	0	251
1932	0	7	25	28	44	109	124	52	13	9	0	0	412
1933	0	4	17	41	64	45	67	82	35	12	0	0	368
1934	0	7	8	6	67	80	24	30	28	3	0	0	253
1935	0	18	38	34	61	89	67	24	11	11	0	0	353
1936	0	12	19	22	49	42	28	29	17	8	0	0	225
1937	0	3	5	14	18	19	23	22	21	10	0	0	135
1938	0	15	22	32	55	43	33	41	33	11	0	0	285
1939	0	8	17	50	110	96	31	8	16	12	0	0	347
1940	0	7	24	29	51	61	24	23	29	9	0	0	257
1941	0	7	9	15	40	51	63	51	12	0	0	0	248
1942	0	5	36	41	93	107	61	61	43	19	0	0	466
1943	0	7	9	40	60	35	27	28	42	28	0	0	276
1944	0	14	14	57	83	70	65	29	16	9	0	0	357
1945	0	4	29	31	23	24	34	62	39	5	0	0	251
1946	0	2	6	14	41	61	68	56	33	15	0	0	296

1947	0	10	24	28	54	51	35	48	33	9	0	0	292
1948	0	8	34	35	32	62	50	11	1	1	0	0	234
1949	0	6	9	18	35	46	42	23	26	18	0	0	224
1950	0	11	22	22	53	110	96	39	22	12	0	0	388
1951	0	24	34	18	62	72	57	69	46	17	0	0	398
1952	0	14	15	28	75	73	55	46	19	3	0	0	328
1953	0	21	42	54	86	60	14	39	36	3	0	0	355
1954	0	16	32	56	92	96	82	82	52	9	0	0	516
1955	0	15	43	62	62	88	64	18	20	6	0	0	377
1956	0	4	8	21	63	68	38	27	28	16	0	0	274
1957	0	7	25	21	29	59	61	31	18	13	0	0	264
1958	0	8	20	19	22	41	60	45	16	4	0	0	234
1959	0	4	18	26	85	92	31	29	32	15	0	0	331
1960	0	3	22	33	53	61	61	41	4	3	0	0	281
1961	0	2	18	32	35	37	22	8	17	12	0	0	183
1962	0	7	10	22	49	81	67	29	28	16	0	0	308
1963	0	5	11	25	86	78	30	29	12	2	0	0	278
1964	0	6	15	27	45	36	30	62	42	1	0	0	263
1965	0	12	19	37	83	76	73	91	42	1	0	0	434
1966	0	3	23	30	76	83	49	35	9	6	0	0	312
1967	0	32	52	35	23	12	15	43	46	14	0	0	271
1968	0	2	5	18	28	28	43	55	34	7	0	0	219
1969	0	12	38	39	27	62	49	12	42	32	0	0	313
1970	0	7	27	33	120	129	25	21	31	15	0	0	408
1971	0	4	12	13	42	57	24	10	14	6	0	0	182
1972	0	4	11	35	61	50	24	37	36	6	0	0	265
1973	0	7	47	43	18	24	24	19	6	3	0	0	191
1974	0	17	32	65	60	33	88	74	12	3	0	0	384
1975	0	23	48	49	55	50	58	57	35	17	0	0	391
1976	0	27	32	19	77	88	46	23	3	1	0	0	316
1977	0	9	11	61	69	50	53	24	13	3	0	0	294
1978	0	1	28	53	56	37	16	38	35	6	0	0	270
1979	0	5	21	38	48	45	34	27	24	12	0	0	253
1980	0	5	10	12	47	74	51	30	33	21	0	0	283
1981	0	6	16	20	67	101	54	16	20	14	0	0	314
1982	0	14	20	50	65	75	77	42	29	11	0	0	381
1983	0	16	30	44	47	62	55	17	10	3	0	0	284
1984	0	7	13	15	47	49	21	39	41	12	0	0	243
1985	0	13	20	23	27	19	24	40	40	14	0	0	219
1986	0	7	15	72	90	51	34	57	62	14	0	0	403
AVERAGE	0	9	21	33	57	62	47	38	27	10	0	0	306

TABLE 021
PRECIPITATION
RESERVOIR 7B
MONTHLY (mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
1912	0	1	6	48	78	65	61	45	23	9	0	0	336
1913	0	17	25	26	62	71	51	31	11	4	0	0	298
1914	0	10	15	7	32	39	16	34	59	32	0	0	244
1915	0	1	1	54	89	65	40	26	25	9	0	0	310
1916	0	24	32	28	72	119	99	51	33	14	0	0	470
1917	0	18	32	14	26	34	25	34	30	11	0	0	224
1918	0	12	26	19	26	37	31	25	26	17	0	0	219
1919	0	12	38	37	18	16	49	54	20	7	0	0	251
1920	0	4	10	33	54	55	40	26	26	14	0	0	262
1921	0	7	16	36	53	57	47	69	64	10	0	0	358
1922	0	2	11	50	102	74	37	27	6	3	0	0	312
1923	0	7	13	17	97	141	71	17	5	4	0	0	372
1924	0	6	7	36	67	60	60	40	43	35	0	0	354
1925	0	12	42	41	31	43	46	57	46	12	0	0	327
1926	0	4	6	35	63	61	77	59	22	8	0	0	335
1927	0	18	33	98	98	58	80	57	38	17	0	0	497
1928	0	8	16	14	67	96	40	7	12	10	0	0	270
1929	0	7	15	36	67	57	24	24	22	5	0	0	257
1930	0	2	25	30	58	59	27	53	48	14	0	0	316
1931	0	8	11	11	39	46	42	57	32	2	0	0	251
1932	0	7	25	28	44	109	124	52	13	9	0	0	412
1933	0	4	17	41	64	45	67	82	35	12	0	0	368
1934	0	7	8	6	67	80	24	30	28	3	0	0	253
1935	0	18	38	34	61	89	67	24	11	11	0	0	353
1936	0	12	19	22	49	42	28	29	17	8	0	0	225
1937	0	3	5	14	18	19	23	22	21	10	0	0	135
1938	0	15	22	32	55	43	33	41	33	11	0	0	285
1939	0	8	17	50	110	96	31	8	16	12	0	0	347
1940	0	7	24	29	51	61	24	23	29	9	0	0	257
1941	0	7	9	15	40	51	63	51	12	0	0	0	248
1942	0	5	36	41	93	107	61	61	43	19	0	0	466
1943	0	7	9	40	60	35	27	28	42	28	0	0	276
1944	0	14	14	57	83	70	65	29	16	9	0	0	357
1945	0	4	29	31	23	24	34	62	39	5	0	0	251
1946	0	2	6	14	41	61	68	56	33	15	0	0	296

1947	0	10	24	28	54	51	35	48	33	9	0	0	292
1948	0	8	34	35	32	62	50	11	1	1	0	0	234
1949	0	6	9	18	35	46	42	23	26	18	0	0	224
1950	0	11	22	22	53	110	96	39	22	12	0	0	388
1951	0	24	34	18	62	72	57	69	46	17	0	0	398
1952	0	14	15	28	75	73	55	46	19	3	0	0	328
1953	0	21	42	54	86	60	14	39	36	3	0	0	355
1954	0	16	32	56	92	96	82	82	52	9	0	0	516
1955	0	15	43	62	62	88	64	18	20	6	0	0	377
1956	0	4	8	21	63	68	38	27	28	16	0	0	274
1957	0	7	25	21	29	59	61	31	18	13	0	0	264
1958	0	8	20	19	22	41	60	45	16	4	0	0	234
1959	0	4	18	26	85	92	31	29	32	15	0	0	331
1960	0	3	22	33	53	61	61	41	4	3	0	0	281
1961	0	2	18	32	35	37	22	8	17	12	0	0	183
1962	0	7	10	22	49	81	67	29	28	16	0	0	308
1963	0	5	11	25	86	78	30	29	12	2	0	0	278
1964	0	6	15	27	45	36	30	62	42	1	0	0	263
1965	0	12	19	37	83	76	73	91	42	1	0	0	434
1966	0	3	23	30	76	83	49	35	9	6	0	0	312
1967	0	32	52	35	23	12	15	43	46	14	0	0	271
1968	0	2	5	18	28	28	43	55	34	7	0	0	219
1969	0	12	38	39	27	62	49	12	42	32	0	0	313
1970	0	7	27	33	120	129	25	21	31	15	0	0	408
1971	0	4	12	13	42	57	24	10	14	6	0	0	182
1972	0	4	11	35	61	50	24	37	36	6	0	0	265
1973	0	7	47	43	18	24	24	19	6	3	0	0	191
1974	0	17	32	65	60	33	88	74	12	3	0	0	384
1975	0	23	48	49	55	50	58	57	35	17	0	0	391
1976	0	27	32	19	77	88	46	23	3	1	0	0	316
1977	0	9	11	61	69	50	53	24	13	3	0	0	294
1978	0	1	28	53	56	37	16	38	35	6	0	0	270
1979	0	5	21	38	48	45	34	27	24	12	0	0	253
1980	0	5	10	12	47	74	51	30	33	21	0	0	283
1981	0	6	16	20	67	101	54	16	20	14	0	0	314
1982	0	14	20	50	65	75	77	42	29	11	0	0	381
1983	0	16	30	44	47	62	55	17	10	3	0	0	284
1984	0	7	13	15	47	49	21	39	41	12	0	0	243
1985	0	13	20	23	27	19	24	40	40	14	0	0	219
1986	0	7	15	72	90	51	34	57	62	14	0	0	403
AVERAGE	0	9	21	33	57	62	47	38	27	10	0	0	306

TABLE D22
PRECIPITATION
RESERVOIR RL1
MONTHLY (mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
1912	0	1	6	48	78	65	61	45	23	9	0	0	336
1913	0	17	25	26	62	71	51	31	11	4	0	0	298
1914	0	10	15	7	32	39	16	34	59	32	0	0	244
1915	0	1	1	54	89	65	40	26	25	9	0	0	310
1916	0	24	32	28	72	119	99	51	33	14	0	0	470
1917	0	18	32	14	26	34	25	34	30	11	0	0	224
1918	0	12	26	19	26	37	31	25	26	17	0	0	219
1919	0	12	38	37	18	16	49	54	20	7	0	0	251
1920	0	4	10	33	54	55	40	26	26	14	0	0	262
1921	0	7	16	36	53	57	47	69	64	10	0	0	358
1922	0	2	11	50	102	74	37	27	6	3	0	0	312
1923	0	7	13	17	97	141	71	17	5	4	0	0	372
1924	0	6	7	36	67	60	60	40	43	35	0	0	354
1925	0	12	42	41	31	43	46	57	46	12	0	0	327
1926	0	4	6	35	63	61	77	59	22	8	0	0	335
1927	0	18	33	98	98	58	80	57	38	17	0	0	497
1928	0	8	16	14	67	96	40	7	12	10	0	0	270
1929	0	7	15	36	67	57	24	24	22	5	0	0	257
1930	0	2	25	30	58	59	27	53	48	14	0	0	316
1931	0	8	11	11	39	46	42	57	32	2	0	0	251
1932	0	7	25	28	44	109	124	52	13	9	0	0	412
1933	0	4	17	41	64	45	67	82	35	12	0	0	368
1934	0	7	8	6	67	80	24	30	28	3	0	0	253
1935	0	18	38	34	61	89	67	24	11	11	0	0	353
1936	0	12	19	22	49	42	28	29	17	8	0	0	225
1937	0	3	5	14	18	19	23	22	21	10	0	0	135
1938	0	15	22	32	55	43	33	41	33	11	0	0	285
1939	0	8	17	50	110	96	31	8	16	12	0	0	347
1940	0	7	24	29	51	61	24	23	29	9	0	0	257
1941	0	7	9	15	40	51	63	51	12	0	0	0	248
1942	0	5	36	41	93	107	61	61	43	19	0	0	466
1943	0	7	9	40	60	35	27	28	42	28	0	0	276
1944	0	14	14	57	83	70	65	29	16	9	0	0	357
1945	0	4	29	31	23	24	34	62	39	5	0	0	251
1946	0	2	6	14	41	61	68	56	33	15	0	0	296

1947	0	10	24	28	54	51	35	48	33	9	0	0	292
1948	0	8	34	35	32	62	50	11	1	1	0	0	234
1949	0	6	9	18	35	46	42	23	26	18	0	0	224
1950	0	11	22	22	53	110	96	39	22	12	0	0	388
1951	0	24	34	18	62	72	57	69	46	17	0	0	398
1952	0	14	15	28	75	73	55	46	19	3	0	0	328
1953	0	21	42	54	86	60	14	39	36	3	0	0	355
1954	0	16	32	56	92	96	82	82	52	9	0	0	516
1955	0	15	43	62	62	88	64	18	20	6	0	0	377
1956	0	4	8	21	63	68	38	27	28	16	0	0	274
1957	0	7	25	21	29	59	61	31	18	13	0	0	264
1958	0	8	20	19	22	41	60	45	16	4	0	0	234
1959	0	4	18	26	85	92	31	29	32	15	0	0	331
1960	0	3	22	33	53	61	61	41	4	3	0	0	281
1961	0	2	18	32	35	37	22	8	17	12	0	0	183
1962	0	7	10	22	49	81	67	29	28	16	0	0	308
1963	0	5	11	25	86	78	30	29	12	2	0	0	278
1964	0	6	15	27	45	36	30	62	42	1	0	0	263
1965	0	12	19	37	83	76	73	91	42	1	0	0	434
1966	0	3	23	30	76	83	49	35	9	6	0	0	312
1967	0	32	52	35	23	12	15	43	46	14	0	0	271
1968	0	2	5	18	28	28	43	55	34	7	0	0	219
1969	0	12	38	39	27	62	49	12	42	32	0	0	313
1970	0	7	27	33	120	129	25	21	31	15	0	0	408
1971	0	4	12	13	42	57	24	10	14	6	0	0	182
1972	0	4	11	35	61	50	24	37	36	6	0	0	265
1973	0	7	47	43	18	24	24	19	6	3	0	0	191
1974	0	17	32	65	60	33	88	74	12	3	0	0	384
1975	0	23	48	49	55	50	58	57	35	17	0	0	391
1976	0	27	32	19	77	88	46	23	3	1	0	0	316
1977	0	9	11	61	69	50	53	24	13	3	0	0	294
1978	0	1	28	53	56	37	16	38	35	6	0	0	270
1979	0	5	21	38	48	45	34	27	24	12	0	0	253
1980	0	5	10	12	47	74	51	30	33	21	0	0	283
1981	0	6	16	20	67	101	54	16	20	14	0	0	314
1982	0	14	20	50	65	75	77	42	29	11	0	0	381
1983	0	16	30	44	47	62	55	17	10	3	0	0	284
1984	0	7	13	15	47	49	21	39	41	12	0	0	243
1985	0	13	20	23	27	19	24	40	40	14	0	0	219
1986	0	7	15	72	90	51	34	57	62	14	0	0	403
AVERAGE	0	9	21	33	57	62	47	38	27	10	0	0	306

TABLE D23
PRECIPITATION
HIGHFIELD RESERVOIR
MONTHLY (mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
1912	0	2	6	50	75	62	68	55	28	8	0	0	353
1913	0	12	18	18	48	62	56	34	12	7	0	0	267
1914	0	11	20	14	39	43	16	28	46	27	0	0	244
1915	0	1	4	56	92	69	41	27	25	8	0	0	325
1916	0	23	29	26	74	121	94	47	36	18	0	0	468
1917	0	11	27	17	40	47	26	34	29	13	0	0	243
1918	0	18	32	27	31	39	34	21	19	11	0	0	232
1919	0	10	26	40	48	37	49	45	20	10	0	0	284
1920	0	9	22	40	60	63	48	26	21	12	0	0	301
1921	0	9	20	34	44	50	49	74	65	12	0	0	357
1922	0	5	15	47	69	52	44	26	7	5	0	0	270
1923	0	7	13	29	90	117	72	24	5	4	0	0	360
1924	0	5	19	41	64	64	61	42	36	29	0	0	361
1925	0	7	30	38	43	49	38	50	40	7	0	0	303
1926	0	5	8	38	56	48	68	60	25	6	0	0	314
1927	0	23	35	90	92	54	66	45	36	17	0	0	458
1928	0	8	16	15	74	102	39	8	12	9	0	0	282
1929	0	8	18	34	49	43	23	18	20	6	0	0	219
1930	0	2	24	33	52	49	26	42	37	14	0	0	279
1931	0	7	10	12	38	41	42	54	27	2	0	0	234
1932	0	7	21	23	52	113	115	50	19	14	0	0	415
1933	0	3	15	40	58	38	58	73	32	9	0	0	326
1934	0	7	8	8	67	75	23	28	22	3	0	0	241
1935	0	18	29	34	68	77	59	30	13	10	0	0	338
1936	0	12	16	26	52	38	24	26	15	5	0	0	213
1937	0	3	6	16	23	28	28	19	16	7	0	0	145
1938	0	12	21	35	50	36	29	34	29	12	0	0	258
1939	0	6	14	38	94	84	24	7	14	11	0	0	292
1940	0	7	23	28	50	59	24	19	24	7	0	0	242
1941	0	7	10	18	39	50	64	48	11	2	0	0	249
1942	0	6	36	40	86	97	53	56	37	13	0	0	422
1943	0	8	9	38	55	31	42	40	37	26	0	0	286
1944	0	14	16	50	82	71	57	27	12	6	0	0	334
1945	0	6	27	29	29	29	28	54	41	8	0	0	251
1946	0	1	6	15	40	65	63	44	32	14	0	0	281

1947	0	7	20	27	64	63	44	54	29	5	0	0	316
1948	0	8	27	27	25	58	56	18	3	1	0	0	222
1949	0	6	7	18	37	44	35	19	23	17	0	0	206
1950	0	10	19	23	52	92	78	33	17	8	0	0	331
1951	0	19	30	16	60	70	61	74	41	13	0	0	384
1952	0	11	11	21	58	70	56	38	17	2	0	0	285
1953	0	16	37	54	86	64	25	39	32	5	0	0	359
1954	0	14	27	47	75	83	89	84	43	6	0	0	469
1955	0	12	51	73	57	87	69	17	17	4	0	0	387
1956	0	5	9	24	58	61	37	23	23	15	0	0	255
1957	0	6	23	21	28	53	48	25	18	12	0	0	234
1958	0	6	16	15	20	43	55	38	17	6	0	0	216
1959	0	5	16	22	73	81	29	39	45	16	0	0	326
1960	0	3	19	29	63	71	49	29	2	2	0	0	266
1961	0	2	18	34	39	32	15	7	17	14	0	0	178
1962	0	8	11	18	49	84	87	47	26	15	0	0	345
1963	0	5	11	26	99	98	46	40	15	3	0	0	343
1964	0	6	14	25	41	37	30	45	31	1	0	0	230
1965	0	12	19	42	80	66	55	69	36	1	0	0	381
1966	0	2	24	33	60	71	59	39	8	5	0	0	301
1967	0	31	48	27	25	20	20	55	55	15	0	0	296
1968	0	2	5	17	31	32	47	59	32	5	0	0	230
1969	0	11	31	30	29	71	54	16	52	38	0	0	332
1970	0	10	31	35	100	101	21	21	25	8	0	0	352
1971	0	7	15	15	36	53	28	13	15	5	0	0	187
1972	0	6	15	40	61	49	35	43	33	8	0	0	289
1973	0	6	49	54	35	32	28	26	11	3	0	0	245
1974	0	17	31	66	60	26	84	75	14	5	0	0	378
1975	0	23	45	44	60	60	55	52	32	14	0	0	383
1976	0	21	28	17	69	89	49	22	4	1	0	0	299
1977	0	12	13	56	68	46	44	24	18	4	0	0	285
1978	0	1	20	52	67	48	25	51	47	6	0	0	317
1979	0	3	16	36	42	42	33	17	22	13	0	0	225
1980	0	7	13	11	40	66	46	29	25	12	0	0	248
1981	0	6	12	17	64	92	48	19	23	13	0	0	294
1982	0	18	25	61	72	61	61	36	28	11	0	0	372
1983	0	16	25	31	37	66	60	27	20	3	0	0	285
1984	0	9	15	16	43	44	20	42	43	11	0	0	243
1985	0	14	23	26	28	23	28	37	37	17	0	0	233
1986	0	5	16	67	79	49	35	55	55	9	0	0	370
AVERAGE	0	9	20	33	56	60	47	37	26	10	0	0	298

TABLE D24
PRECIPITATION
HERBERT RESERVOIR
MONTHLY (mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
1912	0	2	6	50	75	61	70	58	29	8	0	0	358
1913	0	11	17	17	45	61	57	35	12	8	0	0	263
1914	0	11	21	15	41	44	16	27	45	26	0	0	245
1915	0	1	5	57	93	70	42	27	25	8	0	0	328
1916	0	22	29	26	75	121	92	45	37	18	0	0	467
1917	0	10	26	18	42	49	26	34	30	13	0	0	247
1918	0	19	33	28	32	40	35	20	18	10	0	0	235
1919	0	9	24	40	53	42	48	43	20	11	0	0	290
1920	0	10	24	42	60	65	50	27	20	12	0	0	310
1921	0	9	21	33	42	48	50	75	65	12	0	0	358
1922	0	5	16	47	63	49	46	26	7	6	0	0	265
1923	0	7	12	31	89	113	73	26	5	4	0	0	359
1924	0	4	22	42	63	64	61	43	35	28	0	0	362
1925	0	7	28	37	45	49	36	48	39	7	0	0	297
1926	0	5	8	39	55	45	65	60	26	5	0	0	308
1927	0	23	35	89	92	53	62	41	35	17	0	0	448
1928	0	8	16	15	76	102	38	8	12	8	0	0	284
1929	0	8	19	34	45	40	22	17	19	7	0	0	211
1930	0	2	24	33	51	48	26	40	35	14	0	0	272
1931	0	7	10	12	38	40	42	54	26	2	0	0	231
1932	0	7	21	22	54	113	112	49	20	15	0	0	414
1933	0	3	14	40	57	37	55	71	32	8	0	0	316
1934	0	7	8	8	67	74	23	28	21	3	0	0	239
1935	0	18	28	34	69	74	57	31	13	10	0	0	333
1936	0	12	16	27	52	37	22	24	14	4	0	0	209
1937	0	3	6	17	23	30	29	18	15	6	0	0	147
1938	0	12	21	36	49	34	28	32	29	12	0	0	252
1939	0	6	13	36	91	81	22	7	14	11	0	0	280
1940	0	7	23	28	50	58	24	19	23	7	0	0	239
1941	0	7	11	18	39	50	64	48	11	2	0	0	250
1942	0	6	36	40	84	95	50	54	36	12	0	0	413
1943	0	8	9	38	54	31	47	44	37	26	0	0	292
1944	0	14	17	49	82	70	55	26	11	5	0	0	329
1945	0	6	26	28	30	29	27	52	41	9	0	0	249
1946	0	1	6	15	40	66	62	42	32	14	0	0	279

1947	0	7	20	27	67	66	46	56	29	5	0	0	321
1948	0	7	26	25	24	58	57	18	3	1	0	0	219
1949	0	5	6	18	37	43	35	18	23	17	0	0	203
1950	0	10	18	23	51	89	76	32	16	8	0	0	322
1951	0	18	29	16	60	70	62	75	40	12	0	0	382
1952	0	10	11	20	55	69	56	37	17	2	0	0	277
1953	0	15	36	55	86	65	26	39	31	5	0	0	359
1954	0	13	25	45	72	82	92	85	42	6	0	0	463
1955	0	11	51	74	56	86	69	17	16	4	0	0	385
1956	0	5	9	24	57	59	36	22	22	15	0	0	249
1957	0	6	23	20	28	52	46	24	18	12	0	0	230
1958	0	5	16	14	20	43	55	37	17	7	0	0	213
1959	0	5	16	22	71	79	29	41	48	16	0	0	328
1960	0	3	18	28	65	72	47	27	2	2	0	0	263
1961	0	2	18	34	40	32	13	6	17	14	0	0	177
1962	0	9	10	18	49	84	91	51	25	14	0	0	351
1963	0	5	11	26	102	101	48	42	16	3	0	0	353
1964	0	7	14	25	40	37	29	42	29	1	0	0	225
1965	0	12	19	43	79	65	52	66	35	1	0	0	372
1966	0	2	25	33	57	70	61	40	8	5	0	0	300
1967	0	31	48	26	26	23	21	57	57	15	0	0	303
1968	0	2	5	17	32	32	48	60	32	5	0	0	233
1969	0	10	29	28	29	73	55	17	54	39	0	0	334
1970	0	11	31	36	97	97	20	21	23	7	0	0	344
1971	0	7	16	15	35	53	28	14	15	5	0	0	188
1972	0	6	16	40	61	49	37	43	32	8	0	0	291
1973	0	6	49	56	37	34	29	28	11	3	0	0	253
1974	0	17	30	66	61	25	84	76	14	5	0	0	378
1975	0	23	45	43	60	61	55	51	31	13	0	0	382
1976	0	20	27	17	68	89	49	22	4	1	0	0	297
1977	0	12	14	56	68	45	43	25	19	4	0	0	284
1978	0	1	19	52	68	50	27	53	48	6	0	0	323
1979	0	3	15	36	41	42	33	16	22	14	0	0	220
1980	0	7	13	10	39	65	46	29	24	10	0	0	243
1981	0	5	11	16	64	91	47	20	24	13	0	0	291
1982	0	19	26	63	73	58	58	35	27	11	0	0	371
1983	0	15	24	29	36	67	62	29	22	3	0	0	286
1984	0	9	16	17	42	43	21	43	43	10	0	0	244
1985	0	14	24	27	28	23	29	37	37	18	0	0	237
1986	0	4	16	66	77	49	36	55	53	8	0	0	363
AVERAGE	0	9	20	33	56	60	47	37	26	10	0	0	296

TABLE D25
PRECIPITATION
REED LAKE
MONTHLY (mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
1912	0	2	5	50	74	61	74	62	30	8	0	0	366
1913	0	10	14	15	41	58	59	36	13	9	0	0	255
1914	0	11	22	16	43	45	17	26	41	25	0	0	245
1915	0	1	5	58	94	72	42	28	25	8	0	0	334
1916	0	22	28	26	76	122	90	43	39	20	0	0	465
1917	0	8	25	18	46	53	26	34	30	14	0	0	253
1918	0	20	35	31	33	42	37	18	15	8	0	0	241
1919	0	9	20	41	62	49	48	39	19	12	0	0	299
1920	0	11	27	44	62	68	55	28	19	12	0	0	325
1921	0	10	22	33	40	46	52	78	66	13	0	0	359
1922	0	6	17	46	53	44	50	25	8	6	0	0	255
1923	0	7	12	34	86	105	74	29	5	4	0	0	356
1924	0	4	25	43	62	65	62	44	33	27	0	0	365
1925	0	5	25	36	49	51	32	45	37	6	0	0	286
1926	0	5	9	40	52	40	61	59	27	4	0	0	298
1927	0	25	36	87	90	51	54	35	35	17	0	0	431
1928	0	8	16	15	78	104	37	8	12	8	0	0	287
1929	0	8	20	33	40	36	22	15	19	7	0	0	199
1930	0	2	24	34	50	45	25	36	32	14	0	0	261
1931	0	6	9	12	38	38	42	54	25	3	0	0	226
1932	0	7	19	20	56	113	108	48	22	17	0	0	411
1933	0	3	13	40	55	35	51	66	31	7	0	0	300
1934	0	7	8	9	67	72	22	28	20	2	0	0	235
1935	0	18	26	35	71	68	53	33	13	9	0	0	325
1936	0	12	15	28	53	36	20	22	14	3	0	0	204
1937	0	3	7	17	24	34	31	17	14	5	0	0	152
1938	0	11	20	37	48	32	26	30	28	13	0	0	243
1939	0	5	12	32	87	76	19	6	13	10	0	0	261
1940	0	7	23	28	49	58	24	18	21	7	0	0	235
1941	0	7	11	19	39	50	64	47	11	2	0	0	251
1942	0	6	36	40	82	91	46	52	34	10	0	0	398
1943	0	8	9	38	52	30	55	50	35	26	0	0	303
1944	0	14	17	47	82	69	51	26	10	4	0	0	320
1945	0	7	26	27	32	31	24	49	42	10	0	0	247
1946	0	1	6	16	39	67	60	39	32	14	0	0	274

1947	0	6	18	27	70	70	49	58	28	4	0	0	330
1948	0	7	23	23	21	57	59	20	4	1	0	0	215
1949	0	5	6	17	37	43	33	17	23	17	0	0	197
1950	0	9	17	23	50	83	71	31	15	7	0	0	305
1951	0	16	28	16	60	69	63	77	38	11	0	0	378
1952	0	9	10	18	50	67	56	35	16	2	0	0	264
1953	0	14	34	55	87	67	29	39	30	5	0	0	360
1954	0	12	22	43	67	79	96	86	39	5	0	0	451
1955	0	10	52	76	55	85	69	17	15	3	0	0	383
1956	0	5	10	25	55	56	35	20	20	14	0	0	241
1957	0	5	22	20	29	51	43	23	18	12	0	0	223
1958	0	5	14	13	19	44	53	35	17	7	0	0	208
1959	0	5	15	21	68	77	29	45	52	17	0	0	329
1960	0	3	16	26	68	75	43	23	1	1	0	0	258
1961	0	2	18	35	41	31	11	6	18	14	0	0	175
1962	0	9	10	17	49	84	96	57	25	14	0	0	361
1963	0	5	10	26	106	107	52	45	17	3	0	0	371
1964	0	7	14	25	39	38	29	38	26	1	0	0	216
1965	0	12	19	44	78	62	47	59	34	1	0	0	356
1966	0	2	25	33	52	67	64	42	7	4	0	0	297
1967	0	30	46	24	27	26	23	61	60	15	0	0	313
1968	0	3	5	17	33	34	49	61	32	5	0	0	238
1969	0	10	27	25	29	75	56	19	57	40	0	0	339
1970	0	12	33	36	91	89	19	21	22	5	0	0	329
1971	0	8	17	15	33	52	29	15	16	5	0	0	190
1972	0	6	16	42	61	48	40	44	31	9	0	0	297
1973	0	6	50	59	42	36	30	30	13	4	0	0	269
1974	0	17	30	66	61	23	84	77	14	5	0	0	377
1975	0	23	44	41	61	63	54	50	30	12	0	0	379
1976	0	18	25	16	66	89	50	22	5	1	0	0	293
1977	0	13	14	54	67	44	40	25	20	5	0	0	283
1978	0	1	16	51	71	54	29	56	51	6	0	0	336
1979	0	3	13	35	39	41	34	15	21	14	0	0	214
1980	0	7	14	10	37	63	45	29	21	8	0	0	233
1981	0	5	10	15	62	88	45	21	25	13	0	0	285
1982	0	20	28	67	75	55	54	33	27	10	0	0	369
1983	0	15	23	24	33	68	64	33	25	3	0	0	288
1984	0	9	16	17	41	42	21	44	44	10	0	0	244
1985	0	14	25	28	29	24	31	36	36	19	0	0	243
1986	0	4	15	64	74	49	36	54	51	6	0	0	353